1.3 Current Conditions of Infrastructure

1.3.1 Road and Transport

(1) Increase of Traffic Volume

Table 1.3.1 shows a comparison of the traffic volume counted at the boundary of urban area, as shown in Figure 1.3.1, between this Study and JICA UTMP Study in 2007. There is a clear increase in both northern and western directions.

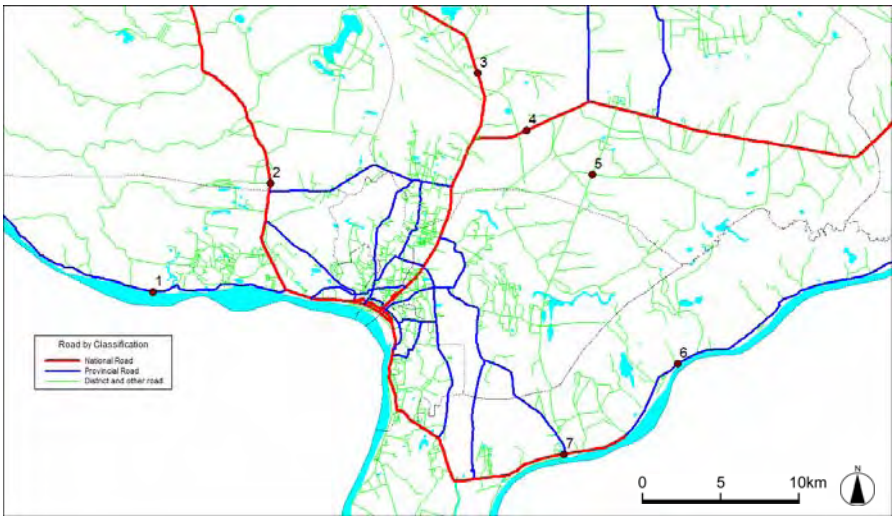
The growth of traffic volume counted at the National Road No.10, 13 North and 13 South generally ranges from 2.2 and 2.3 times (2007-2010), which is equivalent to about 30% of an annual increase. This value indicates that the traffic growth is much higher than the growth of population in Vientiane Capital. The traffic growth at National road 11 is extremely high compared with other locations. It can be said that this road didn't work as a national road in 2007 and has started to be a trunk road as National Road No. 10 and 13.

Traffic between the eastern area of Vientiane Capital and the central area mainly passes Thadeua Road. According to the growth of traffic counted at Thadeua Road, the movement from the eastern area has been increasing by 1.2 times, which is yearly increase by 7%. The yearly growth rate of traffic volume counted at Lao - Thailand Friendship Bridge is about 13%.

Table 1.3.1: Growth of Traffic Volume

No.	Location	2007 (veh/day)	2010 (veh/day)	Growth (10/07)
1	National road 11	1,906	10,459	5.5
2	National road 13 North	8,167	17,687	2.2
3	NR 10	9,179	20,271	2.2
4	NR 13S	6,406	14,831	2.3
5	Nakhao - khoksaad Road	705	3,132	2.4
6	Thadeua Road	6,591	8,090	1.2
7	Friendship Bridge	6,317	9,158	1.4

Source: 2007 JICA UTMP, 2010 JST



Source: JST

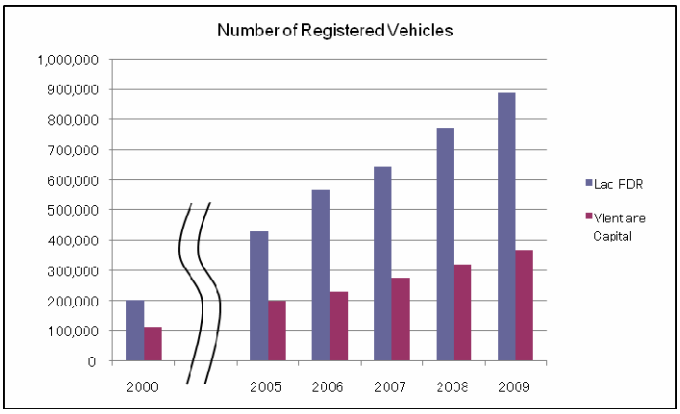
Figure 1.3.1: Survey Locations

(2) Motorization

Figure 1.3.2 and Table 1.3.2 describe a trend of the number of vehicles registered in both the whole country and Vientiane Capital.

The total number of passenger vehicles such as sedans, pickups and vans is 140 thousand in the whole country and more than half of the passenger vehicles, or 79 thousand vehicles, are registered in Vientiane Capital. Considering the population in Vientiane Capital, the car ownership ratio can be calculated at about 100 vehicles per 1,000 people. This figure is relatively high to other developing countries in South East Asia.

The passenger vehicles registered in Vientiane Capital increased about four times from the year 2000 to 2009. This growth is about 17 % annually. The total number of motorcycles registered in Vientiane Capital in 2009 is 272 thousand and this is 3.3 times of the number in 2000.



Source: MPWT

Figure 1.3.2: Number of Registered Vehicles in Lao PDR

Table 1.3.2: Number and Trend of Registered Vehicles in Lao PDR

	Type of Vehicle	2000	2005	2006	2007	2008	2009
Lao PDR	Motorbike	153,781	337,719	453,158	509,421	623,310	711,800
	Tuk-tuk	4,347	8,043	8,441	8,518	8,460	8,624
	Sedan, Pickup, Van	30,238	66,969	88,362	102,906	115,246	140,186
	Heavy Truck	10,559	13,441	15,296	17,994	19,070	23,031
	Large Bus	1,831	4,234	3,033	2,242	2,520	2,707
	Total	200,756	430,406	568,290	641,081	768,606	886,348
Vientiane Capital	Motorbike	83,468	144,507	171,504	201,608	241,808	272,211
	Tuk-tuk	2,445	3,695	3,675	3,721	3,581	3,584
	Sedan, Pickup, Van	19,574	43,220	49,580	61,559	65,675	79,095
	Heavy Truck	6,210	5,405	6,419	7,747	7,521	10,086
	Large Bus	1,130	665	691	838	926	927
	Total	112,827	197,492	231,869	275,473	319,511	365,903

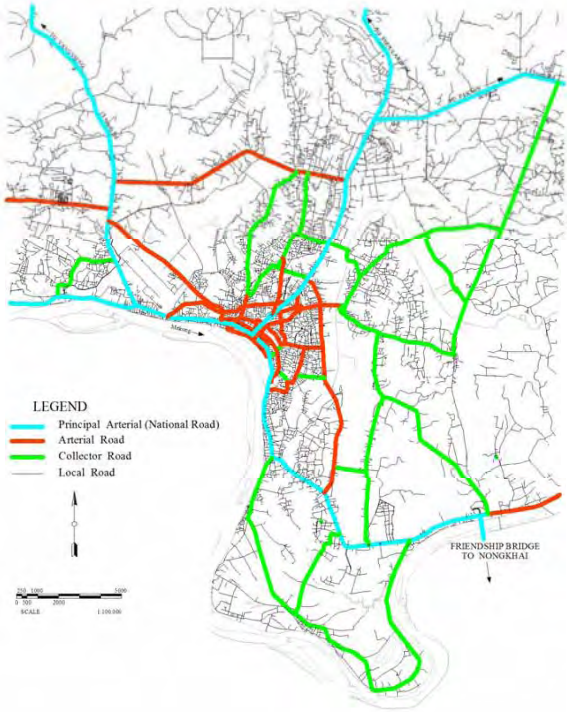
Source: MPWT

(3) Existing Road Network

1) Functional Road Classification

A road network needs to be balanced from the viewpoint of functional hierarchy. Functional classification of the road network in the Study area has not been officially established. VUDAA is considering classifying the roads in its jurisdiction into main road and feeder road but it is not complete yet.

