THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
DEPARTMENT OF HOUSING AND URBAN PLANNING (DHUP)
OF MINISTRY OF PUBLIC WORKS AND TRANSPORT,
DEPARTMENT OF PUBLIC WORKS AND TRANSPORT (DPWT)
OF VIENTIANE CAPITAL,
VIENTIANE CAPITAL WATER SUPPLY STATE ENTERPRISE (NPNL)

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

THE PREPARATORY SURVEY ON VIENTIANE CAPITAL WATER SUPPLY EXPANSION PROJECT

FINAL REPORT

JUNE 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIHON SUIDO CONSULTANTS CO., LTD.

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EXCHANGE RATE

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1USD = 120.4 JPY

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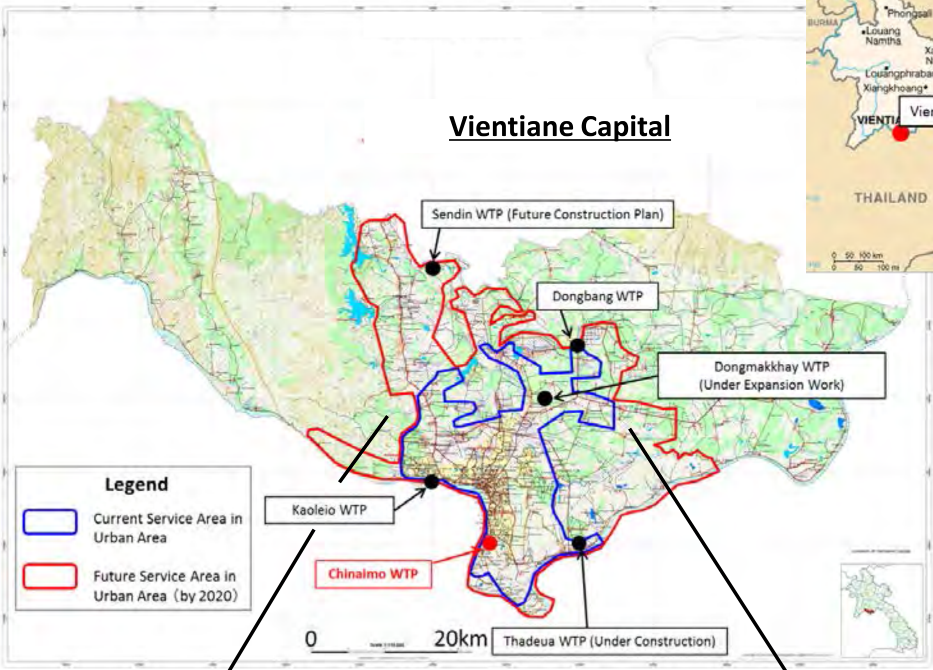
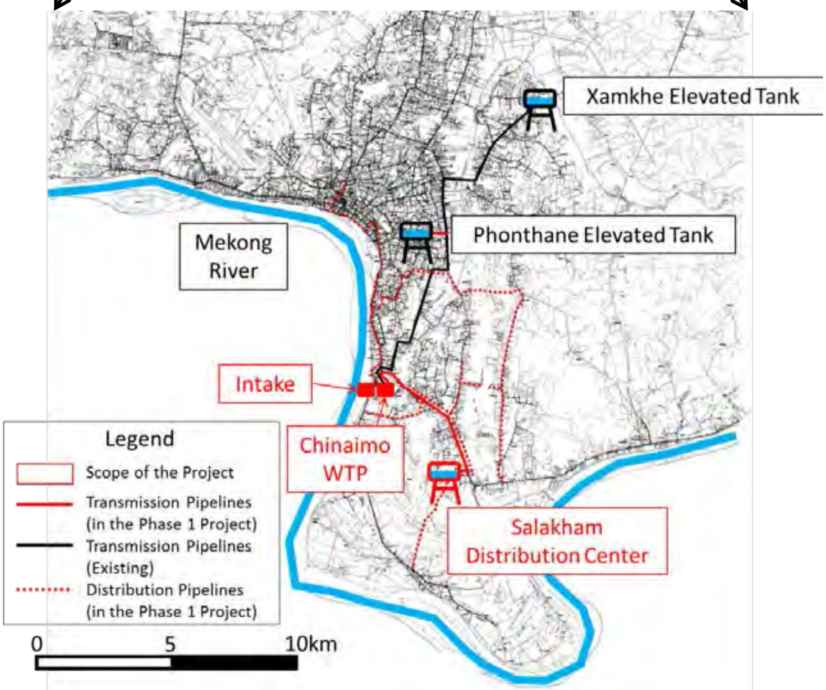
1LAK = 0.0149 JPY

STUDY AREA LOCATION MAP

Lao PDR



The Location of Vientiane Capital Water Supply Expansion Project



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ABBREVIATIONS

ADB	Asian Development Bank
AfD	French Development Agency
DBB	Design Bid Build
DEWATS	Decentralized Wastewater Treatment System
DF/R	Draft Final Report
DHUP	Department of Housing and Urban Planning
DIP	Ductile Iron Pipe
DONRE	Department of Natural Resources and Environment
DPWT	Department of Public Works and Transport
EA	Executing Agency
ECC	Environmental Compliance Certificate
EDL	Electricite du Laos
EIRR	Economic Internal Rate of Return
EIA	Environment Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESS	Environmental and Social Staff
ET	Elevated Tank
FIRR	Financial Internal Rate of Return
F/R	Final Report
F/S	Feasibility Study
GOJ	Government of Japan
GOL	Government of the Lao PDR
GSCP	Grass Fiber Coated Pipe
GSP	Galvanized Steel Pipe
HDPE	High Density Polyethylene Pipe
ICB	International Competitive Bidding
IC/R	Inception Report
IEE	Initial Environmental Examination
IT/R	Interim Report
JICA	Japan International Cooperation Agency
JST	JICA Study Team
Lao PDR	Lao People’s Democratic Republic
LCB	Local Competitive Bidding
LCC	Life Cycle Cost
MAWASU	Management Ability of Water Supply Authority
M/D	Minutes of Discussion
MOD	Ministry of Defense
MOH	Ministry of Health
MONRE	Ministry of Natural Resources and Environment
M/P	Master Plan
MPWT	Ministry of Public Works and Transport
NGPES	National Growth and Poverty Eradication Strategy
NPNL	Vientiane Capital Water Supply State Enterprise
NRW	Non-Revenue Water
NTU	Nephelometric Turbidity Unit
ODA	Official Development Assistance
O&M	Operation and Maintenance
PNP	Water Supply State Enterprises (i.e. Provincial Nam Papa)

PNP-LP	Luang Prabang Provincial Water Supply State Enterprise
PNP-KM	Khammouane Provincial Water Supply State Enterprise
PMU	Project Management Unit
PVC	Polyvinyl Chloride
RPM	Rotation per Minute
SP	Steel Pipe
UDM/P 2011	The Project for Urban Development Master Plan in Vientiane Capital in 2011 (a urban development master plan in Vientiane Capital prepared in 2011 with support by JICA)
uPVC	Un-plasticized Polyvinyl Chloride
VC	Vientiane Capital
WACC	Weighted Average Cost of Capital
WaSRO	Water Supply Regulatory Office
WB	World Bank
WSM/P 2004	The Study on Vientiane Water Supply Development Project in 2004 (a water supply master plan in Vientiane Capital prepared in 2004 with support by JICA)
WSM/P 2014	NPNL Water Supply Assets Master Plan in 2014 (a water supply master plan in Vientiane Capital prepared in 2014 with support by AfD)
WTP	Water Treatment Plant

Chapter 1 INTRODUCTION

1.1 Background of the Survey

In Vientiane Capital, the capital of the Lao People's Democratic Republic (hereafter referred to as the Lao PDR), the population and industry of the urban area are steadily growing in line with economic growth. The development of social infrastructure is not catching up with the growth, and in particular, maintenance and expansion of water utilities is an urgent task. The population in 2013 was approximately 854,000 and it is expected to reach one million in 2020.

There are nine (9) districts in Vientiane Capital. Among them, design service area by piped water is mainly urban area of seven (7) districts (i.e. the entire area of four (4) districts and part of three (3) districts). In the area, the four (4) main water treatment plants, WTPs (i.e. Chinaimo WTP, Kaoleio WTP, Dongmakkhay WTP, and Dongban WTP) exist with a total design capacity of 180,000m^3/day, and the water supply coverage ratio was 72% in 2013. However, recent data records show they have produced, on average, over 199,000 m3/day in 2013. This implies some plants were forced into over load operation recently. Also, the latest water demand projection shows the need for water production of over 400,000 m3/day in 2030 due to rapid population and industry growth. Under such circumstances, improvement of water supply volume is urgently required for better living conditions in Vientiane Capital.

On the other hand, support to the water supply sector in Vientiane Capital has been provided by the Government of Japan (GOJ) for approximately 50 years, starting from the construction of Kaolieo Water Treatment Plant in 1964. Other support includes "Vientiane Water Supply System Improvement Project (1992-1996)" that was the expansion and rehabilitation of Chinaimo Water Treatment Plant, and "Vientiane water supply development project (2006-2009)" that was the expansion of Kaolieo Plant and the improvement of Chinaimo Plant. The GOJ also implements various Technical Cooperation Projects (TCPs) including the currently ongoing "The Capacity Building Project for Improvement of Management Ability of Water Supply Authorities[1]".

Under these situations, the Lao side of: Department of Housing and Urban Planning (DHUP), Department of Public Works and Transport (DPWT), and Vientiane Capital Water Supply State Enterprise (NPNL), and the Japan International Cooperation Agency (JICA) reached a consensus for conducting a feasibility study (F/S) for the expansion of Chinaimo Water Treatment Plant (WTP) as a candidate for a Japanese loan project.

1.2 Objective of the Survey and Survey Area

1.2.1 Objectives of the Survey

The objective of this survey is to conduct an F/S for Vientiane Capital water supply system expansion including Chinaimo WTP expansion in order to carry out safe and stable water supply service to the residents of Vientiane Capital. The survey carried out based on the agreement between the GOL and the Japan International Cooperation Agency (JICA), as

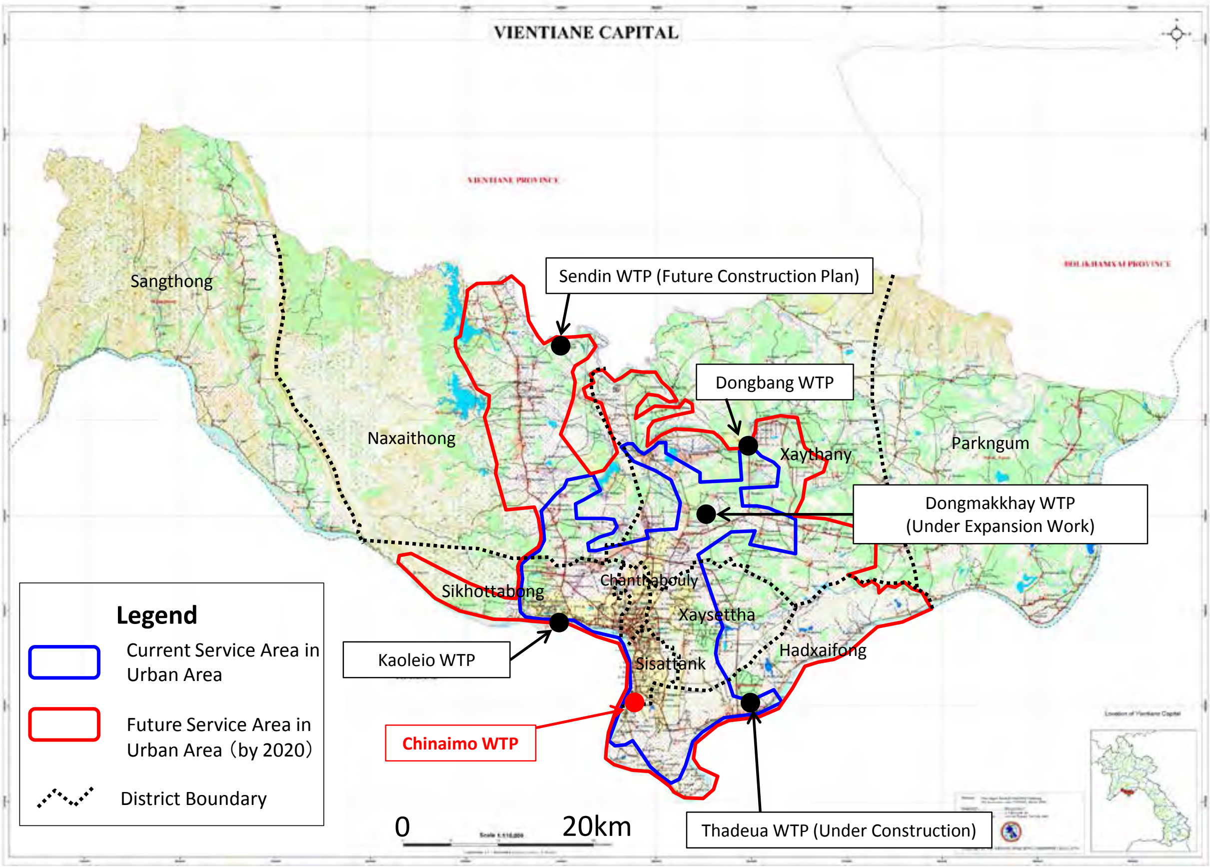
1 Technical guidance to the staff for water supply state enterprise in Vientiane Capital, Luang Prabang Province, and Khammouane Province.

stated in the M/M on 21st February, 2014 (see Attachment 1). The final report took the following plans into consideration:

- NPNL Water Supply Assets Mater Plan in 2014 (WSM/P 2014)
- The Study on Vientiane Water Supply Development Project in 2004 (WSM/P 2004)
- NPNL Long Term Plan (2014-2020)
- The Project for Urban Development Master Plan Study in Vientiane Capital in 2011 (UDM/P 2011)

1.2.2 Survey Area

This survey covered Vientiane Capital, and especially aimed at in the current water supply service areas and future service areas to be expanded by 2020 in urban area of Vientiane Capital, which are shown in Figure 1.2.1, "Areas of the Survey".



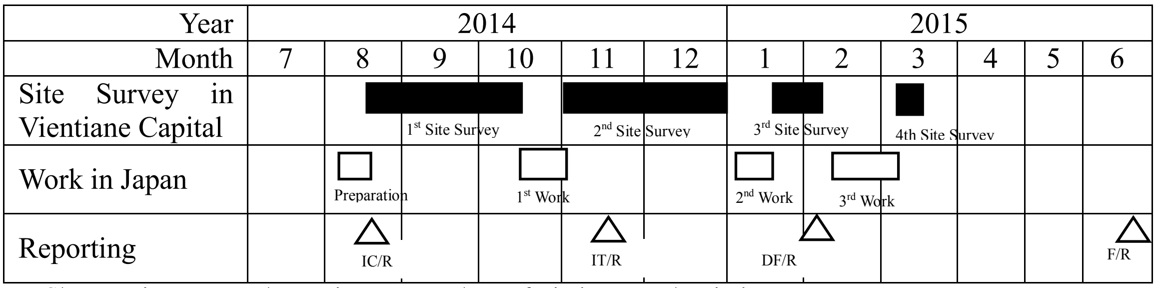
Source: JST

Figure 1.2.1 Areas of the Survey

1.3 Survey Schedule and Work Items

1.3.1 Survey Schedule

The survey will be implemented by Site Surveys in Vientiane Capital and Works in Japan as shown in Figure 1.3.1.



IC/R: Inception Report, IT/R: Interim Report, DF/R: Draft Final Report, F/R: Final Report

Figure 1.3.1 Survey Schedule

1.3.2 Work Items to be carried out

Preparation Work in Japan

(1) Collection and Analysis of the Existing Information and Data
(2) Preparation of Inception Report (IC/R)

1st Site Survey in Vientiane Capital

(3) Explanation and Discussions on Inception Report (IC/R)
(4) Examination of Project Framework

1st Work in Japan

(5) Preparation of Interim Report (IT/R)

2nd Site Survey in Vientiane Capital

(6) Explanation and Discussion on IT/R
(7) Formulation of Facility Plan
(8) Confirmation and Proposal for Sewerage and Drainage Plan
(9) Outline Design for Facilities
(10) Cost Estimation
(11) Formulation of Construction Plan
(12) Formulation of Implementation Plan
(13) Consideration of Project Effect
(14) Economic and Financial Analysis
(15) Examination of Technical Assistance and Cooperation
(16) Recommendation

2nd Work in Japan

(17) Preparation of Draft Final Report (DF/R)

3rd Site Survey in Vientiane Capital: Explanation of Draft Final Report

(18) Explanation and Discussion for DF/R

3rd Work in Japan: Preparation of Final Report

(19) Preparation and Submission of Final Report (F/R)

4th Site Survey in Vientiane Capital: Study for Life Cycle Cost Evaluation in Bidding

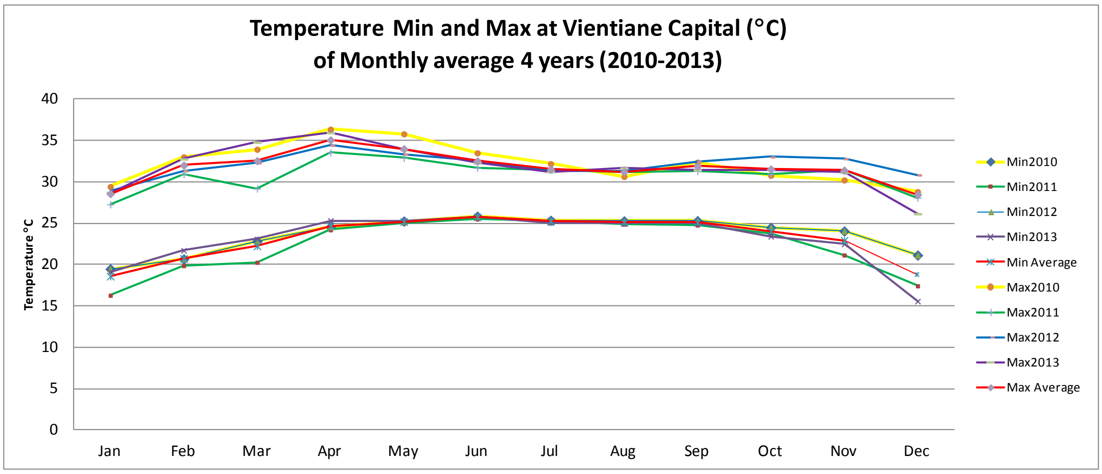
(20) Study for Life Cycle Cost Evaluation in Bidding for the Project

Chapter 2 PRESENT CONDITIONS OF THE SURVEY AREA

2.1 Natural Conditions

2.1.1 Meteorology

The climate in the Vientiane Capital is categorized as Southeast Asia tropical monsoon climate. It has two distinct seasons, monsoon (rainy) season and dry season. The monsoon season is from May to October and the dry season is from November to April. The temperature in Vientiane Capital from January 2010 to December 2013 is shown in Figure 2.1.1 and Table 2.1.1. The precipitation in Vientiane Capital from January 2010 to December 2013 is shown in Figure 2.1.2 and Table 2.1.2. The average monthly maximum temperature ranges from 28.47°C in December to 35.06°C in April. The average monthly minimum temperature ranges from 18.23°C in December to 25.61°C in June. The average monthly precipitation ranges from 7.5 mm in February to 435.2 mm in August, and 1600mm to 1750mm in annual basis. Approximately 87 % of rainfall occurs between May and September.



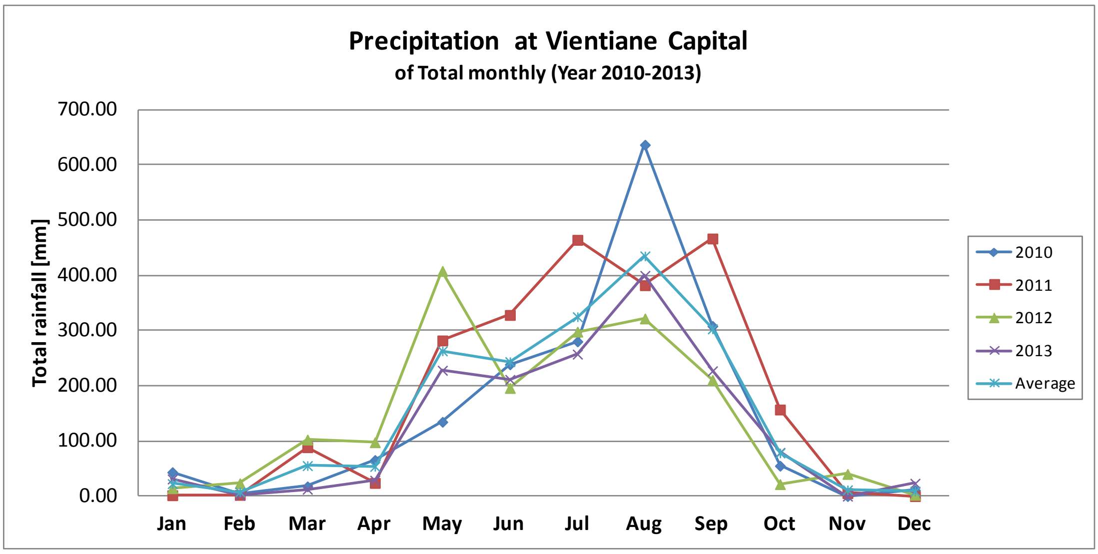
Source: Meteorology and Hydrology Department, Ministry of Natural Resources and Environment

Figure 2.1.1 Temperature in Vientiane Capital

Table 2.1.1 Temperature in Vientiane Capital

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min2010	19.72	20.73	21.64	25.14	26.04	25.29	24.75	24.24	24.29	23.64	20.20	18.75
Min2011	16.29	19.87	20.27	24.20	25.02	25.52	25.26	24.88	24.77	23.75	21.15	17.43
Min2012	19.47	20.68	22.81	24.58	25.25	25.84	25.34	25.27	25.30	24.48	24.05	21.14
Min2013	19.14	21.72	23.09	25.32	25.26	25.79	25.07	24.98	24.99	23.41	22.49	15.58
Min Average	18.65	20.75	21.95	24.81	25.39	25.61	25.11	24.84	24.84	23.82	21.97	18.23
Max2010	29.42	33.01	33.93	36.35	35.79	33.49	32.19	30.64	32.37	30.77	30.22	28.81
Max2011	27.28	30.93	29.19	33.55	32.89	31.70	31.47	31.23	31.30	30.92	31.43	28.09
Max2012	28.88	31.33	32.30	34.41	33.36	32.58	31.28	31.30	32.45	33.00	32.79	30.83
Max2013	28.69	32.75	34.78	35.93	33.89	32.28	31.20	31.66	31.44	31.45	31.13	26.15
Max Average	28.57	32.01	32.55	35.06	33.98	32.51	31.53	31.21	31.89	31.54	31.39	28.47

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



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

Figure 2.1.2 Precipitation in Vientiane Capital

Table 2.1.2 Precipitation in Vientiane Capital

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	43.4	3.2	17.6	65.4	134.6	238.8	280.3	636.8	308.3	55.0	0.0	10.8
2011	1.6	2.2	88.6	23.9	282.1	328.3	464.4	382.2	466.8	156.9	5.4	0.0
2012	14.2	23.2	102.4	97.6	408.0	195.9	298.0	321.9	210.4	21.7	40.1	2.2
2013	31.1	1.4	12.5	28.7	228.0	211.4	257.3	399.9	227.0	79.2	0.0	23.2
Average	22.6	7.5	55.3	53.9	263.2	243.6	325.0	435.2	303.1	78.2	11.4	9.1

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

2.1.2 Topography

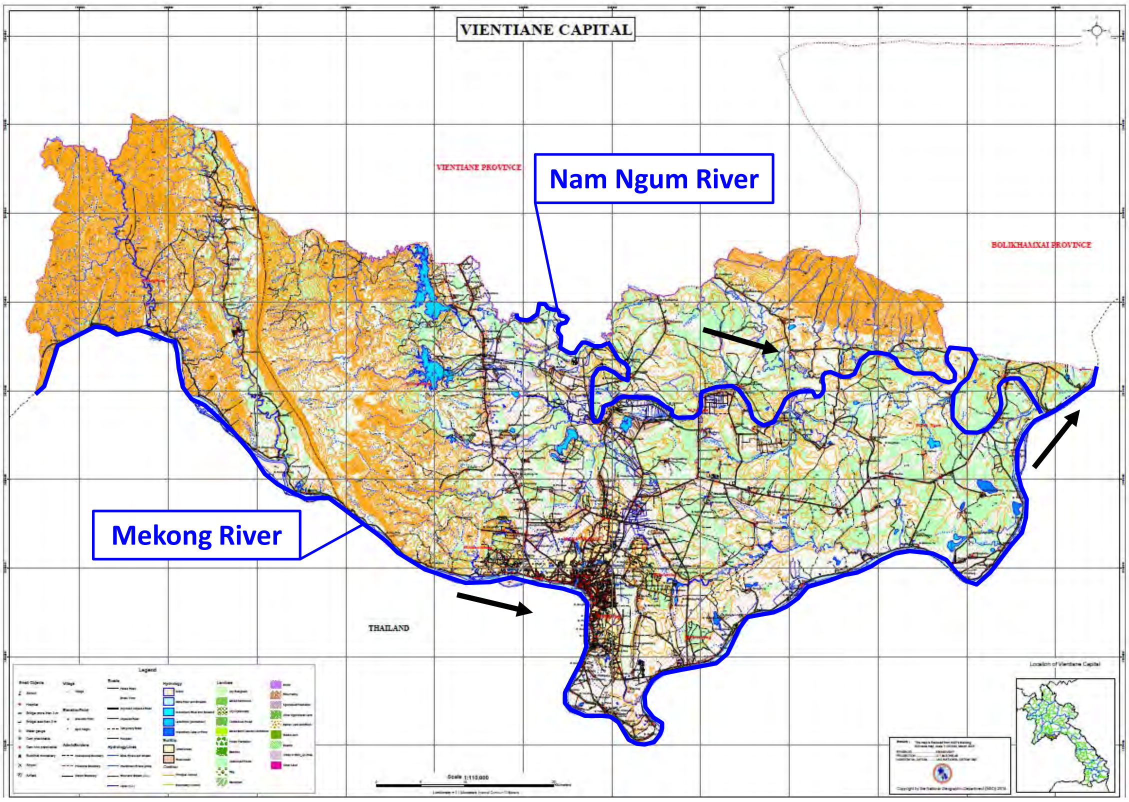
The entire land area of the Lao PDR is 236,800 km^2, of which 80 % is mountainous and 20 % is plain area extending along the Mekong River and its tributaries.

Vientiane Capital is situated on an alluvial plain extending along the left bank of Mekong River east to west. The administrative area of Vientiane Capital is about 3,920 km^2 and ground elevation except for west part of city ranges from 160 m to 180 m above sea level. The west part has elevation over 180 m to 650m above sea level.

Vientiane Capital is comprised of nine (9) districts, which are: Chanthabouly, Hadxaifong, Parkngum, Naxaithong, Sangthong, Sikhottanbong, Sisattanak, Xaysetha and Xaythany.

2.1.3 Hydrology

There are two main rivers in Vientiane Capital, which are: the Mekong River and the Nam Ngum River, as shown in Figure 2.1.3. The Nam Ngum River joins the Mekong River in the east side of Vientiane Capital.



Source: National Geographical Department, Prime Minister's Office

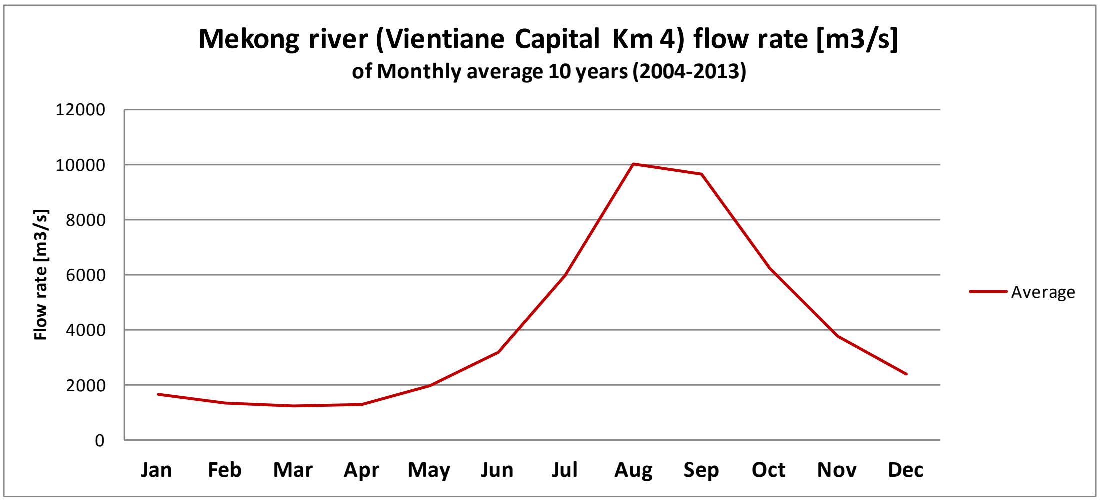
Figure 2.1.3 Map of Vientiane Capital

The following sections will discuss characteristics of the Mekong River only, since this Preparatory Survey aims at Chinaimo WTP expansion, which intakes from the Mekong River.

(1) Flow Rate

The average flow rate of the Mekong River at KM4 (4km from Patuxay monument) in the past 10 years is shown in Figure 2.1.4 and Table 2.1.3.

The figure shows that there is significant difference between the rainy season and the dry season. In 2010, the minimum water discharge of low years, only 912.24 m^3/s or 78,817,589.33 m^3/day, was recorded in March, and the maximum water discharge in the same year was 8908.79 m^3/s or 769,715,950.80 m^3/day in September. On the other hands, the planned intake amount for Chinaimo WTP expansion is 120,000.00 m^3/day – 160,000 m^3/day, which accounts for 0.15 – 0.20 % of the water discharge amount (78,817,589.33 m^3/day) in March 2010. It is obvious that even in an abnormally dry season, the proposed intake amount would have a negligible impact on the water discharge of the Mekong River. Thus, it is concluded that the proposed amount of water intake does not have significant impact on the flow rate of the Mekong River at KM4.



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

Figure 2.1.4 Average Flow Rate of the Mekong River

Table 2.1.3 Average Flow Rate of the Mekong River

	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2004	1355.82	1175.612	950.8481	1199.679	2279.217	4139.094	6802.099	9869.7744	10961.274	6058.518	3070.424	2169.602
2	2005	1838.838	1488.228	1562.94	1804.817	1963.941	4568.468	8860.917	13803.011	13045.816	8666.915	5565.838	2834.861
3	2006	1762.685	1365.46	1221.3	1063.429	1898.409	3195.034	5863.978	9523.9333	8541.2289	8050.663	3495.534	2138.814
4	2007	1568.535	1309.661	1081.003	1291.156	2204.11	2719.773	4125.816	8346.0802	9967.6347	7229.541	3885.343	2273.452
5	2008	1560.907	1554.584	1353.644	1441.051	2253.757	4368.851	9098.956	14468.77	11481.915	7222.11	5817.781	2742.805
6	2009	2110.134	1696.68	1390.021	1404.473	1788.905	2769.604	6165.656	7269.8224	7704.6107	4324.349	2411.728	1813.347
7	2010	1465.601	1095.37	912.2406	1126.636	1403.089	2012.512	3849.835	8394.067	8908.7494	5791.159	3103.342	1954.95
8	2011	1597.485	1240.145	1383.702	1391.856	2653.592	3882.694	7308.897	9813.1491	10481.798	5857.483	3202.547	2000.572
9	2012	1711.25	1225.751	1085.488	1066.464	1401.067	2281.049	3651.137	9863.6449	7215.8839	4451.916	2828.075	2133.11
10	2013	1697.134	1560.184	1404.919	1265.698	1820.252	2175.394	4107.34	8939.2644	8097.5552	4696.212	4203.269	3756.128
	Average	1666.839	1371.168	1234.61	1305.526	1966.634	3211.247	5983.463	10029.152	9640.6466	6234.887	3758.388	2381.764

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

(2) Water Level

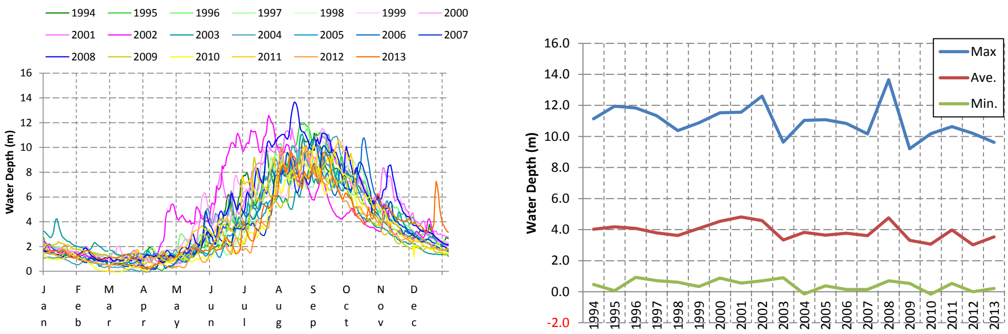
Data of water depth and water flow in the Mekong River is shown in Table 2.1.4 and Figure 2.1.5. It is recognized from these data that water depth has significant fluctuation of over 10 meters between the dry season and the rainy season. It is suggested that intake facility must take into account these fluctuations to obtain enough water amount for water supply, especially during the dry season.

Table 2.1.4 Water Depth of Mekong River

Item	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	All
Max	11.1	12.0	11.8	11.3	10.4	10.9	11.5	11.6	12.6	9.6	11.0	11.1	10.8	10.2	13.7	9.2	10.2	10.6	10.2	9.6	13.66 (2008)
Ave.	4.0	4.2	4.1	3.8	3.6	4.1	4.5	4.8	4.6	3.3	3.8	3.6	3.8	3.6	4.8	3.3	3.1	4.0	3.0	3.5	3.88 –
Min.	0.5	0.1	0.9	0.7	0.6	0.3	0.9	0.6	0.7	0.9	−0.1	0.4	0.2	0.2	0.7	0.5	−0.2	0.5	0.0	0.2	−0.16 (2010)
Max−Min	10.7	11.9	10.9	10.6	9.8	10.6	10.7	11.0	11.9	8.7	11.2	10.7	10.7	10.0	13.0	8.7	10.3	10.1	10.2	9.4	– –

(Unit: m)

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

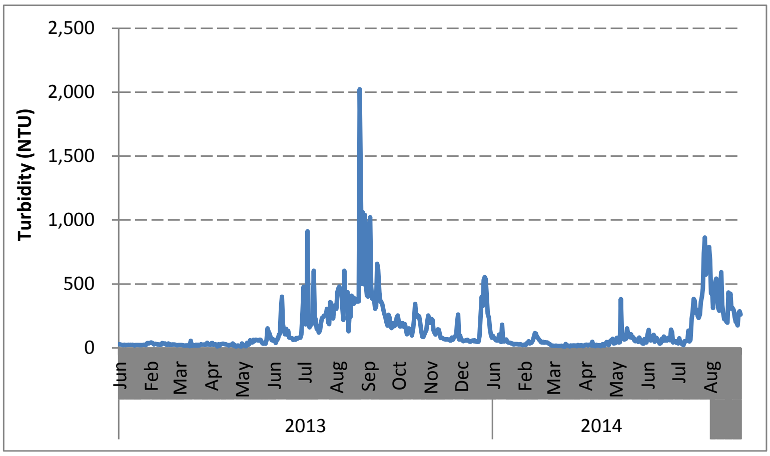


Source: Meteorology and Hydrology Department, Ministry of Natural Resources and Environment

Figure 2.1.5 Water Depth of Mekong River

(3) Raw Water Quality

Generally, turbidity of the Mekong River is high, especially during the rainy season. Figure 2.1.6 shows annual turbidity fluctuation in the Mekong River at Chinaimo WTP. The highest turbidity since January 2013 up to August 2014 was over 2000 in August 2013. Furthermore, it has recorded the highest turbidity of over 3,000 NTU in the past.



Source: Chinaimo WTP

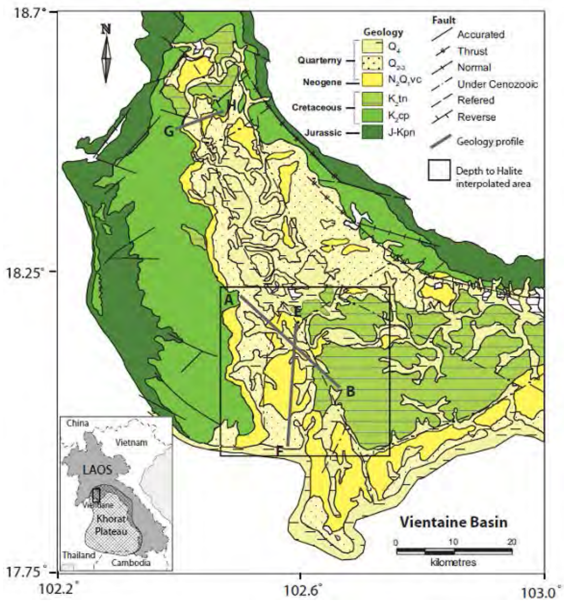
Figure 2.1.6 Turbidity of raw water in Chinaimo WTP

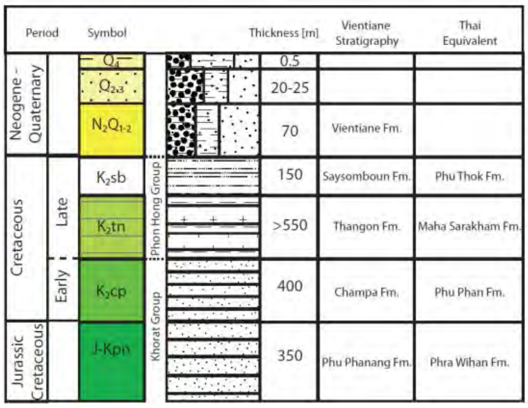
2.1.4 Hydro-geology

The Vientiane Basin is located at the northern part of the Sakhon Nakhon Basin in the Khorat Plateau, as shown in Figure 2.1.7. Seawater flowed in the Khorat Plateau since seawater level was high during the Cretaceous period. The plateau was sporadically isolated from the ocean as all the plateau wasn’t under the seawater level. Owing to this history, there are salt beds and halite under the ground of Vientiane Capital. The salt layer generally ranges between 50 to 200 m in the southern part of the province.

In Vientiane Capital, there are many deep wells which produce salty groundwater. In some deep wells, the chloride concentration is the same as seawater and the water tastes quite salty.

Hence, it is considered that the groundwater in Vientiane Capital is not suitable for the city water supply.





Source: Luleå University of Technology Department of Chemical Engineering and Geosciences Division of Applied Geophysics, 2008, Assessment of Hydrogeological and Water Quality Parameters, Using MRS and VES in the Vientiane Basin, Laos

Figure 2.1.7 Geological map **Figure 2.1.8 Stratigraphy of Vientiane Basin**

2.2 Social and Environmental Conditions

2.2.1 Population and Administration

(1) Population

The population of Laos was 4.57 million according to the 1995 census. The recent census records that Laos had a population of 5.62 million in 2005, and this population increased to 6.51 million in 2012 according to the statistical year book. During these years, the growth rate was around 2.1% per annum.

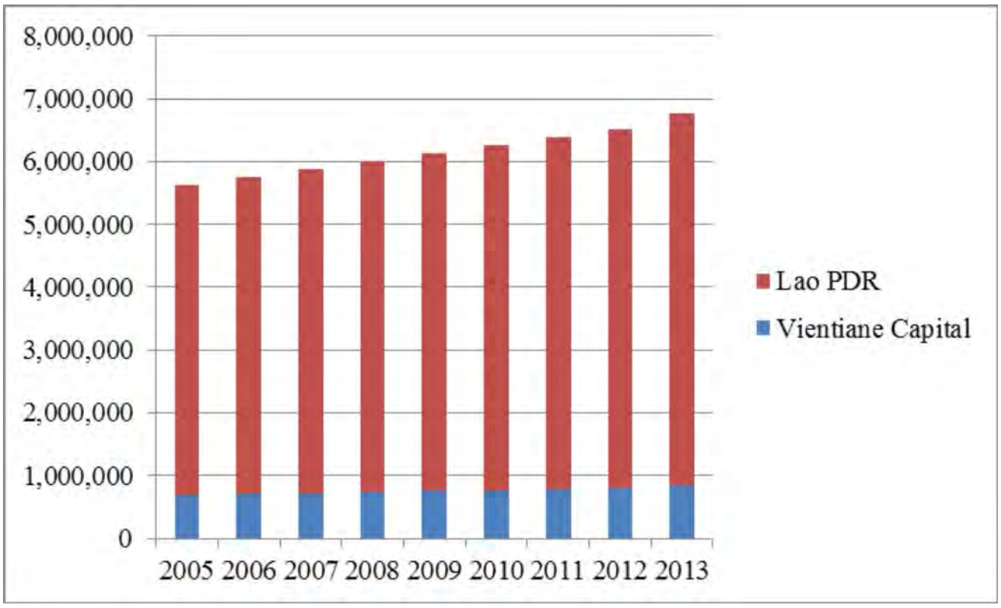
The population of Vientiane Capital was 698,318 in 2005 and increased to 797,130 in 2012, according to Social Statistics from Lao Statistic Bureau. The recent statistics information, Statistic Data of Property Vientiane Capital, prepared by Department of Planning and Investment, Vientiane Capital, shows the population has become 854,069 in 2013.

The recent growths of population in Lao PDR and Vientiane Capital are also shown in Table 2.2.1 and Figure 2.2.1.

Table 2.2.1 Population in Lao PDR and Vientiane Capital (2005 – 2013)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013
Lao PDR	5,621,982	5,747,587	5,873,616	6,000,379	6,127,910	6,256,197	6,385,057	6,514,432	6,771,000
Vientiane Capital	698,318	711,919	725,820	740,010	754,384	768,743	783,032	797,130	854,069

Source: Lao Statistic Bureau: 2005-2012, and Department of Planning and Investment, Vientiane Capital: 2013



Source: Lao Statistic Bureau, and Department of Planning and Investment, Vientiane Capital

Figure 2.2.1 Population Growth in Lao PDR and Vientiane Capital (2005 – 2013)

Vientiane Capital has 41% of the population not born in the capital; they immigrated into the capital from other provinces. Thus, Vientiane Capital has a population of people drifting in from the rural areas.

The current number of households in Vientiane Capital is 145,558 according to the recent statistics information in the year 2013. Then, the average family size was calculated at 5.5 persons per household, as shown in Table 2.2.2.

Table 2.2.2 Population and Family Size in Vientiane Capital (2013)

No.	District Name	Population	Number of Households	Family Size (Average)
1.	Chanthabuly	71,878	12,254	5.9
2.	Sikhottabong	109,096	20,638	5.3
3.	Xaysetha	108,889	21,517	5.1
4.	Sisattanak	78,088	11,196	7.0
5.	Naxaithong	71,795	13,168	5.5
6.	Xaytany	183,838	32,771	5.6
7.	Hadxaifong	90,662	18,217	5.0
8.	Sangthong	30,985	6,137	5.0
9.	Parkngum	55,992	9,660	5.8
	Others	52,846	-	-
Vientiane Capital		854,069	145,558	5.5

Source: Statistics Information and Poverty of Vientiane Capital, DPI

(2) Administrative Boundary

Vientiane Capital has an administrative area of 3,920 km^2 or 1.7% of the national territory, and has nine (9) districts of Chanthabuly, Sikhottabong, Xaysetha, Sisattanak, Naxaithong, Xaytany, Hadxaifong, Sangthong, and Parkngum. Also it has been be split up into 483 villages inside of these districts.

(3) Design Service Area

In Vientiane Capital, the area served by Water Supply State Enterprise (NPNL) currently covers 263 villages out of the 483 villages in the whole nine (9) districts. NPNL plans to expand the served area to another 124 villages by 2020. It should be noted that villages are classified into categories: urban and remote. In Table 2.2.3, villages counted as "Current Service Area" and "Future Expansion Area (2020)" villages and also "Urban Area" and "Remote Area" villages. Also, Figure 2.2.1 shows those locations.

Table 2.2.3 Summary of Villages to be Served Water by NPNL

No.	District Name	Number of Villages			
		Existing	Current Service Area	Future Expansion Area (2020)	Outer Service Area
1.	Chanthabuly	30	30	0	0
2.	Sikhottabong	60	57	3	0
3.	Xaysetha	48	44	4	0
4.	Sisattanak	37	37	0	0
5.	Naxaithong	54	13	41	0
6.	Xaytany	104	33	40	31
7.	Hadxaifong	60	44	16	0
8.	Sangthong	37	3	8	26
9.	Parkngum	53	2	12	39
	Total	483	263	124	96

: Villages in Urban Area (Current Service Area)

: Villages in Urban Area (Future Expansion Area)

: Villages in Remote Area (Current Service Area)

: Villages in Remote Area (Future Expansion Area)

Source: Planning and Investment Department, NPNL
Note: The numbers are as of the year 2013.

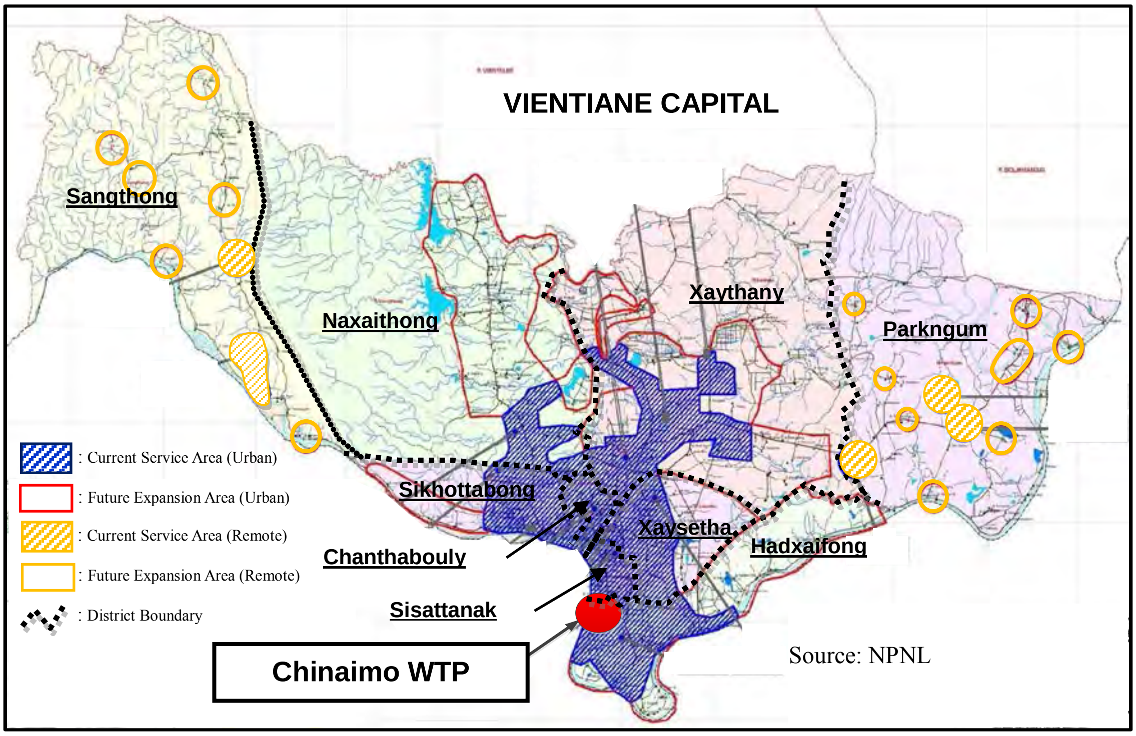


Figure 2.2.2 Current and Future Water Supply Areas in Vientiane Capital

2.2.2 Land Use

Land usage map prepared in 2010 by National Geographical Department, Prime Minister's Office is shown in Figure 2.2.3. In Sisatthanak District and Chanthabouly District, most of the land is used for residential area. In Xaysetha District and Sikhottabong District, about 30-50 % of the land is used for residential area and the rest of the land is a combination of paddy fields and forest areas. In the other districts, most of the area is used for paddy fields.

It is noteworthy to point out that the GOL has promoted dis-concentrating certain urban functions from the Vientiane Capital towards the District, and industrial development in the suburbs of Vientiane Capital. The GOL has also pushed forward the future development of suburban new towns of:

- Nongping City
- Dokchampa City
- Thatluang New City
- Road 450 City

and specific economic zone (SEZ)[2] of:

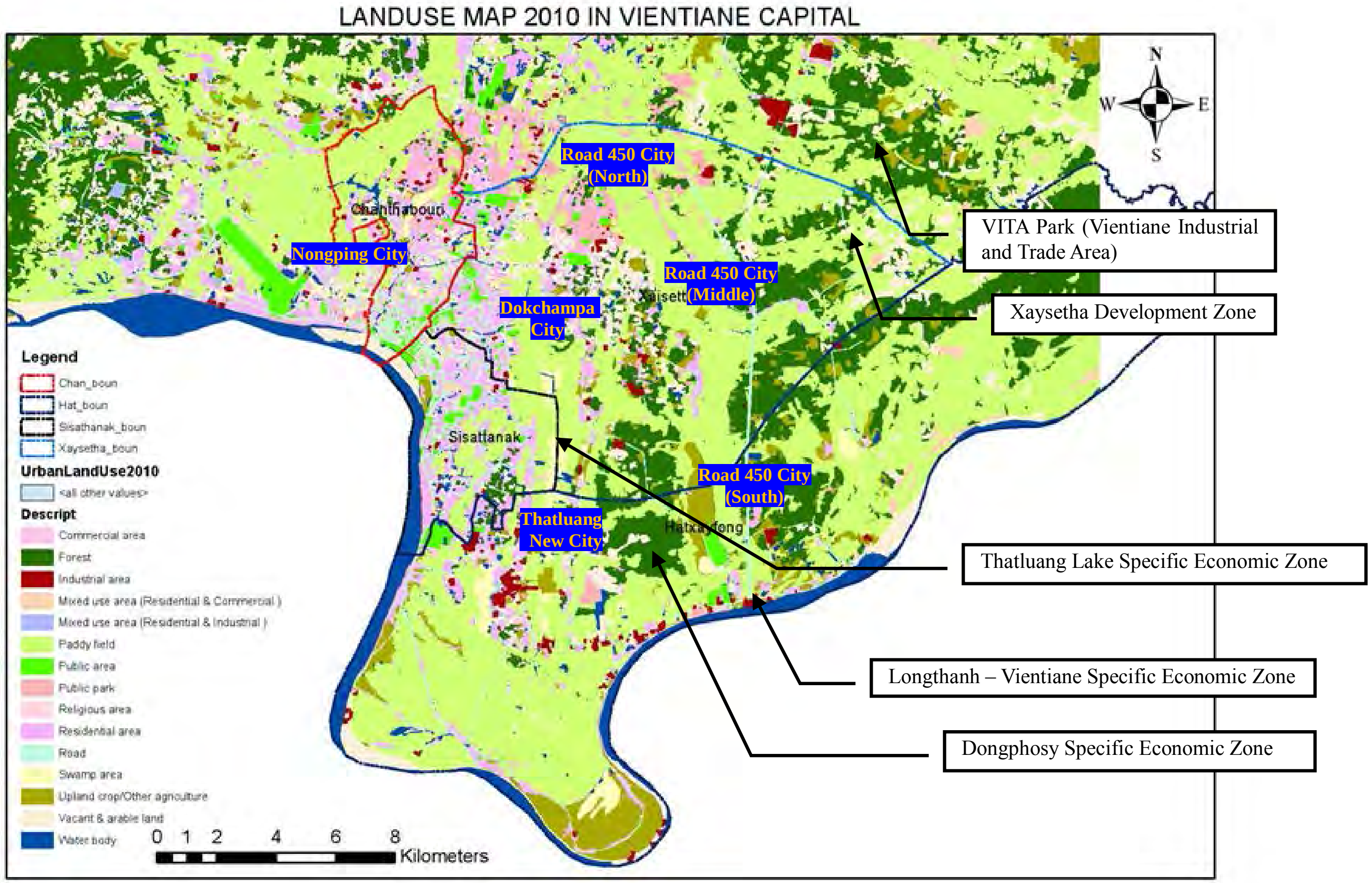
1) Under Construction and some facilities have been operated
- VITA Park (Vientiane Industrial and Trade Area)
- Longthanh – Vientiane Specific Economic Zone

2) Under Construction
- Thatluang Lake Specific Economic Zone
- Dongphosy Specific Economic Zone

3) Under Consideration
- Xaysetha Development Zone

Figure 2.2.3 also overlays those planned new towns and SEZs in Vientiane Capital.

[2] SEZ are composed of 2 types of economic zones, such as; Special Economic Zone and Specific Economic Zone. Special Economic Zone is a modern town, in order to attract domestic and foreign investment, having more than 1,000 ha area, whereas Specific Economic Zone is the specific purpose zone such as industry, production, tourism, duty free, IT, border trade, and so on.



Source: National Geographical Department, Prime Minister's Office

Figure 2.2.3 Land Use Map and Planned Specific Economic Zone (SEZ) & New Towns in Vientiane Capital

2.2.3 Other Social Economic and Environment Conditions

(1) Economy of the Lao PDR

The GOL announced the "New Economic Mechanism" in 1986, which promoted introduction of a self-sufficient financial system for national and public enterprises, liberalization of domestic economy and trade, and so on, in order for the Lao economy to transform from a planned economy to a market economy. From the latter half of 1980's to the latter half of 1990's, accompanied with high growth of the surrounding ASEAN countries, the Lao PDR experienced steady economic growth. The Asian economic crisis in 1997 badly influenced the economy of the country as its GDP growth rate declined in 1998. Nevertheless, it has recovered since 1999 with average 5 to 6% annual GDP growth rate, and even higher economic growth rates of 7 to 8% in recent years (Table 2.2.4).

Table 2.2.4 GDP Growth Rate of the Lao PDR

Unit: %

Year	2008	2009	2010	2011	2012	2013
GDP Growth rate	7.82	7.50	8.53	8.04	8.20	8.15

Source: World Development Indicator, WB

The GOL started to plan to establish the economic special zone in 2008. In 2009 and 2010, several Laws, Decrees and Decisions were announced regarding the Special Economic Zone and Specific Economic Zone (SEZ) (Law on Investment Promotion No.02/NA dated 08/07/2009, No.47/SC dated 26/10/2010, No.443/PM dated 26/10/2010, No.517/PM dated 09/12/2010). Investment preferential treatments were introduced by the Decrees and Decisions listed below. Following those privileges, several industrial zones[3] have been emerging in this country.

Table 2.2.4 Major Investment Preferential Treatments

No.	Types of Investment Preferential Treatments	Legal Basis
1	Exemption of profit tax for 1 year to 10 years, depending on the situation	Law on Investment Promotion No.02/NA
2	Exemption of import duty for materials and so on used for production	Same as above
3	Exemption of export duties for general products for export	Same as above
4	Access to/provision of fund source, information, right to purchasing of land use rights from the State	Same as above
5	Receiving full rights in the development and management of the SEZ	Decree No.443/PM Dated 26/10/2010
6	Right to perform economic and financial management in an independent manner	Same as above
7	Determining the leasing charges of land and of other fixed and movable assets in its zones	Same as above

Source: Law on Investment Promotion No.02/NA dated 08/07/2009, Decree No.443/PM Dated 26/10/2010

In the Lao PDR, there were 10 SEZ as of September 2014. SEZ are composed of 2 types of economic zones, such as; Special Economic Zone and Specific Economic Zone. Definitions of them are described in Table 2.2.5.

[3] The Government has determined as the zone for industry, industrial product manufacturing, and services to manufacturing industry. This area may not be large as the area of the special economic zone. (No.02/NA Law on Investment Promotion)

Table 2.2.5 General Definitions of Special Economic Zone and Specific Economic Zone

No.	Types of SEZ	General Definition
1	Special Economic Zone	As a modern town, in order to attract domestic and foreign investment and to develop it totally, the Government decides the zone with more than 1,000 ha. Special economic zone has its own investment preferential measures and autonomy for economy and finance, as well as security system and sustainable environmental protection system.
2	Specific Economic Zone	Zone which Government decides the specific purpose of the zone. For instance, industrial zone, production for export zone, tourism zone, duty free zone, IT zone, border trade zone, and so on.

Source: Law on Investment Promotion (No. 02/NA, dated 8 July 2009)

Regarding the relationship between surrounding countries, in the aspects of economy and trade, the Lao PDR has strong relations with Thailand due to the geographical advantage, language, and the other reasons. The import values only Thailand accounts for 41.8% (2012) of total import values of Laos. The export values to Thailand accounts for 54.3% (2012) of total export values of Laos.

In the Lao PDR, per capita GDP in the year 2013 was 1,660.7 USD (World Bank (WB)[4]). Compositions of GDP were 28% for agricultural sector, 33% for industrial sector, and 39% for service sector (LSB[5]). However, according to the "Population Census 2005" (hereinafter referred to as the "Census 2005"[6]), majority of the population is working in the Agricultural sector (Table 2.2.6). Including farmer and mixed farmer, almost 78% of the national population is said to be working in the agricultural sector.

(2) Economy of Vientiane Capital

In contrast to the national average, the agricultural population accounts for only 35% of the total working populations in Vientiane Capital. The agricultural sector is important in the country as the workplace for the people. However, non-farming activities attract more working population (64.7%) in Vientiane Capital.

Table 2.2.6 Distribution of Working Population for Each Farmer and Non-Farmer

Unit: %

No.	Province	Farmer	Fisherman	Livestock farmer	Mixed farmer	Non-farm activity	Total
1	Vientiane Capital	25.4	0.1	0.3	9.5	64.7	100
2	The Lao PDR (whole)	64.3	0.1	0.2	14.0	21.5	100

Source: Census 2005

Based on the report of Census 2005, percentage of the population living in urban areas has increased from that of Census 1995. The Census report mentioned that 83% of the population lived in rural areas in 1995, but 73% of population lived in rural areas in 2005 as a national average. Census 2005 also mentioned that this tendency is particularly strong in several provinces and Vientiane Capital. It can be imagined that some parts of rural

4 World Bank HP, http://data.worldbank.org/indicator/NY.GDP.PCAP.CD
5 Statistical Yearbook 2013, Lao Statistics Bureau
6 Population Census 2005, Government of Lao PDR

population had moved into urban areas in Vientiane Capital and started working in non-farming activities. It becomes more and more important for Vientiane Capital to establish better infrastructure for steady growth of the commercial, industrial and service sectors.

As mentioned in the previous section, there were 10 SEZ in this country as of September 2014. Five (5) of them were located in Vientiane Capital (Table 2.2.7). Furthermore, they will be large users of public water.

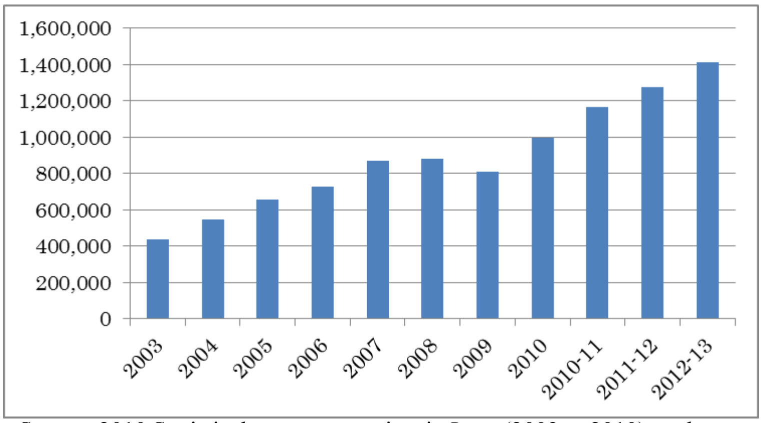
Table 2.2.7 SEZ in Vientiane Capital (as of September 2014)

No.	Name of SEZ	Established Year	Land tenure	Developer	Investment projects
Special Economic Zone					
1	VITA Park (Vientiane Industrial and Trade Area)	2009	75 years	Govt. (Ministry of Industry) & Private	Industry, commerce, and services
Specific Economic Zone					
2	Xaysetha Development Zone	2010	50 years	Govt. & Private (Lao & Chinese)	Agricultural Products Industry, Light Industry, Tourism services
3	Thatluang Lake Specific Economic Zone	2011	99 years	Private 100% (Chinese)	Cultural area, Financial & Business, Residential area, Tourism, Golf
4	Longthanh - Vientiane Specific Economic Zone	2008	99 years	Private 100% (Vietnamese)	Golf, Hotel, Apartment, Resort, Conference hall, Sport, Market, Clinic, etc.
5	Dongphosy Specific Economic Zone	2012	50 years	Private 100% (Malaysia)	Commerce, Industry, Institution

Source: HP of Lao National Committee for Special Economic Zone

(3) Tourism in Vientiane Capital

Figure 2.2.4 shows the trend of tourists number arrived at Vientiane Capital for the last 11 years. In the fiscal year (October to September) 2010 – 2011, total tourist number to Vientiane Capital became over 1 million in 2010 and the number has been increasing afterward.



Source: 2010 Statistical report on tourism in Laos (2003 to 2010), and Socio-Economic Data Vientiane Capital (2010-11 to 2012-13)

Figure 2.2.4 Tourist Arrival at Vientiane Capital

Table 2.2.8 shows the trend of increase of tourism revenue, hotel and restaurant numbers in Vientiane Capital. Caused by the steady increase of tourist arrival, tourism revenue and related industries are also expanding continuously.

Part of the migrating population from rural to urban areas, as mentioned in the previous section, is considered to be absorbed in these hotels, restaurants, and other tourism related industries in Vientiane Capital. Tourism industry is one of the most important industries in

Vientiane Capital, in the aspects of not only foreign currency acquisition and economic expansion, but also for job creation.

Table 2.2.8 Changes of Tourism Revenue, Hotel and Restaurant Number (Vientiane Capital)

Year	2009-2010	2010-2011	2011-2012	2012-2013
Number of Tourists (No.)	994,545	1,164,742	1,276,925	1,412,964
Tourism revenue (USD)	89,215,376	111,938,975	120,185,012	139,808,471
Number of Hotels (No.)	143	154	181	200
Number of restaurants (No.)	186	191	199	217

Source: Socio-Economic Data Vientiane Capital

(4) Religion and Ethnic Group

Religion and ethnic group compositions are shown in Table 2.2.9. Buddhism is a major religion in the Lao PDR, with 66.8% of the total population identifying with Buddhism. Second is Christianity, which accounts for 1.5%. Regarding ethnic groups, Lao is the predominant group, accounting for more than half (54.6%) of the national population. However, it is obvious that there are many smaller ethnic groups in the country, each accounting for less than 10% of all total population.

Table 2.2.9 Religion and Ethnic Group Composition

No.	Religion	Share (%)	Ethnic group	Share (%)
1	Buddhist	66.8	Lao	54.6
2	Christian	1.5	Keummeu	10.9
3	Bahai	0.0	Mong	8.0
4	Muslim	0.0	Tai	3.8
5	Other	30.9	Phuthai	3.3
6	No answer	0.7	Leu	2.2
7	-	-	Katang	2.1
8	-	-	Makong	2.1
9	-	-	Other	13.0

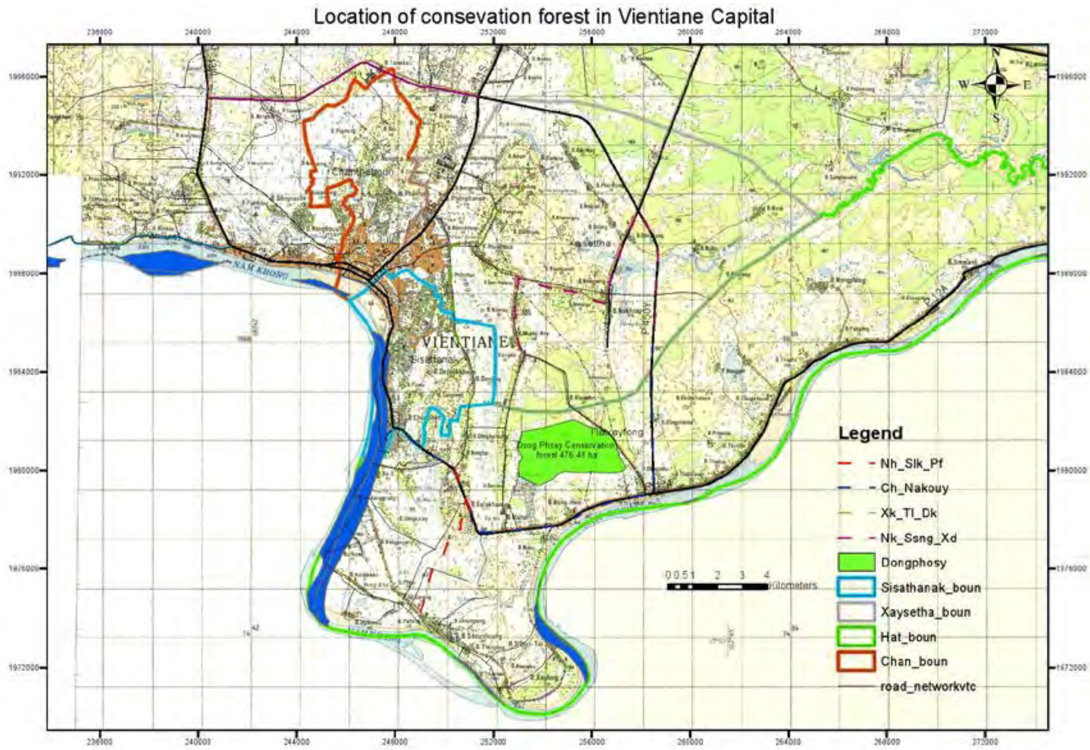
Source: Census 2005

(5) Cultural Heritage

No cultural heritage or archeological site is found in the proposed project sites including water intake, water treatment plant, transmission pipeline, elevated tank and distribution pipeline.

(6) Protected Area / Endangered Species

In Vientiane Capital, there is one district protected area called Dongphosy Conservation Forest. 436ha is conserved for the protected area . The location is shown in Figure 2.2.5. There is, however, no protected area or endangered species confirmed in the proposed project sites including water intake, water treatment plant, transmission pipeline, elevated tank and distribution pipeline.



Source: Department of Natural Resources and Environment, Vientiane Capital

Figure 2.2.5 Location of Dongphosy Conservation Forest

Chapter 3 ANALYSIS OF CURRENT WATER SUPPLY SECTOR

3.1 Current Situation and Problem of the Water Supply Sector

The GOL's National Growth and Poverty Eradication Strategy (NGPES) identifies water supply and sanitation as priority sectors for development to achieve its economic growth and poverty eradication objectives. Accordingly, the GOL gives high priority to improving water supply and sanitation throughout the country, setting an overall goal of 80% coverage of piped water supply for urban communities by 2020. According to WHO data described in "*Progress and Sanitation and Drinking Water 2014 updated*", the coverage ratio of piped water supply in 2012 was still 25 % nationwide, 60 % in urban area and 6 % in rural area respectively.

Vientiane Capital has their policy that the coverage of supply water in urban area should be reached 90 - 95 % by 2020[7]. For the achievement of this goals and sustainable water supply works, the following issues and problems should be addressed in the Vientiane Capital water supply sector.

- Service coverage in the urban area is still 72% as of 2013, also 58 % as a whole Vientiane Capital.
- Expansion of service area by 2020 is planned, but not enough production capacity.
- Existing WTPs have been over loaded 13-16% of their production capacity.
- 17% of connections suffer from water shortage at least one time a day.
- Existing elevated tanks have not been used for a longtime.
- Some areas are subject to low water pressures.
- Existing network hydraulic arrangement and pipe size are not sufficient.
- High leakage due to the material problems (e.g. old pipes, nondurable materials).
- There are many kinds of pipe material (difficulty of maintenance).
- Upskilling for plumbers is required with adequate training.
- Manual management for pipeline network has been continued.
- No strict of water supply regulation exists.

The area that suffers from water shortage due to low water pressure is shown in Figure 3.1.1. According to WSM/P 2014, "the main reason why customers suffer lack of water is due to insufficient piped network hydraulics arrangements and undersized pipes.", and WSM/P 2014 also recommends that "As Chinaimo – Salakham sector, the Salakham elevated tank has been stayed empty, leading to permanent water shortage downstream and upstream from Salakham elevated tank. The Chinaimo – Salakham pump group needs to be reinforced."

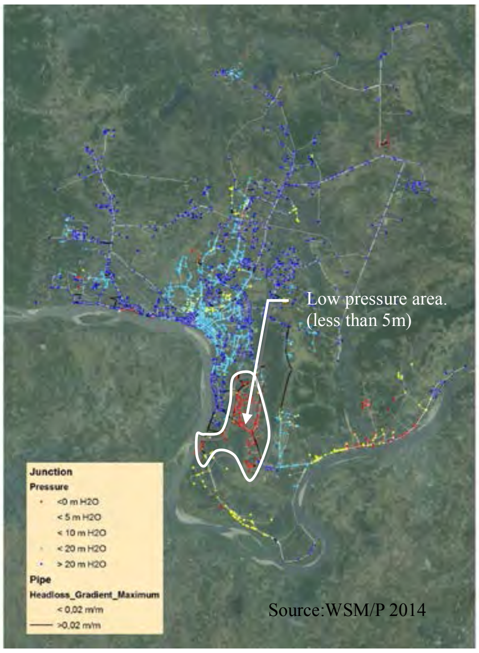


Figure 3.1.1 Areas Suffer from Water Shortage

3.2 Laws, Policies and Plans of the Water Supply Sector

3.2.1 Legal Framework and Laws in Water Supply Sector

Table 3.2.1 summarizes the legal framework in water

[7] This was agreed on the fifth party's meeting of party's member committee in Vientiane capital.

supply sector in the Lao PDR. Prime Minister (PM) Decree No. 37 on the Management and Development of Water Supply and Wastewater Sector, issued on 30th September 1999, establishes the key institutions in the sector. At the central level, the Ministry of Public Works and Transport (MPWT) is assigned for urban water supplies[8]. Following the PM Decision No. 37, MPWT plays the leading role in facilitating, coordinating and providing guidance on all aspects of water supply development and wastewater management in urban and small towns across the country.

Table 3.2.1 Summary of Legal Framework in Water Supply Sector in the Lao PDR

Year	Title	No
1996	Law on Water and Water Resources	05/NA
1997	National Rural Water Supply and Sanitation Strategy and Guidelines National Framework (MOH)	14/11/97
1999	Management and Development on the Water Supply Sector (recognized as the sector policy)	37/PM
2001	Decree to Implement the Law on Water and Water Resources	204/PM
2003	Drinking Water Quality Targets	953/MOH
2004	Decree on Promotion and Developments of SMEs	42/PO
2004	Water Supply Tariff Policy	57/PM
2004	WASA Tariff Determination Guidelines, Version 6	WASA
2005	Regulation of Urban Water Supply Operations	Decree 191/PM
2005	Enterprise Law	11/NA
2005	Organization and Activities of the Water Supply Division, DHUP, MCTPC	8027/DHUP
2005	Management of Drinking Water Quality Standards and Household Water Use	137/MOH
2006	Notice on Conservation of Nam Papa Muang Khua Water Source	137/MOH
2009	Water Supply Law	04/NA
2009	Organization and Activities of the Water Supply Regulator Office (WaSRO)	13266/MPWT

Source: Urban Water Supply and Sanitation in Lao PDR (2012)

The water supply law, approved by the National Assembly and President of the Lao PDR in July 2009, aims to consolidate the water supply legislation and strengthen the legal basis for the provision of sanitation services. This law determines principles, regulations and management principles for construction of urban water supply systems. It aims at promotion of urban water supply to all societies and ethnic groups, as well as ensuring the quality and quantity of water.

3.2.2 Policies and Plans in Water Supply Sector

The responsibility of the urban water sector is born by the Ministry of Public Works and Transport (MPWT), whereas rural areas are under the scope of the Ministry of Public Health.

According to the GOL's 1999 policy statement (PM Decision No. 37), the sector target is to provide 24-hour access to safe drinking water for 80% of the urban population by 2020. To achieve this goal, the GOL has progressively developed water supplies in Vientiane Capital and the provincial centers, and, since 1999, has given increasing focus to development of piped water supplies in the small towns[9] to support economic development.

A sector investment plan, attached to the 1999 policy statement listed all urban center water supply systems in order of priority for rehabilitation, expansion, or development. The 1999 plan was updated in 2004 to reflect the GOL's growing emphasis on equitable development by improving the small towns, particularly in the poorest districts. Investment needs for 2005–2020 were estimated at

[8] Urban water supply projects have been classified into a macro level and local level, then, a policy, which some of them is to be delegated to the local government, has been promoted after the MPWT Minister's Decision in 2012.

[9] Small towns are rural bases to provide public, commercial, and logistical services to surrounding rural villages, and are prospected future economic growth as well as urban development.

$267 million, including $103 million for small towns. A summary is presented in the table here below:

Table 3.2.2 Summary of Investment Plan (2005-2020)

No	Province/Town/Project	Investment $million	Target Population	Funding Source
I	Vientiane Capital	129	672,000	JICA (35)
II	Secondary Towns	20.7	311,000	Not Yet Identified
III	Provincial Capitals	14.6	262,000	Not Yet Identified
IV	Small Town Water Supply Systems	102.5	564,000	ADB & Other (54.5)
Total - Urban water supply sector		**266.8**	**1,953,000**	

Source: Urban Water Sector Regulation in Lao PDR: Reform, Key Measures, Successes and Challenges, WaSRO, MPWT

The investment plan sets specific targets for 2010, 2015 and 2020. Here below are presented these targets for 2020:

Table 3.2.3 Summary of Target for 2020

	Vientiane Capital Secondary Towns	Provincial Capitals	District Towns	Other Small Towns
Service coverage Unit consumption	90% coverage	80% coverage	75% coverage	70% coverage
Service quality	Provide reliable, 24 hour supply with 10m min. residual head for 100% of service area			
Water Quality	Comply fully with Water Quality Regulations			
Unaccounted For Water	<200 L/connection/day	<170 L/conn./day	<140 L/conn./day	<140 L/conn./day
Master plan	Update 20-year water supply master plan			

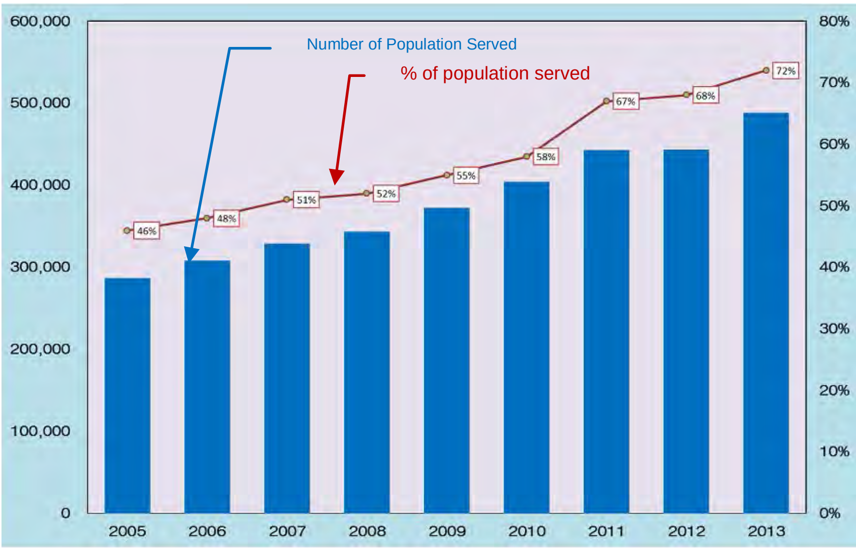
Source: Urban Water Sector Regulation in Lao PDR: Reform, Key Measures, Successes and Challenges, WaSRO, MPWT

The GOL also strive to develop of laws, clarifying roles for not be left either private sector or government at a one-sided disadvantage against damages, and responsibilities for the government and private in water supply, sanitation and wastewater services in order to enable greater private sector participation and stronger community management of water supply.

3.3 Amount of Water Supplied in Vientiane Capital

According to the 1999 policy statement (PM Decision No. 37), NPNL has made strenuous effort to increase the percentage of population served by pipe water from NPNL. Source: NPNL

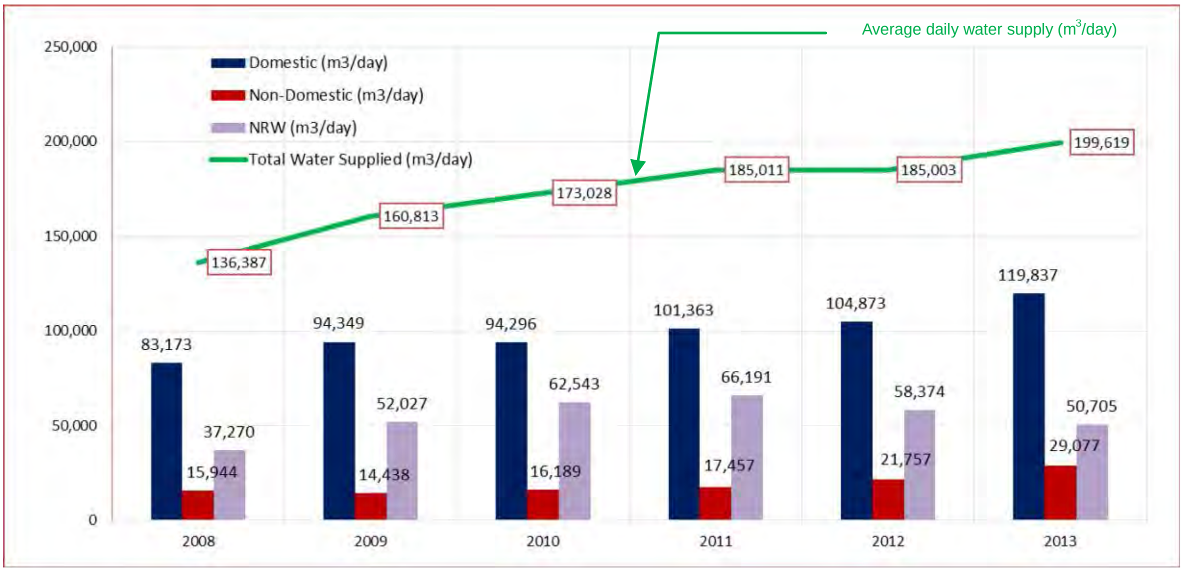
Figure 3.3.1 shows the dramatic change of percentage and number of population served in Vientiane Capital over the years. The population served that was 46% (approx. 287,000 people) in 2005, has become 72% (approx. 489,000 people) in 2013, after 8 years.



Source: NPNL

Figure 3.3.1 Population Served by NPNL

With the improvement of service ratio, water supply amount has also increased drastically. Source: NPNL
Figure 3.3.2 shows increase of amount of water supplied from NPNL in recent years.



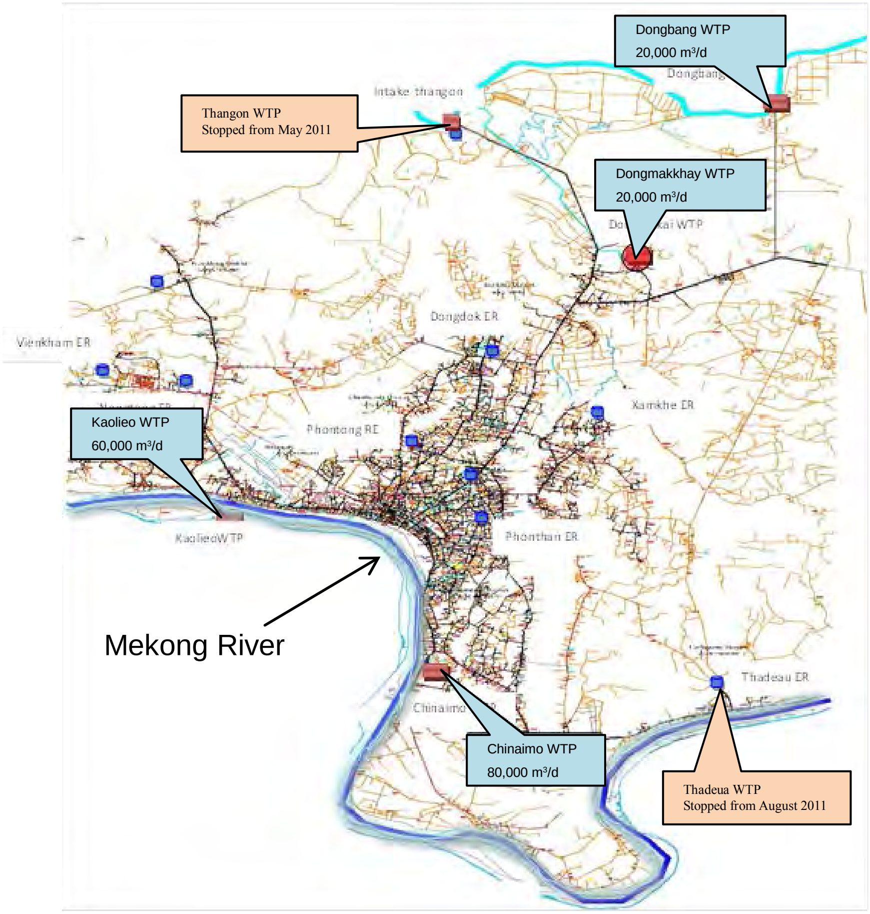
Source: NPNL

Figure 3.3.2 Water Supplied from 2008 to 2013 by NPNL

This figure illustrates that not only domestic water demand but also non-domestic water demand has increased year by year, contrary to non-revenue water (NRW), which has decreased since 2012.

3.4 Current Status of the Water Supply Amount and Capacity of the Existing Water Supply Facilities

Water supply in Vientiane Capital is currently dependent on two (2) raw water sources, namely the Mekong River and the Nam Ngum River. There are four (4) water treatment plants. The locations of the water treatment plants are shown in Figure 3.4.1.



Source: NPNL

Figure 3.4.1 Locations of Existing Water Treatment Plants

The total design production capacity of the existing water treatment plants is 180,000 m3/day. The actual daily production recorded in the year 2013 was, however, exceeding the nominal design capacity. Table 3.4.1 compares the design capacity and actual production for each water treatment plant.

Table 3.4.1 Design Capacities and Actual Daily Production of Existing Water Treatment Plants

Name of WTP	Design Capacity (m^3/d)	Actual Daily Average Production in 2013 (m^3/d)	Rate of Facility Utilization (%)	Year of Operation Start	Source of Fund or Donor
Chinaimo WTP	80,000	93,272	116.6%	40,000 in 1983 + 40,000 in 1996	ADB GOJ (Grant)
Kaoleio WTP	60,000	68,084	113.5%	20,000 in 1964 + 40,000 in 2009	GOJ (Grant) GOJ (Grant)
Dongmakkhay WTP	20,000	22,992	115.0%	2006	GOL own fund
Dongbang WTP	20,000	15,271	76.0%	2009	NPNL& Vietnam Private Company
Total	180,000	199,619	110.9%		

* Operations in Thangon WTP and Thadeua WTP were stopped in 2011.

Source: JST

Among the four water treatment plants, Chinaimo WTP and Kaoleio WTP are being overloaded by 16.6% and 13.5% on annual average, respectively. Dongmakkhay WTP is also overloaded by 15%. Chinaimo WTP and Kaoleio WTP extract additional raw water from Mekong River by using floating pump facilities at the existing intake sites.

Although water treatment processes are usually designed with some allowance in the design capacities, the current overloading at these WTPs by over 10% seems to have reached a limit as floc carryover from sedimentation basins into sand filters is occurring. The water levels in the sedimentation basins have almost reached the overflow levels.

In terms of the water quality of the finished water from the WTPs, even during the overloaded operation, it is maintained to conform to the national drinking water quality criteria according to the past records of water quality analysis carried out by NPNL.

On the other hand, Dongbang WTP is operated at 76 % of its design capacity. This shortfall is explained by the facts that (1) the production has been cut down to avoid floc carryover from the sedimentation basins during periods of high raw water turbidity, and (2) the operation of the WTP was frequently disrupted by repair work of pipe bursts in the transmission pipeline. (The pipe material is GFCP, which causes frequent leaks.)