Figure 1.3.3 shows the functional classification of the road network based on the concept of road hierarchy of VUDAA in the Study area, which was proposed in the JICA Urban Transport Master Plan Study in 2008 (JUTMP 2008). However, this classification follow a simple idea that existing multi-lanes roads in provincial road are classified as arterial road, and all other district roads are classified as collector road. Therefore, it is necessary to review the classification scheme from the view point of functional classification in this Study.



Source: JST

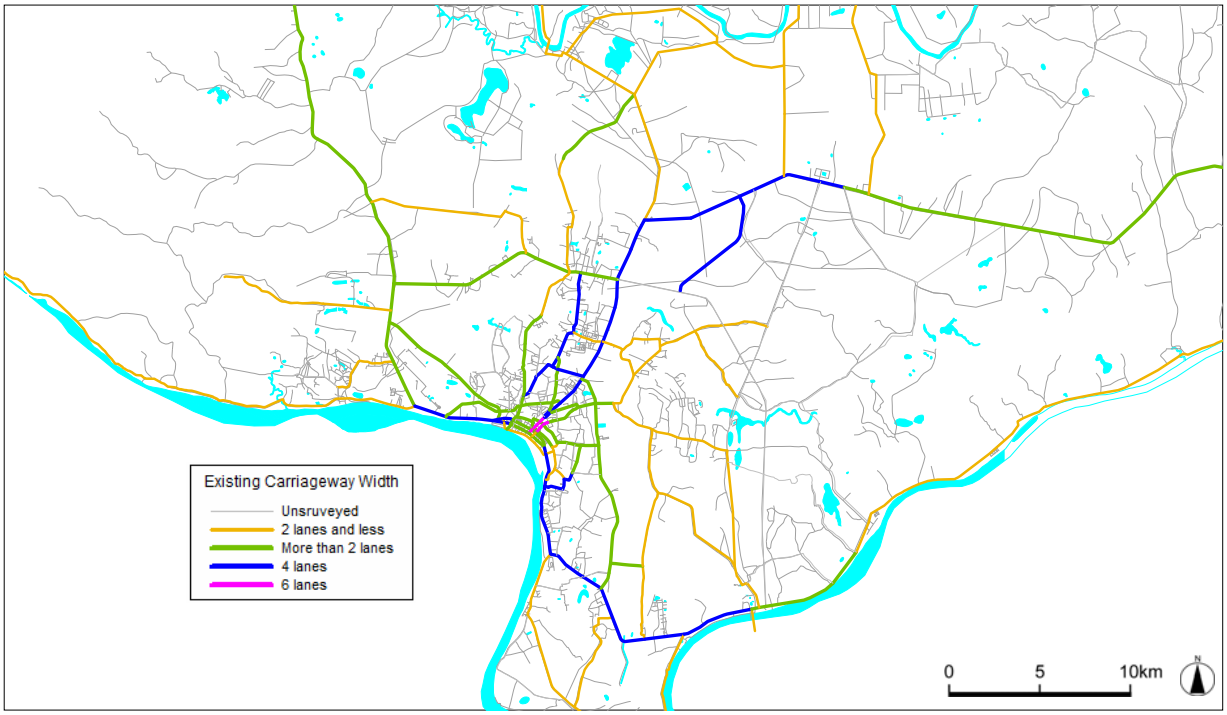
Figure 1.3.3: Road Classification Proposed in JICA Urban Transport Master Plan

2) Carriageway

In the Study area, some road sections of national road are composed with four lanes or more such as Lane Xang Avenue with six lanes, which is a symbol road in Vientiane Capital. Other parts of national road are operated with two lanes in the both directions even though there is enough width for the right of way (ROW) for four lanes.

In the urban area, most roads are two lanes for the both directions with a narrow lane for slow speed vehicles such as motorcycle and tuk-tuk on the both sides. The district roads in rural area are mainly two lanes road without having sidewalk. A sidewalk is basically provided in the urban area but the width of the sidewalk varies according to road side conditions.

The existing carriageway width surveyed in this Study is shown in Figure 1.3.4.



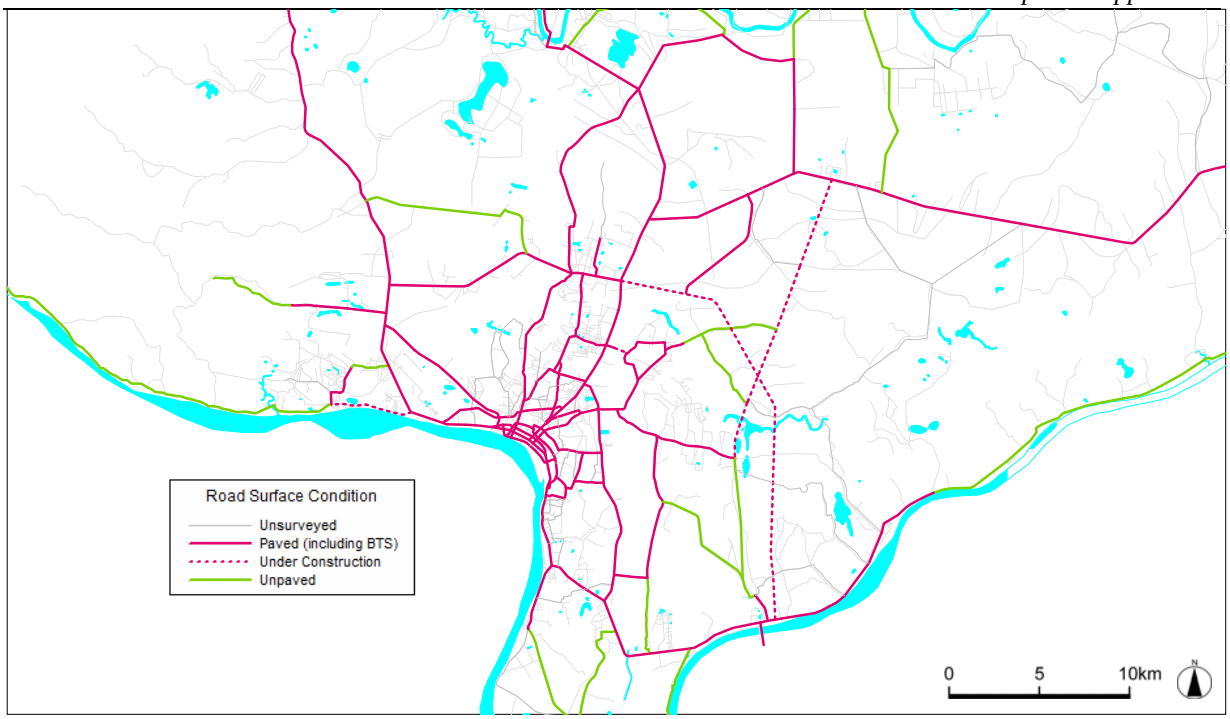
Source: JST

Figure 1.3.4: Existing Carriageway Width

3) Road Surface Condition

In Vientiane Capital, bituminous surface treatment (BST) is the most common surface type even on the national roads. In suburban area, gravel surface is till common. According to JUTMP 2008, recently a number of arterial roads in urban area has the surface upgraded to asphalt concrete. Cement concrete pavement is seen in some limited locations such as Lane Xang Avenue, Lao-Thai Road and Sokpaluang Road.

Most of district roads are paved with BST but each road section has different surface condition depending on the quality and frequency of maintenance. In suburban area, gravel surface sections still remains. Therefore, potholes and rutted road sections are often observed giving an obstacle to smooth flow of travel, especially in the rainy season.



Source: JST

Figure 1.3.5: Road Surface Condition

(4) Public Transport

1) Existing Public Transport System

The existing public transport system in Vientiane Capital is composed of air, rail, bus, paratransit and ferry. Wattay International Airport is located between Dongnasok Road and Souphanouvong Road in the western part of the city. A railway line is operated between Thanaleng Station in Lao PDR and Nong-Khai Station in Thailand for international passengers and freight.

For the public transport in urban area, bus transit, paratransit and taxis are common at present. There are several types of bus transit, which can be categorized into mini, medium and large in size, and also into urban, intercity and international transport in service. For the intracity urban public transport, the Vientiane State Bus Company (VSBC) plays a major role but a private company, Thong Li Pa Si Bus Company, recently started their operation for selected routes.

A paratransit mode complements the bus service as feeder function which is composed of Tuk-Tuk and Sonteo. Tuk-tuks are allowed to operate intracity; Sonteos are used as rural transport for agricultural products and passengers between the City center and suburban villages. In the City center, a small number of taxis and vans are used mainly by businessman, foreigners and tourists for short-distance trips among areas such as hotels, airport, bus stations and sightseeing spots.

In rural area, a motorbike taxi provides transport service for passengers and cargos as an access from their villages to the nearest bus station. A small passenger ferry service is operated at 5 km east of the Friendship Bridge for Nongkhai, Thailand.

Table 1.3.3: Public Transport Vehicle

Vehicle Type	Function	Size	Operation	Fare (kips)
Large Bus	Long distance trip	By type	VSBC/private	By distance
Medium Bus	Medium/urban trip	45 seats	VSBC/private	2,000
Mini Bus	Short trip/commuter	25 seats	VSBC	2,000
Sonteo	Urban trip	12 passengers	Private	By distance
Tuk-tuk	Urban trip	8 passengers	Private	5,000
Taxi	Urban/short trip	4-5 passengers	Private	27,000
Motorbike Taxi	Rural	1-2 passengers	Private	n.a.
Ferry	Thailand	20 passengers	Private	n.a.

Source: JICA Urban Transport Master Plan

2) Bus Service and Operation

Tables 1.3.4 and 1.3.5 show the service of buses departing from Central Bus Station (CBS) operated by VSBC. Mainly, small buses are used for the urban bus service, while medium and large buses are used for the long distance service. There are four major bus routes in the urban bus service; CBS to Thangon via National Road 13 South, CBS to western area such as Thongpong and Tathong via National Road 11, CBS to Friendship Bridge via Thadeua Road, and CBS to National University of Laos (NUOL) in Dongdok via Kaysone Phomvihan Road.

Table 1.3.4: Urban Bus Service by VSBC

Route No.	Destination	No. of Vehicles	Frequency	Fare (kip)	Seat	Type of Vehicle
14	Thadeua	10	45	5,000	25	Nissan(2000)
23	Thangon	6	30	5,000	25	
49	Nongteng	3	17	4,000	28	Mitsubishi(88-89)
32	Donpa Mai	3	28	3,000	20-25	
31	Phontong	6	38	3,000	25	
43	Nongping	1	8	3,000	28	
20	Dongkhamxang	2	12	4,000	28	
40	Nonghai	1	6	-	28	
30	Thongpong	5	27	4,000	28	
3	Tathong	4	24	4,000	28	
33	Nongtha	3	18	-	28	
48	Sikeut	3	18	-	28	
29	Dongdok	3	24	3,000	45	

Source: VSBC

Table 1.3.5: Long Distance Bus Service by VSBC

Route No.	Destination	No. of Vehicles	Frequency	Fare (kip)	Seat	Type of Vehicle
1	Vang Vieng	3	3	35,000	55	Hino (88-89)
4	Kasy	1	1	45,000	55	Hino (88-89)
5	Namxonang	1	3	8,000	55	Hino (88-89)
6	Pealath	1	3	15,000	55	Hino (88-89)
7	Pakcheng	1	3	15,000	55	Hino (88-89)
9	Thalath	5	10	15,000	55	Hino (88-89)
19	Pakxap	1	3	9,000	55	Hino (88-89)
50	Seandin	1	3	8,000	55	Hino (88-89)
56	Thachampa	1	2	10,000	55	Hino (88-89)
	Bandon	1	1	35,000	55	Hino (88-89)
16	Namthon	1	1	45,000	45	Hyundai (2000)
15	Thakhek	1	3	65,000	45	Hyundai (2000)
36	Savannakhet	8	8	85,000	45	Hyundai (2000)
35	Pakxe (Normal)	3	3	130,000	45	Hyundai (2000)
	Pakxe (Express)	1	1	155,000	45	Hyundai (2000)
54	Donkhong	1	1	150,000	45	Hyundai (2000)
51	Attapeu	2	1	160,000	45	Hyundai (2000)
52	Salavan	1	1	150,000	45	Hyundai (2000)
55	Dontalath	1	1	140,000	45	Hyundai (2000)
Thailand-1	Nong Khai	-	6	15,000	45	Hyundai
Thailand-2	Udon Thani	-	6	22,000	45	Hyundai
Thailand-3	Khon Kaen	-	2	50,000	45	Hyundai
Thailand-4	Nakhon Ratchasima	-	1	80,000	45	Hyundai

Source: VSBC

3) Passenger Demand

Table 1.3.6 shows the operational results by VSBC in the years between 2005 and 2009 for both urban bus and long distance bus services. The total number of passengers in 2005 was 5.2 million being for the both services and 3.5 million in 2009. The decrease is 1.6 million, which corresponds to 4,000 decreases daily. Especially the decrease in urban bus service is worse than that of long distance bus service.

In the beginning of 2008, VSBC increased the bus fare to cope with the financial imbalance caused by the increase of fuel price. The revenue of VSBC was improved and produced a profit by this raise of fares. However, this action resulted in the decline of bus users and they did not come back even after the decrease of the bus fare to the previous level in the end of year 2008.