3.5 Current Conditions of Non-revenue Water

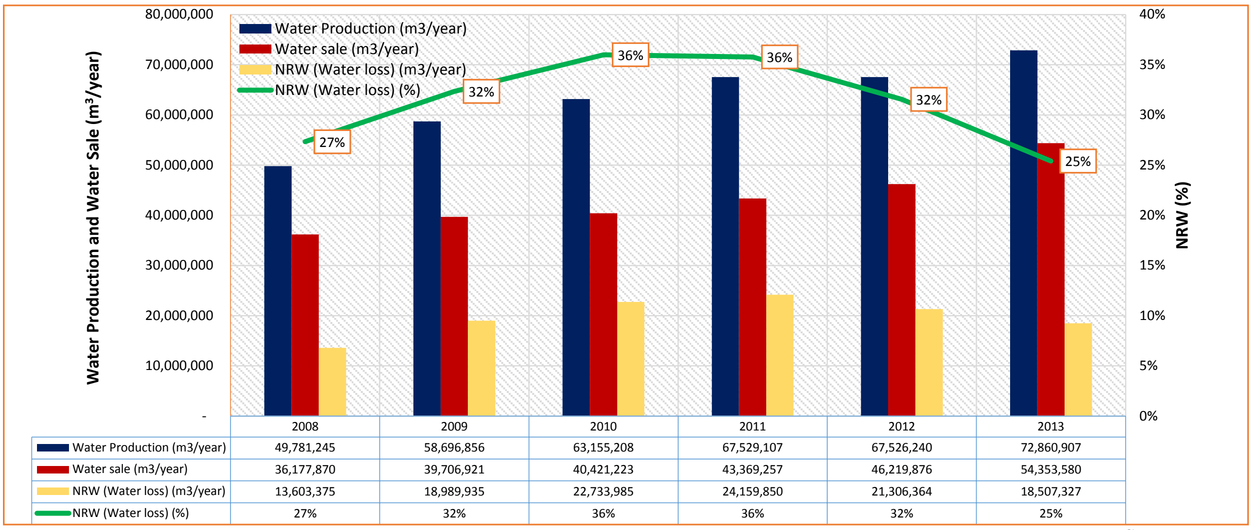
Water productions by the existing WTPs and water sold by the NPNL branches for the past six (6) years are shown in Table 3.5.1.

Table 3.5.1 Breakdown of Annual Water Production and Water Sales

No.	Description	Unit	Year (Unit: m³/year)						Remarks
			2008	2009	2010	2011	2012	2013	
I	**Water Production**	**m^3**	**49,781,245**	**58,696,856**	**63,155,208**	**67,529,107**	**67,526,240**	**72,860,907**	
1	Chinaimo WTP	-//-	31,084,110	30,733,637	31,030,111	31,666,256	31,985,534	34,044,404	
2	Kaoliew WTP	-//-	10,376,985	20,722,610	22,404,972	23,705,576	23,075,997	24,850,598	Expnd@2009
3	Dongmakkhay WTP	-//-	7,814,850	6,885,463	7,229,388	7,418,263	7,734,214	8,392,190	
4	Thadeua WTP	-//-	192,602	58,105	70,657	31,241	-	-	Stop 8/2011
5	Thangon WTP	-//-	312,698	297,041	335,706	314,496	-	-	Stop 5/2011
6	Dongbang WTP	-//-	-	-	2,084,374	4,393,275	4,730,495	5,573,715	Start 6/2010
II	**Water sale**	**m^3**	**36,177,870**	**39,706,921**	**40,421,223**	**43,369,257**	**46,219,876**	**54,353,580**	
1	Commercial section	-//-	8,092,593	8,211,977	7,815,717	8,698,825	9,093,952	12,648,354	
2	Sikhottabong branch	-//-	5,411,064	6,414,455	6,791,283	7,447,845	7,995,542	8,689,470	
3	Chanthabouly branch	-//-	5,407,891	6,097,356	6,253,781	6,400,208	6,564,797	7,383,014	
4	Saysettha branch	-//-	8,559,280	7,840,971	6,789,535	7,265,814	7,585,079	8,364,252	
5	Xaythany branch	-//-	-	1,851,282	3,275,989	3,909,817	5,012,073	5,971,917	set up 2009
6	Sisattanak branch	-//-	7,513,307	8,051,463	7,385,657	6,079,391	6,410,578	7,231,594	
7	Hadxayfong branch	-//-	914,950	1,007,614	1,777,237	3,216,026	3,557,855	4,064,979	
8	Thangon branch	-//-	278,785	231,803	332,024	351,331	-	-	2012 belong xaythany
III	**NRW (Water loss)**	**%**	**13,603,375**	**18,989,935**	**22,733,985**	**24,159,850**	**21,306,364**	**18,507,327**	
			27%	**32%**	**36%**	**36%**	**32%**	**25%**	

Source: NPNL

Non-Revenue Water (NRW) in Vientiane Capital for the past six (6) years is illustrated in Figure 3.5.1. It indicates the recent trend that NRW ratio had increased until the year 2010 reaching 36%. Then, the ratio started declining since the year 2011 and decreased to 25% in the year 2013.



Source: NPNL

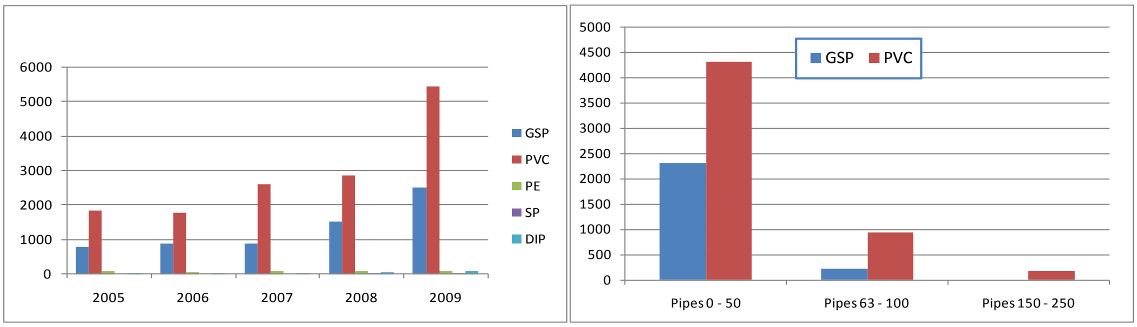
Figure 3.5.1 Annual Water Production, Water Sales and NRW

This recent reduction of NRW is explained by the activities described below. NPNL has launched NRW reduction program with assistance from the French Development Agency (hereafter, AfD) since 2012. The major activities in the program are listed as follows:

- to enhance the performance of customer meter readers by establishing a section to check the performance,
- to review standards for pipe materials and pipe laying technique,
- to reduce response time for leak detection and repair by clarifying procedures for repair and promoting the phone No. 1169 for leak reports,
- to check and follow up flow meters and promote the calibration and replacement of inaccurate meters, and

- to check and follow up customer meters and promote the replacement of defective meters.

Another important activity that significantly contributed NRW reduction is the replacement of old GSP pipes with HDPE or uPVC pipes.



Source: NPNL

Figure 3.5.2 Leakage Cases by Pipe Materials and Diameters

Records indicated that most cases of leakage occurred from Galvanized Steel Pipe (GSP) and Polyvinyl Chloride (PVC) pipes of diameters less than 100 mm, as shown in Figure 3.5.2. Based on such knowledge obtained from past experiences as well as data analysis, NPNL carried out the replacement of old GSP into High Density Polyethylene Pipe (HDPE) or un-Plasticized Polyvinyl Chloride (uPVC) pipes. The remaining length of GSP over 30 years old of diameter less than 100 mm is now merely 1,539 m (760 m for dia. 50mm and 688 m for dia. 75 mm).

3.6 Comprehensive Plan for Water Supply Facilities in Vientiane Capital

NPNL's basic concepts of the comprehensive development plan for the future water supply facilities are described in the following:

1) The service areas presently identified with water shortage or low water pressure such as surrounding areas of Dongdok University, 150-bed hospital, and Xamkhe Elevated Tank, as well as many villages located at higher elevations, should be addressed for immediate improvement.

2) In order to cope with increasing water demands due to the future development projects such as special economic zones (SEZ) and industrial zones discussed in the previous Chapter, water supply facilities should be strategically developed so as to accommodate these water demands in time.

3) The government offices and political functions of Vientiane Capital will be relocated to Thangone Area, which is located at the northern edge of Vientiane Capital.

3.7 Current Projects for Water Supply Sector in Vientiane Capital

For the past years, a number of bilateral and multilateral agencies have been supporting the GOL in its efforts to increase access to water and sanitation in the urban areas: the Asian Development Bank (ADB), the Japan International Cooperation Agency (JICA), the French Development Agency (AfD), UN-Habitat, the Water and Sanitation Program (WSP) of the World Bank, The Export-Import Bank of China (China Exim Bank), etc. Also, there are a few Public-Private Partnerships (Hereafter, PPP) based on private investment ongoing or in preparation.

Current projects related to water supply sector are listed in Table 3.7.1.

Table 3.7.1 Summary of Current Projects Related to Water Supply in Vientiane Capital

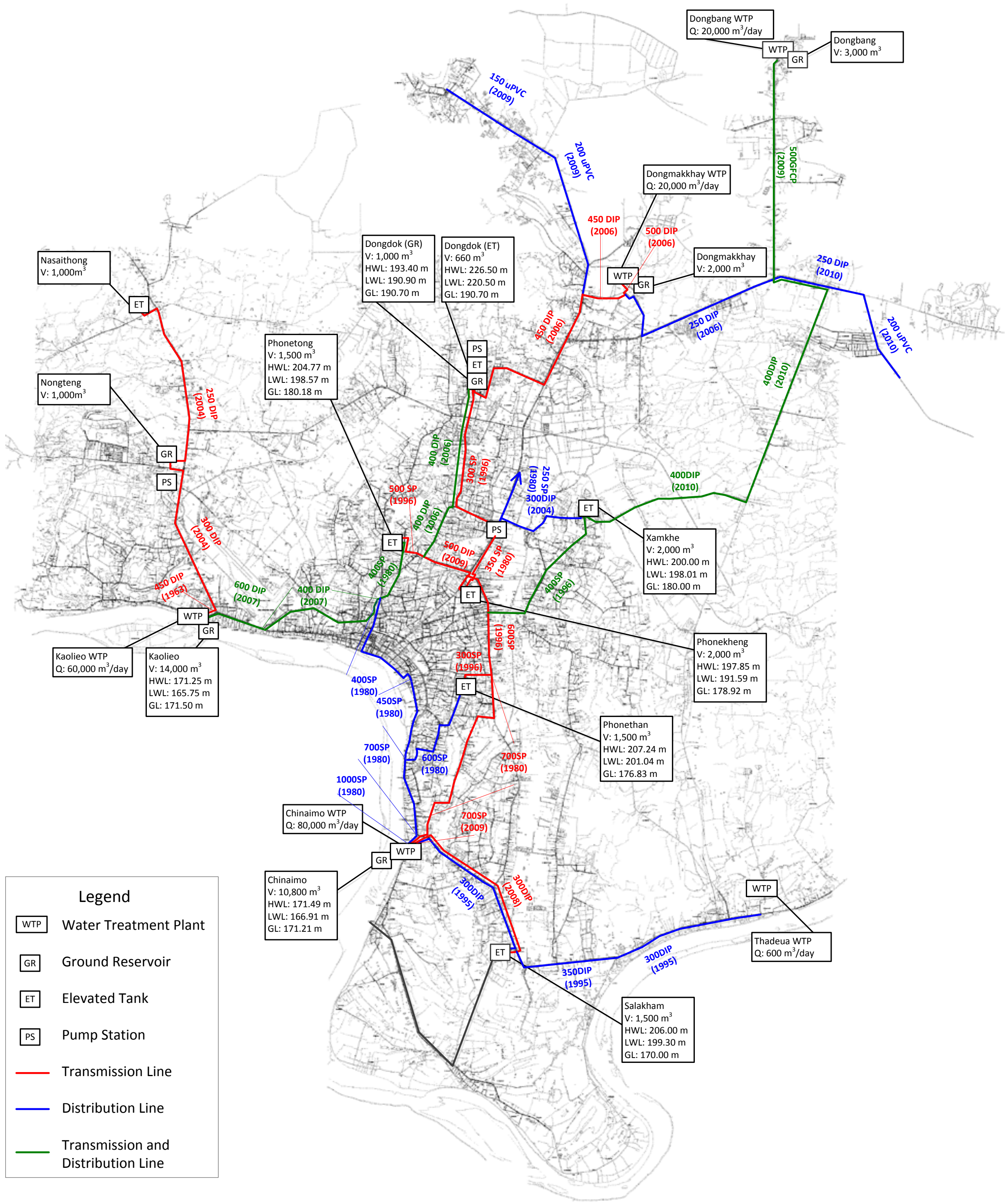
Project Name	Financed by	Remarks	Status
Nam Papa Nakhone Luang Water Supply Assets Master Plan, September 2014	AfD	Water supply master plan preparation for the target year of 2030.	Prepared the final report in Sep. 2014.
Replacement of GSP Pipes for Nakhone Luang Water Supply System – Phase II	AfD	Existing pipe replacement project	Completion of financial support by Nov. 2013
Dongmakkhay Extension Water Supply System	China Exim Bank Loan	Dongmakkhay WTP expansion (100,000 m^3/day) and pipe installations by EPC	Under construction, expected completion in the end of 2015
Vientiane Capital Water Supply Expansion Project	JICA	Chinaimo WTP expansion (40,000 m^3/day in Phase 1 and more 40,000 m^3/day in Phase 2) and pipe installations	Prepared the final report in June 2015.
Capacity Building Project for Water Supply Authorities	JICA	Technical cooperation project	On-going, continue to Aug. 2017
Thadeua Water Supply Project	Local Private Investor	Thadeua WTP construction (20,000 m^3/day) and pipe installations by BOT	Under construction (started since Jan. 2015), and expected completion in 2016.
Sendin Water Supply Project	Local Private Investor	Sendin WTP construction (20,000 m^3/day) and pipe installations byBOT	MOU was signed in May 2014. Contract signing would be in July 2015, and expected operation starts from 2017.
Dongbang Expansion Project	Under Consideration	Dongbang WTP expansion (20,000 m^3/day) and pipe installations	

Source: JST

The projects listed above will be discussed in a later part of this Chapter.

3.8 Existing Water Supply Facilities in Vientiane Capital

General layout of the existing water supply facilities in Vientiane Capital is illustrated in Figure 3.8.1.



Source: Prepared by JST from NPNL data

Figure 3.8.1 General Layout of the Existing Water Supply Facilities in Vientiane Capital

There are four (4) main water treatment plants. Treated water from the water treatment plants is once transmitted to the elevated tanks located at strategic locations in the distribution network to supply water to customers by gravity, or distributed directly by pumping from the water treatment plants to customers. Due to recent water shortages, the existing elevated tanks are, however, not utilized and by-passed.

3.8.1 Intake

Water supply in Vientiane Capital is dependent on two (2) main surface water sources, the Mekong River and the Nam Gnum River.

The Mekong River has a tendency of seasonal water level fluctuation of over 10 meters, and several types of water intake facilities were adopted to ensure constant water intake throughout the year. For instance, the oldest intake facility of NPNL is a tower type set in the Old Kaolieo WTP, constructed in 1964. In the New Kaolieo WTP, constructed next to the old one (i.e. Kaolieo WTP expansion 2006-2009), an intake pipe type was applied in order to minimize interference with each other. On the other hand, an intake gate has been used for around 35 years in Chinaimo WTP.

The Nam Gnum River also has a seasonal fluctuation of water level similar to the Mekong River. The Dongmakkhay WTP, however, extracts raw water from the existing irrigation canal derived from the irrigation intake facilities at Nam Gnum River. Dongban WTP utilizes floating pump intake facilities, which are applicable when the treatment capacity is not so large compared with Chinaimo and Kaoleio WTPs.

3.8.2 Water Treatment Plant

The main features of the existing four water treatment plants serving to Vientiane Capital are summarized in Table 3.8.1.

Table 3.8.1 Summary of the Existing Water Treatment Plants in Vientiane Capital

WTP	Completion Year	Capacity (m^3/d)	Water Source	Treatment method	Funding
Chinaimo	1968	40,000	Mekong River	Conventional rapid sand filtration	ADB
	1996 Rehabilitation Expansion	40,000	Mekong River	Conventional rapid sand filtration	Grant Aid of GOJ
Kaoleio	1964	20,000	Mekong River	Conventional rapid sand filtration	Grant Aid of GOJ
	2008 Expansion	40,000	Mekong River	Conventional rapid sand filtration	Grant Aid of GOJ
Dongmakkhay		20,000	Nam Ngum River	Conventional rapid sand filtration	GOL own fund
Dongban	2008	20,000	Nam Ngum River	Up-flow Clarifier + Self-backwash Rapid sand filter	NPNL+ Vietnam Private Company

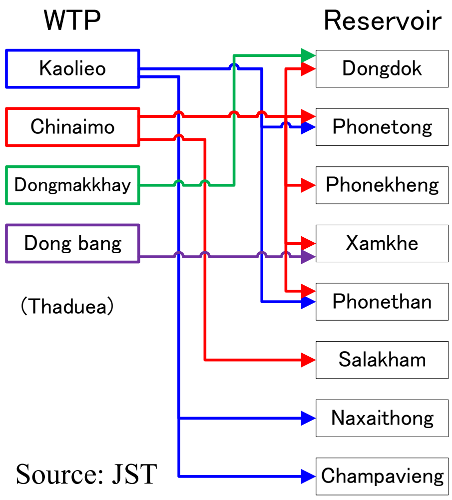
Source: JST

3.8.3 Transmission Pipelines

Existing transmission system from the existing WTPs to reservoirs are illustrated schematically in Figure 3.8.2.

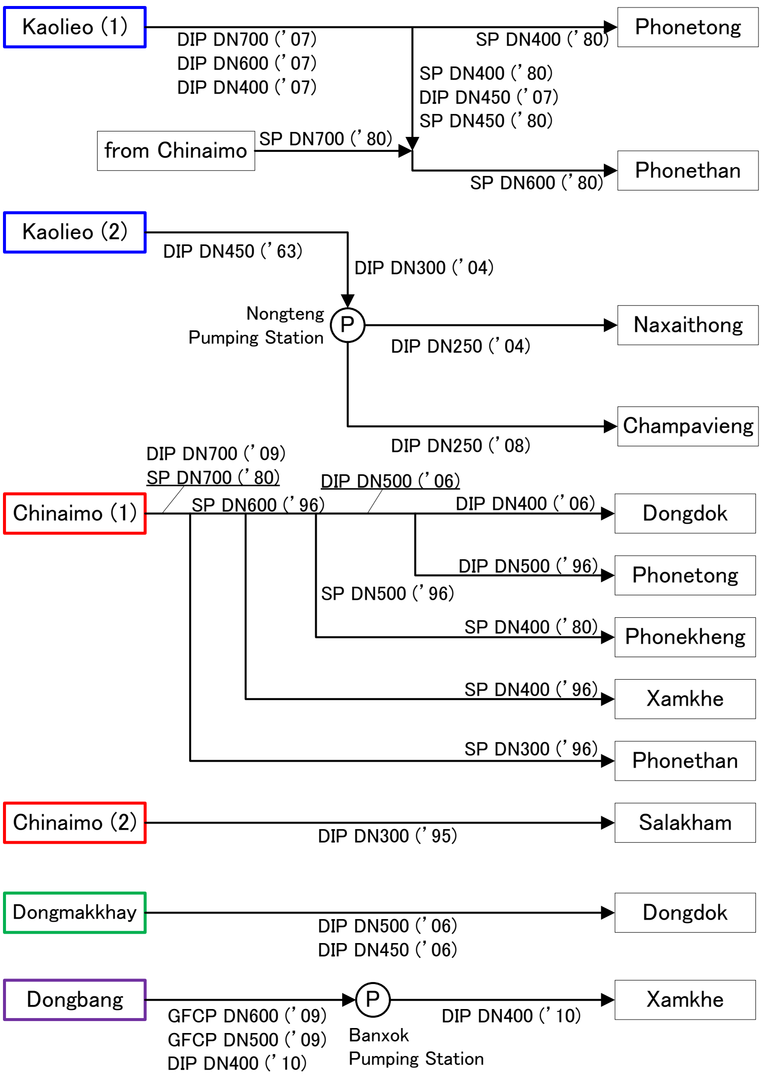
A single pipeline from each WTP, except Chinaimo WTP, functions as both transmission and distribution pipeline. Chinaimo WTP has separate transmission and distribution pipelines since the pipelines were isolated to stabilize the water supply by Japanese grant aid in 2009.

Materials, diameter and constructed year of transmission pipeline from each WTP are shown in Figure 3.8.3.



Source: JST

Figure 3.8.2 Schematic Chart of Transmission System



Source: JST

Figure 3.8.3 Materials, Diameter, and Constructed Year of Transmission Pipelines

3.8.4 Distribution Reservoir

The existing distribution reservoirs in Vientiane Capital are comprised of eight elevated tanks, two ground reservoirs, and four clear water reservoirs (a total of 14 reservoirs). A noteworthy fact is that all of the elevated tanks have not been operated for years due to water shortage. If the elevated tanks are operated in this situation, water flow in the pipelines would stop because air enters the pipeline. Thus, water supply to Vientiane Capital is presently distributed mainly by pumping. The summary of distribution reservoirs is shown in the following table.

Table 3.8.2 Summary of Distribution Reservoirs

Name	Type	Capacity (m^3)	Water Level (m)	WTP system	Remarks
Dongdok	Ground Reservoir	1,000	HWL +193.40 LWL +190.90	Chinaimo Dongmakkhay	-
Dongdok	Elevated Tank	660	HWL +226.50 LWL +220.50	Chinaimo Dongmakkhay	Unuse
Phonetong	Elevated Tank	1,500	HWL +204.77 LWL +198.57	Chinaimo Kaolieo Dongmakkhay	Unuse
Phonekheng	Elevated Tank	2,000	HWL +197.85 LWL +191.59	Chinaimo	Unuse
Xamkhe	Elevated Tank	2,000	HWL +200.00 LWL +198.01	Chinaimo Dongbang	Unuse
Phonethan	Elevated Tank	1,500	HWL +207.24 LWL +201.04	Chinaimo Kaolieo	Unuse
Salakham	Elevated Tank	1,500	HWL +206.00 LWL +199.30	Chinaimo	Unuse
Naxaithong	Elevated Tank	1,000	HWL +200.70 LWL +195.70	Kaolieo	Unuse
Nogteng	Ground Reservoir	1,000	HWL - LWL -	Kaolieo	-
Champavieng	Elevated Tank	400	HWL - LWL -	Kaolieo	Unuse
Sub-total		12,560			
Chinaimo WTP	Clear Water Reservoir (Ground)	10,800	HWL +170.60 LWL +167.90	Chinaimo	-
Kaolieo WTP	Clear Water Reservoir (Ground)	14,000	HWL +170.60 LWL +166.60	Kaolieo	-
Dongmakkhay WTP	Clear Water Reservoir (Ground)	2,000	HWL - LWL -	Dongmakkhay	-
Dongbang WTP	Clear Water Reservoir (Ground)	3,000	HWL - LWL -	Dongbang	-
Sub-total		29,800			
Total		42,360			

Source: Prepared by JST from NPNL data

Note: A total capacity of the clear water reservoirs set in vicinity of WTPs is 29,800 m^3. These reservoirs cannot be a buffer reservoir for water distribution.

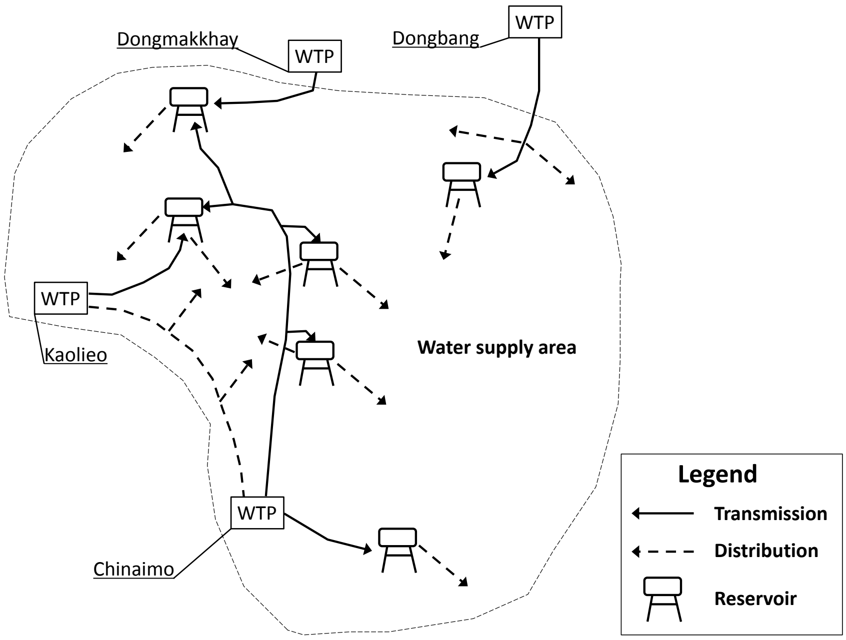
Salakham elevated tank

Phonethan elevated tank

3.8.5 Distribution Pipelines (Network) and Service Connection

(1) Block Distribution System

Block distribution systems have not been formulated in the areas covered by each of the reservoirs and WTPs. Thus, pipelines from reservoirs and WTPs are connected to each other in an ad hoc manner.



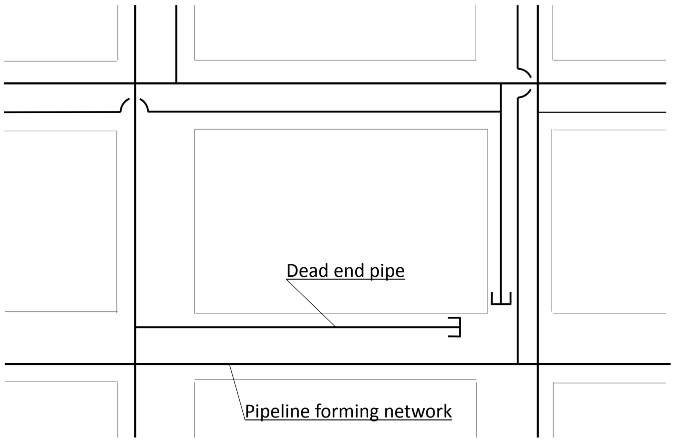
Source: JST

Figure 3.8.4 Schematic drawing of current water supply system (surrounding Chinaimo WTP)

(2) Situation of Pipeline Network

Current situation of the pipeline network is as follows.

- Pipeline is arranged as a network in the centre part of city. However, there is no pipeline positioned as the distribution main, and the pipe diameters are small in general. It is presumed that such a situation causes low water supply pressure.
- There are several small pipelines in some roads. It is presumed from such a situation that as water demand grew, instead of increasing the diameter of the network/distribution main pipelines, new (smaller diameter) pipe lines were laid parallel to the existing network to meet demand.
- Most of these pipelines laid in parallel do not constitute the pipeline network and form dead ends, as shown in the following figure. The dead end pipe causes the low water pressure.



Source: JST

Figure 3.8.5 Image of pipeline network in centre part of city

(3) Pipe Length

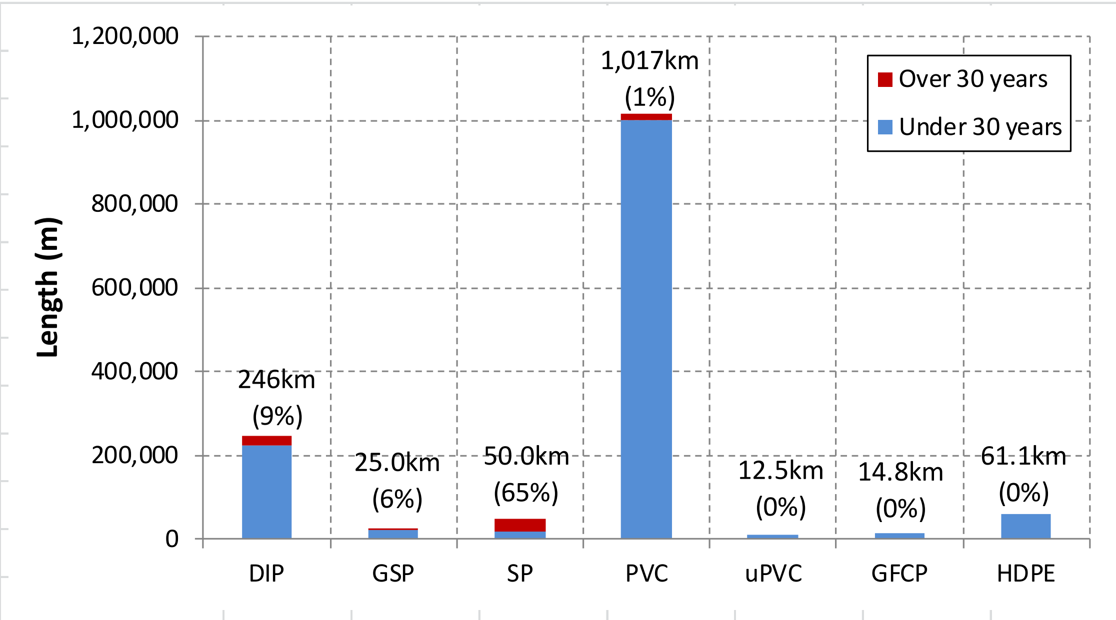
Table 3.8.3 and Figure 3.8.6 shows the total length of transmission and distribution pipes managed by NPNL. NPNL controls about 1,426 km of pipelines in Vientiane Capital.

There is 1,016 km of PVC, which accounts for 72 % of all pipeline in Vientiane Capital. There is 246 km of DIP, which accounts for 17 % of the network. The remainder of the network is composed of other materials, which share a consistent distribution in the range from 12 km to 61 km.

Table 3.8.3 Total Pipe length (Transmission and Distribution)

Diameter	Pipe Material (m)							Total (m)	Ratio (%)
	DIP	GSP	SP	PVC	uPVC	GFCP	HDPE		
ϕ 1000			386					386	0%
ϕ 700	1,538		9,685					11,223	1%
ϕ 600	3,118		7,774			150		11,042	1%
ϕ 500	464		2,919			14,678		18,061	1%
ϕ 450	18,465		7,296					25,761	2%
ϕ 400	23,400		10,875					34,275	2%
ϕ 350	9,735		4,264					13,999	1%
ϕ 300	38,211		6,607					44,818	3%
ϕ 250	36,736	50		50,544				87,330	6%
ϕ 200	36,833	153	42	101,094			400	138,522	10%
ϕ 150	22,481	631	27	131,092				154,231	11%
ϕ 110					3,996			3,996	0%
ϕ 100	24,685	3,695		199,341				227,721	16%
ϕ 90				18,873	8,503		693	28,069	2%
ϕ 80	36							36	0%
ϕ 75	27,437	7,338		253,212				287,987	20%
ϕ 63				32,667			34,280	66,947	5%
ϕ 50	2,870	8,249		159,820			24,542	195,481	14%
ϕ 40		4,858		70,323			1,227	76,408	5%
Total	246,009	24,974	49,875	1,016,966	12,499	14,828	61,142	1,426,293	100%
Ratio	17%	2%	3%	72%	1%	1%	4%	100.0%	−

Source: NPNL



Source:NPNL

Figure 3.8.6 Pipeline length (Transmission and Distribution)

Table 3.8.4 shows amount and types of piping over 30 years old. The longest pipe material over 30 years is Steel Pipe (SP), which has length of about 33 km, and then Ductile Iron Pipe (DIP) which has 22 km. The oldest existing pipe is DIP, installed in 1963. Age of the oldest pipe is over 50 years old.

Table 3.8.4 Pipe length over 30 years

Pipe System	Type	Dia	Installation Year				Length	Remarks
			1963	1973	1980	1983	Total (m)	
Distribution Pipe	uPVC	75				30	30	
		90					0	
		100		470			470	
		150				8,679	8,679	
		160					0	
		200					0	
		250				5,882	5,882	
		Subtotal					15,061	
Distribution Pipe	GSP	50	760				760	
		75				688	688	
		90					0	
		100					0	
		150			79		79	
		200			12		12	
		Subtotal					1,539	
Transmission and Distribution Pipe	DIP	75	2,231			24	2,255	
		100	2,409				2,409	
		150	11,731			502	12,233	
		200	1,944	1,309	156	707	4,116	
		250				520	520	
		300	27				27	
		350					0	
		400					0	
		450	492				492	
		500					0	
		600					0	
		700					0	
		800					0	
		900					0	
		1000					0	
		Subtotal					22,052	
Transmission and Distribution Pipe	SP	100			79		79	
		200			32		32	
		250	162		298		460	
		300			16		16	
		350			4,363		4,363	
		400			6,804		6,804	
		450			6,320		6,320	
		500					0	
		600			4,316		4,316	
		700			9,621		9,621	
		800			90		90	
		1000			438		438	
		1100			107		107	
		Subtotal					32,646	
Transmission	GFCP	500					7,200	Outlet from Dongbang WTP
Total			19,756	1,779	32,731	17,032	78,498	

Source: NPNL

(4) Pipe Materials

It was observed from the existing pipeline arrangement that pipe materials do not particularly correlate with diameters (i.e.: over 300mm is ductile iron pipe and under 250mm is polyethylene pipe etc). The current situation of pipe materials is as follows.

Table 3.8.5 Overall condition of pipe materials

• Pipe materials over 300mm diameter	
Ductile iron pipe	: Relatively new distribution pipe
Steel pipe	: Relatively old distribution pipe
• Pipe materials under 250mm diameter	
Cast iron pipe	: Distribution pipe laid in before or after 1963
Ductile iron pipe	: Distribution pipe laid after 2004
PVC (polyvinyl chloride) and uPVC	: Most part of distribution pipe
Steel pipe	: Old and below 50mm distribution pipe
Asbestos Cement Pipe	: Only small portion of distribution pipe
High Density Polyethylene Pipe	: Comparatively new pipe
• Pipe materials of house connection pipe	
HDPE	: DN20-63

Source: JST

3.8.6 Service Connection

The number of service connections in Vientiane Capital at the time of the 1st site survey (Sep. 2014) is 98,690 connections and the range of diameter is from 15 mm to 200 mm. The breakdown is shown in the following table.

Table 3.8.6 Number of existing water meters in Vientiane Capital

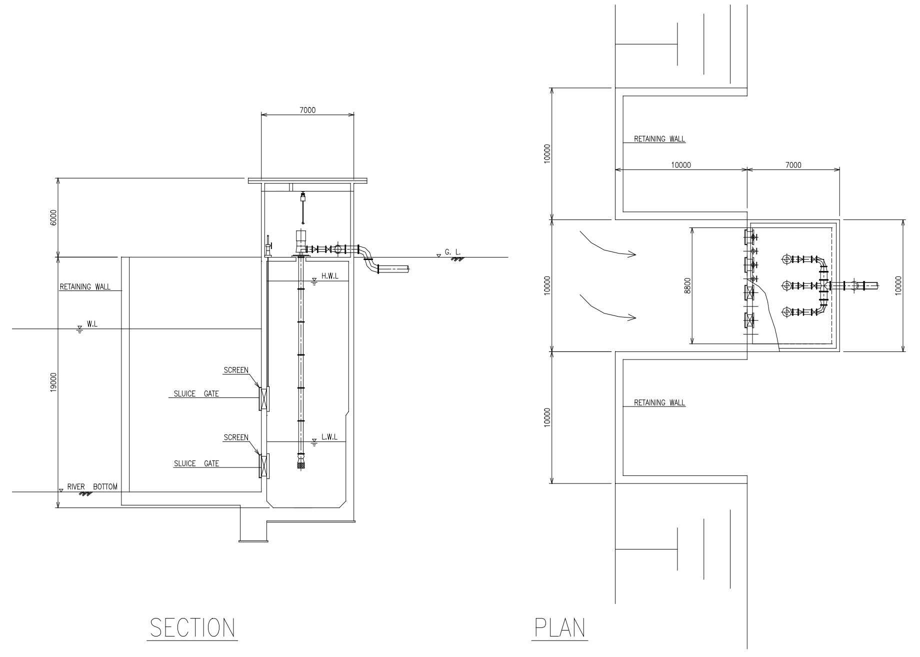
Name of Branch	DN15	DN20	DN25	DN40	DN50	DN80	DN100	DN150	DN200	Total
Sikhottabong + Naxaythong Branch	14,627	5,377	1,291	147	26	20	3			21,491
Chanthabuly Branch	9,496	5,415	945	169	7	16				16,048
Saysettha Branch	12,245	6,191	942	169	16	5				19,568
Sisattanak Branch	10,134	4,279	951	144	12	3				15,523
Xaithany Branch	10,457	3,528	500	155	13	1				14,654
Hatxayfong Branch	7,626	2,194	222	32	5	1	2			10,082
Commercial Section	141	361	241	333	78	101	69	8	4	1,336
Total	64,726	27,345	5,092	1,149	157	147	74	8	4	98,702

Source: Nampapa Water Meter Management Section (date: 28, Aug. 2014)

3.9 Existing Facilities in Chinaimo WTP

3.9.1 Intake Facility in Chinaimo WTP

The following sections further explain the existing conditions of Chinaimo intake facilities, as shown in Figure 3.9.1.

Chinaimo Intake (Intake Gate Type)	

Source: JST

Figure 3.9.1 Existing Water Intake Facilities for Chinaimo Water Treatment Plants

a. Raw Water Intake Structure

The raw water intake structure was inspected and observed, and there was no any severe or critical damage in over 35 years of service. No trash rack or screen were provided.

b. Raw Water Pumps

A total of six pumps were installed in the raw water intake pump station. The basic specifications of them are tabulated below.

Pump No.	Insta. Unit	Each Pump Capacity m^3/min	Pump TDH m	Type of Pump	Note
P-RW1 to 4	4	18	14.8	Vertical Mixed Flow	Having line shaft protection pipe with water seal
P-RW5&6	2	18	14.8	Submersible	Special water sealed submersible motor

Source: JST

At the time of filed inspection, pumps No. 2, 3, 4 and 5 were in service, and operation condition of the vertical mixed flow pumps No.2, 3 and 4 were observed without any vibration or noise. They were well maintained. On the other hand, the operation condition of pump No.5 was not confirmed visually due to under water operation. Total pump discharge flow was indicated at a monitor and control panel, and was about 4,000 m^3/hr (96,000 m^3/day). Motor of pump No.1 was removed for repair.

Pumps No.1 to No.4 have been in service since 1978 and were overhauled in 1994 by JICA grant aid project. They have been in service for over 35 years without any serious troubles due to very good maintenance work. It was reported that the pump shaft bearing and shaft sleeve located near the pump impeller are replaced every 1.5 to 2 years due to wearing, while the line shaft is protected by a protection pipe, and clear water lubrication is provided.

In addition, two submersible motor pump units were installed under JICA grant aid project in 1994, and since commencement of service, no operation and maintenance issues have been reported.

c. Electrical Power Supply and Pump Control Panels
Electrical power is supplied from motor control centers (MCC-1 and MCC-7) located at water treatment plant to motor control centers (MCC-2 and MCC-6) for raw water pumps. All electrical panels mentioned and other panels are well maintained and no serious problem of electric power supply system is reported.

3.9.2 Water Treatment Facility in Chinaimo WTP

The details of the existing conditions of Chinaimo WTP are further described below:

a. Receiving Well and Rapid Mixing
Raw water pumped by raw water pumps enters the receiving well through raw water main pipes. It is split into four (4) streams by four (4) fixed weirs at the receiving well, and flows into four (4) flocculation basins. The system was designed with two (2) possible coagulant injection points: 1) two (2) dosing pipes at the spout of the raw water discharge pipe, and 2) four (4) dosing shower pipes above the four (4) fixed weirs, but neither are currently utilized. At present, the system has been modified so that coagulant and alum are dosed at the raw water main pipe, before the receiving well.

After close observation of floc formation at the flocculation basins, it was judged that rapid mixing, mixing raw water and coagulant, was achieved relatively well. However, it was understood that coagulated water after alum injection was resulting in high hydraulic energy due to falling water at the flow split weirs, and there was possibility of breaking the small floc formed due to high hydraulic energy. Thus, it was recommended to dose coagulant and alum at the flow splitting weirs by using the alum dosing showers originally designed and provided.

b. Flocculation Basins and Sedimentation Basins
Coagulated water enters four (4) flocculation basins having zig-zag and up&down hydraulic flocculation system and at the inlet part of each flocculation basin, polymer is injected. Coagulated water is given hydraulic energy for flocculation, and proper flocculation by using hydraulic energy is observed. According to engineering practice of polymer injection point design, the present injection point of polymer is considered not proper. It is recommended to seek other injection points of polymer, further downstream the flocculation basin for the creation of bigger floc.

Floc laden water enters four (4) horizontal flow sedimentation basins and time is given for floc settlement for sedimentation. Overflow collection weirs provided collect~~s~~ settled water properly. As result of observing settled water with low turbidity, flocculation and sedimentation process of main water treatment process at the plant was judged good. Settled water collected enters the filter inlet conduit.

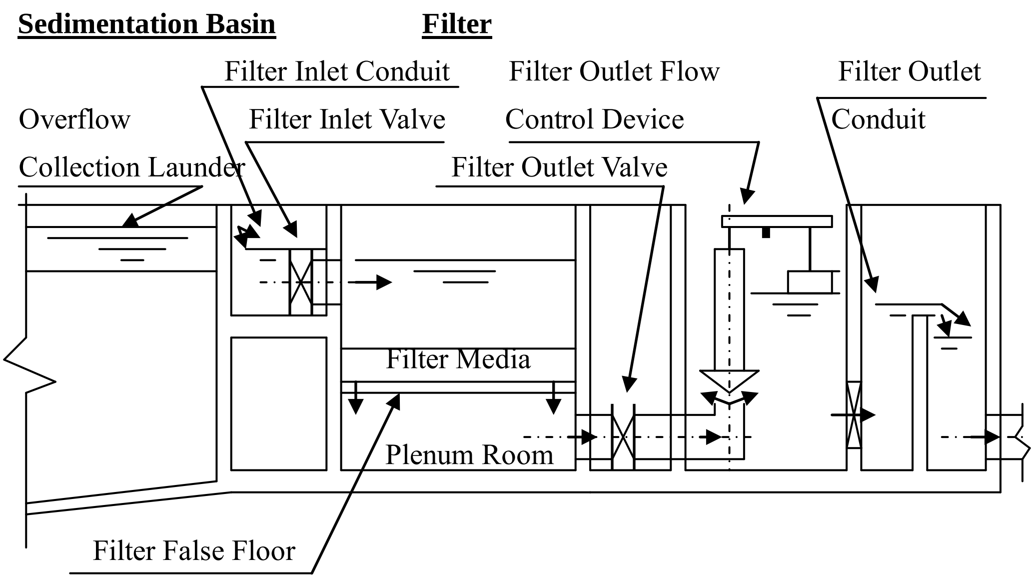
c. Filters
Filter type is common inlet and outlet water level type, and constant filtration rate is achieved with use of filter outlet flow control devices. A total of eight (8) filters were constructed. At present, seven (7) filters are in service and one (1) filter is out of service to repair cracks in the filter false floor, which is made of porous concrete. It is theorized that the cracking of the false floor occurred due to

insufficient air ventilation after air scouring of the filter. Air vent valves were designed and provided at the air scouring pipes. It is recommended to pay close attention for proper air venting after air scouring by opening the air vent valve of each filter.

Filter outlet flow control device of the filters in service function well, and outlet water level of each filter is properly controlled for constant filtration.

Filter washing facilities, consisting of two (2) back wash pumps, each with capacity of 25.5 m3/min x 6 m x 37 kW, and two (2) air souring blowers, each with capacity of 83 m3/min x 90 kW, were designed and installed. According to visual inspection, they are well maintained. All pumps, and one (1) blower, were manufactured in 1978 and have been in service for over 35 years. Another blower also has been in service for over 20 years. The figure below illustrates the basic flow of the existing filter.

Basic Flow of Existing Filter



Source: JST

d. Chemical Feed System

There are chemical feed systems such as coagulant (alum) feed system, lime feed system, calcium hypochlorite feed system and polymer feed system. Present status of operation condition of each system is described as follows.

1) Alum Feed System

Alum solution is prepared by mixing alum stone and water in alum preparation tanks, each having a mixer constructed of concrete with anti-acid lining. Alum solution prepared is fed to the alum injection point by gravity, and dosing of alum is measured by using a manual measuring device; a multi-step adjustable weir at constant water level tanks. This gravity dosing system was observed to be relatively effective based on observation of good floc formation. Linings of all alum preparation tanks were observed to be seriously damaged. For precise and economical operation of the alum feeding process, it is recommended to consider alum feed systems consisting of solution tanks having good anti-acid properties and alum feeding with use of metering pumps.

2) Lime Feed System

A lime feed system, consisting of two (2) lime milk preparation tanks, each having a mixer and a lime saturator, that is able to continuously produce lime water and saturated lime water were designed and constructed. However, lime feeding is currently not carried out because lime feeding is currently not required. All equipment of the lime feed system seem to be out of service due to long time stoppage of equipment.

3) Calcium Hypochlorite Feed System

The calcium hypochlorite feed system consists of three (3) solution tanks, each having a mixer and constant water level feed tanks with measuring device; a multi-step adjustable weir. Granule calcium hypochlorite is dissolved in solution tanks and a solution of calcium hypochlorite is prepared. Feeding is controlled by a manual measuring device; a multi-step adjustable weir at constant water level tank, and fed to pre- and post-chlorination points by gravity. It was observed that all facilities of the calcium hypochlorite feed system were well maintained, but serious corrosion of ferrous materials was observed due to insufficient ventilation.

4) Polymer Feed System

Two (2) polymer solution tanks are located beside the receiving well, and the polymer solution prepared is manually dosed to the inlet part of the flocculation basin by gravity without using any measuring devices. Considering not only precise feeding but also saving cost of polymer, it is recommended to provide metering device for polymer solution.

e. Transmission and Distribution Pumps

There are two (2) pump stations. The old pump station is located beside the filter outlet conduit and the other one is the new distribution pump station. The old pump station houses two (2) transmission pumps (small, manufactured in 1978), each rated at 4.3 m^3/min x 66 m, three (3) transmission pumps (No.1 to No.3, manufactured in 1978), each rated at 14.1 m^3/min x 56 m, three (3) transmission pumps (No.4 to No.6, manufactured in 1994), two (2) backwash pumps, and two (2) air scouring blowers. The new pump station houses four (4) distribution pumps (No. 2 and No. 4, manufactured in 2007), each rated at 13.4 m^3/min x 72 m. All pumps and blowers were kept in good condition. At the time of filed inspection, one (1) transmission pump (small No.2), two (2) transmission pumps (No.3 and No.6) and two (2) distribution pumps (No.2 and No.4) were in service. Discharge flow of each pump in service was estimated as follows based on total pump dynamic head (reading of discharge pressure gauge – reading of suction pressure gauge), while indications of flow meters for transmission and distribution were not available since flow measuring devices were not in service.

Table 3.9.1 Parameters of Pump in Service

Name of Pump in Service	Reading Discharge Pressure, DP, m	Reading Suction Pressure, SP, m	TDH = DP-SP	Pump Discharge Flow m^3/min*	Memo
Transmission Pump (small) 4.3 m^3/min x 66 m	52	-4	56	7	TDH :56 m < 66 m rated
Transmission Pump No.3 14.1 m^3/min x 56 m	56	-2.72	58.72	13	TDH:58.72m >56 m rated
Transmission Pump No.6 14.1 m^3/min x 56 m	52	-2.85	54.85	15	TDH:54.72m < 56 m rated
Distribution Pump, No.2 13.4 m^3/min x 72 m	65.26	- 3.67	68.93	15	TDH:68.93m < 72m rated
Distribution Pump, No.4 13.4 m^3/min x 72 m	Not reading	Not reading	-	15 (assumed)	Based on No.2 pump

Total Transmission and Distribution Flow	65 m^3/min = 93,500 m^3/day
Raw Water Flow indicated	96,000 m^3/day

Note:
*: Pump discharge flow is assumed according to estimated pump QH curve based on pump TDH (distribution pressure – suction pressure) under operation. In case of smaller TDH than rated pump head, pump discharge flow being bigger than it rated and in case of higher TDH than rated pump head, pump discharge flow being smaller than it rated in accordance pump capacity – head characteristic.
Source: JST

f. Electric Power Receiving and Distribution System

Electric power substation was modified under JICA grand aid project in 2007 and after modification, electrical power receiving and distribution system are as follows.

1) 22 kV high tension power is supplied from electric power supply company and received by 24 KV incoming panel,
2) 22 kV high tension power is stepped down to 380 V low tension power by two (2) main transformers, each rated at 1,000 kVA,
3) 380 V low tension power is supplied from one (1) main transformer to a secondary incoming panel at the distribution pump station for power supply of distribution pumps located in the new distribution pump station, through low voltage feed panel,
4) 380 V low tension power from the secondary incoming panel is distributed to distribution control panels (No.1 to No.4) for the four (4) distribution pumps and to the auxiliary equipment feeder panel,
5) 380 V low tension power is supplied from the other main transformer to two (2) 380V feeder panels, No.1 and No.2, for power supply of the water treatment plant and raw water pump station and
6) 380 V low tension power is supplied from 380 V feeder panels No.1 to No.2 to two (2) motor control centers (MCC-7 and MCC-1), and from the motor control centers MCC-7 and MCC-1, 380 V low tension power is supplied to the raw water pump station.

All electrical equipment of electric power receiving and distribution system is well maintained and is in service. As result of field investigation, electric power supply from electric power supply company is deemed stable and reliable as loop electric power supply system is provided.

The present electricity consumption in Chinaimo WTP is approximately 30,000 kWh per day, which constitutes 46% of the total electricity consumption of the entire NPNL and 0.9% of the total electricity consumption of Vientiane Capital. Table 3.9.2 shows the annual electricity consumptions of Chinaimo WTP, NPNL and Vientiane Capital.

Table 3.9.2 Annual Electricity Consumptions of Chinaimo WTP, NPNL and Vientiane Capital in the Year 2013

(unit: kWh)

Chinaimo WTP	The Entire NPNL	Vientiane Capital
11,134,652	24,122,704	1,187,030,381

Source: NPNL, and EDL

3.9.3 Transmission and Distribution Facility in Chinaimo WTP

At Chinaimo WTP, a trunk line, which was originally mixture of transmission and distribution mains, was separated to a transmission line and a distribution line in the Project for the Vientiane Water Supply Development (2006-2009) by JICA's Grant Aid as shown in Figure 3.9.2

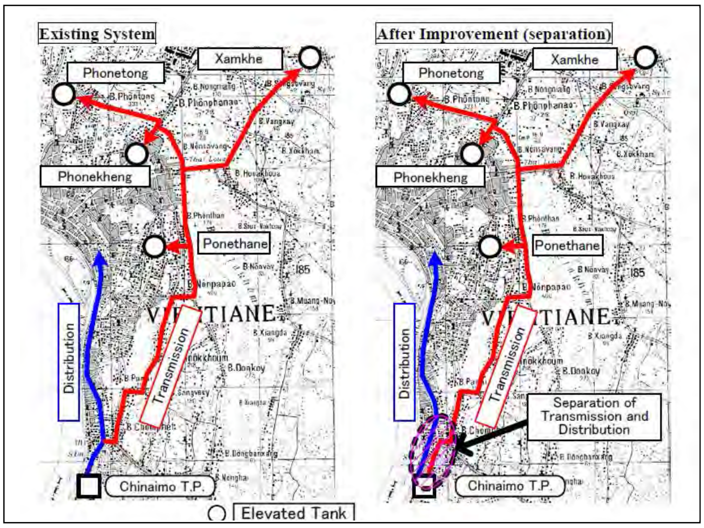


Figure 3.9.2 Separation of Transmission and Distribution lines at Chinaimo

Source: BD Report on the Project for Vientiane Water Supply Development (2005)

This scheme aimed to improve water supply service by reducing fluctuations in water supply and stabilize the amount of water available.

The materials of the transmission pipeline is ductile iron pipe (DIP) with a nominal diameter of DN700mm installed in 2009, and that of the distribution pipeline is steel pipe (SP) with a nominal diameter of DN700mm installed in 1980.

According to the results of hydraulic network analysis, the quantities of water for transmission and distribution are:

- Water Transmission 29,000 m^3/day
- Water Distribution 51,000 m^3/day

Total 80,000 m^3/day

3.9.4 Power Availability

Power supply to Chinaimo WTP is supplied by Electricite du Laos (EDL), which is a state-owned enterprise under Ministry of Energy and Mines. Chinaimo WTP site is located within the double 115 kV main transmission lines of the existing EDL national power grid, which can supply to the WTP from the branched 22 kV loop line from the two different directions.

According to the Chinaimo WTP director, power supply to Chinaimo WTP is stable with no serious power outage, and the recent discussion between NPNL and EDL confirmed reliable power supply would be continuously maintained from EDL to Chinaimo WTP. Further confirmation with EDL will be made when the power capacity requirement of the planned new equipment and facilities are fixed.

3.10 Operation and Maintenance

3.10.1 Water Treatment Plants

Water treatment processes of the existing water treatment plants are operated by monitoring the raw water quality, clarified water quality from sedimentation basins, and filtered water quality, and chemical dosages are adjusted based on Jar test results conducted by laboratory staff.

NPNL has long-term operation experience of conventional rapid sand filter systems, and the finished water quality is consistently satisfactory for drinking water quality standards, even when raw water turbidity levels reach several thousand NTU.

Although there seems to be no serious problems concerning operation and maintenance of the water treatment plants, the following maintenance works are, among others, identified as the most important tasks for the plant operators;

- flow measurement equipment,
- intake pumps (vertical-shaft pumps),
- transmission and distribution pumps, and
- de-sludging of sediments of Mekong river at the intake site during dry seasons.

Regarding the operation cost, approximately 68% of the total expenditure was electricity cost, and chemical cost constituted 21 % for Chinaimo WTP in the year 2013. Electricity cost is mainly derived from the operation of pumps, and constitutes majority of the operation expenditure because raw water intake and water transmission and distribution are all dependent on pumping. Table 3.10.1 shows the record of operation costs in Chinaimo WTP (current capacity of 80,000 m^3/day) in 2013.

Table 3.10.1 Chinaimo WTP Operation Costs (Current: Capacity 80,000 m^3/day) in 2013

Items	Operation Cost	Amount(LAK)	Amount(USD)	Percentage
1	Electricity	7,383,170,880	922,896	67.8%
2	Chemical	2,279,520,810	284,940	20.9%
	2.1 Alum	1,440,617,600	180,077	-
	2.2 Chlorine	805,672,800	100,709	-
	2.3 Polymer	33,230,410	4,154	-
3	Fuel	46,800,000	5,850	0.4%
4	Personal Cost	1,160,208,717	145,026	10.7%
5	Vehicle	22,000,000	2,750	0.2%
6	Others (Overtime Wages)	0	0	
Total		10,891,700,407	1,361,463	100.0%

Source: Chinaimo WTP

3.10.2 Water Transmission and Distribution Network

The existing distribution network has not been properly arranged to distribute water evenly within proper water pressure range to customers. This is due to the fact that many small diameter pipes were installed on a patchwork basis without proper hydraulic design to catch up with the past increasing water demands. Substantial sections of the existing service area are now subject to low water pressure, and it is indicative that there are a lot of bottle-neck pipes in the network system. What is worse, most of the transmission mains are presently utilized for distribution pipes as the elevated tanks are by-passed due to the lack of water transmitted from the water treatment plants to the elevated tanks.

This situation makes it difficult for NPNL to control the transmission and distribution system as the present practice of NPNL is only operating the network valves, and this brings very limited effects. NPNL Master Plan also identified such problems of existing distribution system control, and proposed the establishment of 18 distribution zones to improve the transmission and distribution system and to facilitate the effective distribution control.

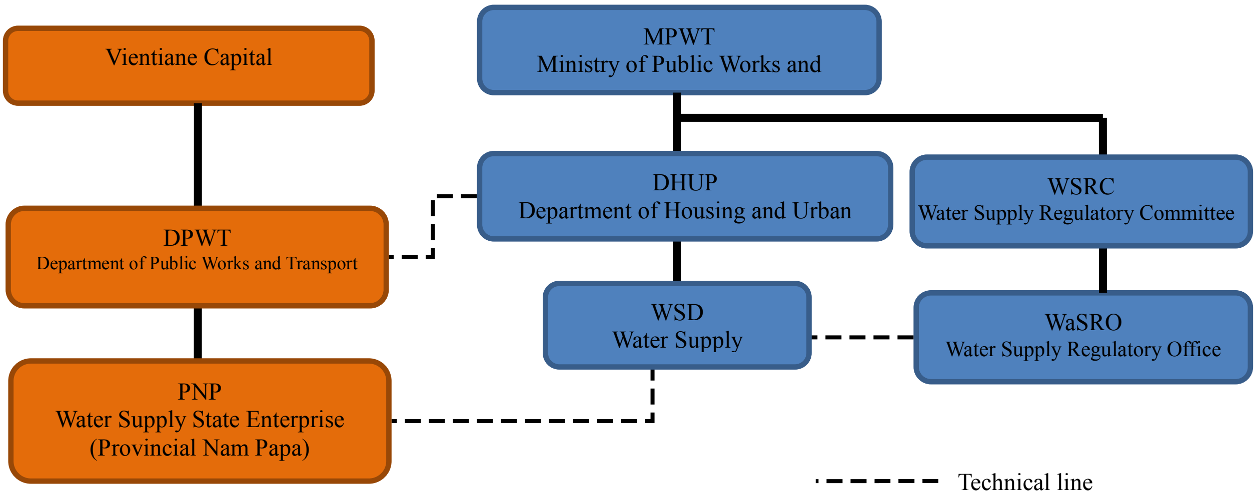
Regarding leakage control, NPNL organized four leakage control teams. Each team consists of 3 – 4 crew members. Among the four teams, one is responsible for leakage detection and minimum night flow measurement, and the other three for leak repair. The present way of leakage control is still categorized as “passive maintenance” since most of the repair works begin with the customers’ complaints on leakage.

Preventive maintenance policy does not seem to be introduced in many related technical areas of NPNL. Importance of selecting proper pipe materials and improvement of workmanship of pipe installation has been, however, recognized among the NPNL staff.

NPNL is now monitoring water quality (residual chlorine) and water pressure at 90 points and 108 points, respectively, in the distribution network.

3.11 Water Supply Sector Organizations

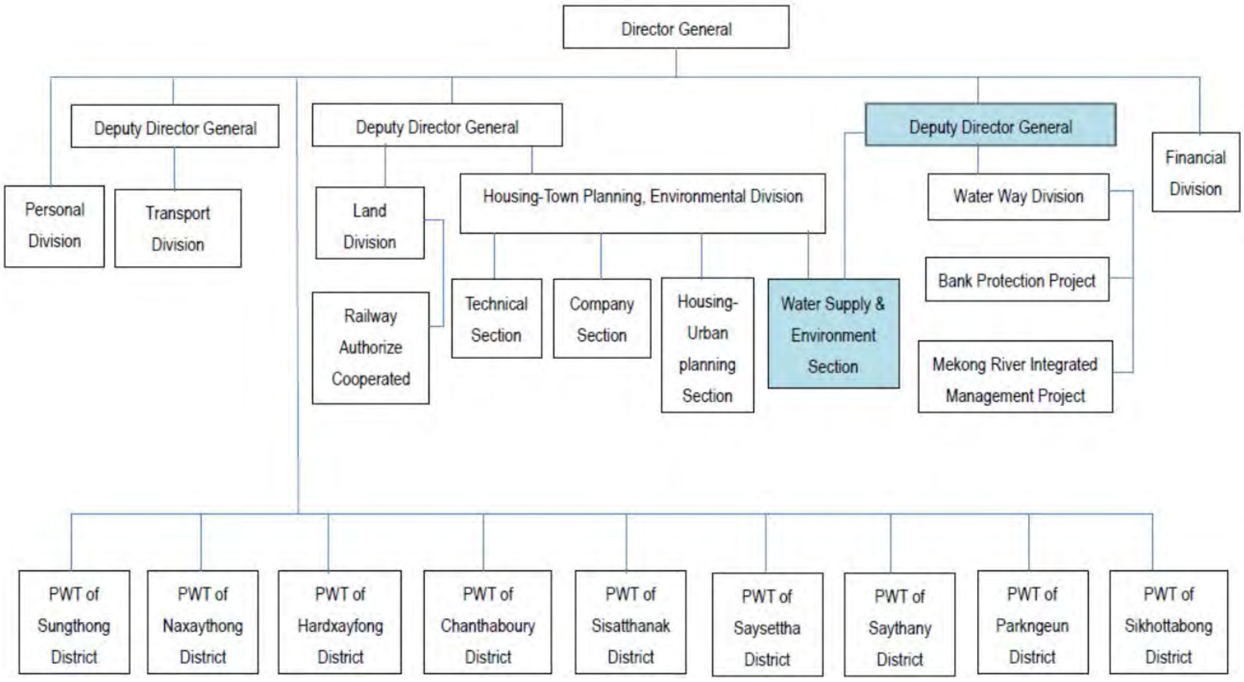
At the national level, the Ministry of Public Works and Transportation (MPWT) is responsible for urban water supply in the Lao PDR. The MPWT mandate includes planning and programming, mobilizing financing, developing guidelines for design, construction, and operation and maintenance of urban water supply facilities, and technical assistance to Water Supply State Enterprises (i.e. State-owned Provincial Nam Papa, PNP). Within MPWT, this responsibility is lodged with the Department of Housing and Urban Planning (DHUP), and further delegated to the Water Supply Division (WSD). The DHUP is responsible for 1) creating and improving laws, agreement, regulations and technical standards, 2) monitoring, inspections and creating those mechanism, 3) arrange of training and creating instruction paper or manual for the usage of unit price setting, bidding regulations, etc. 4) funding and coordination with the donors, and 5) approving a survey, design and cost of water supply projects with the total cost of more than 10 billion Kip. Water Supply Regulatory Committee (WSRC) under MPWT regulates both public and private service providers. It is chaired by MPWT’s Vice Minister and has nine members including representatives from the government, the private sector industry, consumers, and water operators. Water Supply Regulatory Office (WaSRO) as the secretariat of WSRC is responsible for drafting of regulatory plans, regulations and guidelines, and monitoring and evaluation of providers’ performance.



Source: DPWT Vientiane Capital,

Figure 3.11.1 Water Supply Sector Organizations related to the Project

With regard to water supply projects in Vientiane Capital, Department of Public Works and Transportation (DPWT) Vientiane Capital is responsible for 1) survey, design, planning and issuing construction permit for a construction project, 2) confirmation and approve of the survey-design and cost of the construction and repair projects with the total cost of 5 – 7 billion Kip, and 3) arrangement of the bidding for procurement, employment or negotiation as well as implementation of all construction projects. One of the main tasks of DPWT is to prepare plans for developing activities on public works and transport within the province and Vientiane Capital by endorsement of a provincial governor/mayor and to submit those plans to the Minister of MPWT for approval. DPWT shall also coordinate with district offices, provincial departments and Vientiane Capital and all departments under Ministries for implementation of its activities at the provincial or municipality (micro) level. The technical line in Figure 3.11.1 means relationship of technical advice and regulation. Figure 3.11.2 shows the organization chart of DPWT.

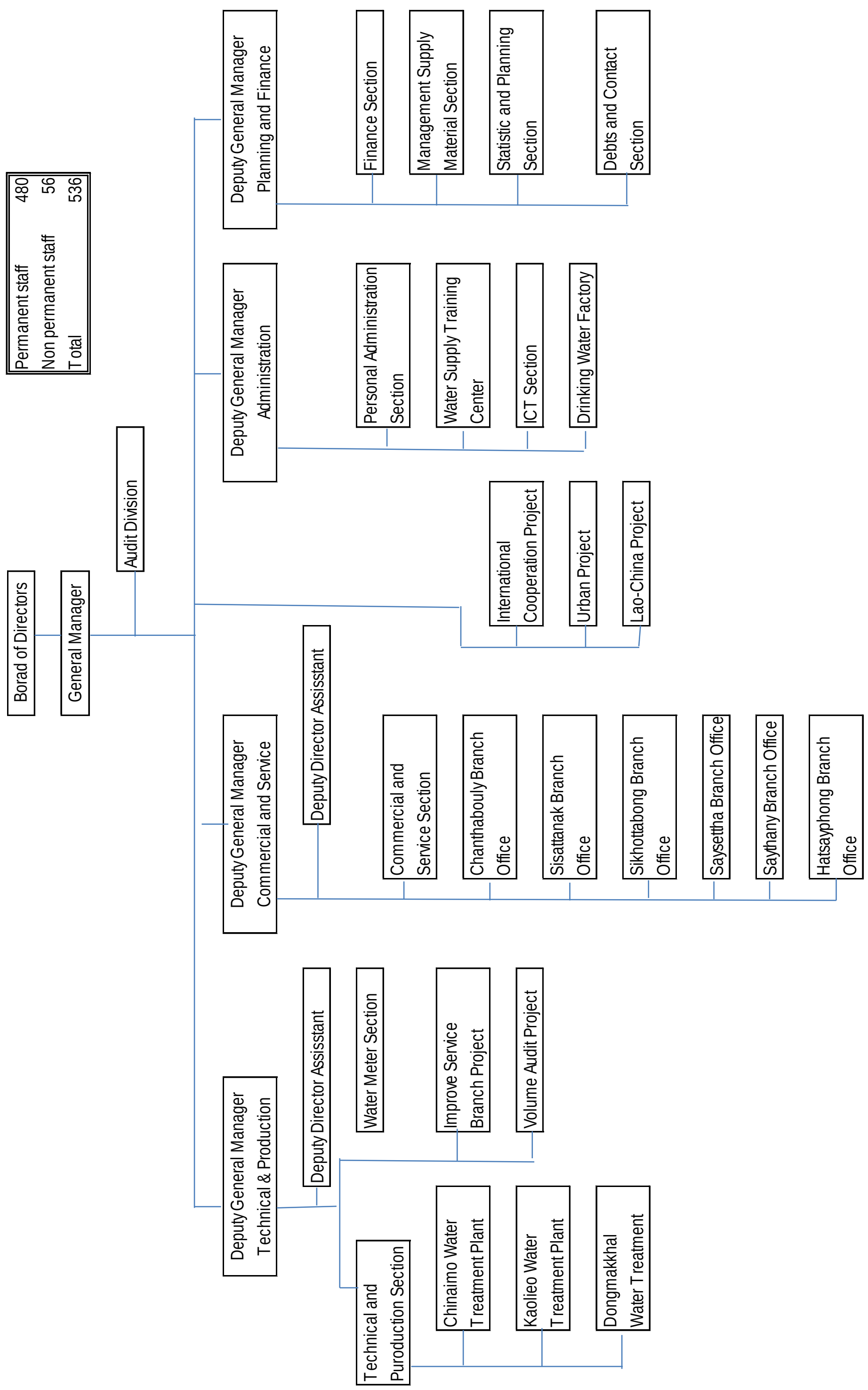


Source: DPWT Vientiane Capital

Figure 3.11.2 Organization Chart of DPWT Vientiane Capital

Under the control of DPWT, Vientiane Capital Water Supply State Enterprise, known as NamPapa Nakhone Luang (NPNL) is responsible for water supply in Vientiane Capital. The organization chart of the NPNL is shown as Figure 3.11.3. It is noted that the Technical and Production Section is directly responsible for water distribution facilities.

NPNL describes its mission as follows: NPNL has to provide an uninterrupted supply of potable water to its consumers at an affordable and reasonable tariff. It aims to meet 90% of the urban water supply needs of Vientiane Capital by the year 2020 in an efficient and cost effective manner. It is committed to becoming self-financing for capital investment, providing adequate returns to the government on its investment, delivering a high level of service efficiently to consumers.



Source: NPNL

Figure 3.11.3 Organization Chart of NPNL

Board of Directors, Technical and Production Section, Dongmakkhay Water Treatment Plant, Debts and Contracts Section

3.12 Water Tariff Setting

Water tariff table and category of customers are shown in Table 3.12.1 and Table 3.12.2, respectively. This tariff table was agreed with Governor of Vientiane Capital and noticed by General Director of NPNL on September 2014. The tariff table also includes the planned future water tariffs, which were approved at the same time. NPNL will raise it 3% to 5% every year, up to the year 2018, continuously.

Table 3.12.1 Present and Future Water Tariff of NPNL (effective from the end of Sept. 2014)

Category	Type of User	Change of Unit price (LAK /m^3) of each year				
		2014	2015	2016	2017	2018
		-	3%	3%	4%	5%
1	Category 1: Household					
	1-10 m^3/month	1,300	1,339	1,379	1,434	1,560
	11-30 m^3/month	1,800	1,854	1,910	1,986	2,085
	31-50 m^3/month	2,300	2,369	2,440	2,538	2,665
	51m^3/month and more	2,800	2,884	2,970	3,089	3,244
2	Category 2: Governmental, embassy, and international organization	2,300	2,369	2,440	2,538	2,665
3	Category 3: Business industry & commercial	2,800	2,884	2,971	3,089	3,244

Note: The above water tariff is effective from September 2014 until 2018
Source: Agreement No.900, dated 4 September 2014, Vientiane Capital Governor

Table 3.12.2 Category of Water Tariff (NPNL)

No.	Category	Type of Customer
I	Category 1: Household	- Farmer - Soldier / police staff - Retired staff - Household
II	Category 2: Government	- State administrative organization - Public hospital / school - Ministry - Park - International organization
III	Category 3: Business industry & commercial	- Industry, factory & company - Hotel, guesthouse, restaurant - Private school / hospital

Source: NPNL

Water tariff system of NPNL is a volumetric charge with increasing block rate[10]. All of the customers have installed respective water meters, which are read to calculate monthly water bills to implement the tariff. Customers are categorized into three (3) types: households, government, and commercial & industry.

[10] Water charge is calculated by consumption volume (volumetric charge), unit price is differ for each range of volume (block), with higher unit price for higher block (increasing block rate).

In Vientiane Capital, water tariffs are set to cover all of the necessary costs of water supply service, including construction, operation & maintenance, replacement of water supply systems, inclusive of a proper amount of profit, since the water supply enterprise (Nam Papa) must be run on a stand-alone financially self-sufficient system. The planned consecutive five (5) years tariff raise for households is mainly caused by recent financial losses of NPNL (as will be explained later).

Table 3.12.3 to Table 3.12.5 show the changes of water tariff for the past several years. Changed from the water tariff in May 2007, three (3) customer categories were integrated into one (1) category and the same unit prices were applied to all types of customers by the water tariff in April 2009. For household, unit prices were raised at April 2009. On the other hand, unit prices were reduced for the other categories (such as commercial, industry, and government). Then, unit price for household for the consumption over 31m^3 was reduced soon at September of the same year (2009), since the tariff raise at April was very high and NPNL received a lot of claims from the household customers. In 2014, after five (5) years from this reduction of tariff, NPNL was eventually able to raise it because of the recent year's financial difficulties of it.

Table 3.12.3 Past Water Tariff of NPNL (Effective from May 2007)

Category	Description	m^3 range	LAK /m^3
1	Domestic, State organization, Police, Soldiers	0 - 5	420
		6 - 30	685
		30 -	1,060
2	SOE, Private Enterprises & Commercial, Factories, Hotels, Guesthouse, Restaurants, Bottling Factories	0 - 10	1,575
		11 - 50	2,670
		50 -	4,140
3	International Organizations, Embassies, Foreigners, Foreign companies	0 - 10	5,685
		11 - 50	6,745
		50 -	8,655

Source: Notice No.11, dated 3 May 2007, Vientiane Capital Governor

Table 3.12.4 Revised Water Tariff of NPNL (Effective from April 2009)

Category	Description	m^3 range	LAK /m^3
1	All types of customer	0 – 10	500
		11 – 30	1,000
		31 - 50	2,500
		50 -	5,000

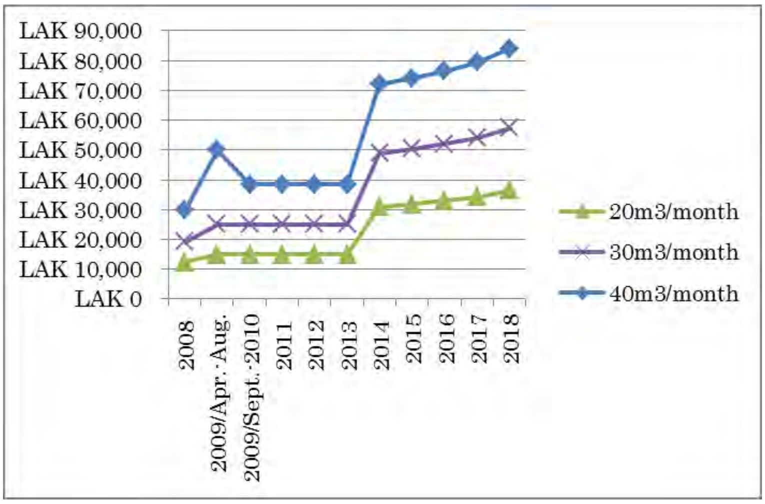
Source: Agreement No.170, dated 21 April 2009, Vientiane Capital Governor

Table 3.12.5 Revised Water Tariff of NPNL (Effective from Sept. 2009)

Category	Description	m^3 range	LAK /m^3
1	All types of customer	0 - 10	500
		11 - 30	1,000
		31 - 50	1,350
		50 -	2,700

Source: Agreement No.494, dated 7 September 2009, Vientiane Capital Governor

Figure 3.12.1 shows the changes of water charge (household) per month for several water consumption volumes. The tariff change in 2014 has more influence (larger change of bill) on the customers who consume more water. It is important that whether the revised tariff system is successfully accepted by the customers or not, so as to realize the healthy financial condition of NPNL.



Source: JST

Figure 3.12.1 Change of Water Charge for 3 Cases of Consumption

3.13 Financial Analysis of NPNL

3.13.1 Management Conditions of NPNL

Table 3.13.1 shows some management related information and management indicators of NPNL for the last five years. Followings are annual growth rates of some management information; Water production: 5.6% (for the period: 2010-2013), Water sales: 8.3% (2010-2013), No. of customer: 8.3% (2010-2013).

Table 3.13.1 Management Indicator of NPNL for the last 5 years

Items	Unit	2009	2010	2011	2012	2013
Management related information						
1. Water production	m^3/year	58,696,856	63,155,208	67,529,107	67,526,240	72,860,907
2. Water sales	m^3/year	39,706,921	40,421,223	43,369,257	46,219,876	54,353,580
3. No. of customer	Case	69,898	75,792	81,617	87,901	96,288
4. Water tariff billing	1,000 LAK/year	N.A.*1	61,938,375	71,674,155	78,512,545	98,671,231
5. Water income (collection)	1,000 LAK/year	79,138,236	58,047,985	70,216,857	78,060,457	98,220,071
6. Staff number of NPNL *2	Person	487	521	551	547	529
Management indicators						
7. NRW (Water loss) *3	m^3/year	18,989,935	22,733,985	24,159,850	21,306,364	18,507,327
	%	32.4%	36.0%	35.8%	31.6%	25.4%
8. Collection efficiency *4	%	-	93.7%	98.0%	99.4%	99.5%
9. Staff per 1,000 connections *5	Person	6.97	6.87	6.75	6.22	5.49
10. Average tariff *6	LAK/m^3	-	1,532.32	1,652.65	1,698.67	1,815.36
11. Unit production cost *7	LAK/m^3	1,711.89	1,515.38	1,360.05	1,542.91	1,605.04
12. Water consumption / customer *8	m^3/month	47.34	44.44	44.28	43.82	47.04
13. Water billing/customer *9	LAK/month	-	68,101	73,181	74,433	85,396

Note: *1; N.A., Accurate data is not available. *2; Staff number of NPNL covers permanent and contracted staff. *3; NRW volume is calculated by (=1.-2.). NRW ratio is calculated by (=3./1.). *4; Collection efficiency is calculated by (=5./4.). *5; Staff per 1,000 connection is calculated by (=6./(3./1,000)). *6; Average tariff is calculated by (=4./2.). *7; Unit production cost is calculated by (=(Total operating expenditure + Financial expenses)/1. Water production), financial data from Table 3.15-4, *8; Water consumption / customer is calculated by (=(2./3.)/12). *9; Water billing/customer is calculated by (=4./3.)

Source: prepared by JST, based on the data from NPNL.

The management indicators suggest some management conditions of NPNL.

- "NRW ratio" is still high at around 25% to 36%, but the number has been becoming lower (better) for the past 3 years.
- "Bill collection efficiency" is high and still improving for these years. Billing amount (LAK) information in 2009 is not available, because of the confusion caused by sharp tariff raise and reduction within one year in 2009.
- "Staff per 1,000 connections" (5.49 to 6.97) is relatively good, compared to the international data (7.2 to 8.3, in Table 3.13.2). The performance has been improving for the past 5 years. Staff productivity is high in NPNL and the staff number is proper in comparison with its customer number.
- "Average tariff" is 1,815 LAK /m^3 (0.23 USD) in 2013. "Unit production cost" is 1,605 LAK /m^3(0.20 USD).
- "Water consumption / customer" is about 44 m^3/month from 2010 to 2012. Then, it increased to 47 m^3/month in 2013. "Average tariff" and "Water billing/customer" also increased in 2013. According to the NPNL staff, a lot of customer water meters, especially for non-domestic, were replaced to new ones in 2013. After that, many non-domestic customers were measured accurately and their consumption volume often increased by precise measurement. Customer water meter replacement is considered to raise the values of these indicators.

Table 3.13.2 International Data of No. of Staff per 1,000 Connections

Source	Average	Target cities
Water in Asian City, ADB, 2004	8.3	Southeast Asian 18 cities (e.g., Ho Chi Minh, Delhi)
2007-Benchmarking and data book of water utilities in India, ADB, 2007	7.4	20 cities in India (Mumbai, Bangalore, Varanasi, etc.)
Data book of Southeast Asian Water Utilities, ADB, 2005	7.2	Southeast Asian 20 cities (17 cities in Vietnam, and 3 other countries)

Source: JST

For reference, and related to collection efficiency, general work flow of meter reading, billing and collection of water charge are described in the following Box 3.13.1. It is preferable that NPNL started to apply multiple ways of receiving customers' payment of water tariff.

Box 3.13.1 General Work Flow of Meter Reading, Billing, and Collection

Followings are the general work flow of meter reading, billing and collection work by NPNL;

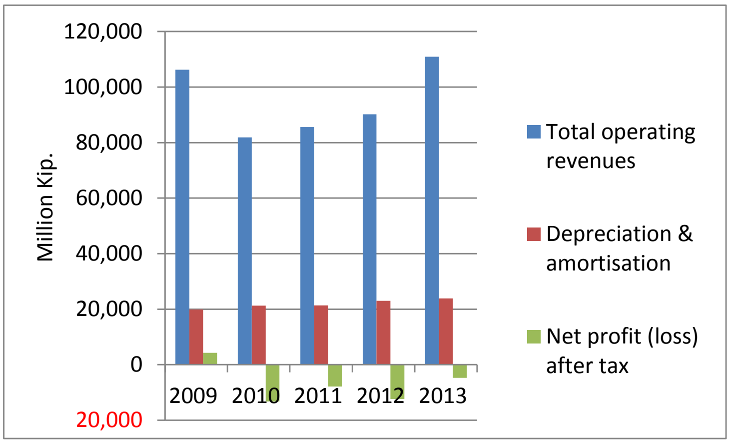
1. All NPNL customers have a water meter.
2. Meter readers of NPNL go to check the water consumption volume once a month for all customers.
3. They report to headquarters of NPNL the water consumption volumes for all customers.
4. The consumption volume is checked by staffs of commercial section of NPNL headquarters, and if the information is normal, it is input into customer database.
5. Water tariff bills are printed out at commercial section at headquarter of NPNL.
6. Printed bills are delivered to customers' place by meter readers by 10th day of each month.
7. Customers must pay the bills by the end of the month.
8. Customers can pay at any of the following places; NPNL branch offices & headquarters, designated private banks, ATM of the banks, e-banking (utilizing mobile phone), to meter reader on site.
9. Customer database of NPNL headquarters are connected to branch offices and designated private banks on line, in order to update the payment data by each customer.
10. In case that a certain customer does not pay water tariff for two (2) months, NPNL basically sends staff to the concerned location in order to stop the water supply to him or her.

Inputting consumption volume data into customer database at NPNL HQ

Bill printing at NPNL HQ

3.13.2 Financial Conditions of NPNL

Table 3.13.3 and Table 3.13.4 show the Balance sheet and Income statement of NPNL for the last 5 years. As shown in the Income statement, NPNL has been generating annual loss since the year 2010. The amount of losses (Net loss after tax) is approximately 4% to 16% of its annual operating revenues of each year (Table 3.13.4).



Source: JST

Figure 3.13.1 Operating Revenues and Net Loss of NPNL (last 5 years)

Table 3.13.3 Balance Sheet of NPNL (last 5 years)

BALANCE SHEET					Unit: 1,000 LAK
	31 Dec. 2009	31 Dec. 2010	31 Dec. 2011	31 Dec. 2012	31 Dec. 2013
I. ASSETS					
1. Current assets					
Cash & cash equivalent	3,154,970	3,710,420	4,878,429	2,395,597	1,429,129
Inventory	23,594,156	29,299,717	26,564,335	27,419,273	23,288,508
Receivables	75,083,970	48,468,349	25,163,886	33,814,983	44,246,670
Total current assets	**101,833,096**	**81,478,486**	**56,606,650**	**63,629,853**	**68,964,307**
2. Non-current assets					
Intangible fixed assets	520,758	520,758	520,758	5,979,879	5,979,879
Tangible fixed assets	322,970,017	324,336,496	318,131,845	310,719,206	293,832,966
Fixed assets in process of purchase or production	6,086,240	9,348,519	10,623,088	12,207,436	12,147,456
Other non current assets	3,800,016	5,983,723	6,201,717	8,396,369	15,922,589
Total non-current assets	**333,377,031**	**340,189,496**	**335,477,408**	**337,302,890**	**327,882,890**
TOTAL ASSETS	**435,210,127**	**421,667,982**	**392,084,058**	**400,932,743**	**396,847,197**
II. LIABILITIES AND EQUITY					
1. Current liabilities					
Short term loan	0	0	0	0	0
Suppliers & related accounts	24,507,807	31,655,367	9,432,885	17,065,915	23,796,232
Reserve & revenue received in advance	642,702	358,968	1,141,916	1,722,211	1,116,575
Other payables	8,999,155	5,211,836	11,181,678	12,427,863	13,076,585
Total current liabilities	**34,149,664**	**37,226,171**	**21,756,479**	**31,215,989**	**37,989,392**
2. Non-current liabilities					
Reserve & revenue received in advance	0	0	0	0	0
Loan & financial debt	63,125,468	55,578,671	58,787,940	62,440,123	58,179,244
Revenue to be paid	16,663,841	18,550,468	4,052,919	6,076,583	8,028,707
Total non-current liabilities	**79,789,309**	**74,129,139**	**62,840,859**	**68,516,706**	**66,207,951**
3. Equity					
Owner's equity	321,271,154	310,312,672	307,486,720	301,200,048	292,649,853
Registered capital	16,831,695	10,218,419	15,078,258	21,107,296	21,326,601
Increment in value & reserve	261,565,351	267,858,628	267,858,628	267,858,628	263,801,154
Difference in asset re-evaluation	47,769,152	47,769,152	47,917,541	47,917,540	47,917,540
Net profit	4,215,957	(13,236,433)	(7,834,180)	(12,315,709)	(4,712,026)
Other capital - cumulative	(9,111,001)	(2,297,094)	(15,533,527)	(23,367,707)	(35,683,416)
Total equity	**321,271,154**	**310,312,672**	**307,486,720**	**301,200,048**	**292,649,853**
TOTAL LIABILITIES AND EQUITY	**435,210,127**	**421,667,982**	**392,084,058**	**400,932,743**	**396,847,196**

Source: prepared by JST, based on the Financial Statements of NPNL.