Table 1.3.6: Yearly Operational Results

Year	Urban Bus				Long Distance Bus			
	Total Operation Days	Total Trips	Total Distance (1,000 km)	No. of Passengers (1,000 pax)	Total Operation Days	Total Trips	Total Distance (1,000 km)	No. of Passengers (1,000 pax)
2005	5,232	105,034	3,421	3,853	6,704	23,437	6,708	1,332
2006	4,638	97,388	3,119	3,368	6,502	21,498	5,601	1,274
2007	4,193	81,699	2,477	2,957	6,239	22,989	5,276	1,430
2008	3,800	81,462	2,336	2,998	5,539	20,084	4,629	1,286
2009	3,862	87,159	2,465	2,624	5,127	17,198	4,339	919

Source: VSBC

(5) Parking

A parking inventory survey and a parking car counting survey were conducted in Vientiane Capital city center area surrounded by Khounboulom Road, Khouvieng Road and Fa Ngum Road for the Vientiane Urban Transport Master Plan Study, funded by AFD in 2004. The results of these surveys show that there are 5,731 parking lots in the area of which 77.4% is on-street parking lot.

Table 1.3.7: Parking Space in City Center

	On Street	Off Street	Total
Parking Lot	4,434	1,297	5,731
Rate	77.4%	22.6%	100.0%

Source: Vientiane Urban Transport Master Plan, BCEOM

The number of vehicles to park in the peak hour was calculated at 2,665 vehicles in the same Study. This number exceeds the off-street parking capacity so that it is necessary to park on-street. Besides, parking demand might have been increased at present compared with this result and measures for parking demand should be considered as one of the most important components of transport master plan study.

Moreover, in the JUTMP 2008, a parking demand survey was conducted covering a wider area than the above mentioned area, and the following roads are listed up as a road section with high parking demand.

- Lane Xang Avenue
- Mahosot Road and Noongbone Road
- Asian Road (T2 Road)
- Dongpalane Road

1.3.2 Water Supply

Two type of water supply system is applied in Vientiane Capital, i) water network system applied in urbanized area served by Nam Papa Vientiane Capital, Water Supply Company of the Vientiane Capital (NPVC) and ii) independent wells / bore holes or small scale water networks applied in rural area served by resident itself or villages. The service ratios of i) and ii) are about 50% respectively in Vientiane Capital at present. The present condition of water supply is described below,

(1) Organization

1) National Level

a) WSRC and WaSRO in MPWT

Water Supply Authority (WASA) was reformed at the end of 2008 and became the Water Supply Regulatory Office (WaSRO) in accordance with the Minister's Decisions. WaSRO was designated as the secretariat of the Water Supply Regulatory Committee (WSRC) under Ministry of Public Works and Transportation (MPWT). WSRC which meets on a quarterly basis works for directing, monitoring and supervising activities of WaSRO. The Prime Ministerial Decree and subsequent Ministerial Decrees have established the legal framework for WSRC as regulator of the urban water supply in Lao PDR and the responsibilities are as follows,

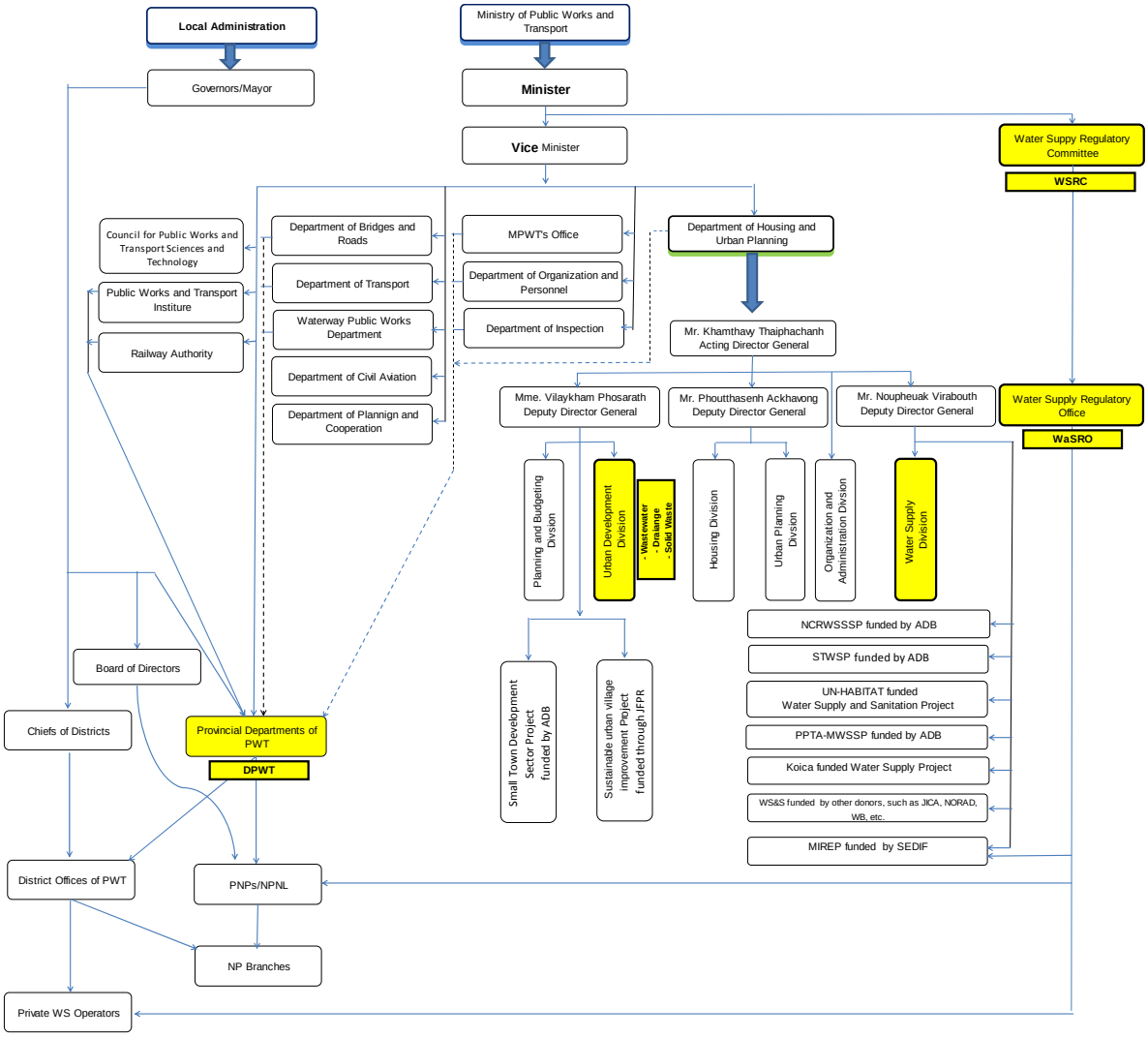
- Assisting the Provincial authorities in issuing licenses and obligations to suppliers
- Ensuring that suppliers carry out their responsibilities
- Undertaking independent tariff reviews
- Encouraging suppliers to become more efficient
- Ensuring that suppliers carry out their activities in an environmentally sustainable manner

WSRC does not have jurisdiction over rural water supplies.

b) WSD, DHUP in MPWT

Water Supply Division (WSD) of DHUP under MPWT is responsible in policy, planning and development for urban water supply sector.

MPWT related in water and wastewater is shown below,



Source: NPVC

Figure 1.3.6: Ministry of Public Works and Transportation (MPWT) Related in Water and Wastewater

c) Nam Saat in Ministry of Health

Rural water supply is the responsibility of Nam Saat (National Center of Environmental Hygiene and Rural Water Supply) under the jurisdiction of the Ministry of Health. Rural water supply is defined to be population served with less than 2,000. Nam Saat has no water supply services in Vientiane Capital.

Nam Saat conducts groundwater quality analysis of wells and bore holes before the public use of the water sources and periodical monitoring for whole of Lao PDR including Vientiane Capital.

d) Water Resource and Environment Agency (WREA)

WREA is in charge of protection of the water resources and the environment.

2) Vientiane Capital Level

a) DPWT in Vientiane Capital

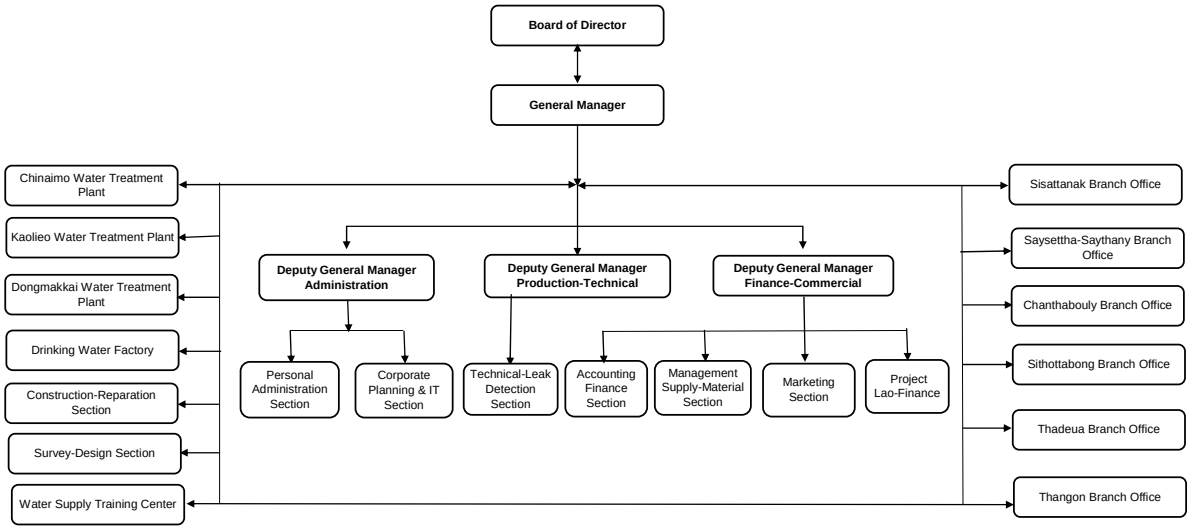
DPWT is an organization under Vientiane Capital supported by MPWT. Water Supply & Environment Unit is in charge of water supply, wastewater management, drainage and environment under Housing, Town Planning and Environment Division under the DPWT.

b) Nam Papa Vientiane Capital (NPVC)

Water supply in Lao PDR is conducted by 17 Nam Papa State Owned Enterprises (NPSEs) under control of the MPWT. NPSEs have responsibility for day-to-day management of urban water supply. NPSEs is expected to manage the water supply work with self supporting system.

NPVC has a responsibility to supply drinking water to the whole area of Vientiane Capital consisting of 9 districts. However, at present, NPVC supplies water only in 7 districts consisting of Chanthabouly, Sikhottabong, Xaysetha, Sisattanak, Naxaithong, Xaythany and Hadxaifong.

NPVC consists of one head office and six branch offices as presented in Figure below. Total staff number of NPVC is 471 employees in 2007.



Source: NPVC

Figure 1.3.7: Organization Chart of NPVC

(2) Water Supply Development Policy

1) National policy

National policy for water service ratio is as follows based on DHUP, MPWT.

Urbanized area: Service ration will be 80% by 2020

2) Vientiane Capital policy

Vientiane Capital policy for water service ratio follows DPWT, as shown in an article described in the 7th 5year plan would be approved in April 2010 in Vientiane Capital.

- Urbanized area: 100% by 2015
- Rural area: 90% by 2015 and 100% by 2020 for whole Vientiane Capital

(3) Drinking Water Standard

Water quality standard is determined by the Department of Hygiene and Prevention under the Ministry of Health. According to the Decision on the Management of Quality Standard for Drinking Water and Household Water Supply No.1371/MoH, drinking water quality standards are categorized by the following parameters:

1) Bacteriological Parameters

Table 1.3.8: Bacteriological Parameters

Organisms	Unit	Concentration
Fecal Coliform	Number/100 ml	0
Total Coliform	Number/100 ml	0

Source: Decision No. 1371/MOH

2) Physical-Chemical Parameters (Aesthetic Significance)

Table 1.3.9: Physical-Chemical Parameters

Parameters	Minimum concentration	Maximum Concentration	Units
Aluminum (Al)	0.1	0.2	mg/l
Ammonia (NH3)	0.5	1.5	mg/l
Chorine (CL-)	200	250	mg/l
Copper (Cu)	1.0	2	mg/l
Iron (Fe)	0.3	<1	mg/l
Manganese (Mn)	0.1	0.5	mg/l
Sodium (Na)	200	250	Mg/l
Sulfate (SO4)	200	250	mg/l
Hydrogen Supplied (H2S)	0.05	0.1	mg/l
Conductivity 25-30 °		<1000	uS/cm
Total dissolves solids	500	600	mg/l
Salt (Nacl)	100	300-350	mg/l
Hardness	50	300	mg/l
Turbidity		<10	NTU
Color		5	TCU
Taste and Order	Acceptable	Acceptable	Acceptable
pH	6.5	8.5	
Temperature	25	35	° C
Residual Chloride (If chlorine disinfection is used)		<0.2	mg/l

Source: Decision No. 1371/MOH

3) Health Significant Chemical Parameters

Table 1.3.10: Health Significant Chemical Parameters

Parameters	Maximum concentration	Unit
Antinomy (Sb)	0.005	mg/l
Arsenic (As)	0.05	mg/l
Barium (Ba)	0.7	mg/l
Boron (B)	0.5	mg/l
Cadmium (Cd)	0.003	mg/l
Chromium (Cr)	0.05	mg/l
Cyanide (CN)	0.07	mg/l
Fluoride (F)	1.5	mg/l
Lead (Pb)	0.01	mg/l
Mercury (Hg)	0.001	mg/l
Nitrate (NO3)	50	mg/l
Nitrite (NO2)	3	mg/l
Selenium (Se)	0.01	mg/l

Source: Decision No. 1371/MOH

(4) Present Condition of Water Supply in Vientiane Capital

Vientiane, the capital of Lao PDR, is estimated at a population of 740,000 in 2008 and its area is 3,920 km^2 in total. The population of Vientiane Capital has growing with an annual growth rate of 2.0 %.

According to WSRC, service coverage ratio for population served with a piped water supply relative to the total population in the service area is 67% on an average of 17 NPSEs in 2008, while in Vientiane Capital 49% in 2009. The present condition of water supply in Vientiane Capital is summarized below.