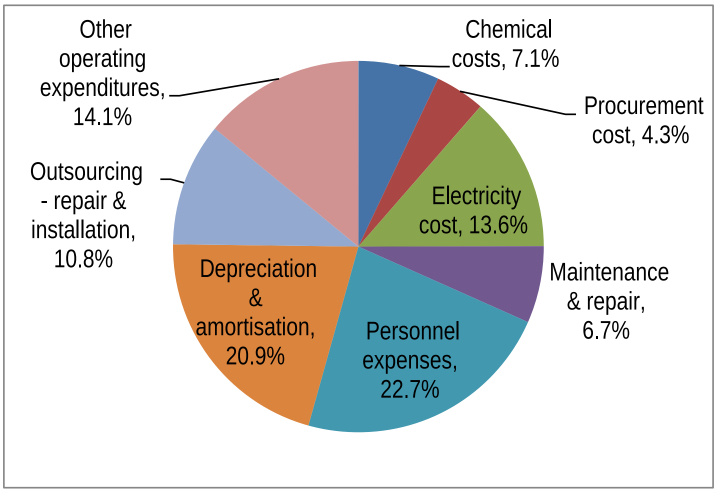
Table 3.13.4 Income Statement of NPNL (last 5 years)

INCOME STATEMENT					Unit: 1,000 LAK
	2009	2010	2011	2012	2013
I. Operating Revenues					
Water sales	75,561,397	56,130,309	62,210,132	68,713,149	86,722,923
Revenue from installation/connection	9,393,401	11,403,638	21,864,370	19,041,633	20,700,532
Other revenues	21,254,579	14,358,622	1,554,379	2,431,570	3,514,913
I. Total operating revenues	**106,209,378**	**81,892,569**	**85,628,881**	**90,186,352**	**110,938,368**
II. Operating expenditures					
Chemical costs	6,549,574	14,937,661	8,045,895	7,148,524	8,064,774
Procurement of equipment and pipes	15,771,446	11,091,247	11,974,187	10,768,654	4,962,148
Electricity cost	12,700,941	12,022,357	11,413,278	14,417,116	15,464,386
Maintenance & repair cost	14,782,721	7,891,640	5,152,974	8,637,070	7,639,295
Personnel expenses	12,406,998	12,741,287	13,283,943	14,928,890	25,876,503
Depreciation & amortization	19,931,807	21,298,057	21,401,468	23,002,347	23,898,883
Write back (resumption) depr. & amrt. & reserve	0	873,384	372,483	0	90,466
Outsourcing - repair & installation, security	1,973,965	3,220,909	4,755,603	6,459,259	12,269,346
Other operating expenditures	11,654,063	10,888,846	14,703,195	16,236,038	16,036,553
II. Total operating expenditures	**95,771,514**	**93,218,620**	**90,358,061**	**101,597,898**	**114,121,422**
III. Operating income (I-II)	**10,437,864**	**(11,326,051)**	**(4,729,180)**	**(11,411,546)**	**(3,183,054)**
IV. Non-operating revenues / costs					
Other business revenues	2,236,350	2,267,638	211,748	3,520,268	1,320,492
Other business expenditure	1,272,842	1,759,018	1,843,313	1,722,709	1,293,540
Taxes, fees, and others	186,657	482,160	592,664	567,648	241,269
Unusual expenses	184,091	1,607	8,941	10,878	1,059,373
Financial revenues	211,321	550,591	612,822	465,748	2,567,985
Financial expenses	4,710,965	2,485,826	1,484,652	2,588,944	2,823,267
VI. Total Non-operating revenues (costs)	**(3,906,884)**	**(1,910,382)**	**(3,105,000)**	**(904,163)**	**(1,528,972)**
V. Profit (loss) before tax	**6,530,980**	**(13,236,433)**	**(7,834,180)**	**(12,315,709)**	**(4,712,026)**
Taxes on revenues	2,274,046	0	0	0	0
Dividends to be paid to the State	0	0	0	0	0
VI. Net profit (loss) after tax	**4,256,934**	**(13,236,433)**	**(7,834,180)**	**(12,315,709)**	**(4,712,026)**

Source: prepared by JST, based on the Financial Statements of NPNL.

Figure 3.13.2 shows the distribution of operating costs of NPNL in the year 2013. Personnel expenses are largest in operating expenses. Depreciation & amortization cost is second largest. Electricity cost is third largest. High share of depreciation cost is preferable, since it indicates the saving for the future replacement or renovation of the facilities.

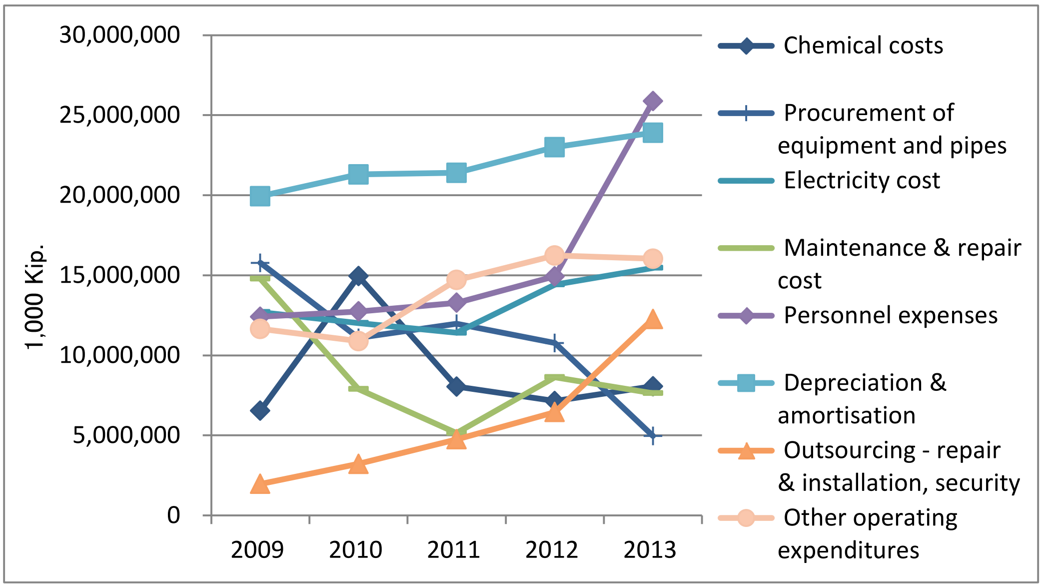
NPNL have recorded annual net loss. However, the cost item includes depreciation & amortisation, which is larger than net loss of each year. Since the depreciation & amortisation cost is an accounting procedure and not an actual cash outflow, it is considered that NPNL still has a certain amount of annual cash flow.



Source: JST

Figure 3.13.2 Share of Cost items in Operating Expenses (2013)

Figure 3.13.3 shows trend of changes of each cost items of operating expenses for the last 5 years. Among 8 cost items, "Personnel expenses" has increased most for these years, and then, "Outsourcing – repair & installation, security" has also increased for this period, especially in 2013. According to NPNL staff, this personnel cost increase is caused by new policy of Ministry of Finance regarding staff salary raise. Increase of outsourcing is caused by independence of several sections of NPNL and outsourcing to these independent companies. They are "Construction Water Supply and Sanitation State Company (CWSSC)" and "Water and Environment Engineering State Enterprise (WEE)". CWSSC is engaged in construction for water supply and sanitation facilities. WEE is engaged in engineering services in water supply and environmental fields.



Source: JST

Figure 3.13.3 Trend of Changes of Each Cost of Operating Expenses

NPNL has increased operating revenue for the last four (4) years (2010 to 2013) by customer number increase and water consumption volume increase, especially in 2013. On the other hand, operating expenses have also increased, largely due to personnel expenses and outsourcing expenses. As a result, NPNL has made annual net loss for the last 4 years. However, the amount of loss has been declining.

Table 3.13.5 shows several financial indicators of NPNL calculated based on the NPNL's financial statements. Followings are the outline of each value;

Table 3.13.5 Financial Indicators of NPNL

	2009	2010	2011	2012	2013	Reference for evaluation
Profit margin	9.83%	-13.83%	-5.52%	-12.65%	-2.87%	Average 5% in private (Japan), good in high figure.
Working ratio	0.90	1.14	1.06	1.13	1.03	Ave. 1.05 (18 large water supply entities in Asia), good in low figure.
Return on Equity (ROE)	1.33%	-4.27%	-2.55%	-4.09%	-1.61%	Ave. 2% in private (Japan), good in high figure.
Return on Assets (ROA)	1.50%	-3.14%	-2.00%	-3.07%	-1.19%	Ave. 4% in private (Japan), good in high figure.
Equity ratio	73.8%	73.6%	78.4%	75.1%	73.7%	Ave. 37% in private (Japan), good in high figure.
Interest coverage ratio	2.22	-4.56	-3.19	-4.41	-1.13	Ave. 5 in private (Japan), good in high figure.
Debt service coverage ratio	5.07	0.91	3.09	1.95	2.91	If less than 1, not enough payment capability. If more than 1.5, it is healthy (Japan). Higher the better
Current ratio	298%	219%	260%	204%	182%	Ave. 117% in private (Japan). More than 200% is preferable.

Source: prepared by JST, based on the Financial Statements of NPNL.

Notes: Profit margin = Operating income before interest / Total operating revenues
Working ratio = Annual O&M cost / Annual revenue
Return on equity = Net profit after tax / Owner's equity
Return on assets = Profit before tax / Total Assets
Equity ratio = Owner's equity / Total Assets
Interest coverage ratio = Operating income before interest / Interest expenses
Debt service coverage ratio = (Operating income + depreciation) / (Loan repayment + interest paid)
Current ratio = Current assets / Current liabilities

Profit margin: This indicator is to show the profitability of the enterprise, regarding the share of operating income before interest in proportion to total operating revenue. In terms of NPNL, it is good only in 2009, as it shows profit and more profitable than the average of Japanese private companies (5%). However, it became worst in 2010 and still in red in 2013. As a trend, it is becoming better in 2013 from -13.8% to -2.9%.

Working ratio: This shows the relative size of annual O&M cost in comparison with annual revenue. The smaller of the indicator, the better is the enterprise's performance. NPNL shows 0.9 to 1.14 for the last five (5) years. These are close to the average figure of private companies in Japan (1.05). The performance of NPNL was better in 2009, but it became worse from 2010 to 2012. In 2013, it became a little better.

Return on Equity (ROE) / Return on Assets (ROA): These are indicators to check the profitability of enterprise in the aspect of Equity / Assets. Average figures are 2% (ROE) and 4% (ROA) for private companies in Japan. Reflecting the annual net losses after 2010, these indicators of NPNL were worse but they recovered in 2013 a little.

Equity ratio: This is an indicator to check the level of safety of the enterprise in the aspect of the size of loans in comparison with owner's equity. If this figure is higher, it is healthier in financial condition since the share of owner's equity is larger and liability (loan, etc) is smaller. In NPNL, these figures were more than 70% for the last five (5) years, which is higher than average of private company of Japan (37%). Therefore, for NPNL, the amount of loan is almost stable in proportion to total assets and it is less than that of private companies in Japan.

Interest coverage ratio: This shows the ratio of operating income before interest the enterprise has in comparison with interest expenses. Average figure is five (5) times in private companies in Japan. On the contrary, that of NPNL is 2.22 in 2009 and negative number after that, because of the negative operating income for the period.

Debt service coverage ratio: This is to check the ratio of disposable income (operating income plus depreciation) NPNL has in comparison with repayment for principal and interest. If it is more than 1.5, it is considered healthy in Japan. In case of NPNL, it has been more than 1.95 in these years excluding only 2010. That is because unusual repayment happened in this year. Generally speaking, loan repayment amount is still under the ceiling of the repayment capacity of NPNL.

Current ratio: This is to check whether the size of current liability is safe or not by comparing it with the size of current assets. If this indicator is more than 200%, it is considered healthy. In case of NPNL, it has been more than 200% for these years, excluding 2013 (182%). NPNL is still not in the dangerous situation, but it is advisable to carefully check and control the amount of current liability from now on.

As a whole, one of the most important financial issues for NPNL is to make positive net profit continuously. It is considered that the total loan amount and burden of interest and principal payment is still under the ceiling of the payment capacity of NPNL, as far as it generates positive profit. Now, as of September 2014, NPNL announced new water tariff with future increase schedule. For the healthy financial management of NPNL, it is strongly desired that customers receive this tariff change smoothly.

3.13.3 Willingness to Pay and Affordability for Water Supply Service

In order to obtain the information concerning the socio-economic situation of Vientiane Capital, especially concerning the water use status, willingness to pay and affordability to pay water bill of household (hereinafter referred to as “HH”), “Survey on social condition (Interview Survey)” was conducted through sub-contracting to local consulting company from September to November 2014.

The survey (interview survey) collected a total of 1,000 samples (900 samples for households, and 100 samples for commercial). Sample distribution of each 1000 samples was decided according to the population size of each district as shown in Table 3.13.6.

Table 3.13.6 Sample Distribution of Interview Survey

No.	Name of District	No. of Villages	Population (2013)	Number of Sample Household		Number of Sample Non-household	
1	Chanthabuly	30	71,878	80.74*1	100*2	10.06*3	10
2	Sikhottabong	60	109,096	122.55	100	15.27	15
3	Xaysetha	48	108,889	122.31	100	15.25	15
4	Sisattanak	37	78,088	87.71	100	10.93	10
5	Naxaithong	54	71,795	80.65	100	10.05	10
6	Xaytany	104	183,838	206.50	200	25.74	25
7	Hadxaifong	60	90,662	101.84	100	12.69	15
8	Sangthong	37	30,985	34.80	100	0	0
9	Parkngum	53	55,992	62.89		0	0
	Total	**483**	**801,223**	**900**	**900**	**100**	**100**

Source: prepared by JST, based on the population data of NPNL.

Notes: *1; Number of sample household is calculated by total number of sample (900) divided by total population (801,223), multiplied by population of the district (e.g., 71,878). *2; Changed detailed number of sample household into hundred units, by round off of tenth digit. *3; Number of sample of Non-household is calculated by total number of sample (100) divided by total population excluding M. Sangthong and M. Parkngum (714,246), multiplied by population of the district (e.g., 71,878).

Details of the survey results are contained in "DATA BOOK, B.5 Socio Economic Survey (Interview Survey)". Summary of the survey results are shown in the Table 3.13.7 at the end of this section. Followings are descriptions of the important survey results to be mentioned in the aspect of willingness to pay and affordability to pay for water supply service.

(1) Monthly Average Water Bill : *53,696 LAK /month*

When inquired about the monthly water bill, the average response from 900 sample HHs in Vientiane Capital was 53,696 LAK./month. As shown in "3.13.1 Management Conditions of NPNL", actual average monthly water bill is calculated at 85,398 LAK/month including governmental and commercial customers. It is considered that HH recognition of the amount of water bill which he/she pays is reasonable. 447 HHs (72.7%) among 615 public water using HHs answered that the level of water bill was "normal". 141 HHs (22.9%) of 615 HHs answered that it was "expensive".

- *Results of Interview Survey for Commercial 100 Samples:*
  For reference, the average response to the monthly water bill inquiry from 100 sample commercial entities in Vientiane Capital was 548,252 *LAK*/month.

(2) Usage Condition and Requests to Public Water Supply: *Not for Drinking, More Volume & Pressure*

Based on the Survey, public water supply is not used for direct "Drinking" without boiling but water bought from water vender and bottle water are used for direct drinking. On the other hand, the largest request for public water supply is "More quantity (volume)" at 441 HHs (71.7%) among 615 public water using HHs. Second largest is "More water pressure" at 284 HHs (46.2%) among 615 HHs. HHs who raised "Lower tariff level" is only 3.3% (20 HHs) among 615 HHs.

(3) Willingness to Pay: 62,268 LAK/month (Public water user), 41,036 LAK/month (Others)

Against the question to public water users; "If the service level of public water supply becomes better in terms of volume, quality, supply hours, and pressure by management and facility improvements, how much are you willing to pay for the water supply service per month maximum?", the survey obtained the average at 62,268 LAK/month. This amount is 8,572 LAK/month (16.0%) more than the amount of average monthly water bill (53,696 LAK/month).

On the other hand, to the non public water user, the survey asked the question; "If a public water supply pipe comes near your house, do you want to use the public water supply? If "Yes", how much are you willing to pay for public water supply with good quality per month?" 96.5% of non public water using HHs answered "Yes". The average of willingness to pay of non public water users is 41,036 LAK/month. Almost all of non public water users wanted to connect public water. Nevertheless, their willingness to pay is not so high.

- *Results of Interview Survey for Commercial 100 Samples:*
  For reference, an average willingness to pay of commercial entities for improved public water supply is 609,341 LAK/month for public water users, and is 221,111 LAK/month for non public water users.

(4) Average HH income per Month: 6,302,383 LAK/month (about 783 USD)

The survey resulted that the average monthly HH income per month is 6,302,383 LAK/month in Vientiane Capital. However, the amount varies for each district from the lowest at 4,272,167 LAK/month (Parkngum District) to the highest at 8,372,000 LAK/month (Chanthabuly District). Generally speaking, a questionnaire survey result of HH income tends to be smaller than actual because HH tends to answer modest amount. Therefore, the actual average HH income may be a little higher than this value.

In comparison with average water bill and willingness to pay, average water bill (53,696 LAK/month) is 0.85% and willingness to pay (62,268 LAK/month) is 0.99% of the average HH income (6,302,383 LAK/month).

(5) Affordability to Pay Estimation: 220,583 LAK/month – 252,095 LAK/month

In terms of affordability to pay of HH for water supply service, two international organizations estimated the percentage of the amount in proportion to an average HH income. The IBRD (International Bank for Reconstruction and Development) estimated the limit for household affordability to pay as 4% of household income for the water supply services, and 1% for sewerage services (Project Appraisal Manual, IBRD). The Pan American Health Organization also recommends that the total water supply and sewerage charge should be less than 5% of the household income, consisting of 3.5% for water supply and 1.5% for sewerage. When calculating the affordability to pay amount for Vientiane Capital based on the above percentage, it is 220,583 LAK/month (3.5% of average HH income) and 252,095 LAK/month (4% of average HH income).

Through the Survey on social conditions (Interview survey), following points are found;

a) In Vientiane Capital, a willingness to pay of HH (62,268 LAK/month) is quite lower than the estimated amount of an affordability to pay of HH (220,583 to 252,095 LAK/month).

b) Usually, the people use public water for the other purposes than drinking. Water vender and bottle water is for drinking.
c) Average water bill accounts for less than 1% of average HH income, and most people considers it is not expensive (normal or cheap).
d) People's major requests on public water supply are to increase water supply volume and water pressure.

Table 3.13.7 Summary of the Results of Socio Economic Survey (Interview Survey)

1. Survey Results: Households

<table>
<tr><th>No.</th><th>Item</th><th colspan="2">Figure/Value</th><th colspan="2">Number of answers</th><th>Notes</th></tr>
<tr><td>1</td><td colspan="3">Number of collected samples</td><td colspan="2">900 samples</td><td></td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Survey Area of household (HH)</td><td colspan="2">Existing public water supply</td><td colspan="2">615</td><td></td></tr>
<tr><td colspan="2">Non public water supply</td><td colspan="2">285</td><td></td></tr>
<tr><td>A</td><td colspan="6"><u>Water Supply Condition</u></td></tr>
<tr><td rowspan="4">3</td><td rowspan="4">To public water users: Monthly average total water bill for the public water supply /LAK./month</td><td colspan="2">Monthly average water bill</td><td colspan="2">53,696 LAK/month</td><td rowspan="4"></td></tr>
<tr><td colspan="2">The household think it is: Expensive</td><td colspan="2">141</td></tr>
<tr><td colspan="2">Normal</td><td colspan="2">447</td></tr>
<tr><td colspan="2">Cheap</td><td colspan="2">27</td></tr>
<tr><td rowspan="7">4</td><td rowspan="7">Using water</td><td>Using water</td><td>Drinking</td><td>Washing</td><td>Bathing / Shower</td><td>Gardening / car wash</td></tr>
<tr><td>Public water supply</td><td>0</td><td>615</td><td>615</td><td>615</td></tr>
<tr><td>well water</td><td>0</td><td>279</td><td>279</td><td>279</td></tr>
<tr><td>Bore well (deep well)</td><td>0</td><td>95</td><td>95</td><td>95</td></tr>
<tr><td>River</td><td>0</td><td>31</td><td>31</td><td>31</td></tr>
<tr><td>Water vendor</td><td>900</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Bottle water</td><td>126</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td rowspan="10">5</td><td rowspan="10">To public water users: Do you have any requests concerning the public water</td><td colspan="4">Yes: 491, No: 124</td><td></td></tr>
<tr><td colspan="2">More Quantity (volume)</td><td colspan="2">441</td><td rowspan="9">Multiple answers allowed</td></tr>
<tr><td colspan="2">More water pressure</td><td colspan="2">284</td></tr>
<tr><td colspan="2">Less smell of water</td><td colspan="2">96</td></tr>
<tr><td colspan="2">No turbidity / colour</td><td colspan="2">21</td></tr>
<tr><td colspan="2">Longer supply hour</td><td colspan="2">73</td></tr>
<tr><td colspan="2">Lower tariff level</td><td colspan="2">20</td></tr>
<tr><td colspan="2">Less time to repair if leaked</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Better attitude of staff</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Others</td><td colspan="2">6</td></tr>
<tr><td>6</td><td colspan="3">To public water users: If the service level of public water supply becomes better in terms of volume, quality, supply hours, and pressure, how much are you willing to pay per month maximum?</td><td colspan="2">62,268 LAK/ month</td><td></td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">To non public water users: If a public water supply pipe comes near your house, do you want to use the public water supply?</td><td colspan="4">Yes: 275 No: 10</td><td></td></tr>
<tr><td colspan="2">Average monthly willing to pay for public water supply with good quality.</td><td colspan="2">41,036 LAK/month</td><td></td></tr>
<tr><td colspan="2">Average Willingness to pay for connecting cost.</td><td colspan="2">881,091 LAK</td><td></td></tr>
<tr><td>B</td><td colspan="6"><u>Family Status</u></td></tr>
<tr><td>8</td><td colspan="3">To All: How many persons are there in your family</td><td colspan="2">5.21 Persons/family</td><td></td></tr>
<tr><td>9</td><td colspan="3">To All: Average income per Household per month</td><td colspan="2">6,302,383 LAK/month</td><td></td></tr>
</table>

Source: Survey on social condition (Interview Survey), 2014

2. Survey Results: Commercial

No.	Item	Figure/Value	Number of answers	Notes
1	Number of collected samples		100 samples	
2	Survey Area of commercial entity	Existing public water supply	91	
		Non public water supply	9	
A	***Water Supply Condition***			
3	How do you obtain water for your daily business?	Public water supply	91	Multiple answers allowed
		Well	8	
		Bore well (deep well)	7	
		Water vender	100	
		Bottle water	80	
4	**To public water users**: Monthly average total water bill for the public water supply	Monthly average water bill	548,253 LAK/month	
		The household think it is: Expensive	22	
		Normal	67	
		Cheap	2	
5	**To public water users**: If the service level of public water supply becomes better in terms of volume, quality, supply hours, and pressure, how much are you willing to pay per month maximum?		609,341 LAK/month	
6	**To non public water users**: If a public water supply pipe comes near your house, do you want to use the public water supply?	Yes: 9	No: 0	
		Average monthly willing to pay for public water supply with good quality.	221,111 LAK/month	
		Average Willingness to pay for connecting cost.	1,094,444 LAK	

Source: Survey on social condition (Interview Survey), 2014

3.14 Related On Going Studies and Projects

3.14.1 Water Supply Master Plan 2014 by AfD

With assistance from AfD, a water supply master plan, Nam Papa Nakhone Luang Water Supply Assets Master Plan (WSM/P 2014) has been prepared. The objectives of WSM/P 2014 are:

- To design 10 year scale master plan to assist NPNL’s projects.
- To review the water supply system in Vientiane Capital, especially to address NRW issues.
- To elaborate the priority project and cost estimation for the asset.
- To overlay the urban development master plan approved by Vientiane Capital.
- To propose future water supply plan and development orientation

The target year was set in 2030, and the results of the estimation for population, water demand, and proposed water production by the year 2030 are summarized as follows.

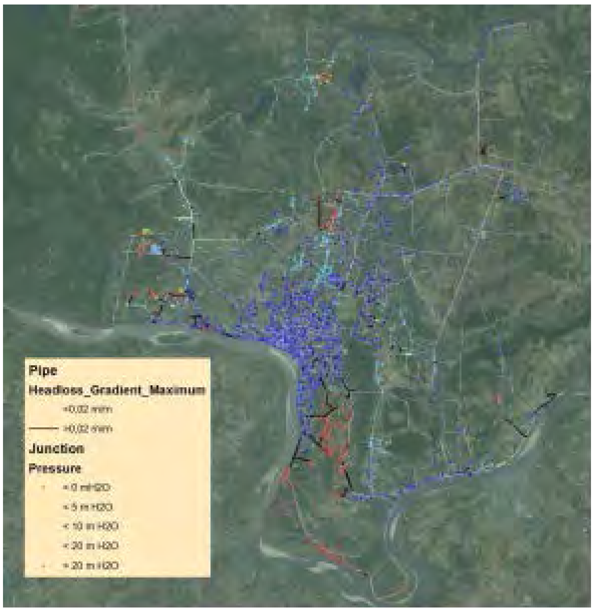
Table 3.14.1 Estimation of Population, Water Demand and Production by WSM/P 2014

	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

In WSM/P 2014, elaborate hydraulic models (by Water GEM) for pipe network of NPNL have been also prepared for the years of 2015, 2020, 2025 and 2030. Figure 3.14.1 shows a sample of the model design for 2025.

It would also be expected that further sectorial analysis (e.g. zoning plan), GIS establishment, and further M/P would be carried out with AfD assistance.



Source: WSM/P 2014

Figure 3.14.1 NPNL Model 2025 (Sample)

3.14.2 Existing Pipe Replacement Project by AfD

Pipe replacement project has been implemented as a part of the project "Alimentation d'Eau Potable (AEP-II)", which started in 2007 under the grant financing of AfD which amounted to 5.2 million euro in conjunction with JICA grant aid for Vientiane Water Supply Development Project (2006-2009).

The original project scope and budget demarcation between JICA and AfD are shown in Table 3.14.2. JICA financed the expansion of Kaoleio WTP and a part of transmission and distribution mains, while AfD covered the rest of the scope.

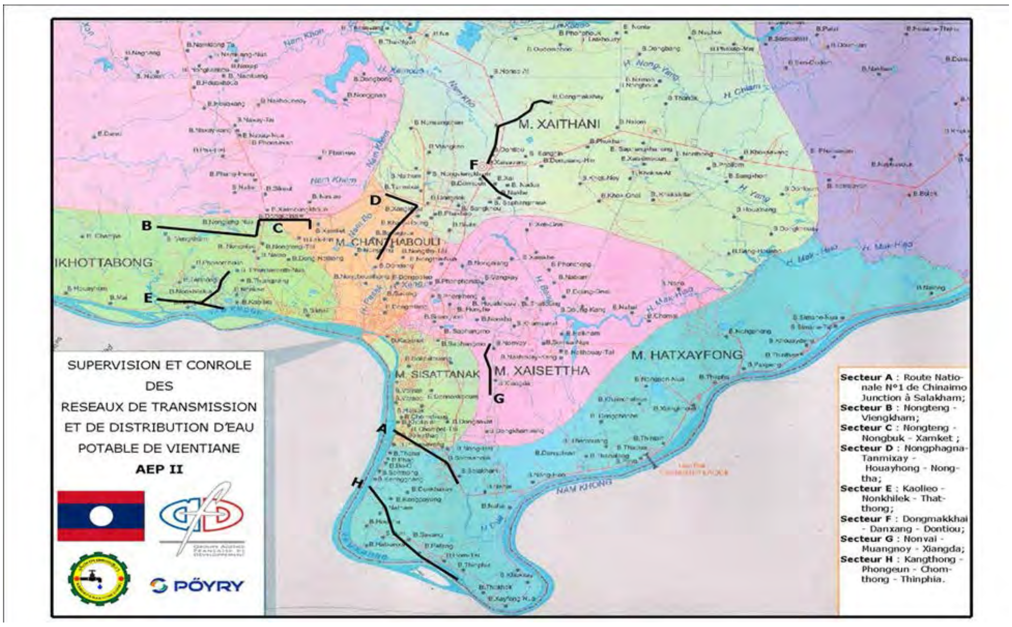
Table 3.14.2 Original Project Scope and Budget Demarcation between JICA and AfD

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.

Among the above project scope, the component 1.2 was implemented with the actual contract price of 2.9 million euro. The location of new transmission and distribution mains installed by AEP-II are shown in Figure 3.14.2.



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 (AEP-II Project)

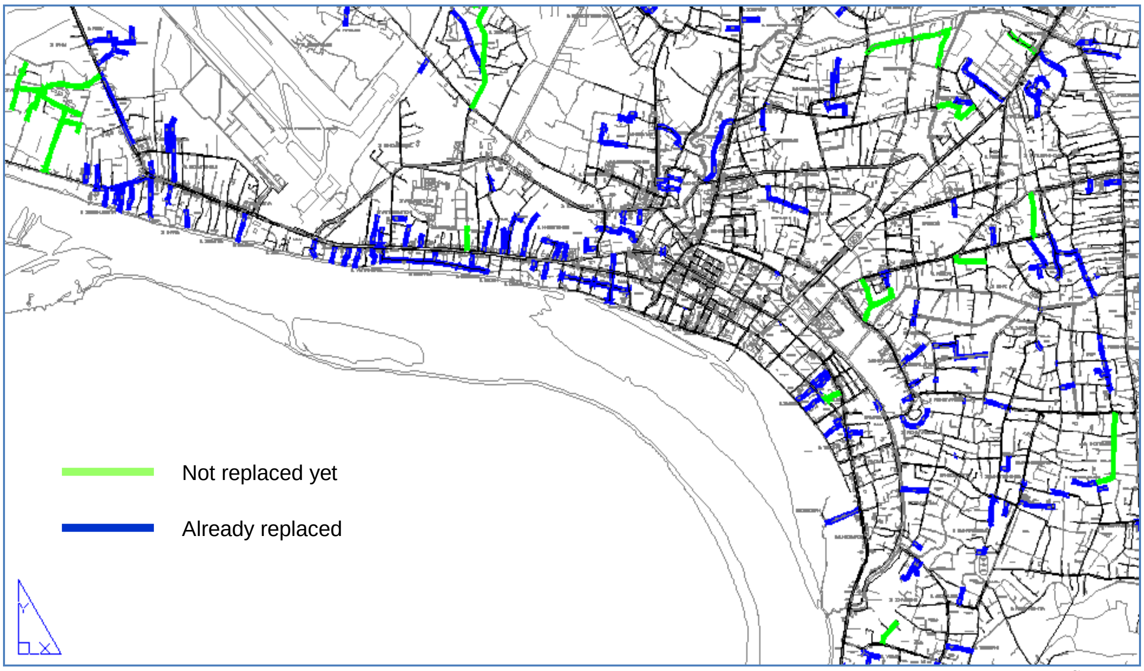
Figure 3.14.2 Locations of Transmission and Distribution Mains Installed under AEP-II

By utilizing the balance to the original budget, 1.1 million euro plus contingency, the following works were added in the project scope;

1) Replacement of GSP pipes (diameter up to 100 mm) into DPE or uPVC (total length 60km)
2) NPNL Master Plan Preparation and Hydraulic Analysis Model Development
3) Hiring financial management consultants for financial audit for the years 2010-2012, and
4) Procurement of backhoes, vehicles and office computers.

The above item 1) was, thus, implemented as the additional scope of AEP-II project, and the total pipe length replaced amounted to 62 km. The existing GSP pipes with the diameter of less than 100 mm were, however, targeted in AEP-II

The locations of the pipe replacement work implemented are indicated on Figure 3.14.3.



Source: NPNL

Figure 3.14.3 Locations of GSP Pipes Replaced under AEP-II Project and NPNL's Own Program

3.14.3 Dongmakkhay Expansion Project

(1) Project Scope

The expansion of Dongmakkhay water supply system is presently underway with the preferential loan from the Export-Import Bank of China under EPC contract between MPWT and China Yunnan Construction Engineering Group Co., Ltd.

The major project scope of the expansion work is as follows:

1) New intake at Nam Gum River
2) Raw water transmission pipelines (2 lines each 18.9 km, DN 1000, reinforced plastic mortar pipes (RPMP))
3) Water treatment plant with the capacity of 100,000 m^3/day
4) Clear water transmission pipelines (19.5 km, DN 1200 – DN 500, DCIP)
5) SCADA system

(2) Project Cost

The estimated project cost is 78.75 million US$, and the cost breakdown is shown in Table 3.14.3 according to the F/S report.

Table 3.14.3 Project Cost Breakdown for Dongmakkhay Water Supply Project

Cost Items	Amount (1,000 US Dollar)	Proportion in Total Cost
1. Construction	61,255.6	77.96%
1.1 Water Intake and Raw Water Transmission Works 1.2 Water Treatment Plant 1.3 Clear Water Transmission Pipeline	20,937.0 21,691.3 17,894.7	
2. Preliminary Work Cost, Engineering Investigation/Survey/ Design Cost, Insurance Premium for the Project, Cost for Construction of Contractor's Residential Camp, Personnel Transfer Cost, Vehicle Purchase and Maintenance Cost, Other Management Cost, etc.	6,286.7	8.00%
3. Contingency Cost	8,476.1	10.79%
4. Loan Interest during Construction Period	1,451.6	1.85%
5. Initial Working Capital	1,100.0	1.40%
Total Cost of Engineering Construction	78,570	100%

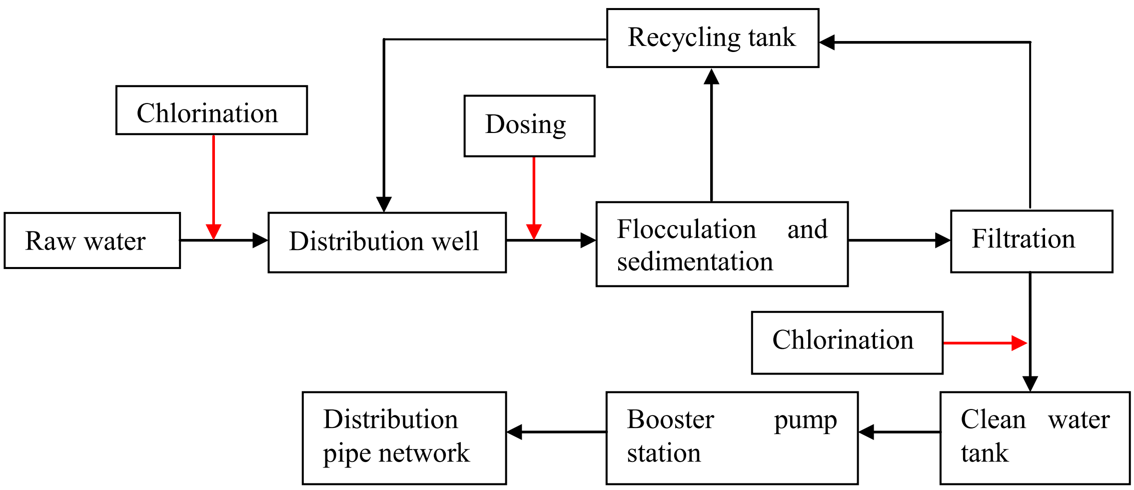
Source: F/S Report for Dongmakkhay Water Supply Project

(3) Raw Water Intake and Transmission Pipes

The raw water source is Nam Gum River. Raw water is pumped up to the water treatment plant through double raw water transmission pipes with the diameter of 1000 mm. The total length of the raw water transmission main is 18.8 km each, and the pipe materials are of DCIP for 8.6 km and Reinforced Plastic Mortar Pipe (RPMP) for 10.3 km.

(4) Water Treatment Plant

Water treatment system employed consists of conventional rapid sand filtration system with horizontal sedimentation basins. The flowchart of the treatment processes are illustrated in Figure 3.14.4.



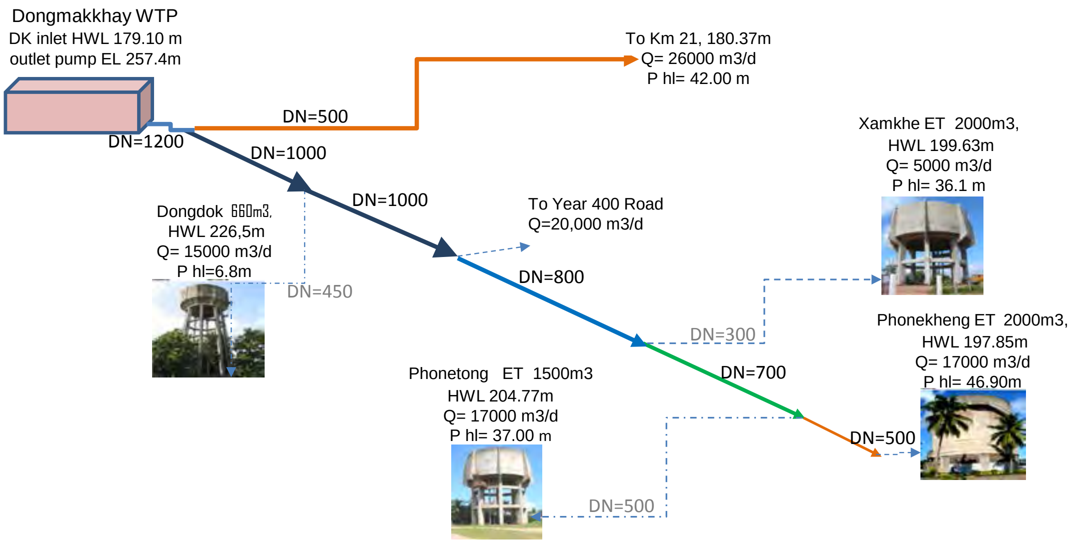
Source: Feasibility Study Report, Dongmakkhay Water Treatment Plant (2011)

Figure 3.14.4 Flowchart of Dongmakkhay Water Treatment Processes

(5) Water Transmission and Distribution System

Water produced from Dongmakkhay WTP is planned to be transmitted to the existing elevated tanks and new industrial zone. The project will cover the installation of new transmission mains which are connected to the existing feeder mains to the existing four elevated tanks, namely, Phonetang ET, Phonekeng ET, Xamkhe ET and Dongdok ET.

Figure 3.14.5 shows the water transmission system plan from Dongmakkhay WTP.



Source: Feasibility Study Report, Dongmakkhay Water Treatment Plant (2011)

Figure 3.14.5 New Water Transmission System Plan from Dongmakkhay WTP

3.14.4 Technical Cooperation Project by JICA

The Capacity Development Project for Improvement of Management Ability of Water Supply Authority was started in August 2012 and will be completed in August 2017. The executing organization of the project is DHUP of MPWT and the implementing organizations are WaSRO of MPWT, WSD of DHUP and three pilot Water Supply State Enterprises (i.e. Provincial Nam Papa, PNPs) which are NPNL, Luang Prabang Provincial Water Supply State Enterprise (PNP-LP) and Khammouane Provincial Water Supply State Enterprise (PNP-KM).

The Project aims for the capacity development of nationwide water supply authorities including MPWT and provincial PNPs and NPNL by following five approaches: 1) strengthening the data management for corporate planning at the pilot PNPs, 2) establishing the management based on the long-term, mid-term and short-term corporate planning at the pilot PNPs; 3) strengthening the monitoring of the performance of the pilot PNPs; 4) developing the technical guidelines on corporate planning; and 5) developing the dissemination mechanism relevant to the new technical guidelines.

The outputs of the Project and organization(s) in charge of each output are summarized as Table 3.14.4.

Table 3.14.4 Output and responsible organization(s)

Outputs	Organization(s) in charge
1. Data necessary for long-term, mid-term and short-term	Overall: DHUP

Outputs	Organization(s) in charge
corporate planning at each pilot PNP are available on an ongoing basis	Pilot WEEs: NPNL, PNP-LP and PNP-KM
2. The pilot PNPs are managed based on long-term, mid-term and short-term Corporate plans through Plan-Do-Check-Act (PDCA) cycles	Overall: DHUP Pilot WEEs: NPNL, PNP-LP and PNP-KM
3. Monitoring of the Corporate Plan including Performance Indicators (PIs) is strengthened	Overall: WaSRO Pilot WEEs: NPNL, PNP-LP and PNP-KM
4. Technical guidelines on corporate planning are developed, utilizing the results of output 1 to 3	DHUP
5. A mechanism to disseminate techniques and knowledge relevant to the new technical guidelines to other PNPs and private enterprises is developed, utilizing the results of Output 1 to 4	Overall: WaSRO Pilot WEEs: NPNL, PNP-LP and PNP-KM
0. The Project is managed and coordinated properly	Overall: WaSRO Pilot WEEs: NPNL, PNP-LP and PNP-KM

(Source: R/D and Minutes of Meeting (M/M) signed on June 27, 2012)

As the technical cooperation project aims to improve the management capacity of NPNL and has close relationship with the proposed Project, it is expected that synergistic effect of the outcomes of the both projects.

3.15 Other Donor's Assistance and Projects by PPP in Water Supply Sector

3.15.1 Thadeua Project

(1) Project Scope

Thadeua Project is the construction of a water supply system in Hatsaifong District, Vientiane Capital. The capacity is 20,000 m^3/day. This project will be carried out through a Build-Operate-Transfer (hereafter, BOT) scheme of a private local company, Vientiane Automation and Solution Engineering Company (VASE). The project consists of:

- Construction of intake, with the capacity to pump 21,000 m^3/day from the Mekong River
- Construction of water treatment plant including: coagulation, flocculation, sedimentation, filtration, water tank, pumping system,
- Installation of pipeline system: main pipe DN 250-DN 600 mm, length 25,026 m, and uPVC length 58,808 m (but not including house connections)

The contract between NPNL and VASE was signed on June 2014, after a Memorandum of Understanding (hereafter, MOU) dated on January 2014. It has been under construction since January 2015, and is expected to be complete in 2016. The concession period is 35 years from the completion of the construction.

(2) Project Cost

The estimated project cost is 19.8 million USD (not including interest). Table 3.15.1 shows the breakdown according to the feasibility study.

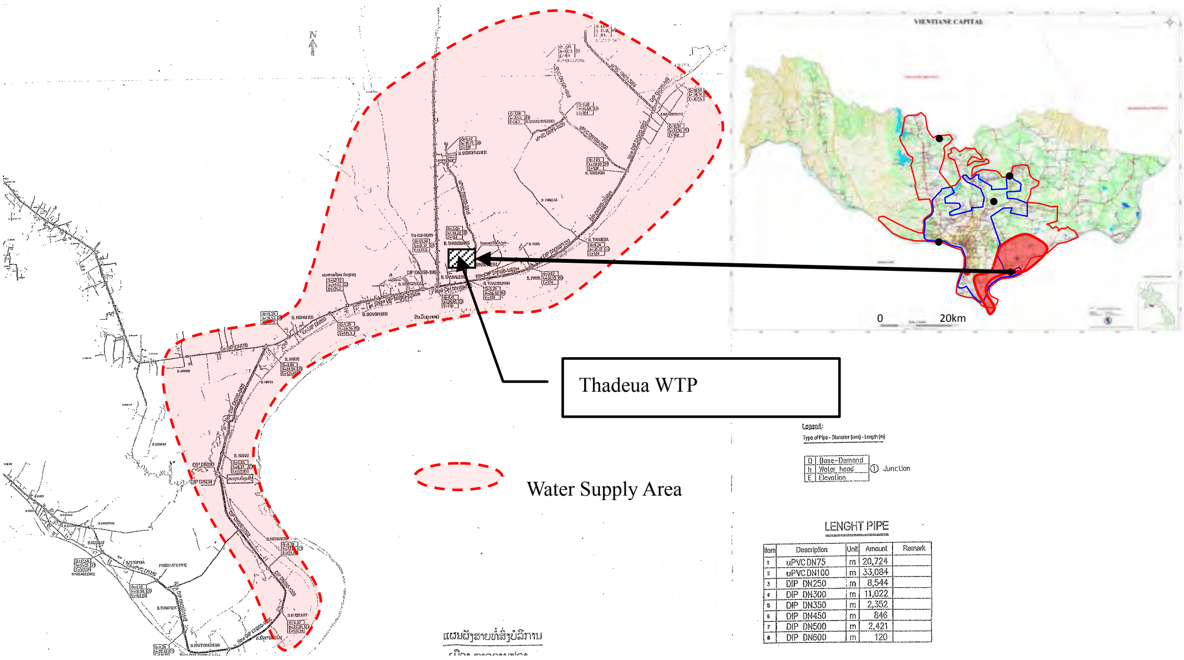
Table 3.15.1 Expected Increase of Water Production by 2025

	Amount (1,000 USD)	Proportion in Total Cost
1. Construction of water treatment plant (including intake)	10,000	50.5
2. Installation of pipelines uPVC 75-100 and DIP 250-600	9,800	49.5
Total Cost	19,800	100.0

Source: Proposal of Project for the Construction of Water supply system in Hatsaifong District, Vientiane Capital

(3) Water Supply Area

The raw water source is the Mekong River, and water supply area is shown in Figure 3.15.1.



Source: Proposal of Project for the Construction of Water supply system in Hatsaifong District, Vientiane Capital

Figure 3.15.1 Water Supply Area in Thadeua Project

(4) Water Supply Facilities

The summary of water supply facilities to be constructed is shown in Table 3.15.2, and the diagram of the water treatment plant is illustrated in Figure 3.15.2.

Table 3.15.2 Summary of Water Supply Facilities

Facilities	Design
Production System	Gravity Flow
Intake	Intake is a Tower type set in Mekong River with a design capacity of 21,000 m^3/day
Water Treatment Plant	- Capacity of 20,000 m^3/day - Coagulation consisting of: receiving tank and mixing tank - Sedimentation consisting of: sedimentation tank and weir - Filtration consisting of: rapid sand filter and filtration tank
Clear Water Tank	1500m^3 x 2 tanks

Backwash System	Air Blower
Transmission Pump	Transmission Pump Station and Booster Pump
Transmission and Distribution Pipe	- DIP DN600mm, 120m length - DIP DN500mm, 2,142m length - DIP DN450mm, 846m length - DIP DN350mm, 2,352m length - DIP DN300mm, 11,022m length - DIP DN250mm, 8,544m length - uPVC DN100mm, 33,084m length - uPVC DN75mm, 20,724m length

Source: Proposal of Project for the Construction of Water supply system in Hatsaifong District, Vientiane Capital

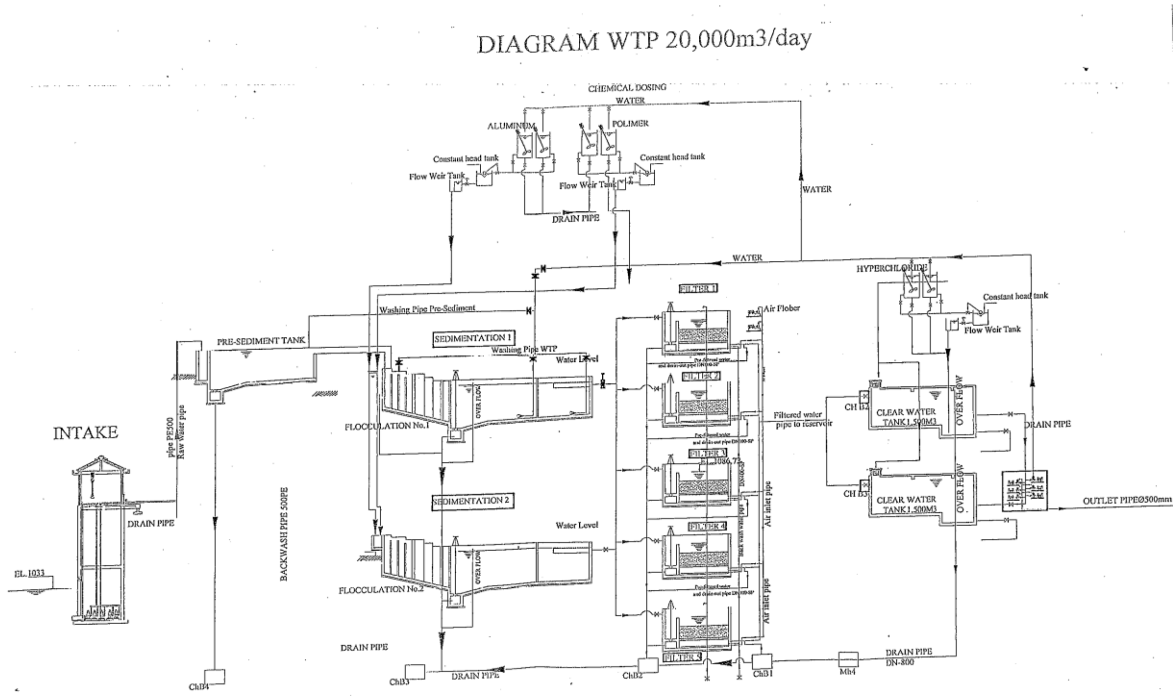


Figure 3.15.2 Diagram of WTP in Thadeua

(5) Price of Water Supply

After the completion of construction, water produced from Thadeua WTP will be sold to NPNL as bulk water supply. The private enterprise (investor), VASE, proposed the price with 6 steps as shown in the table below.

Table 3.15.3 Proposal of Water Supply Price from Investor

Step	Duration	Unit	Price
1	2016-2018	Kip/m^3	1,750
2	2019-2021	Kip/m^3	2,500
3	2022-2025	Kip/m^3	3,000
4	2026-2030	Kip/m^3	3,600
5	2031-2035	Kip/m^3	4,300
6	2036-2050	Kip/m^3	4,500

Source: Proposal of Project for the Construction of Water supply system in Hatsaifong District, Vientiane Capital

3.15.2 Sendin Project

(1) Project Scope

The Sendin Project is the construction of a water supply system in Naxaithong District, Vientiane Capital. The capacity is 20,000 m^3/day. This project will be carried out by BOT of private local company, Asia Investment and Service Sole Co., Ltd. The project consists of:

- Construction of intake from the Nam Ngum River
- Construction of water treatment plant with the capacity of 20,000 m^3/day,
- Construction of clear water tanks (2 elevated tanks)
- Installation of transmission pipe from intake to water treatment plant, and from treatment plant to elevated reservoir with a total length of 5,500m
- Installation of distribution pipe with a total length of 147,900m

The MOU was made in May 2014, and the contract signing is expected in July 2015. Also the operation start is expected from 2017.

(2) Project Cost

The estimated project cost is 12.1 million USD. Table 3.15.4 shows the breakdown according to the pre-feasibility study.

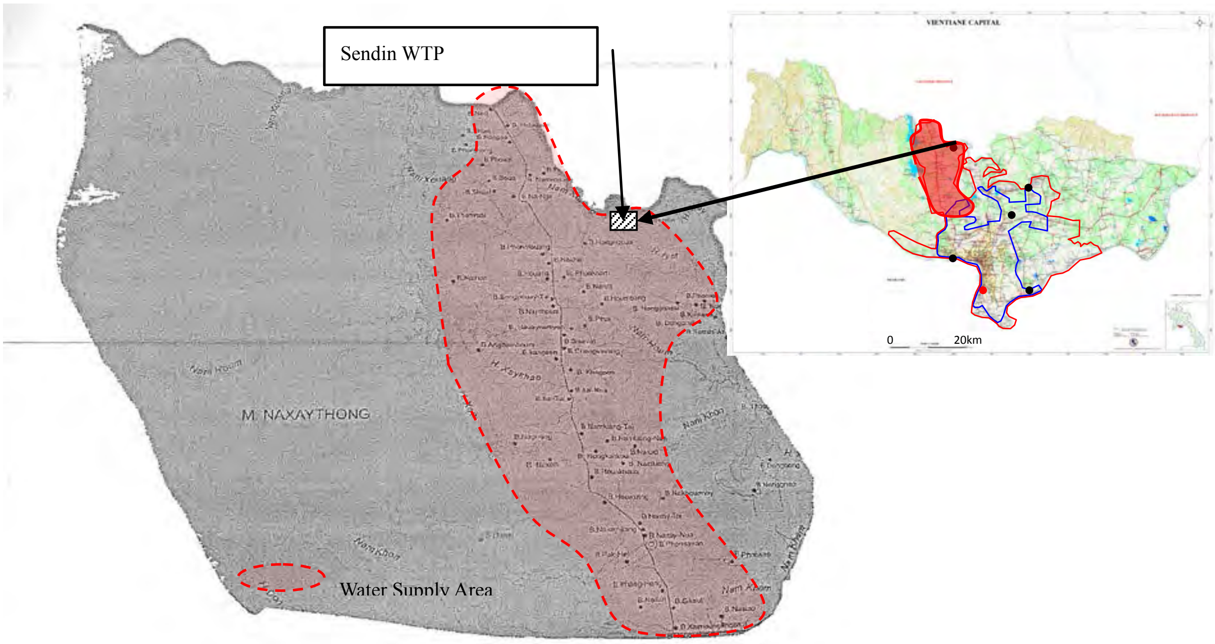
Table 3.15.4 Expected Increase of Water Production by 2025

	Amount (1,000 USD)	Proportion in Total Cost
1. Construction of water treatment plant (including intake)	1,800	14.9
2. Construction of 2 elevated tanks	800	6.6
3. Construction of transmission and distribution pipelines	9,500	78.5
Total Cost	12,100	100.0

Source: Pre-feasibility Study on Water Supply Project Sendin Village, Naxaihong District, Vientiane Capital

(3) Water Supply System

The raw water source is the Nam Gum River, and water supply area is shown in Figure 3.15.3.



Source: Pre-feasibility Study on Water Supply Project Sendin Village, Naxaihong District, Vientiane Capital

Figure 3.15.3 Water Supply Area in Sendin Project

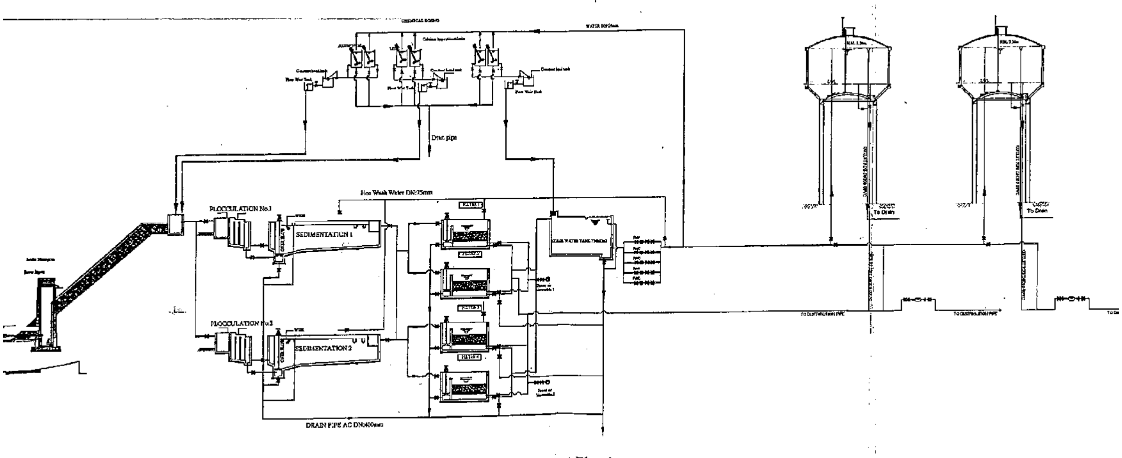
(4) Water Supply Facilities

The raw water source is the Nam Gum River, and the summary of water supply facilities to be constructed is shown in Table 3.15.5, and the hydraulic diagram of the facilities is illustrated in Figure 3.15.4.

Table 3.15.5 Summary of Water Supply Facilities

Facilities	Design (up to 2030)
Production System	Gravity Flow
Intake	Intake sump in border and connect to Nam Gum River with pipe 20m long, made of reinforced concrete
Water Treatment Plant	- Pre-sedimentation 10x34m, 2 tanks - Flocculation 10x7m, 2 tanks - Sedimentation 12x42m, 2 tanks - Filtration 4.8 x 8.7m, 5 tanks
Elevated Tanks	18x18x3.8m, 2 tanks
Backwash System	Air Blower
Transmission Pipe	DIP DN450mm, 5,500m length
Distribution Pipe	- DIP DN400mm, 18,000m length - DIP DN300mm, 10,000m length - DIP DN 200mm, 4,000m length - DIP DN150mm, 1,800m length - DIP DN100mm, 33,000m length - DIP DN75mm, 37,000m length - uPVC DN50mm, 44,000m length - GSP DN450mm, 120m length - GSP DN400mm, 60m length

Source: Pre-feasibility Study on Water Supply Project Sendin Village, Naxaihong District, Vientiane Capital



(Process of B XENDIN Water Treatment Plant)

Source: Pre-feasibility Study on Water Supply Project Sendin Village, Naxaihong District, Vientiane Capital

Figure 3.15.4 Hydraulic Diagram in Sendin

3.15.3 Dongbang Expansion Project

The existing Dongbang WTP (Capacity of 20,000m^3/day) was the first joint venture project, with an investment capital of US $10 million, in Vientiane water supply system between NPNL and Vietnamese private company, Mai Dong company. Capital investment cost was borne by NPNL (51%) and Mai Dong (49%), and the water treatment plant has been in operation since 2009.

NPNL is, at present, seeking a donor and fund, including from the private sector, for Dongbang Expansion Project.

3.16 Long-term Plan for Improvement of Water Supply Facilities

Water Supply Master Plan for Vientiane Capital (WSM/P 2014) has been prepared with the project horizon up to the year 2030 with assistance by AfD[11]. WSM/P 2014 proposes three different water supply development scenarios to the year 2030. The main technical characteristics of these three options are summarized in Table 3.16.1.

Table 3.16.1 Main Technical Characteristics of the Three Scenarios for 2030

Technical Characteristics	Option 1	Option 2	Option 3
Water Demand (m^3/day)	373,000 m^3/day	408,000 m^3/day	408,000 m^3/day
Total Pipe Extensions (km) (> dia. 200 mm)	436 km	436 km	436 km
Total Pipe Reinforcements	60 km	99 km	135 km
	(Replacement of pipes with high head loss gradients)		
WTP Production Expansion (m^3/day)	Existing: 180,000 Dongmakkhay: 100,000 Chinaimo: 40,000 Thadeua: 20,000 Sendin: 20,000 Thangone*: 40,000 Nongda*: 20,000 420,000	Existing: 180,000 Dongmakkhay: 100,000 Chinaimo: 40,000 Thadeua: 20,000 Sendin: 20,000 Thangone*: 40,000 Nongda*: 20,000 420,000	Existing: 180,000 Dongmakkhay: 100,000 Chinaimo: 40,000 Thadeua: 20,000 Sendin: 20,000 Chinaimo*: 20,000 Dongban*: 20,000 Thadeua*: 20,000 420,000
Storage (m^3)	10,000	50,000	25,000
Cost (euro)	50,000,000	73,000,000	68,000,000
Cost incl. Production (euro)	80,000,000	103,000,000	98,000,000
	(Dongmakkhay, Chinaimo 40,000 m^3/day, Tadeua WTPs are excluded.)		

Source: Prepared from NPNL Water Supply Assets Mater Plan, AfD 2014
*: WTPs to be expanded in order to increase production capacity more 60,000 m^3/day by 2030.

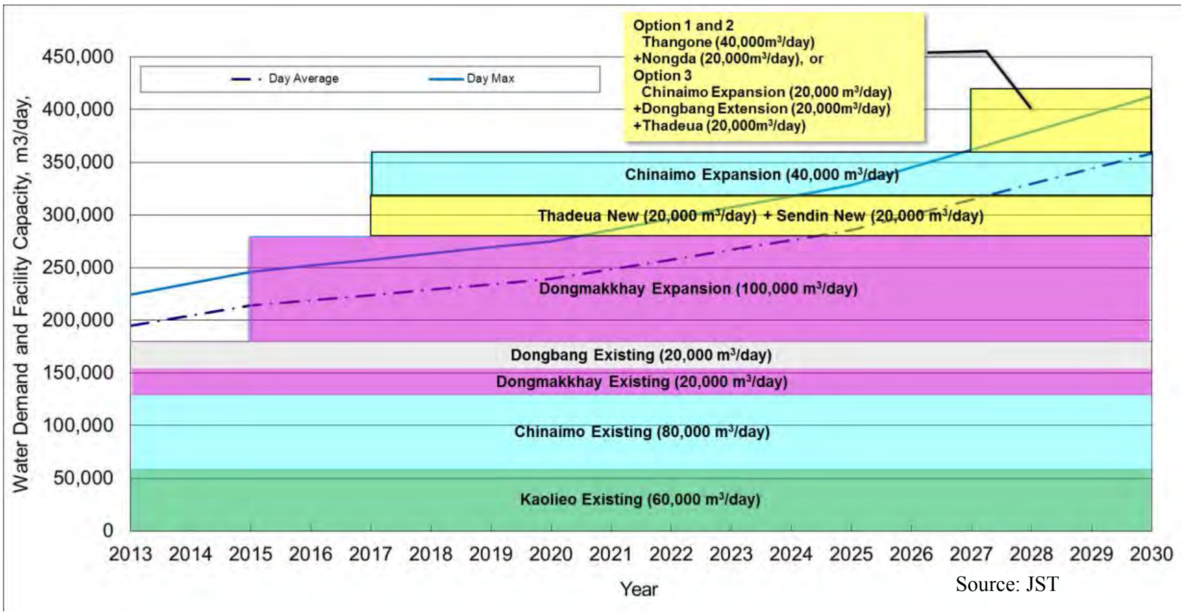
NPNL currently plans Dongmakkhay expansion (100,000m^3/day) in the end of 2015, Chinaimo expansion (40,000m^3/day) and Thadeua (20,000m^3/day) in 2017, and Sendin expansion (20,000m^3/day), though the implementation year is unknown. The capacity of more 60,000m^3/day should be increased by 2030 depending on the following options.

<u>Option 1 and 2</u>
- Thangone 40,000 m^3/day
- Nongda 20,000 m^3/day

<u>Option 3</u>
- Chinaimo 20,000 m^3/day
- Dongban 20,000 m^3/day
- Thadeua 20,000 m^3/day

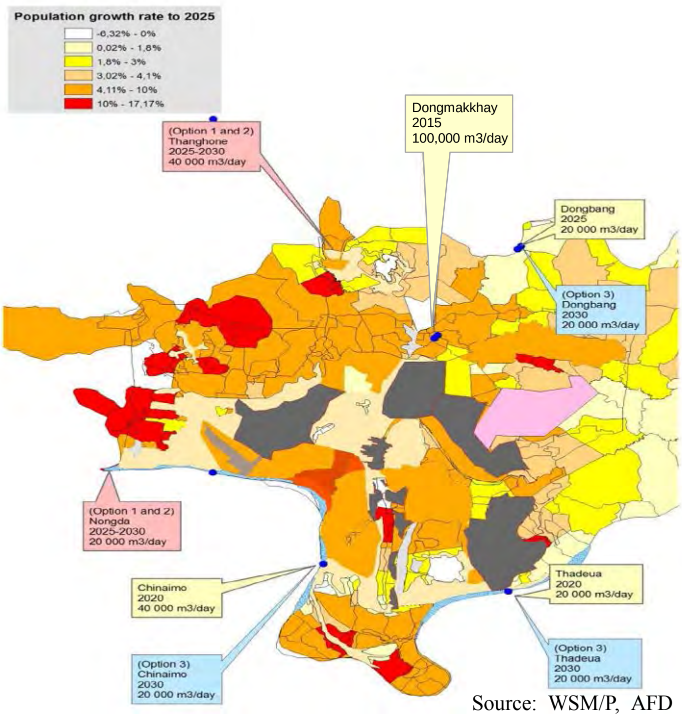
Figure 3.16.1 illustrates the long-term plan development plan for water supply system for option 1 to 3 above, and Figure 3.16.2 shows these locations.

[11] WSM/P 2014 was prepared and submitted to NPNL in September, 2014; it, however, has not been authorized as of May, 2015. It has been supposed to be current M/P in concerned parties.



Source: JST

Figure 3.16.1 Long-term Plan for Improvement of Water Supply Plan



Source: WSM/P, AFD 2014

Figure 3.16.2 Locations of Long-term Plan for Improvement of Water Supply Plan

Moreover, WSM/P 2014 has identified the necessary pipe extension and bottle-neck pipes in the distribution network to be replaced with larger diameters to improve the present suppressed supply conditions, and proposed the replacement of pipes over 40 years old.

3.17 Long-term Financial Plan

As a Long-term Financial Plan, the NPNL is preparing the financial plan (composed of financial analysis of the NPNL and business plan for the future) with the support of AfD. GRET, French development NGO, has been providing technical assistance to the NPNL for this project funded by AfD, which is called the MaDeVie project (Improving Business Management & Increasing Access to Water Supply in Vientiane Capital). The above mentioned financial plan is being prepared as one of the major components of the MaDeVie, to modernize commercial and financial management.

This section describes general contents of the draft business plan, which is a part of financial plan, in order to know the present long-term financial plan of the NPNL. The source of the description of business plan of this section is, "DRAFT FOR REVIEW, Development of the NPNL financial plan, made by GRET, Project Madevie: Funding AfD, September 2014".

(1) Business Plan: The methodology

The business plan (by the year 2030) is prepared based on present financial statements of the NPNL with several assumptions. Future cash-flow statement is formulated to understand the future condition of yearly cash-flows and cumulated cash flows. Important assumptions of the business plan are as follows;

- Period of business plan: from 2014 to 2030
- Tariff level: previous tariff table and present one (in 2014)
- The growth rate of new connections is 7% per year until 2020 and 4% per year from 2020 to 2030.
- Thadeua WTP starts operation in 2016, Sendin WTP starts operation in 2017 based on the same purchase conditions.
- Dongmakkhay WTP starts operation in 2015. The value of assets equals the values of the loan (95% of the investment) and loan conditions are; 10 years repayment period without grace period at 2% interest rate.
- Network extensions and reinforcements of the planned master plan (M/P) are applied.
- NRW ratio is set at 25%.

(2) Business Plan Scenarios: Outputs

1st Scenario:

Additional Assumption:

- PREVIOUS tariff table (by September 2014) is applied.

Results:

- Negative cash-flows.
- Operating cash-flow could not afford to pay the principal of loans.
- Net income also becomes negative caused by heavy depreciation cost of Dongmakkhay WTP and loan repayment for it.
- The NPNL have to wait until the year 2028 to make positive net income under the previous tariff.

2nd Scenario:

Additional Assumption:

- Present (after October 2014) water tariff table is applied.

Results:

- Positive net income (profit) every year.
- The NPNL is able to pay back all of the debt.

- However, the balance is not enough to cover the cost to implement the M/P (network extensions and reinforcements).

3rd Scenario:
Additional Assumptions:
- Present (after October 2014) tariff table is applied.
- Condition of the Exim Bank loan for Dongmakkhay project is changed to 25 years repayment period with 5 years grace period.
- Furthermore, the loans for AEP1 and AEP2 are assumed to be changed to grant.

Results:
- Significant improvement of cash-flow of the NPNL.
- Cash-flow of 5 years (from 2015 to 2018, and 2020) becomes negative, but the others become positive by the year 2030 even with covering the cost of implementing M/P.
- After the year 2023, the NPNL is expected to accumulate the profit year by year.

4th Scenario:
Additional Assumptions (to 3rd Scenario):
- 20% discount of treated water purchase cost from WTP by negotiation.
- To make short the receivable cycle.
- To make small the stocks of materials.

Results:
- More favourable for the NPNL than 3rd Scenario.
- Negative cash-flow is observed only for 3 years (2016-2018), and positive cash-flow continues for the other years.
- There is no need for NPNL to borrow any money to implement the M/P.

(3) Conclusion

Business plan prepared by GRET with the support of AfD is considered to provide a lot of important suggestions to NPNL with some of the ideas already realized. However, it includes some old or faulty assumptions in it as follows;

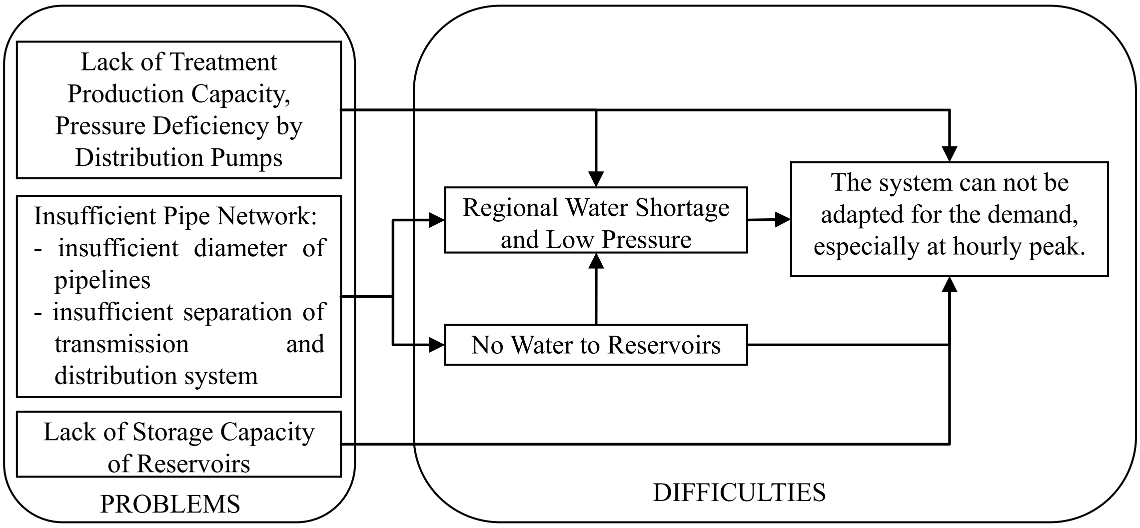
- Old water tariff table is still utilized.
- Future approved water tariff raises in the year 2015, 2016, 2017, 2018 are not applied for the projection. These certainly contribute to make the projection result better.
- Costs for new NPNL's office building construction (30.1 billion LAK), on the way, may not be considered in the business plan.

It is indispensable for the financial planning of this survey to consider the above changes of situations with respecting on the results of several scenarios of the business plan prepared by GRET supported by AfD.

3.18 Identification and Evaluation of Present Water Supply Conditions in NPNL

3.18.1 Technical Aspect

There are some problems in Vientiane Water Supply System. The reasons are summarized as shortage of water treatment production capacity, pressure deficiency by distribution pumps, insufficient pipe network accounting for regional water shortage, low pressure, and lack of storage capacity of reservoirs. Therefore, the system can not be adapted for the demand, especially in peak periods. Figure 3.18.1 illustrates the problems of the existing water supply system in view of technical aspect.



Source: JST

Figure 3.18.1 Problem and Difficulty of Current Water Supply System in Vientiane Capital

(1) Shortage of Treatment Production Capacity and Pressure Deficiency by Transmission and Distribution Pumps

Although the total production capacity of the existing treatment plants, Chinaimo and Kaolieo, Dongmakkhay, Dongban is 180,000 m^3/day, the average daily discharge in 2013 was over 199,000 m^3/day as discussed in previous Section. Therefore the existing treatment plants are operating under overloaded conditions, beyond their rated production capacity. In order to secure a stable and steady water supply service to meet the demand for water, it is obvious that the Vientiane Water Supply System is facing a situation where the treatment production capacity needs urgent improvement. Although the pipe network has been extended to the outer areas from central city zone, distribution pump heads seem~~s~~ insufficient to these areas. With zoning plan, pump heads should also be examined.

(2) Insufficient Size of the Existing Pipelines

WSM/P 2014 points out the main reason for lack of water and low pressure due to piped network hydraulic arrangements and under sized pipes (critical linear head loss). According to the results of pipeline network analyses in WSM/P 2014, reinforcement of pipelines to adequate size is required.

(3) Lack of Storage Capacity of Reservoirs

The total amount of storage capacities for the existing reservoirs is 12,560 m^3, and this is less than two (2) hours for designed water supply capacity (180,000 m^3/day) from the existing WTPs. Because reservoir has the buffer function in the hourly peak demand, increase of storage capacity is required as well as increase of water supply amount by expansion of WTPs.

3.18.2 Operational Aspect

Major performance indicators of NPNL related to the operation aspect are shown in Table 3.18.1 in comparison with those of Phnom Penh Water Supply Company and several Japanese city waterworks.

Table 3.18.1 Comparison of Performance Indicators Related to Operation Aspect

No.	KPI	Calculation	Unit	Vientiane 2013	Phnom Penh 2012	Japan's Cities Sapporo 2011	Niigata 2011	Akita 2012	Yokosuka 2010	Kagoshima 2010
1	Water quality % of (Water samples conforming to Water Quality Standards)	= (Number of samples that meet the specified potable water standards/Total number of water samples)	%	94.5	N/A	100	100	100	100	100
2	Water Treatment Plant Capacity	= Quantum of bulk water supply/Installed capacity of the WTP	%	110.9	N/A	71.6	67.6	63.4	81.5	73.8
3	Storage Level: Distribution Reservoir Capacity	=total reservoir capacity/Average day water distribution=42,360m3/199,618m3/d	%	21	N/A	103	79	107	104	158
4	Staff per 1,000 connections	=529 persons/96,288 connections*1000	staff/1000 connections	5.49	3.0	0.77	0.93	0.86	0.88	1.21
5	Energy consumption per unit water production	=Electroenergy consumption for water intake and water production annual / Water intake volume annual	KWh/m3	0.35	N/A	0.16	0.34	0.42	0.22	0.57
6	Non-Revenue Water Ratio	=(Total water produced and put into the transmission and distribution system-Total water sold)/(Total water produced and put into the transmission and distribution system)	%	25	6.6	7.2	6.6	10.6	10.0	8.3
7	Leakage ratio		%	N/A	N/A	3.0	3.6	7.6	7.5	6.0
8	Pipes Exceeding Legal Durable Years (>40 years)	Pipe length over 40 years (21,535 m)/Total length of pipe with dia. 75 mm and over (1,087,456m)	%	2.0	N/A	1.5	10.2	2.2	17.8	19.2
9	Customer Complaints (water supply service)	=reported cases of customer complaints on water supply services/1000 customers	cases/1000 customers	0.106	N/A	0.08	0.12	0.43	2.3	0.05
10	Customer Complaints (Water Quality)	=reported cases of customer complaints specialy on water quality/1000 customers	cases/1000 customers		N/A	0.16	0.04	0.13	0.41	0.51

Source: NPNL, Phnom Penh Water Supply Authority, Japan Water Works Association

From the above comparison the following are identified and evaluated:

The present NRW ratio is reported to be 25%. Although the leakage ratio cannot be presently estimated, it is necessary to analyze the components of NRW correctly to conduct effective countermeasures for the reduction of NRW. NPNL has started the measurement of minimum night flow at two pilot areas in 2014. It is expected that the experiences in these pilot areas will be disseminated to the other service areas of NPNL and contribute the further reduction of NRW ratio in the near future.

The current water treatment plant overloading ratio, 110.9%, indicates the delay of the implementation of water production facility development plan against the rapidly increasing water demand in Vientiane Capital. Water supply development should be in time to avoid overloaded operation of the water supply facilities. This is because finished water quality cannot be guaranteed under the overloaded conditions of water treatment processes, and water supply pressure at customers' taps declines resulting in the increase of customers' complaints.

Proportion of aged pipes over 40 years of NPNL is not high when compared with those of Japanese waterworks. Since most of the existing pipelines were installed after the 1980's in Vientiane this ratio is still low. However, proper pipe asset management plan will be required in the near future as aged pipes over 40 years will be increasing after the 2020’s. NPNL is presently establishing GIS, and it is expected that this will contribute the preparation of correct inventory of existing pipe data and the development of the future pipe asset management plan.

Water quality of distributed water is presently examined at ninety six (96) sampling points in the distribution network once a month. Turbidity, pH and residual chlorine are measured as indicators, and 5.5% of the total samples examined in 2013 failed to conform to the drinking water quality criteria. According to Chinaimo laboratory, however, sampling was not conducted at some sampling points due to low water pressure or no water supply. As such samples are also counted as failed samples, it is presumed that the figure by only water samples actually examined is lower than 5.5%. The safety of the water quality in the distribution network can be guaranteed only when appropriate water pressure is constantly maintained in the distribution network.

Electricity consumption per unit water production is not very high at present when compared with the other waterworks. NPNL is, however, fully dependent on pumping both for raw water abstraction and distribution of treated water to customers due to rather flat topographic conditions all over the service area. NPNL’s annual electricity consumption presently accounts for approximately 1% of the total electricity consumption in Vientiane Capital. Further efforts for optimum operation of pumps in conjunction with the employment of high efficiency pumps and control system will be important for holding down the operation costs of the pumping facilities.

The indicator regarding customer complaints shows very high value. It is inferred that there are some service areas where water pressure is very low or nil and many complaints are derived from these areas. Types of complaints are not categorized at present, and only the number of complaints is being monitored by NPNL. Categorizing the customer complains in terms of water pressure, water quality, leakage and others would help NPNL analyze the problems and undertake proper countermeasures.

3.18.3 Financial Aspect

In Vientiane Capital, NPNL is responsible for financial management of water supply service. Therefore, it is indispensable to check the financial condition of NPNL to conduct the identification and evaluation of present water supply conditions.

Evaluation of financial conditions of NPNL is analyzed and described in “3.13 Financial Analysis of NPNL” and “3.18 Long-term Financial Plan”. This section briefly mentions the important points of these sections.

(1) NPNL’s Financial Condition

NPNL kept making annual net loss after 2010 caused by lower tariff rate. However, the size of net loss is still smaller than the amount of depreciation cost, which is not actual cash outflow. Therefore, NPNL has not yet faced the cash flow problem. New water tariff was effective in October 2014. As of December 2014, the new tariff is applied without many complaints from customers. From several financial indicators, it is observed that financial condition of NPNL has been worse since 2010. However, it will be better after the year 2015 from revenue increases provided the by tariff raise.

(2) Long-term Financial Plan

It is predicted that tariff as of October 2014 is not enough to implement Master Plan (network extensions and reinforcements). Furthermore, the loans for AEP1 and AEP2 must be changed to grants and a certain amount of discount of treated water purchase price with some management improvements.

Average tariff was 1,815 LAK/m^3 (0.23 USD) in 2013. On the other hand, unit production cost was 1,605 LAK/m^3(0.20 USD) in 2013. Considering a series of tariff raise from 2014 to 2018, the average tariff will still be higher than unit production cost. If this holds true, there will be more possibilities to generate annual net profit. NPNL's financial conditions have not been good for the last several years. However, it is considered that NPNL's financial situation shall become preferable in the future with relevant financial management.

3.18.4 Human Resources Aspect

The total number of NPNL staff is 533 including 53 nonpermanent staff (as of September, 2014). Table 3.18.2 shows staff number of each section.

Table 3.18.2 NPNL Staff Allocation

Position/Department	No of Permanent Staff	No of Non-permanent Staff
General Manager	1	
Deputy General Manager	4	
Audit Division	4	
Technical and Production Section	49	6
Chinaimo Water Treatment Plant	28	5
Kaolieo Water Treatment Plant	36	2
Dongmakkhay Water Treatment Plant	28	1
Water Meter Section	23	1
Improve Service Branch Project	15	3
Volume Audit Project	3	
Commercial and Service Section	17	
Chanthabouly Branch Office	26	1
Sisattanak Branch Office	27	2
Sikhottabong Branch Office	31	1
Saysettha Branch Office	28	
Saythany Branch Office	30	1
Hatsayphong Branch Office	26	2
Sungthong Branch Office	6	
Parkngerm Branch Office	4	3
International Cooperation Project	4	
Urban Project	3	
Personal Administration Section	25	9
Water Supply Training Center	7	5
ICT Section	15	
Drinking Water Factory	3	11
Finance Section	13	
Management Supply Material Section	10	
Statistic and Planning Section	7	
Debts and Contact Section	7	
Total	480	53

Source: NPNL

Staff productivity is measured as the number of staff per 1,000 connections. In case of NPNL the number of staff per 1,000 connections is 5.2 staff and it can be said that its productivity is almost appropriate based on the international benchmarking standards (5 staff per 1,000 connections).

Regarding human resources development, NPNL has a technical training center, which was established by the assistance from AfD, within the compound of the Chinaimo water treatment plant. JICA also supported the development of the NPNL training systems including ToT (Training of Trainers), preparation of textbooks, etc through “Project for Capacity Development of Urban Water Supply Authorities (2003-2006)”

The technical training center provides both technical and administrative modules in 2014 based as shown in Table 3.18.3. The training period of each course is normally 4 - 5 days.

Table 3.18.3 Technical and Administrative Modules of the Technical Training Center

No	Technical Module
1	Basic for water distribution and pipeline component
2	Controlling of water pipeline using
3	Pipeline laying (Level 1)
4	Pipeline laying (Level 2)
5	Use and maintenance of water measure
6	Control of wastewater in pipe system
7	Basic of hydraulic and Hydrostatic
8	Select and install the pump
9	Topographical survey
10	Estimation and calculate of connection to household
11	Water supply network design
12	Basic design of water treatment plant
13	Using GIS in the water system
14	Analysis the problem (pump) of water treatment plant
15	Electricity of water treatment plant
16	3 Phase electrical and connection
17	Electrical and controlling
18	Installation, using and maintenance
19	Production control and maintenance of water treatment plant
20	Water quality analysis (Level 1)
21	Water quality analysis (Level 2)
22	Water quality analysis (Level 3)
23	Analysis by use chemical in water production

No	Administrative Module
1	Water supply administration
2	Management and development for personal
3	Training of trainer
4	Water supply basic knowledge (For new staff)
5	Administrative and secretary
6	Statistic and KPI
7	Corporation and Planning
8	Water tariff setting
9	Financial basic and Nampapa business
10	Financial analysis
11	Financial and water supply management
12	Commercial account
13	Storage management
14	Bidding and procurement
15	Customer service (Meter record, bill, money collection)
16	Basic of using program AutoCAD
17	Basic of using program water CAD
18	Using Word and Excel
19	Using word and Excel (Advance)
20	Using Program Powerpoint and Internet-Email
21	Program installation and computer maintenance

Source: Technical Training Center, NPNL

According to the Prime Minister's proclamation (37/PM), the NPNL is required to offer technology development, courses and workshops for the training of all water supply enterprises in Lao PDR. NPNL is also given the responsibility to spread information about training, manuals and staff development methods. Therefore, the technical training center is utilized not only for NPNL but also for all water supply enterprises in Lao PDR. Most of the trainers are staff~~s~~ of NPNL and each water supply enterprise pays training fees to the technical training center. In 2013 NPNL paid 244,197,727 LAK for the training courses, while the other enterprises paid 75,966,000 LAK in total. Although NPNL planned to send 475 staff to training courses in 2013, only 361 staff received the trainings because of their busy daily works.

Compared other water supply enterprises, NPNL has many experienced and capable staff~~s~~. However, it is pointed out that there are still less experienced staff and basic trainings are necessary for them. Especially for maintenance management works, the number of engineers is limited and fixing broken equipment in an expedient manner is found to be difficult. Outsourcing of the maintenance works will be examined for more efficient operation and maintenance.

Chapter 4 PLANNING OF THE PROJECT

4.1 Water Demand Projection by 2030

4.1.1 Population Forecast

(1) Population Forecast in Vientiane Capital

Population forecasts for Vientiane Capital have been carried out by several studies. This Preparatory Survey made a comparative study of:

- Nampapa Nakhone Luang Water Supply Assets Mater Plan in 2014 (WSM/P 2014),
- The Project for Urban Development Master Plan Study in Vientiane Capital in 2011 (UDM/P 2011),
- The Study on Vientiane Water Supply Development Project in 2004 (WSM/P 2004).

These studies have applied the growth ratio of 3.0% in WSM/P2014, 2.6-3.0% in UDM/P, and 2.8% in WSM/P2014. The comparison of the above studies is shown in the table below.

Table 4.1.1 Population Forecasts by WSM/P2014, UDM/P2011, and WSM/P2004

Study Name	2015	2,020	2,025	2030
WSM/P 2014	943,840	1,094,169	1,268,442	1,470,472
UDM/P 2011	943,840	1,074,000	-	1,439,000
WSM/P 2004	902,716	1,034,521	-	-

Recent statistic information counts the population of Vientiane Capital was 854,069 in 2013. The population growth for the recent five (5) years from 2008 (740,010) was approximately 3%. Taking SEZ and new towns developments into the consideration, the growth ratio of 3.0% of WSM/P 2014 is deemed appropriate, and the Preparatory Survey reviewed the population forecast with using this growth rate as follows. The detailed population forecast is also shown in SUPPORTING REPORT, A6.

Table 4.1.2 Population Forecasts by the Preparatory Survey

Study Name	2013	2015	2,020	2,025	2030
Preparatory Survey	854,069	906,082	1,050,397	1,217,698	1,411,646

Note: Population data in 2013 is shown in DATA BOOK, C1

The numbers of these results of forecast are almost the same. Figure 4.1.1 represents their similarity.

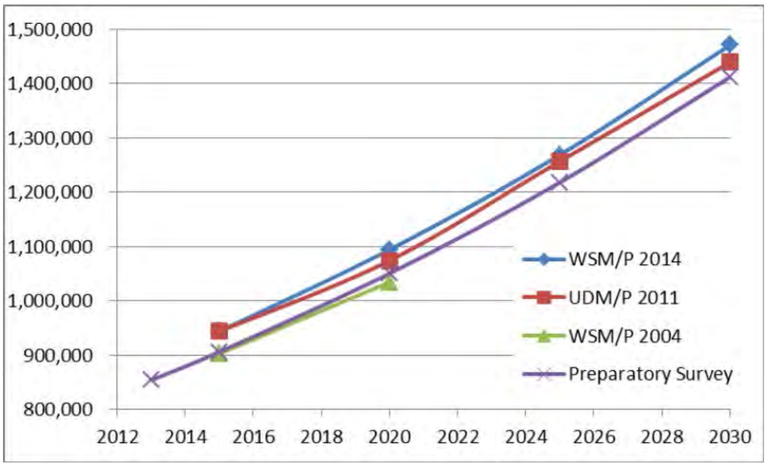


Figure 4.1.1 Population Forecast in Vientiane Capital

(2) Served Population in Vientiane Capital

These studies also projected the future served population in urban area of Vientiane Capital. Table 4.1.3 compares these numbers.