Table 1.3.11: Benefit Monitoring and Evaluation (BME) 2000-2009 in Vientiane Capital

Description	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Remark
Water Demand												
Population in Vientiane Capital (9Districts)	No.	597,800	616,000	633,100	650,600	669,467	698,318	718,569	725,820	740,010	760,730	Ref. **NSC**
Population in Service Area (7 Districts)	No.	539,216	555,632	571,056	586,757	603,773	625,560	643,701	648,856	660,891	679,396	
Population Served (7 Districts)	No.	237,042	252,312	258,558	277,884	285,678	286,935	308,347	328,895	343,640	372,906	
Coverage (in Vientiane Capital)	%	40	41	41	43	43	41	43	45	46	49	
Coverage (in Service Area)	%	44	45	45	47	47	46	48	51	52	55	
Per Capita Consumption	lpd	182	174	176	178	169	186	174	182	174	175	
Total Area in Vientiane Capital	Km^2	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,920	
Service Area 7 Districts	Km^2	1,521	1,521	1,521	1,521	2,652	2,652	2,652	2,652	2,652	2,652	
Pipes Network (Size ≥ 40 mm)	Km	330	346	361	363	467	545	634	721	741	806	
New Extention fo Pipe	Km	5	16	16	2	103	78	89	87	19	65	
Pipe Leakage	No.	6,170	3,676	3,314	2,960	3,121	3,192	2,970	3,676	4,416	7,193	
Replace of Water Meter	No.	1,307	994	-	1,537	3,390	6,571	1,256	1,868	1,344	1,090	
Number of New connection	No.	1,275,445,676	17,853,788,443	3,017,782,295	3,898,952,715	6,882,330,913	7,631,651,358	6,209,768,722	10,891,229,412	11,256,694,031		
Number of Employees at year	No.	458	440	432	406	413	416	483	471	487	494	
Storage (Elevated Reservoir)	m3	9,360	9,360	9,360	9,360	11,360	11,360	11,360	11,360	11,360	11,360	
Production												
Total Water Production	**m3**	**36,273,290**	**38,378,969**	**41,365,415**	**43,786,885**	**43,205,699**	**43,871,789**	**43,440,196**	**49,197,540**	**49,781,245**	**58,696,856**	
Chinaimo WTP	m3	29,975,480	32,345,051	33,548,692	33,075,199	32,061,006	33,823,285	33,212,527	32,491,689	31,084,110	30,733,637	
Kaoleo WTP	m3	6,297,810	6,033,918	7,816,723	10,593,110	11,038,245	9,584,557	9,223,755	8,347,104	10,376,985	20,722,610	
Dongmakkai WTP	m3	-	-	-	-	-	-	427,738	7,902,381	7,814,850	6,885,463	
Thadeua WTP	m3	-	-	-	118,576	106,448	174,357	258,174	158,991	192,602	58,105	
Thangon WTP	m3	-	-	-			289,590	318,002	297,375	312,698	297,041	
Total Water Production	**m3/day**	**99,379**	**105,148**	**113,330**	**119,964**	**118,372**	**120,197**	**119,014**	**134,788**	**136,387**	**160,813**	
Chinaimo WTP	m3/day	82,125	88,617	91,914	90,617	87,838	92,667	90,993	89,018	85,162	84,202	
Kaoleo WTP	m3/day	17,254	16,531	21,416	29,022	30,242	26,259	25,271	22,869	28,430	56,774	
Dongmakkai WTP	m3/day	-	-	-	-	-	-	1,172	21,650	21,411	18,864	
Thadeua WTP	m3/day	-	-	-	325	292	478	707	436	528	159	
Thangon WTP	m3/day	-	-	-	-	-	793	871	815	857	814	
Water Sold												
Total Water Sales	**m3**	**24,992,460**	**27,834,267**	**28,829,294**	**31,350,134**	**30,484,816**	**31,509,756**	**31,679,467**	**35,562,330**	**36,177,870**	**39,706,921**	
Domestic (cat 1)	m3	13,698,682	21,193,619	22,409,366	24,398,746	24,010,768	25,461,574	25,850,730	29,567,867	30,358,130	34,437,210	cat1+cat2
Government (cat 2)	m3	5,408,236	-	-	-	-	-	-	-	-	-	
Commercial &Business &Industry (cat 3	m3	4,021,539	3,714,380	3,232,286	3,652,169	616,400	5,740,238	5,534,359	5,675,024	5,526,418	4,936,306	cat3+cat4
Large Commercial (cat 4)	m3	1,473,463	2,539,150	2,857,251	2,997,065	5,561,643	-	-	-	-	-	
Foreigner (cat 5)	m3	390,540	387,118	330,391	302,154	296,005	307,944	294,378	319,439	293,322	333,405	
NRW												
Non Revenue Water (NRW)	m3	**11,280,830**	**10,544,702**	**12,536,121**	**12,436,751**	**12,720,883**	**12,362,033**	**11,760,729**	**13,635,210**	**13,603,375**	**18,989,935**	
Non Revenue Water (NRW)	%	31	27	30	28	29	28	27	28	27	32	

Source: NPVC

Future water demand is projected for domestic and non-domestic purpose separately according to Water Supply Master Plan. Table below shows summary of future water demand projection.

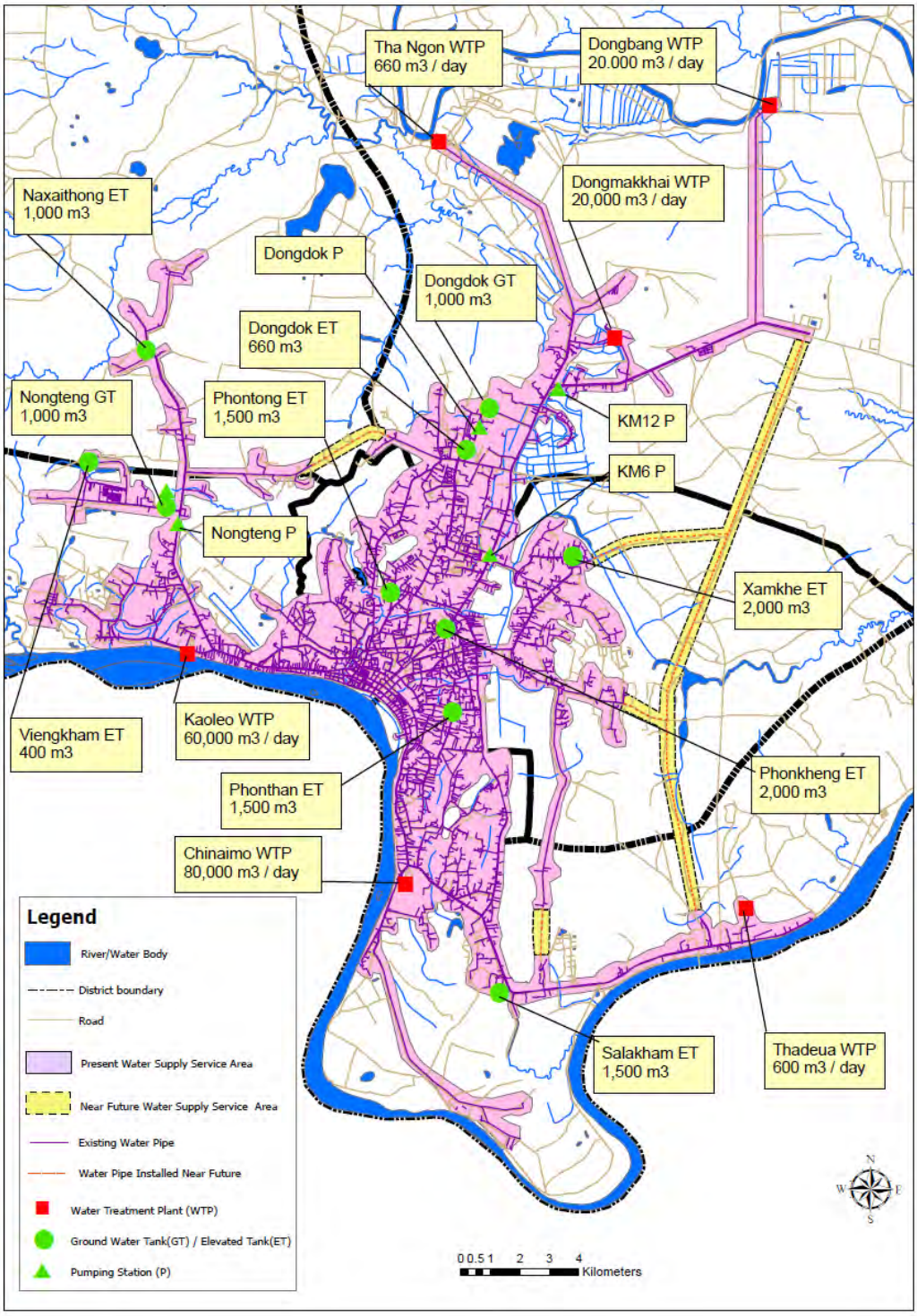
Table 1.3.12: Water Demand Projection in Vientiane Capital

	Unit	2000	2005	2010	2015	2020
Population	person	599,000	687,084	788,165	902,716	1,034,521
Served Population	person	215,522	275,567	370,269	466,981	564,648
Service Ratio	%	36.0%	40.1%	47.0%	51.7%	54.6%
Population in Service Area	person	297,575	380,342	499,737	586,710	662,441
Service Ratio in Service Area	%	72.4%	72.5%	74.1%	79.6%	85.2%
Number of Domestic Connections	nos.	34,210	43,741	58,773	74,124	89,627
Number of Non-domestic Connections	nos.	5,095	6,340	7,889	9,817	12,215
Total Number of Connections	nos.	39,305	50,081	66,662	83,940	101,842
Served Population (Incremental)	person		60,046	94,702	96,712	97,667
Number of Domestic Connections (Incremental)	nos.		9,531	15,032	15,351	15,503
Per Capita Consumption	lpcd	174	172	170	170	170
Total Domestic Water Demand	m3/day	37,501	47,398	62,946	79,387	95,990
Non-Domestic Water Demand	m3/day	30,361	37,780	47,011	58,499	72,793
Total Water Demand	m3/day	67,862	85,177	109,957	137,885	168,783
UFW Ratio	%	33%	28%	25%	25%	25%
Day Average Water Demand	m3/day	101,286	118,302	146,609	183,847	225,044
Day Maximum Water Demand	m3/day	111,415	130,132	161,270	202,232	247,548

Source: The Study on Vientiane Water Supply Development Project in Lao People's Democratic Republic, Master Plan, JICA, 2004

(5) Present Water Supply Facilities in Urbanized Area of Vientiane Capital

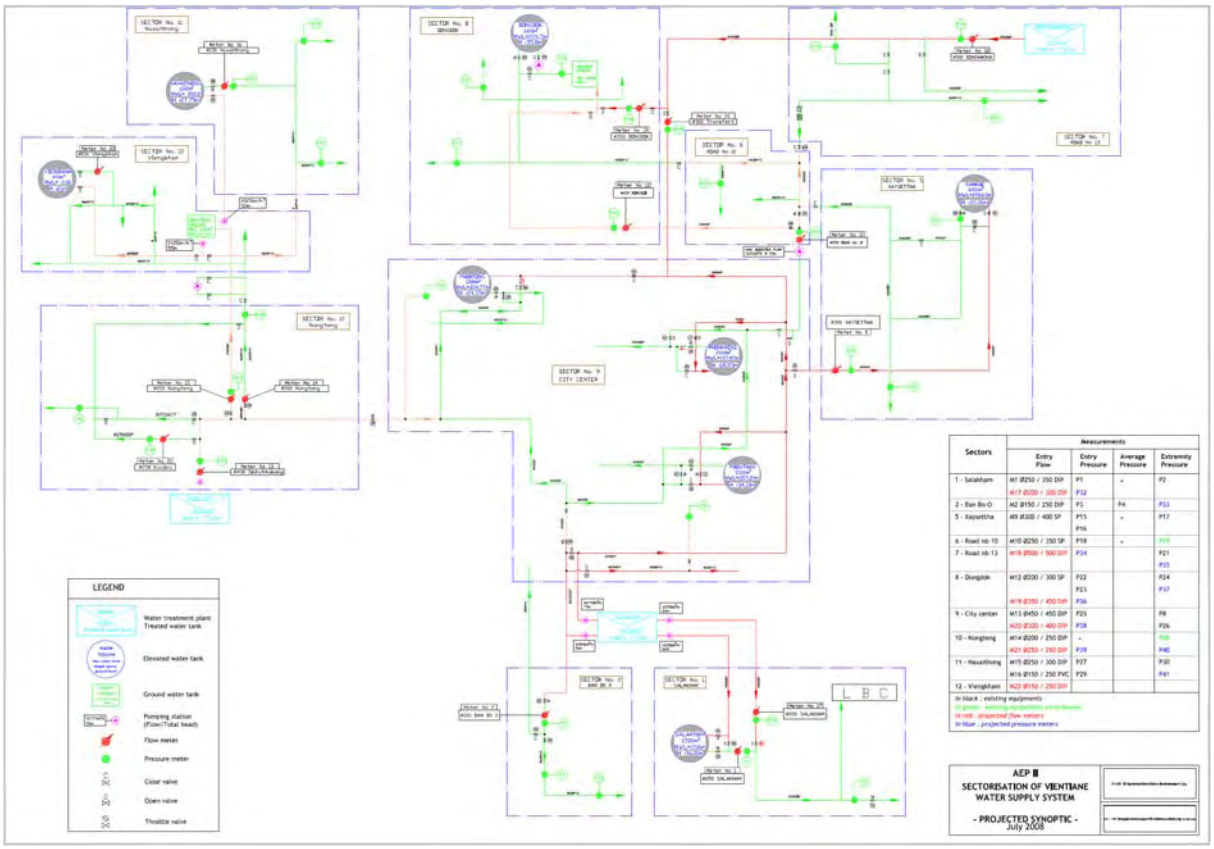
The present service area and location of main water supply facilities are presented in Figure below.