Table 4.1.3 Comparison of Numbers of Population Served by NPNL

Study Name	2015	2,020	2,025	2030
WSM/P 2014	561,373	650,785	754,438	917,996
UDM/P 2011	506,000	620,000	-	915,000
WSM/P 2004	467,000	564,000	-	-

In Vientiane Capital, recent population growth of from 2005 to 2012 in urban area was relatively low (0.0 to 3.0%) when compared to that of the outer urban and outskirts areas (2.0 to 4.0%).

In this Preparatory Survey, the numbers of served population were calculated with the growth rates of 1.5% for the existing service area by NPNL, and 3.0% for the future extension area. Consequently, served population that is currently 486,710 in 2013 is estimated at 921,787 in 2030 as shown in the table below. The detailed population forecast is also shown in SUPPORTING REPORT, A6.

Table 4.1.4 Population Forecasts by the Preparatory Survey

Study Name	2013	2015	2,020	2,025	2030
Preparatory Survey	489,175	557,287	689,167	804,207	921,787

Note: The above numbers are populations of urban area by piped water extended to 4 districts and partway of 3 districts (i.e. urban area of 7 districts: 1.Chanthabouly, 2.Sikhottabong, 3.Xaysetha, 4.Sisattanak, 5.Naxaithong, 6.Xaythany, and 7.Hadxaifong).

The results of WSM/P 2014 and this survey show the numbers of served population is higher than estimated for previous projects. Figure 4.1.2 illustrates the comparison of the numbers estimated by those studies and this Preparatory Survey.

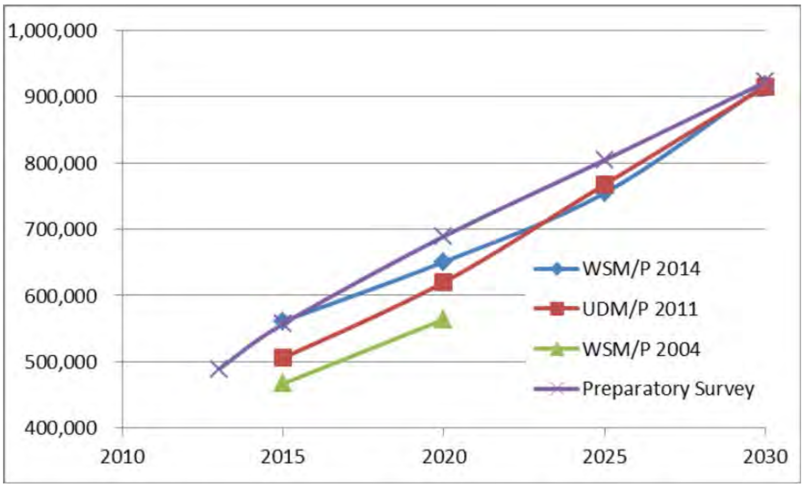
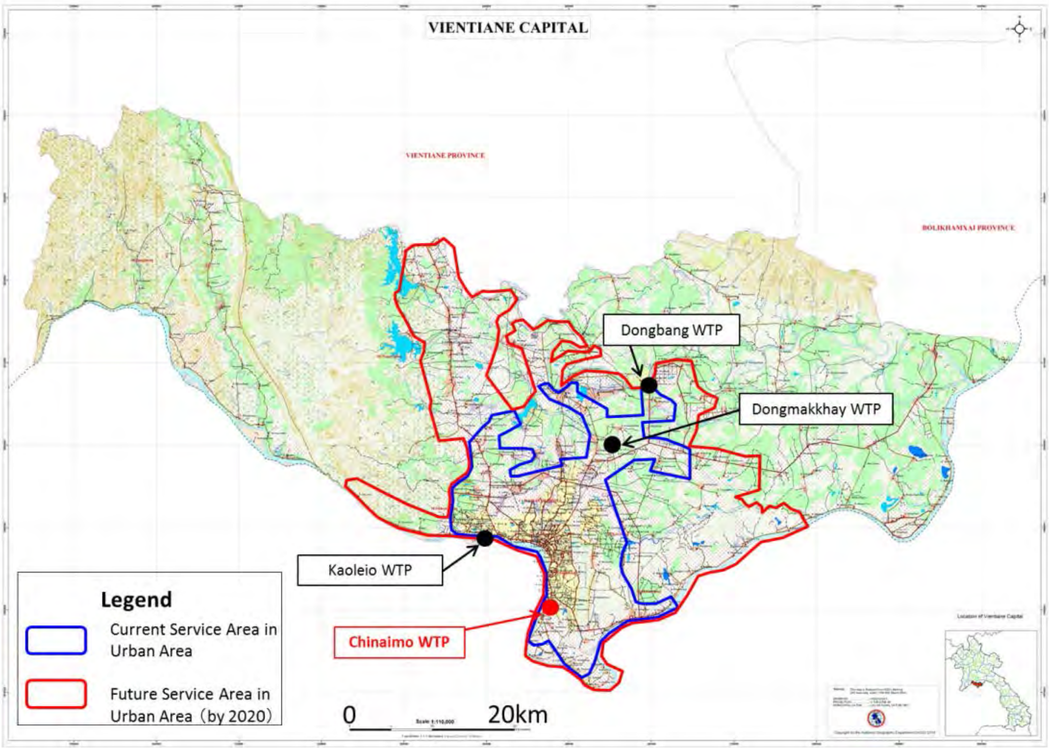


Figure 4.1.2 Estimates of Population Served in Vientiane Capital

4.1.2 Water Demand

(1) Future Service Area

NPNL has supplied water to urban area by the four (4) water treatments plants: namely Chinaimo, Kaoleio, Dongban, and Dongmakkhay WTPs. This urban water supply area has spread to seven (7) districts. Figure 4.1.3 shows the urban water supply area currently and in future to be expanded by 2020.



Source: JST

Figure 4.1.3 Current and Future Water Supply Area

The following sections will discuss this design service area (i.e. current and future service area in urban area of Vientiane Capital).

(2) Domestic Water Demand

According to NPNL's data, water sold to domestic households in 2013 was 43,740,423m^3/year (daily average of 119,836m^3/day). The per capita water consumption was computed as approximately 245 Liters/day/person, lpcd, since the served population in 2013 was an estimated 489,175. The domestic water uses of the past 3 years were also computed at around 235-245 lpcd. In the past reports, the domestic water use was 182 lpcd in 2000, 188 lpcd in 2005, and 208 lpcd in 2010. The trend is toward increase these few decades.

On the other hand, *Management and Technical Guidance Water Supply (2009)* issued by Water Supply Division (WSD) of Department of Housing and Urban Planning (DHUP) in Ministry of Public Works and Transport (MPWT), guides the following design standard for water supply planning.

Table 4.1.5 Guideline for Domestic Water Use in Water Supply Planning

No	Category	Number of People Already Served	l/p/c/d (lpcd)
I	Municipality	> 100,000	200 -250
II	Large City	50,000 - 100,000	120 - 200
III	Small City	20,000 - 50,000	100 - 120
IV	Small Town (but many people living)	5,000 - 20,000	80 - 120
V	Small Town (but not many people living)	2,000 - 5,000	60 - 80
VI	Community	< 2,000	40 - 60

Source: *Management and Technical Guidance Water Supply (2009)*, WSD of DHUP in MPWT

Current domestic water uses in Vientiane Capital approach the upper limits of the guideline. As the capital of the Lao PDR, applying 245 lpcd as the per capita water consumption for the domestic water demand projection is considered in this Preparatory Survey.

(3) Non-Domestic Water Demand

In NPNL's data, water sold to non-domestic entities in 2013 was 10,613,657m^3/year (daily average of 29,078m^3/day). This amount is 24% of domestic use, and this percentage has increased year by year (e.g. it was 15% in 2009). On the other hand, *WSM/P 2014* forecast the percentage will increase up to 50% in year 2030 as the table below.

Table 4.1.6 Forecast of Non-Domestic Projection by WSM/P 2014

	2010	2015	2020	2025	2030
Non-Domestic Water Demand (m^3/day)	22,175	37,117	49,606	73,878	99,636
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%

Source: *WSM/P 2014*, WAT, AfD, and NPNL

In recent years, the ratio for non-domestic water has been increasing. It is expected this trend will be continued in the future also with further urbanization in Vientiane Capital such as SEZ development. Therefore, this Preparatory Survey applies the above percentages for the non-domestic water demand projections.

(4) Non-Revenue Water (NRW)

Recent NPNL data show a dramatic improvement for non-revenue water (NRW) in Vientiane Capital. The percentage, which was once 36% in 2011, has been reduced to 25% in 2013. This is considered a result of AfD cooperation for capacity development of meter readers of NPNL, procurement of meter calibration & test equipment, and establishment of Water Meter

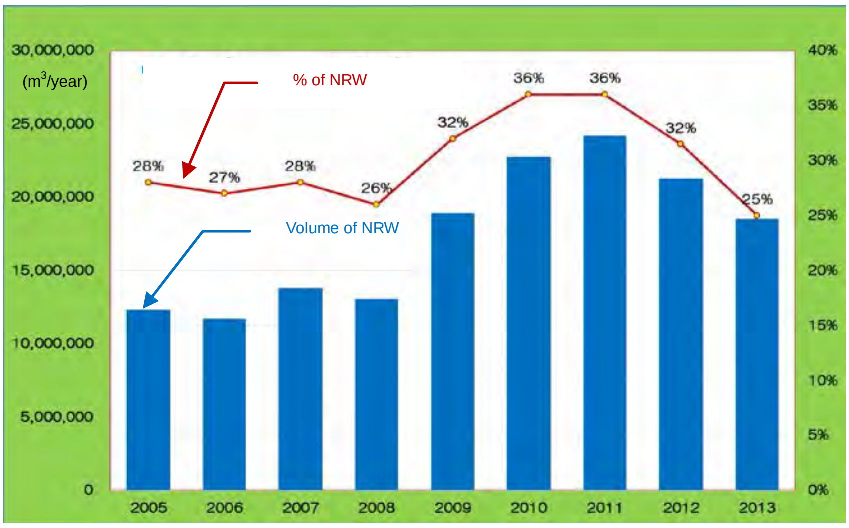


Figure 4.1.4 Transition of Volume and Percentage of NRW in Vientiane Capital

Source: NPNL

Management Section in NPNL.

Continuing activities for NRW reduction, it is expected that the percentage would be reduced to 10% by 2030, in prospect of 1% reduction per year in approximately 15 years.

(5) Peak Daily Factor

Analyzing the data of water production from Chinaimo WTP, the peak daily factor was computed as 1.1 (day max 100,773m^3/day divided by day average 91,627 m^3/day). This peak daily factor is applied for calculation of the daily maximum water demand up to 2030.

(6) Summary of Water Demand Projection

Setting served population, per capita consumption, percentage of non-domestic water demand, NRW ratio, and peak daily factor discussed, Table 4.1.7 shows the summary of projected water demand up to 2030. Elaboration of Water Demand Projection is also shown in SUPPORTING REPORT.

Table 4.1.7 Summary of Water Demand Projection

	Unit	2013	2015	2020	2025	2030
Population	person	854,069	906,082	1050,397	1,217,698	1,411,648
Population in Urban Area*	person	675,751	700,498	766,891	840,368	921,787
Served Population	person	489,175	557,287	689,167	804,207	921,787
Service Ratio	%	72%	80%	90%	96%	100%
Per Capita Consumption	lpcd	245	245	245	245	245
Total Domestic Water Demand	m^3/day	119,848	136,535	168,846	197,031	225,838
Non-Domestic Water Demand	%	24%	27%	35%	45%	50%
	m^3/day	28,764	36,864	59,096	88,664	112,919
Total Water Demand	m^3/day	148,612	173,399	227,942	285,695	338,757
Non-Revenue Water (NRW)	%	25%	25%	20%	15%	10%
	m^3/day	49,537	57,800	56,986	50,417	37,640
Day Average Water Demand	m^3/day	199,619	231,199	284,928	336,112	376,397
Peak Daily Factor		1.1	1.1	1.1	1.1	1.1
Day Maximum Water Demand	m^3/day	219,600	254,300	313,400	369,700	414,000

Population in Urban Area* is the population in current and future service area which extends to the four (4) districts and partway of three (3) districts (i.e. Chanthabouly, Sikhottabong, Xaysetha, Sisattanak, Naxaithong, Xaythany, and Hadxaifong).
Source: JST

Comparing the daily maximum water demand estimated by this Preparatory Survey with that estimated to WSM/P 2014 by NPNL with assistance by AfD, it is confirmed that there is not much difference between both results as shown in Table 4.1.8.

Table 4.1.8 Comparison of Numbers of Day Maximum Water Demand Forecast with WSM/P 2014

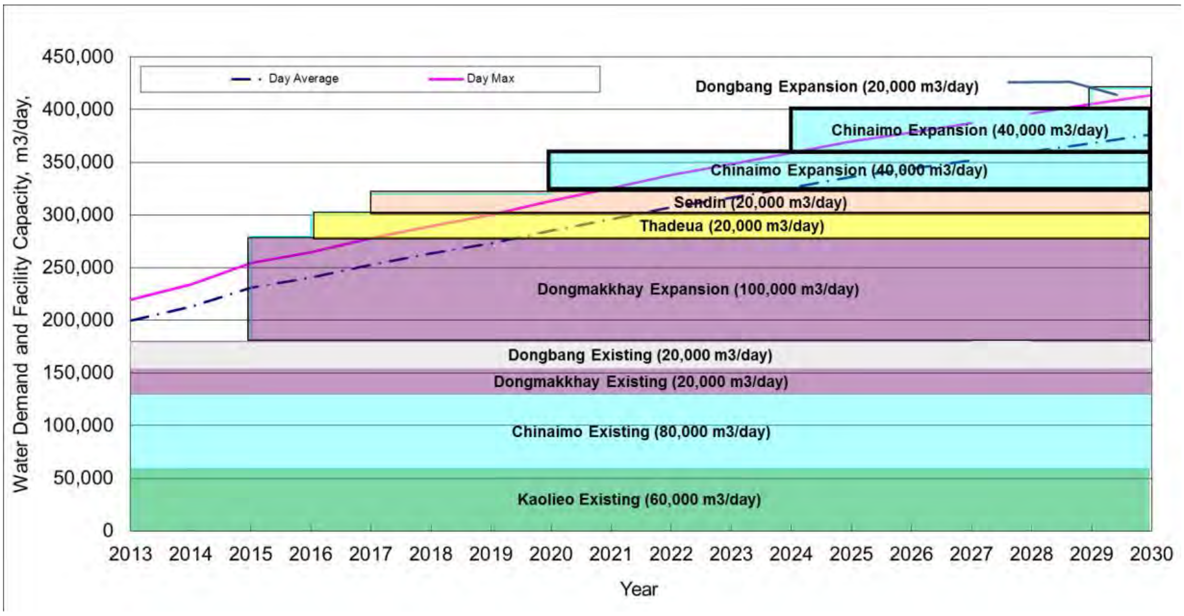
Study Name	2015	2,020	2,025	2030
Preparatory Survey (m^3/day)	254,300	313,400	369,700	414,000
WSM/P 2014 (m^3/day)	246,004	275,047	328,512	412,494

Source: JST

4.2 Proposed Development Plan for Water Supply Facilities

The total of the existing WTP capacities is 180,000m^3/day (i.e. 80,000 m^3/day in Chinaimo WTP, 60,000 m^3/day in Kaolieo WTP, 20,000 m^3/day in Dongmakkhay WTP, and 20,000 m^3/day in Dongbang WTP). At present, the Dongmakkhay WTP expansion project, with a design capacity of 100,000 m^3/day, is under construction and is expected to be completed in 2015. Also, construction of

Thadeua WTP, with a capacity of 20,000 m^3/day, commenced in January 2015, and its operation is expected to start in 2016. Sendin WTP with a capacity of 20,000 m^3/day is also expected to start operation from 2017. Considering these factors, Figure 4.2.1 shows a development plan for the Chinaimo WTP expansion.



Source: JST

Figure 4.2.1 Development Plan (Chinaimo WTP Expansion Plan)

Initially, the request from the GOL was an expansion of 40,000 m^3/day in the existing Chinaimo WTP. However, from the results of the water demand projection in this survey, even if Chinaimo WTP is expanded up to 120,000 m^3/day in the design capacity with the expansion of 40,000 m^3/day by 2020, the water supply amount from the WTPs would dip from the day maximum water demand after 2024, and then, water shortage would again occur in urban area of Vientiane Capital. Therefore, in Chinaimo WTP expansion, it was proposed a stepwise development plan shown in Figure 4.2.1, i.e. expansion of 40,000 m^3/day by 2020 as Phase 1 and further expansion of 40,000 m^3/day by 2024 as Phase 2, up to 160,000 m^3/day in the design capacity which is the maximum expansion capacity within the limited site (property) of Chinaimo WTP. The GOL agreed to the proposal.

Table 4.2.1 shows the summary of the stepwise expansion in Phase 1 and Phase 2.

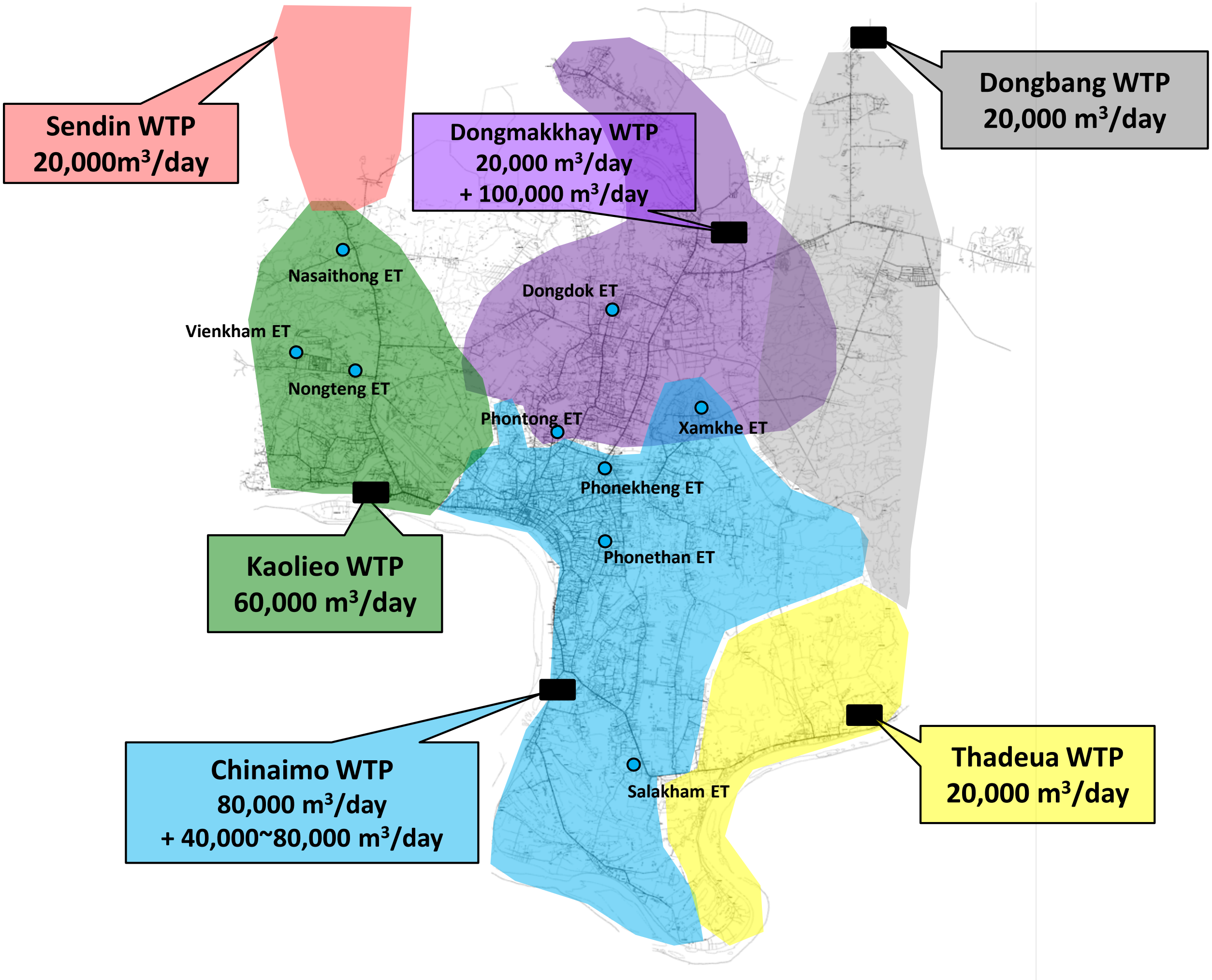
Table 4.2.2 Summary of Phase 1 and Phase 2 for Chinaimo WTP Expansion

Phase	Design Capacity of Chinaimo WTP	Remarks
Phase 1	120,000m^3/day	40,000 m^3/day expansion from 80,000 m^3/day capacity
Phase 2	160,000m^3/day	40,000 m^3/day expansion from 120,000 m^3/day capacity

Source: JST

4.3 Identification of Supply Area from Expanded the Chinaimo Water Treatment Plant and Other Water Treatment Plant(s)

Although there exists no water distribution zoning plan in the water supply system in Vientiane Capital, the basic idea of water distribution demarcation among the future water treatment plants are, understood among the officials concerned, as illustrated in Figure 4.3.1.



Source: JST

Figure 4.3.1 Future Plan for Water Distribution Demarcation by WTPs

Chinaimo WTP will be a main supply source for the center of Vientiane Capital as well as the southern tip of the capital, including the area along Thadeua road to Salakham ET. Supply to the center of Vientiane Capital will be provided through Phonetang ET as well as direct pumping supply to the consumers. Thatlouang New Town will be also supplied mainly from Chinaimo WTP.

Thadeua WTP will cover the development area (two special economic zones) along Thadeua Road and the developing area near the friendship bridge. Thadeua WTP will also extend its supply to Thatlouan New Town project with 6,000 m^3/d according to the system design.

Donmakkhay WTP will be another main supply source to the north and the center of Vientiane Capital through Phonetong ET, Phonekeng ET, Doungduk ET and Xamkhe ET. Supply towards 450-year-road will be also provided by branch pipe connection from the newly installed transmission mains.

Kaoleio WTP's supply area will be shifted towards the west and north west of Vientiane Capital after the expansion of Dongmakkhay WTP and Chinaimo WTP are completed.

Dongban WTP will mainly supply to the newly developed industrial area which is located at north-east of Vientian Capital.

Sendin WTP will cover~~s~~ the north west area from the central urban area located in Naxayhong District. It is better to link the water supply system with the Kaoleio water supply system.

4.4 Planning of the Water Supply Facilities of the Project

With careful consideration of the present constraints of water supply in Vientiane Capital and the existing facility conditions of Chinaimo WTP system the following basic concepts are adopted in planning the water supply facilities for the expansion project:

(1) The first operation of Chinaimo WTP (Phase 1 project) dates back to the year 1980 with the production capacity of 40,000 m^3/d. In 1993 – 1996, Phase 2 project was implemented to rehabilitate the Phase 1 facilities and construct new facilities for the expansion up to the total production capacity of 80,000 m^3/d. The mechanical and electrical equipment such as pumping facilities installed during these past projects have been still in use but have already got aged, reaching more than 25 to 40 years by the year 2020. Further continuous use of these facilities after the year 2020 is not recommendable since unforeseeable sudden failures due to their ages and the difficulty of procuring old type spare parts are anticipated. In the proposed plan, the renewal of most of these existing old mechanical and electrical equipment should be included so as to ensure the current production capacity of 80,000 m^3/d of the existing facilities beyond the year 2020.

(2) The water source for the project is the Mekong River, which has a tendency of very high turbidity (around 4000 NTU according to the past records) during the rainy season. The planned water treatment plant should be able to treat such high turbidity water continuously to secure the designed production and treated water quality constantly throughout the year.

(3) The water level of the Mekong River fluctuates seasonally more than 10 meters. The planned raw water intake pump facilities should be able to deliver sufficient raw water continuously and efficiently to the WTP throughout the year.

(4) The facility plan will include the modification and rehabilitation of the existing treatment facilities, such as filters and chemical feeding systems, so as to facilitate or improve the operation and control of the treatment processes.

(5) Due to the limited land availability of the Chinaimo WTP premises, compact facility arrangement would be required.

(6) Upon definition of the service areas supplied by gravity through the elevated tanks and by direct pumping from Chinaimo WTP, the effective use of the existing elevated tanks should be considered. The distribution areas covered by Chinaimo WTP will then be divided into the areas supplied by direct pumping from the WTP and those supplied by gravity from Phone Tang, Xamkhe and Salakham ETs for easier operation.

(7) The new water transmission and distribution pump systems should be controlled effectively and efficiently in consideration with simple and reliable operation as well as less maintenance.

Based on the above concept, analyses for intake and distribution pumps were carried out, and economic pump numbers and control methods were examined. While analyses by pipe network calculations, supply area from Chinaimo WTP, necessary pipe diameters of water transmission and distribution pipelines, and location and capacity of distribution center were studied. These matters considered were appropriately discussed by the Interim report and the draft final report meeting, and then confirmed and determined with the GOL.

4.5 Overall Planning for the Project

4.5.1 Overall Operation Plan

By the project horizon of the year 2030, Chinaimo WTP needs to be expanded up to 160,000 m^3/d of the production capacity. The phased expansion work could be, however, implemented by two phases so as to meet the increasing water demand in a timely manner and hold down the initial investment costs.

As discussed in Chapter 4.2 two phased development plan of Chinaimo WTP is considered as one of the options.

Phase 1 construction is expected to be completed in the year 2020, and Phase 1 facilities can cover the water demand up to the year 2025. Meantime, Phase 2 project should be completed by the year 2024 to catch up with the continuously increasing water demand up to the year 2030.

The future projects expected and listed in the WSM/P 2014 are Dongmakkhay WTP Expansion project, Thaedeua WTP project, Chinaimo WTP Expansion project, Thangone WTP project, Nongda WTP project and Dongbang WTP Expansion project. Among which, the projects presently under way are only Dongmakkhay WTP expansion project and Thadeua WTP project. As other project not listed, Sendin WTP is currently planned, and Minutes of Understanding (MOU) was made between NPNL and a Lao private investor in May 2014.

Dongmakkhay WTP is presently under construction and will be completed within the year 2015, but the construction of the water transmission pipes has not started yet. Considering the time necessary for the construction of transmission mains, the supply from Dongmakkhay WTP system will start from the year 2016 at the earliest.

Thadeua WTP construction has not been started yet but expected to start in the year 2015, and the supply from Thadeua WTP is expected to start from the end of year 2016.

Sendin WTP construction is also expected to start within this year after authentic agreement, and expected to commence its operation in 2017.

In the Chinaimo WTP Expansion project, it should be considered such future situation of these projects' implementation conditions, on the way of phased development.

4.5.2 Concept of Overall Plan

Chinaimo WTP has to be expanded to 120,000 m3/day after Phase 1 project and to 160,000 m^3/day after Phase 2 project based on the phasing concept described in "4.2 Proposed Development Plan for Water Supply Facilities". The basic concept for phasing plan has to be prepared to construct the facilities in stages. The basic idea for phasing plan is shown below.

- Phased construction is carried out for facilities which can be constructed in stages (Phase1: 120,000 m^3/day, Phase2: 160,000 m^3/day)
- Ultimate construction is carried out based on Phase 2 capacity for facilities which cannot be constructed in stages.

The concept for phasing plan of each facilites are shown in Table 4.5.1 based on the above .

Table 4.5.1 Concept for phasing plan of each facilities

Facilities	Concept of phasing construction	Remarks
Intake	• Construction based on the capacity of Phase 2	Not phasing construction
Raw water pipeline	Same with above	Not phasing construction
Water treatment plant	• Phase1: Construction based on the capacity of Phase 1 (120,000m^3/day) • Phase2: Construction based on the capacity of Phase 2 (160,000m^3/day)	Phasing construction
Reservoir	• Construction based on the capacity of Phase 2	Not phasing construction
Pumps (intake, transmission and distribution)	• Phase1: Construction based on the capacity of Phase 1 (120,000m^3/day) • Phase2: Construction based on the capacity of Phase 2 (160,000m^3/day)	Phasing construction
Transmission and distribution pipelines	• Phase1: Water supply area is setting with consideration of the amount of 120,000m^3/day • Pipelines which will be constructed during Phase1 are constructed based on the Phase2 capacity	Phasing construction

Source: JST

4.5.3 Phase Plan

The overall project scope falls into the following four major components:

1) Expansion of Chinaimo raw water intake pump station
2) Expansion of Chinaimo WTP
3) Construction of Salakham Distribution Center
4) Expansion of the transmission and distribution pipes

The project will be implemented based on the phased development plan, and the demarcation of the above project components between Phase 1 and Phase 2 is further described in Table 4.5.2.

Table 4.5.2 Major Contents of Project Scope for Each Phase

Project Components	Phase 1 Scope	Phase 2 Scope
1) Expansion of Chinaimo Raw Water Intake Pump Station	• Construction of new raw water intake civil structure • Installation of new raw water pump facilities for the production of 120,000 m^3/d • Installation of new raw water transmission pipe • Installation of new power substation	• Installation of new raw water pump facilities for additional production of 40,000 m^3/d
2) Expansion of Chinaimo Water Treatment Plant	• 40,000 m^3/d Treatment facilities expansion (receiving well, flocculation basin, sedimentation basin, filters, chemical feeding facilities) • Installation of new power substation • Installation of new transmission and distribution pump facilities • Construction of new administration building • Construction of new transmission and distribution pumping station • Construction of new chemical building • Construction of new clear water reservoir • Modification of the existing filtration system	• 40,000 m^3/d Treatment facilities expansion (flocculation basin, sedimentation basin, filtration basin, chemical feeding facilities) • Installation of additional transmission and distribution pump facilities
3) Salakham Distribution Center Construction	• Construction of Salakham Distribution Center(incl. new ground reservoir with high lift pump facilities and new elevated reservoir)	• Installation of additional high lift pump facilities
4) Expansion of Transmission and Distribution Pipes	• Installation of transmission pipes to Salakham Distribution Center (5,815 m) • Installation of branch pipes from the existing transmission pipe to Phonethan elevated tanks (885 m) • Installation of distribution pipes (Approx. 43 km)	• Installation of distribution pipes (Approx. 98 km)

Source: JST

Chapter 5 OUTLINE OF THE PROJECT

5.1 Outline of Planned Water Supply Facilities

5.1.1 Planned Water Supply Facilities (Intake and water treatment facilities)

Intake and water treatment facilities were planned with the following conditions. General layout plan of the expanded Chinaimo raw water intake pump station and water treatment plant in the year 2030 is illustrated in Figure 5.1.1.

1) Layout of the future facilities for the expansion was carefully examined, and all of the necessary facilities for both the new Chinaimo raw water intake pump station and water treatment plant can be accommodated within the existing NPNL premises.

2) The new raw water intake pump station will be constructed just upstream of the existing intake facilities .

3) Of the new water treatment facilities for the Phase 1 expansion, enough vacant land is available on the eastern side of the existing premises for the expansion of flocculation basins, sedimentation basins and filters. However, there seems to be one minor constraint. There are fences between Chinaimo WTP and the military school (Kaysone Phomvihane Academy of National Defense) on the eastern and southern boundaries. These fences need to be temporarily removed, and at a least five to ten meter width of land inside the military premises along the boundaries should be borrowed during the period of construction work.

4) Treatment facilities for Phase 2 will be constructed on the land presently occupied by the administration cum chemical building. Since the new chemical feeding facilities will be needed for Phase 1 expansion, new administration building and chemical building will be constructed separately during Phase 1 expansion. The new administration building will be located at the intake premises in front of the treatment plant.

5) A new clear water reservoir will be also constructed in Phase 1 expansion, and the new chemical building as well as the new transmission and distribution pump station will be constructed on this new clear water reservoir.

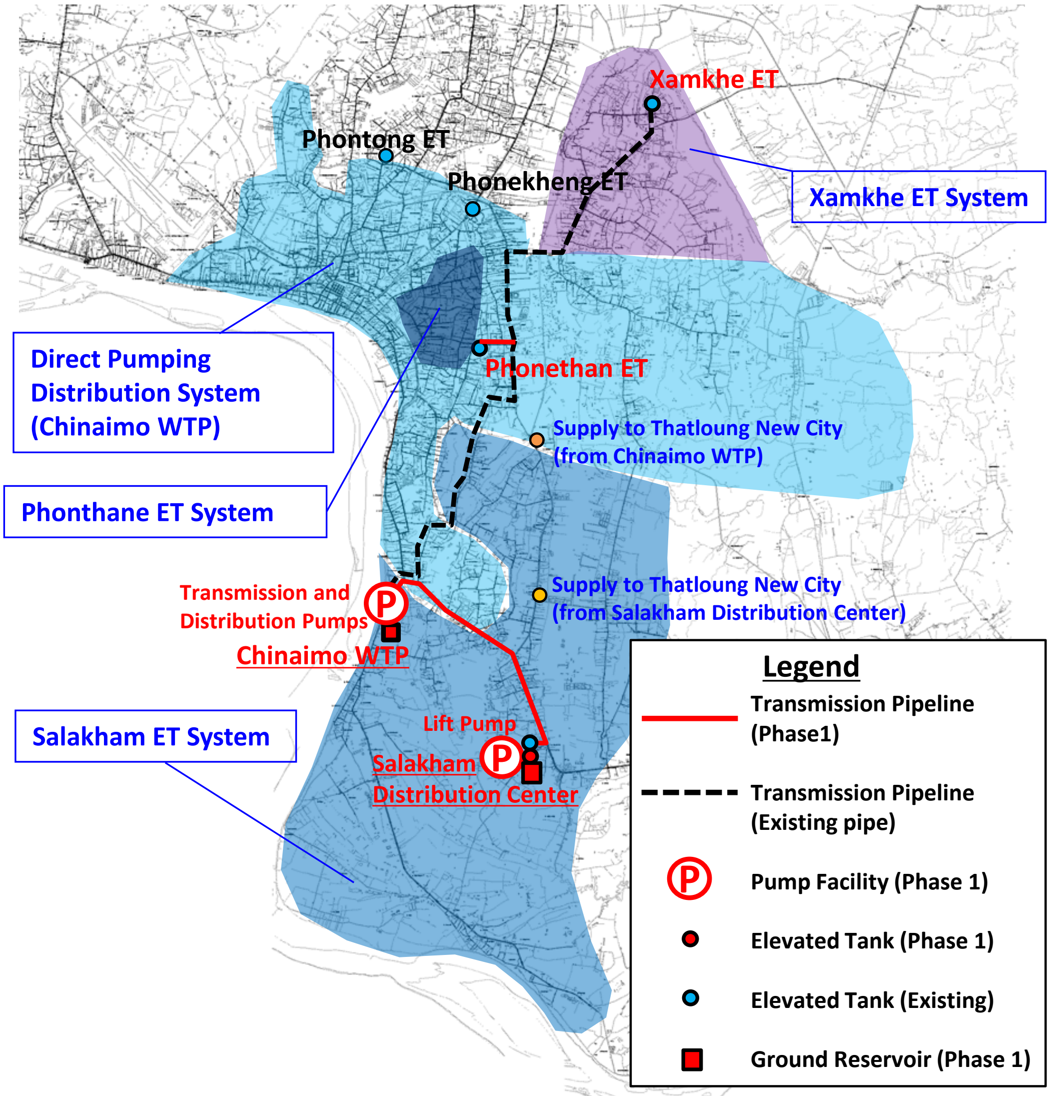
Source: JST

Figure 5.1.1 Layout Plan of the Expanded Chinaimo WTP and Raw Water Intake Pump Station

5.1.2 Planned Water Supply Facilities (Transmission and Distribution System)

Figure 5.1.2 shows the outline of the expansion of the transmission and distribution system from Chinaimo WTP, which is composed of the following three systems:

1) Transmission System to Xamkhe and Phonethan Elevated Tanks and Distribution System
2) Transmission System to Salakham Distribution Center and Distribution System
3) Direct Pumping Distribution System from Chinaimo WTP



Source: JST

Figure 5.1.2 Outline of the expansion of the transmission and distribution system from Chinaimo WTP

There will be two transmission mains extending from the Chinaimo WTP. One is to the existing Phonethane ET and Xamkhe ET, and the other is to the newly constructed Salakham Distribution Center.

First, the existing transmission main will be continuously used for transmission to Phonethane ET and Xamkhe ET. The areas supplied by these ETs will be isolated by closing valves on the boundaries with service areas covered by direct pumping distribution from Chinaimo WTP.

Second, the existing Salakham ET system will be expanded as the new Salakham Distribution Center, which will consists of a new 2000 m^3 elevated tank, a new 5,200 m^3 ground reservoir with high lift pumping system, and the existing 1,500 elevated tank constructed in the existing Salakham ET premises. This distribution center will cover new service areas in the southern part of Vientine Capital and also some service areas which are presently covered by the direct pumping distribution from Chinaimo WTP.

Third, majority of the central area of Vientiane Capital will continued to be supplied by direct pumping from Chinaimo WTP. Distribution mains, however, need~~s~~ to be augmented to larger diameter to secure sufficient supply pressure and flow.

5.2 Design of Facilities

5.2.1 Chinaimo Raw Water Intake Pump Station

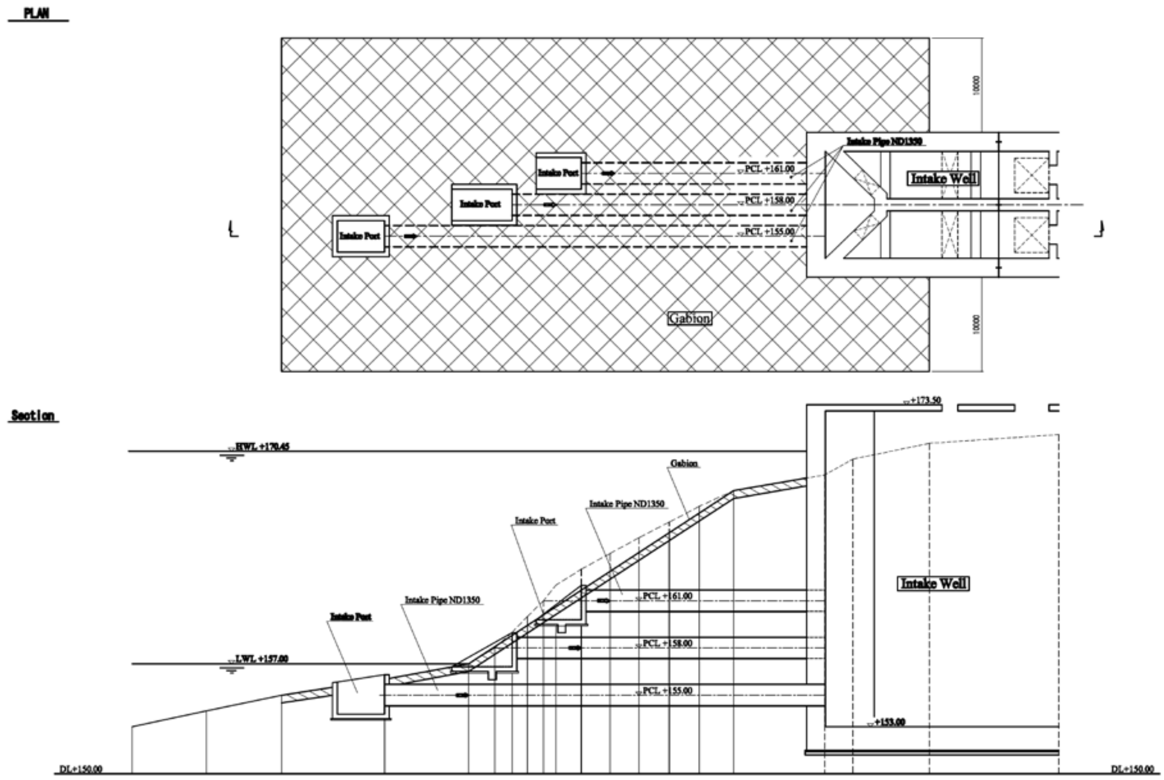
A new raw water intake pump station will be constructed upstream adjacent to the existing intake pumping station to accommodate new intake pumps.

Since the water level of the Mekong River fluctuates over 10 m, raw water from the Mekong River raw is introduced into the intake pump well through the three inlet pipes with diameter of 1350 mm extended into the Mekong River so as to abstract raw water at three different levels.

1) Inlet Screens

According to the report from Chinaimo WTP director, raw water pumping is occasionally disrupted by clogging of pump impellers when floating foreign matter~~s~~ in raw water, such as small driftwood pieces, plastic rubbish, etc are sucked into the pumps. Coarse and fine screens will be provided to cope with such disruptions. Coarse screens with power-operated rake and traveling fine screens will be used to effectively prevent such foreign materials from entering the pump suction well.

Figure 5.2.1 illustrates the plan and section of the new raw water intake pump station.



Source: JST

Figure 5.2.1 Plan and Section of the New Raw Water Intake Pump Station

2) Raw Water Intake Pumps

a. Basic Design Conditions

Basic design conditions for new raw water intake pumps are summarized in Table 5.2.1.

Table 5.2.1 Basic Design Factors for Raw Water Intake Pumps

Design Factor		Remarks
Required Total Pump Discharge	127,400 m^3/d (168,000 m^3/d)	Phase 1 (Phase 2)
Lowest Suction Water Level	+157 m	LWL
Average Suction Water Level	+164 m	Adopted as the design pump duty point (average water level of Mekong River)
Maximum Static Pump Head	Max.: +19.5 m	Water level at new receiving well of +16.5 m – LWL of +157 m
Pump Discharge Pipe Loss of Head	1.5 m	
Loss of Head Allowance	1.0 m	
Maximum Dynamic Pump Head	22 m	19.5 m + 1.5 m + 1.0 m= 20 m

Source: JST

b. Selection of Pump Type

Most suitable pump type was selected from the comparison of the three applicable types such as 1) vertical mixed flow type, 2) water sealed submersible motor pump and 3) double suction volute pump.

Table 5.2.2 summarizes the comparison of the three typical pump types.

Table 5.2.2 Comparison of Three Typical Pumps Types for Raw Water Intake

Item	Vertical Mixed Flow Type	Water Sealed Submersible Type	Double Suction Volute Type
Application	Very Popular	Popular	Very Popular
Capacity & Head	Possible	Possible	Possible
Pump Impeller	Open	Open	Closed
Pump Construction	Complicated by very long line shaft and many shaft bearing installation with seal water supply	Simple	Slightly complicated by gland seal water required
Operation	Pressurized Seal water supply is required.	Very easy and no action required for normal operation	Pressured seal water supply is required.
Maintenance	Need skill for line shaft bearing replacement	Almost free	Requirement for gland packing replacement
Pump Room Space	Small	Small	Very big and deep pump installation pit is required.
Screen for floating objects	Coarse screen is required.	Coarse screen is required.	Coarse and fine screens are required due to clogging of impeller.
Pump Unit Price	1.00	1.05	0.70

Source: JST

As the result of the comparison, the water sealed submersible motor pump is recommended for the new raw water pump station due to the following reasons:

- Very long and trouble free operation: over 20 years since 1994 of the existing Chinaimo raw water pump station and also Kaolieo raw water pump stations,
- Having long experiences of handling of this type of pump,
- Familiarity of operation and maintenance work of this type of pump,
- Proven long life time of this type of pump without maintenance work and less requirement of spare parts compared with the operation and maintenance required for the existing vertical mixed flow pumps,
- Simple pump construction mechanism and no complicated auxiliary system, and
- Very limited land availability at Chinaimo intake premises.

c. Pump Capacity, Installation and Operation Number

According to the phased expansion plan of Chinaimo WTP, the recommended schedule of the raw water pump installation and the operation number is shown in Table 5.2.3. It is also recommended to keep the existing raw water pumps for emergency stand-by units.

Table 5.2.3 Schedule of Pump Installation, Operation Number and Capacity

Items	Phase 1	Phase 2	Total
Required Pump Units	3	2	5
Operation Pump Units	3	4	4
Each Pump Rated Capacity	29.5 m^3/min	29.5 m^3/min	29.5 m^3/min
Total Pumping Capacity	88.5 m^3/min (127,400 m^3/d)	118 m^3/min (169,920m^3/d)	118 m^3/min

Source: JST

3) Raw Water Flow Control

According to very high pump suction water level fluctuation (+157 m to +170.45 m), pump discharge flow also varies very much. Without any flow control of pump discharge, pumps may be operated at over discharge side resulting in overloading of pump drive motors, and serious damage of pumps may occur due to vibration and cavitation.

Not only for protecting pumps from such damage but also for securing required raw water flow constantly throughout the year regardless of Mekong River water level fluctuation, raw water pumped flow should be controlled and regulated. There are two typical methods such as 1) fixed speed pump system with pump discharge flow regulation by discharge valve throttling, which gives artificial loss of head by the dissipation of energy given by pumps, and 2) variable speed pump system, which gives only required energy for pumping raw water in accordance with the variation of the pump suction water level.

Cost Comparison of Pump Discharge Flow Regulation Methods

The two methods of pump discharge flow regulation were compared by the present worth method with the following calculation conditions.

- Electric Power Cost: 11 Japanese Yen / kWh (734 LAK/kWH)
- Discount Rate: 3.27 %
- Starting Period of Comparison Study: Year 2014
- Operation Period: 20 years from Year 2019 to 2038
- Daily maximum flow is applied for three months and daily average flow is applied for the rest of months in a year. 5.3 Result of Comparison Study

The results of the present worth comparison is shown in Table 5.2.4.

Table 5.2.4 Cost Comparison of Raw Water Intake Pump Discharge Flow Regulation Methods

Item	Fixed Speed Pump System (Million Yen)	Variable Speed Pump System (Million Yen)
Present Worth of Construction Cost (Phase 1)	116	163
Present Worth of Construction Cost (Phase 2)	68	96
Total Present Worth of Construction Cost*1	184	259
Present Worth of Operation Cost (Phase 1)	115	93
Present Worth of Operation Cost (Phase 2)	449	314
Total Present Worth of Operation Cost*2	564	407
Total Present Worth(*1 + *2)	748	666

Source: JST

The total present worth including construction cost and operation cost of fixed speed pump system is more than that of variable speed pump system although the present worth of construction cost of fixed speed pump system is less than that of variable speed system.

As the result of the comparison, it is recommended to apply variable speed pump system for the new raw water intake pump system.

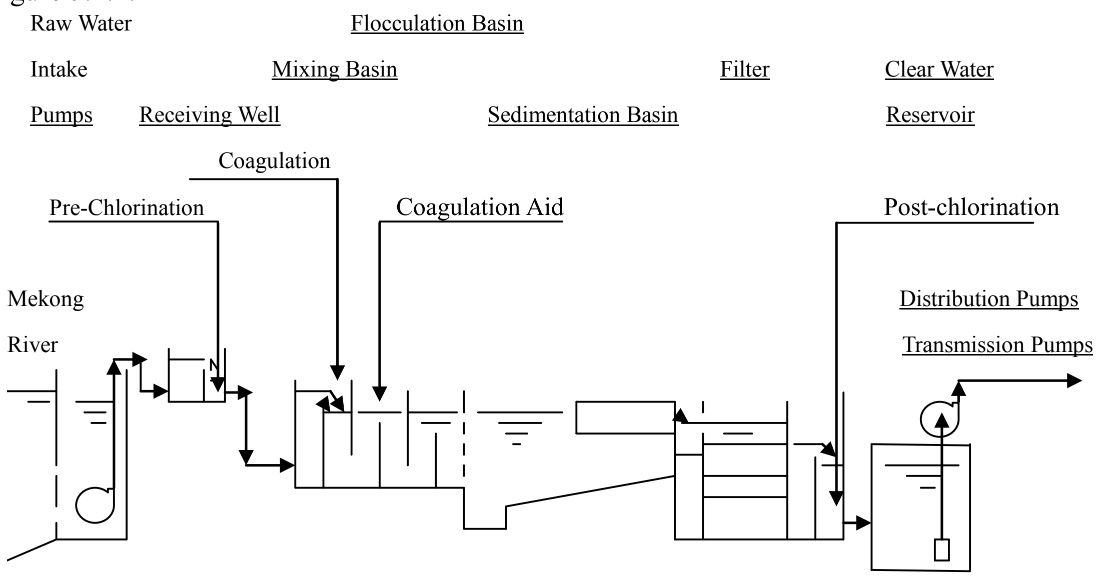
5.2.2 Chinaimo Water Treatment Plant

Raw water quality of the Mekong River is characterized by very high turbidity during rainy seasons and high alkalinity throughout the year. According to the past results of the water quality analysis, the highest turbidity exceeded 4,000 NTU. The existing rapid sand filtration system, however, has proven satisfactory performance for a long period of time since Chinaimo WTP commissioned in 1980.

In fact, the first Chinaimo WTP commissioned in 1980 was equipped with mechanical flush mixers and mechanical horizontal paddle type flocculators. But most of such mechanical mixers had been damaged during high turbidity seasons due to heavily accumulated sludge on the rapid mixing and flocculation basins. Majority of those damaged mixers had been already dismantled before the rehabilitation project of Chinaimo WTP, which was implemented in 1994-1995. In the rehabilitation project, the mechanical mixers had been totally replaced with hydraulic mixing type, and these hydraulic mixers are still in use with good performance.

Cognizant of the above fact, the same type of the existing conventional rapid filtration system with the use of hydraulic mixing is reasonably adopted for the expansion work. However, further modification or betterment of the treatment processes will be also incorporated in the design, taking into account the findings during this survey.

The flow diagram of proposed water treatment processes and chemical application are shown in Figure 5.2.2.



Source: JST

Figure 5.2.2 Water Treatment Process Flow Diagram for New Chinaimo WTP

Table 5.2.5 Basic Design Dimensions and Specifications for Water Treatment Plant

Design Factor	Dimensions, Type, Specifications
Receiving Well	Reinforced Concrete Structure Quantity: 1 Water Level：HWL＋176.50m LWL+175.50m Detention Time：T= 2min, Volume：V= 240 m^3
Rapid Mixing Basin	Reinforced Concrete Structure Quantity: 1 (44,000 m^3/day) Type: Hydraulic mixing
Flocculation Basin	Reinforced Concrete Structure Quantity: 4 (44,000 m^3/day) Type: Up-down zig-zag flow Detention Time：T= 21min, Mean Velocity：V= 12.20 cm/s
Sedimentation Basin	Reinforced Concrete Structure Quantity: 2 (44,000 m^3/day) Surface Loading：Q/A=17 mm/min、Mean Velocity：V=0.38 m/min
Filter	Reinforced Concrete Structure, Spread Foundation Quantity: 4 (44,000 m^3/day) Filtration Area: 77 m^2each, Filtration Rate：V=143.00 m/day
Backwash Pumps	Type: Water sealed submersible motor pump Number: 3 units (2 duty + 1 standby) Capacity: 15.5 m^3/min, Head: 10 m, Motor output: 45 kW
Blowers	Type: Rotary, positive displacement roots type with acoustic box Number: 2 units (1 duty + 1 standby) Capacity: 96 m^3/min, Pressure: 35 kPa, Motor output: 110 kW
Clear Water Reservoir	Reinforced Concrete Structure, Spread Foundation Quantity：1 Water Level：HWL＋170.61m LWL+165.61m Effective Volume：V=9,800 m^3 (4,900m^3 × 2)

Source: JST

1) Receiving Well

The existing WTP has the combined structure of receiving well and rapid mixing well. Raw water flow is divided into four flocculation basins by four weirs equipped in this receiving cum rapid mixing well.

In the expansion work, a new receiving well will be built to stabilize the raw water flow and secure the constant static water head to deliver raw water to the WTP by gravity. The location of the receiving well is just downstream from the new raw water intake pump station so as to operate the intake pumps without any effects from the downstream treatment processes. Raw water will be lifted to the receiving tank with sufficient water head and overflow from the weir into the raw water transmission pipe by gravity. Raw water will then be transmitted to the existing receiving cum rapid mixing basin and a new rapid mixing basin. Raw water flow into each mixing basin will be controlled by the control valve and flow meter installed on the inlet pipe to each mixing basin.

2) Rapid Mixing Basin

Hydraulic mixing type created by water fall will be provided in the rapid mixing basins. The existing rapid mixing basin has four weirs to divide raw water flow into the following flocculation process. Water fall is created by these weirs and the available head for this hydraulic mixing is approximately 40 cm.

For the expansion work, rapid mixing basins using the same hydraulic jump type will be adopted. Coagulant (aluminium sulfate) will be dispersed over the weir so that alum could be mixed into the entire mass of water instantaneously.

3) Flocculation Basin

The vertical up-and-down hydraulic flocculation type, which is the same type of the existing flocculation basins will be employed. Tapered flocculation with the range of GT value from 100 sec^{-1}

to 20 sec^{-1} will be provided in the same way. The total head loss during the flocculation basin is approximately 0.3 m and the retention time is approximately 20 minutes.

4) Sedimentation Basin

The existing sedimentation basin is of horizontal flow type with extended effluent launders of approximately 20 m length.

The main design factors of the existing sedimentation basins are as follows, and the same factors will be used for the design of the expansion work.

Number of existing sedimentation basins	:	4 basins
Dimension of sedimentation basin	:	W 13.6 m x L 64 m
Retention time	:	160 minutes
Surface loading rate	:	17 mm/min
Horizontal flow velocity	:	0.38 m/min on average
Effluent launder loading rate	:	138 $m^3/d/m$
Sludge removal method	:	manual desludging with flush water

5) Filter

The existing rapid sand filters use concurrent air-water backwash system. The main design factors of the existing filters are summarized in Table 5.2.6.

Table 5.2.6 Major Design Factors of the Existing Filters

Item	Description
Number of filters:	8 filters
Filter area:	77 m^2/each
Filtration rate:	6 m/hr
Filter sand effective diameter:	1.0 mm (uniformity coefficient 1.3)
Filter sand layer thickness:	sand 1000 mm, gravel 40 mm
Filter underdrain:	50 mm porous concrete slab
Filter backwash rate:	0.36 $m^3/min/m^2$
Designed duration of backwash:	20 minutes
Filtration control system:	constant rate by valvocet

Source: JST

The total number of filters will be increased to twelve (12) for Phase 1 and sixteen (16) for Phase 2 expansion, and the same dimensions as those of the existing filters will be used. However, some modification or betterment will be applied to both expansion work and rehabilitation of the existing filters to improve the performance of the filters.

The major design factors for the new filters will be as shown in Table 5.2.7.

Table 5.2.7 Major Design Factors of the Existing Filters

Item	Description
Total number of filters:	12 filters (Phase 1) 16 filters (Phase 2)
Filter area:	77 m^2/each
Filtration rate:	6 m/hr
Filter sand effective diameter:	1.0 mm (uniformity coefficient 1.3)
Filter sand layer thickness:	Sand: 1000 mm, gravel: 40 mm
Filter underdrain:	concrete slab with nozzles
Filter backwash rate:	0.4 $m^3/min/m^2$ (0.2 $m^3/min/m^2$ air-water concurrent wash)
Air scouring rate:	1.0 $m^3/min/m^2$
Designed duration of backwash:	20 minutes (Tentative)
Filtration control system:	Declining rate

Source: JST

a. Filter Underdrain

Concurrent air-water backwash system will be employed. The filter underdrain system will be, however, modified to use nozzle type underdrain system. This is because the existing porous concrete slabs have been often damaged during the backwash, and the repair work usually takes as long as one or two months. Eventually, the damaged filter is out of service for a long time. It is deemed that such damage can occur as the inside porous concrete slab becomes gradually clogged after a long period of filter run, and air and backwash water pressure under the slabs becomes excessive and finally damages the slabs.

Nozzle type underdrain is easy for maintenance as nozzles can be easily replaced with spare nozzles if they are damaged. Nozzle type underdrain is the proven system for a long time in many water utilities all over the world, and concurrent air-water backwash method is also applicable for this system.

b. Filter inlet

Supernatant water from the existing sedimentation basin is collected by the effluent launders and introduced into each filter directly through the two openings with the dimensions of W1000 mm x D400 mm each. It is observed after backwash that the filter inflow through the openings is very strong and agitates the sand surface as there is no device to control the flow. Inlet flume guides, which dissipate the inlet flow intensity, will be provided for the improvement.

c. Backwash water pipe system

The existing backwash water system is that backwash water is pumped up from the filtered water channel to the overhead backwash tank which is located under the filter operation gallery, and then backwash water is injected into the filters by gravity. Although the existing backwash system is intended to operate as concurrent air-water backwash mode, the present operation practice shows that the filters are washed by only water following to air scouring. This is because there is no control device for the backwash water flow rate, and the constant flow rate is adopted for both water only washing and air-water concurrent washing. This is a common way for air-water concurrent backwash filters to provide different backwash water flow rates for water only washing and air-water concurrent washing. The lower backwash flow rate is usually applied during the process of air-water concurrent washing. If higher backwash water flow rate is adopted during the time of air-water concurrent washing the loss of filter sand will increase.

In order to sort out this problem, it is proposed to provide backwash water by direct pumping into the filters and to adjust the flow rates within the optimum ranges by the use of control valves and flowmeters. The backwash flow rate will be adjusted by the control valves in conjunction with the backwash processes.

The proposed air-water concurrent backwash method is as follows:

Backwash Process	Air	Water
Air Scouring (Air Only)	1.0 $m^3/min/m^2$	Not applied
Air-Water Concurrent Backwash	1.0 $m^3/min/m^2$	0.2 $m^3/min/m^2$
Water Backwash (Water Only)	Not applied	0.4 $m^3/min/m^2$

The duration of each washing process will be adjusted based on the actual operation experiences but air scouring (2 – 3 min), concurrent backwash (4 – 6 min) and water backwash (5- 8 min) are usually adopted.

d. Filter Sand

Chinaimo WTP has been operated since 1980, and in 1994 – 1996 rehabilitation and expansion work for filters was implemented. During the rehabilitation work the filter sand in the old filters was only sieved to adjust the uniformity coefficient, and the replacement of the sand was not conducted. Thus the existing filter sand has been used for a very long period of time until today, and it is presumed that the sand has already worn by air scouring and backwashing, and the effective diameters have decreased after a long time usage. Therefore, filter sand replacement is included.

e. Filtration Control System

The existing filters are equipped with valvocets, which are the products of Emvico company and this type of filtration controller is nowadays not available in the market. Moreover, these valvocet have already served for more than 20 years.

Such a filtration control system with valvocets was necessary when the first Chinaimo WTP was constructed in the 1970's as the total number of filters was designed to be only four. But after the expansion work the total number of the filters will increase to twelve (12), and thanks to the simultaneous operation of many filters much simpler filtration control system can be applied. Declining rate filtration, which is known as very simple filtration control method, can be adopted. The existing valvocets will be dismantled, and control valves and flow meters will be installed in the filter outlet pipes.

f. Backwash Pumps and Blowers

All the existing backwash pumps and filter air scouring blowers are judge to be so old even if they are presently in running conditions. All of them are designed to be replaced with new ones. New backwash pumps are designed to be housed in the new pump station and also new air scouring blowers are designed to be housed in the pipe gallery of the new filter building.

Basic specifications of new backwash pumps and air scouring blowers are stipulated in Table 5.2.8.

Table 5.2.8 Basic Specifications of New Backwash Pumps and Scouring Blowers

Name of Pump	Backwash Pump	Air Scouring Blower
Type	Water sealed submersible motor	Rotary, positive displacement roots type with acoustic box including fan
Number	3 units (2 duty + 1 standby)	2 units (1 duty + 1 standby)
Each Pump Capacity CMM	15.5	96
Pump Head	10 m	35 KPa
Pump Speed min^{-1}	990	1450
Motor Output kW	45	110
Electric Power Supply V	380	380

Source: JST

6) Chemical Feeding System

Chemicals which will be used in the treatment processes are summarized in Table 5.2.9. Application points of chemicals for the new water treatment plant are recommended based on the current plant operation practice with the assumption that similar raw water quality trend will continue in the future.

Table 5.2.9 Chemicals used for Treatment Processes

Chemical	Purpose	Application Point
Alum (alum stone)	Coagulation	Rapid Mixing Basin
Polymer	Coagulation aid	Flocculation Basin
Pre-Chlorination (Chlorine gas)	Disinfection and oxidation	Receiving well
Post-Chlorination (Chlorine gas and Calcium hypochlorite for emergency use)	Disinfection	Filter outlet conduit

Source: JST

Based on the long experience of Chinaimo WTP to treat Mekong River raw water for more than 35 years as well as the actual chemical dosage records obtained from the Chinaimo WTP laboratory, the ranges of chemical dosage rates were determined for the expansion wok as shown in Table 5.2.10.

Table 5.2.10 Proposed Ranges of Chemical Dosage Rates

Dosage Rate	Alum	Polymer	Pre-chlorination	Post-chlorination
Maximum (mg/l)	100	1	1	2
Average (mg/l)	35	0.3	0.5	1
Minimum (mg/l)	10	0.05	0.2	0.5

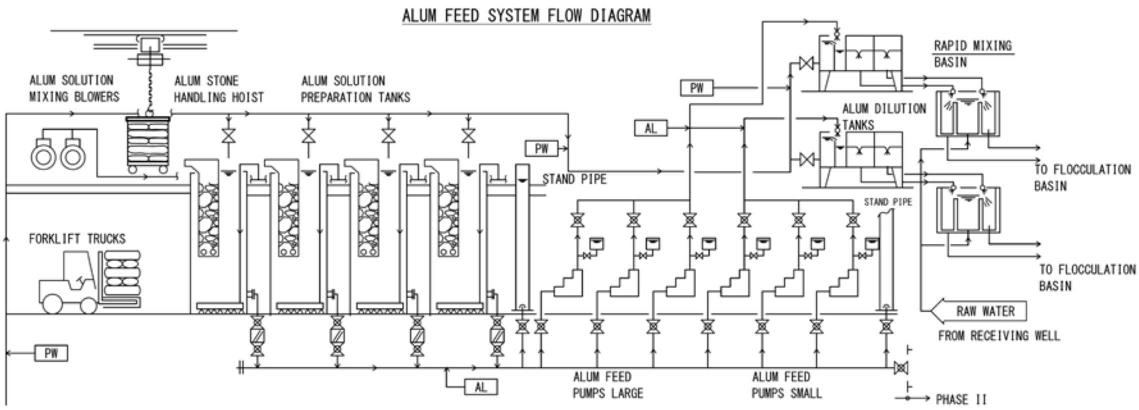
Source: JST

a. Alum Feeding System

Lump alum, which is now produced at Kaolio WTP, can continue to be used. Lump alum will be dissolved into 10% or 20% solution in FRP chemical tanks by mixing with air blowing, and alum solution will be dosed by metering pumps. Major components of alum feeding system are as follows:

Number of Alum Solution Tank	:	4 units
Each Solution Tank Capacity	:	15 m^3
Type of Feed Pump	:	Diaphragm metering pump
Feed Pump Capacity	:	Large 1.37 to 13.7 l/min
		Small 0.75 to 7.5 l/min
Number of Feed Pump	:	Large (Phase 1) 3 (2 duty + 1 standby)
		Small (Phase 1) 3 (2 duty + 1 standby)
		Small (Phase 2) 3 (2 duty + 1 standby)

The flow diagram of the proposed alum feed system is illustrated in Figure 5.2.3.



Source: JST

Figure 5.2.3 Flow Diagram of Alum Feed System

b. Polymer Feeding System

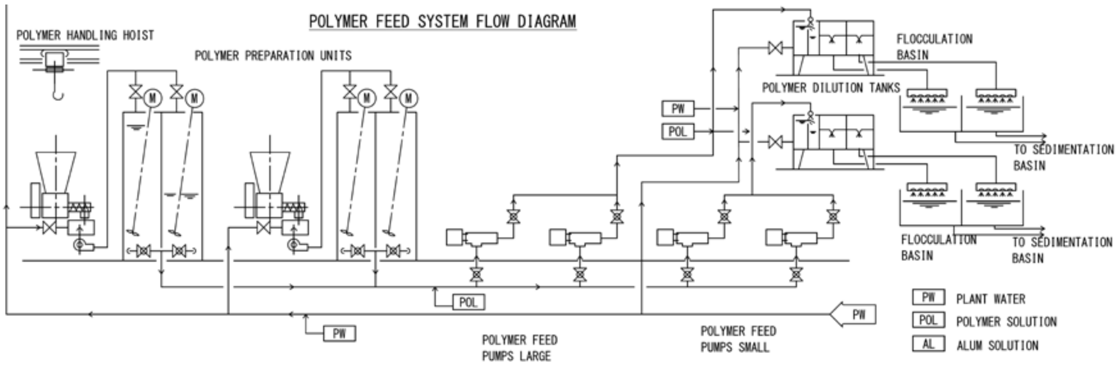
Polymer as coagulant aid will be used when raw water turbidity is very high. The existing plant has very simple polymer dosing facilities, with manual dissolving tank, and the dosing is simply adjusted by opening of the cock installed at the bottom of the tank. Polymer solution is then dripped by gravity into the flocculation basins. This is a very simple way, but polymer dissolving and accurate adjustment of dosing rate are not easy. In order to ensure accurate dosage adjustment and easy preparation of polymer solution without creating fish-eyes, package type preparation unit with the following specifications is selected:

Type	:	Package type, automatic batch solution preparation system having powder feeder, mixing device solution tank and piping
Number	:	2 units (1 duty and 1 standby)
Capacity	:	40 batches of 1,666 liter each with 30 minutes aging time

Polymer solution will be injected by the feeder pumps as specified below:

Type of Feed Pump	:	Progressing cavity pump
Capacity of Feeder Pump	:	Large 1.0 to 21 l/min Small 0.5 to 10.5 l/min
Number of Feeder Pump	:	Large (Phase 1) 2 (1 duty + 1 standby) Small (Phase 1) 2 (1 duty + 1 standby) Small (Phase 2) 2 (1 duty + 1 standby)

The flow diagram of the proposed polymer feed system is shown in Figure 5.2.4.



Source: JST

Figure 5.2.4 Flow Diagram of Polymer Feed System

c. Chlorination system

Calcium hypochlorite is presently used as disinfectant at Chinaimo WTP. But the following problems are identified for the use of calcium hypochlorite. This is because calcium hypochlorite is supplied in the powder form, which is very strong oxidant, and is partially dispersed into the air while hypochlorite solution is prepared, causing the conditions listed:

- Motorized chain hoists used in the chemical preparation room are terribly rusted and some parts have been already removed.
- Existing mixers are still operable but the body is already rusted.
- Ventilation fans and frames had been also deteriorated and already removed.

Moreover, prepared calcium hypochlorite solution also has a problem in that it has a tendency to clog the feeding pipes.

Considering the above situation and the increasing amount of calcium hypochlorite usage upon the expansion, handling of powdered hypochlorite will become a heavier duty for the plant operators than ever.

It is proposed to employ liquid chlorine gas feeding system for the expansion work. Although liquid chlorine gas is very strong oxidant and lethal gas, provided that proper safety devices and operators' training are ensured, the handling of liquid chlorine gas is not very difficult. The reliability of liquid chlorine gas feeding system has been already proven through long time use by many waterworks in southeast Asian cities such as Bangkok, Jakarta, Phnom Penh, Ho Chi Minh, etc. But for Vientiane Capital calcium hypochlorite feeding system is also provided for the emergency case when the importation of liquid chlorine gas from the neighboring countries is suspended.

Proposed chlorination system is composed of the following major equipment:

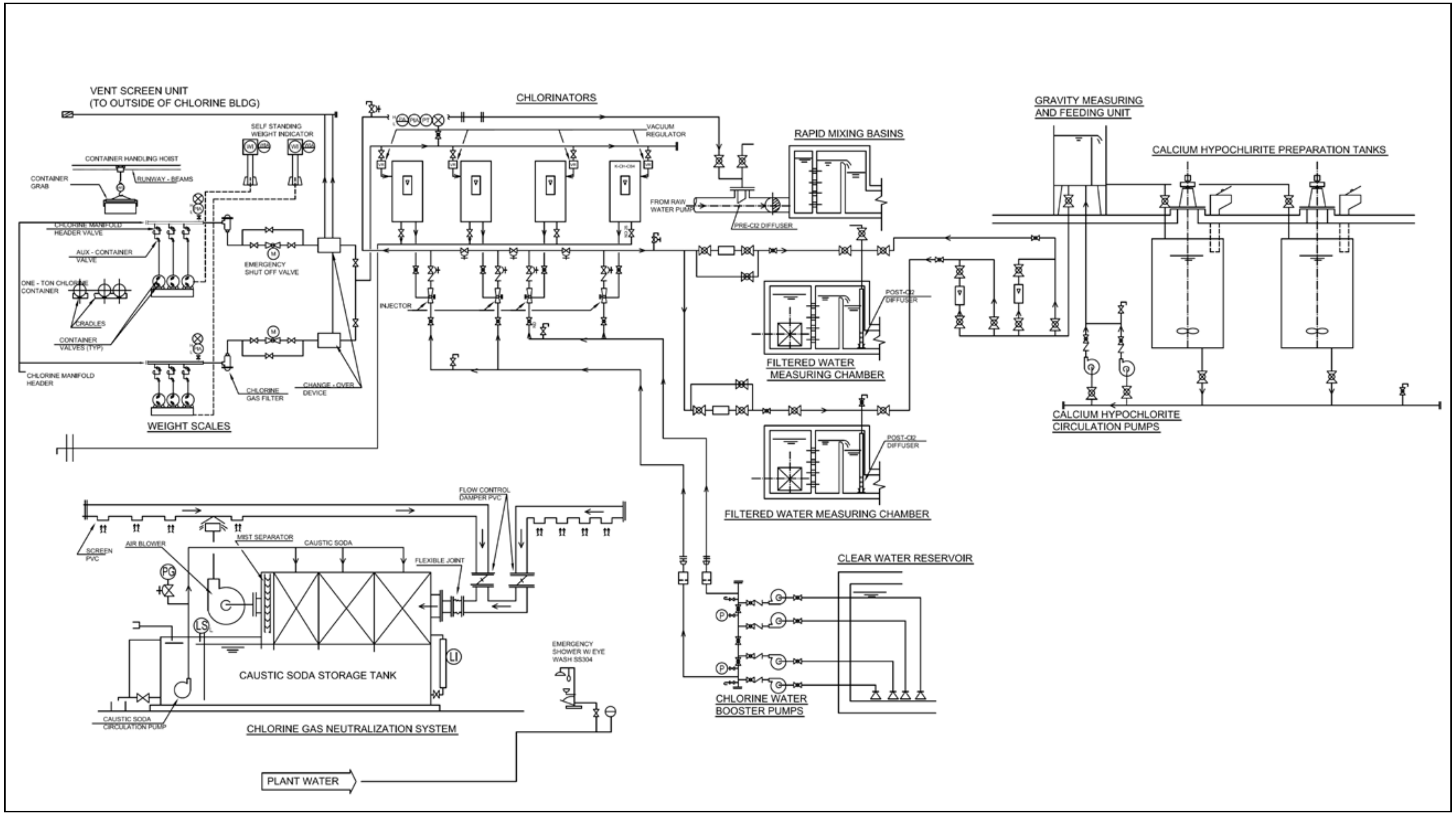
Liquid Chlorine Gas Feeding System

- Ton Container Weighing Scale : 2 units
- Container Handling Hoist : 1 unit
- Chlorinator Pre-chlorination : 2 units (each 20 kg/hr capacity)
  Post-chlorination : 2 units (each 20 kg/hr capacity)
- Chlorine Water Booster Pump (each 250 l/mi capacity)
  Pre-chlorination : 2 units (1 duty + 1 standby)
  Post-chlorination : 2 units (1 duty + 1 standby)
- Neutralization System : 1 unit
  (Package type chlorine gas neutralization having scrubber absorber, integral caustic soda tank, circulation pump, air blower and control panel)
- Chlorine Gas Leak Detection System and Alarm System : 1 lump sum
- Safety Cabinet: : 1 set
  (with two complete sets of compressed air breathing apparatuses, two complete sets of PVC protecting clothing and emergency repair kit)

Calcium Hypochlorite Feeding System

- Chemical Solution FRP Tank : $15m^3$ each x 2 units
- Calcium Hypochlorite Circulation Pump : 2 (each 20 l/min capacity)
- Gravity Measuring and Feeder Unit : 2 units

Figure 5.2.5 shows the flow diagram of the proposed chlorination system.



Source: JST

Figure 5.2.5 Flow Diagram of Chlorination and Neutralization System

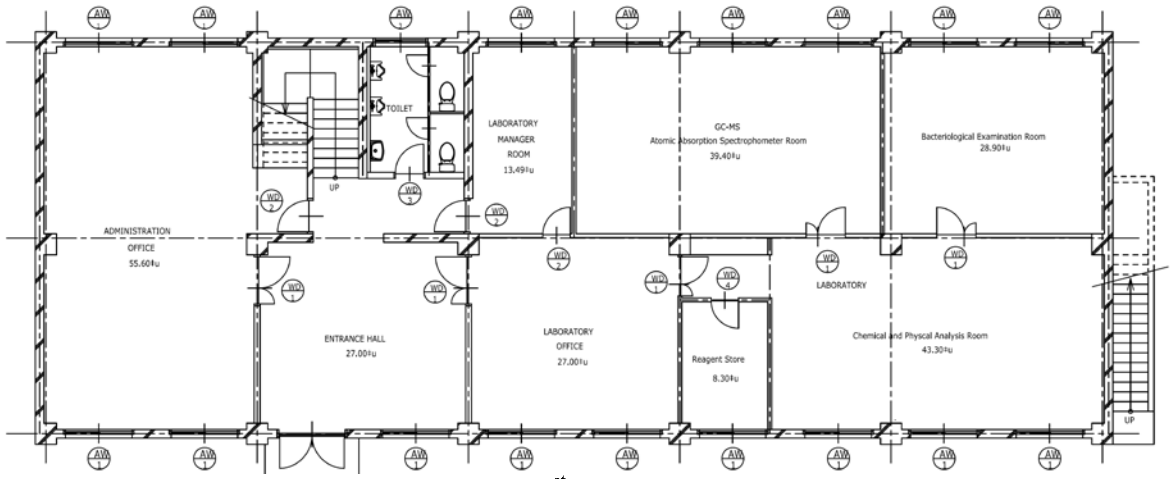
7) Administration Building and Chemical Building

The existing administration building is old (nearly 35 years), and there is leakage from the aluminium sulfate solution tanks located upstairs to the laboratory located downstairs. It is presumed that the inside concrete structures have been damaged by leaking of such strong acid solution. In addition, the existing floor space is not enough to accommodate all the necessary offices and rooms as well as chemical feeding facilities required for the future expansion.

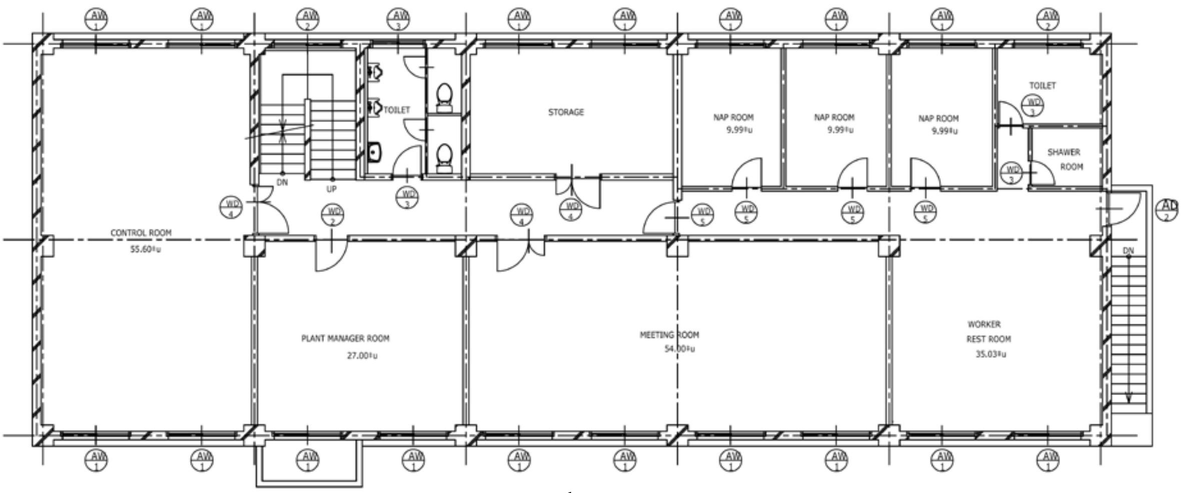
A new administration building and a new chemical building will be constructed at separate locations, and the existing administration cum chemical building will be left as it stands. Considering the very limited land availability within Chinaimo WTP premises, a new administration building will be moved to the raw water intake site just in front of the Chinaimo WTP. The land presently occupied by the existing administration building will be reserved for the future construction of new treatment facilities for Phase 2 expansion.

a. Administration Building

The new administration building will be a of two-storied concrete structure, having the total floor area of approximately 550 m^2 as shown in Figure 5.2.6.



1st Floor



2nd Floor

Source: JST

Figure 5.2.6 Floor Arrangement Plan of the Administration Building

The administration building will accommodate a plant manager room, a laboratory, a central control monitor room, an administration office, a meeting room and three nap rooms for shift operators.

b. Chemical Building
The chemical building will be a of two-storied concrete structure constructed over the new clear water reservoir, having the total floor area of 1,800 m^2. The chemical building will accommodate chemical storage, alum feeding room, polymer feeding room, chlorination room, neutralization room, calcium hypochlorite feeding room and blower room.

8) Laboratory
It is proposed that the new laboratory should have the following roles;

1) To analyze and monitor raw water quality
2) To control and monitor treatment process performance
3) To confirm the conformity of finished water quality to the drinking water quality criteria
4) To confirm residual chlorine concentration, turbidity, pH in the distribution network
5) To analyze water samples upon customer complaints

The new laboratory will be established in the new administration building with a chemical analysis room, a bacteriological examination room, reagent store, a laboratory manager room and a laboratory staff office with total floor area of 160 m^2.

The major equipment provided will be determined as follows:

- Water sampling system (tapping from raw water, sedimentation water, filtered water and finished water processes will be provided to the laboratory)
- Jar Tester
- Turbidity meter, pH meter, conductivity meter, residual chlorine meter
- Spectrophotometer
- GC-MS
- Atomic Absorption Spectrophotometer
- Laboratory tables and drafters
- Distiller
- Bacteriological Examination (Autoclaves, Sterilizers, Incubators)
- Miscellaneous (other conventional analysis instruments, laboratory glassware, reagent)

9) Clear Water (cum Distribution) Reservoir
A new clear water reservoir with the capacity of 9,800 m^3 will be constructed in the Chinaimo WTP premises to cope with the increasing production amount, and facilitate the operation of transmission and distribution system. The Chinaimo total reservoir capacity will be augmented from 10,800 m^3 to 20,600 m^3, which is equivalent to 3.8 hours of the average daily production of Chinaimo WTP.

The new reservoir will be an underground structure with reinforced concrete. Due to the limited land availability, a new chemical building will be constructed on the top slab of the reservoir. All of the new transmission and distribution pumps will be housed in the new pump station built on the clear water reservoir.

10) Power Supply and Receiving System
The existing power substation is located at the WTP premises and supply power to both the WTP facilities and the existing raw water intake pump station. According to the plant operators, voltage drop at the raw water pump station sometimes occurs due to this combined power receiving system.

In accordance with the WTP expansion electric power supply required for the Chinaimo WTP and for raw water pump station will be increasing, it is recommended that individual power receiving from EDL be provided for the raw water pump station so as not to get any influence of the electric power supply system at the WTP side.

a. Power Substation for Raw Water Intake Pump Station

The new power sub-station for power receiving and distribution is designed to basically consist of the following main equipment:

- 1 set of power transformer, rated at 22 kV/380V x 1,000 kVA,
- 22 kV incoming and feeder panels,
- 380 V incoming and feeder panels,
- Raw water pump panels,
- 380 V feeder panels to the existing pump station for operating the existing pumps,
- Instrumentation equipment including flow measuring and level measuring.

b. Power Substation for Water Treatment Plant

In accordance with increasing required electric power supply for the Chinaimo WTP the existing power receiving system from EDL is recommended to be renewed. The new power sub-station of power receiving and distribution is designed to basically consist of the following main equipment:

- 22 kV incoming Panel,
- 22 kV feeder Panels,
- 1 set of power transformers, rated at 22 kV/3.3 kV x 2000 kVA,
- 1 set of power transformer, rated at 22 kV.380 V x 1,500 kVA,
- 3.3 incoming panels,
- Distribution pump panels
- Transmission pump panels,
- Backwash pump panels,
- 380 V incoming Panels,
- 380 V Feeder Panels, and
- Instrumentation equipment for water treatment plant and water transmission and distribution system.

11) Central Monitoring System

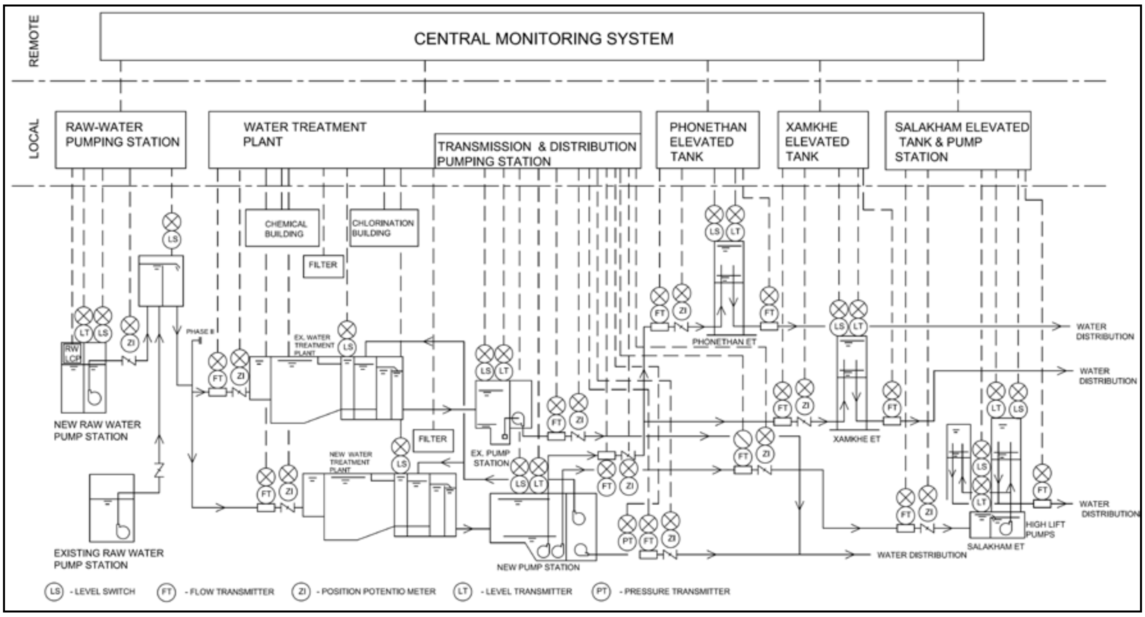
A central monitor room equipped with central monitor servers, operator workstations and a graphic monitor panel will be provided in the administration building.

The central monitoring system will receive its information from RTUs (remote terminal units) and PLCs (Programmable Logic Controllers), which can get the information from the sensors and manually inputted data. The information collected and monitored by the central monitoring system are as shown in Table 5.2.11, and the proposed instrumentation diagram is shown in Figure 5.2.7.

Table 5.2.11 Operation Information Transmitted to Central Monitoring System

Raw Water Intake Pump Station	Water Treatment Processes	Chemical Feeding and Chlorination	Distribution and Transmission Pump Station	Reservoirs and Elevated Tanks
Water Level Coarse and Fine Screen Operation Status Intake Pump Operation Status Flow Control Valve Position Raw Water Turbidity	Inlet Flow Sedimentation Basin Level Alarm, Filter Operation Status Backwash Pump Operation Status Air Blower Operation Status	Chemical Feed Pump Operation status Alum Mixing Blower Operation Status Alum Preparation Tank Water Level Alarm Cl2 Gas Leakage Alarm Neutralization System Status Chlorine Water Booster Pump Status	Each Pump Status Reservoir Water Level Flow Rate of Water Transmitted to Xamkhe ET & Phonethan ET Flow Rate of Water Transmitted to Salakham W Reservoir Distribution Pump Pressure and Flow Position of Flow Control Valves	Inlet Flow of ET and Salakham W Reservoir Position of Flow Control Valve Water Level of ET , Salakham W Reservoir and Salakham ET ET and Reservoir Overflow Alarm Salakham High Lift Pump Status Distribution Flow Rate at Xamkhe ET Phonethan ET and Salakham ET

Source: JST



Source: JST

Figure 5.2.7 Instrumentation Diagram of Chinaimo WTP System

5.2.3 Treated Water Transmission and Distribution Pump Systems

(1) Design Conditions for New Treated Water Transmission and Distribution Pump Systems

a. Design flow

Basic design flows for transmission and distribution facilities such as daily average flow, daily maximum flow and peak hourly flow from Chinaimo WTP system are tabulated in Table 5.2.12.

Table 5.2.12 Basic Design Flows for Transmission and Distribution Facilities

Phase	Daily Average (Daily Max. x 1/1.1)	Daily Maximum	Peak Hourly (Day Max. x 1.54)
Phase 1	109,000 m^3/d	120,000 m^3/d	185,000 m^3/d
Phase 2	145,000 m^3/d	160,000 m^3/d	246,000 m^3/d

Source: JST

b. Transmission and Distribution System Flow

Water treated at Chinaimo WTP will be supplied to customers through the following three transmission and distribution systems.

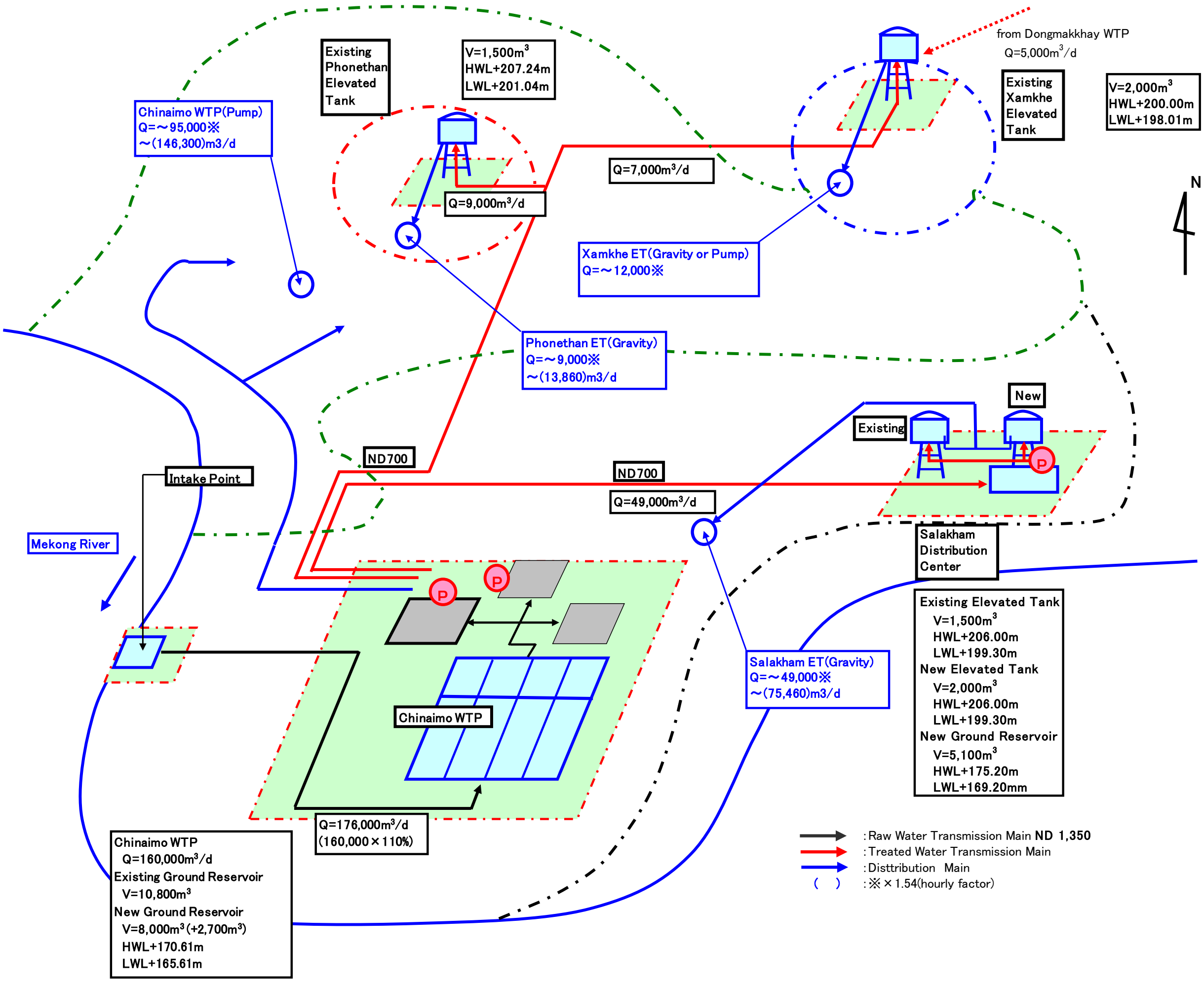
- Transmission System to Xamkhe and Phonethan Elevated Tanks
- Transmission System to Salakham Distribution Center, consisting of the existing elevated tank, the new elevated tank and the ground reservoir with high lift pump system
- Direct Pumping Distribution System from Chinaimo WTP

Table 5.2.13 summarizes the demarcation of the water distribution for the above three systems, and Figure 5.2.8 shows the schematic flow for water distribution from Chinaimo WTP.

Table 5.2.13 Demarcation of Water Distribution for the Three Systems

	Transmission System to Xamkhe ET	Transmission System to Salakham D.C.	Direct Distribution from Chinaimo WTP	Total
Phase 1 Daily Max. Flow	12,000 m^3/d	37,000 m^3/d	71,000 m^3/d	120,000 m^3/d
Phase 2 Daily Max. Flow	16,000 m^3/d	49,000 m^3/d	95,000 m^3/d	160,000 m^3/d

Source: JST



Source: JST

Figure 5.2.8 Schematic Flow for Water Distribution from Chinaimo WTP

(2) Basic Design Concepts for Water Transmission and Distribution Pump systems

a. Optimum Energy Inputting

For economical operation with energy saving, optimum energy inputting for not only transmission system but also distribution system is determined. Based on this optimum energy input concept, the number of operation pumps in each system is examined in accordance with the flow requirement under each Phase so as to minimize energy inputting for water transmission and distribution.

b. Simple and Optimum System Operation

In designing the transmission and distribution systems, taken into account is the simple operation without any special monitoring and control system, unnecessary link-up or feed-back and other complicated automatic operation mode.

Transmission system should be designed to have constant flow function by pumping with energy dissipating flow control system with the use of flow control valves at the pump discharge side in order to carry out proactive flow control so as to avoid pumping from unforeseeable shut-off, which may result in problems of the transmission line pressure surging and pump motors. At the remote point where water is received, no flow control systems are not provided. Even if the water level at water receiving point reaches high water level, closing inlet valve of water receiving point is not executed so as to avoid such unforeseen shut-off at the water receiving point without prior control at the transmission pump station.

In contrast, the control of water distribution system with the use of distribution pump is much different from that of water distribution system with the use of elevated tanks, and also much different from that of water transmission system with the use of transmission pumps. Distribution system should be designed to keep distribution pump discharge pressure constant at the level required to distribute water to consumers equally and uniformly. It is emphasized that distribution pressure with flow at consumers' taps would be balanced with the number of opened water taps of the consumers and the number of operation pump unit, and that the distribution flow and pressure at the consumers' taps cannot be controlled by the distribution pump station. It is only possible to keep the distribution pressure at the distribution pump station by controlling the pump operation number and/or by controlling the pump speed.

Suppose the most extreme example that all of the taps of the consumer are closed and no leakage from the distribution pipe network exists. The pressure in the distribution pipe network reaches the pump shut off pressure and the discharge flow from the pump becomes zero.

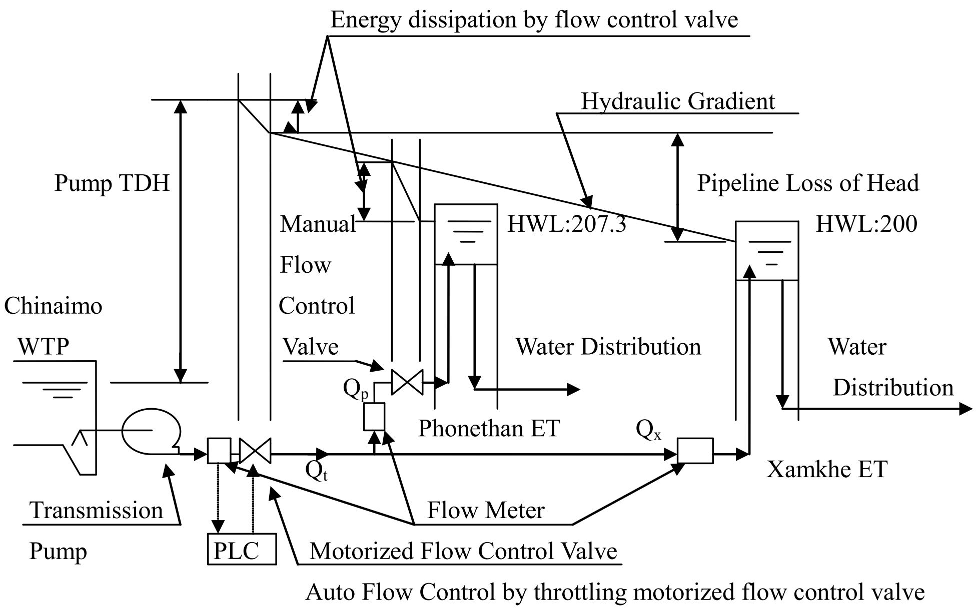
c. Utilization and demolishing of the Existing Facilities

Utilization of the existing facilities is examined considering the ages of the existing facilities when Chinaimo WTP Phase 1 and Phase 2 expansion is to be completed in 2020 and in 2025, respectively. Some existing facilities are intended to be demolished due to age~~s~~, and the functions of the existing facilities to be demolished are designed to be integrated in the expansion works.

(3) Basic Design of Treated Water Transmission and Distribution System

a. Transmission System to Xamkhe and Phonethan Elevated Tanks

This transmission system will consist of independent transmission pumps to two elevated tanks at Xamkhe and Phonethan ETs through the existing single transmission main with one branch transmission pipe to Phonethan ET. Basic flow diagram of the transmission system to Xamkhe ET and Phenethan ET is shown in Figure 5.2.9.



Source: JST

Figure 5.2.9 Flow Diagram of Transmission System to Xamkhe and Phonethan ETs

Basic system functional design is as follows:

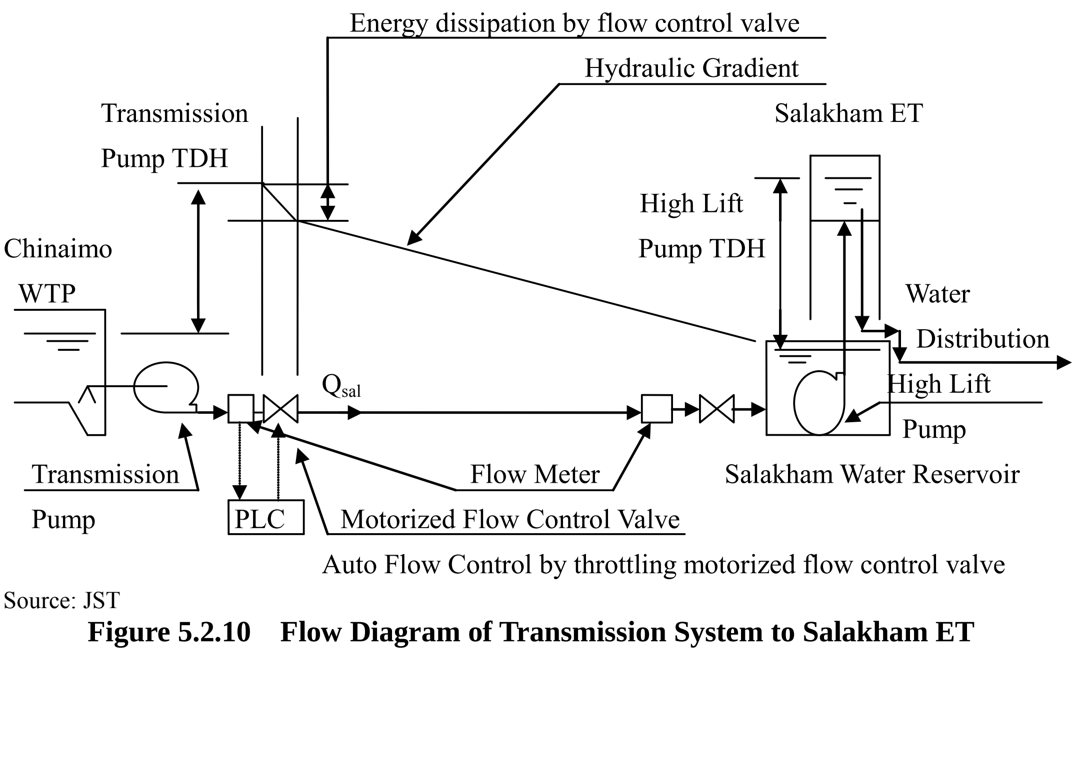
- Transmission flow pumped is regulated and controlled to be Q_t (Q_p + Q_x) automatically according to the fluctuation of the pump suction water level with the use of motorized flow control valves located at pump discharge header pipes of transmission pumps and PLCs.
- At the inlet of Phnethan ET, the inlet flow Q_p is controlled manually by throttling the flow control valve. Under the constant transmission flow condition, once this valve position is set manually, the required flow constantly enters into elevated tank.
- Remaining flow, Q_x enters into Xamkhe ET without any flow control.

b. Transmission System to Salakham Distribution Center

There is an existing elevated tank at Salakham but compared with water demand, the capacity of the existing elevated tank, 1500 m^3, is not enough to absorb the peak water demand. Therefore, it is proposed to construct a new elevated tank. Considering the limited land space availability, the capacity of new elevated tank is planned to be only 2,000 m^3, and it is also proposed to construct a new ground water reservoir utilizing space under the new elevated tank. This new ground water reservoir will have 5,200 m^3 capacity. The total storage capacity at Salakham Distribution Center will become 8,700 m^3, and the total detention time becomes 4.5 hours against the daily maximum flow.

Transmission system from the Chinaimo Water Treatment Plant is designed as described below and the flow diagram is illustrated in Figure 5.2.10.

- Treated water flow pumped is regulated and controlled by flow control valves located at the pump discharge header pipes of transmission pumps with PLCs.
- Treated water is transmitted to the new ground reservoir,
- Water stored in the ground reservoir is then pumped up to the elevated tanks. The flow into the elevated tanks is controlled with the use of automatic over-riding pump unit operation method interrelated with the water level fluctuation in the elevated tanks so as to keep the water level over the minimum water volume level, and
- Water stored in the elevated tanks flows to consumers by gravity.



Source: JST

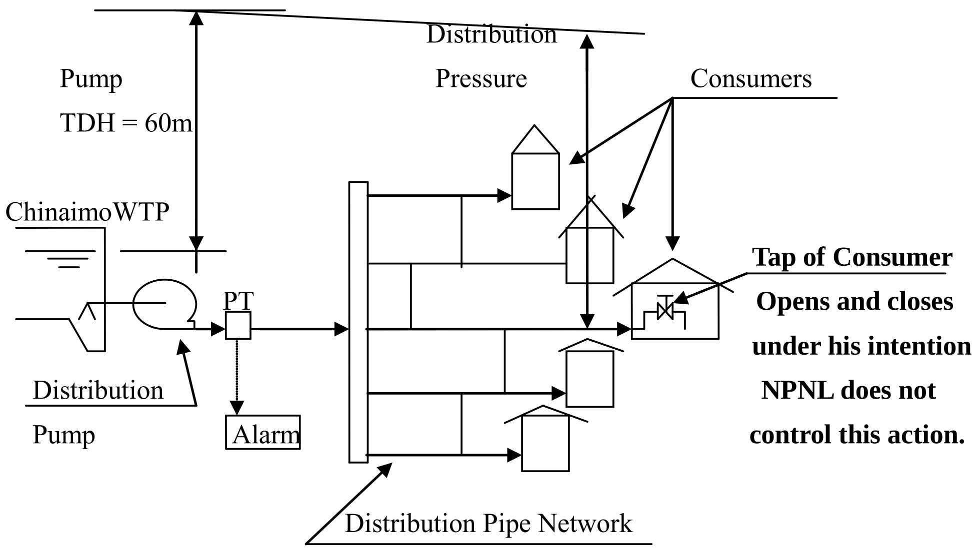
Figure 5.2.10 Flow Diagram of Transmission System to Salakham ET

c. Treated Water Distribution System from Chinaimo WTP

Treated water will be distributed directly by distribution pumps to water distribution zones such as central Vientiane areas as defined in the distribution plan. The basic operation of the distribution system is dependent on the operation pump unit control method by keeping the pump discharge pressure constant at the required pressure level for uniform and equal water distribution to all the consumers. According to the modification plan of the existing distribution pipe network, distribution pump pressure is designed to be 60 m considering the optimum and economical water distribution with the intention of reducing leakage from distribution pipe network.

Basic system function design of the treated water distribution by pumps is described below and the flow diagram is illustrated in Figure 5.2.11.

- Treated water is pumped to consumers through distribution pipe network directly and distribution pressure is monitored by pressure transmitter at the pump discharge header pipes of distribution pumps.
- In case that water demand is increased according to the increasing number of opened water taps of consumers, the pump discharge pressure decreases and poises naturally in accordance with the pump Q-H curve.
- In case of the distribution pressure being lower than pre-set distribution pressure, alarm of LOW pressure will be signaled by pressure transmitter.
- In response to this alarm, LOW pressure, additional pump will start running so as to keep the distribution pressure to be pre-set distribution pressure and the pump discharge pressure is balanced with the required distribution pressure.
- In case that water demand is decreased according to the decreasing number of opened water taps of consumers, the pump discharge pressure increases and poises naturally in accordance with the pump Q-H curve.
- In case of distribution pressure being higher than pre-set distribution pressure, alarm of HIGH pressure will be signaled by pressure transmitter.
- In response to this alarm, HIGH pressure, one pump being in service will stop so as to keep the distribution pressure to be pre-set distribution pressure and the pump discharge pressure is balanced with the required distribution pressure.



Source: JST

Figure 5.2.11 System Flow Diagram of Water Distribution System with use of Pumps

The economy of the operation system by the operation pump unit control method is also examined by comparing with variable pump speed method.

The variable pump speed system sometimes becomes a very economical system of energy saving if distribution system has wide range of flow fluctuation, very low night time demand, and very high peak demand, even if the capital cost of additional variable speed electric panels and control devices with medium voltage electric power supply becomes very expensive.

The following is the summary of the comparison showing that the operation pump unit system is superior in terms of electrical consumption to the variable pump speed system for the case of the distribution system of Chinaimo WTP. The detail study is described in SUPPORTING REPORT, A4.

Table 5.2.14 compares the annual electric power consumptions for the two systems calculated as the present worth, and the results indicate that the power consumption of the fixed speed pump system is lower than that of variable speed pump system for both Phase 1 and Phase 2.

Table 5.2.14 Electric Power Consumption Comparison for Fixed and Variable Speed Pump Systems

Items	Fixed Speed Pump	Variable Speed Pump
Phase 1 Electric Power Consumption kWh	4,818,361	4,918,452
Phase 2 Electric Power Consumption kWh	6,156,265	6,554,609

Note: It is assumed that the pumps are operate at maximum daily discharge for 3 months and at average daily discharge for 9 months in a year.

In the previous section, 5.2.1, the comparison result showed applying variable speed pump system for the new raw water intake pump system has an advantage over the fixed speed pump system. It is explained that the water level of the Mekong River fluctuates over 13m between dry season and rainy season; i.e. actual pump head will heavily change. If applying fixed speed pump system, excess energy in the pumps occurs in rainy season (i.e. relatively high water level in the Mekong River) and it is not economical operation system. Therefore, controlling by variable speed pump system is preferred in the intake pumps.

On the other hand, fixed pump speed system had an advantage in transmission and distribution pumps in the above comparison. It is explained that the actual pump head is fixed between those pumps and destination points such as elevated tanks and tapping point of distribution pipelines; i.e. actual pump head will not change. Therefore, controlling by fixed speed pump system was more economical than the variable speed pump system, which is much costly in the initial investment.

(4) Selection of Pump Type for Transmission and Distribution Pump Systems

There are considerable 3 typical types of pump such as 1) vertical mixed flow type, 2) water sealed submersible motor pump and 3) double suction volute pump for transmission, distribution and high lift pump under this project. Basic comparison for the three typical types of pump is summarized in Table 5.2.15.

Table 5.2.15 Comparison of Three Typical Pump Types

	Vertical Mixed Flow Type	Water Sealed Submersible Type	Double Suction Volute Type
Application	Very Popular*1	Popular*2	Very Popular*3
Capacity & Head	Possible	Possible	Possible
Pump Impeller	Open	Open	Closed
Pump Construction	Complicated with line shaft and shaft bearings	Simple*4	Slightly complicated with gland seal water required
Operation	Self-gland seal water piping is required	Very easy and no any action for normal operation	Self-gland seal water piping is required
Maintenance	Need skill for line shaft bearing replacement	Almost free	Requirement for gland packing replacement
Pump Room Space	Small	Small	Very Big and dry, and deep pump installation pit is required
Pump Unit Price	1.00	1.05	0.70

Note:
*1: This type of pump has been being in service since 1978 in Chinaimo raw water pump station.
*2: This type of pump has been being in service since 1994 in Chinaimo raw water pump station. The existing pumps have proven almost trouble free operation. At two Kaolieo raw water pump stations, this type of pump is in service with almost trouble free operation.
*3: Many of this type of pumps have been being in service for transmission and distribution since 1978 in Chinaimo WTP and Kaolieo WTP.
*5: Pump is complete sealed canned type and only very small amount of non-pressurized clear water supply is required.
Source: JST

Considering the above comparison results, two types of pumps, namely the water sealed submersible motor pump and the double suction volute pump are recommendable for the new transmission, distribution and high lift pump systems of the Chinaimo Water Treatment Plant.

- Very long and trouble free operation, over 20 years since 1994 of the existing Chinaimo raw water pump station and also Kaolieo raw water pump stations,
- Having long experiences in handling of this type of pump,
- Familiarization with operation and maintenance work of this type of pump,
- Proofing long life time of this type of pump without maintenance work and less requirement of spare parts and
- Simple pump construction mechanism and no complicated auxiliary system.

However, the availability of land space for pump stations is also considered in selecting either double suction volute pump or water sealed submersible motor pump in the total design.

Table 5.2.16 summarizes the selection of pump types, the required number of pumps and basic specifications for the expansion work including the handling of the existing pumps.

Table 5.2.16 Selected Pump Types, Number of Pumps and Specification of Pumps for Transmission and Distribution Systems

Item	Description	Phase 1	Phase 2
Existing Distribution Pumps (installed in 2006)	Utilized but only motors with electrical Panels	-	-
Existing Transmission Pumps (installed in 1978)	Not utilized	-	-
New Transmission Pumps (Phonethan and Xamkhe ET)	Water sealed submersible motor; 5.6 m^3/min x 50 m x 90 kW	3 units (2 duty + 1 standby)	-
New Transmission Pumps (Salakham Distribution Center)	Water sealed submersible motor; 11.5 m^3/min x 30 m x 110 kW	3 units (2 duty + 1 standby)	1 unit
New Distribution Pumps Small (to be replaced with existing pumps)	Double suction volute; 12 m^3/min x 60m x 220 kW(ex. Motor)	3 units (2 duty + 1 standby)	1 unit
New Distribution Pumps Large	Double suction volute; 24 m^3/min x 60m x 355 kW	3 units (2 duty + 1 standby)	2 units
New High Lift Pumps (Salakham ET)	Water sealed submersible motor; 12.5 m^3/min x 37 m x 132 kW	4 units (3 duty + 1 standby)	1 unit

Source: JST

5.2.4 Transmission and Distribution Pipe Facilities

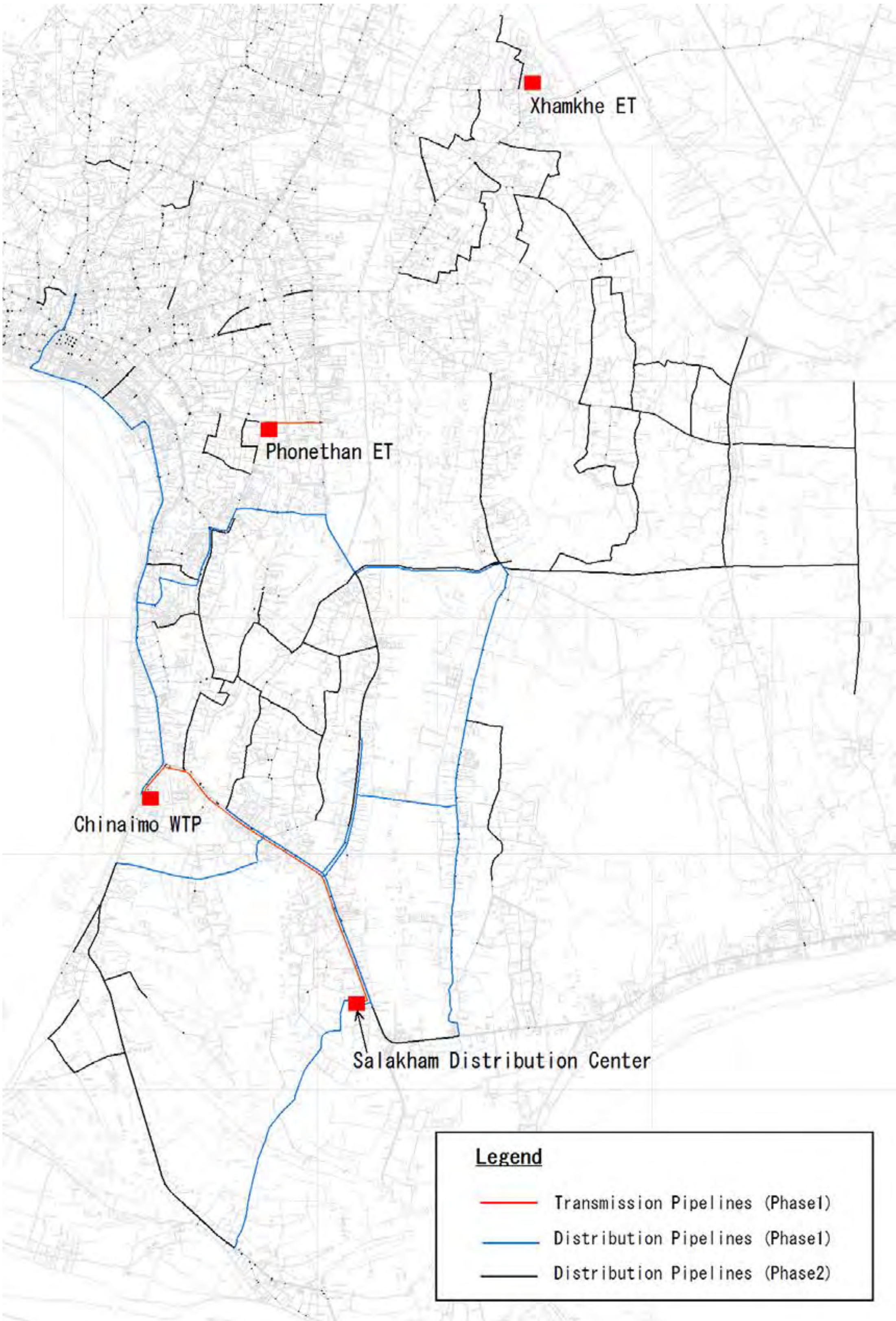
(1) Outline of Transmission and Distribution Pipe Facilities

The location of transmission and distribution to be constructed in Phase1 and Phase2 is shown in Figure 5.2.12. The information on pipeline length to be constructed is shown in Table 5.2.17.

The pipelines for Phase 1 and phase 2 were grouped based on the following concept.

- The pipelines are constructed to supply all the water of 120,000m^3/day in Phase 1 stage.
- High density area especially for center of Vientiane Capital is prioritized for construction of distribution pipelines. The center of Vientiane Capital is now supplied by both Kaolieo and Chinaimo WTPs. NPNL has the plan that the center of Vientiane Capital will be supplied by only Chinaimo. The plan leads Kaolieo WTP supply water to north side of Kaolieo WTP where water supply is not enough. Therefore, the approach to have the priority in the center of Vientiane Capital match with the NPNL's plan.
- Pipelines will be constructed in Phase 2 in the area that can be supplied by existing pipeline for water demand in Phase 1.
- The pipelines in the east side near the Road 450 City will be constructed in Phase 2, as the capacity of 120,000m^3/day in Phase 1 is not enough for the area.

The detailed information such as pipe diameter and length in each area (Phonethan and Xamkhe ETs area, Salakham Distribution Center area and Chinaimo direct pumping area) are described below.



Source: JST

Figure 5.2.12 Outline of Pipeline Augmentation and Expansion in the Project (Phase1/Phase2)

Table 5.2.17 List of Distribution Pipelines to be Augmented or Newly Installed in the Project (Phase1/Phase2)

Phase	Transmission /Distribution	Diameter	Pipe Material	Length (m)
Phase 1	Transmission	450	DIP	885
		700	DIP	5,815
	Sub-Total			6,700
	Distribution	300	DIP	2,308
		350	DIP	6,221
		400	DIP	11,086
		500	DIP	724
		600	DIP	1,669
		700	DIP	2,031
		800	DIP	5,930
		1,000	DIP	9,306
		1,100	DIP	258
		1,200	DIP	3,156
	Sub-Total			42,689
Phase 1 Total				49,389
Phasae 2	Distribution	150	DIP	29,643
		200	DIP	23,885
		250	DIP	9,677
		300	DIP	18,277
		350	DIP	6,856
		400	DIP	3,256
		450	DIP	210
		500	DIP	2,607
		600	DIP	845
		700	DIP	2,308
Phase 2 Total				97,564
Grand-Total				146,953

Source: JST

(2) Network Calculation

1) Objective

Network calculation, which implements the simulation of water supply, is carried out to confirm the availability of adequate water amount and water pressure in water supply area. The necessary pipe diameter and length are calculated from the results of the network calculation.

2) Calculation Method

The network calculation is carried out by using the “EPANET” which was developed by U.S. Environmental Protection Agency (EPA) and is distributed without charge. Therefore the “EPANET” is commonly employed for network calculation.

3) Calculation Conditions

Calculation conditions for network analysis are shown in Table 5.2.18.

Condition of necessary water pressure was set as 15 meter at each node. However, in case that the necessary water pressure is not secured due to physical condition, the condition of 10 meter that is shown in Guideline[12] was applied.

The diameter of pipeline is determined by the smallest diameter of pipeline which meets the necessary water pressure through the network calculation.

Table 5.2.18 Calculation Conditions

Item	Condition	Remark
Calculation Method	Hazen-Williams formula	$H=10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$ H: Friction Head Loss (m) C: Coefficient of flow velocity (C value) D: Internal diameter of pipe (m) Q: Flow rate (m^3/s) L: Length (m)
C value	110	Same condition with M/P(2005)
Hourly Factor	1.55	The condition which is for area of housing and factories was applied* Hourly Factor$=1.8665(Q/24)^{-0.0214}$ Q: Daily Max Flow (=160,000 m^3/day)

* Design Criteria for Japanese Waterworks Facilities (2012) was applied since materials to set the Hourly Factor were not available in Vientiane.
Source: JST

The condition of water level for network calculation is shown in Table 5.2.19.

Table 5.2.19 Condition of Water Level

Supply Area	Distribution Method	Ground Level(m)	Low Water Level (m)	Pump Head (m)
Direct Pumping Distribution Area	Pumping	171.21m	-	56m
Salakham	Gravity	171.54m	Ground Level + 27.5m	-
Phonethan	Gravity	176.83m	Ground Level + 24.5m	-
Xamkhe	Gravity	180.00m	Ground Level + 18.01m	-

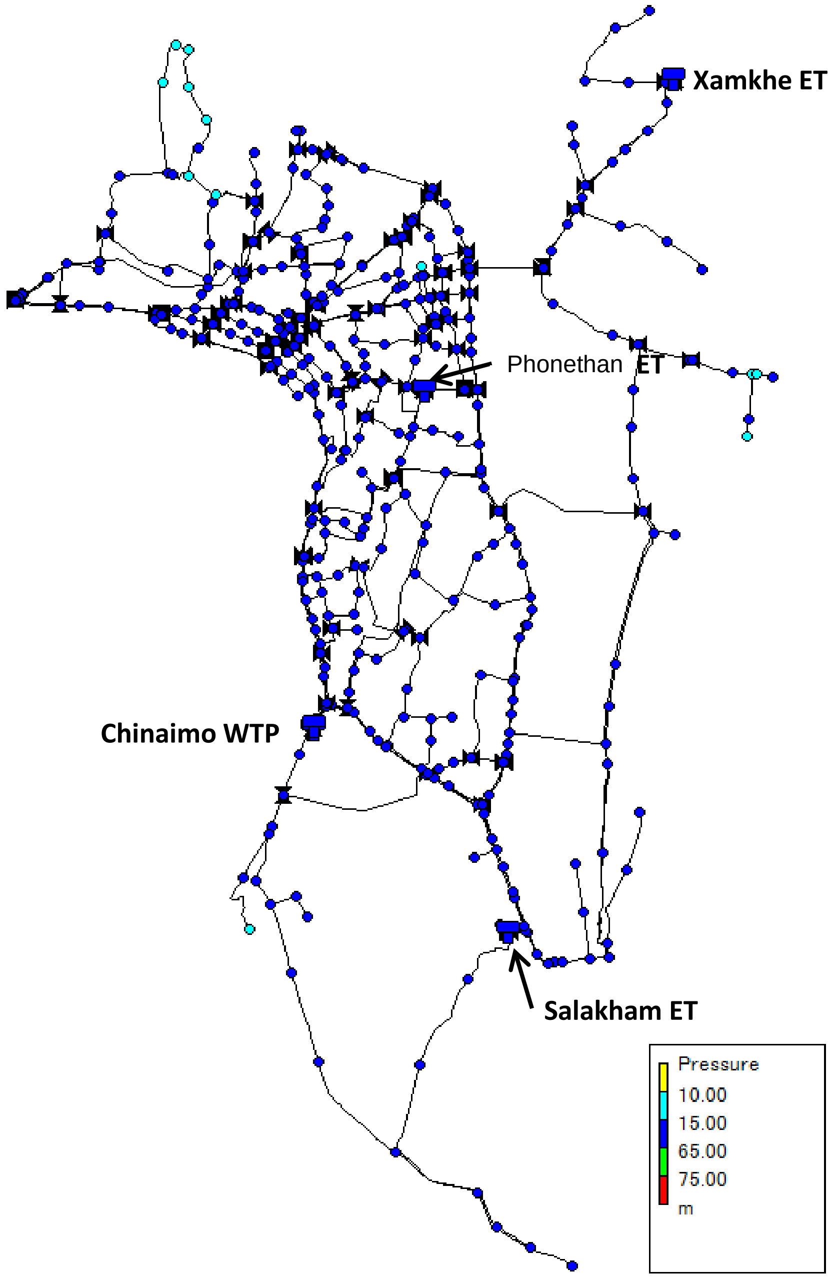
Source: JST

[12] Guideline: MANAGEMENT AND TECHNICAL GUIDELINES WATER SUPPLY (February 2009) Ministry of Public Works and Transport, Department of Housing and Urban Planning, Water Supply Division

4) Results of Network Calculation

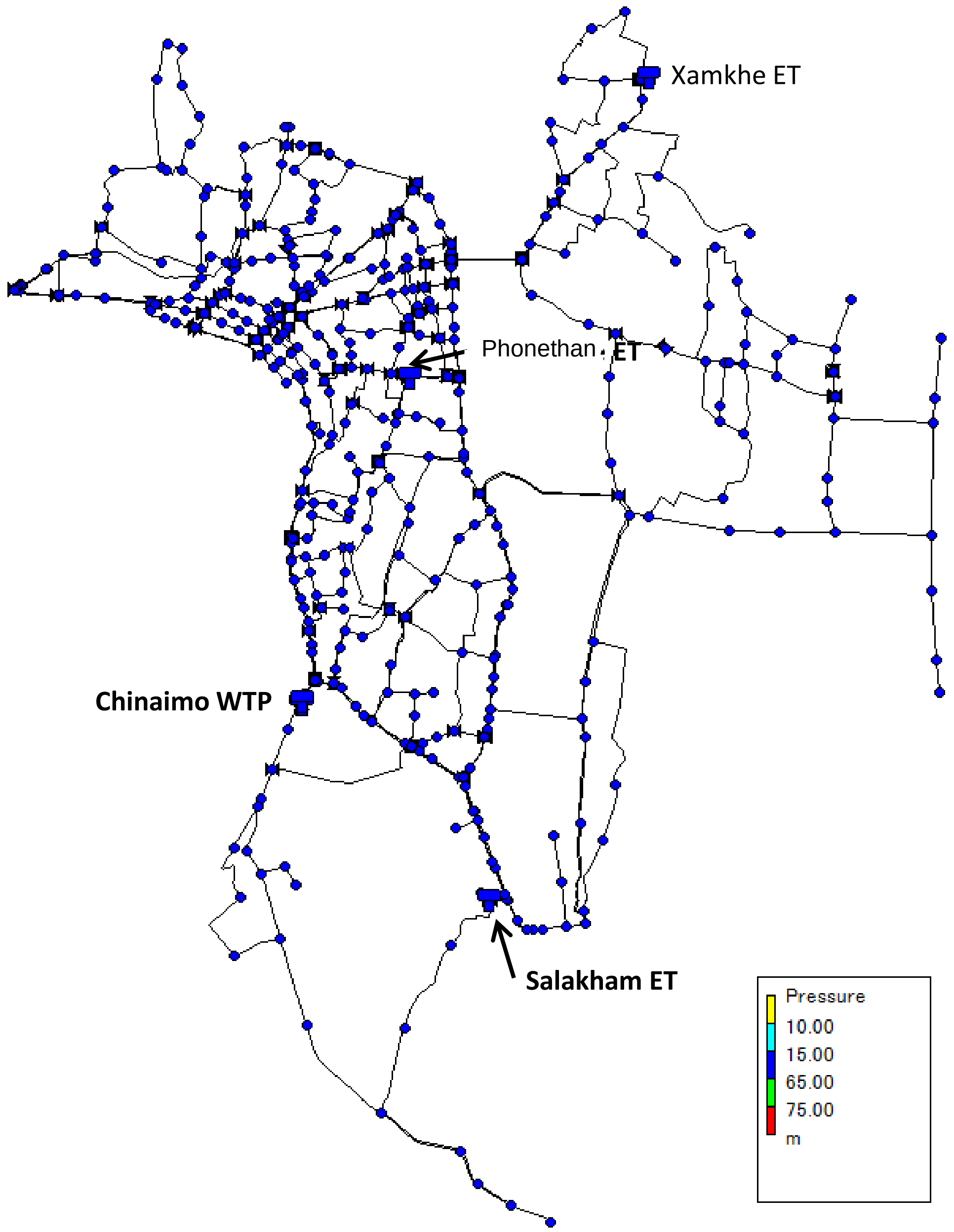
The results of network calculation for Phase 1 and Phase 2 are shown in Figure 5.2.13 and Figure 5.2.14.

Water pressure after Phase 1 is almost enough although some area has water pressure with under 15 meters and over 10 meters. After Phase 2, all supply area from Chinaimo WTP has enough water pressure with over 15 meters.



Source: JST

Figure 5.2.13 Results of Network Calculation (After Phase 1)



Source: JST

Figure 5.2.14 Results of Network Calculation (After Phase 2)

(3) Transmission and Distribution Pipe System of Xamkhe and Phonethan Elevated Tank System

Transmission and Distribution Pipe System of Xamkhe and Phonethan Elevated Tank System

Treated water from Chinaimo WTP will be transmitted to Phonethan ET and Xamkhe ET through the existing transmission main, and supplied to the surrounding customers by gravity through the existing pipes. Only branch pipe of 885 m in length from the main transmission pipe to Phonethan ET is required to be enlarged from dia. 300 mm to dia. 450 mm. The enlargement is based on the result of study in " 5.2.3(3) Basic Design of Treated Water Transmission and Distribution System". The existing transmission pipelines are used in other part of transmission pipelines to Phonethan and

Xamkhe since the existing pipelines which were constructed in 1980 and 1996 have the capacity corresponding to Phase 2 and no serious problems now.

The service areas covered by these elevated tanks are identified by hydraulic network analysis, and the boundary of each service area will be isolated by installing valves from the service areas which are supplied by direct pumping from Chinaimo WTP.

The list of transmission pipe and distribution pipes installed at the areas supplied from Phonethan ET and Xamkhe ET is as shown in Table 5.2.20.

Table 5.2.20 List of Transmission Pipe and Distribution Pipes to be Installed at the Areas Supplied from Phonethan ET and Xamkhe ET

Phase	Elevated Tank	Transmission / Distribution	New Installation /Renewal	Diameter	Material	Length (m)
Phase 1	Phonethan	Transmission	Renewal	450	DIP	885
Phase 2	Phonethan	Distribution	New Installation	150	DIP	977
				450	DIP	210
				Sub-Total		1,187
			Renewal	150	DIP	2,300
				250	DIP	781
				Sub-Total		3,081
		Distribution Total				4,268
	Xamkhe	Distribution	New Installation	150	DIP	3,411
				200	DIP	3,225
				300	DIP	6,783
				Sub-Total		13,419
			Renewal	-	-	-
		Distribution Total				13,419
Phase1&2 Total						18,572

Source: JST

(4) Transmission and Distribution Pipe System of Salakham Distribution Center

The existing Salakham elevated tank site will be renovated as the Salakham Distribution Center, which consists of the existing elevated tank, the newly expanded elevated tank and ground reservoir with the high lift pump facilities. The role of Salakham Distribution Center is to supply water by gravity to the-areas along the Thadeua road, the neighborhood located to the south of Chinaimo WTP and around the southern tip of Vientiane Capital

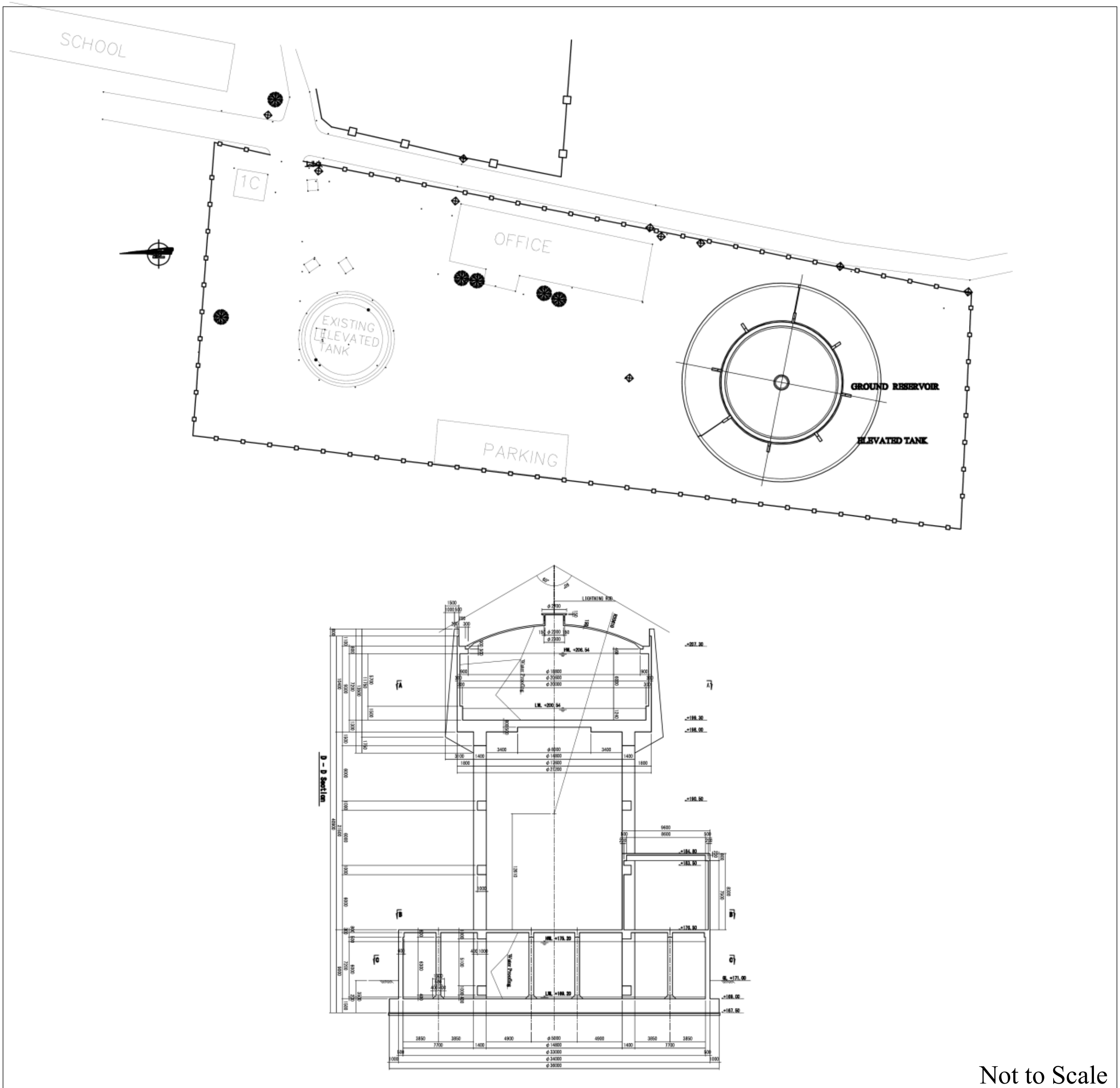
Treated water will be transmitted first into the new ground reservoir with the capacity of 5,100 m^3, and then lifted to the existing elevated tank with 1,500 m^3 and the new elevated tank with 2,000 m^3. The total reservoir capacity (8,600m^3) will be equivalent to 6.2 hours of daily maximum consumption (33,470m^3/day) and 5.6 hours of daily maximum consumption (36,818m^3/day) for Phase 1.

Due to the limited land availability the new ground reservoir and the new elevated tanks will be of combined RC structure, and the new elevated tank will be constructed on the ground reservoir. Treated water will be lifted to the two elevated tanks by high lift submersible pumps installed in the pump well of the ground reservoir.

New power supply from EDL will be newly required for this pumping system. A new power sub-station for power receiving and distribution basically is designed to consist of the following major equipment:

- 1 set of power transformer, rated at 22 kV/380V x 1,000 kVA,
- 22 kV incoming and feeder panels,
- 380 V incoming and feeder panels,
- High lift water pump panels,
- Instrumentation equipment including flow measuring and level measuring

Figure 5.2.15 shows the plan of Salakham Distribution Center and the section of the new ground reservoir and elevated tank.



Not to Scale

Source: JST

Figure 5.2.15 Plan of Salakham Distribution Center and Section of New Ground Reservoir and Elevated Tank

The transmission pipe from Chinaimo WTP to Salakham Distribution Center will be augmented by the installation of diameter 700 mm pipe with a total length of 5,825 m to deliver 36,818 m^3/d (daily maximum) of treated water for Phase 1, and 49,090 m^3/d for Phase 2 by pumping.

Distribution from the Salakham Distribution Center to customers is by gravity flow through the existing and newly installed distribution pipes. The list of distribution pipes newly installed in the area covered by Salakham Distribution Center is shown in Table 5.2.21.

Table 5.2.21 List of Distribution Pipes Newly Installed in the Area Covered by Salakham Distribution Center

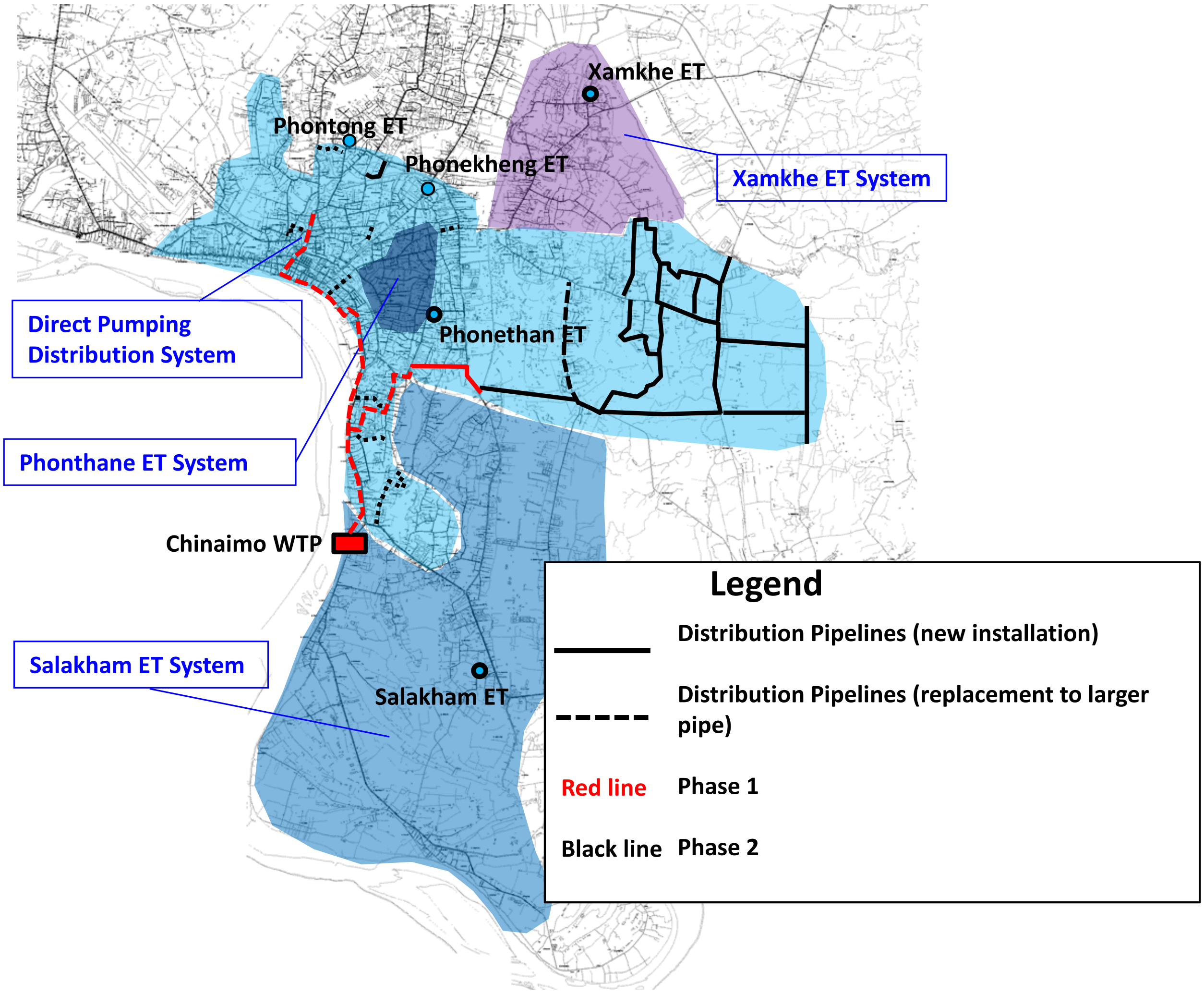
Phase	Transmission / Distribution	New Installation /Renewal	Diameter	Material	Length (m)
Phase 1	Transmission	Renewal	700	DIP	5,815
	Distribution	New Installation	300	DIP	2,308
			500	DIP	6,221
			600	DIP	10,209
			Sub-Total		18,738
		Renewal	400	DIP	877
			500	DIP	724
			600	DIP	1,093
			800	DIP	1,341
			1000	DIP	2,224
			1100	DIP	258
			Sub-Total		6,517
		Total			25,255
	Phase 1 Total				31,070
Phase 2	Distribution	New Installation	150	DIP	6,896
			200	DIP	6,879
			250	DIP	3,532
			300	DIP	2,408
			Sub-Total		19,715
		Renewal	150	DIP	2,682
			200	DIP	420
			250	DIP	2,487
			300	DIP	6,765
			350	DIP	841
			400	DIP	1,679
			Sub-Total		14,874
	Phase 2 Total				34,589
Phase1&2 Total					65,659

Source: JST

(5) Direct Pumping Distribution System

According to the results of the hydraulic analysis of the future distribution network, replacement of distribution pipes with larger diameters and new distribution pipe installation are required.

The existing distribution pipelines from Chinaimo WTP which should be augmented or newly installed are identified in Figure 5.2.16.



Source: JST

Figure 5.2.16 Distribution Pipelines to be Augmented or Newly Installed in Direct Pumping Distribution System

Table 5.2.22 shows the list of distribution pipelines to be augmented or newly installed in diameters.

Table 5.2.22 List of Distribution Main Replacement/Augmentation

Phase	Transmission / Distribution	New Installation /Renewal	Diameter	Material	Length (m)
Phase 1	Distribution	New Installation	1000	DIP	2,354
			Sub-Total		2,354
		Renewal	600	DIP	576
			700	DIP	2,031
			800	DIP	4,589
			1000	DIP	4,728
			1200	DIP	3,156
			Sub-Total		15,080
	Distribution Total				17,434
Phase 2	Distribution	New Installation	150	DIP	11,838
			200	DIP	13,112
			250	DIP	2,877
			300	DIP	1,623
			350	DIP	3,890
			400	DIP	714
			500	DIP	2,607
			600	DIP	845
			700	DIP	2,308
			Sub-Total		39,814
		Renewal	150	DIP	1,539
			200	DIP	249
			300	DIP	698
			350	DIP	2,125
			400	DIP	863
			Sub-Total		5,474
	Distribution Total				45,288
Phase1&2 Total					62,722

Source: JST

5.3 Operation and Maintenance Plan for the Facilities of the Project

As stated in Chapter 4.4.2 simple operation and less maintenance requirement is one of the key considerations in designing the water supply facilities constructed or installed for the expansion work. Corresponding to the design concepts described in the previous sections the operation and maintenance plan for the main water supply facilities is prepared as shown in Table 5.3.1.

Moreover, the expansion project will provide the new laboratory and Central Monitoring System as described in Chapter 5.2.2 8) and 11), respectively, so as to help the plant operators obtain necessary information and judge their proper actions for optimum operation and maintenance both for water quality and water quantity management.

Table 5.3.1 Operation and Maintenance Plan for the Major Water Supply Facilities

Facilities	Operation	Maintenance
Intake Screens	• Basically automatic operation adjusted by timer or water level setting • Manual operation for checking the performance at least twice (say, morning and evening) a day.	Mechanical maintenance in accordance with manufacturers' recommendations should be applied.
Raw Water Intake Pumps	• Optimum shifting of pumps • Pump discharge head monitoring	• N/A
Raw Water Intake Pump Well	• Periodical desludging	• N/A
Rapid Mixing Basin	• Mixing by hydraulic water jump • Optimum dilution of alum solution by water	• Cleaning of feeding pipe shower orifices
Flocculation Basin	• Hydraulic up-and-down tapered flocculation • Intensity of flocculation can be adjusted by baffled plates	• Periodical desludging
Sedimentation Basin	• Manual desludging with flush water at the appropriate frequency dependent on raw water turbidity conditions	• N/A
Filter	• Monitoring of filtered water flow • Optimum air-water concurrent backwash • Maintaining the normal filter run time at 24 hours	• Periodical sieving of surface sand and refill of sand as required
Alum Feeding System	• Adjustment of correct alum solution concentration • Optimum dosage adjustment	• Cleaning and flushing of feeding pumps
Polymer Feeding System	• Make up polymer solution with optimum concentration • Optimum dosage adjustment	• Cleaning and flushing of feeding pumps
Chlorination System	• Same conditions quantity and temperature • Optimum dosage adjustment • Periodical test run of neutralization system	• Periodical check of leak detection system
Transmission Facilities to Salakham	• Transmission flow control at the pumping station by automatic or manual mode	• Periodical check and refill of seal water

Facilities	Operation	Maintenance
Transmission Pump Facilities to Phonethang ET and Xamkhe ET	• Optimum shifting of the pumps • Transmission flow control at the pumping station by automatic or manual mode • Optimum shifting of the pumps	• Periodical check and refill of seal water
Distribution Pump Facilities to Vientiane City	• Pump discharge pressure control by using operation unit control to secure required water pressure	• Air venting by opening the vent valve at the top of the pump casing. • Adjustment of gland packing

N/A: Non Particular Maintenance Required
Source: JST

5.4 Overall Project Cost

5.4.1 Project Components

Overall project components by Phase 1 and 2 are consisted of following works.

Table 5.4.1 Project Components (Phase 1 and Phase 2)

Components	Type of Works	Phase 1	Phase 2
Chinaimo Raw Water Intake Pump Station	Civil Work (G)	160,000m^3/day	-
	Raw Water Pipeline (G)	160,000m^3/day	-
	Intake Pump Mechanical and Electrical Work (E)	120,000 m^3/day (Including existing pump renewal)	40,000 m^3/日 (Total of 160,000 m^3/day)
	Building (G)	New Administration Building	-
Chinaimo Water Treatment Facilities Expansion	Civil Work (G)	40,000 m^3/日 (Total of 120,000 m^3/日)	40,000 m^3/日 (Total of 160,000 m^3/日)
	Special Work (G)	Method of non-suspension water	Nothing
	Transmission and Distribution Pump Mechanical and Electrical Work (E)	120,000 m^3/ day (Including existing pump renewal)	40,000 m^3/日
	Chemical Feed System Mechanical and Electrical Work (E)	120,000 m^3/ day	40,000 m^3/日
	Monitoring System (E)	New Monitoring System Mechanical and Electrical Work	-
	Building (G)	New Chemical Feeding Facilities	-
	Improvement of the Existing Facility (E)	Improvement of the Existing Sand Filter	-
	Equipment	Laboratory Equipment	-
Salakham Distribution Center	Civil Work (G)	7,200m^3	-
	Lift Pump Mechanical and Electrical Work (E)	36,818m^3/ day	12,273m^3/日
Expansion of Transmission and Distribution Pipeline	Transmission pipeline (G)	Approx. 6.7km	-
	Distribution Pipeline (G)	Approx. 42.7km	Approx. 97.6km

*(G): "General" including civil, pipeline and building works.
*(E): "Equipment" including mechanical and electrical works for pumps and these appurtenances.
Source：JST 作成

5.4.2 Base Cost

Base cost for the above project contents is shown in Table 5.4.2.

Table 5.4.2 Overall Base Cost (Phase 1 and Phase 2)

Facility	Phase I			Phase II			Total		
	FC (Million JPY)	LC (Million LAK)	Sub-total (Million JPY)	FC (Million JPY)	LC (Million LAK)	Sub-total (Million JPY)	FC (Million JPY)	LC (Million LAK)	Sub-total (Million JPY)
Intake (G)	221	14,930	444	1	307	6	223	15,237	450
Intake pump Mechanical	387	484	394	122	121	124	508	605	517
Inteke pump Electrical	244	484	251	83	121	85	327	605	336
Chinaimo WTP (G)	138	37,257	693	67	18,132	338	206	55,389	1,031
Transmission and distribution pump Mechanical	386	1,210	404	74	323	79	460	1,533	483
Transmission and distribution pump Electrical	485	1,210	503	31	323	36	516	1,533	539
Chemical feed system Mechanical (E)	251	726	262	18	162	20	269	888	282
Chemical feed system Electrical (E)	97	726	108	2	162	5	100	888	113
Monitoring system (E)	130	81	131	0	0	0	130	81	131
Method of non-suspension water	300	0	300	0	0	0	300	0	300
Salakham (G)	33	8,818	164	0	0	0	33	8,818	164
Salakham pump Mechanical	156	81	157	31	20	31	187	101	188
Salakham pump Electrical	190	81	191	12	20	13	203	101	204
Raw water pipeline (G)	65	4,360	130	26	1,744	52	91	6,104	181
Transmission pipeline (G)	282	4,270	346	0	0	0	282	4,270	346
Distribution pipeline (G)	1,838	23,730	2,191	1,140	20,280	1,442	2,978	44,010	3,633
Rehabilitation	105	1,765	131	0	0	0	105	1,765	131
Laboratory Equipment	100	0	100	0	0	0	100	0	100
Dispute Board	25	0	25	25	0	25	49	0	49
Total	5,432	100,213	6,925	1,632	41,716	2,254	7,064	141,929	9,178

*(G): “General” including civil, pipeline and building works.
*(E): “Equipment” including mechanical and electrical works for pumps and these appurtenances.
Source: JST

5.4.3 Operation and Maintenance Cost

Operation and maintenance costs in the future shall be calculated from the following conditions based, on the current costs in Chinaimo WTP that has 80,000 m^3/day capacity.

Calculation conditions of O&M cost for Chinaimo WTP

Electricity

- Cost for electricity shall be calculated in proportion to the amount of water production in Chinaimo WTP. (Ex. If capacity of Chinaimo WTP was expanded to 160,000 m^3/day, electric bill would be 2 times compared to that in 80,000 m^3/day capacity.) However, it shall be considered for the electric bill that full amount of water production will not be supplied in transitional phase such as just after the expansion of WTP.

Chemical

- Cost for chemical shall be calculated in the same method with electricity.

Fuel and Vehicle

- Phase1: Current cost X 1.5
- Phase2: Current cost X 2.0

Personnel Cost

- Phase1: Current cost X 1.25
- Phase2: Current cost X 1.5

Calculation conditions of O&M cost for Salakham Distribution Center

Electricity

- Cost for electricity shall be calculated based on the pump head and planned amount of supply water from Salakham Distribution Center.

Chemical

- No cost

Fuel, Vehicle and Personnel Cost

- 20 percent of current cost in Chinaimo WTP with consideration of assumed number of staff

Operation and Maintenance cost projection for Chinaimo WTP and Salakham Distribution Center from present to 2050 is shown in Table 5.4.3 calculated on the above conditions. The breakdown of the operation and maintenance cost in Chinaimo WTP and Salakham Distribution Center were shown in Table 5.4.4.

Table 5.4.3 Operation and Maintenance Cost

Unit: LAK

Year	Chinaimo		Salakham		Total/year	Total/year	Remarks
	Electricity, Chemical	Others	Electricity	Others	(LAK)	(JPY)	
2015	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	Chinaimo 80,000 m^3/day
2016	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	
2017	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	
2018	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	
2019	9,662,691,690	1,229,008,717	0	0	10,890,000,000	162,261,000	
2020	10,870,528,151	1,391,234,807	1,160,700,000	245,801,743	13,670,000,000	203,683,000	Chinaimo 120,000 m^3/day
2021	11,595,230,028	1,553,460,896	1,238,080,000	245,801,743	14,630,000,000	217,987,000	
2022	12,319,931,905	1,553,460,896	1,315,460,000	245,801,743	15,430,000,000	229,907,000	
2023	13,044,633,782	1,553,460,896	1,392,840,000	245,801,743	16,240,000,000	241,976,000	
2024	13,769,335,658	1,553,460,896	1,470,220,000	245,801,743	17,040,000,000	253,896,000	
2025	14,494,037,535	1,553,460,896	1,547,600,000	245,801,743	17,840,000,000	265,816,000	
2026	15,460,306,704	1,877,913,076	1,845,440,000	245,801,743	19,430,000,000	289,507,000	Chinaimo 160,000 m^3/day
2027	16,426,575,873	1,877,913,076	1,960,780,000	245,801,743	20,510,000,000	305,599,000	
2028	17,392,845,042	1,877,913,076	2,076,120,000	245,801,743	21,590,000,000	321,691,000	
2029	18,359,114,211	1,877,913,076	2,191,460,000	245,801,743	22,670,000,000	337,783,000	
2030	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2031	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2032	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2033	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2034	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2035	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2036	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2037	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2038	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2039	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2040	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2041	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2042	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2043	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2044	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2045	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2046	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2047	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2048	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2049	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	
2050	19,325,383,380	1,877,913,076	2,306,800,000	245,801,743	23,760,000,000	354,024,000	

1 LAK = 0.0149 JPY

Source: JST

Table 5.4.4 Breakdown of Operation and Maintenance Cost in Chinaimo WTP (Phase 1 and Phase 2)

1 USD = 8,094 LAK
1 LAK = 0.0149 JPY

Chinaimo WTP Operation Cost (Current: Capacity 80,000 m^3/day)

Items	Operation Cost	Total (LAK)	Total (USD)	Total (JPY)	Percentage	Remarks
1	Electricity	7,383,170,880	922,896	110,009,246	67.8%	
2	Chemical	2,279,520,810	284,940	33,964,860	20.9%	
	2.1 Alum	1,440,617,600	180,077	21,465,202	–	
	2.2 Chlorine	805,672,800	100,709	12,004,525	–	
	2.3 Polymer	33,230,410	4,154	495,133	–	
3	Fuel	46,800,000	5,850	697,320	0.4%	
4	Personnel Cost	1,160,208,717	145,026	17,287,110	10.7%	
5	Vehicle	22,000,000	2,750	327,800	0.2%	
	Total	10,891,700,407	1,361,463	162,286,336	100.0%	

Chinaimo WTP Operation Cost (Phase 1: Capacity 120,000 m^3/day)

Items	Operation Cost	Total (LAK)	Total (USD)	Total (JPY)	Percentage	Assumption
1	Electricity	11,074,756,320	1,384,345	165,013,869	69.0%	Current *1.5
2	Chemical	3,419,281,215	427,410	50,947,290	21.3%	Current *1.5
	2.1 Alum	2,160,926,400	270,116	32,197,803	–	–
	2.2 Chlorine	1,208,509,200	151,064	18,006,787	–	–
	2.3 Polymer	49,845,615	6,231	742,700	–	–
3	Fuel	70,200,000	8,775	1,045,980	0.4%	Current *1.5
4	Personnel Cost	1,450,260,896	181,283	21,608,887	9.0%	Current *1.25
5	Vehicle	33,000,000	4,125	491,700	0.2%	Current *1.5
	Total	16,047,498,431	2,005,937	239,107,727	100.0%	

Chinaimo WTP Operation Cost (Phase2: Capacity 160,000 m^3/day)

Items	Operation Cost	Total (LAK)	Total (USD)	Total (JPY)	Percentage	Assumption
1	Electricity	14,766,341,760	1,845,793	220,018,492	69.6%	Current *2
2	Chemical	4,559,041,620	569,880	67,929,720	21.5%	Current *2
	2.1 Alum	2,881,235,200	360,154	42,930,404	–	–
	2.2 Chlorine	1,611,345,600	201,418	24,009,049	–	–
	2.3 Polymer	66,460,820	8,308	990,266	–	–
3	Fuel	93,600,000	11,700	1,394,640	0.4%	Current *2
4	Personnel Cost	1,740,313,076	217,539	25,930,665	8.2%	Current *1.5
5	Vehicle	44,000,000	5,500	655,600	0.2%	Current *2
	Total	21,203,296,456	2,650,412	315,929,117	100.0%	

Salakham Reservoir Operation Cost (Phase 1)

Items	Operation Cost	Total (LAK)	Total (USD)	Total (JPY)	Percentage	Assumption
1	Electricity	1,547,600,000	193,450	23,059,240	86.3%	
2	Chemical		0	0	0.0%	Current *0
3	Fuel	9,360,000	1,170	139,464	0.5%	Current *0.2
4	Personnel Cost	232,041,743	29,005	3,457,422	12.9%	Current *0.2
5	Vehicle	4,400,000	550	65,560	0.2%	Current *0.2
	Total	1,793,401,743	224,175	26,721,686	100.0%	

Salakham Reservoir Operation Cost (Phase 2)

Items	Operation Cost	Total (LAK)	Total (USD)	Total (JPY)	Percentage	Assumption
1	Electricity	2,306,800,000	288,350	34,371,320	90.4%	
2	Chemical		0	0	0.0%	Current *0
3	Fuel	9,360,000	1,170	139,464	0.4%	Current *0.2
4	Personnel Cost	232,041,743	29,005	3,457,422	9.1%	Cuurent *0.2
5	Vehicle	4,400,000	550	65,560	0.2%	Cuurent *0.2
	Total	2,552,601,743	319,075	38,033,766	100.0%	

Source: JST

5.5 Outline of Phase 1 Project

5.5.1 Contract Packages

The study team recommends that the contracts for construction and equipment purchase to be grouped into packages as shown in Table 5.5.1.

It is assessed that the design bid build (DBB) is appropriate for both package 1 and 2 to adopt the conventional treatment method for expansion of Chinaimo WTP considering following reasons.

- There are three alternative treatment methods (1.Conventional method, 2.Upflow clarifier, 3.Ceramic filtration) considered for expansion of Chinaimo WTP. Among the three methods, “2.Upflow clarifier” and “3.Ceramic filtration” are not able to treat high raw water turbidity effectively and economically.

- In contrast, “1.Conventional method” has proven its good performance against high raw water turbidity for a long period of time.

- Adopting different treatment process form existing process may cause complexity of operation and increase burden to the plant operators.

Table 5.5.1 Contract Packages for the Phase 1 Project

Package	Scope	Component	ICB/LCB
Package 1	- Intake (G) - Raw water pipeline (G) - Chinaimo WTP (G) - Chinaimo WTP (E) - Laboratory equipment - Salakham Reservoir (G) - Transmission Pipeline (G) - Distribution Pipeline (G)	- Intake Civil (160,000m^3/day) - Pipe jacking at intake pipe - Raw water pipeline (225m) - Chinaimo WTP Civil and Building (40,000m^3/day) - Method of non-suspension water - Chinaimo WTP Mechanical and Electrical Equipment such as Chemical feed system (excluding pump equipment) - Equipment for laboratory in Chinaimo WTP - Salakham Reservoir Civil (5,100 m^3+2000m^3) - Transmission pipeline (6,700m) - Distribution pipeline (42,689m)	ICB
Package 2	- Intake pump (E) - Transmission and distribution pump (E) - Salakham pump (E) - Monitoring System	- Intake pump and related facilities (120,000 m^3/day) - Transmission and distribution pump and related facilities (120,000 m^3/day) - Salakham high lift pump and related facilities (37,000 m^3/day) - Monitoring System	ICB

(G) means “General” works including civil, pipeline and building works.
(E) means “Equipment” works including mechanical and electrical works.
Source: JST

Above packaging was grouped by the following considerations. The both packages are tendered by International Competitive Bidding (ICB).

Package 1: The construction of intake, raw water pipeline, chemical feed system, buildings in WTP and monitoring system, expansion of WTP, procurement of laboratory equipment, and construction of Salakham reservoir, transmission and distribution pipelines for Phase 1 project would be one contract to standardize construction materials thereby simplifying operation and maintenance. This package would be tendered by International Competitive Bidding (ICB), since the construction requires advanced technology such as pipe jacking method, method of non-suspension water and advanced mechanical and electrical equipment and massive amount of ductile iron pipe by import.

Package 2: Life Cycle Cost (LCC) Bidding Method will be adopted for procurement of Package 2 in order to procure the pumps and related equipment by the lowest cost considering Equipment costs and O/M costs for the certain life cycle periods of the equipment in Chinaimo intake, WTP and Salakham Distribution Center for Phase 1 project. This package would be tendered by International Competitive Bidding (ICB), since the construction would require advanced mechanical and electrical equipment by import.

The reasons that package 1 and package 2 are grouped separately is as follows.

- If pump facilities are included in the package for intake and water treatment plant construction and LCC bidding is applied, the LCC of the pump facilities will be evaluated in combination with the other construction costs and the magnitude of the LCC of the pump facilities cannot be reflected reasonably in the total combined bid evaluation. Thus, only pump facilities are to be separated as an individual package.

- Appropriate construction cost for one package was considered to create proper competitive situation for both packages.

5.5.2 Recommendation of TOR for Consulting Service (Detailed Design, Tender Assistance, Construction Supervision, etc.)

In order to carry out effective consulting service, following activities are recommended to be included in TOR for consulting service,

(1) Detailed Design

The consulting services for detailed design include the following:

- Review all documents relating to the project including F/S and Preparatory Study reports.
- Discuss and clarify the requirements of the project with Executing Agency (EA) and its subordinate organization delegated some responsibility from the EA.
- Carry out basic design and detailed design.
- Carry out topographic and pipeline survey for construction of intake, Chinaimo WTP expansion, Salakham Distribution Center, and transmission and distribution pipeline.
- Carry out geotechnical survey for construction of intake, Chinaimo WTP expansion, Salakham Distribution Center, transmission and distribution pipelines.
- Chinaimo WTP has to be expanded during opreration of existing WTP. In order to avoid

affecting operation of existing WTP, method of non-suspension water has to be considered.

- Carry out test pit survey for construction of Chinaimo WTP expansion and transmission and distribution pipeline in order to avoid water supply suspension due to damage to existing pipeline during construction stage.

(2) Tender Assistance

Under this component the engineers would support the following tasks. Regarding to package 2, the engineers support the procedures of the LCC bidding which evaluates both the initial cost and operation cost.

- Pre-qualification tasks;
- Preparation and modification of tender document;
- Evaluation of bid;
- Contract negotiation.

(3) Construction Supervision

The engineering services for construction supervision include the following:

- Review the construction schedule proposed by the contractor;
- Monitor the progress of work and instruct the contractor to update the schedule when required;
- Assist Executing Agency (EA) and its subordinate organization with progress meetings;
- Review construction shop drawings submitted by the contractor;
- Process contractor's progress and final payment requisitions and issue progress certificates for EA/JICA approval/concurrence.
- Monitor and advise Executing Agency (EA) and its subordinate organization of the financial progress of the work;
- Advise Executing Agency (EA) and its subordinate organization on contract variations and claims issues;
- Provide quality assurance during construction phase through supervision of civil and geotechnical engineering works and M&E plant installation work;
- Check and approve contractor's O&M manual and as-built drawings.

(4) Capacity Building

- The Consultants would deliver an operator training program for NPNL through O&M training program for expanded Chinaimo WTP.

5.5.3 Preliminary Cost Estimation with Demarcation of Foreign Currency and Local Currency as for Japanese ODA Loan Projects

(1) Base Cost

Base cost for the project is shown Table 5.5.2. The base cost is grouped into three packages. The explanation of how to group the packages is shown in “ 5.8.2 Contract Packages”.

Table 5.5.2 Detail Cost Breakdown (Base Cost) for the Phase 1 Project

Package1: Intake (G), WTP (G, E), Salakham (G), Transmission and Distribution (G)

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	LAK	yen	LAK	yen
Intake (G)	Ls	1	221,440,000	14,930,000,000	221,440,000	14,930,000,000	443,897,000
Raw water pipeline (G)	Ls	1	64,670,000	4,360,000,000	64,670,000	4,360,000,000	129,634,000
Chinaimo WTP (G)	Ls	1	138,150,000	37,257,000,000	138,150,000	37,257,000,000	693,279,300
Method of non-suspension water	Ls	1	300,000,000	0	300,000,000	0	300,000,000
Chemical feed system Mechanical (E)	Ls	1	250,970,000	726,000,000	250,970,000	726,000,000	261,787,400
Chemical feed system Electrical (E)	Ls	1	97,150,000	726,000,000	97,150,000	726,000,000	107,967,400
Rehabilitation	Ls	1	104,500,000	1,765,000,000	104,500,000	1,765,000,000	130,798,500
Laboratory Equipment	Ls	1	100,000,000	0	100,000,000	0	100,000,000
Salakham (G)	Ls	1	32,700,000	8,818,080,000	32,700,000	8,818,080,000	164,089,392
Transmission pipeline (G)	Ls	1	281,990,000	4,270,000,000	281,990,000	4,270,000,000	345,613,000
Distribution pipeline (G)	Ls	1	1,837,710,000	23,730,000,000	1,837,710,000	23,730,000,000	2,191,287,000
Dispute Board Expence	Ls	1	24,682,000	0	24,682,000	0	24,682,000
							0
Total					3,453,962,000	96,582,080,000	4,893,034,992

Package2: Pumps and related equipment, Monitoring System

item	unit	Quantity	Unit Price		Cost		Total
			Foreign	Local	Foreign	Local	
			yen	LAK	yen	LAK	yen
Intake pump Mechanical	Ls	1	386,664,000	484,050,000	386,664,000	484,050,000	393,876,345
Inteke pump Electrical	Ls	1	244,164,000	484,050,000	244,164,000	484,050,000	251,376,345
Transmission and distribution pump	Ls	1	385,785,000	1,210,140,000	385,785,000	1,210,140,000	403,816,086
Transmission and distribution pump Electrical	Ls	1	485,385,000	1,210,140,000	485,385,000	1,210,140,000	503,416,086
Salakham pump Mechanical	Ls	1	155,844,000	80,680,000	155,844,000	80,680,000	157,046,132
Salakham pump Electrical	Ls	1	190,194,000	80,680,000	190,194,000	80,680,000	191,396,132
Monitoring System	Ls	1	129,594,000	80,680,000	129,594,000	80,680,000	130,796,132
							0
Total					1,977,630,000	3,630,420,000	2,031,723,258

*(G): "General" including civil, pipeline and building works.
*(E): "Equipment" including mechanical and electrical works for pumps and these appurtenances.
Source: JST

(2) Preliminary Cost Estimation

The conditions for preliminary cost estimation in accordance with General Guideline for Fact Finding Mission for FY 2014 Japanese ODA Loan Project in Lao PDR. are shown in Table 5.5.3. The result of preliminary cost estimation based on the following conditions is shown in Table 5.5.4.

Table 5.5.3 Conditions for preliminary cost estimation

Items	Condition
Base Year for Cost Estimation	April 2015
Exchange Rates	USD = 120.4 Yen USD = 8,094.60 LAK LAK = 0.0149 Yen
Price Escalation	FC: 2.0% LC: 7.9%
Physical Contingency	Construction: 10% Consulting Service: 5%
Rate of Tax	VAT: 10.0% of procurement by Local Currency Import Tax: 0%
Rate of Administrative Cost	5.0% of Consulting Services and Construction Cost
Import Tax	0 %
Front End Fee	0.2 % of JICA Finance Portion
Rate of Interest During Construction	Construction: 0.7% Consultant: 0.01%
Fiscal Year	Jan.-Dec.

Source: JST

Table 5.5.4 Result of Preliminary Cost Estimation for the Phase 1 Project

Discription	Total				Percentage
	FC Million JPY	LC Million LAK	Total Million JPY	Total Million USD	
A. ELIGIBLE PORTION	7,266	179,097	9,934	82.5	92%
Ⅰ) Procurement / Construction	6,472	149,750	8,703	72.3	-
Base Cost	5,432	100,213	6,925	57.5	-
Package 1	3,454	96,582	4,893	40.6	-
Package 2	1,978	3,630	2,032	16.9	-
Price escalation	452	35,924	987	8.2	-
Physical contingency	588	13,614	791	6.6	-
Ⅱ) Consulting services	794	29,347	1,231	10.2	-
Base cost	710	21,688	1,033	8.6	-
Price escalation	45	6,261	139	1.2	-
Physical contingency	38	1,397	59	0.5	-
B. NON ELIGIBLE PORTION	0	52,593	784	6.5	7%
a Procurement / Construction	0	0	0	0.0	-
b Land Acquisition	0	0	0	0.0	-
c Administration cost	0	33,336	497	4.1	-
d VAT	0	17,910	267	2.2	-
e Import Tax	0	0	0	0.0	-
f Front End Fee	0	1,347	20	0.2	-
C. Interest during Construction	103.1	0.0	103.1	1.1	1%
i Interest during Construction(Const.)	102.8	0.0	102.8	0.9	-
ii Interest during Construction (Consul.)	0.3	0.0	0.3	0.3	-
GRAND TOTAL (A+B+C)	7,369	231,690	10,821	90.1	100%
D. JICA finance portion incl. IDC (A + C)	7,369	179,097	10,037	83.6	93%

Source: JST

5.5.4 Comparison of the estimated Project Cost with that of Other Similar Projects in order to verify the Appropriateness of the Project Cost

Comparison of the estimated project cost with that of other similar projects is carried out in order to verify the appropriateness of the project cost. List of the target for comparison is shown in Table 5.5.5.

Table 5.5.5 List of Other Similar Project for Comparison

Country	Main Location	Treatment Capacity (m^3/day)	Project Cost (Million JPY/ Million USD)	Remarks
Laos	Chinaimo WTP	40,000 (Expansion)	10,821 Million JPY (90.1 Million USD)	This project
	Kaolieo WTP[1)]	40,000 (Expansion)	2,870 Million JPY	Japan Grant Aid (2005)
	Thakhek[2)]	15,000 (New)	1,560 Million JPY	Japan Grant Aid (2013)
	Dongmakkhay[3)]	100,000 (Expansion)	78.6 Million USD	preferential loan from the Export-Import Bank of China (F/S in 2011)
Cambodia	Niroth	130,000 (New)	6,352 Million JPY	Cofinance by Japan and France ODA (2008 to 2013)
	Kampong Cham[4)]	11,500 (New)	3,360 Million JPY	Japan Grant Aid (2013)
	Battanbang[4)]	22,000 (New)		
India	Salaulim WTP[5)]	100,000 (Expansion)	14,778 Million JPY	Japan ODA Project (F/S in 2006)

1) Vientiane Water Supply Development Project (2005)
2) Thakhek Water Supply Development Project (2013)
3) Feasibility Study Report (Fsr) Dongmakkhay Water Treatment Plant, Phase Ii (2011)
4) Expansion of Water Supply Systems In Kampong Cham And Battanbang (2013)
5) Study On Augmentation of Water Supply And Sanitation for The Goa State in The Republic of India (2006)
Source: JST

However, it is inappropriate to compare only project costs due to the following reasons:

- This project is not only expansion of capacity 40,000 m^3/day, but also includes the renewal of exiting mechanical and electrical equipment corresponding to 80,000 m^3/day.
- Intake facility is constructed with capacity 160,000 m^3/day for the renewal of existing intake and adjustment final capacity (Phase 2)
- Pipe diameter and length are different by each project.

Considering the above points, the comparison of each project is carried out by unit cost that is calculated by combination of cost and capacity. The results of the comparison is shown in Table 5.5.1. Based on the content of Phase 1 project, the civil structures of the intake for this project contribute 160,000 m^3/day, and that of WTP civil structures contribute 40,000 m^3/day, and mechanical and electrical components contributes 120,000 m^3/day.

Table 5.5.6 Comparison by unit cost (USD/m^3) of intake and water treatment facility

Item	Location	1.Capacity	2.Direct Construction Cost(USD)				Unit Cost(USD/m^3) (2÷1)			
		m^3/day	Civil	Mechanical	Electrical	Sub-total	Civil	Mechanical	Electrical	Sub-total
Intake	Kampong Cham	Civil, M & E: 11,500	1,037,374	472,952	268,397	1,778,723	90	41	23	155
	Thakhek	Civil, M & E: 15,000	898,328	413,355	238,804	1,550,487	60	28	16	103
	Battanbang	Civil, M & E: 22,000	701,160	448,684	357,284	1,507,128	32	20	16	69
	Chinaimo	Civil: 160,000 M & E: 120,000	3,700,000	3,298,400	2,104,900	9,103,300	23	27	18	–
WTP	Kampong Cham	Civil, M & E: 11,500	1,657,544	1,417,577	1,026,900	4,102,021	144	123	89	357
	Thakhek	Civil, M & E: 15,000	1,578,940	1,409,042	867,285	3,855,267	105	94	58	257
	Battanbang	Civil, M & E: 22,000	2,326,465	1,718,040	1,125,649	5,170,154	106	78	51	235
	Chinaimo	Civil: 40,000 M & E: 120,000	5,780,000	5,573,000	5,118,800	16,471,800	145	46	43	–
Intake & WTP	Kampong Cham	Civil, M & E: 11,500	2,694,918	1,890,529	1,295,297	5,880,744	234	164	113	511
	Thakhek	Civil, M & E: 15,000	2,477,268	1,822,397	1,106,089	5,405,754	165	121	74	360
	Battanbang	Civil, M & E: 22,000	3,027,625	2,166,724	1,482,933	6,677,282	138	98	67	304
	Kaolieo	Civil, M & E: 40,000	3,885,002	3,296,385	1,447,657	8,629,044	97	82	36	216
	Chinaimo	Intake Civil: 160,000 WTP Civil: 40,000 M & E: 120,000	9,480,000	8,871,400	7,223,700	25,575,100	–	74	60	–

*"M & E" means Mechanical and Electrical

* Comparison by available data
Source: JST

The unit cost of the project is less than other projects. It is evaluated that cost for the project is appropriate since larger facilities generally tend~~s~~ to have lower unit cost. Unit cost for water treatment plant of the project is higher than other project. The high cost is caused by application of nozzle type underdrain for filters basin that is not applied to other WTPs.

5.5.5 Rehabilitation and Renewal Cost

Methods of thinking about renewal cost for civil structure and mechanical and electric equipment are shown in below.

Civil Structure

- The first operation of Chinaimo WTP (Phase 1 project) dates back to the year 1980 with the production capacity of 40,000 m^3/day. In 1996 new water treatment facility with additional 40,000 m^3/day capacity was constructed by Phase 2 project. Thirty five (35) years passed after the construction of the facility by Phase 1 and nineteen (19) years passed after Phase 2 project. On the other side, the oldest WTP in Vientiane is Kaolieo WTP which was constructed in 1964. Fifty one (51) years already passed after the construction of Kaolieo WTP. Kaolieo WTP is in operation without problems and renewal plan for civil structure is not considered due to its healthy condition. One of the reasons for its continued healthy condition is the water quality of the Mekong River as raw water resource. Alkalinity of the Mekong River is comparatively high. This leads to less oxidation of the concrete structures and contributes to healthy condition.

- Study team evaluated that renewal of civil structure is not necessary until 2050 because of current healthy condition of Chinaimo civil structure and the above actual record of Kaolieo WTP*.

* The renewal of Chinaimo Intake is implemented not due to aging but due to capacity shortage, since existing facility does not have the capacity of 160,000 m^3/day.

Mechanical and Electrical Equipment

- Mechanical and electrical equipment in current Chinaimo WTP are definitely well maintained. For example, intake and distribution pumps installed in 1980 (35 years passed) are still working.

- Generally it is said that renewal cycle of mechanical and electrical equipment is 15 years. However the equipment to be installed by the project will be well maintained and kept better condition as current equipment. Therefore following renewal cost is calculated considering above polite maintenance work.

    - ➢ Mechanical and electrical construction cost excluding the pipe around pumps, crane and hoist shall be expected as renewal cost until 2050. The necessary cost is 1,584 Million JPY.

    - ➢ Half of the necessary cost (832.2 Million JPY) is expected after 15 years of completion of construction. The remaining half (832.2 Million JPY) is expected after 20 years of the completion.

Pipeline

- Pipe renewal is not required until 2050 since the average life expectancy of pipeline is approximately 50 years or more*. Pipeline requires maintenance work for mainly water leakage. The cost for the maintenance is anticipated as 5 percent of construction cost, and it is distributed to every year from 10 years later of project completion.

*The renewal of pipeline is implemented not due to ageing but due to capacity shortage.

- Necessary maintenance cost up to 2050 is as follows.

  2,467 Million JPY X 5 % = 124 Million JPY

  Maintenance cost of each year: 124 Million JPY /20 years(2031-2050) = 6.2 Million JPY /year

The renewal cost up to the year 2050 for the facilities to be constructed by the Phase 1 project calculated on the above method is shown in Table 5.5.7.

Table 5.5.7 Renewal Cost up to 2050 for the Facilities to be Constructed by the Phase 1 Project

Year	Total Cost for Rehabilitation and Renewal (Million JPY)	Total Cost for Rehabilitation and Renewal* (Million LAK)	Chinaimo Capacity
2015	-	-	80,000m^3/day
2016	-	-	-
2017	-	-	-
2018	-	-	-
2019	-	-	-
2020	-	-	120,000m^3/day
2021	-	-	-
2022	-	-	-
2023	-	-	-
2024	-	-	-
2025	-	-	-
2026	-	-	160,000m^3/day
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
2031	6.2	416	-
2032	6.2	416	-
2033	6.2	416	-
2034	6.2	416	-
2035	832.2	55,852	-
2036	6.2	416	-
2037	6.2	416	-
2038	6.2	416	-
2039	6.2	416	-
2040	832.2	55,852	-
2041	6.2	416	-
2042	6.2	416	-
2043	6.2	416	-
2044	6.2	416	-
2045	6.2	416	-
2046	6.2	416	-
2047	6.2	416	-
2048	6.2	416	-
2049	6.2	416	-
2050	6.2	416	-
Total	1,776.0	119,192	

*1LAK=0.0149JPY

Source: JST

5.5.6 Project Implementation Schedule

The project implementation schedule for the Phase 1 project is shown in Table 5.5.8. The schedule is based on the following time frames for completion.

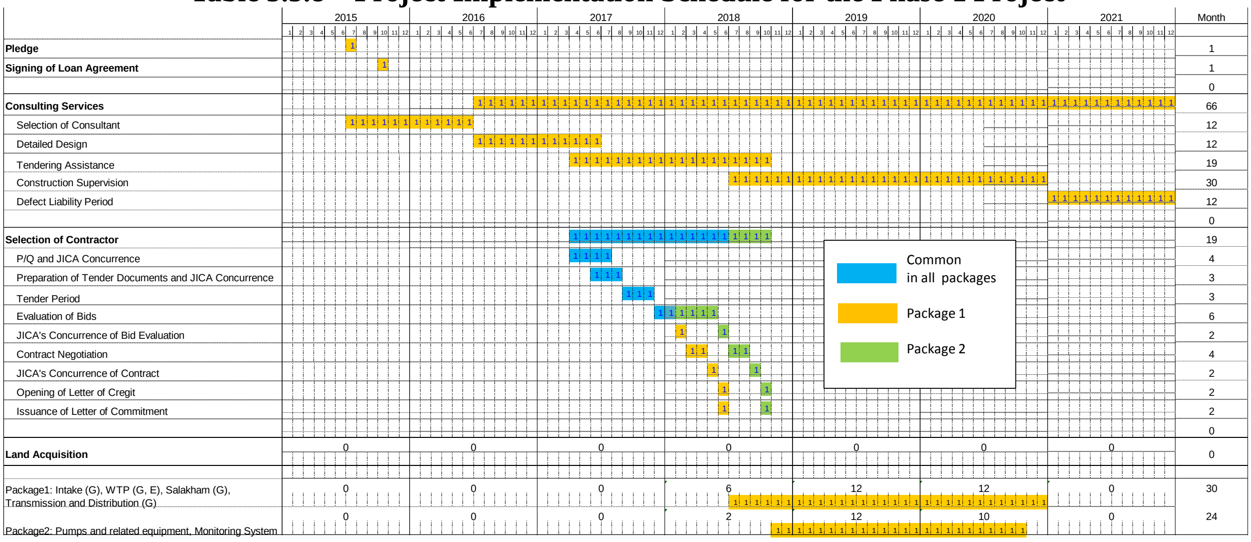
(1) Selection of consultants : 12 Months

(2) Detailed Design : 12 Months

(3) Tender Assistance for International Competitive Bidding (ICB) : 15 Months

- Preparation of Tender Documents and JICA Concurrence : 3 Months
- Tender Period : 3 Months
- Evaluation of Bids : 4 Months
- JICA Concurrence of Bid Evaluation : 1 Months
- Contract Negotiation : 2 Months
- JICA Concurrence of Contract : 1 Months
- Opening of Letter of Credit and Issuance of Letter of Commitment : 1 Months

Table 5.5.8 Project Implementation Schedule for the Phase 1 Project



Source: JST

5.5.7 Construction method

(1) General

The construction in Chinaimo intake, Chinaimo WTP and Salakham Distribution Center need~~s~~ to be carried out while continuing to operate exiting facilities to avoid disruptions to water supply. Therefore, elaborate understanding of operation methods of existing facilities, and locations of existing facilities such as pipelines and wiring by field surveys, including test pit survey, is required.

Flexible pipe made by ductile iron and steel is applied to connecting part of structure.

(2) Intake facility

Sheet pile will be applied to the construction of the structure, since the site has existing intake facility and the construction is in narrow area. The earthworks are carried out by machine such as backhoes and clamshells. Lead-pipe jacking method is applied to the construction of intake pipe. Sheet pipe for the construction of receiving well is used as departure shaft for the pipe jacking. Arrival shaft for the pipe jacking is constructed in the Mekong River by temporary construction. The temporary construction is constructed by sheet pile which stops the river water into the arrival shaft. Bank protection work is required after the construction of intake pipe. The bank protection work is carried out to guard against corrosion and collapse by bank sliding.

(3) Water treatment facility

The water treatment facility constructed by expansion in Phase 1 will be located very close to the land boundary between Chinaimo WTP and Military School. Therefore, the construction requires borrowing the Military land during the construction works. It is necessary to borrow approximately 5 or 10 meters from the current boundary for the construction works. Removal of an existing fence before construction, and restoration after construction are required. The construction needs to be carried out so as to not affect the existing buildings on Military land near the boundary fence.

Non-suspension water method will be applied to change the existing pipe route for the construction of new connecting pipe to expanded facility, since the existing WTP will be in operation during the construction.

(4) Transmission and Distribution pipeline

Ductile iron pipe will be applied to all of the transmission lines and distribution pipelines based on the NPNL guideline (NPNL guideline accepts the use of DIP and uPVC for pipelines under 250 mm in diameter. This project uses DIP for all pipelines under 250 mm diameters, since the pipelines which will be installed in this project have important functions for water supply in the target area).

Open cut method will be applied to the entire pipeline route. Retaining walls will be applied for the safety of workers with the depth over 2 meters considering the past actual situation. Excavation without retaining walls will be applied to the depth under 2 meters.

5.5.8 Procurement Plan and Method

The following materials and construction methods need to be imported for the project. Other materials such as cement, stone, brick, sand, timber, plywood, concrete block, fence, gabion mesh, wire nail, gasoline, diesel, lubricant, scaffolding and various small items are available in Lao PDR.

(1) Imported Materials

- Mechanical equipment (various pumps, motor, flow meter, various valves and flexible joint .etc)
- Electrical equipment
- Pipe materials (Ductile Iron Pipe)
- Steel (for temporary works)

(2) Imported Construction Method

- Pipe jacking method (for construction of intake pipe)
- Method of non-suspension water (for the expansion of WTP during operating existing WTP)

Chapter 6 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

6.1 Conditions in the Project Area

In order to understand the social environment in the proposed project sites for water intake, water treatment plant, transmission pipeline, elevated tank and distribution pipeline, information relevant to the social environment of 4 districts, Sisatthanak District, Hadxaifong District, Xaysetha District and Chanthabouly District, in which these facilities are planned to construct, are specifically collected.

(1) Ethnicity in the Project Area

Ethnic groups and their ratios are shown in Table 6.1.1. Due to unavailability of Capital Vientiane's data, ethnicity in national level is presented. In compare with the ethnic group distribution in national level, the ratio of the Lao ethnic group is very high in all surveyed districts. Thus, special consideration for minor ethnic groups is not necessary. However, attention should be paid when ethnic minority groups are found among the project's affected households.

Table 6.1.1 Ethnic Groups in 2013

No.	District	Ethnic Group (%)				
		Lao	Mong	Keummeu	Tai Noua	Others
1	Nation*	54.6	8.0	10.9	3.3	23.2
2	Sisatthanak	99.48	0.35	0.17	-	-
3	Hadxaifong	99.02	0.35	0.22	0.01	0.4
4	Xaysetha*	N/A	N/A	N/A	N/A	N/A
5	Chanthabouly	93.31	0.6	0.32	4.74	1.03

*There is no statistic data available, however, according to the Statistic Division in Xaysetha, most of the ethnic group is Lao.
Source: Lao statistic Bureau, Ministry of Planning and Investment, Statistic Division in each District Office

(2) Vulnerable People

Vulnerable households in the surveyed districts from 2009 to 2013 are shown in Table 6.1.2. Except for the three (3) households recognized as vulnerable in Xaysetha District, there were no vulnerable households recorded in the surveyed district in 2013.

Table 6.1.2 Vulnerable People in 2013

No.	District	Vulnerable Household				
		2009	2010	2011	2012	2013
1	Vientiane Capital	N/A	N/A	N/A	N/A	N/A
2	Sisatthanak	0	0	0	0	0
3	Hadxaifong	0	0	0	0	0
4	Xaysetha	-	-	-	-	3
5	Chanthabouly	39	0	0	0	0

Source: Statistic Division in each District Office

Definition of Vulnerable:

The definition of vulnerable is stipulated in Article 3, Decrees on Vulnerable and Standard for Development during 2012 and 2015, No. 309/PM Nov. 2013 as follows;

- the indicator to measure vulnerable is average income per month per person without differentiate of age or sex, less than 1) 192,000 LAK/person/month or 24USD[13]/person/month at national average,

[13] 1USD = 8,000LAK

2) 180,000 LAK/person/month or 22.5 USD/person/month at rural area and 3) 240,000 LAK/person/month or 30 USD/person/month at urban area.

(3) Social Infrastructure

Number of hospitals, schools and electrification rates are shown in Table 6.1.3. Drinking water source and water supply rates are shown in Table 6.1.4. Electrification rate is 100 % in all surveyed area. The coverage of piped water supply by NPNL in Vientiane Capital is 72% . It ranges from 100 % in Sisatthanak District to 70 % in Hadxaifong District.

Table 6.1.3 Number of Hospitals, Schools and Electrification Rate in 2013

No.	District	Hospital (Number)	Clinic (Number)	School (Number)				Electrification* (%)
				Nursery	Primary	Secondary	University	
1	Vientiane Capital	50	349	243	387	96	2	100%
2	Sisatthanak	6	104	42	41	19	1	100%
3	Hadxaifong	7	36	37	55	17	0	100%
4	Xaysetha	2	130	48	70	12	2	100%
5	Chanthabouly	1	109	32	39	19	0	100%

*Grid connection rate

Source: Statistic Division in each District Office

Table 6.1.4 Drinking Water Source and Water Supply Rate in 2013

No.	District	Drinking Water Source		Water Supply Rate	
		Bottled Water from Factory (%)	Ground water (%)	Water Supply* (%)	River/ground water (%)
1	Vientiane Capital	N/A	N/A	72%	28%
2	Sisatthanak	100%	0%	100%	0%
3	Hadxaifong	100%	0%	70%	30%
4	Xaysetha	95%	5%	84%	16%
5	Chanthabouly	100%	0%	95%	5%

*Water supply by Vientiane Capital Water Supply Enterprise

Source: NPNL Statistic Division in each District Office

6.2 Project Components with Potential Impact on Environment

Among all of the project components, significant negative impacts directly affecting the natural environment are not predicted throughout the construction and operation phases. Minor negative impacts are however, predicted on the natural environment due to activities in the construction phase (see detailed in 6.6.2 Result of the IEE). Accordingly, project components with potential impacts on the environment in this section are rather focused on the social environment.

Expansion of Chinaimo WTP

Proposed facilities for new water treatment plants and related facilities will be located within the premises of the existing Chinaimo WTP. Accordingly, no land acquisition will be necessary.

Expansion and Development of Water Intake Facilities and Raw Water Transmission Pipeline

There will be no land acquisition for expanding the intake since new facilities will be constructed in the exiting intake premises.

Raw water transmission pipeline is to be connected from the new intake to the new water treatment plants will be laid under existing public roads located between the two premises. Accordingly, there will be no land acquisition.

During construction, about 4 m width of a public road will be excavated for installing the raw water transmission pipeline.

Expansion and Development of Water Supply Facilities

Water supply facilities will be comprised of (a) treated water transmission pipeline connecting water treatment plant and elevated tank and (b) elevated tank with underground reservoir.

The proposed treated water transmission pipeline will be connected from the Chinaimo WTP to the proposed water elevated tank constructed in the premises of existing Salakham water elevated tank.

Treated water transmission pipeline connecting new water treatment plant and elevated tank will be installed under public roads. Accordingly, there will be no land acquisition.

During construction, about 3m width of a public road will be excavated for installing transmission pipeline. There will be no land acquisition for constructing elevated tank because new elevated tank will be constructed in the premises of existing elevated tank.

Expansion and Development of Distribution Pipeline

Distribution pipeline will be installed under public roads. Accordingly, there will be no land acquisition. During construction, about 4m to 1m width of a public road will be excavated for installing distribution pipeline.

6.3 Legal and Institutional Framework in the Lao PDR

6.3.1 Legislations on Environmental and Social Considerations

(1) Summary of Legal Framework on Environmental and Social Considerations

Table 6.3.1 shows the list of laws and regulations related to the environmental assessment.

Table 6.3.1 Legal Framework on Environmental and Social Considerations

No	Law	Enacted No. and Year	Key Contents
1	Constitution	No.25/NA May 2003	States the responsibility of all organizations and citizens to protect the natural environment and natural resources of the state
2	Environmental Protection Law	No. 29/NA December 2012	Specifies principles, rules and measures to manage, monitor, restore and protect the environment, natural resources and biodiversity Ensures sustainable socio-economic development
3	Ministerial Instruction on the Process of Environmental and Social Impact Assessment of the Investment Projects and Activities	No.8030/MONRE December 2013	Establishes uniform environmental and social impact assessment requirements and procedures for all investment projects categorized as Grope 2 in Ministerial Agreement No.8056/MONRE
4	Ministerial Instruction on the Process of Initial Environmental Examination of the Investment	No.8029/MONRE December 2013	Establishes uniform initial environmental examination requirements and procedures for all investment project categorized as Grope 1 in

No	Law	Enacted No. and Year	Key Contents
	Projects and Activities		Ministerial Agreement No.8056/MONRE
5	Ministerial Agreement on the Environment and Promulgation of List of Investment Projects and Activities Requiring for Conducting Environmental and Social Impact Assessment	No.8056/MONRE December 2013	Categorizes investment projects and activities into two groups as: (1) group1 shall prepare Initial Environmental Examination (IEE) and (2) group 2 shall prepare environmental and social impact assessment (ESIA) and classified the investment projects and activities into 5 sectors as: (1) Energy Sector,(2) Agriculture and Forestry Sector, (3) Industrial Processing Sector,(4) Infrastructure and Service Sector, and (5) Mining Sector.
6	Environment Impact Assessment Guidelines	MONRE November 2011	Gives instructions for preparing an EIA report pursuant to the Decree on Environmental Impact Assessment
7	Agreement on National Environmental Standards	No.2734/WREA December 2009	Establishes national environmental standards as a basis for environmental monitoring and pollution control on water, air, soil and noise
8	Water and Water Resources Law	No.02-96/ NA October 1996	Regulates the management, exploitation, development, protection and sustainable use of water and water resources
9	Law on Aquatic Animals and Wild Life	No.07/NA December 2007	Provides principles and measures to protect and manage wildlife and aquatic animals
10	Agreement on Drinking Water and Household Water Quality Standard	No.1371/MPH Oct 2005	Defines rules, standards and measures relating to organizations and operational management activities, surveillance, monitoring and control of quality of drinking water and water used in households and service areas in order to manage and promote consumer health through clean and safe water for drinking and water uses.
11	Decree on the Compensation and Resettlement of the Development Project	No.192/PM July 2005	Defines principles, rules, and measures on compensation and resettlement on the development project
12	Regulation for Implementing Decree No.192/PM on Compensation and Resettlement of People Affected by Development Projects	No.2432/STEA November 2005	Defines principles, rules and measures on compensation and resettlement of the development project
13	Technical Guidelines on Compensation and Resettlement in Development Projects	Prime Minister’s Office STEA February 2011	Gives instructions for implementing social impact assessment of development project focusing on the principles and procedures on compensation and resettlement
14	Land Law	No.04/NA Oct 2003	Provides rules on management, protection and use of land
15	Degree on the Implementation of the Land Law	No.88/PM June 2008	Gives instructions for implementing the Land Law relating to the management, protection, use and development of land as well as ensuring the compliance with the set-targets and the uniformity of practice throughout the country
16	Public Road Law	No.04/99 NA April 1999	Defines principles, regulations and measures relating to management, use, planning, survey, design, construction and maintenance of public road. Article 20 stipulate total area of roads as road surface, road shoulder, footpaths, drainage channels, road slope and delimitation area for

No	Law	Enacted No. and Year	Key Contents
			public road.
17	Law on National Heritage	No.08/NA November 2005	Determines the principles, regulations and measures for the administration, use, protection, conservation, restoration, rehabilitation of the national culture, history and natural heritage

Source: JST

(2) The Water Rights

There are no specific stipulations addressed on taking water from the Mekong River in the legislations of the Lao PDR for water supply project. Thus, it is not necessary to apply for taking water from the Mekong River. [14]

(3) Environmental Assessment Procedures for the Project

A project developer must conduct initial environmental examination (IEE) or environmental impact assessment (EIA) and obtain an environmental compliance certificate (ECC) before the commencement of construction works depending on the classification of the project in the Ministerial Agreement on the Endorsement and Promulgation of List of Investment Projects and Activities Requiring for Conducting the Initial Environment Examination or Environmental and Social Impact Assessment (No.8056/MONRE 2013). In the ministerial agreement, a project classified into a Group 1 is required to submit an IEE and a project classified into a Group 2 is required to submit an EIA. As for this project, it is categorized as "3.35 water supply processing factory"[15] in the Ministerial Agreement No.8056, and it is stipulated that all water supply processing factory projects are required to conduct an IEE.

The procedure of IEE is stipulated in the Ministerial Instruction on the Process of Initial Environmental Examination of the Investment Projects and Activities (No.8029/MONRE). It is stated that at least 50 business days, which comprised of 10 business days of administrative review and 40 business days of content review, is necessary to go through the review process and obtain an ECC. In case of this project, the project developer shall submit the IEE report to Department of Natural Resources and Environment (DONRE) in Vientiane Capital Government for obtaining the ECC.[16]

After submitting the IEE report to DONRE, it was reviewed with two stakeholder meetings (village/district level and district /Vientiane Capital level). Then, the ECC was issued on 17 February, 2015 by DONRE. The ECC is attached in DATA BOOK B.6, Environmental Compliance Certificate.

(4) Environmental and Social Considerations by JICA

As for the Yen-loan financed project, the project is required to comply with the JICA guidelines for environmental and social considerations (hereinafter referred as "the Guidelines").

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[14] As per water intake permit, it is necessary to confirm if it is stipulated in the upcoming revised water and water resource law.

[15] It was confirmed at Department of Environmental and Social Impact Assessment in MONRE that water supply project is categorized as water processing factory in the Ministerial Agreement No.8056 (as of September 2014).

[16] Article 2.4 Review of the Initial Environmental Examination Report, Ministerial Instruction on the Process of Initial Environmental Examination of the Investment Projects and Activities (No.8029/MONRE)

Based on the Guidelines, the project was classified as a Category B project. It is stipulated that "generally the proposed projects are site-specific, few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily"[17]. As for the Category B project, environmental and social considerations studies require~~s~~ the IEE level including mitigation measures to avoid, minimize or compensate for adverse impact, a monitoring plan and institutional arrangement. It also requires analysis of alternatives covering "without project" situations. Consultations with local stakeholders on the result of the environmental and social considerations shall be conducted for all Category A projects and for Category B projects as needed.

(5) Policy Gap Between the Government of the Lao PDR and JICA

Based on the legislation in the Lao PDR, an IEE must be conducted for the project. Based on the Guidelines, the project is classified as a Category B project, which requires IEE. The items to be examined for the IEE in the legislation of the Lao PDR are more detailed and rather close to EIA requirements in the Guidelines. Accordingly, the requirements stipulated in the Guidelines are all satisfied with the legislations of the Lao PDR. Thus, there is no policy gap between the Government of the Lao PDR and JICA.

6.3.2 Institutional Framework

The following are the institutions relevant to environmental and social considerations for the project.

(1) Environmental Impact Assessment Office at Department of Natural Resources and Environment (DONRE) in Vientiane Capital

The Environmental Impact Assessment Office at DONRE in Vientiane Capital is responsible for reviewing and approving IEE reports of development projects which are located under its jurisdiction. After approving the report, it issues an ECC to project developers and supervises monitoring activities implemented by the project developers according to the environmental management plan in the IEE report. In case of the project, the project developer shall obtain the ECC from the DONRE.

(2) Water Supply and Environmental Unit, Housing/Urban Planning and Environment Division, Department of Public Works and Transportation in Vientiane Capital Government (DPWT)

The Water Supply and Environmental Unit are established in Housing/Urban Planning and Environment Division in DPWT. The tasks of the unit is stipulated in the agreement on Function of Housing-Town planning and Environmental division, No. 4042/DPWT. VC, Sep 2011. It manages, improves and develops the housing-Town planning, the construction material procedure, water supply, and environmental management in the area under its jurisdiction.

(3) Chinaimo Water Treatment Plant Laboratory, Chinaimo Water Treatment Plant, Vientiane Capital Water Supply State Enterprise

The Chinaimo Water Treatment Plant Laboratory is located in the Chinaimo WTP. It is responsible to measure the water quality at intake, water treatment plant and distribution area of the Chinaimo WTP. Two staff at the Chinaimo Water Treatment Plant Laboratory are assigned for daily water quality measurement at four sites in intake and water treatment plant. In addition, the staff also measure 34 sites in the Chinaimo WTP's distribution area weekly. Since it is the only laboratory specialized for drinking water in the Vientiane Capital, it also measures water quality upon other water treatment plants' request.

[17] 2.2 Categorization, JICA Guidelines for Environmental and Social Considerations, 2010

6.4 Alternatives

Intake Location

The result is summarized in Table 6.4.1. After the examination, alternative 2, in which the intake to be constructed is on the premises of the existing Chinaimo Intake, was selected as the most feasible option. In case of 40,000m2/day expansion only, the case "without project" is also feasible.

Table 6.4.1 Alternatives on Intake Location

Parameter	Without project (use existing intake with expanding water intake capacity)		Alternative 1 (same type of intake to be constructed using land adjacent to the existing intake)	Alternative 2 (construct in the premises of the existing intake
	Expansion of 40,000m3/day only	Expansion of 80,000m3/day		
Land Availability	◎	△	△	◎
Structure of Intake	◎	△	△	◎
	Result			
Feasibility	◎ Existing intake is able to be used with expanding water intake capacity.	△ The existing intake is not enough space and need to construct new facility in acquiring land outside of the existing intake premises.	△ Same type of intake requires extra land outside of the existing intake premises. There is no vacant land on either side of the existing intake.	◎ By adapting different design requiring smaller space, the intake is to be constructed in the premises of the existing intake. Accordingly, no land acquisition will be needed.

Source: JST

Water Treatment Plant Location

The result is summarized in Table 6.4.2. After the examination, alternative 2, in which the water treatment plant to be constructed is on the premises of the existing Chinaimo WTP, was selected as the most feasible option.

Table 6.4.2 Alternatives on Water Treatment Plant

Parameter	Without project (use existing water treatment plant)	Alternative 1 (same type of water treatment plant to be constructed using land adjacent to the existing water treatment plant)	Alternative 2 (construct in the premises of the existing water treatment plant)
Land Availability	◎	△	◎
Structure of Water Treatment Plant	△	◎	◎
Result			
Feasibility	△ Existing water treatment plant capacity is already overloaded and it is not designed to treat more than the designated capacity.	△ Same type of water treatment plant requires extra land outside of the existing water treatment plant premises. There is no vacant land on either side of the existing water treatment plant.	◎ By re-arranging layout of facilities in the existing water treatment plant, extra space can be made. No land acquisition will be needed.

Source: JST

Water Elevated Tank Location

The result is summarized in Table 6.4.3. After the examination, alternative 3, in which the water elevated tank to be constructed is on the premises of the existing Salakham Water Elevated Tank, was selected as the most feasible option.

Table 6.4.3 Alternatives on Water Elevated Tank Location

Parameter	Alternative 1 (rebuilt Phone Kheng Water Elevated Tank and rebuilt new tank with larger capacity)	Alternative 2 (construct new water elevated tank)	Alternative 3 (construct in the premises of the existing water elevated tank in Salakham and expand the reservoir capacity in the Chinaimo WTP)
Land Availability	△	△	◎
Structure of Elevated Tank	△	◎	○
Running Cost	△	◎	○
Result			
Feasibility	△ Due to minimal land availability in the existing premises of the Phone Kheng Water Elevated Tank, the size of new elevated tank would be limited and insufficient to reserve enough water for distribution.	△ Capacity of the tank is large enough to reserve necessary water and running cost is to be cheapest among alternatives. However, land is not available without acquiring land used by individuals.	○ Construction of a new water elevated tank and reservoir in the premises of the existing Salakham water elevated tank and expansion of the reservoir capacity in the premises of Chinaimo WTP do not require land acquisition.

Source: JST

6.5 Scoping

The project was reviewed in the light of environmental and social considerations. The scoping result is summarized in Table 6.5.1 below. Based on the scoping result, it is concluded that no significant negative impacts are predicted. The main negative impacts includes temporary pollution due to construction activities in the construction phase. As for positive impacts, the creation of local employment will contribute to the local economy during construction phase. The outcome of the project, increase in the water supply coverage, will be marked as the most positive impact on items such as the "local economy, employment and livelihood" and the "existing social infrastructures and services" in an operation phase.

Table 6.5.1 Scoping

No.	Impacts	Rating		Brief Description
		Pre-Construction/ Construction	Operation	
1. Anti Pollution				
1.1	Air Pollution	C	-	**Construction**: Limited air pollution is expected due to heavy machinery and construction activities **Operation**: No air pollution is anticipated.
1.2	Water Pollution	C	-	**Construction**: Temporary water pollution due to concrete mixing and excavation is expected. In addition, temporally water pollution from contractor's employee camp/office is expected. **Operation**: No water pollution is anticipated.
1.3	Waste	B	C	**Construction**: Due to constructing new water treatment facilities, waste soil will be generated.

No.	Impacts	Rating		Brief Description
		Pre-Construction/ Construction	Operation	
				Operation: Sludge will be generated in the process of treating water at water treatment plant.
1.4	Soil Contamination	-	-	**Construction/Operation**: No soil contamination is anticipated.
1.5	Noise and Vibration	C	-	**Construction**: Noise and vibration resulting from construction activities is anticipated. **Operation**: No noise and vibration pollution is anticipated.
1.6	Ground Subsidence	-	-	**Construction/Operation**: No activity that will cause ground subsidence is anticipated.
1.7	Offensive Odor	-	C	**Construction:** No activity that will cause offensive odor is anticipated. **Operation:** Offensive odor would be generated due to mishandling of chloride at water treatment plant.
1.8	Bottom Sediment	-	-	**Construction/Operation**: No activity that will effect bottom sediment is anticipated.
2. Natural Environment				
2.1	Protected Area	-	-	Protected area is not included in the project area.
2.2	Flora, Fauna and Biodiversity	-	-	Effect on flora, fauna, or biodiversity is not anticipated since project is implemented either in the existing sites (intake and water treatment plant) or urban area of Vientiane Capital.
2.3	Hydrological Situation	-	-	**Construction/Operation**: No activity that will affect negative impact on hydrological situation is anticipated.
2.4	Topography and Geographical Features	-	-	**Construction/Operation**: No activity that will affect negative impact on topography and geographical features is anticipated.
3. Social Environment				
3.1	Involuntary Resettlement	U	-	**Construction:** No resettlement is anticipated. However, temporary disturbance to neighborhoods near construction sites would be anticipated. Extent of impacts need to be surveyed. **Operation:** No activity that will cause involuntary resettlement is anticipated.
3.2	Vulnerable (poor households, female- headed households etc)	-	-	No direct impact on vulnerable residing near construction site is anticipated.
3.3	Indigenous and Ethnic Minority	-	-	No direct impact on ethnic minority residing near construction site is anticipated.
3.4	Local Economy, Employment, Livelihood	C+	A+	**Construction**: Positive impact such as creation of local employment is expected. **Operation**: Increase water supply coverage will contribute the well-being of residents in Vientiane Capital.
3.5	Land Use and Utilization of Local Resources	-	-	No significant impact on land use or change of local resources is anticipated since project is implanted either in the existing facilities (intake and water treatment plant) or under public road.
3.6	Water Usage or Water Rights of Common	U	-	Extent of impact on water usage near intake needs to be surveyed.
3.7	Existing Social Infrastructures and Services	C	A+	**Construction**: Due to construction activities, traffic circulation would be disturbed temporally. **Operation**: Water supply coverage will be increased after

No.	Impacts	Rating		Brief Description
		Pre-Construction/ Construction	Operation	
				expansion of water supply capacity.
3.8	Social Institutions and Local Decision-Making	-	-	The project is purposed to increase water supply coverage in expanding existing facilities and extending water supply pipelines under public road. Accordingly, negative impact on social institutions is not anticipated.
3.9	Misdistribution of Benefit and Damage	-	-	The project is purposed to increase water supply coverage in expanding existing facilities and extending water supply pipelines under public road. Accordingly, negative impact on misdistribution of benefit and damage is not anticipated.
3.10	Local Conflict of Interest	-	-	The project is purposed to increase water supply coverage in expanding existing facilities and extending water supply pipelines under public road. Accordingly, negative impact on local conflict of interest is not anticipated.
3.11	Cultural Heritage	-	-	No cultural heritage is located in the project area.
3.12	Landscape	-	-	The project is purposed to increase water supply coverage in expanding existing facilities and extending water supply pipelines under public road. Accordingly, negative impact on landscape is not anticipated.
3.13	Gender	-	-	The project is purposed to increase water supply coverage in expanding existing facilities and extending water supply pipelines under public road. Accordingly, negative impact on gender is not anticipated.
3.14	Children's Rights	-	-	The project is purposed to increase water supply coverage in expanding existing facilities and extending water supply pipelines under public road. Accordingly, negative impact on children's rights is not anticipated.
3.15	Communicable Diseases such as HIV/AIDS	C	-	**Construction**: Inflow of construction workers from construction worker's camp to local communities will raise risks on communicable diseases. **Operation**: No activities raising the risk of communicable diseases are anticipated.
3.16	Working Environment (includes work safety)	C	-	**Construction**: Inappropriate management of working environment will raise the risk of accident and disease. **Operation**: No activities raising the risk of working environment are anticipated.
4. Others				
4.1	Accidents	C	-	**Construction**: The construction activities on public road would increase the risk of accidents to the local community. **Operation**: No activities raising the risk of accidents are anticipated.
4.2	Global Warming	-	-	**Construction/Operation:** No activity that will give negative impact on global warming is anticipated.

Rating
A: Serious impact is expected, B: Some impact is expected, C: Small impact is expected, +Positive impact is expected, U: Extent of impact is unknown and examination is needed, Impact may become clear as study progresses, -: No impact is expected
Source: JST

6.6 IEE

6.6.1 TOR of the IEE

Table 6.6.1 shows a Terms of Reference (TOR) on the IEE which was prepared based on the scoping result. With the TOR, the IEE for this project will be conducted.

Table 6.6.1 TOR for IEE

No.	Impacts	Items for Study	Methodology
1. Pollution Control			
1.1	Air Pollution	1.Collect information on present air quality 2.Confirm present condition in the project area 3.Evaluate impacts of the construction phase	1.Collect existing information 2.Hold hearings with relevant authorities, collect information on similar projects 3.Confirm content, method, period, location, area on construction works and access road for construction vehicles
1.2	Water Pollution	1.Collect information on present water management 2.Confirm present condition in the project area 3. Evaluate impacts of the construction phase	1.Collect existing information 2. Hold hearings with relevant authorities, collect information on similar projects 3.Confirm content, method, period, location, area on construction works and access road for construction vehicles
1.3	Waste	1.Collect information on present water management 2.Confirm present condition in the project area 3. Evaluate impacts of the construction phase 4. Evaluate impacts of the operation phase	1.Collect existing information 2. Hold hearings with relevant authorities, collect information on similar projects 3.Confirm content, method, period, location, area on construction works and location of construction worker's camp/office 4.Confirm management system on existing facilities in the Chinaimo WTP
1.5	Noise and Vibration	1.Confirm ambient noise standard in the Lao PDR 2.Confirm present condition in the project area 3. Evaluate impacts of the construction phase	1.Collect existing information 2. Hold hearings with relevant authorities, collect information on similar projects 3.Confirm content, method, period, location, area on construction works and location of construction worker's camp/office
1.7	Offensive Odor	1. Evaluate impacts of the operation phase	1.Confirm management system on existing facilities in the Chinaimo WTP
3. Social Environment			
3.1	Involuntary Resettlement	1.Confirm present condition in the project area 2. Access impacts during the construction phase	1. Hold hearings with relevant authorities, conduct route survey 2.Confirm content, method, period, location area on construction works and access road for construction vehicles
3.6	Water Usage or Water rights of Common	1.Confirm present condition in the existing intake area	1. Hold hearings with relevant authorities and local communities on river usage around the existing intake area
3.7	Existing Social Infrastructures and Services	1. Evaluate impacts of the construction phase	1.Confirm content, method, period, location, area on construction works
3.15	Communicable Diseases such as HIV/AIDS	1. Evaluate impacts of the construction phase	1.Confirm content, method, period, location, area on construction works
3.16	Working Environment (includes work safety)	1.Confirm legislations on working environment in the Lao PDR	1.Confirm information on similar projects
4. Others			
4.1	Accidents	1. Evaluate impacts of the construction phase	1.Confirm content, method, period, location, area on construction works

No.	Impacts	Items for Study	Methodology
	Stakeholder Meeting	Conduct stakeholder meeting based on the guidelines of JICA and Ministerial Instruction No.8029/MONRE December 2013	Meeting type: Individual basis during IEE, group meeting after drafting IEE report Target：Relevant authorities such as DONRE and DPWT in Vientiane Capital, NPNL, DONRE and DPWT in Districts, village heads

Source: JST

6.6.2 Result of the IEE

The IEE was conducted by examining available data, hearing from stakeholders, and carrying out site reconnaissance. According to the result of the IEE, predicted impacts from the Project were mostly the same as the scoping. Consequently, it was concluded that no significant negative impact was predicted and the predicted minor impacts could be avoided or minimized by applying countermeasures. The main negative impacts included temporary and site specific pollution such as air pollution, water pollution, waste generation, and noise and vibration due to construction activities in the construction phase. The following is the summary of the result. The comparative table on the scoping result and the IEE result is shown in Table 6.6.2. Based on the result, materials for appraisal were prepared as attached in A.14 Screening Form, and A.15 Environmental Check List, respectively.

Table 6.6.2 Result of Scoping and IEE

No.	Impacts	Rating at Scoping		Rating Based on the Result of IEE		Brief Description
		Pre-Construction/Con-struction	Operation	Pre-Construction/Constructio n	Opera-tion	
1. Anti Pollution						
1.1	Air Pollution	C	-	C	-	**Construction**: Limited air pollution is expected due to heavy machinery and construction activities. Considering the scale of construction, however, the negative impact from the construction works will be limited. **Operation**: No air pollution is anticipated.
1.2	Water Pollution	C	-	C	-	**Construction**: Temporary water pollution due to concrete mixing, aggregate collection and excavation is anticipated. In addition, temporally water pollution from construction contractor's worker's offices/camps is expected. Considering the scale of construction, however, the negative impact from the construction works will be limited. **Operation**: No water pollution is anticipated.
1.3	Waste	B	C	C	-	**Construction**: About $80m^3$-$160m^3$ of waste soil, which would be disposed of 9m x 9m with 2m height will be generated from the construction site of intake and

No.	Impacts	Rating at Scoping		Rating Based on the Result of IEE		Brief Description
		Pre-Construction/Con-struction	Operation	Pre-Construction/Construction	Opera-tion	
						water treatment plant. Domestic waste such as vegetable debris and human waste will be generated from construction constructor's office/camp. Negative impacts will be avoided or minimized with appropriate management. As for waste soil, it will be stock piled within the Chinaimo Water Treatment Premises for future use. Thus, no waste soil will be generated and transported ~~to~~ outside of the Chinaimo Water Treatment Premises. A contract will be made with municipal waste collection agency for processing domestic waste. Septic tanks will be installed to process human waste. **Operation**: About 310t/day (40,000m3/day expansion) – 620t/day (80,000m3/day expansion) of sludge will be generated in the process of treating water at water treatment plant. Similar to the sludge generated from the existing Chinaimo Water Treatment Plant, it will be diluted with water to 4%-5% and generated to the Mekong River through drainage. Construction of facilities to dry up and dispose of sludge is recommended in the near future.
1.4	Soil Contamination	-	-	-	-	**Construction/Operation**: No soil contamination is predicted.
1.5	Noise and Vibration	C	-	C	-	**Construction**: Noise and vibration resulting from construction activities are anticipated. Impacts will be minimized by installing walls to insulate the noise at sites adjacent to houses located next to intake construction site and school located behind water treatment plant. Working hours of construction shall be limited to daytime only (from 8:00-19:00). **Operation**: No noise and vibration pollution is anticipated.
1.6	Ground Subsidence	-	-	-	-	**Construction/Operation**: No activity that will cause ground subsidence is anticipated.
1.7	Offensive Odor	-	C	-	C	**Construction:** No activity that will cause offensive odor is anticipated. **Operation:** Offensive odor could be generated due to mishandling of liquid gas chlorine. The impact will be avoided by providing proper instruction on dealing with liquid gas chlorine.

No.	Impacts	Rating at Scoping		Rating Based on the Result of IEE		Brief Description
		Pre-Construction/Con-struction	Operation	Pre-Construction/Construction	Opera-tion	
1.8	Bottom Sediment	-	-	-	-	**Construction/Operation**: No activity that will effect bottom sediment is anticipated.
2. Natural Environment						
2.1	Protected Area	-	-	-	-	Protected area is not included in the project area.
2.2	Flora, Fauna and Biodiversity	-	-	-	-	Effect on flora, fauna, or biodiversity is not anticipated since project is implemented either in the existing sites (intake and water treatment plant) or urban area of Vientiane Capital.
2.3	Hydrological Situation	-	-	-	-	**Construction:** No activity that will have negative impact on hydrological situation is anticipated. **Operation:** The proposed intake amount for Chinaimo WTP expansion is 40,000.00 m^3/day to 80,000 m^3/day, which account for 0.05 % to 0.10 % of water discharge amount (78,817,589.33 m^3/day) in the driest month in the past ten years between 2003 to 2013. Accordingly, the proposed intake amount would have a negligible impact on the water discharge of the Mekong River.
2.4	Topography and Geographical Features	-	-	-	-	**Construction/Operation**: No activity that will have negative impact on topography and geographical features is anticipated.
3. Social Environment						
3.1	Involuntary Resettlement	C	-	C	-	**Construction:** There is no land acquisition or resettlement since all construction sites belong to government land. However, some disturbance such as temporally blockage (4 to 6 days at a time) of part of the public roads during installation of treated water transmission pipeline and/or distribution pipeline will be anticipated. During the construction of water treatment plant, about 5m from the boundary wall between the Chinaimo WTP and the school under Ministry of Defense need to be moved toward the school side to secure space for construction vehicles to pass by. The wall shall be restored to the original location after completion of the construction activities. A partial land of military school located south side of the existing Chinaimo WTP needs to be transferred from Ministry of Defense to construct new chemical building near the injection

No.	Impacts	Rating at Scoping		Rating Based on the Result of IEE		Brief Description
		Pre-Construction/Con-struction	Operation	Pre-Construction/Construction	Opera-tion	
						point. **Operation:** No activity that will cause involuntary resettlement is anticipated.
3.2	Vulnerable (poor households, female- headed households etc)	-	-	-	-	No direct impact on vulnerable people residing near construction site is anticipated.
3.3	Indigenous and Ethnic Minority	-	-	-	-	No direct impact on ethnic minority groups residing near construction site is anticipated.
3.4	Local Economy, Employment, Livelihood	C+	A+	C+	A+	**Construction**: Positive impact such as creation of local employment is predicted. **Operation**: Increased water supply coverage will contribute to the well-being of residents in Vientiane Capital.
3.5	Land Use and Utilization of Local Resources	-	-	-	-	No significant impact on land use or change of local resources are anticipated since project is implemented either in the existing facilities (intake and water treatment plant) or under public roads.
3.6	Water Usage or Water Rights of Common	U	-	C	-	**Construction:** *Water usage:* No river related activities confirmed near the proposed intake site. Some disturbance to fishery (non-commercial) may be anticipated. However, the impact would be minor. *Water rights:* Application on taking water from the Mekong River for the intake needs to be made and approval from DONRE obtained.
3.7	Existing Social Infrastructures and Services	C	A+	B	A+	**Construction**: Due to construction activities, traffic circulation would be disturbed temporarily. In case there is not enough space for materials, equipment or stock pile of excavated soil along the road where the treated water pipeline or distribution pipeline to be installed, road will be partly occupied for 4 to 6 days at one site. **Operation**: Increased water supply coverage will contribute to the well-being of residents in Vientiane Capital.
3.8	Social Institutions and Local Decision-Making	-	-	-	-	The project is purposed to increase water supply coverage by expanding existing facilities and extending water supply pipelines under public roads. Accordingly, negative impact on social institutions is not anticipated.

No.	Impacts	Rating at Scoping		Rating Based on the Result of IEE		Brief Description
		Pre-Construction/Con-struction	Operation	Pre-Construction/Construction	Opera-tion	
3.9	Misdistribution of Benefit and Damage	-	-	-	-	The project is purposed to increase water supply coverage by expanding existing facilities and extending water supply pipelines under public roads. Accordingly, negative impact on misdistribution of benefit and damage is not anticipated.
3.10	Local Conflict of Interest	-	-	-	-	The project is purposed to increase water supply coverage by expanding existing facilities and extending water supply pipelines under public roads. Accordingly, negative impact on local conflict of interest is not anticipated.
3.11	Cultural Heritage	-	-	-	-	No cultural heritage is located in the proposed facility locations.
3.12	Landscape	-	-	-	-	The project is purposed to increase water supply coverage by expanding existing facilities and extending water supply pipelines under public roads. Accordingly, negative impact on landscape is not anticipated.
3.13	Gender	-	-	-	-	The project is purposed to increase water supply coverage by expanding existing facilities and extending water supply pipelines under public roads. Accordingly, negative impact on gender is not anticipated.
3.14	Children's Rights	-	-		-	The project is purposed to increase water supply coverage by expanding existing facilities and extending water supply pipelines under public roads. Accordingly, negative impact on children's rights is not anticipated.
3.15	Communicable Diseases such as HIV/AIDS	C	-	C	-	**Construction**: Inflow of construction workers from construction worker's camp to local communities will raise risks of communicable diseases. Considering the scale of construction, the impact will be limited. **Operation**: No activities raising the risk of communicable diseases are anticipated.
3.16	Working Environment (includes work safety)	C	-	C	-	**Construction**: Inappropriate management of working environment will raise the risk of accident and disease. Considering the scale and type of construction, the impact will be limited. **Operation**: No activities raising the risk of working environment are anticipated.
4. Others						
4.1	Accidents	C	-	C	-	**Construction**: The construction activities

No.	Impacts	Rating at Scoping		Rating Based on the Result of IEE		Brief Description
		Pre-Construction/Con-struction	Operation	Pre-Construction/Construction	Opera-tion	
						for installing treated water pipeline and distribution line under public road would increase the risk of accidents to the local community. With appropriate countermeasures, such as fencing the construction site and assigning traffic control person on site, the impact would be avoided and minimized. **Operation**: No activities raising the risk of accidents are anticipated.
4.2	Global Warming	-	-	-	-	**Construction/Operation:** No activity that will give negative impact on global warming is anticipated.

Rating
A: Serious impact is expected, B: Some impact is expected, C: Small impact is expected, +Positive impact is expected, U: Extent of impact is unknown and examination is needed, Impact may become clear as study progresses, -: No impact is expected

Source: JST

(1) Land use and River Related Activities near the Proposed Intake

In order to evaluate the impact of the project, especially the construction of new intake (the Proposed Intake) located in the premises of the existing Chinaimo Water Intake, hearings from local people were conducted.[18] The Proposed intake is located in the boundary of two villages, namely Xaysathan village (upstream side) and Phonsavang village (downstream side). Location map is shown in Figure 6.6.1.

[18] The hearing result is summarized in DATA BOOK B.6.

Figure 6.6.1 Location of New Intake in the Existing Chinaimo Water Intake

Source: SEED Co., Ltd

Land use around the Proposed Intake: The houses located next to the upstream side of the intake are rented to foreigners. The area of about 300 to 400m downstream from the intake belongs to Ministry of Defense. The small boat slip in the area is rented to a mixing cement factory for transporting gravel from Sangthong District to Vientiane urban area. The house located next to the downstream side of the intake is used as dormitory for Ministry of Defense. The Chinaimo WTP is located across the road from the Proposed Intake.

River Related Activities near the Proposed Intake

- Drinking, Washing or Bathing: All households in two (2) villages, Saysathan and Phonesavang, have connected to water supply system. Therefore no households use river water for their daily activities such as drinking, washing or bathing.

- Riverbank Gardening: Riverbank gardening around intake area is officially prohibited. No riverbank gardening was confirmed around the Proposed Intake area.

- Fishery: In Xaysathan village, it was confirmed that eight (8) households practice fishery upstream of the proposed intake. Fishing has been practiced only to supplement domestic consumption. No commercial fishery was practiced around intake area. As for Phonsavang village, no household was confirmed as practicing fishery. No fish culture was practiced around the proposed intake.

Aquatic Biota and Habitats

There were no statistic data available on the aquatic biota and habitats near existing Chinaimo intake area in the Mekong River. Accordingly, the information on the aquatic biota and habitats near the intake was collected by conducting hearing from locals. The types of fish around the intake area are shown in Table 6.6.3.

No endangered species were confirmed around intake area.

Table 6.6.3 Type of Fish Caught around Intake Area

Types of fish
Puntius bevris
Pangasius pleurotaenia
Hemibagrus wychioides
Cat fish
Barbonymus gonionotus

Source: SEED Co., Ltd

(2) Treated Water Transmission Pipeline and Distribution Pipeline Route

The route surveys of the proposed treated water transmission pipeline and distribution pipeline were conducted in October and November 2014 in order to grasp the characteristics of the land usage along the pipeline route.

As for the treated water transmission pipeline, total length of the pipeline will be about 6,000m, which is composed of 85% paved roads and 15% unpaved roads. The location map of the treated water transmission pipeline is shown in Figure 6.6.2.

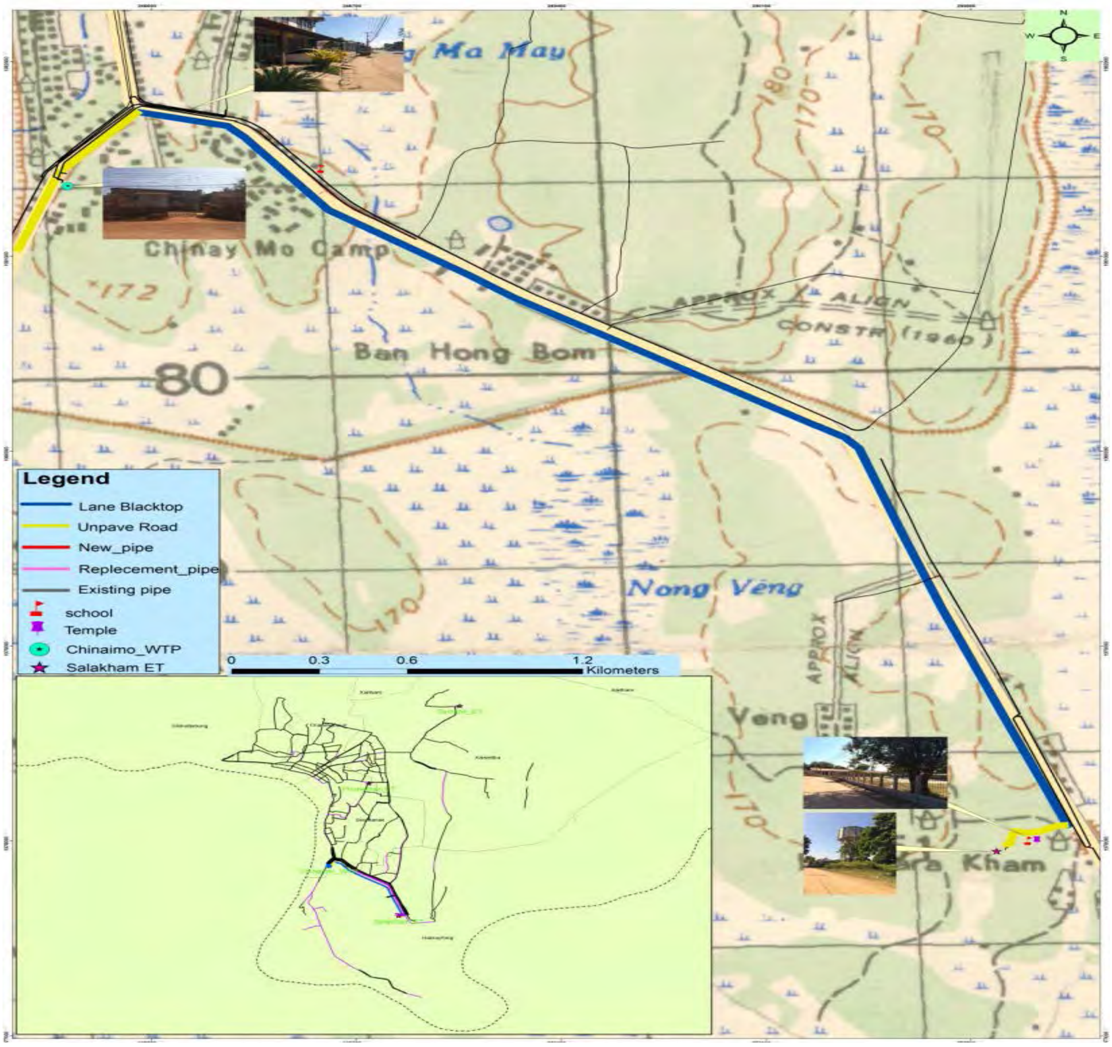


Figure 6.6.2 Location Map of the Treated Water Transmission Pipeline

Source: JST

As for the distribution pipeline, total length will be about 150km. In Chanthabouly District, where the center of the Vientiane Capital is located, 100% of the distribution pipeline route will be located under paved roads. In Sisattanack District, 59% of the proposed route is already paved, 34% is unpaved and 7% is under paving construction. More than 50% of the pipeline route is unpaved in Xaysettha District and Hatxayfong District. However, the paving construction is progressing in many parts of the route. The summary of the length and type of road in 4 Districts are shown in Table 6.6.4. The typical land usage along the paved road, unpaved road, and paving construction road are shown in Figure 6.6.3, Figure 6.6.4 and Figure 6.6.5 respectively.

Table 6.6.4 Length of Distribution Pipeline with Road Condition

District	Total Length of Distribution Line (m)	Paved Road (%)	Unpaved Road (%)	Road Under Paving Construction (%)
Chanthabouly	6,100	100	0	0
Xaysettha	60,000	21	59	20
Sisattanak	3,7000	59	34	7
Hatxayfong	45,000	34	28	38

Source: SEED Co., Ltd

Figure 6.6.3 Paved Road

Figure 6.6.4 Unpaved Road

Figure 6.6.5 Paving Construction Road

Source: JST

(3) Resettlement, Land Acquisition and Compensation

The proposed project sites are located in governmental land with no settlement. Thus, no resettlement, land acquisition, or compensation are expected due to the Project. The proposed sites of intake and water treatment plant to be constructed are in the existing Chinaimo WTP premises. Similarly, the proposed water elevated tank is to be constructed in the existing Salakham water elevated tank premises. The water pipelines, including raw water transmission pipeline, treated water transmission pipeline, and distribution pipeline, are to be installed under public roads.

During the construction of water treatment plant, about 5m from the boundary wall between the Chinaimo WTP and the school under Ministry of Defense (Kaysone Phomvihane Academy of National Defense) needs to be moved toward the school side to secure space for construction vehicles to pass by. The wall shall be restored to the original location after completion of the construction activities.

A partial land of the school located south side of the existing Chinaimo WTP needs to be transferred from Ministry of Defense to construct new chemical building near the injection point.

In case of water pipeline installation, the following policies have been applied to the water pipeline installation project in the past. Similarly, the policies will be applied to the Project.

- Water pipelines are to be installed avoiding legal (electric poll, telecommunication tower etc) and illegal assets (fence belong to private facility) constructed in the area of public roads.[19]
- After completion of the installation, the site would be rehabilitated to the previous condition

The water pipeline route will be finalized among stakeholders at the land clearance committee, which is to be established during detail design phase.

6.7 Environmental and Social Management and Monitoring Plan

6.7.1 Institutional Arrangement

The roles and responsibilities of institutions concerned for the Project's environmental and social management in construction and operation phases are summarized in Table 6.7.1. The institutional arrangement will be finalized by the appraisal of the Project.

[19] The total area of the road is defined as the road includes road surface, road shoulder, footpaths, drainage channels, road slope and delimitation area for public road (Article 20, Public Road Law 1999)

Table 6.7.1 Roles and Responsibilities for Institutions Concerned

Institution	**Roles and Responsibilities**
Construction Phase	
Project Owner	- Submit environmental monitoring report to DONRE, Vientiane Capital
Project Implementer	- Assign a staff dealing with environmental and social issues in the Project - Review monitoring report prepared by environmental and social staff
Environmental and Social Staff (ESS)	- Take a responsibility for the Project's environmental and social management based on the certified environmental and social management and monitoring plan (ESMMP) - Supervise the contractor's mitigation activities in accordance with the ESMMP - Prepare monitoring report and submit to the Project Implementer for review - Coordinate monitoring activities carried out by DONRE (every 3 months) - Coordinate between locals and contractor
Site Clearing Committee Chair: DPWT DONRE (Vientiane Capital, 4 District*)) District Heads EDL (Vientiane Capital,) DOAF**(Vientiane Capital) DOT (Vientiane Capital)*** NPNL (Water Supply State Enterprise) Village Heads EDL	- Review pipeline route and give an advice for finalization of the route during detail design - Act as grievance committee to mediate the complain by affected people
Environmental and Social Staff in the Construction Contractor's Office	- Deal with environmental and social issues - Ensure the implementation of the contractor's ESMMP in all construction site - Prepare environmental and social report and submit to PIU regularly
Operation Phase	
Chinaimo WTP in NPNL	Implement periodical check-up on water quality for the water treated at its own Water Treatment Plant. Water in each processing stage is to be checked according to an monitoring plan prepared by Chinaimo WTP.

*4 districts comprises of Sisathanak District, Hadxaifong District, Xaysetha District and Chanthabouly District.
**Department of Agriculture and Forestry
***Department of Telecommunications
Source: JST

(1) Construction Phase

Based on the mitigation measures addressed in the ESMMP, the construction contractor shall prepare the contractor's environmental and social management and monitoring plan (CESMMP). Accordingly, the construction contractor shall carry out mitigation activities in line with the CESMMP. These activities shall be managed by an environmental and social staff assigned in the construction contractor. The result of the activities shall be regularly reported to the Project implementer.

The mitigation activities by the construction contractor shall be monitored by an environmental and social staff (ESS) assigned by the Project implementer The result of monitoring will be submitted to the Project implementer and reviewed with an environmental engineer. After review, the report would be submitted to DONRE by the Project owner regularly until the completion of the Project's construction phase.

DONRE, together with Department of Natural Resources and Environment in the district concerned, will come to the construction site every three (3) months to monitor the Project's environmental and social management throughout construction phase.

(2) Operation Phase

After completion of construction works the newly constructed facilities will be managed together with existing facilities by NPNL according to a monitoring plan prepared by Chinaimo WTP.

6.7.2 Mitigation and Monitoring

(1) Mitigation measures, monitoring method and responsible organization

Based on the IEE result, the mitigation measures are prepared for each environmental impact. The state of mitigation activities will be monitored regularly. The project's mitigation measures, monitoring methods and responsible organizations in the pre-construction/construction phase and operation phase are shown as the Project's Thematic Environmental Management Action Plan in Table 6.7.2 and Table 6.7.3, respectively. During the construction phase, based on the ESMMP, the environmental and social staff in the Project implementer's organization will supervise the mitigation activities by the construction contractor. In the operation phase, newly constructed facilities will be managed together with the existing facilities by NPNL.

The ESMMP will be reviewed and finalized during the detailed design phase. In line with the ESMMP, the construction contractor will prepare the contractor's ESMMP (CESMMP) and obtain approval by the environmental engineer before commencement of construction activities.

Table 6.7.2 Project's Thematic Environmental Management Action Plan in Construction Phase

Predicted Impacts	Mitigation Measures	Construction Site to be Applied	Monitoring Method	Responsible Organization
1.Pollution Control				
1.1 Air Pollution				
- Emission gas from construction vehicle, - Dust under dry weather	- Vehicles to be maintained in good condition to minimize exhaust emissions - Use fuel and lubricants of good quality in comply with national standards - Barricade construction site - Cover load-carrying platform properly when carrying fine construction materials or earth/sand - Spray water on unpaved road during dry weather - Initiate good traffic control to reduce congestion - Instruct construction vehicle only use access road approved by the Engineer to the construction site	- Intake - Water Treatment Plant - Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline - Elevated Tank	Visual inspection on site	Mitigation measures implemented by the construction contractor Monitoring implemented by ESS
1.2 Water Pollution				
- Polluted water from construction contractor's office/camp/construction site	- Ensure good sanitation including kitchens and latrines and install good drainage and install septic tank - Construct hygienic human waste disposal systems such as mobile toilets and install septic tank in comply with national standards - Periodical check-up on water quality at discharged water from septic tank,	- Construction contractor's office/camp - Intake -Water Treatment Plant -Raw Water Transmission Pipeline	Visual inspection on site Check the record on water quality from septic	Mitigation measures and periodical check-up implemented by the construction contractor Monitoring

Predicted Impacts	Mitigation Measures	Construction Site to be Applied	Monitoring Method	Responsible Organization
- Polluted water from batching plant	settlement pond and the Mekong River near intake construction site - By constructing settlement ponds, neutralize cleaning water generated from concrete mixing at batching plant with national standards - Restore sites properly on completion of work	-Treated Water Transmission Pipeline - Distribution Pipeline - Elevated Tank	tank, settlement pond and discharge point from intake constructio n site at the Mekong River	implemented by ESS
1.3 Waste				
-Waste generated from construction contractor's office/camp/construction site	- Designate disposal site for waste soil and disposed of the waste soil only at the designated site - Make arrangement to sort out recyclable waste such as paper, cans, thins, bottles, cardboard, and polythene at collecting points and disposed of complying with local authority's regulations - Store hazardous materials at designated place, keep record and dispose of at designated place	- Construction contractor's office/camp - Intake -Water Treatment Plant - Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline - Elevated Tank	Visual inspection on site	Mitigation measures implemented by the construction contractor Monitoring implemented by ESS
1.4 Noise and Vibration				
- Noise and vibrations from vehicles transporting construction materials/on-site construction activities	- Limit transportation and construction activities from 8:00 am to 19:00 pm in places close proximity to residential area - Prohibit the use of loud air horns - Barricade construction site - Construct noise wall near schools and hospitals as appropriate - Periodical check-up on noise level at construction site (intake, water treatment plant, water elevated tank)	- Intake - Water Treatment Plant -Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline	Visual inspection on site Check the record on noise level at constructio n site (intake, water treatment plant, water elevated tank)	Mitigation measures implemented by the construction contractor Monitoring implemented by ESS
2. Social Environment				
2.1Involuntary resettlement				
- Temporary blockage of accessing public road for locals reside along the road due to installing treated water transmission pipeline and distribution pipeline	- Install assess point to public road	- Treated Water Transmission Pipeline - Distribution Pipeline	Visual inspection on site	Mitigation measures implemented by the construction contractor Monitoring implemented by ESS
2.2 Water Usage of Common				
- Disturbance to fishery near intake construction site	- Ensure the discharged water from construction site to the Mekong River satisfy the national standard	- Intake	Check the record on water quality	Mitigation measures implemented by the construction

Predicted Impacts	Mitigation Measures	Construction Site to be Applied	Monitoring Method	Responsible Organization
				contractor Monitoring implemented by ESS
2.3 Existing Social Infrastructures and Services				
- Damage to the social infrastructure (road, bridges etc) - Disturbance to traffic circulation	- Limit loading capacity depends upon local conditions such as restrictions on bridges - After completion of the water pipeline installation, restore the site to original state - Assign traffic control person on site	- Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline	Visual inspection on site	Mitigation measures implemented by the construction contractor Monitoring implemented by ESS
2.4Communicable Diseases such as HIV/AIDS				
- Spread of infection of communicable diseases	- Conduct Information, Education and Communication (IEC) campaigns to all the Site staff and worker and to the immediate local communities concerning the risks, dangers and impact, and appropriate avoidance behavior with respect to, of Sexually Transmitted Diseases (STD) - or Sexually Transmitted Infections (STI) in general and HIV/AIDS in particular	- Construction contractor's office/camp	Check the record of IEC	Mitigation measures implemented by the construction contractor Monitoring implemented by ESS
2.5 Working Environment (includes worker's safety)				
- Raise the risk of accidents and diseases due to inappropriate management of working environment	- Ensure adequate health systems are on site - Eliminate stagnant water to prevent breeding patricianly of the malaria, filarial and dengue causing mosquitoes - Install safety devices - Equip construction worker's with safety gears - Ensure occupational safety among workers	- Construction contractor's office/camp - Intake - Water Treatment Plant - Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline - Elevated Tank	Visual inspection on site Check the record of training course on occupation al safety	Mitigation measures implemented by the construction contractor Monitoring implemented by ESS
3. Others				
3.1 Accidents				
- Raise the risk of accidents due to inappropriate management of construction works	- Enforce traffic rules and adapt measures to prevent accidents - Barricade the construction sites - Assign traffic control person on site - Prepare contingency plans	- Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline - Elevated Tank	Visual inspection on site Check the contingenc y plan and approve	Mitigation measures implemented by the construction contractor Monitoring implemented by ESS

Note: ESS: Environmental and Social Staff in the organization of the Project Implementer

Source: JST

Table 6.7.3 Project's Thematic Environmental Management Action Plan in an Operation Phase

Predicted Impacts	Mitigation Measures	Construction Site to be Applied	Monitoring Method	Responsible Organization
1.Pollution Control				
1.1 Waste				
Improper management of sludge generated from water treatment process	- Dispose of the sludge at designated place	Chinaimo Water Treatment Plant	Visual inspection on site	Mitigation measures and monitoring implemented by NPNL (Chinaimo Water Treatment Plant)
1.2 Offensive Odor				
Improper management of chloride at water treatment plant	- Ensure proper handing procedure of liquid gas chlorine	Chinaimo Water Treatment Plant	Visual inspection on site	Mitigation measures and monitoring implemented by NPNL (Chinaimo Water Treatment Plant)

Source: JICA Survey Team

(2) Monitoring Plan

In line with the Project's Thematic Environmental Management Action Plan, the monitoring plan in the construction phase and operation phase is developed in Table 6.7.4 and Table 6.7.5, respectively. In the construction phase, ESS will monitor the mitigation activities by the construction contractor in checking the environmental report submitted by the construction contractor and inspecting the construction site. Effectiveness of the monitoring plan shall be reviewed regularly and revised as appropriate. During the operation phase, new construction sites will be monitored by Chinaimo WTP, NPNL together with existing facilities. Proposed monitoring form is attached in A.16 Monitoring Form.

Table 6.7.4 Monitoring Plan in a Construction Phase

Monitoring Items	Monitoring Methods	Measurement Point	Frequency	Responsible Organization
Air Pollution				
-Vehicles to be maintained in good condition to minimize exhaust emissions - Use fuel and lubricants of good quality in comply with national standards - Fence the site properly - Cover load-carrying platform properly when carrying fine construction materials or earth/sand - Spray water on unpaved road during dry season - Initiate good traffic control to reduce congestion - Instruct construction vehicle only use access road approved by the Engineer to the construction site	-Visual inspection on site	- Intake -Water Treatment Plant - Elevated Tank (-Treated Water Transmission Pipeline/Distribution Pipeline as appropriate)	Monthly	ESS
Water Pollution				
- Ensure good sanitation including kitchens and latrines and install good drainage and install septic tank - Construct hygienic human waste disposal	-Visual inspection on site - Check the record on water quality	- Construction contractor's office/camp - Intake	Monthly	ESS

Monitoring Items	Monitoring Methods	Measurement Point	Frequency	Responsible Organization
systems such as mobile toilets and install septic tank in comply with national standards - Periodical check-up on water quality at discharged water from septic tank, settlement pond and the Mekong River near intake construction site - By constructing settlement ponds, neutralize cleaning water generated from concrete mixing at batching plant with national standards - Restore sites properly on completion of work	from septic tank (BOD^5), settlement pond (pH, COD) and discharge point from intake construction site at the Mekong River (pH, COD) -Visual inspection on site	-Water Treatment Plant - Raw Water Transmission Pipeline -Treated Water Transmission Pipeline - Distribution Pipeline - Elevated Tank		
Waste				
- Dispose of construction waste such as waste soil from excavation at designated place - Make arrangement to sort out recyclable waste such as paper, cans, thins, bottles, cardboard, and polythene at collecting points and disposed of complying with local authority's regulations - Store hazardous materials at designated place, keep record and dispose of at designated place	- Visual inspection on site	- Construction contractor's office/camp - Intake - Water Treatment Plant - Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline - Elevated Tank	Monthly	ESS
Noise and Vibration				
- Limit transportation and construction activities from 8:00 am to 19:00 pm in places close proximity to residential area - Prohibit the use of loud air horns - Fence construction site - Construct noise wall near schools and hospitals as appropriate - Periodical check-up on noise level at construction site (intake, water treatment plant, water elevated tank)	- Hearing from locals on site -Visual inspection on site - Check the record on noise level at construction site (intake, water treatment plant, water elevated tank)	- Intake - Water Treatment Plant - Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline - Elevated Tank	Monthly	ESS
Disturbance to locals along the road				
- Install assess point to public road	- Visual inspection on site	- Treated Water Transmission Pipeline - Distribution Pipeline	Monthly	ESS
Water Usage of Common				
- Ensure the discharged water from construction site to the Mekong River satisfy the national standard	Check the record on water quality (pH, COD)	Intake	Monthly	ESS
Existing Social Infrastructures and Services				
- Limit loading capacity depends upon local conditions such as restrictions on bridges - After completion of the water pipeline installation, restore the site to original state - Assign traffic control person on site	- Visual inspection on site	- Raw Water Transmission Pipeline - Treated Water Transmission Pipeline	Monthly	ESS

Monitoring Items	Monitoring Methods	Measurement Point	Frequency	Responsible Organization
		- Distribution Pipeline		
Communicable Diseases such as HIV/AIDS				
- Conduct Information, Education and Communication (IEC) campaigns to all the Site staff and worker and to the immediate local communities concerning the risks, dangers and impact, and appropriate avoidance behavior with respect to, of Sexually Transmitted Diseases (STD) - or Sexually Transmitted Infections (STI) in general and HIV/AIDS in particular	- Check the record of IEC	- Construction contractor's office/camp	Every 6 Months	ESS
Working Environment (includes worker's safety)				
- Ensure adequate health systems are on site - Eliminate stagnant water to prevent breeding patricianly of the malaria, filarial and dengue causing mosquitoes - Install safety devices - Equip construction worker's with safety gears - Ensure occupational safety among workers	- Visual inspection on site - Check the record of training course on occupational safety	- Construction contractor's office/camp - Intake - Water Treatment Plant - Raw Water Transmission Pipeline -Treated Water Transmission Pipeline - Distribution Pipeline	Monthly Every 6 Months	ESS
3. Others				
3.1 Accidents				
- Enforce traffic rules and adapt measures to prevent accidents - Barricade the construction sites - Assign traffic control person on site - Prepare contingency plans	-Visual inspection on site - Check the record of training course on occupational safety	- Raw Water Transmission Pipeline - Treated Water Transmission Pipeline - Distribution Pipeline	Monthly Every 6 Months	ESS

Source: JST

Table 6.7.5 Monitoring Plan in an Operation Phase

Monitoring Items	Monitoring Measures	Monitoring Point	Frequency	Responsible Organization
Waste				
- Dispose of the sludge at designated place	Visual inspection on site	Chinaimo Water Treatment Plant	Monthly	NPNL (Chinaimo Water Treatment Plant)
Offensive Odor				
- Ensure proper handing procedure of liquid gas chlorine	Visual inspection on site	Chinaimo Water Treatment Plant	Monthly	NPNL (Chinaimo Water Treatment Plant)

In addition to the monitoring items above, water quality check-up at new intake, new water treatment plant and new distribution pipeline will be conducted together with the water quality at existing facilities.

Source: JST

(3) Monitoring Schedule

1) Monitoring in the Construction Phase

The implementation state of mitigation measures by the construction contractor is to be monitored. The type of monitoring and brief content for each monitoring activities are as follows;

Monthly monitoring

Agreed time schedule would be arranged once a month, during the environmental and social staff in the Project implementer's organization will come to project site to monitor and evaluate the state of mitigation measures implemented by the construction contractor based on the ESMMP.

The main tasks include:

(a) Inspecting the construction contractor's mitigation activities on site

(b) Consulting with the Technical officer in Project implementer's organization to see if the ESMMP is working as expected or not

(c) Participating in some field works of Project owner's organization

(d) Conducting some interviews with the villagers on construction site regarding the effectiveness of the mitigation measures in the ESMMP

(e) Preparing a field report to the Project implementer

Three Months Monitoring

As an agreed time schedule, a joint monitoring and evaluation team between the ESS and the DONRE in Vientiane Capital together with Department of Natural Resources and Environment in District concerned will come to project site every 3 months with the main tasks of:

(a) Inspecting the construction contractor's mitigation activities on site

(b) Working with Project implementer's organization to review of the work progress and to see if the ESMMP is effective and carry on according to the set timeframe

(c) Recording on the possibility of the adjustment to the ESMMP if there is any requirement with the aims to make the ESMMP more effective

(d) Consulting with villages' representative and villagers on suggestions and/or opinions for improvement of the mitigation measures

(e) DONRE preparing a field inspection report with recommendation and send to DHUP

(f) Submitting the monitoring result of past three months with respect to environmental and social considerations as a part of quarterly progress report to DONRE and JICA

External Monitoring and Evaluation

It is recommended to conduct an external monitoring and evaluation program at the end of the construction phase in order to gain some experience for its implementation in future projects, as well as to enhance transparency. The social specialist would be engaged for the following tasks:

(a) Reviewing the relevant documents including IEE, progress reports and monitoring reports

(b) Interviewing some villagers within project area

(c) Preparing a report and presenting it to concerned parties

The above monitoring and evaluation will be carried out in the following schedule as shown in Table 6.7.6.

Table 6.7.6 Monitoring Schedule in a Construction Phase

Monitoring by:	M 1	M 2	M 3	M 4	M 5	M 6	24 Months	Project Completed
ESS	❋	❋	❋	❋	❋	❋		
ESS & DONRE Vientiane Capital			❋			❋		
External								✸

Source: JST

2) Monitoring in an Operation Phase

Chinaimo WTP will implement periodical check-ups on water quality for the water treated at its own Water Treatment Plant. Water in each processing stage is to be checked according to a monitoring plan prepared by Chinaimo WTP. Frequency of the periodical check-ups will depend on the monitoring plan. Frequency of the inspection on the management of waste and offensive odor at site is set at once a month at this stage. The monitoring plan in the operation phase shall be finalized at the end of construction phase, in line with updated legislation requirements and situations.

(4) Monitoring Budget

The cost incurred for environmental monitoring is estimated based on the assumption as follows;

- Construction period is 30 months
- Environmental and social staff conducts the monitoring monthly throughout the construction period

- Officers from DONRE conduct the monitoring in every 3 months throughout the construction period

The cost estimate based on above assumption is shown in Table 6.7.7. The total cost for monitoring in the construction phase is USD$29,146. The monitoring cost is to be budgeted under the administration cost.

Table 6.7.7 Cost Regarding Environmental Management in the Construction Phase

Environmental and Social Staff

Description	Amount (USD)
Field Work	312
Vehicle*	1,920
	2,232

**Vehicle includes driver and petrol cost*

Water and Noise Sampling

Description	Amount (USD)
Water Sampling*	5,400
Water Sampling Container	91
Noise Sampling	14,400
	19,891

DoNRE

Description	Unit Price (USD)	Qty	Amount
Field Work	4.5	16*	72
Vehicle*	70	16	1,120
Contingency**	10% of Total Amount		119
Total			1,311

**2 officers from DoNRE for quarterly monitoring*
***Contingency includes cost incurred for emergency inspection*

Department of Natural Resources and Environment in District

Description	Unit Price (USD)	Qty	Amount
Field Work	4.5	32*	144
Vehicle*	70	32	2,240
Contingency**	10% of Total Amount		238
Total			2,622

**1officer from Department of Natural Resources and Environment in the District of Sisathanak, Hadxaifong, Saysetha and Chanthabouly for quarterly monitoring*
***Contingency includes cost incurred for emergency inspection*

External Monitoring

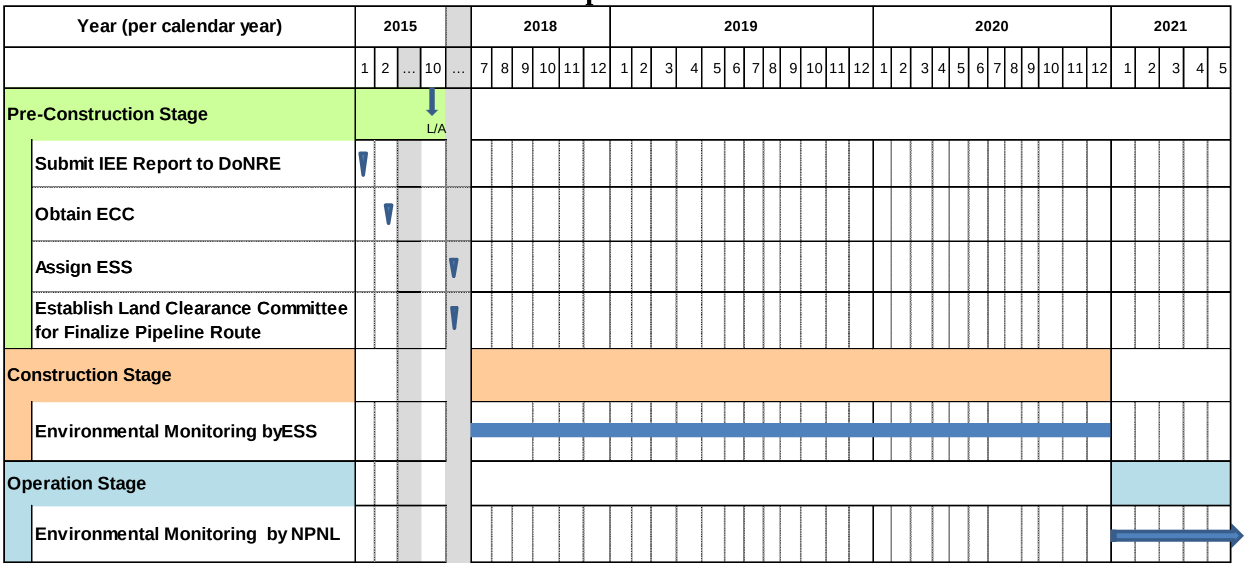
Description	Unit Price (USD)	Qty	Amount (USD)
External Monitoring		Lump Sum	3,000
Total			3,000

Monitoring cost in the operation phase is not discussed here because the monitoring activity will be conducted together with existing facilities by NPNL.

(5) Implementation Schedule

Implementation schedule is shown in Table 6.7.8. Total construction period will be 30 months.

Table 6.7.8 Implementation Schedule



Source: JST

(6) Complaints and grievances mechanism

Any person with complaints about the project can consult with the ESS. As a mediator, the ESS will coordinate to resolve the issue caused by construction activities between complainant and construction contractor. In case no settlement is made, the issue is to be discussed and resolved in the grievance committee. The Grievance committee is comprised of the same member in the land clearance committee. Depending on the issue, relevant stakeholders are convened from the grievance committee for settling the problem.

6.8 Consultation Meeting

Throughout the IEE process formal and informal consultations were undertaken with key stakeholders, including central and local government officials and persons and communities in the Project area. The primary objectives of stakeholder consultation are to provide information on the Project such as purpose of the project, layout of the project, schedule and method of construction and likely environmental and social impacts of the project construction and operation. In addition throughout meeting environmental and social information on the project area and public concerns about the project are to be collected.

Consultation with stakeholders took the following form,

- Formal meetings with concerned departments of the central and local governments
- Interviews with village heads
- Household surveys and interviews with heads of households whose land or built assets were likely to be directly impacted by the Project

The outcomes of the stakeholder meetings are shown in Table 6.8.1. The information obtained from administrative bodies as well as opinions collected from the individual, focused and stakeholders meeting were reflected on the project design.

Table 6.8.1 Outcomes of the Consultation Meetings

Category	Stakeholder	Main Topic	Remarks
Formal meeting with administrative bodies	Department of Environmental and Social Impact Assessment, Ministry of Natural Resources and Environment (MONRE)	- Environmental assessment requirement for the Project	- Project required to conduct IEE - IEE to be submitted to Department of Natural Resources and Environment (DONRE) in Vientiane Capital for obtain ECC
	Department of Water Resources, MONRE	- Legal requirement on water usage of the Mekong River	- No official procedure stipulated in legislations - In practice, request for obtaining approval for water intake from MONRE to be made by Vientiane Capital
	Water Supply Division, Department of Housing and Urban Planning (DHUP), Ministry of Public Works and Transport (MPWT)	- Environmental assessment requirement for the Project - Water usage of the Mekong River	- Project required to conduct IEE - Information regarding water usage shall be obtain from MONRE
	Department of Public Works and Transport (DPWT), Vientiane Capital	- Pipeline installation policy - Water usage of the Mekong River	- Establish land clearance committees to give comments for finalizing pipeline route - In practice, request for obtaining approval for water intake from MONRE to be made by Vientiane Capital
	Division of Water Supply and Environment, DPWT	- Existing scheme on environmental monitoring	-Not formed yet
	Vientiane Capital Water Supply State Enterprise (NPNL)	- Pipeline installation policy	- Establish land clearance committees to give comments for finalizing pipeline route
	Chinaimo Water Treatment Plant	- Existing scheme on environmental monitoring at Chinaimo Water Treatment Plant	- Practice regular water quality check up
Interview	Villages Heads (Xaysathan Village,Phonsavad	- River related activities near existing Chinaimo Water Intake	- No commercial fishery near intake area - Type of fish near intake area (Minutes, participant list and photo were attached in DATA BOOK B.6. Field Survey)
	Villagers near Chinaimo Water Intake		
Focused meeting	Villages Head (Xaysathan Village) and villagers near Chinaimo Water Intake		
Village/District level stakeholder meeting	Villages Heads (90 villages), District officials concerned (4 Districts) in the Project area	- Project description - Result of IEE	- All stakeholder agreed the project implementation - Prompt implementation of the project was requested - Shot time construction period in a site for reducing disturbance to the activities along the road was requested (Minutes attached in B6 Stakeholder Meeting)
District/Vientiane Capital stakeholder meeting	District officials concerned (4 Districts) in the Project area and Vientiane Capital officials concerned	- Project description - Result of IEE	Under preparation (as of December 2014)

Source: JST

6.9 Procedures Ahead for the Project Implementation

The following procedures need to be carried out for the project implementation;

- Coordination to be made with Ministry of Defense for the land adjacent to Chinaimo WTP

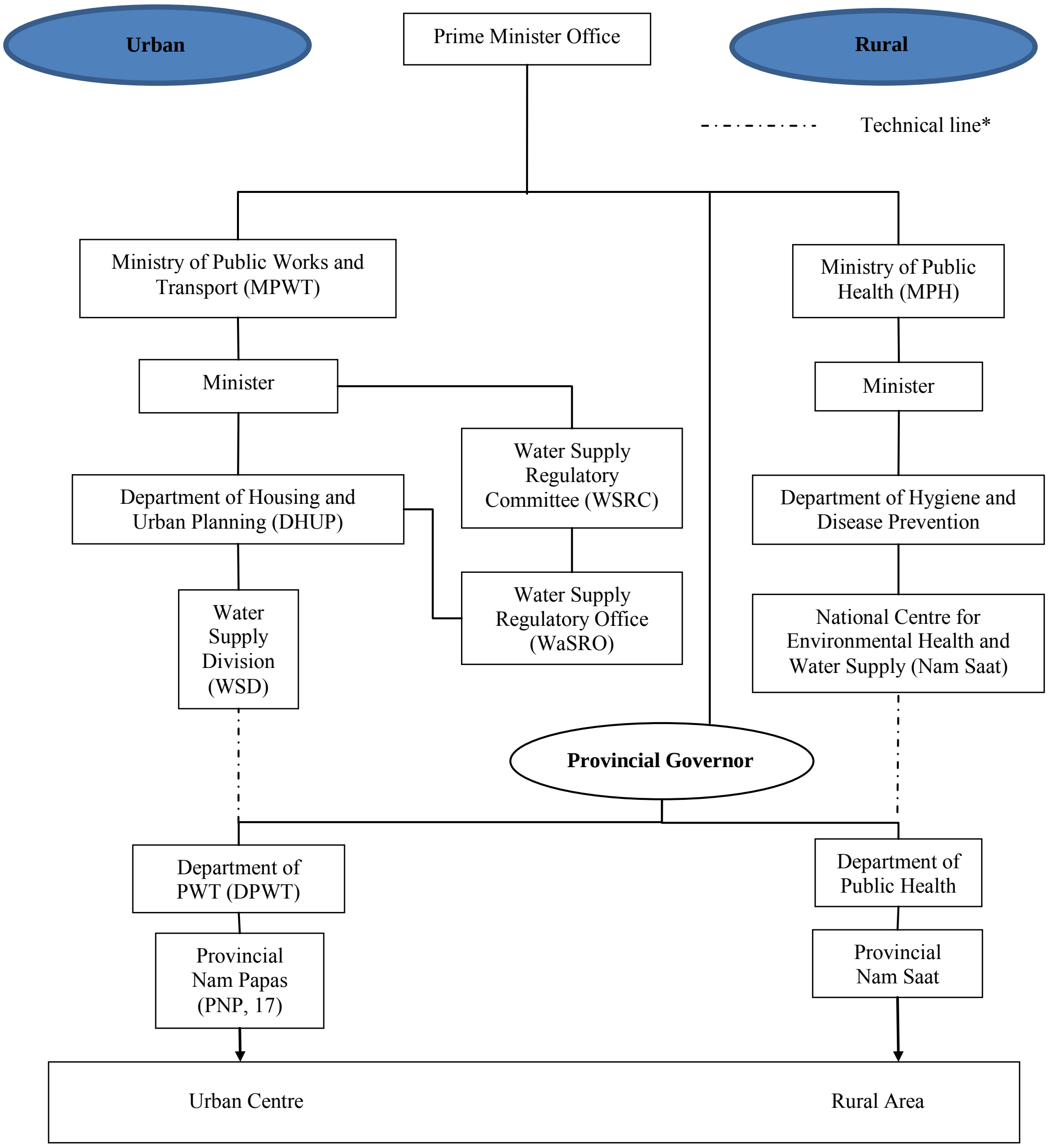
DPWT shall coordinate the transfer the land necessary for the construction of the new chemical building, and arrange for temporary access to land necessary for access roads of construction vehicles with the Ministry of Defense.

Chapter 7 INSTITUTIONAL ARRANGEMENTS

7.1 Project Implementation

7.1.1 Organization for Project Implementation

The responsibility for urban and rural water supply fall within the remit of two Ministries: Ministry of Public Works and Transport (MPWT) and Ministry of Public Health (MPH). They are responsible for the urban and rural sectors respectively. Figure 7.1.1 shows the current institutional framework for the water supply.



*Technical Line means relation of technical advice and regulation; however, it is not administrative line.

Source: Regulation of Water Supply Operation in Lao PDR, WASA, and modified by JST

Figure 7.1.1 Current Institutional Framework for Water Supply

Urban water supply projects have been classified into a macro level and local level. A policy delegating the responsibilities from the central government (Ministry Level) to the local government (Municipality / Provincial Level) has been promoted after the MPWT Minister's Decision in 2012.

(1) Ministry Level

Ministry of Public Works and Transport (MPWT)

In the Urban Sector, MPWT is a government ministry responsible for the coordination of the development process for water supply in urban areas throughout the country.

Department of Housing and Urban Planning (DHUP)

DHUP is responsible for urban water supply sector strategies and plans, technical standards, and the long-term capital investment program. They also plan and develop water supply facilities in other towns where development is lacking, under the supervision of the project steering committee of MPWT.

Water Supply Division (WSD)

WSD, which belongs to DHUP, sets out the developing water supply sector policies, strategies and investment plans; mobilizing funding; developing and supervising investment projects; preparing and implementing standards and guidelines; and developing human resources of water sector institutions.

Water Supply Regulatory Committee (WSRC)

WSRC is a state organization under MPWT. It studies draft strategies, policies, regulations and other legislation concerning the regulation of the water supply services, including directing the regulation of the urban water supply operations throughout the country. The WSRC consists of the following members. The Minister of MPWT appoints members.

1. Vice Minister of MPWT (Chairperson)
2. Director General of DHUP (Vice-Chairperson)
3. Director of Office for State-owned Enterprise Restructure, Prime Minister's Office (member)
4. Head of Water Supply Division, DHUP (member)
5. General Manager of State-owned Enterprise Vientiane Capital (member)
6. Chairperson of MPWT's Women Union on behalf of Customers (member)
7. Director of Secretariat of the Regulatory Committee (member)

Water Supply Regulatory Office (WaSRO)

The secretariat of WSRC is Water Supply Authority (WASA) and its name was currently changed to Water Supply Regulatory Office (WaSRO). The director of WaSRO is one of the members of WSRC. The secretariat has an important role in the development of strategies, regulations and guidelines, as well as monitoring the compliance with these. WaSRO also advises on water tariff determination and produces statistics and annual reports on the performance of the sector.

(2) Municipality / Provincial Level

Department of Public Works and Transport (DPWT)

The municipal or provincial field office, DPWT, is the guiding and managing body for implementation of activities at the provincial level while the district field office is responsible for district level. It is envisaged that the DPWT will be the licensing authority for urban water supplies in the future.

State-owned Provincial Nam Papa (PNP)

Operational responsibility for urban water supply has been delegated to the province under decentralization/de-concentration policy introduced in 2000. The organization officially responsible for operation and maintenance (O&M) for the urban water supply facility is PNP. All PNPs are under the authority of the province or municipality, i.e. a Nam Papa per province or municipality. In the Lao PDR, there are 16 provinces and Vientiane Capital (municipality), thus creating a total of 17 PNPs.

The 1999 policy statement (PM Decision No. 37) also made PNPs responsible for setting tariffs to generate sufficient revenue to meet the cost recovery for all water supply systems, whereas this tariff should be within the constraints of affordability and willingness to pay of consumers. In addition, tariff should be set to generate surplus revenue in order to meet a proportion of deprecation or debt service payments. In practice, the PNPs seek provincial governors' approval for tariff adjustments. PNPs submit annual budgets and requests for tariff adjustment to PNP board. Each PNP is governed by PNP board with reporting to the provincial governor.

7.1.2 Executing and Implementing Agencies

Taking past and on-going project experiences into consideration, the implementation framework for this project was discussed among DHUP, DPWT, and NPNL, and the Lao side proposed the line ministry, executing agency, project management unit, and project steering committee as follows.

- Line Agency will be MPWT,
- Executing agency will be DPWT-VC,
- Project Management Unit will be established (composing of DPWT-VC and NPNL) under DPWT-VC
- Project Steering Committee will be established (among ministries and departments concerned) for coordinating the project.

Figure 7.1.1 also shows a brief overview of the implementation framework for this project.

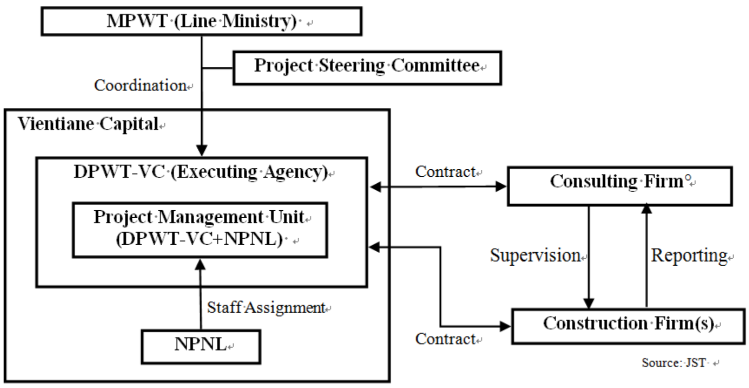


Figure 7.1.2 Implementation Framework for the Project

7.2 Management and Operation & Maintenance

7.2.1 Management and Operation & Maintenance (O&M) Plan

Operation and maintenance plan for the proposed water supply facilities is proposed at 5.3 “Operational Maintenance Plan related to the Facilities to be constructed under the Project” and this section describes NPNL’ s overall management, operation and maintenance plan for smooth implementation and operation of the proposed Chinaimo WTP expansion project.

(Water quality management)

Four laboratories in water treatment plants collect and analyze turbidity, residual chloride and color of 98 samples monthly in order to supply clean and safe water for 24 hours. The chief staff of the laboratory of Chinaimo WTP had received training from JOCV and JICA experts under the program of JICA technical cooperation projects and possesses sufficient capability to conduct required water quality analysis for operation of a WTP. In fact, water quality analysis is conducted on a daily basis and the results are recorded satisfactorily. It is a challenge of water quality management for NPNL to increase the number of water quality analysis items.

(Reduction of NRW)

NPNL has been promoting NRW reduction program with assistance by AfD since 2012 as described at 3.5 “Current Conditions of Non-revenue Water”. Before the AfD assistance, Saitama City Waterworks Bureau, Japan provided technical assistance to NPNL for operation and maintenance of water distribution pipes and service pipes from 2004 to 2006 (three years) under the JICA Grassroots Technical Cooperation Project Scheme. Regardless of the efforts to reduce NRW by replacement of old GSP pipes and quick response to repair, the NRW ratio was still 25% in 2013. Continued and long-term implementation of the NRW management plan is required. It is necessary to introduce systematic training programs especially for plumbers by OJT and at NPNL technical training center.

(Operation & Maintenance of Equipment)

As described in “3.19.4 Human Resource Aspect”, lack of engineers who can repair broken equipment such as pumps is a serious problem for operation & maintenance. Although it is required to increase mechanical/electrical engineers, outsourcing of maintenance management service will be provided as another solution. Outsourcing periodic inspection, repair, regular supply of spare parts of mechanical and electrical equipment is worth considering for effective and efficient operation & maintenance. However, it is noted that there are few capable private companies which can provide such services in Lao PDR, because the market demand is limited. Joint venture with a foreign company which has rich experience of maintenance management service will be a condition of the outsourcing agreement. At the same time, NPNL shall consider opening its technical training center to private companies to raise the level of their engineers.

(Human resources management)

It is necessary to increase the number of staff to reflect the increasing supplied water volume and customers. NPNL is planning to increase its staff from 480 in 2014 to 597 in 2020, and validity of the staff number and the detailed staff allocation plan are under review at present. While increasing the number of staff, it is also necessary to improve the efficiency of each staff member with adequate training. The technical training center of NPNL plans its annual training courses based on the requests from each department of NPNL and other water supply enterprises. According to the human resources development plan in NPNL long-term plan, more than total 500 staff receive a training course (4~5 days) in the technical training center. However, it is pointed out that it is difficult to achieve the planned number because of daily busy operation. There is a need to consider strategic human resources management based on the expected career path with necessary training of each job category. For example, OJT will be one of the effective trainings in the human resources development.

(Corporate plan)

NPNL is currently preparing “Long-term plan 2020” under MAWASU project. The Long-term plan 2020 will be a foundation of long-term management plan for NPNL. NPNL annual programs and/or activities are expected to be implemented along with the long-term plan. Therefore, it is strongly required to incorporate the proposed project into the long-term plan accordingly and to implement the long-term plan with monitoring and review.

The long-term plan of October 22, 2014 includes the following detailed plans based on three pillars of 1) Safe water supply, 2) Stable water supply, and 3) Sound management.

- Water quality management plan
  The water quality management plan includes Lab Equipment Renewal Plan and required new staff plan.

- Facility development plan (new construction)
  Facility development plan includes 15 new small water treatment plant (total capacity: 24,620m^3) construction plans for new water supply areas.

- Expansion, renewal, improvement plan of WTPs (large-scale repair)
  The target WTP for expansion, renewal and improvement are Dongmakkhai, Dongbang, Thadeau and Chinaimo. Regarding Chinaimo WTP, 40,000m^3/day expansion, renewal of intake pumps and transmission and distribution pumps, improvement of filters are planned and it is required to review and adjust the plan based on this Chinaimo WTP expansion project.

- Pipeline expansion plan
  Pipeline expansion plan includes pipeline renewal plan and mapping system introduction. The estimated length of pipeline extension for the year 2014-2020 is total 596,988 m.

- NRW management plan
  NRW management plan includes more detailed action plans related to water leakage inspection, collection of general information on service pipe, master meter and water meter improvement, water pressure management, and aging pipe renewal.

- Human resources development plan
  Human resources development plan shows training cost based on total expected staff number.

- Staff recruitment plan
  Staff recruitment plan shows retired staff number and planned new staff number. NPNL plans to have 597 permanent staff in 2020. The annual budget for recruitment and retired expense are also estimated.

- Call center establishment and improvement plan
  Call center establishment and improvement plan include annual budget plans from 2014 to 2010.

- Customer questionnaire implementation plan
  Customer questionnaire implementation plan also includes annual budget plans from 2014 to 2010.

- Waterworks education class implementation plan
  Waterworks education class implementation plan includes annual budget plans from 2014 to 2010.

- Website improvement plan
  Website improvement plan includes annual budget plans from 2014 to 2010.

Those plans with estimated budgets have gathered from responsible sections/departments and it is necessary to confirm and to adjust the details of the contents. C/Ps of MAWASU Project are reviewing them based on the coordination among related sections/department with advices from MAWASU project's Experts.

If those plans are smoothly implemented, the Chinaimo WTP expansion project works effectively as a part of NPNL corporate plan. NPNL is recommended to initiate budgetary arrangements to finance the project implementation. It is scheduled that monitoring and review of the long-term plan are carried out by the end of MAWASU project in August 2017. Therefore, it is proposed to follow-up the implementation of the long-term plan by utilizing the Chinaimo WTP expansion project for effective collaboration with the technical cooperation project.

7.2.2 Examination of Technical Assistance and Cooperation

The outline of the proposed technical assistance with the Chinaimo WTP Expansion Project is shown in Table 7.2.1

Table 7.2.1 Proposed technical assistance component

Objective	Input	Activities
Follow-up & promotion of the long-term plan 2020	● WTP O&M Expert 1.4MM (0.47 * 3times) ● Pipeline Development and O&M Expert (0.47 * 3times) ● Expert for Finance (0.47 * 3times)	● To monitor the progress of activities based on the long-term plan ● To advise how to review the plan 2020
Examination for introduction of outsourcing	● Training in Japan (2weeks, 6 persons) ● Contract Expert 0.93MM (0.47 * 2 times)	● To advise for introduction of outsourcing based on Japanese water works practices ● To provide necessary advices on the contracts/agreements with a private company for outsourcing

Source:JST

Follow-up & promotion of the long-term plan 2020

As described in 7.2.1, NPNL is currently preparing the long-term plan 2020 under MAWASU project. NPNL has to promote and review the long-term plan by itself after the completion of MAWASU project. In order to strengthen NPNL capability of operation and maintenance through interaction between the MAWASU project and the Chinaimo WTP Expansion Project, it is proposed technical assistance for follow-up & promotion of the long-term plan 2020 as the consulting service. The technical assistance includes monitoring of the progress of activities based on the long-term plan 2020 and advice to review the long-term plan 2020.

Examination for introduction of outsourcing

As described in 3.18.4 and 7.2.1, the number of engineers is limited and fixing broken equipment in an expedient manner is found to be difficult. Although NPNL has to increase of the capable engineers in order to improve those situation, it takes a time to secure enough number of the engineers. On the other hand, outsourcing of the maintenance works will be examined for more efficient operation and maintenance. The outsourcing works include periodical inspection and repairing works of mechanical and electrical equipment, and periodical replacement of spare parts. The objective of the technical assistance is to support NPNL to examine introduction of the outsourcing services through Japanese waterworks experiences.

Chapter 8 Life Cycle Cost Bidding

8.1 Purpose of Introducing Life Cycle Cost Bidding

The purpose of introducing Life Cycle Cost (LCC) bidding, is to minimize not only the initial costs including capital investment costs, purchase, and installation costs of the facility and/or equipment, but also the future costs such as operating and maintenance costs (O&M costs) and capital replacement costs over the life-time of the project, in order to give the Lao side the best choice of the equipment and /or facility to be used for the long period.

8.2 Applicable LCC Bidding Patterns

8.2.1 Case of Sewage Treatment Plant Construction Project under the World Bank Loan

LCC evaluation was applied for the bid of selecting a contractor for the design build contract of sewage treatment plant construction. LCC is defined as the certain period (life cycle) cost composed of the cost breakdown of initial cost (including construction cost, design cost, installation cost, etc.) and O&M cost as indicated in Table 8.2.1.

Table 8.2.1 Breakdown of LCC

LCC Breakdown	O&M Breakdown
1. Construction Cost	1. Personnel Cost
2. Design Cost	2. Electric Power Cost
3. Installation Cost	3. Chemical Cost
4. Spare Parts Cost	4. Parts Replacement Cost
5. O&M Cost	5. Sludge Treatment and Disposal Cost

Source: JICA Study Meeting on August 25, 2014

The following conditions are given by Employer (Project Owner) in the bidding documents for the computation of LCC.

i. The number of years to be used for life cycle
ii. Unit costs for computation of operation cost (unit costs for: power, chemicals, personnel, etc.)
iii. Discount rate used to calculate present value for all annual future costs.

In the case of the project 15 years was used for the life cycle.

The conditions of contract requires the Contractor to guarantee the sum of present values of O&M costs, which is to be calculated based on data gathered during the process proving period as shown in Figure 8.2.1, shall not exceed the sum of the O&M costs guaranteed by the Contractor at the time of bidding.

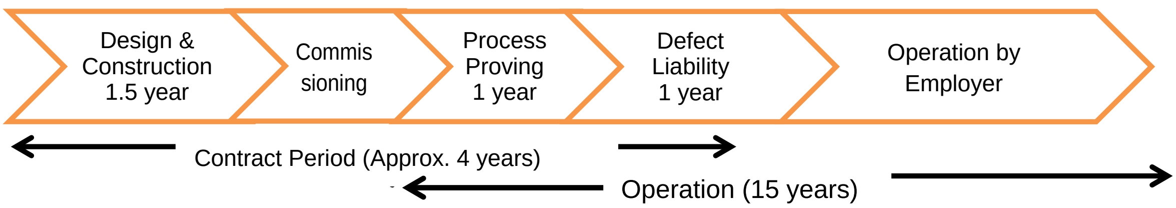


Figure 8.2.1 Flow of LCC Bidding and Project Life of 15 Years

In addition, the conditions of contract stipulate penalties for the cases that the Contractor fails to prove the guaranteed performance. If the sum of O&M costs during the process proving period exceeds the guaranteed sum of O&M costs more than 105%, the Contractor shall at its own cost make improvements until the sum of O&M costs reach below 105%. Moreover, the Contractor shall pay liquidated damages equal to such excess over the guaranteed sum of O&M costs.

8.2.2 Case of Water Supply Project under Japanese ODA Loan

The facilities which require substantial operating and maintenance costs in water supply projects are generally applicable for LCC bidding, and identified as the following facilities

i. Pumping facilities for raw water intake, water transmission and water distribution
ii. Water treatment plant

In the operation of water supply projects, except the case where gravity water flow can be widely applicable throughout the system by utilizing the advantage of topographic conditions, water intake, transmission and distribution processes are, in general, significantly dependent on pumping facilities. LCC bidding is considered applicable for such pumping facilities since the O&M costs of the pumping facilities constitute the large part of the life cycle cost of the project in many cases.

In addition, the O&M costs of water treatment processes including power costs, chemical costs, labour costs and parts replacement costs are another major cost factor for the life cycle cost of the project. The life cycle cost might be, however, reduced if alternative treatment processes proposed by water treatment plant manufacturers are employed similar to the case applied in the World Bank Loan. In this case, design build contract should be adopted to invite proposals from different water treatment plant manufactures as many as possible and select most suitable treatment system to achieve the best performance and the lowest life cycle cost.

The LCC bidding as adopted in the sewerage treatment plant construction under the World Bank Loan has not been experienced in the past projects funded by Japanese ODA Loan so far. There is, however, a similar case as explained below.

In the water supply project of the Metropolitan Waterworks Authority, MWA, in the Kingdom of Thailand, the pump operating costs computed from the pump efficiency were used for bid evaluation. The pump operation costs together with the pump body price and installation costs are combined and defined as the evaluated bid price. One single package, which consists of pumps, pipes surrounding pumps, electrical power receiving equipment, and pump panels, was formulated for this evaluation to separate the pump facilities from other construction packages. Penalties against failing the guaranteed efficiencies are also defined in this method. The evaluated bid price was composed of the cost breakdowns shown in Table 8.2.2.

Table 8.2.2 Breakdown of Evaluated Bid Price in the Water Supply Project in Bangkok

No.	Work Item	Amount
Initial Costs	- Intake Pumps and Spare Parts - Transmission Pumps and Spare Parts	
Installation Costs	- Transportation and Installation - Testing and Commissioning	
Operation Costs	- Operation Energy Cost for Intake Pumps for 20 years - Operation Energy Cost for Transmission Pumps for 20 years	
	EVALUATED BID PRICE	

Source: JST

A comparison of the above two patterns under the World Bank Loan and Japanese ODA Loan is shown in Table 8.2.3.

Table 8.2.3 Comparison of LCC Bidding Method by World Bank Loan and That for the Project

Item	Sewage Treatment Plant Construction by WB Loan	Method Recommended by the Project
Contract Modality	Design-Build	Construction contract based on the design by consulting engineers
LCC Applicable Scope	Entire construction of Sewage Treatment Plant	Procurement and installation of intake, transmission and distribution pumping facilities
O&M Costs included in LCC	1)Personnel cost 2)Power cost 3)Chemical cost 4)Parts replacement cost 5)Costs for sludge	1)Power cost 2)Parts replacement cost
Test Operation	3 months	1 to 3 months
Calculation of LCC	O&M cost + construction cost + design cost + installation cost + spare parts cost discounted for 15 years	Power cost + procurement cost + installation cost + spare parts cost discounted for 15 or 20 years
Process Proving	One year process proving is mandated. The costs during process proving period are evaluated.	No process proving period is required. Only factory inspection is mandated. (Guaranteed pump efficiency, which is the basis for calculation of power cost for 20 years, is evaluated.)
Penalty	Guaranteed O&M cost and the actual cost incurred during process proving period are compared. If the O&M costs during the process proving period exceeds the guaranteed sum more than 105%, improvements is mandated until the sum reaches below 105%. Moreover, the Contractor shall pay liquidated damages equal to such excess over the guaranteed O&M costs. （where、the maximum liquidated damage is limited to 10% of the contract amount.）	Contractor shall pay liquidated damage for the deficit calculated for each 0.1% below the guaranteed efficiency. (Where, the maximum liquidated damage should be determined.)

Source: JST

8.3 Potentiality of Introducing LCC Bidding to the Project

8.3.1 Main Considerations on Introducing LCC Bidding

The following three conditions should be taken into account for introducing LCC bidding in the Project.

i. Chinaimo Water Treatment Plant (WTP) will have the treatment capacity of 120,000m3/d after Phase 1 expansion, which will become the largest in Lao PDR. While the existing treatment system with the capacity of 80,000 m3/d is of conventional treatment system composed of horizontal flow sedimentation basins and rapid sand filters, it is necessary to select the most appropriate treatment system for the expansion of 40,000 m3/d capacity.
ii. Raw water turbidity of Mekong River becomes very high (sometimes over 3000 NTU) during the rainy seasons. This fact would limit the selection of applicable treatment processes, and NPNL's operation skills and experiences are another important factors for the selection.
iii. Due to rather flat topographical condition of Vientiane Capital which does not allow gravity flow, raw water intake as well as water transmission/distribution should be totally dependent on pumping.

8.3.2 Recommended LCC Bidding

Annual O&M cost of Chinaimo WTP in the year 2013 is approximately 10.9 billion LAK. Among which, approximately 89% consists of power cost (68%) and chemical cost (21%), and personal cost accounts for 11%. This fact implicates the possibility that procurement of high efficient and effective equipment will contribute the reduction of O&M cost, and the LCC be minimized eventually.

However, it is necessary to consider the natural conditions such as raw water turbidity as well as present operation practice and skill of plant operators in order to judge whether LCC bidding can be applicable for the full-scale expansion of Chinaimo WTP similar to the case of the World Bank Loan, or only for the specific facilities.

Table 8.3.1 compares three alternative treatment methods considered for the expansion of Chinaimo WTP. Among which, 2) Upflow clarifier and 3) Ceramic filtration are not able to treat high turbidity effectively and economically. In contrast, 1) Conventional type has proven its good performance against high turbidity for a long period of time. Furthermore, the project aims at expanding the existing treatment plant which has 80,000 m^3/d by 40,000 m^3/d, and the land space for the expansion is reserved parallel to the existing treatment processes. Cognizant of the above, it is not recommendable to introduce a different treatment process for the expansion as it may cause complexity of operation and increase burden to the plant operators.

Table 8.3.1 Comparison of Treatment Methods Applicable to Chinaimo WTP

Comparison Item	1) Conventional (Horizontal flow sedimentation + Rapid sand filtration)	2) Upflow Clarifier + Rapid Sand Filtration	3) Ceramic Filtration
Operation Experience in Lao PDR	More than 45 year	i. Upflow sludge blanket type is being operated at Dongbang WTP. ii. Upflow clarifier (slurry circulation type) with 16,000 m^3/d, belong to Beer Lao Factory, which treats Mekong river raw water has started since July 2014.	Non
Treatment Capability against High Raw Water Turbidity (Mekong River raw water tends to elevate over 3000 NTU.)	Treated water conforms to the drinking water quality standards for dry and rainy seasons throughout year	i. Production amount of Dongbang declines when raw water turbidity of Nam Gum river increases. (approx. 20% loss annually in treated water amount) ii. Upflow clarifier at Beer Lao Factory is being operated presently at only 50% of the nominal capacity and the treated water quality is acceptable. It is not proven whether it can treat very high turbidity at full-capacity operation. iii. According to Japanese design criteria for clarifier, water production of such clarifier decreases by 10% when raw water becomes 1000 NTU. (If raw water turbidity is 3000 NTU about 30% of water produced will be lost with sludge extraction from the clarifier to maintain the adequate sludge concentration in the clarifier.	i. No performance data for high water turbidity ii. Pretreatment processes such as coagulation/flocculation basin and sedimentation basin are required to reduce turbidity.
Major Mechanical and Electrical Facilities which significantly affects O&M Costs	i. Chemical feeding facilities ii. Filter backwash system iii. Desludging is manually operated.	i. Chemical feeding facilities ii. Filter backwash system iii. Circulator of clarifier iv. Automatic desludging system required	i. Chemical feeding facilities ii. Filter pumps iii. Ceramic filter backwash water system and compressed air system (Ceramic filter requires backwash at intervals of 4 to 12hours.)
Construction Cost*	1	0.8 to 1	1.5 to 2times
Chemical Cost*	1	0.9	Same as ① during high turbidity. Lower than ① during low turbidity.
Power Cost*	1	Slightly higher than ①	Rather higher than ①
Overall Evaluation	○	△	X

Note: The cost for conventional type is regarded as 1 for the above cost comparison

Source: JST

The expansion of Chinaimo WTP would be planned accordingly to employ the same type as the existing conventional treatment processes designed by consultants, and the bidding for the construction contact for expansion work be carried out separately based on the consultants' design (i.e DBB).

On the other hand, it is a fact that power cost which comprises approximately 70% of O&M cost is mainly derived from the operation of pumping facilities for water intake, transmission and distribution. It is anticipated that future O&M costs can be reduced if pumps with better efficiencies are procured under the project. It is proposed to apply LCC bidding, similar to Bangkok water supply project under Japanese ODA Loan, for the package which includes only pumping facilities.

Table 8.3.2 shows the contents of the pump facilities package. It is envisaged that the scale of the package is large enough to formulate one independent package for international bidding.

Table 8.3.2 Contents of the Pump Facilities Package

Scope of Package for Pump Facilities	Contents
- Intake Pump (120,000 m3/day) - Transmission and Distribution Pump (120,000 m3/day) - Salakham Pumps (36,818 m3/day)	pumps, pipes surrounding pumps, electrical power receiving equipment, and, pump panels

Source: JST

If pump facilities are included in the package for intake and water treatment plant construction and LCC bidding is applied, the LCC of the pump facilities will be evaluated in combination with the other construction costs and the magnitude of the LCC of the pump facilities cannot be reflected reasonably in the total combined bid evaluation. Thus, only pump facilities are to be separated as an individual package.

8.3.3 Laws and Regulations related to Procurement in Lao PDR

As for the laws and regulations related to the procurement of Lao PDR, the following documents have been issued by Procurement Monitoring Office (ProMO) in Ministry of Finance (MOF).

1) Decree of the Prime Minister on Government Procurement of Goods, Works, Maintenance and Services No. 03/PM, Dated 09 January 2004 (so called Procurement Decree)
2) Implementing Rules and Regulation on Decree of Government Procurement of Goods, Work, Maintenance and Services No. 063/MOF, Dated 12 March 2004 (so called IRR)
3) No. 0861/MOF, Dated 05 May 2009 (Amended Version of the above 2))
4) Procurement Manual, 2009

The following contents are incorporated into the " Article 29: Award Criteria, Part VI: Criteria for Awarding Contracts " of the above document 2) as an article related to LCC.

“In addition to price, the evaluation criteria may include the following which shall be qualified in monetary terms in the tender documents. Evaluation criteria that are not quantifiable in monetary terms shall be expressed in terms of pass-fail criteria.

(a) Period for completion of works and services and/or delivery of goods;
(b) Life-cycle operating costs;
(c) After-sale services and technical assistance;
(d) Supply of spare parts related to the use of goods;
(e) Payment terms”

According to the above description a bidding system based on LCC concept is considered applicable in Lao PDR.

8.3.4 Justification of the Application of LCC Bidding to the Project

In contrast to the case by the World Bank loan where design-build contract bidding is allowed to design and construct the entire sewage treatment plant as a whole by one contractor, the design by consulting engineers as the conventional treatment method is employed for the case of Chinaimo WTP expansion is recommended due to the natural conditions such as raw water turbidity and operational constraints of treatment processes envisaged in the Project.

On the other hand, the intake, transmission and distribution pumping facilities will increase the flow capacities more, and the power cost, which is the major component of the O&M cost, will become accordingly to substantial amount. In this regard, the selection of optimum pumping facilities with better efficiencies is very important to reduce the future costs. It is very advantageous to introduce LCC bidding, which can evaluate the overall costs of the pumping facilities including O&M costs. In view of the anticipated size of bidding price for the pumping facilities for the project, it is large enough to formulate one single tender package which can reasonably attract major international pump manufacturers.

In addition to the above, it should be also considered that the implementing agencies and other agencies concerned of the Lao side are not accustomed to international bidding procedures under the loans from international lending agencies. It would be premature for the implementing agencies to manage such complicated LCC and the contract for the entire water treatment system including process proving period. By contrast, it would be more practical to evaluate LCC only for the pumping facilities since CC evaluation of the pump performance can be carried out based on the results of factory inspection as shown in Table 8.2.3 in comparison with the case by World Bank loan.

8.4 Procedure and Evaluation Method for LCC Bidding

8.4.1 Evaluated Bid Price

Submitted bids will be evaluated with the evaluated bid prices obtained by adding the power costs in a prescribed number of years (Life Cycle) to the pump, spare parts, and installation costs as shown in Table 8.4.1. Power consumption will be calculated based on the pump efficiency and motor efficiency that the supplier guarantees, in addition to the discharge and heads as specified.

Table 8.4.1 Summary of Evaluated Bid Price for Pump Facility Package in the Project

Item	Contents	Amount
Initial Costs	- Intake Pumps and Spare Parts - Transmission & Distribution Pumps and Spare Parts - Salakam High Lift Pumps and Spare Parts - Monitoring System and Spare Parts	
Installation Costs	- Transportation and Installation - Testing and Commissioning	
Operating Costs	- Operation Energy Cost for Intake Pumps for 15- 20 years - Operation Energy Cost for Transmission and Distribution Pumps for 15-20 years - Operation Energy Cost for Salakam High Lift Pumps for 15-20 years	
	EVALUATED BID PRICE	

Source: JST

For calculation of the amount of electric power consumption, guaranteed values by the supplier for the parameters shown in Table 8.4.2 are used.

Table 8.4.2 Guaranteed Values by Bidders

Item	Guarantee Value
1. Discharge of Pump, Q, (CMM)	
2. Speed (RPM)	
3. Rated Head of Pump, H, (m)	
4. Pump Efficiency, np	
5. Motor Efficiency, nm	

From the above guaranteed values, power consumption will be calculated from the following formula, and by multiplying the specified electricity unit cost and operation period by hours, the electricity costs of the project life are able to be estimated.

- Hydro-Power (kW), HyP = 0.163 x Q x Rated Head of Pump
- Overall Efficiency, n = np x nm
- Total Power Requirement in kW, TP = HyP / n

On the other hand, penalty is also provided on the efficiency as described later if the result of factory inspection does not satisfy the efficiency guaranteed by the supplier, the pump is rejected or the supplier should pay for corresponding fines depending on the conditions of the contract.

8.4.2 Proving Energy Consumption (Factory Inspection)

In the package of pump facilities, in order to measure the pump performance proposed and gathered at the time of bidding, the factory inspection will be carried out before shipment. Examination contents associated with LCC includes the items shown in Table 8.4.3.

Table 8.4.3 Items of Factory Inspection for Pump Equipment

Test Item	Result
1. Discharge of Pump, Q, (CMM)	
2. Speed (RPM)	
3. Rated Head of Pump, H, (m)	
4. Pump Efficiency, np	
5. Motor Efficiency, nm	
6. Suction Performance	

When any result has a value out of the rated value specified, the pump will be rejected.

Performance proving of pump efficiency is carried out only at factory inspection, and in-situ inspection after installation of the pump is not adopted. This is because only factory inspection can provide accurate evaluation of pump efficiency, and it is difficult to prepare all necessary measurement instruments and equipment as well as engineers for the evaluation at the site. Moreover, the actual site where pumps procured in this project is subject to continuous water level fluctuation at the suction side and hydraulic fluctuation at the delivery side. It makes the accurate efficiency measurement more difficult. It is realistic and reasonably acceptable to utilize the efficiency measured at the factory inspection for the evaluation.

8.4.3 Penalty

Even though the factory inspection results satisfy the minimum efficiency specified in technical specifications, if the pump performance could not reach the efficiency guaranteed by the supplier, the supplier shall pay penalties (fines).

The basic idea of the penalties is to avoid non-responsible bidders who conspire false guaranteed pump efficiency and bidders who propose lower efficiency pumps with the payment of penalties to award the bid.

Penalty will be calculated based on the deficit of efficiency as below:

Each pump – xxx* LAK (or JPY) per 0.1 % of efficiency lower than guarantied values, but not exceed zzz* million LAK (or JPN)

Each motor –yyy* LAK (or JPY) per 0.1 % of efficiency lower than guarantied values, but not exceed zzz* million LAK (or JPN)

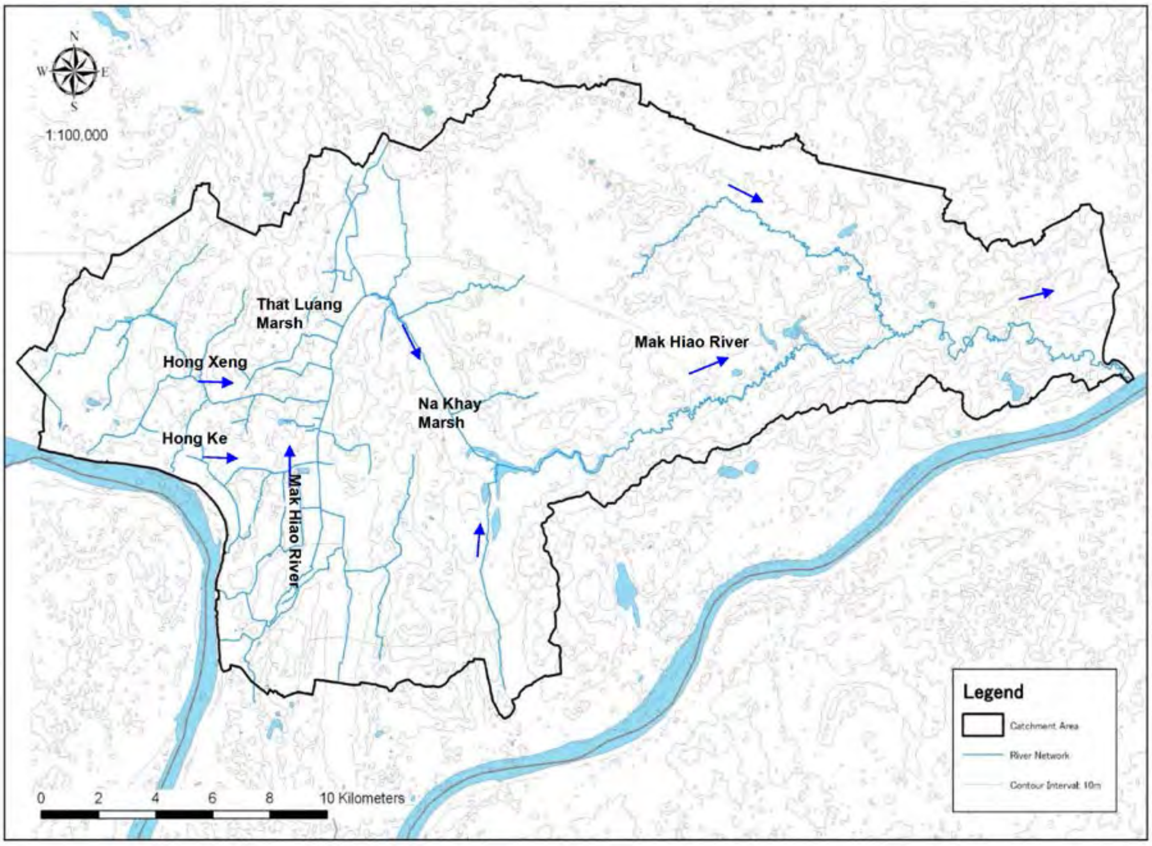
*Rate and amount for penalty will be considered and discussed in further stage (detailed design and tendering stages).

Chapter 9 ANALYSIS OF SEWERAGE AND DRAINAGE SECTOR

9.1 Current Situation and Problem on the Sewerage and Drainage Sector

9.1.1 Current Situation of the Sewerage and Drainage Sector

With the exception of three (3) Decentralized Wastewater Treatment System (DEWATS) , Vientiane Capital has no centralized wastewater treatment plants at the moment, and only has the drainage networks. Sewerage flows into the drainage networks and flows down the Hong Xeng Hong Ke, then reaches the MaK Hiao River, except for a channel of water in front of the Don Chan Palace Hotel that discharges directly to the Mekong River by pump station. After that, the sewerage passes the That Luang Marsh and Na Khay Marsh, and finally joins the Mekong River at a point about 30km east of the Vientiane Capital downtown. (Figure 9.1.1)



Source: The Study on Improvement of Water Environment in Vientiane City, 2011

Figure 9.1.1 Target area figure

Facilities and site situations are shown in Photos 9-1 to 9-6.

Photo 9-1 water channel in front of Don Chan Palace Hotel

Photo 9-2 pumping station (screen)

Photo 9-3 gate at MaK Hiao River estuary

Photo 9-4 confluence of Mekong and MaK Hiao

Photo 9-5 Na Khay Marsa

Photo 9-6 That Luang Marsh

Vientiane Capital's Drainage Network reaching the MaK Hiao River and its simplified diagram are shown in Figure 9.1.2 and Figure 9.1.3, respectively. Pictures of major points are shown in Photos 9-7 to 9-12.

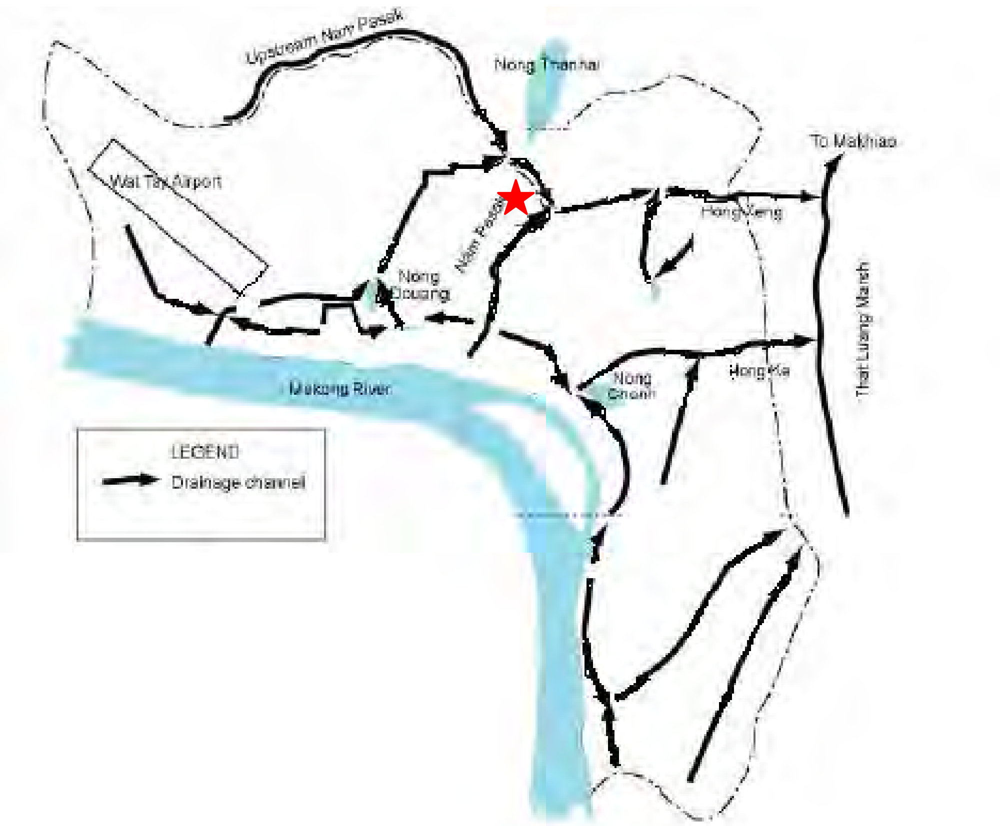


Figure 9.1.2 Vientiane Capital's Drainage Network

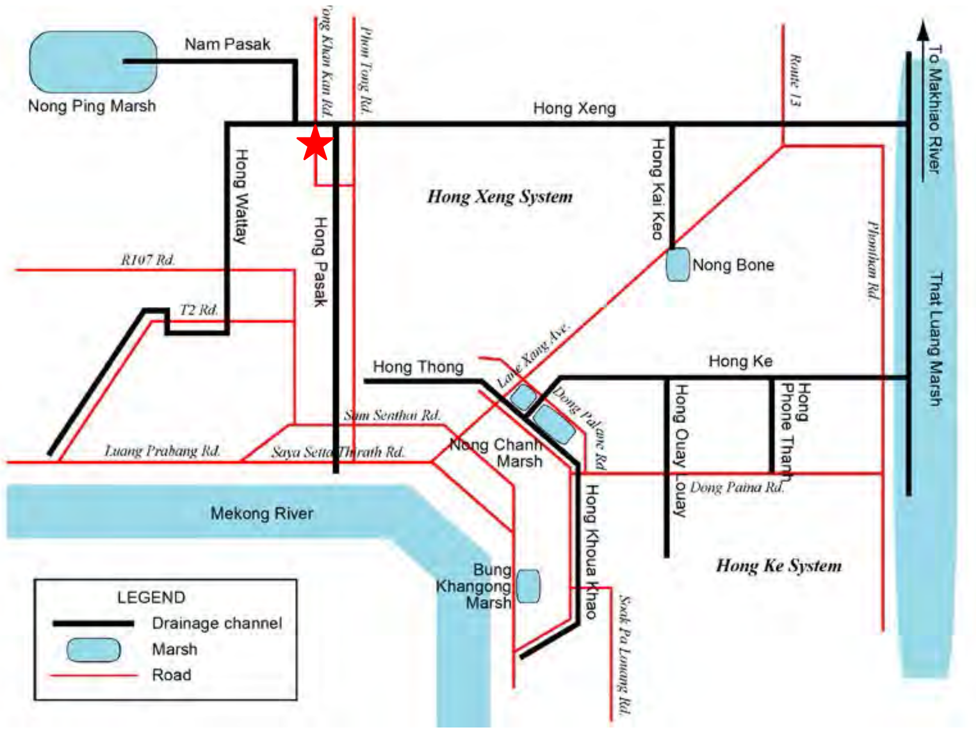


Figure 9.1.3 View showing a frame format of Drainage Network

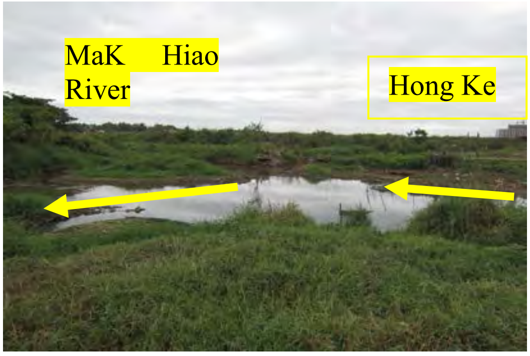


Photo 9-7 confluence of Hong Ke and MaK Hiao

Photo 9-8 confluence of Hong Xeng and MaK Hiao

Photo 9-9 Hong Ke canal

Photo 9-10 Hong Xeng canal

Photo 9-11 example of Hong Ke branch

Photo 9-12 example of Hong Xeng branch

9.1.2 Current Problem on the Sewerage and Drainage Sector

Sewerage and Drainage Network in Vientiane Capital has the following features and problems.

1) Generally, sewerage and drainage in Vientiane Capital does not flow into the Mekong River directly, but connects to the Mekong River at a point about 30km east of Vientiane Capital downtown via marsh and the MaK Hiao River. The water quality at the effluent point is good.(BOD2～3mg/l)

2) Vientiane Capital has clearly rain season and dry season. Hence, inflow amount to the drainage is different depending on the season. The size of the canal is determined by inflow amount during rainy season. However, there is only septic tank overflow and gray water flow in the canal during dry season. Therefore, sewerage is stagnant at the end of the branch river and garbage is floating in the river. Occasionally, nasty odor is caused by these situations.

3) Improved living standards with economic growth, increasing population, and the expansion of urban area are influential to a large amount of untreated gray water, and thus sewage amount is certainly increased.

4) There are no sewage treatment plants in Vientiane Capital. Purification of water depends on septic tanks and purification capability of marshes and rivers. The increase of the polluting load might cause the river water quality and hygienic environment to become worse.

9.2 Policies and Plans of the Sewerage and Drainage Sector

9.2.1 Technical cooperation relationship of the past

(1) Japan

“THE STUDY ON IMPROVEMENT OF WATER ENVIRONMENT IN VIENTIANE CITY” (01/2009～09/2011) was conducted by JICA and drew up a master plan. In the report, it advised the issues of: early action of water environment improvement plan by construction, ceasing of canal cover installation, conservation of marsh, strengthening of administrative direction, and strengthening of maintenance of drainage canal and monitoring. Also, JICA installed two (2) Decentralized Water Treatment (hereafter, DEWAT) plants in collaboration with the Bremen Overseas Research and Development Association (hereafter, BORDA). The detailed design survey was then conducted from July 2012 to May 2013 for collecting needed information, analysis, studying content of cooperation, and conducting preliminarily review.

Based on these results, a three (3) year project entitled “The Project for Urban Water Environment Improvement in Vientiane Capital” was initiated in 2014.

Expected outcomes are 1) the strengthening of the ability to plan and design for sewerage treatment plant with considering environment, 2) the strengthening of the ability to operate the laws and regulations for water environment management, 3) the raising environmental awareness of citizens through environmental education.

In addition, as a JICA Partnership Program, Chiba Prefecture has been conducting transfer of skill programs related to development of human resources and development of ability of environment division staff since 2012.

(2) Germany

The International NGO, BORDA and Department of Housing and Urban Planning(DHUP) started a cooperation project to expand the use of DEWATS developed by BORDA, and an inception meeting was held in July 2013. After that BORDA held a DEWATS seminar in 15 locations and selected several suitable sites. At the present, BORDA is seeking a donor.

DEWATS is an anaerobic treatment device. It is expected to have low construction cost and low maintenance fee.

(3) South Korea

Since South Korea established Diplomatic relations with the Lao PDR. in 1974, they have especially been deepening the relationship since the 90’s. A South Korean company, Sunjin, conducted a feasibility study of Sewerage Works from 2011 to 2012, and has submitted the F/S report to Vientiane Capital.

The content of report includes installation of about 210 km pipe lines by 2020, construction of sewerage treatment plant (30,000m^3/d), and also includes installation of about 280 km pipe lines by 2030, construction of a sewerage treatment plant (70,000m^3/d), with a total construction cost of about 166,100,000 USD.

9.2.2 Policy of the Lao PDR

The GOL has considered installing DEWATS of BORDA in communities, schools, private companies, and other institutions to improve the environment gradually, because centralized systems requires high costs.

Vientiane Capital has not developed Sewerage Work Plan. The reason is tha Vientiane Capital’s sewerage and drainage do not flow out to the Mekong River directly and is partly processed by the purification capability of marsh and river, the water discharged from the MaK Hiao River is in good condition. Hence, Vientiane Capital has not faced serious problems of the sewage in the past.

However, the GOL has realized the need to improve sanitary environment and sewerage treatment for residents not only in the capital but also in other big cities. With the national economic growth, the expansion of city area, the population increasing, it has an increased need for wastewater treatment.

Action Plan toward 2030 is shown in Figure 9.2.1.

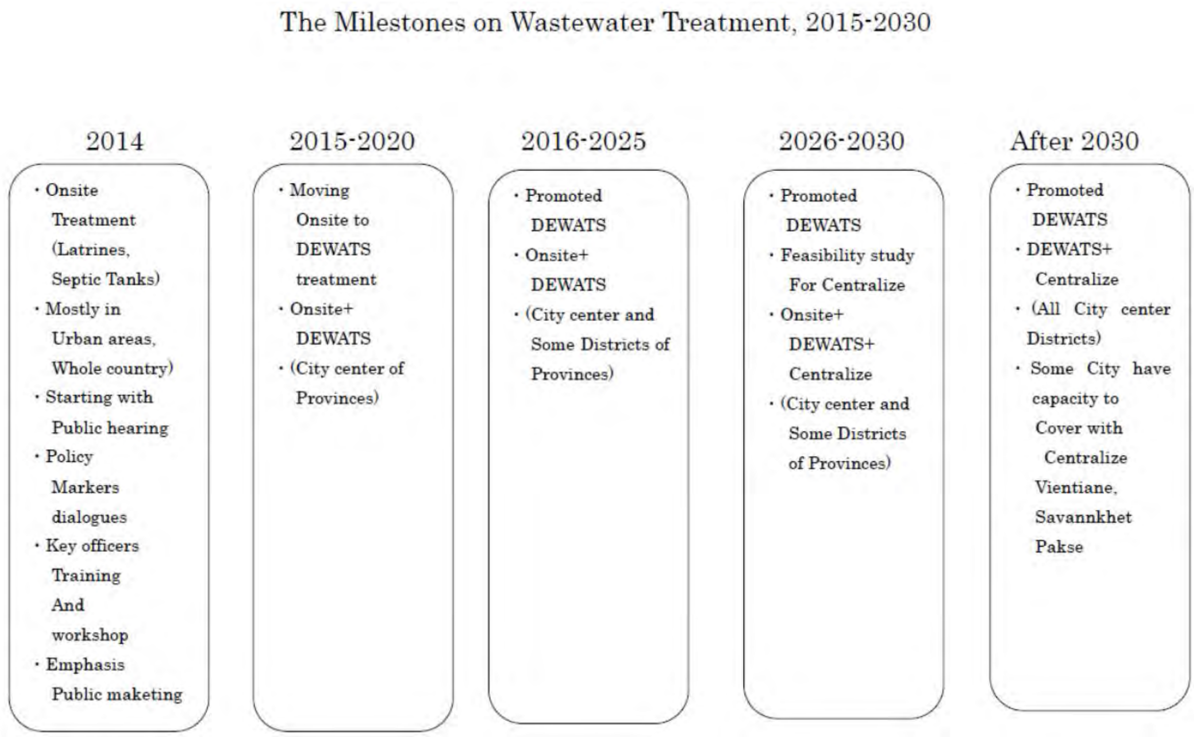


Figure 9.2.1 The Milestones on Water Treatment

9.3 The Impacts of Increasing Sewerage and Drainage based on Water Supply Expansion

9.3.1 Water supply expansion plan

At the moment, Vientiane Capital is mainly supplied to urban area, with a water supply coverage ratio of 72%. The four (4) water treatment plants have the total production capacity of 180,000m^3/d. However, recent data records show they have produced, on average, over 199,000 m^3/day in 2013. This implies some plants were forced into over load operation recently. Also, the latest water demand projection shows the need for water production of over 400,000 m^3/day in 2030 due to rapid population and industry growth.

9.3.2 The Impacts of Water Supply Expansion toward Sewerage and Drainage in Vientiane Capital

"The Study on Improvement of Water Environment In Vientiane City"（09/2011）has not studied the above mentioned water supply expansion, but has done the water quality prediction calculation based on increasing population and economic growth. According to the calculation, water quality (BOD) at the estuary of MaK Hiao River is estimated to rise from 1.9mg/l in 2009 to 3.1mg/l in 2020.Thus, water quality is predicted to get worse in 2030, target year of water supply expansion.

9.4 Comprehensive Plan for the Sewerage and Drainage Facilities in Vientiane Capital

9.4.1 The review of past recommendations

In the past, international cooperation organizations made some recommendations of the drainage and sewage. These recommendations have been divided into software side (procedure, method, etc.) and hardware side (construction, equipment, etc.). The both side recommendations are reviewed and additional ones are listed in the following.

(1) Software side

“The Study on Improvement of Water Environment In Vientiane City”（09/2011） recommended the following proposals related to the software side.

・Conservation measures of marsh
・Strengthening the ability to operate the laws and regulations
・Strengthening environmental education.
・Strengthening the maintenance and monitoring of drainage canal
・Develop scheme of sewerage treatment

Among these proposals, especially conservation measures of marsh is most important because marsh area is connected to purification capacity for future environment improvement. Therefore, prohibition of development activities in the mash and strengthening of drainage regulations with development are recommended.

(2) Hardware side

The following countries recommended the following proposals related to the hardware side.

South Korea：developing sewerage networks
Germany：popularization of DEWATS
Japan：Structural method（vegetation purification facilities）
Ceasing of canal cover installation

Vientiane Capital’s sewerage does not directly cause negative affects to the Mekong River. Currently, sewerage networks are considered not to be undertaken immediately.

DEWATS was recommended to the GOL by BORDA. DEWATS is an anaerobic treatment system. The maintenance and operation costs are low because aeration is not needed. On the other hand, it requires long reaction time. If tank volume is not sufficient, it seems unable to achieve good treatment ability or good water quality. Therefore, it is realistic measures to install DEWATS in the places where are available.

9.4.2 Measures to be considered separately

(1) Box Culvert

Water quality at the estuary of the MaK Hiao River will not deteriorate significantly worse even if sewerage amount in Vientiane Capital increases. On the other hand, water quality of drainage canals in Vientiane Capital are expected to exceed 30mg/l (BOD) before flowing into the MaK Hiao River or marsh.

Therefore, the current odor problem may become further exasperated. Especially, without flow quantity, the flow becomes stagnant at the end of river branches in most–place~~s~~. “The Study on Improvement of Water Environment in Vientiane City”（09/2011） suggested not installing canal covers as one structural method from the aspect of environmental education. Furthermore, both main and branch rivers have wide river widths. Thus it is difficult to cover the river.

For these reasons, it is conceivable that trapezium natural channel (roughness coefficient is big) will be converted to rectangle box culvert (roughness coefficient is small). An example of a culvert constructed without using the public funds is introduced below.

Photo 9-13 SIGNBOARD FOR WORK

Photo 9-14 Backside of board

Open channel is converted to box culvert at the back side of the left photo.
Signboard for work shows the following contents.

- Project : Development of Parkpasuk water drainage as parking area
- Project site: Parkpasuk drain water from Vatchan to Synorm Village, Chanthabary District, Vientiane Capital
- Concession by: Miss Thipphaphone Dityavong
- Concession period: 35 years
- Date: 21 November 2013

This contents of signboard are meant to be as follows.

1) Miss Thipphaphone Dityavong proposed building parking lot over the canal.
2) She constructs box culvert with permission by self-financing.
3) She will collect the parking fee there over 35 years.
4) After 35 years passed, the box culvert will be returned to Public.

There are 2 methods of culvert construction. First method is covering the river between road and mall with box culvert to make it easy for vehicles to enter and exit. Another method is including the culvert near branch river in the new road construction.

Photo 9-15 mall and culvert

Photo 9-16 New road and culvert

(2) River treatment plant

1) Hon・Xeng drainage

Sewage of each home comes into the drainage network through the drainage pipe. In the dry season, the drainage pipe plays a role of the sewage pipe. Thus, it is conceivable to purify the river water directly. There are purification facilities provided in high-water channels in Japan, but there are no appropriate high-water channels in the Hon・Xeng drainage. It is suggested to construct the purification facilities by using the farmland. The installation site is a place where confluence of the Hong Wattay and Nam Pasak further confluent with the Hong Pasak, so that the purification of almost three tributaries can be done at one point. (Figure 9.1.2, Figure 9.1.3).

2) Hon ke drainage

In Hon ke drainage, it is difficult to install river treatment plant because of site limitation. As a possible method, it is suggested to construct the purification facilities at places where high-water channels are built. Another option is constructing the purification facilities underground at mall site.

Photo 9-17 join point (1)

Photo 9-18 join point (2)

Photo 9-19 Hon Ke branch flood - channel

Photo 9-20 mall site

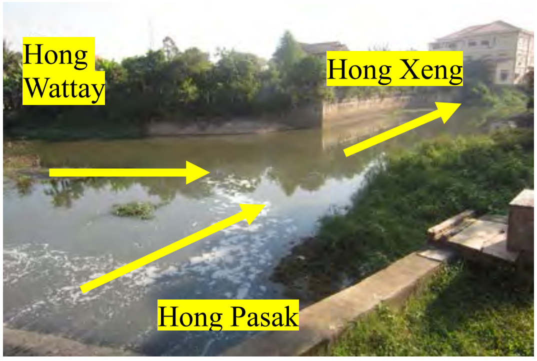


Photo 9-21 join point (3)

Photo 9-22 candidate site for plant

To summarize the contents of which have been described above, Vientiane Capital's sewerage and drainage do not flow out to the Mekong River directly and is partly processed by the purification capability of marsh and river. The water discharged from the MaK Hiao River is in good condition without a sewerage treatment plant. In view of this fact, promotion of developing sewerage networks with secondary treatment plants are considered not to be undertaken immediately.

To keep the marsh and rivers of purification capacity is particularly important conservation of marsh. To do this, the prohibition of development activities in the marsh and strengthening of drainage regulations with development are needed.

With the current status of increasing economic growth and population of Vientiane Capital, and expansion of city area, water quality deterioration and odor problems may occur. Countermeasures have 1) promotion to install inexpensive wastewater treatment system like DEWATS in the places where are available, 2) promotion to the lid hanging in the places where are available, 3) construction of the facilities purifying the river water directly. Using these measures, it should be done to conserve the marsh and to improve water quality in the drainage networks.

Chapter 10 ASSESSMENT OF PROJECT EFFECTIVENESS

10.1 Calculation of the Project's Economic Internal Rate of Return (EIRR) and Financial Internal Rate of Return (FIRR)

10.1.1 Financial Analysis

(1) Methodology of the Analysis

Financial analysis in this survey was conducted utilizing the discounted cash flow method, which tabulates the revenues and costs of each year through the evaluation period and converts the balances of revenue minus cost of each year into the present value by applying the discount rate. Revenue is the water tariff. Costs are composed of construction costs, O&M costs, and replacement costs. Whether the project is financially feasible or not is judged by whether the project FIRR is over the WACC (Weighted Average Cost of Capital) as a discount rate or not. In case that FIRR is over the WACC, the project is judged as financially feasible.

(2) Preconditions

Major preconditions of financial analysis are as follows;

Table 10.1.1 Major Conditions and Assumptions of Financial Analysis

1	Project period	2020 – 2049 (30 years)
2	Evaluation period	2015 – 2049
3	Price level	Year 2014
4	Exchange rate	0.0149 JPY per 1.00 LAK and 120.4 JPY per US$1.00
5	Weighted Average Cost of Capital (WACC)	4.0 %*1

Note: *1; Nominal interest rate is 1.7%. Weighted average of corporate income tax is 0.25% of water revenue. Inflation rate is 5.6%. Considering these conditions, real interest rate was calculated. Calculated real interest rate became less than 4%. Then, Minimum Rate Test (MRT) was applied. In MRT, in case the real interest rate is less than 4%, the value is replaced with 4% in financial analysis to ensure conservative analysis. (refer to "Guidelines for Financial Management and Financial Analysis of Projects", African Development Bank, 2006)

Source: JST

Japanese Yen loan is expected to be the major fund source for this project. The loan shall be provided to Ministry of Finance (MOF), government of Lao PDR. fter the conclusion of Loan Agreement (L/A) between MOF and JICA, sub-loan contract shall be agreed between MOF and NPNL for the loan to be repaid by NPNL. Sub-loan conditions between MOF and NPNL have not been decided yet[20]. However, most probable sub-loan conditions are as follows, based on the information from the NPNL staff:

- ✓100% of the amount from government of Japan to MOF becomes loan for NPNL.
- ✓Interest rate of loan repayment for NPNL to MOF is 0.5% to 1.0% higher than interest rate of Japanese Yen Loan.
- ✓Repayment and grace periods are the same condition as that of Japanese Yen Loan: 30 years repayment period with 10 years grace period.

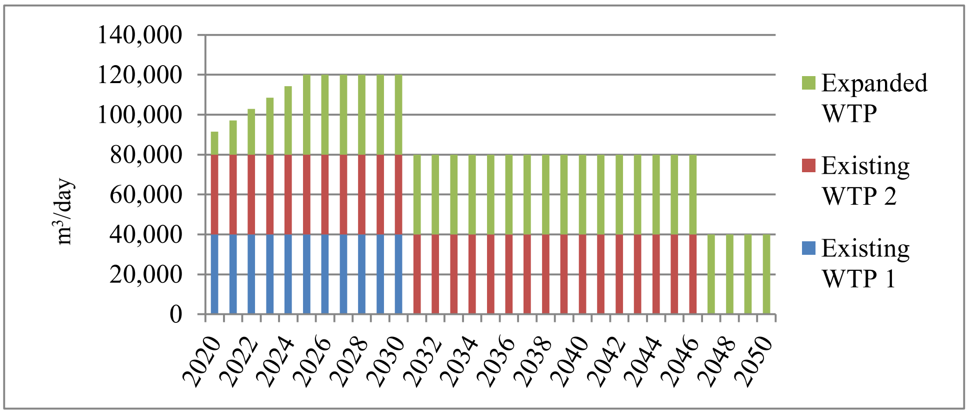
[20] According to Ministry of Finance Japan, it is usual that sub-loan condition is determined after concluding loan agreement.

Nominal interest rate for this project, as shown in note of Table 10.1.1, is set at 1.7%, by adding 1.0% to the original loan interest set by the condition of Japanese Yen Loan (1st April, 2015) at 0.7%.

Costs and revenues of the project used in financial analysis are defined as the difference between costs or revenues with the project and those without the project. Revenue of the project is assumed that tariff revenues from estimated total number of customers with the project minus those without the project.

The project includes both the expansion of Chinaimo WTP (40,000 m^3/day) and rehabilitation of the existing Chinaimo WTP (80,000 m^3/day). The rehabilitation works include replacements of electrical and mechanical equipment such as pumps, which have not been replaced for the past 20 to 40 years at intake facility and WTP, and demolishing and newly constructing the chemical dozing facility. Almost all of the mechanical and electrical facilities of the existing WTP shall be renewed by the project. Only the civil structure shall not be renovated, since it is assumed to be usable for 50 years in total and the existing ones were constructed in 1980 and in 1996.

In financial and economic analysis of this project, it is assumed that the existing Chinaimo WTP would be stopped before 2020, caused by the aging of the mechanical & electrical facilities which have already passed the typical duration time. Therefore, production capacity to calculate financial revenue for this project is not only 40,000 m^3/day produced by expanded WTP, but also 80,000 m^3/day produced by rehabilitated existing WTP. However, the revenue generated by existing WTP is presupposed to continue for typical duration period of civil structure (40,000 m^3/day upto 2030, 40,000 m^3/day upto 2046, both 50 years after the construction), as shown in Figure 10.1.1.



Source: JST

Figure 10.1.1 Production Volume of this Project for Financial & Economic Analysis

Costs of the projects are composed of the initial investment costs and replacement costs of the projects and incremental O&M costs with the projects.

(3) Limitation of Financial Analysis

Financial evaluation is conducted based on the many preconditions and assumptions for the analysis. If there are some changes for these preconditions and assumptions, the results of FIRR may also be changed. For example, if the NRW reduction is not improved as planned, FIRR will certainly be deteriorated. Change of collection efficiency of water rates will also influence the financial evaluation results. FIRR may become not feasible in case of remarkable change of the preconditions. It is important to observe the conditions of financial evaluation and recalculate it when the preconditions or assumptions are changed.

(4) Financial Analysis of the Project

1) Revenue from Proposed Projects

Financial revenue of the proposed project is originated from the tariff revenue from the customers for the portion of incremental consumption of water. Average household water rate is set at 2,081 LAK/m^3 (0.258 USD/m^3), based on the NPNL water tariff table and the average household water consumption volume. Average water rates for governmental and commercial customers are 2,665 LAK/m^3 and 3,244 LAK/m^3 respectively, referring NPNL tariff table.

Water consumption volume for each domestic (household) and non-domestic (governmental plus commercial) are set at water demand projection with the same NRW ratio as used in the projection. Then, a water consumption volume for each governmental and commercial customer is set based on actual percentages of water consumption volume for each of them. Collection efficiency is assumed at 99.6% in the year 2016, which is 0.1% higher than present situation, to be 99.9% in the year 2021 (5 years later) and to be kept at the same rate after that.

The basic information for the calculation of unit price is included in the “SUPPORTING REPORT, A.17 FIRR and EIRR Calculation, Financial Plan of NPNL”. Price for initial installation charge is assumed as 1,600,000 LAK/case. Unit price for meter rent charge is assumed as 3,600 LAK/case. Both prices are referred from the Regulation of NPNL (Announcement No. 0243/NPNL, dated 04 Mar. 2014, and Decision No. 059/NPNL/2013, Dated 07 May 2013). The total financial benefit and breakdown of the Project are also included in the SUPPORTING REPORT, A.17 for each year through the evaluation period.

2) Costs for Proposed Projects

Financial costs of the proposed projects consist of initial investment cost, operation and maintenance (O&M) cost, and replacement cost of the mechanical/electrical equipment. Initial investment cost is composed of procurement/construction cost, consulting service cost, physical contingency, price contingency, interest during construction, and so on. Although price contingency and interest during construction are calculated, they are not included in the financial analysis, because inflation is not considered in the financial revenue either. Construction cost covers mainly the expansion works and rehabilitation works for the existing facilities. O&M cost consists of electricity cost, chemical cost, personnel cost, fuel and vehicle costs. Each item of O&M cost covers both the expanded and rehabilitated facilities, since financial revenue also covers number of customers both expanded and rehabilitated WTPs. Replacement cost covers replacement of machinery and equipment of expanded and rehabilitated facilities of the project.

3) Result of Financial Analysis of the Project

Cost and benefit stream of proposed water supply project during the evaluation period is shown in the Table 10.1.2**.** In case without unit water price increase in constant price after scheduled tariff raise upto 2018, financial internal rate of return (FIRR) is calculated at 9.29%, which is higher than WACC at 4%. As a result, proposed water supply project is financially feasible under the present water rate.

Table 10.1.2 Cost and Benefit Stream of the Project

Phase 1 only

Assumptions:

Existing Chinaimo WTP stops operation by the year 2020 without rehabilitation work planned by this Project. Therefore, production volume of this project is set at maximum 120,000m³/day.

Following is shown in real term, therefore, water tariff must be raised regularly for inflation adjustment.

Tariff must be raised at **0.00 %** in the year 2019 from that of the year 2018.

(Unit: million JPY)

	Year	Cost				Revenue	Balance
		Const-ruction *1	Replace-ment	O&M	Total	Total	
-4	2015	0.00	0.00	0.00	0.00	0.00	0.00
-3	2016	156.00	0.00	0.00	156.00	0.00	-156.00
-2	2017	266.00	0.00	0.00	266.00	0.00	-266.00
-1	2018	1,436.00	0.00	0.00	1,436.00	0.00	-1,436.00
0	2019	3,287.00	0.00	0.00	3,287.00	0.00	-3,287.00
1	2020	3,138.00	0.00	16.97	3,154.97	88.12	-3,066.85
2	2021	418.00	0.00	217.99	635.99	1,139.64	503.65
3	2022	0.00	0.00	229.91	229.91	1,221.79	991.88
4	2023	0.00	0.00	241.98	241.98	1,303.93	1,061.95
5	2024	0.00	0.00	253.90	253.90	1,386.07	1,132.17
6	2025	0.00	0.00	265.82	265.82	1,468.22	1,202.40
7	2026	0.00	0.00	265.82	265.82	1,391.88	1,126.06
8	2027	0.00	0.00	265.82	265.82	1,404.37	1,138.55
9	2028	0.00	0.00	265.82	265.82	1,417.04	1,151.22
10	2029	0.00	0.00	265.82	265.82	1,429.91	1,164.09
11	2030	0.00	0.00	265.82	265.82	1,443.08	1,177.26
12	2031	0.00	6.20	177.21	183.41	951.28	767.87
13	2032	0.00	6.20	177.21	183.41	951.28	767.87
14	2033	0.00	6.20	177.21	183.41	951.28	767.87
15	2034	0.00	6.20	177.21	183.41	951.28	767.87
16	2035	0.00	832.20	177.21	1,009.41	951.28	-58.13
17	2036	0.00	6.20	177.21	183.41	951.28	767.87
18	2037	0.00	6.20	177.21	183.41	951.28	767.87
19	2038	0.00	6.20	177.21	183.41	951.28	767.87
20	2039	0.00	6.20	177.21	183.41	951.28	767.87
21	2040	0.00	832.20	177.21	1,009.41	951.28	-58.13
22	2041	0.00	6.20	177.21	183.41	951.28	767.87
23	2042	0.00	6.20	177.21	183.41	951.28	767.87
24	2043	0.00	6.20	177.21	183.41	951.28	767.87
25	2044	0.00	6.20	177.21	183.41	951.28	767.87
26	2045	0.00	6.20	177.21	183.41	951.28	767.87
27	2046	0.00	6.20	177.21	183.41	951.28	767.87
28	2047	0.00	6.20	88.60	94.80	935.12	840.32
29	2048	0.00	6.20	88.60	94.80	935.12	840.32
30	2049	0.00	6.20	88.60	94.80	935.12	840.32

FIRR: 9.29% NPV: 4,774 million JPY B/C: 1.45

Note: *1; Construction cost excludes the 'Price escalation', 'Interest during construction' and adjusted the 'Contingency' also.

Source: prepared by JST

10.1.2 Economic Analysis

(1) Methodology of Economic Analysis

The economic viability of a capital investment project is analyzed on the basis of discounted cash flow method. In this method, net cash flows (project benefits minus project costs) from the project of each year are converted into present values by a certain discount rate. These present values of net cash flows are summed up for the entire evaluation period. A discount rate, which makes the total present values zero, in other words, which makes present value of economic benefit equals present value of economic cost, is called Economic Internal Rate of Return (EIRR). In terms of economic analysis, the discount rate is theoretically the opportunity cost of capital of the country. In this project, 12% is set as the opportunity cost of capital. In Lao PDR, 10% and 12% are often used as the opportunity cost of capital. In order provide a conservative analysis of the results, the higher standard is used for this project. When the calculated EIRR is more than the opportunity cost of capital (12%), it suggests that the economic profitability of the project is higher than national standard opportunity cost of capital. Therefore, the project is said to be economically viable.

(2) Assumptions for Economic Analysis

Regarding the economic analysis, followings are the major conditions and assumptions for this study.

Table 10.1.3 Major Conditions and Assumptions of Economic Analysis

1	Project life	2020 – 2049 (30 years)
2	Evaluation period	2015 – 2049
3	Price level	Year 2014
4	Exchange rate	0.0149 JPY per 1.00 LAK and 120.4 JPY per US$1.00
5	Opportunity cost of capital	12 % per annum
6	Standard Conversion Factor	0.95*

Note: *; Several JICA projects in Lao PDR uses the Standard Conversion Factor (SCF) at 0.9 or 0.95. In this survey, higher SCF (0.95) is utilized to provide conservative results of the Economic Analysis. For reference, SCF at 0.9 is used at the project, *"The Master Plan Study on the Development of the New CNS/ATM Systems in Cambidia, Lao PDR, and Vietnam, JICA"*. SCF at 0.95 is used at the project, *"Preparatory Survey on Nam Ngum 1 Hydropower Station Expansion in Lao PDR, JICA"*.

Source: JST

(3) Economic Analysis

1) Conversion from Financial Value to Economic Value

At first, project cost and benefit of the project are identified and quantified in monetary terms all through the evaluation period. The total cost is enumerated in terms of market price, or in other words, 'financial value'. For the purpose of economic evaluation, this financial value must be converted into economic value, since economic evaluation is conducted to see the relationship between benefit and cost from the view point of national economy. Following points were considered, in order to convert the financial cost into economic cost.

- Exclusion of transfer payment: tax, interest, subsidy are considered as the transfer payment from/to the government, and not as the true consumption of the resources for the project.
- Adjustment of the exchange rate distortion: avoid the price distortion of the foreign exchange rate of the country, which are originated from the import tax, export duty, export subsidy, etc.

In this analysis, international price level is applied to the whole items of cost. As a result, the total cost in economic value is expressed in foreign currency (Japanese Yen). Prices of local goods/materials must be adjusted to avoid the exchange rate distortion through multiplying the Standard Conversion Factor (SCF). In case of this survey, SCF is set at 0.95 as was mentioned in the previous section.

2) Economic Benefits of the Project

Table 10.1.4 shows the economic benefits of the water supply project. The benefits of the project are divided into two categories, quantifiable / tangible benefits and unquantifiable / intangible benefits. Economic evaluation includes all the quantifiable benefits as economic benefits of the project. In this study, No. 2-1 and 2-2 of the Table 10.1.4 are selected as quantifiable benefits.

Table 10.1.4 Economic Benefits of the Water Supply Project

No.	Effect	No.	Concrete Effects	Tangible/ Intangible
1	Improvement of amenity	1-1	Improvement of quality of life of domestic customers	Intangible
2	Cost reduction effects	2-1	Saving of alternative water procurement cost other than public water supply	**Tangible**
		2-2	Saving of incurred costs by public water supply stoppage	**Tangible**
3	Improvement of public hygiene	3-1	Saving of medical expenditure by decrease of water borne diseases	Intangible
		3-2	Increase of working days by decrease of waterborne diseases	Intangible
4	Economy stimulation effects	4-1	Stimulation of regional economy by project investment	Intangible
5	Environment preservation effects	5-1	Preservation of underground water source by constraining increase of wells	Intangible

Source: JST

Tangible economic benefits are explained below in more detail.

Cost reduction effect

- Saving of alternative water procurement cost other than public water supply

  According to the result of "Survey on Socio-Economic (Interview survey)" conducted during this survey, 42% of the sample household uses open well or deep well in addition to bottle water and water vender (20 liter plastic tank). Without the Project, water demand volume over the present water supply capacity will be satisfied by alternative water sources other than public water supply, such as ground water. However, with the project, water supply facilities will be established to satisfy the water demand volume in target water supply areas. In other words, alternative water procurement costs including construction and O&M costs for well and pumps etc., are saved with the project. Benefits by saving the alternative water acquisition cost are estimated as follows (refer to **SUPPORTING REPORT, A.17** for details);

Year	Water supply volume (m^3/day)		Unit cost of alternative water (LAK/m^3)		Total Benefit by saving alternative water cost (mil. JPY/year)		
	Domestic	Non-domestic	Domestic	Non-dom.	Domestic	Non-dom.	Total
2025	71,964	31,315	7,726	3,216	3,023.77	547.71	3,571.48
2030	75,235	32,738			3,161.21	572.59	3,733.80
2035	50,157	21,826			2,107.49	381.74	2,489.23

- Saving of incurred costs by public water supply stoppage

  Without the project, same as the present situation, about 26% of households and 62% of commercials (Survey on Socio-Economic (Interview Survey)) are reserving water in their houses by installing water tanks for water supply stoppage, since the water supply volume is insufficient.

  With the project, water supply capacity becomes more than water demand. Thus, public water will be continuously supplied, and it is imagined that some of the public water users will not install the water tank (or, not replace their current tank in the future).

  Saving of procurement and O&M costs of water tank is one of the economic benefits of water supply project. Benefits of saving water tank costs are estimated as follows;

Year	No. of water tank to be saved	Annual cost of water tank (LAK/year)	Total Benefit of saving water tanks	
			(mil. LAK/year)	(mil. JPY/year)
2025	6,372	228,527	1,456.174	21.70
2030	6,662		1,522.447	22.68
2035	4,441		1,014.888	15.12

  Total economic benefits of the Project are summarized as follows;

Table 10.1.5 Total economic benefits of the Project

	Phase 1 only								
	Year	Water supply by the project			Benefit (million JPY)				
		Domestic (m^3/day)	Non domestic (m^3/day)	Total (m^3/day)	Alternative water supply			Saving water tank cost	Grand Total
					Domestic	Non domestic	Total		
-4	2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-3	2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-2	2017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-1	2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0	2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	2020*1	50,308	21,892	72,200	176.15	31.91	208.06	1.26	209.32
2	2021	54,639	23,776	78,415	2,295.81	415.85	2,711.66	16.47	2,728.13
3	2022	58,971	25,661	84,632	2,477.83	448.82	2,926.65	17.78	2,944.43
4	2023	63,302	27,546	90,848	2,659.81	481.79	3,141.60	19.09	3,160.69
5	2024	67,633	29,430	97,063	2,841.79	514.74	3,356.53	20.39	3,376.92
6	2025	71,964	31,315	103,279	3,023.77	547.71	3,571.48	21.70	3,593.18
7	2026	72,595	31,589	104,184	3,050.29	552.50	3,602.79	21.89	3,624.68
8	2027	73,238	31,869	105,107	3,077.30	557.40	3,634.70	22.08	3,656.78
9	2028	73,892	32,154	106,046	3,104.78	562.38	3,667.16	22.28	3,689.44
10	2029	74,557	32,443	107,000	3,132.72	567.44	3,700.16	22.48	3,722.64
11	2030	75,235	32,738	107,973	3,161.21	572.59	3,733.80	22.68	3,756.48
12	2031	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
13	2032	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
14	2033	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
15	2034	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
16	2035	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
17	2036	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
18	2037	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
19	2038	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
20	2039	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
21	2040	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
22	2041	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
23	2042	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
24	2043	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
25	2044	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
26	2045	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
27	2046	50,157	21,826	71,983	2,107.49	381.74	2,489.23	15.12	2,504.35
28	2047	25,078	10,913	35,991	1,053.72	190.87	1,244.59	15.12	1,259.71
29	2048	25,078	10,913	35,991	1,053.72	190.87	1,244.59	15.12	1,259.71
30	2049	25,078	10,913	35,991	1,053.72	190.87	1,244.59	15.12	1,259.71

Note: *1; Water supply volume of the year 2020 is assumed for 1 month.

3) Economic Costs of Water Supply Project

Construction cost covers all of the related costs to procurement, construction and consulting services for the Project. Methodology of conversion from financial cost to economic cost is mentioned in "10.1.2 Economic Analysis, (3) Economic Analysis, 1) Conversion from Financial Value to Economic Value."

Residual values of replaced equipment are not deducted from the cost in the last evaluated year, since the values are negligible. Price escalation and interest during construction were also excluded from economic costs, as inflation was also not reflected on the economic benefit.

(4) Results of Economic Analysis

Results of economic analysis of this Project are shown as follows.

	Economic Internal Rate of Return (EIRR)	NPV	B/C
Water Supply Project	**27.30%**	**6,707 million JPY**	**2.15**

Note: NPV and B/C are computed using the 12% opportunity cost of capital as discount rate.

Computed EIRR is over the opportunity cost of capital (12%), therefore, this Project is economically viable.

Table 10.1.6 Cost Benefit Stream in Economic Value for Water Supply Project Phase 1 only

(Unit: million JPY)

	Year	Cost				Benefit	Balance
		Const-ruction	Replace-ment	O&M	Total	Total	
-4	2015	0.00	0.00	0.00	0.00	0.00	0.00
-3	2016	154.06	0.00	0.00	154.06	0.00	-154.06
-2	2017	262.26	0.00	0.00	262.26	0.00	-262.26
-1	2018	1,418.57	0.00	0.00	1,418.57	0.00	-1,418.57
0	2019	3,255.34	0.00	0.00	3,255.34	0.00	-3,255.34
1	2020	3,106.17	0.00	16.12	3,122.29	209.32	-2,912.97
2	2021	413.35	0.00	207.09	620.44	2,728.13	2,107.69
3	2022	0.00	0.00	218.41	218.41	2,944.43	2,726.02
4	2023	0.00	0.00	229.88	229.88	3,160.69	2,930.81
5	2024	0.00	0.00	241.20	241.20	3,376.92	3,135.72
6	2025	0.00	0.00	252.53	252.53	3,593.18	3,340.65
7	2026	0.00	0.00	252.53	252.53	3,624.68	3,372.15
8	2027	0.00	0.00	252.53	252.53	3,656.78	3,404.25
9	2028	0.00	0.00	252.53	252.53	3,689.44	3,436.91
10	2029	0.00	0.00	252.53	252.53	3,722.64	3,470.11
11	2030	0.00	0.00	252.53	252.53	3,756.48	3,503.95
12	2031	0.00	6.20	168.35	174.55	2,504.35	2,329.80
13	2032	0.00	6.20	168.35	174.55	2,504.35	2,329.80
14	2033	0.00	6.20	168.35	174.55	2,504.35	2,329.80
15	2034	0.00	6.20	168.35	174.55	2,504.35	2,329.80
16	2035	0.00	832.20	168.35	1,000.55	2,504.35	1,503.80
17	2036	0.00	6.20	168.35	174.55	2,504.35	2,329.80
18	2037	0.00	6.20	168.35	174.55	2,504.35	2,329.80
19	2038	0.00	6.20	168.35	174.55	2,504.35	2,329.80
20	2039	0.00	6.20	168.35	174.55	2,504.35	2,329.80
21	2040	0.00	832.20	168.35	1,000.55	2,504.35	1,503.80
22	2041	0.00	6.20	168.35	174.55	2,504.35	2,329.80
23	2042	0.00	6.20	168.35	174.55	2,504.35	2,329.80
24	2043	0.00	6.20	168.35	174.55	2,504.35	2,329.80
25	2044	0.00	6.20	168.35	174.55	2,504.35	2,329.80
26	2045	0.00	6.20	168.35	174.55	2,504.35	2,329.80
27	2046	0.00	6.20	168.35	174.55	2,504.35	2,329.80
28	2047	0.00	6.20	84.17	90.37	1,259.71	1,169.34
29	2048	0.00	6.20	84.17	90.37	1,259.71	1,169.34
30	2049	0.00	6.20	84.17	90.37	1,259.71	1,169.34
	EIRR:	27.30%	NPV:	6,707	million JPY	B/C:	2.15

Source: JST

10.1.3 Financial Plan

In this section, financial plan for the entire NPNL including several on-going and future investment plans is prepared, in order to check whether NPNL can be financially sustainable or not by implementing this project and the other projects.

Financial plan of this survey is the future projection of income statement and cash flow statement for the next 30 years. Outputs of the financial plan are net profit / loss and positive or negative cash flow (and accumulated cash flow) of each year for the projected period. It is generally understood that annual profit / loss amount is different from the cash amount since depreciation cost, for instance, is one of the cost items of income statement though it is not an actual cash outflow. Annual net loss is not always a serious financial problem but negative accumulated cash flow is a serious problem to be avoided.

(1) Assumptions of Financial Plan

Important assumptions for preparing the financial plan are as follows:

- ✓ Excluding inflation both for income and expenditures. Therefore, water tariff must be raised at the rate of inflation even if a tariff raise is not scheduled in the financial plan.
- ✓ Existing loan schedule (such as, ADB, JICA, AfD) between NPNL and MOF is supposed to be kept with the same conditions as of November 2014, which is mentioned in "*Loan Calculator ADB / JICA / AfD1 + AfD2, July 2010, NPNL*".
- ✓ For Dongmakkhay WTP construction project, loan condition between NPNL and MOF (as a sub-loan from Chinese EXIM Bank) was not decided yet as of November 2014. It is assumed that the condition is 30 years repayment period with 5 years grace period with the interest rate at 2%. Loan amount is assumed at 415 billion LAK, as shown in "*Draft for Review, Development of the NPNL financial plan, September 2014, GRET, supported by AfD*" (hereinafter referred to as "AfD financial plan").
- ✓ Water tariff is set, following the approved present and future tariff (Decision No.1130, dated 20 Oct, 2014) upto the year 2018. In case that it is necessary to implement additional tariff raise, it will be shown in the financial plan.
- ✓ NRW ratio is assumed at; 25% (year 2015), 20% (2020), 15% (2025), 10% (2030), and constant after that, following the assumptions of water demand projection of this survey.
- ✓ Water tariff collection efficiency is assumed at; 99.6% (year 2015), 99.9% (2020), and constant after that, considering the present ratio at 99.5% in 2013.
- ✓ NPNL will purchase treated water from Dongbang WTP, Thadeua WTP and Sendin WTP in the future. The price of purchasing treated water is assumed to be raised as follows, which is based on the conditions of purchasing treated water from Thadeua WTP.

Table 10.1.7 Unit Price Increase Assumption for Treated Water Purchase

Unit: LAK/m^3

Year	2016-18	2019-21	2022-25	2026-30	2031-35	2036-50
Unit price of treated water	1,750	2,500	3,000	3,600	4,300	4,500

Source: NPNL

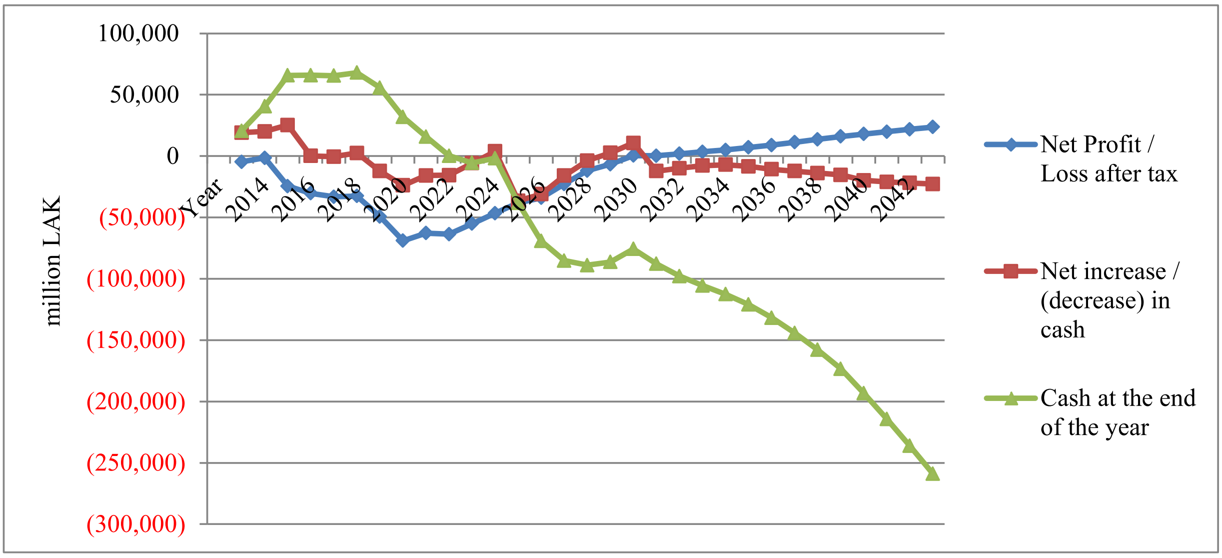
Note: The above unit price is assumed as current prices.

- ✓ The consultant employed by AfD is preparing the Master Plan for NPNL. Investment plan is formulated though the fund source is not decided yet. The amount and disbursement schedule is reflected according to the AfD financial plan. That is, a total amount at 841.632 billion LAK, with yearly disbursement at 68.442 billion LAK for 6 years from 2015 to 2020 and 43.098 billion LAK for 10 years from 2021 to 2030.
- ✓ Fund of the above Master Plan is assumed to be sourced from foreign aid with concessional interest rate and repayment period, considering the size of investment. It is assumed at 30 years repayment period with 10 years grace period with 2% interest rate.
- ✓ Costs for new office building construction, presently on-going, are also reflected in the financial plan.

(2) Results of Financial Plan

➢ Base Scenario (without additional tariff raise after 2019)

Figure 10.1.2 shows the results of financial plan with the above important assumptions (Details of financial plan is attached in **SUPPORTING REPORT, A.17 Financial Plan**);



Source: JST

Figure 10.1.2 Net Profit / Loss and Cash Flow Balance Projection for NPNL (Base Scenario)

Figure 10.1.2 is the simulation without additional water tariff raise after 2019. Until the year 2029, NPNL will make annual net loss because of depreciation cost and interest repayment for the past loans. Cash flow balance (Cash at the end of the year) will steadily decrease after the year 2019 and be negative after 2023, caused by large amount of loan principal repayments and investment expenses for Master Plan.

As shown in “10.1.1 Financial Analysis”, water tariff raise is not necessary for only this project to be financially feasible. On the other hand, NPNL has to implement necessary but non-profitable investment, such as, Master Plan; mainly composed of pipe extension, pipe and valve replacement, reinforcement, and storage, which will not directly generate additional revenue. Also, NPNL has certain amounts of loan principals and interests to be paid for the past projects. Therefore, NPNL, as a whole, requires additional water tariff raise before the cash balance will be wholly expended.

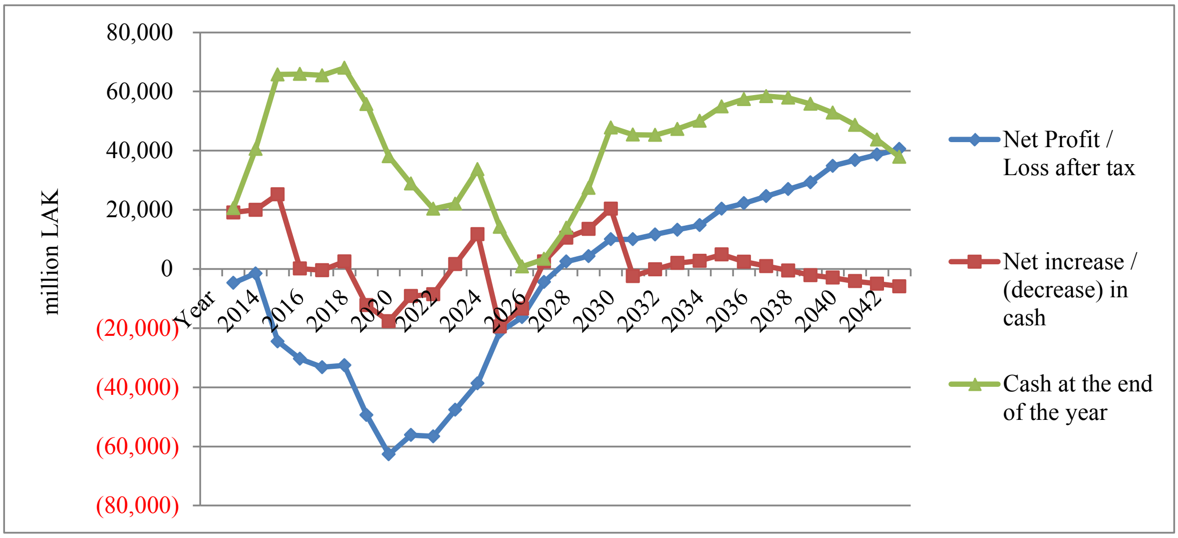
- 2nd Scenario (with 3.5% tariff raise once every 5 years)
  Figure 10.1.3 is the simulation with additional water tariff raise at 3.5% once every 5 years starting from 2020. In other words, tariff raises at 3.5% are scheduled in the year 2020, 2025, 2030, 2035, and 2040.

Table 10.1.8 Additional Water Tariff Increase

Year	2020	2025	2030	2035	2040
Water tariff increase both for domestic and non-domestic	3.5%	3.5%	3.5%	3.5%	3.5%

Source: JST

Note: The above unit price excludes inflation adjustment.



Source: JST

Figure 10.1.3 Net Profit / Loss and Cash Flow Balance Projection for NPNL (2nd Scenario)

In 2nd Scenario, 3.5% tariff raise over inflation adjustment is scheduled once every 5 years, NPNL will have positive cash flow balance through all 30 years. It is observed that annual net profits are higher than those in base Scenario and that net decrease in cash is also smaller in 2nd Scenario. In 2nd scenario, NPNL is able to repay all of the loan principals and interests with annual net profit and provision for depreciation with conducting the Master Plan.

It should be noted that above mentioned 3.5% tariff raise every 5 years is the constant prices (real term) excluding price escalation. In reality, NPNL must plan its tariff raise with considering the inflation adjustment. For example, if the inflation rate for material, electricity, chemical, and so on, is at 6%, NPNL is required to plan 6% tariff raise every year, or 19% raise once in every 3 years. The above mentioned 3.5% tariff raise once every 5 years is purely additional to this inflation adjustment.

(3) Findings from Financial Plan

- Implementation of Master Plan
  Implementation of Master Plan by AfD is necessary for pipe reinforcement and extension and replacement. Nevertheless, it does not directly generate the revenue for NPNL and would be some burden on the NPNL. Therefore, it is recommended that NPNL implements the Master Plan not at once but with a stage wise strategy, focusing on specific components or distribution zones. Then, it should be extended to other components or zones after checking the financial condition of NPNL. It is also recommended that the source of fund for Master Plan should be loan with longer repayment period with grace period and concessional (lower) interest rate, such as foreign aid. The use of loan as fund source makes it possible for NPNL to share cost burden of the project to wider generations of the customers, such as the duration of the installed pipelines, and so on.

- Bulk Water Unit Price
  Bulk water unit price is one of the most influential factors for NPNL's financial plan. Purchasing treated water from another company will allow it to save the initial construction costs and O&M and replacement cost for a contract period. However, the higher bulk water price will reduce the profitability of NPNL and will raise the necessity of water tariff increase on customers of NPNL. It should be noted that NPNL shall be careful about the unit price raise for treated water purchase.

- Burden on NPNL by Loan Principal Repayment

From now on, NPNL is planned to increase the loan amount from MOF. These loans with interests must be repaid as scheduled by utilizing the amount accumulated from annual profits. This financial plan is prepared based on the assumptions of conditions for several loans (Dongmakkhay, Chinaimo expansion, Master Plan, and so on), since the precise conditions of them are not decided yet. It is necessary for NPNL to prepare the precise future loan repayment schedule to understand the necessary amount of fund to repay them.

10.1.4 Analysis of Impact on Water Tariff Rate by the Project

The purpose of this section is to check whether expected water tariff raise by this project is payable by household, especially low income households.

(1) Necessity of NPNL's Water Tariff Raise

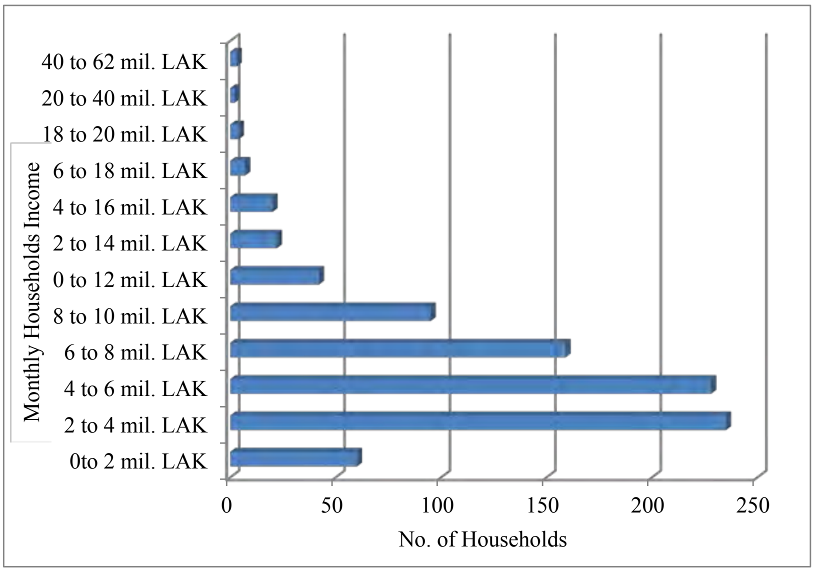
Results of financial analysis for this project are described in "10.1.1 Financial Analysis". Based on the financial analysis, tariff raise is not necessary for this project to be financially feasible in addition to the approved series of tariff raises up to 2018. On the other hand, financial plan described in "10.1.3 Financial Plan" has a result that NPNL should conduct the water tariff raise at 3.5% once every 5 years over the inflation adjustment from 2020 to 2040, in order to achieve positive cash flow balance for the next 30 years.

(2) Affordability to Pay of Low Income Households

Survey on social condition (Interview Survey) conducted for this survey has obtained the household income data for about 900 samples around the Vientiane Capital.

Figure 10.1.4 shows sample household number for each income level, which indicates the width of income such as 40 to 62 mil. LAK. Most household are categorized into income level 2 to 4 million LAK/month. Second most is income level of 4 to 6 million LAK/month.

In this section, 10% households with lowest income in Survey on social condition (Interview Survey) are considered as 'low income households' in Vientiane Capital. Average monthly income of low income households (10%) is calculated at 1,853,920 LAK/month per household, less than one third with compare to the average monthly income for all sample (6,302,383 LAK/month).

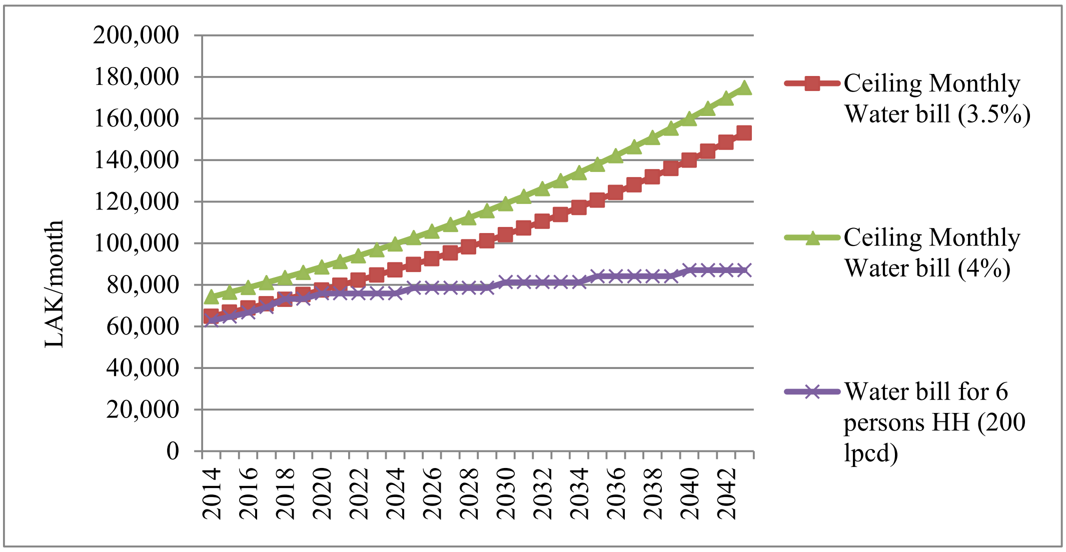


Source: Socio-economic Survey (Interview Survey)

Figure 10.1.4 No. of Sample Households for Each Income Level

Regarding the household affordability to pay for water supply service, two international organizations estimated the upper limit shares for water charges among household income. The IBRD (International Bank for Reconstruction and Development) estimates the limit for household affordability to pay as 4% of household income for the water supply. The Pan American Health Organization also recommends that the total water supply and sewerage charge should be less than 5% of the household income, consisting of 3.5% for water supply and 1.5% for sewerage.

On the other hand, per capita GDP in real term has grown at 5.9% on average from 2005 to 2013. If it is assumed that average income for low income household will increase at about 3% on average in the future, the ceiling of water bill calculated from average income and typical water bill for low income household are estimated as follows;



Source: JST

Figure 10.1.5 Projection of the Ceiling Monthly Water Bill and Typical Water Bill for Low Income Household (with 3% income growth)

The purple line shows the water bill increase for a six (6) person household with 3.5% tariff increase once every 5 years. Green and red lines are ceiling monthly water bills as 3.5% and 4% of average income of low income household with 3% annual income growth. For 30 years, purple line is always under the green and red lines.

For calculating the water bill of the Figure 10.1.5, the average size of a low income household is assumed as six (6) persons per household, which is slightly more than the actual average size (5.21 persons, Socio-economic survey). However, per capita water consumption of them is kept lower than standard water consumption volume (245 lpcd).

It is considered that the planned tariff raise (3.5% every 5 years after 2020) is payable or under the ceiling of affordable water bill amount even for low income household by considering the future modest income growth.

10.2 Selection and Calculation of Operation and Effect Indicators

10.2.1 Selection of Operation and Effect Indicators for Project

It will be important to implement performance measurement to monitor the impact of the project and to ensure that it is performing as originally intended. The following indicators are proposed as the impact by Phase1 of the project.

- population served from Chinaimo WTP
- amount of water supplied from Chinaimo WTP
- rate of facility utilization in Chinaimo WTP

The selected indicators are standard when assessing the operation and effectiveness of water supply services. Also, the data required to inform these indicators is easily collected. The indicators are explained further in Table 10.2.1

Table 10.2.1 Operational and Effectiveness Indicators

No.	Parameters	Impact being assessed
1.	Population Served from Chinaimo WTP* (person)	Improvement of water supply service level
2.	Amount of Water Supply from Chinaimo WTP (m^3/day)	Improvement of water supply service level
3.	Rate of Facility Utilization in Chinaimo WTP (%)	Improvement of effective operational level of treatment plant

It should be noted that the parameters marked with an asterix (*) may be affected by the performance of NPNL that have responsibility for water supply service connections after expansion of Chinaimo WTP.

10.2.2 Acquisition of the Data

Acquisition of the data required to calculate the indicators will be readily available, as the data can be collected during routine works and operation of water supply system as shown in Table 10.2.2.

Table 10.2.2 Acquisition of the Data

No.	Parameters	Frequency	Procedure
1.	Population Served from Chinaimo WTP* (person)	Yearly	House connection numbers with identifying the water supply area from Chinaimo WTP and counting water bill number or water meter number. Multiply “house connection number” by “average family size”
2.	Amount of Water Supply from Chinaimo WTP (m^3/day)	Daily	Flow meter readings at outlets of Chinaimo WTP.
3.	Rate of Facility Utilization in Chinaimo WTP (%)	Daily	Flow meter readings at outlets of Chinaimo WTP. Divide “average treated water amount” by “design capacity of 120,000m^3/day”.

10.2.3 Quantitative Effects

Quantitative effects, measured by the proposed indicators, are determined according to the nature of the project and are presented in Table 10.2.3. In this Phase 1 project, the target year is assumed set in 2023, which is 2 years after completion of the project.

Table 10.2.3 Quantitative Effect for Indicators by Chinaimo Expansion

No.	Parameters	Present (2013)	Target Year (2023)
1.	Population Served from Chinaimo WTP* (person)	230,000	295,000
2.	Amount of Water Supply from Chinaimo WTP as Day Average (m^3/day)	93,272	103,800 (114,200 as Day Max.)
3.	Rate of Facility Utilization in Chinaimo WTP (%)	116.6%	86.5 % (95.2% as Day Max.)

* marked with an asterix (*) may be affected by the performance of NPNL that have responsibility for water supply distribution pipes, service pipes, and house connections after expansion of Chinaimo WTP.

As reference, Table 10.2.4 shows quantitative effects for the urban water supply area in Vientiane Capital.

Table 10.2.4 Quantitative Effect for Indicators in Urban Water Supply Area of Vientiane Capital

No.	Parameters	Present (2013)	Target Year (2023)
1.	Population Served in Urban Area* (person)	489,175	760,840
2.	Amount of Water Supply in Urban Area as Day Average (m^3/day)	199,619	316,665
3.	Rate of Population Served* (%)	72%	94 %

* marked with an asterix (*) may be affected by the performance of NPNL that have responsibility for water supply distribution pipes, service pipes, and house connections, and performances of WTPs supplying to urban area other than Chinaimo WTP.

Basis of numbers for the above quantities effects (indicators) are shown in SUPPORTING REPORT, A18 also.

10.2.4 Qualitative Effects

In addition to the above, the following qualitative effects are expected by the project.

1. The project will enable to the stable water supply, aiming at 24-hour continuous supply.
2. The project will contribute to improvement of public hygiene conditions.

Chapter 11 PROJECT EVALUATION AND RECOMMENDATIONS

In this Chapter, matters for the Phase 1 project are evaluated and recommended. For the Phase 2 project, its F/S and evaluation should be carried out later on and timely before the implementation of the Phase 2 project, with reviewing this survey report based on future some changes on water supply circumstance in Vientiane Capital, other project situation, other donor's movement, law and regulation relevant to water supply development.

11.1 Evaluation

For the reasons outlined below, the proposed Phase 1 project can be assessed as feasible.

Throughout the planning process of the water supply system improvement works for the Phase 1 project, continuous attention was paid by the JICA Survey Team to ensure that any improvement works to be proposed can be implemented, operated and maintained within the level of technical skills and engineering capacity currently and future available in Vientiane Capital and in Laos PDR. It is therefore expected that the Phase 1 project can be implemented within the time frame envisaged, and that the project, once it has been implemented, can be managed on a sustainable basis.

Phase 1 projects, Chinaimo WTP expansion with a capacity of 40,000m^3/day, will increase the supply capacity of the NPNL's water supply system from the present 180,000 m^3/day to 360,000 m^3/day including three (3) other undergoing projects which are: Dongmakkhay WTP expansion with a capacity of 100,000m^3/day, Thadeua WTP BOT Project with a capacity of 20,000m^3/day, and Sendin BOT Project with a capacity of 20,000m^3/day. This drastic increase in supply capacity is expected to alleviate the chronic water shortage situation in Vientiane Capital. Additional transmission and distribution pipelines also will be installed under the Phase 1 project so as to distribute additional treated water from the expanded Chinaimo Treatment Plant.

Details of economic and financial evaluation are described in "10.1 Calculation of the Project's Economic Internal Rate of Return (EIRR) and Financial Internal Rate of Return (FIRR)." The results of the analysis are to show financial feasibility and economic viability of the project without any tariff increases in addition to those which have already scheduled by NPNL up to 2018.

Table 11.1.1 Results of Financial and Economic Analysis of the Project

Types of Analysis	Value of Indicator	Evaluation of the Value	Results
Financial Analysis	FIRR: 9.29%	More than discount rate: 4%	The Project is financially feasible
Economic Analysis	EIRR: 27.30%	More than discount rate: 12%	The Project is economically viable

Source: JST

It can be said that this project is highly recommended to implement in the aspects of financial and economic points of view.

In order to evaluate the Project's feasibility from the environmental and social points of view, the IEE was conducted in examining available data, hearing from stakeholders and carrying out site reconnaissance. According to the result of the IEE, it is concluded that no significant negative impact was predicted. As for the selection of the project locations, design efforts were made to avoid any land acquisition or resettlement. Consequently, there will be no land acquisition or resettlement incurred because the proposed new facilities will be either constructed within the existing facilities owned by NPNL or installed under public roads. The main negative impacts include temporary and site specific pollution such as air pollution, water pollution, waste generation, noise and vibration due to construction activities in the construction phase. The impacts could be avoided or minimized by applying countermeasures proposed in the IEE report as an Environmental and Social Management and Monitoring Plan (ESMMP).

11.2 Recommendations

(1) Coordination with the Existing Plan Relevant to Water Supply Sector

Final Report of WSM/P 2014 was prepared by NPNL in September 2014 with support from AfD. Also, NPNL Long Term Plan (2014-2020) was prepared with the assistance of JICA technical cooperation project. These report and plan should be updated by NPNL considering the contents of this final report for the preparatory survey.

(2) Future Chlorine Agent

In the preparatory survey, the use of chlorine gas as disinfection method, instead of the current use of bleaching powder, was proposed in Chinaimo WTP after expansion. In respect to this proposal, the Lao PDR reached a consensus to use chlorine gas as disinfection method in Chinaimo WTP, on the condition that a bleaching powder feeding facility is also provided for emergency use due to shortage of chlorine gas supply. This matter, however, should be also discussed again in the future stage.

(3) Coordination with Ministry of Defense for the Land neighboring Chinaimo WTP

During the construction of new water treatment facilities, it will be necessary to use some land that belongs to a military school located on the east side of the existing Chinaimo WTP. Acquisition of military school land on the south side of the existing Chinaimo WTP is also proposed for the construction of the new chemical building near the injection point for efficient operation and maintenance.

(4) Future Sludge Treatment

Currently, there is no regulation about sludge disposal to the Mekong River. In the Phase 1 project, sludge generated from Chinaimo WTP will be disposed to the Mekong River without sludge treatment facilities, as well as other WTPs. Policy on sludge treatment for the future may be, however, suggested when Phase 2 starts if the circumstance is changed. When the sludge treatment facility is required in the future, the southern part of the land of Chinaimo WTP which belongs to military school is recommended for its best location.

(5) Reduction of NRW

Water supply conditions will be improved by the implementation of not only Chinaimo expansion project, but also Donmakkhay WTP expansion project. Increased pressure in the distribution system will secure a stable and continuous supply to the whole service area. Therefore, as a side effect, water leakage will increase after completion of the those projects. It is strongly recommended that the NPNL concentrate fully on reinforcing the existing pipeline networks and reducing the leakages upon completion the projects. Assistance from AfD, JICA, or other organizations will be of great help for the future of NPNL's NRW reduction activities.

(6) Recruiting and Training of Additional Staff

Additional staff for the expanded Chinaimo WTP and the expanded pipeline system will be required. It is necessary to recruit additional staff and provide training for them.

(7) Review of the Master Plan and Implementation of Feasibility Study for Phase 2

Upon completion of the Phase 1 Project, a feasibility study will be required for the Phase 2 project for its successful implementation. At the same time, a review of the existing master plan at that time will also be required. The master plan is the long term plan, and the Vientiane Capital water supply situation will change because of unforeseen factors. Therefore, the master plan should be reviewed at every turning point during the progress of the water supply development.

After completion of the Phase 1 project, a feasibility study will be required to implement the Phase 2. During the feasibility study for the Phase 2, the scale of the Phase 2 will be reviewed. If the maximum water demand varies (increased or decreased) by any change on the amount of water consumption or NRW, and is much greater or less than that estimated by this survey, the plan of the Phase 2 should be reviewed, and the investment for the project will be adjusted. Such modifications of scale to the Phase 2 project should be examined during the feasibility study for the Phase 2 project.

(8) Environmental Requirement

Before construction, information on construction schedule shall be disseminated in each construction site. The monitoring plan in an operation phase shall be finalized at the end of construction phase in line with the latest legislation requirement and situation.

(9) Installation of Distribution, Service Pipes, and House Connections

This project is intended to contribute to the improvement of 90-95% of water supply coverage ratio in urban areas of the Capital Vientiane by 2020. For this achievement, it is significant to improve distribution network. The GOL is required to implement constantly installation of distribution and lateral pipelines, and house connections with service pipes during and after this project. It is important that NPNL or the GOL reliably perform a budget allocation based on the long-term plan up to 2020 or more.

(10) Response to Climate Change

In recent years, the central and southern parts of the Lao PDR are facing problems, such as floods in rainy season and decrease in water level of the Mekong River in dry season. In the detailed design stage, with obtaining data concerning flood/inundation records and changes in the Mekong River water level around the construction site of this project, appropriate measures should be considered in the facility design if there is future possibility of any prospective effect on the facility to be constructed by this project.

In general, possible effect to global warming in water supply sector is thought of as emission of carbon dioxide (CO^2) from thermal power plant caused by energy consumption by using various pumps such as transmission, distribution, and back wash pumps. In Vientiane Capital, it is considered there is no adverse effect to global warming in this project, since hydraulic power plants that do not emit CO^2 are applied for the power supply to the city. However, low-emission and energy-saving pumps are, of course, preferred from the low running costs and environmental aspects.

Attachment

Attachment 1 Minutes of Meetings on the Preparatory Survey on Vientiane Capital Water Supply Expansion Project in the Lao People's Democratic Republic on February 21, 2014.

THE MINUTES OF MEETINGS
ON
THE PREPARATORY SURVEY
ON
VIENTIANE CAPITAL WATER SUPPLY EXPANSION PROJECT
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
AGREED UPON BETWEEN
MINISTRY OF PUBLIC WORKS AND TRANSPORT
AND
DEPARTMENT OF PUBLIC WORKS AND TRANSPORT OF
VIENTIANE CAPITAL
AND
VIENTIANE CAPITAL WATER SUPPLY STATE ENTERPRISE
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

Vientiane Capital, February 21, 2014

Based on a series of discussions between the Government of Lao People's Democratic Republic (hereinafter referred to as " Lao PDR") and Japan International Cooperation Agency (hereinafter referred to as "JICA") concerning the project formulation for expanding water supply capacity in Vientiane Capital, JICA dispatched a mission to Lao PDR from 17 to 21 February, 2014 to identify the necessity, develop its scope, and confirm the implementation arrangements of the Preparatory Survey of the Vientiane Capital Water Supply Expansion Project (hereinafter referred to as "the Project").

The main points discussed during its visit are described in the Annex 1. The scope and implementing arrangements of the Preparatory Survey are described in the Annex 2.

It should be noted that the implementation of the Preparatory Survey does not imply any decision or commitment by JICA to extend its loan for the Project at this stage.

Annex 1: Main Points Discussed

Annex 2: Scope and Implementing Arrangements of the Preparatory Survey

Khamthavy THAIPHACHANH
Director General,
Department of Housing and Urban Planning,
Ministry of Public Works and Transport

Detsongkham THAMMAVONG
Director General,
Department of Public Works and Transport,
Vientiane Capital

Khampheuy VONGSAKHAMPHOUI
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浅岡 祥吾

Asaoka Shogo
Water Supply Specialist,
Water Resources Management Division 1,
Global Environment Department,
JICA

MAIN POINTS DISCUSSED

1. Target Year

The target year of the Project is 2030. Water supply demand and capacity of facilities will be calculated by the target year. The target year will be finally confirmed during the Preparatory Survey.

2. Counterpart Agency

Department of Housing and Urban Planning (DHUP) of Ministry of Public Works and Transport (MPWT) would be the Coordinating and Supervising Agency. Department of Public Works and Transport (DPWT) of Vientiane Capital and Vientiane Capital Water Supply State Enterprise (NPNL) would be the Counterpart Agency. The Executing Agency of the Project will be decided before the appraisal of the Project.

3. Scope of Works

The construction of the new water treatment plant(s) and the sites examined in the Preparatory Survey will be decided before commencement of the Survey.

4. Implementation Schedule

Currently implementation schedule is estimated for around 6 months (in case of treating Chinaimo water treatment plant expansion). However, if a new water treatment plant(s) is added in the Preparatory Survey, the schedule may be subject to change.

(END)

Annex 2

SCOPE AND IMPLEMENTATION ARRANGEMENTS OF THE PREPARATORY SURVEY

I. BACKGROUND OF THE PREPARATORY SURVEY

Lao PDR has achieved around 8% of economic growth in these days. Accordingly, the urban population in Lao PDR has been increased. Population of Vientiane Capital which was only 600,000 in 2000 has reached 790,000 in 2010, and is estimated to exceed 1,000,000 by 2020. Although the number of population has been increased, the living environment for residents in Vientiane Capital is still not satisfactory. Under such circumstances, it is urgently necessary to improve infrastructure for better living in Vientiane Capital.

Lao PDR set the target of 65 % coverage of piped water supply for urban population and 80% coverage of access to safety water for all population by 2015 in the 7th National Socio-economic Development Plan (NSEDP) 2011 - 2015. Additionally, "Strategic Poverty Reduction Planning in Vientiane" states that 80% of citizen in urban areas in Vientiane Capital would access safe water by 2020 and 100% by 2030. In reality, there is still a long way to achieve these targets.

There are 9 districts in Vientiane Capital and piped water is supplied to only 7 districts with water supply coverage ratio of 71%. Although current water supply capacity in urban area of Vientiane Capital is 180,000 m^3 /day as total, water demand would reach 400,000 m^3/day in 2030 due to rapid population growth. Therefore, insufficient water supply capacity becomes a very serious issue in Vientiane Capital in these days.

Japan has long cooperation history for water supply sector in Vientiane Capital, nearly 50 years. Japan provided several grant-aid projects in order for constructing, rehabilitating, and expanding capacity of Chinaimo and Kaoleio Water Treatment Plants and related facilities. In addition to hard infrastructure, Japan has provided assistance in capacity development for Vientiane Capital Water Supply State Enterprise (NPNL) for years through implementing technical cooperation projects, dispatching experts /volunteers and providing trainings.

In August 2013, the Director General of the Department of Housing and Urban Planning (DHUP) in Ministry of Public Works and Transport (MPWT) requested JICA to support for an expansion of capacity of Chinaimo Water Treatment Plant. In order to verify the feasibility of the project, JICA considered implementing the Preparatory Survey. In order to clarify the scope of works of the Preparatory Survey, JICA dispatched a TOR (Terms of Reference) mission to Lao PDR from February 17 to 21, 2014.

II. OBJECTIVES OF THE PROJECT

The objectives of the Project is to increase water supply capacity in Vientiane Capital by constructing facilities (intake facilities, water treatment plant, transmission pipelines, reservoirs, and distribution networks) thereby contributing to the accomplishment of Vientiane Capital Master Plan for 2030 and the improvement of the living environment of residents in Vientiane Capital.

III. SCOPE OF THE POJECT

The Project covers the expansion (or construction) of a water treatment plant(s) and pumping stations, laying new transmission and distribution pipelines and its connection to service pipes. The scope will consist of the following components:

(1) Expansion of Chinaimo Water Treatment Plant
- Construction of Intake Facilities
- Expansion of Chinaimo Water Treatment Plant
- Expansion of a Transmission Pumping Station in Chinaimo Water Treatment Plant

(2) Construction of a New Water Treatment Plant(s)
- Construction of Intake Facilities
- Construction of a New Water Treatment Plant(s)
- Construction of a Transmission Pumping Station(s) in New Water Treatment Plant(s)

(3) Construction or Rehabilitation of Transmission and Distribution Facilities
- Transmission Pipelines
- Distribution Reservoirs
- Distribution Pumping Stations
- Distribution Pipelines
- Service Connections

(4) Consulting Services
- Detailed Design
- Tender Assistance
- Construction Supervision
- Environment and Social Considerations
-Another contents, if necessary

The scope may be subject to adjust during the course of the Preparatory Survey and the appraisal of the Project. The construction of the new water treatment plant(s) and the sites examined in the Preparatory Survey will be decided before commencement of the Survey.

IV. PROVISIONAL TERMS OF REFERENCE FOR THE PREPARATORY SURVEY TEAM

The provisional Terms of References (TOR) of the Preparatory Survey are listed as follows. The contents may be subject to change during the preparation and the course of the Preparatory Survey.

1. Review of Existing Studies and Implementation of Additional Studies

1-1 Collection and analysis of present conditions to confirm the background of the Project through existing data, information and field survey in Lao PDR

1) Natural conditions (meteorology, topography, hydrology, hydro-geology, etc.)
2) Socio-economic conditions and trends (population, industries, land use, social infrastructure, economic conditions, etc.)
3) Environment conditions (environmental laws and regulations, public health, etc.)
4) Evaluation of present water supply conditions and identification of problems

1-2 Collection and analysis of the present condition of the Project area through existing data, information and field survey

1) Current situation and problems of the water supply sector
2) Policies and plans of the water supply sector
3) Current status of the water supply amount and capacity of existing water supply facilities

4) Water demand in Vientiane Capital
5) Comprehensive plan for water supply facilities in Vientiane Capital
6) Other projects for water supply in Vientiane Capital
7) Situation of water sources
8) Raw water quality
9) Topographic survey
10) Geotechnical survey
11) Existing water supply facilities in Vientiane Capital
12) Current conditions of non-revenue water
13) Water supply sector organizations
14) Water tariff setting
15) Financial analysis of NPNL
16) Willingness to pay and affordability for water supply service
17) Power availability (situation of electric power supply and demand)
18) Social opinion about water supply
19) Related on-going studies and projects
20) Other donors' assistance and projects by PPP (Public-Private Partnership) in water supply sector
21) Long-term plan for improvement of water supply facilities
22) Long-term financial plan
23) Identification and evaluation of present water supply conditions

1-3 Collection and analysis of sewerage and drainage sector

1) Current situation and problem on the sewerage and drainage sector
2) Policies and plans of the sewerage and drainage sector
3) Current status of the sewerage and drainage amount and capacity of existing those facilities
4) Comprehensive plan for the sewerage and drainage facilities in Vientiane Capital

2. Feasibility Study for the Vientiane Capital Water Supply Expansion Project

2-1 Planning of the Project

1) Water demand projection by 2030
2) Setting necessary capacity of the proposed water supply facilities
3) Identification of supply area from expanded the Chinaimo water treatment plant and other water treatment plant(s)

4) Planning of the water supply facilities of the Project
5) Overall operation plan
6) Calculation of the area required for land acquisition for the Project
7) Land acquisition method and regulation

2-2 Basic design of the Project

1) Identification of the Project scope
2) Design of facilities (intake facilities, water treatment plant, transmission pipelines, reservoirs, and distribution networks)
3) Development of the operation and maintenance plan related to the facilities to be constructed under the Project
4) Preliminary cost estimation with demarcation of foreign currency and local currency as for Japanese ODA loan projects
5) Comparison of the estimated project cost with that of other similar projects in order to verify the appropriateness of the project cost
6) Elaboration of the project implementation schedule and confirming necessary procedures for the approval of the Project implementation (Environment Impact Assessment (EIA), land acquisition etc.)
7) Suggestion of the Project's procurement plan, method and contract packages
8) Analysis of impact on water tariff rate by the Project
9) Recommendation on TOR for consulting services (detailed design, tender assistance, construction supervision, etc.)
10) Project evaluation;
    -Technical evaluation
    -Economic and financial evaluation
    -Environmental and social evaluation
    -Institutional evaluation

2-3 Consideration of environmental and social impacts

1) Analysis of the Project from the environmental and social perspective in accordance with the requirements of "JICA Guidelines for Environmental and Social Considerations (April 2010)" (preparation of EIA, Environmental Monitoring Plan (EMP) and Resettlement Action Plan (RAP), if necessary)
2) Review of necessary procedures and legal requirements in Lao PDR including laws and regulations related to environmental considerations (such as EIA, information disclosure act, etc.)

3) Proposal of appropriate institutional arrangements to compensate discrepancies between JICA Guidelines and those of Lao PDR

2-4 Assessment of project effectiveness

1) Financial Analysis of NPNL (water supply tariff, operation and maintenance cost)
2) Selection and calculation of performance indicators (operation and effect indicator) and setting up baseline and target data
3) Identification of the qualitative effectiveness (positive impact in Vientiane Capital)
4) Analysis of the environmental impact (environmental improvement effect by substitution)
5) Calculation of the Project's economic internal rate of return (EIRR) and financial internal rate of return (FIRR)

V. IMPLEMENTATION FRAMEWORK OF THE PREPARATORY SURVEY

1. Survey Area

The Preparatory Survey will cover Vientiane Capital.

2. Team Composition of the Preparatory Survey

JICA will select and dispatch a survey team (hereinafter referred to as "the Team") to carry out the Preparatory Survey. The Team is expected to include at least the following experts:

1) Water Supply Engineer A (team leader/ water supply planning)
2) Water Supply Engineer B (deputy team leader/ design of intake facilities and water treatment plant)
3) Water Supply Engineer C (deputy team leader/ design of transmission and distribution facilities)
4) Mechanical/Electrical Engineer
5) Procurement Planning and Cost Estimation Specialist
6) Economic and Financial Specialist (Economic and Financial Analysis)
7) Business Management Specialist
8) Environment and Social Considerations Specialist
9) Sewerage/Drainage Engineer (Sewerage and Drainage Sector Analysis)

The assignment of the experts may be subject to adjust. The Team should engage local consultants and/or other supporting staffs.

3. Steering Committee

The Steering Committee will be established and chaired by DHUP and co-chaired by Department of Public Works and Transport (DPWT) of Vientiane Capital and NPNL, and participated by Ministry of Planning and Investment (MPI), Ministry of Finance (MOF), and JICA Lao Office and the Team.

4. Tentative Implementation Schedule

The Preparatory Survey will be carried out in accordance with the tentative schedule shown as follows. The schedule may be subject to change during the preparation and the course of the survey.

Year	2014					
Month	June	July	Aug.	Sep.	Oct.	Nov.
Work in Laos						
Work in Japan						
Report	▲ IC/R		▲ IT/R		▲ DF/R	▲ F/R

IC/R: Inception Report, IT/R: Interim Report,
DF/R: Draft Final Report, F/R: Final Report

5. Reports

The Team shall prepare and present the following reports:

(1) Inception Report : 20 copies (English), 5 copies (Japanese), and electronic data will be submitted before the beginning of the first work phase in Lao PDR. This report will cover basic approaches, plan of operations, a work schedule, staffing, organizations and other aspects of the survey.

(2) Interim Report: 20 copies (English), 5 copies (Japanese) and electronic data will be submitted about three months after the beginning of the Preparatory Survey. This report will cover results of the midterm of the survey.

(3) Draft Final Report : 20 copies (English), 5 copies (Japanese), electronic data will be submitted at the end of the survey in Laos. The member of the Steering Committee shall submit its comments after receipt of the Report.

(4) Final Report (Summary): 20 copies (English), 5 copies (Japanese) , electronic data will be submitted within one month after receipt of the comments on the Draft Final Report.

6. Monitoring

The work of the Team shall be subject to periodic review by JICA. JICA staffs shall attend meetings between the Team and Lao PDR during the implementation of the Preparatory Survey as necessary.

VI. UNDERTAKING BY THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

DPWT of Vientiane Capital and NPNL shall act as the counterpart agency to ensure the smooth implementation of the Preparatory Survey.

DPWT of Vientiane Capital and NPNL shall, at its own expense, provide the Team with the following items in cooperation with other concerned organizations;

(1) security-related information as well as measures to ensure the safety for the Team;
(2) information as well as support to have access to medical service;
(3) data and information related to the Preparatory Survey;
(4) counterpart personnel from related organizations;
(5) authorization letters;
(6) entry permits necessary for the Team members to conduct field surveys;
(7) support in making travel arrangements to destinations and making appointments
(8) office space, and;
(9) assistance to the Team in customs clearance, exemption from any duties with respect to equipment, instruments, tools and other articles to be brought into and out of Lao PDR in connection with the implementation of the survey, according to Lao regulation and laws in force.

DPWT of Vientiane Capital and NPNL shall bear claims, if any arises, against members of the Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Preparatory Survey, except when such claim arises from serious negligence or willful misconduct on the part of the member of the Team.

VII. CONSULTATION

JICA, DHUP, DPWT of Vientiane Capital, and NPNL shall consult with each other in respect of any matters that may arise from or in connection with the Preparatory Survey.

VIII. INFORMATION DISCLOSURE

The JICA Mission explained to Lao PDR the JICA's policy of information disclosure as follows;

1. Based on the Information Disclosure Law of Japan, JICA has a policy to disclose information to the public. However, confidential information will be kept undisclosed, such as bidding information to secure fairness of tender procedures and other issues to be mutually agreed.

2. Under the policy, the final report will be disclosed excluding confidential information to the public as soon as practical.

The JICA Mission and Lao PDR agreed that such information related to bidding for procurement of goods and services such as cost estimate, Bills and Quantities (B/Q), TOR, and person-months should be kept confidential until a relevant contract agreement is concluded.

Other information which Lao PDR requests to keep undisclosed, if any, will be so kept based on mutual agreement between Lao PDR and JICA. Lao PDR agreed to submit a list of such information, if any, together with timing of disclosure to JICA by the date of the draft final report submission.

IX. OTHERS

1. The nature of services to be rendered by the Team shall be exclusively advisory. All decisions as to whether to accept or implement any recommendations made or instructions given in the course of the implementation of the services shall be the responsibility of DPWT of Vientiane Capital and NPNL and other concerned agencies.

2. DPWT of Vientiane Capital and NPNL through Lao PDR shall take, with its own responsibility, all necessary measures for the use of recommendations and outcomes of the Preparatory Survey of Japanese ODA loan Project.

3. The Preparatory Survey will be conducted in a participatory manner, and intensive consultation with all concerned stakeholders.

(END)

Attachment 2 Minutes of Meeting on Inception Meeting (August 21, 2014) on September 30, 2014.

MINUTES OF MEETING

ON

INCEPTION MEETING

(AUGUST 21, 2014)

FOR

THE PREPARATORY SURVEY

ON

VIENTIANE CAPITAL WATER SUPPLY EXPANSION PROJECT

IN

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

SEPTEMBER 30, 2014

This Minutes of Meeting was prepared after the Inception Meeting held on 21 August, 2014 for the purpose of confirming the Inception Report, which was prepared by the JICA Preparatory Survey Team (hereinafter referred as "the Survey Team"), for the Preparatory Survey on Vientiane Capital Water Supply Expansion Project in the Lao People's Democratic Republic (hereinafter referred as "the Survey"). The Survey Team submitted and explained the Inception Report to the Lao side. As the result of the discussions, both sides agreed upon the Inception Report. The confirmed matters are attached hereto.

It should be noted that this Minutes of Meeting does not mean the commitment of the project scope, project implementation, design and method to be implemented. The final project scope, project implementation, designs, etc. will be decided through the Appraisal of this project.

Khamthavy THAIPHACHANH
Director General,
Department of Housing and Urban Planning,
Ministry of Public Works and Transport

星野 孝

Takashi HOSHINO
Team Leader
JICA Preparatory Survey Team

Detsongkham THAMMAVONG
Director General,
Department of Public Works and Transport,
Vientiane Capital

Khampheuy VONGSAKHAMPHOUI
General Manager,
Vientiane Capital Water Supply State Enterprise

1. Overall Result of the Inception Meeting

Both sides confirmed the contents of the Inception Report. In particular, the following points were agreed by both sides.

(1) Survey Condition

1) Survey Area: current and future expansion water supply area in Vientiane Capital, especially in the urban area as shown in Attachment 1.

2) Target Year: Year 2030

(2) Survey Schedule and Scope of Work

The Survey Team explained to the Lao side the current survey schedule as shown in Attachment 2 and the Scope of Works for the Survey. The Lao side agreed upon the survey schedule and the Scope of Works for the Survey.

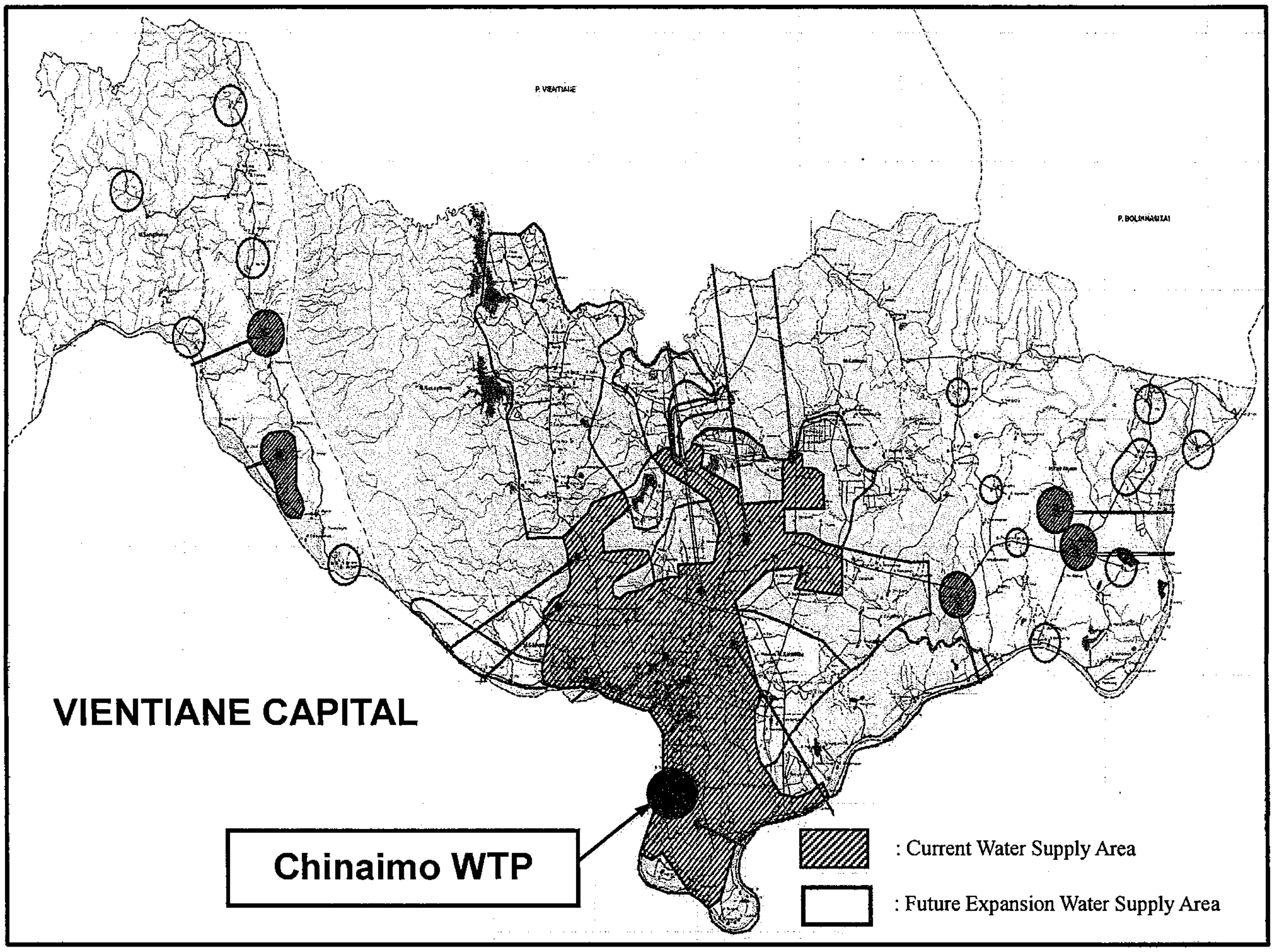
(3) Counterpart and Steering Committee

The Survey Team requested to the Lao side to assign counterpart personnel and to establish Steering Committee. The Lao side agreed with the requests. A list of counterpart personnel is shown in Attachment 3. Department of Housing and Urban Planning will report to the Survey Team on the list of the Steering Committee members as soon as their decision is made.

<u>Attachments</u>

1. The Areas of the Survey
2. Current Survey Schedule
3. The List of Counterpart Personnel

1. The Areas of the Survey



The Areas of the Survey

2. Current Survey Schedule

Description	2014						2015		
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Preparation in Japan		□							
1st Site Surveys in Vientiane		■	■						
1st Work in Japan				□					
2nd Site Surveys in Vientiane				■	■	■			
2nd Work in Japan							□		
3rd Site Survey in Vientiane (Explanation / Discussion of DFR)							■		
3rd Work in Japan (Preparation of F/R)								□	
Reporting		△ IC/R		△ IT/R			△ DF/R	△ F/R	

3. The List of Counterpart Personnel

No.	Name	Position	Organization
1.	Mr. Khamthavy THAIPHACHANH	Director General	DHUP, MPWT
2.	Mr. Detsongkham THAMMAVONG	Director General	DPWT, VC
3.	Mr. Bounchank KEOSITHAMMA	Deputy Director General	DPWT, VC
4.	Mr. Khampheuy VONGSAKHAMPHOUI	General Manager	NPNL
5.	Dr.Xaypasa LIENGSONE	Project Coordinator of Water Supply Division	DHUP, MPWT
6.	Mr. Khammone CHOMMANIVONG	Deputy Head of Housing Urban Planning Office	DPWT, VC
7.	Mr. Korlakanh SENBOUTTALATH	Engineer of Housing Urban Planning Office	DPWT, VC
8.	Mr. Sisamone KONGMANY	National Project Director	NPNL
9.	Mr. Southin KHIENGSOMBATH	Chinaimo WTP Manager	NPNL
10.	Ms. Thavikhun PHANAKHONE	Manager of Financial Division	NPNL

Attachment 3 Minutes of Meeting on Interim Report Meeting (November 25, 2014) on December 25, 2014.

MINUTES OF MEETING
ON
INTERIM REPORT MEETING
(NOVEMBER 25, 2014)
FOR
THE PREPARATORY SURVEY
ON
VIENTIANE CAPITAL WATER SUPPLY EXPANSION PROJECT
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

DECEMBER 25, 2014

This Minutes of Meeting was prepared after the Interim Report Meeting held on 25 November, 2014 for the purpose of confirming the progress and orientation in the middle of the Preparatory Survey on Vientiane Capital Water Supply Expansion Project in the Lao People's Democratic Republic (hereinafter referred as "the Survey"), which has been carried out by the JICA Preparatory Survey Team (hereinafter referred as "JST"). JST also submitted the Interim Report to the Lao side on 25 December 2014. As the result of the discussions and submission, both sides agreed upon the Interim Report Meeting. The confirmed matters are attached hereto.

It should be noted that this Minutes of Meeting does not mean the commitment of the project scope, project implementation, design and method to be implemented. The final project scope, project implementation, designs, etc. will be decided through the Appraisal of this project.

Khamthavy THAIPHACHANH Director General, Department of Housing and Urban Planning (DHUP), Ministry of Public Works and Transport (MPWT)	星野 孝 Takashi HOSHINO Team Leader JICA Preparatory Survey Team (JST)

Detsongkham THAMMAVONG
Director General,
Department of Public Works and Transport (DPWT),
Vientiane Capital (VC)

Khampheuy VONGSAKHAMPHOUI
General Manager,
Vientiane Capital Water Supply State Enterprise (NPNL)

1. Steering Committee Establishment

A Steering Committee was established for the Survey. The Minister's Decision on the Steering Committee assignment on November 19, 2014, and the member list are shown in Attachment 1 and 2, respectively.

2. Phasing Plan of Chinaimo WTP Expansion

JST presented 5 options, Case 1, 2, 2a, 3, and 3a, for the Chinaimo WTP expansion. Among the options, DHUP, DPWT and NPNL gave them assent to the stepwise expansion plan, that is, expansion of 40,000 m^3/day in Phase 1 and more 40,000 m^3/day in Phase 2 as Case 3a (or more 20,000 m^3/day as Case 2a) up to the total capacity of 160,000 m^3/day (or 140,000 m^3/day) of Chinaimo WTP by the year 2030. The proposed stepwise expansion plans, Case 2a and 3a, are shown in Attachment 3.

3. Concept on Service Area Demarcation among the WTPs

Basic concept on the demarcation of service areas among the existing and planned WTPs was confirmed among DHUP, DPWT, NPNL, and JST as explained in the JST presentation. The basic concept of service areas among the existing and planned WTPs is shown in Attachment 4.

4. New Administration and Chemical Buildings in Chinaimo WTP

JST proposed to separate the existing administration office and chemical feeding facilities that those are currently in the same building, and to construct new administration and chemical buildings while the expansion work of Chinaimo WTP. DHUP, DPWT and NPNL gave them assent to the JST's proposal.

5. Land Lending and Possibility of Land Acquisition for Chinaimo WTP Expansion

JST explained that it is necessary to rent the land with 5 m space from outside of the fence of the existing Chinaimo WTP where belongs to military school, during construction period, in order to construct new water treatment facilities in the Chinaimo WTP. JST also proposed to acquire the land (20 m) of military school near the injection point, to construct new chemical building near the injection point because of efficient operation and maintenance. Requested land lending and proposed acquisition area are shown in Attachment 4.

The Lao side made a reply that it would be difficult to acquire the land from Ministry of Defense (MOD) for expansion of new water supply facilities; however, we can request MOD to lend and acquire the land via Vientiane Capital. Meeting with Vice Mayor of Vientiane Capital will be arranged by the Lao side.

6. Disinfection Method

JST proposed to use chlorine gas as disinfection method instead of the current method, use of bleaching powder, in Chinaimo WTP after expansion. In respect to this JST's proposal, DHUP, DPWT and NPNL reached a consensus to use chlorine gas as disinfection method of Chinaimo WTP, on the condition that a bleaching powder feeding facility is also provided for emergency use due to shortage of chlorine gas supply, and also to discuss again about this matter in the future stage.

7. Project Implementation Framework

JICA mission would be dispatched to Vientiane in January, 2015 and the project implementation framework would be discussed at that time. The Lao side also will discuss internally about an appropriate project implementation framework before the mission dispatch by JICA.

8. Electricity

In connection with Chinaimo WTP expansion, it should be able to keep the sufficient electricity supply to Chinaimo WTP from EDL. Therefore, a meeting with EDL will be arranged by the Lao side for this matter.

9. Sludge Treatment

Currently, there is no regulation about sludge disposal to Mekong River. JST asked the Lao side the same policy would continue in the future. The Lao side made a reply that there is currently no problem to dispose sludge to Mekong River without sludge treatment facilities. Policy on sludge treatment for the future may be, however, suggested when Phase 2 starts if the circumstance is changed. The Lao side requested JST to add some recommendation regarding sludge disposal in the report, so that concerned parties in Vientiane Capital may consider the future policies and measures.

Attachments

1. The Minister's Decision on Steering Committee Assignment on November 19, 2014
2. Member List for the Steering Committee
3. Proposed Stepwise Expansion Plan
4. Basic Concept of Service Areas among the Existing and Planned WTPs
5. Requested Land Lending and Proposed Acquisition Area
6. List of Attendance for the Interim Report Meeting

1. The Minister's Decision on Steering Committee Assignment on November 19, 2014

ສາທາລະນະລັດ ປະຊາທິປະໄຕ ປະຊາຊົນລາວ

ສັນຕິພາບ ເອກະລາດ ປະຊາທິປະໄຕ ເອກະພາບ ວັດທະນະຖາວອນ

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ຍທຂ PWT

ກະຊວງໂຍທາທິການ ແລະ ຂົນສົ່ງ

ເລກທີ 17714/ຍທຂ

ນະຄອນຫຼວງວຽງຈັນ, ວັນທີ 19.11.2014

ຂໍ້ຕົກລົງ

ຂອງລັດຖະມົນຕີວ່າການ

ວ່າດ້ວຍ ການແຕ່ງຕັ້ງຄະນະກຳມະການຊີ້ນຳລວມ ກ່ຽວກັບການກະກຽມສຳຫຼວດ

ໂຄງການຂະຫຍາຍລະບົບນ້ຳປະປາ ນະຄອນຫຼວງວຽງຈັນ.

- ອີງຕາມດຳລັດຂອງນາຍົກລັດຖະມົນຕີ ສະບັບເລກທີ 373/ນຍ ລົງວັນທີ 22/10/2007 ວ່າດ້ວຍການຈັດຕັ້ງ ແລະ ການ ເຄື່ອນໄຫວ ຂອງກະຊວງ ໂຍທາທິການ ແລະ ຂົນສົ່ງ.
- ອີງຕາມ ໃບສະເໜີ ຂອງ ກົມເຄຫາ ແລະ ຜັງເມືອງ, ສະບັບເລກທີ 19519/ກຄຜ, ລົງວັນທີ 03/10/2014.
- ອີງຕາມ ແຈ້ງການ ຂອງ ຫ້ອງການ, ສະບັບເລກທີ 19914/ຫກ.ສລ, ລົງວັນທີ 14/10/2014.

ລັດຖະມົນຕີວ່າການ ຕົກລົງ :

ມາດຕາ 1. ແຕ່ງຕັ້ງຄະນະກຳມະການຊີ້ນຳລວມ ກ່ຽວກັບການກະກຽມສຳຫຼວດ ໂຄງການຂະຫຍາຍລະບົບນ້ຳປະປາ ນະຄອນຫຼວງວຽງຈັນ ດັ່ງມີລາຍຊື່ລຸ່ມນີ້:

1. ທ່ານ ຄຳທະວີ ໄທພະຈັນ	ຫົວໜ້າກົມເຄຫາ ແລະ ຜັງເມືອງ	ເປັນປະທານ
2. ທ່ານ ບຸນຈັນ ແກ້ວສີທຳມະ	ຮອງຫົວໜ້າພະແນກ ຍທຂ ນະຄອນຫຼວງວຽງຈັນ	ເປັນຮອງປະທານ
3. ທ່ານ ຄຳເຜີຍ ວົງສາຄຳຊຸຍ	ຜູ້ອຳນວຍການໃຫຍ່ ລັດວິສາຫະກິດນ້ຳປະປາ ນະຄອນຫຼວງວຽງຈັນ	ເປັນກຳມະການ
4. ທ່ານ ຜູ້ຕາງໜ້າຈາກ ກະຊວງແຜນການ ແລະ ການລົງທຶນ		ເປັນກຳມະການ
5. ທ່ານ ຜູ້ຕາງໜ້າຈາກ ກະຊວງການເງິນ		ເປັນກຳມະການ
6. ທ່ານ ຜູ້ຕາງໜ້າຈາກ ຫ້ອງການໄຈກາປະຈຳ ສປປ ລາວ		ເປັນກຳມະການ
7. ທ່ານ ຜູ້ຕາງໜ້າຈາກ ທີມງານສຶກສາຂອງ ອົງການໄຈກາ		ເປັນກຳມະການ

ມາດຕາ 2. ຄະນະດັ່ງກ່າວ ມີໜ້າທີ່ຊີ້ນຳລວມໂຄງການ, ປະສານສົມທົບກັນ ແລະ ປະສານສົມທົບກັບພາກສ່ວນທີ່ກ່ຽວຂ້ອງ ເພື່ອເຮັດໃຫ້ວຽກງານການກະກຽມການສຳຫຼວດໂຄງການຂະຫຍາຍລະບົບນ້ຳປະປາ ນະຄອນຫຼວງວຽງຈັນ ໃຫ້ໄດ້ຮັບຜົນສຳເລັດເປັນຢ່າງດີ.

ມາດຕາ 3. ໃຫ້ບັນດາທ່ານທີ່ຖືກແຕ່ງຕັ້ງທຸກພາກສ່ວນທີ່ກ່ຽວຂ້ອງຈົ່ງຮັບຮູ້ ແລະ ໃຫ້ການຮ່ວມມືໃນການປະຕິບັດວຽກງານໃຫ້ໄດ້ຮັບຜົນດີ.

ມາດຕາ 4. ຂໍ້ຕົກລົງສະບັບນີ້ ມີຜົນບັງຄັບໃຊ້ ນັບແຕ່ມື້ລົງລາຍເຊັນເປັນຕົ້ນໄປ.

ລັດຖະມົນຕີວ່າການ

ດຣ ບຸນຈັນ ສິນທະວົງ

ບ່ອນສົ່ງ:

- ກົມຈັດຕັ້ງ ແລະ ພະນັກງານ 1 ສະບັບ
- ຫ້ອງການກະຊວງ 1 ສະບັບ
- ບ່ອນກ່ຽວຂ້ອງ 2 ສະບັບ
- ສຳເນົາ 3 ສະບັບ

(Translated into English)

Lao People's Democratic Republic

Peace Independence Democracy Unity and Prosperity.

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Ministry of Public Works and Transportation (MPWT)

No. 19914/PWT.

Vientiane Capital, dated 19 Nov. 2014

Minister's Decision

On Steering Committee Assignment about Preparatory Survey on the Project for Extension of Water Supply System in Vientiane Capital.

- Based on decree of Prime Minister No. 373/PM, dated 22/10/2007 (22 Oct. 2007), Regarding the Organization and Activities of Ministry of Public Works and Transportation (MPWT).
- Based on Application Letter of DHUP, No. 19519/DHUP, dated 03/10/2014 (03 Oct. 2014).
- Based on announcement of Permanent Secretary Office (PSO), No. 19914/PSO. Administration Section, dated 14/10/2014 (14 Oct. 2014).

Minister Decide that:

Article 1: To assign Steering Committee about preparatory survey on the project for Extension of Water Supply System in Vientiane Capital as follow:

1. Mr. Khamthavy THAIPHACHAN, Director General of DHUP, MPWT Chairman/Chairperson
2. Mr. Bounchan KEOSITHAMMA, Deputy Director General of DPWT Vientiane Capital Deputy Chairperson.
3. Mr. Khampheuy VONGSAKHAMPHIOU, General Manager of Water Supply States Enterprise in Vientiane Capital (NPNL) member.
4. The representative from Ministry of Planning and Investment (MPI) member.
5. The representative from Ministry of Finance (MOF) member.
6. The representative from JICA Lao Office member.
7. The representative from study team of JICA member.

Article 2: This committee has duty for general lead or give general instruction, coordinate with each other and coordinate with related agency to make preparatory survey of the project for Extension of Water Supply System in Vientiane Capital has effective.
Article 3: The persons who was assigned please acknowledge and give cooperation on operating to get achievement.
Article 4: This decision has effective since sign on.

Minister of Ministry of Public Works and Transportation (MPWT).
Dr. Bounchan SINTHAVONG

2. Member List for the Steering Committee

Chairman

1.	Mr. Khamthavy THAIPHACHANH	Director General	DHUP, MPWT

Deputy Chairman

2.	Mr. Bounchank KEOSITHAMMA	Deputy Director General	DPWT, VC

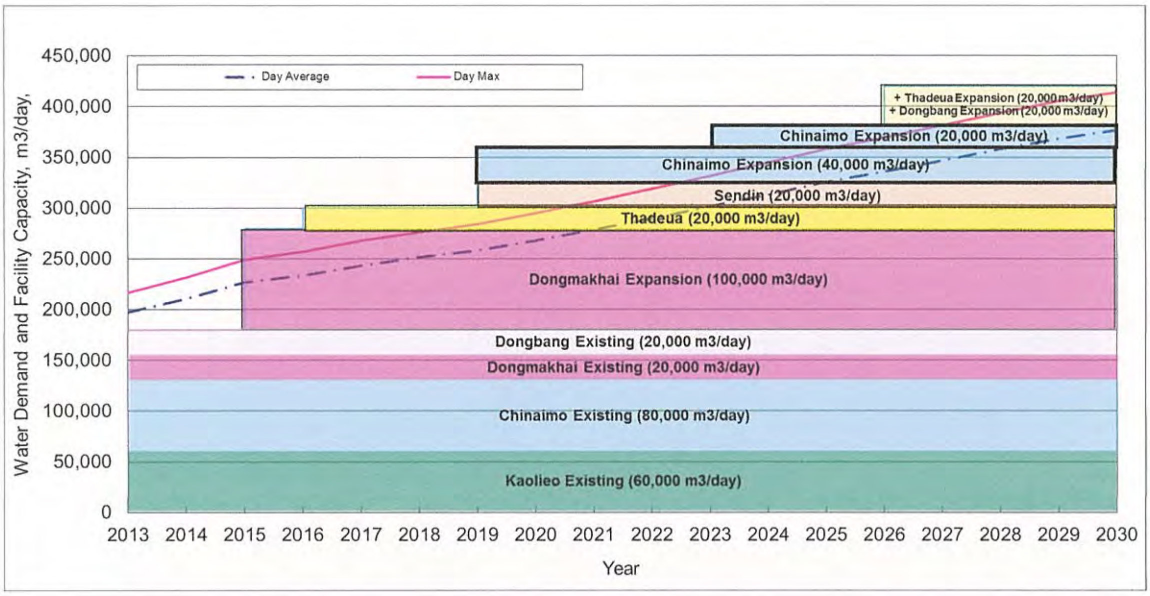
Member

3.	Mr. Khampheuy VONGSAKHAMPHOUI	General Manager	NPNL
4.	Ms. Phonemany Chovmmaly	Technical Official	MOF
5.	Mr. Vilasack Xayaphet	Asia and Pacific Division, Department of International Cooperation	MPI

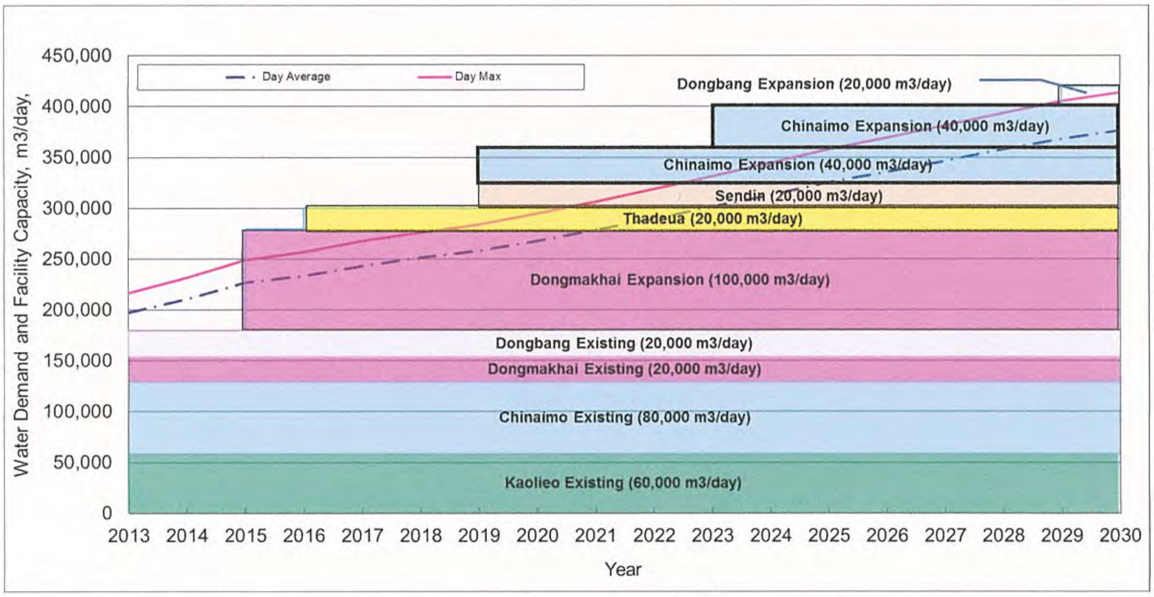
Advisory Organization and Consultant

6.	JICA	Project Formulation Advisor	JICA Lao Office
7.	Mr. Takashi HOSHINO	Team Leader, JICA Survey Team	Consultant

3. Proposed Stepwise Expansion Plan

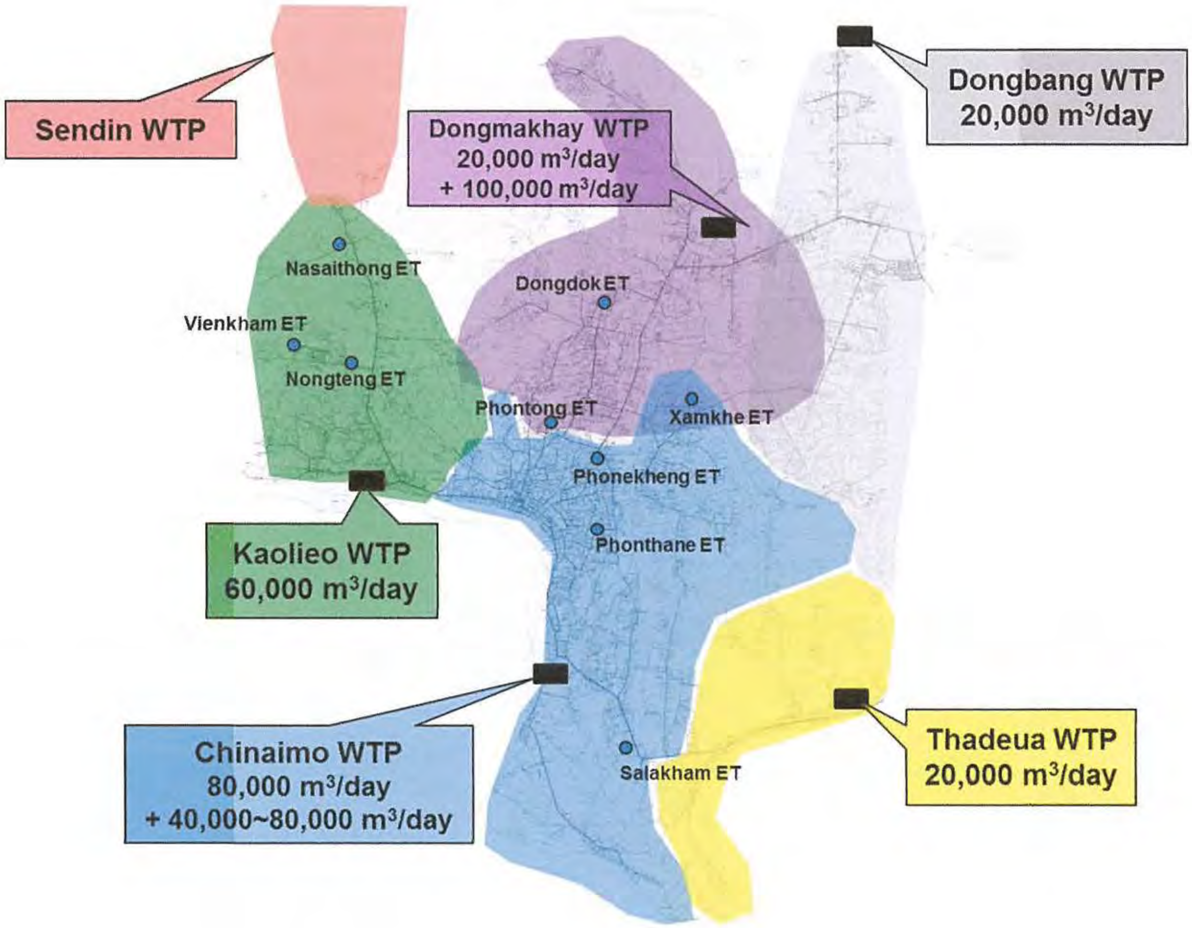


Stepwise Expansion Plan (Chinaimo Exp. 60,000 m^3/day Stepwise: Case 2a)



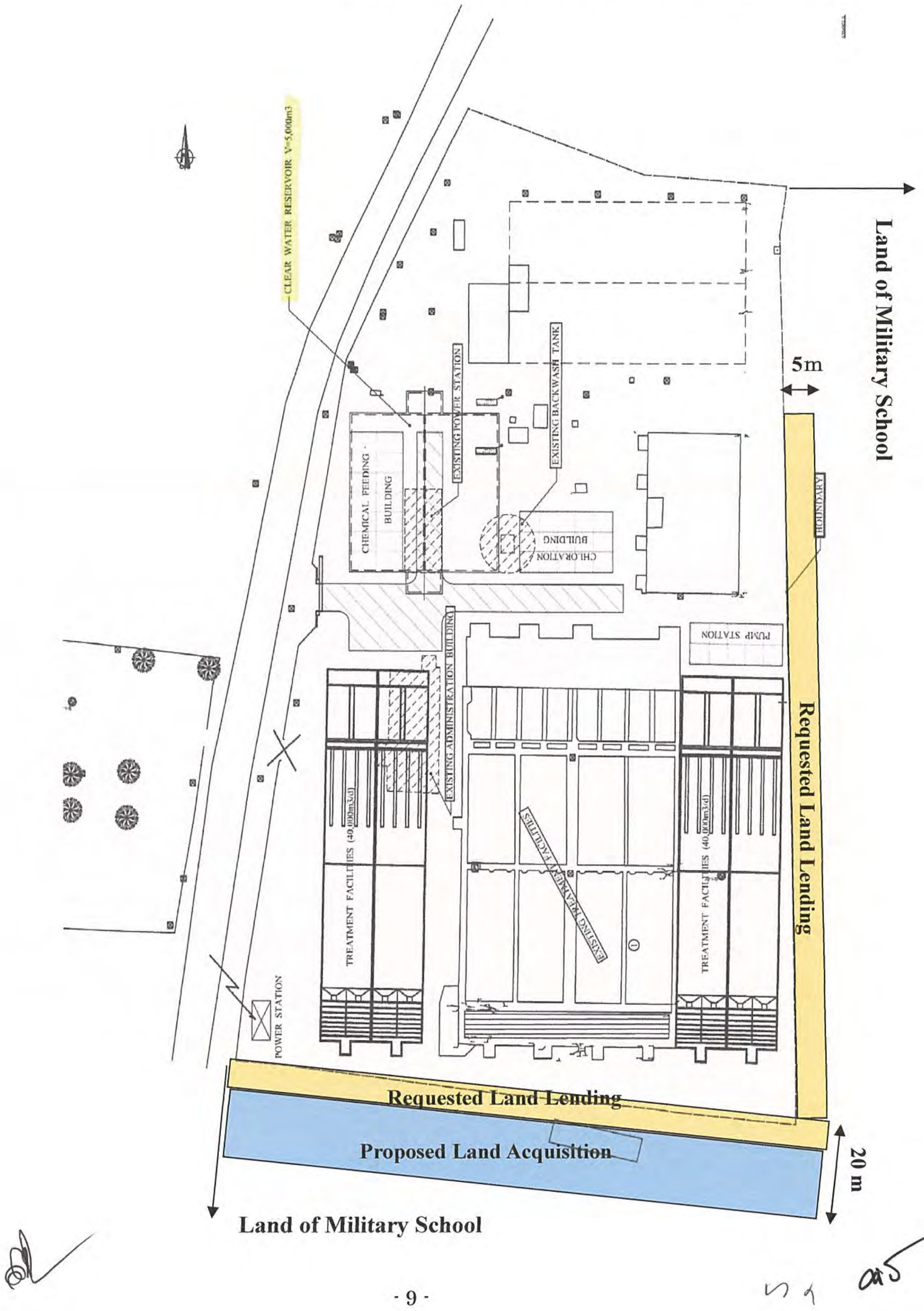
Stepwise Expansion Plan (Chinaimo Exp. 80,000 m3/day Stepwise: Case 3a)

4. Basic Concept of Service Areas among the Existing and Planned WTPs



General Concept of Water Distribution Demarcation by WTPs

5. Requested Land Lending and Proposed Acquisition Area



6. List of Attendance for the Interim Report Meeting

No.	Name	Position	Organization
FROM DHUP, MPWT			
1.	Mr. Khamthavy THAIPHACHANH	Director General	DHUP, MPWT
2.	Mr. Khanthone VORACHITH	Director of Water Supply Division	DHUP, MPWT
3.	Dr.Xaypasa LIENGSONE	Project Coordinator of Water Supply Division	DHUP, MPWT
4.	Mr. Velh Saysovlinh	Cabinet Office	MPWT
FROM DPWT			
5.	Mr. Bounchank KEOSITHAMMA	Deputy Director General	DPWT, VC
6.	Mr. Khammone CHOMMANIVONG	Deputy Head of Housing Urban Planning Office	DPWT, VC
7.	FROM NPNL		
8.	Mr. Khampheuy VONGSAKHAMPHOUI	General Manager	NPNL
9.	Mr. Sisamone KONGMANY	National Project Director	NPNL
10.	Mr. Southin KHIENGSOMBATH	Chinaimo WTP Manager	NPNL
11.	Mr. Houmphan OUDOMSAVATH	Manager of Technical Division	NPNL
FROM MOF (Ministry of Finance)			
12.	Ms. Phonemany Chovmmaly	Technical Officil	MOF
FROM MPI (Ministry of Planning and Investment)			
13.	Mr. Vilasack Xayaphet	Asia and Pacific Division, Department of International Cooperation	MPI
FROM JICA			
14.	Ms. Akiko KISHIUE	Project Formulation Advisor	JICA Lao
15.	Ms. Fuyuko OHKI	Representative	JICA Lao
	FROM JST		
16	Mr. Takashi HOSHINO	Water Supply Planning Specialist (Team Leader)	JST
17	Mr. Yoshiaki YOKOTA	Water Facility Planning Specialist for Intake, Raw Water Transmission, and WTP (Co-Team Leader)	JST
18	Mr. Hideharu KIKUCHI	Water Facility Planning Specialist for Transmission and Distribution Mains	JST
19	Mr. Akira HAYASHI	Mechanical and Electrical Facility Planning Specialist	JST
20	Mr. Toru AOKI	Procurement / Cost Estimation Specialist / Natural Condition Survey Supervisor	JST
21	Ms. Chinatsu MAEDA	O&M / Technical Assistance Planning Specialist	JST
22	Mr. Daizo IWATA	Economic and Financial Analyst / Business Analysis Analyst / Socio-economic Survey Supervisor	JST
23	Ms. Mayumi GOTO	Environmental and Social Considerations Specialist	JST
24	Mr. Akira OGURO	Sewage and Drainage Specialist	JST

Attachment 4 Minutes of Meeting on Draft Final Report Meeting (January 27, 2015) on February 3, 2015.

MINUTES OF MEETING

ON

DRAFT FINAL REPORT MEETING

(JANUARY 27, 2015)

FOR

THE PREPARATORY SURVEY

ON

VIENTIANE CAPITAL WATER SUPPLY EXPANSION PROJECT

IN

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

FEBRUARY 3, 2015

This Minutes of Meeting was prepared after the Draft Final Report Meeting held on 27 January, 2015 for the purpose of confirming the contents of Draft Final Report for the Preparatory Survey on Vientiane Capital Water Supply Expansion Project in the Lao People's Democratic Republic (hereinafter referred to as "the Survey"), which has been carried out by the JICA Preparatory Survey Team (hereinafter referred to as "JST"). JST also submitted the Draft Final Report to the Lao side on 3 February 2015. As the result of the discussions and submission, both sides agreed upon the Draft Final Report The confirmed matters are attached hereto.

It should be noted that this Minutes of Meeting does not mean the commitment of the project scope, project implementation, design and method to be implemented. The final project scope, project implementation, designs, etc. will be decided through the Appraisal of this project.

Khamthavy THAIPHACHANH
Director General,
Department of Housing and Urban Planning (DHUP),
Ministry of Public Works and Transport (MPWT)

星野 孝

Takashi HOSHINO
Team Leader
JICA Preparatory Survey Team (JST)

Detsongkham THAMMAVONG
Director General,
Department of Public Works and Transport (DPWT),
Vientiane Capital (VC)

Khampheuy VONGSAKHAMPHOUI
General Manager,
Vientiane Capital Water Supply State Enterprise (NPNL)

1. Overall Result of the Draft Final Report Meeting

Both JST and the Lao side principally agreed upon the contents of the Draft Final Report (DFR), however, both sides agreed the contents will be finalized by reflecting the comments in the Draft Final Report Meeting on the Final Report. In particular, the following points were agreed by both sides.

(1) Raw Water Intake Pump Station

A new raw water intake pump station will be constructed in the Phase 1 of the Project with new submersible motor pumps. Screen facilities will be installed at the intake pump station to prevent plastics and other objects drifting in the Mekong River from flowing into the intake pump wells. The details of the screen facilities will be further discussed in the detailed design stage.

(2) Administration Building

The existing administration building will be kept as it is during the Phase 1 of the Project. A new administration building will be, however, constructed in Phase 1 to accommodate new central monitoring system (which will cover the monitoring of both treatment processes and transmission/distribution system) and new laboratory enhanced with new water quality analysis equipment.

(3) Chemicals for Coagulation and Disinfection Method

JST has proposed to use of aluminum sulfate as same as the current method in the Draft Final Report. NPNL asked future possibility of PAC instead of the current method. The type of coagulants (aluminum sulfate or PAC) will be further studied and reviewed during the detailed design stage in view of supply reliability, costs and suitability/sustainability for operation and maintenance.

(4) Sludge Removal Method in Sedimentation Basin

Sludge removal is planned to carry out manually as same as the current method since it is difficult to modify the bottoms of the sedimentation basins to install mechanical scrapers. NPNL requested for JST to study the installation of mechanical scrapers instead of the manual method by comparing overall efficiency such as water loss amount and electricity costs of each method in the detailed design stage. JST agreed the further study for this matter in the detailed design stage in terms of initial cost, electricity cost, water loss amount, practicability, etc.

(5) Depth of Flocculation Basin

NPNL proposed that it would be better to make the depth of the flocculation basin deeper than that of the existing one in order to make floc more effectively. JST replied that there are some factors for making floc effectively (e.g. optimum quantities and locations of chemical injection). This matter should be further studied and discussed in the detailed design stage.

(6) Pipe Installation at Public Road

There are current or future concrete pavement road on the planned pipeline routes for the Phase 1 of the Project. The pipeline route, alignment, and road crossing locations will be further considered in the detailed design stage.

(7) Administration Cost
Both side confirmed that the administration cost is estimated as 5% of Consulting Services and Construction Cost, and this will be again fixed in the appraisal mission for the Phase 1 of the Project.

(8) FIRR and EIRR
Lao side basically understood and agreed with the methodology and results of the financial analysis and economic analysis of the Phase 1 of the Project.

2. Further Discussions
Both sides confirmed that not only the above mentioned matters, but also other technical matters such as details of facilities, equipment, and specifications also should be continuously discussed in the detailed design stage.

Attachments
1. List of Attendance for the Draft Final Report Meeting

1. List of Attendance for the Draft Final Report Meeting

No.	Name	Position	Organization
FROM DHUP, MPWT			
1.	Mr. Vorsith DENGKAYAPHICHITH	Civil Engineer of Water Supply Division	DHUP, MPWT
FROM DPWT			
2.	Mr. Khammone CHOMMANIVONG	Deputy Head of Housing Urban Planning Office	DPWT, VC
FROM NPNL			
3.	Mr. Khampheuy VONGSAKHAMPHOUI	General Manager	NPNL
4.	Mr. Viengthouay VANNARATH	Deputy General Manager	NPNL
5.	Mr. Sisamone KONGMANY	National Project Director	NPNL
FROM JST			
6	Mr. Takashi HOSHINO	Water Supply Planning Specialist (Team Leader)	JST
7	Mr. Yoshiaki YOKOTA	Water Facility Planning Specialist for Intake, Raw Water Transmission, and WTP (Co-Team Leader)	JST
8	Mr. Hideharu KIKUCHI	Water Facility Planning Specialist for Transmission and Distribution Mains	JST
9	Mr. Toru AOKI	Procurement / Cost Estimation Specialist / Natural Condition Survey Supervisor	JST
10	Mr. Daizo IWATA	Economic and Financial Analyst / Business Analysis Analyst / Socio-economic Survey Supervisor	JST