Source: NPVC, JST

Figure 1.3.8: Existing Water Supply System in Vientiane Capital

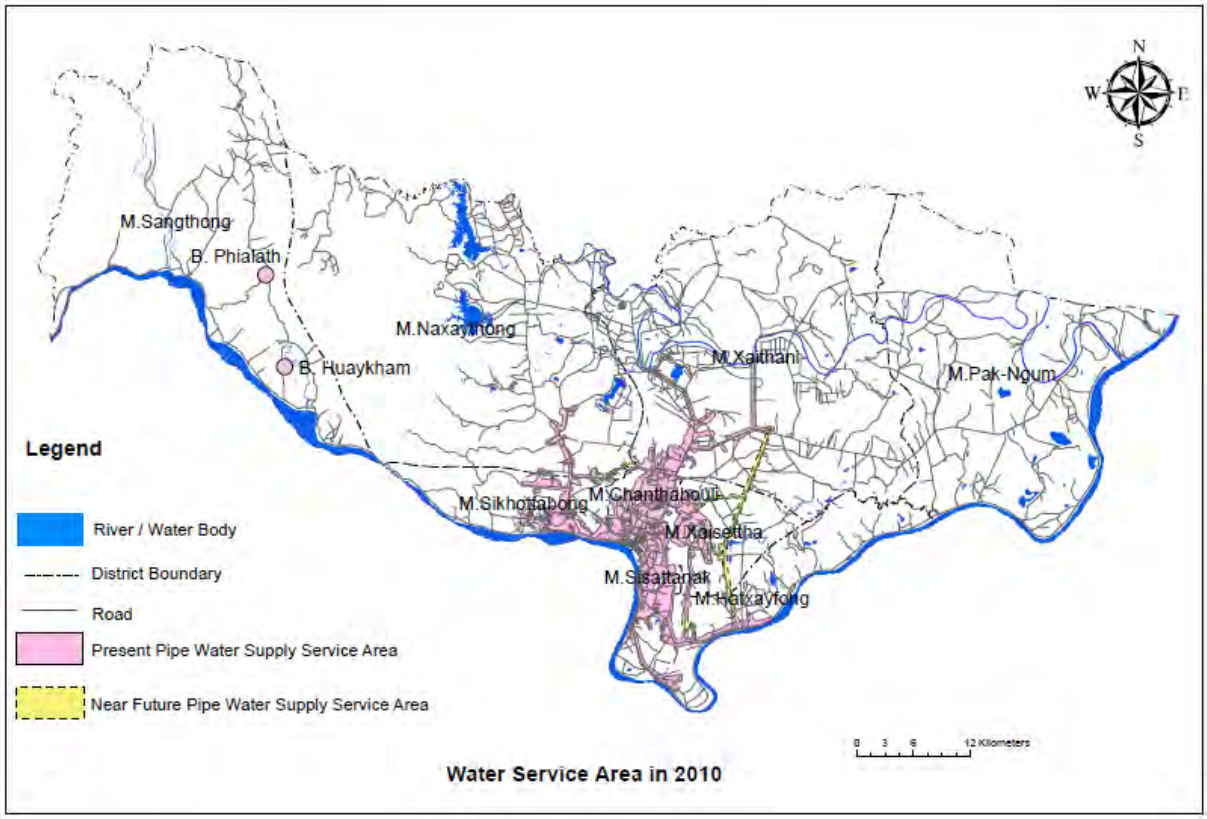
The Schematic diagram of water supply facilities is presented in Figure below.



Source: NPVC

Figure 1.3.9: Existing Water Supply System in Vientiane Capital

In Vientiane Capital, not only center of Vientiane Capital but there are water supply service area in two rural areas of Phialath village and Houaykham village as shown in figure below,



Source: NPVC, JST

Figure 1.3.10: Location of Existing Water Supply Service Area in Vientiane Capital

1) Water Treatment Plant

The existing conditions of four water treatment plants (WTPs) and one borehole station operated by NPVC are summarized below.

Table 1.3.13: Existing Water Treatment Plant in Vientiane Capital as of July 2010

WTP	Design Capacity (m3/d)	Source	Remark
Kaolieo	60,000	Mekong River	20,000m3/day: constructed in 1964 by Japan 40,000m3/day: constructed in Mar. 2009 by Japan
Chinaimo	80,000	Mekong River	40,000m3/day: constructed in 1980 by ADB 40,000m3/day: constructed in 1996 by Japan. Rehabilitated in 1996 and 2008 by Japan
Dongmakkhay	20,000	Dongmakkay Irrigation Canal from Nam Ngum River	Constructed in Nov. 2009
Dongbang	20,000	Nam Ngum River	Constructed in 2010 (10,000m3/day has been constructed in May and the other 10,000 has been constructed around July 2010.
Tha Ngone	660	Nam Ngum River	Constructed in 1993
Thadeua	600	1 Borehole (ground water)	Constructed in 1994 by France
Total	181,260		

Source: NPVC

Kaolieo WTP Chinaimo WTP Dongmakkhay WTP

Source: JST

Figure 1.3.11: Pictures of Major WTPs in Vientiane Capital

Kaolieo and Chinaimo WTP have no extra land to expand the capacity. Dongmakkhay WTP has a vacant land in the premises to expand the capacity to be about 5-6 times of the present capacity. But The Dongmakkhay WTP is taking raw water from a regulation pond connected through irrigation canal pumped up from the Nam Ngum River, the irrigation facilities are constructed for the Agricultural, Rural Development Project in the Suburbs of Vientiane by Japan in 1994. The pump up water flow is 3.06m^3/sec (=264,000 m^3/day) for irrigation activities. One pump was additionally installed for supplying raw water to Donmakkhay WTP. If the plant is expanded, new construction of raw water pipe or a channel will be necessary in order not to affect the irrigation work.

Water production capacity in 2009 is about 161,000 m^3/day excluding the capacity of newly constructed Dongbang WTP. The actual water demand in the water service area looks higher than the total WTP capacity due to rapid expansion of urban area and lack of funds for water

supply development. Water production capacity in 2010 is about 181,000 m^3/day including the capacity of newly constructed Dongbang WTP. The actual water demand in the water service area looks equivalent to the total WTP capacity as described in Chaper 4.3.2. Further WTP development is required to support future sustainable Vientiane Capital development.

2) Water Reservoir and Pumping Station

Reservoirs and pumping stations are shown below and total capacity of elevated tank and ground tank is 12,560 m^3 that is about 1.7 hours capacity of water production of 181,260 m^3/day. Total of reservoir capacity with reservoirs of WTP is about 42,300 m3 (=12,560+29,742) that is about 5.6 hours capacity. It is generally recommended each distribution reservoir volume holds more than 6 hours capacity to supply stable water, so the present reservoir volume is not enough. But, most of the reservoirs are not fully used as the present WTP capacity is less than the water demand at the moment.

NPVC has been preparing District Metered Area (DMA) as shown in Figure 1.3.10 and the sector reservoirs are shown below. There are no reservoirs at some sectors as shown in the figure and table. That means transmission and distribution pipes are not clearly separated, this is not appropriate for water supply management.

Table 1.3.14: Existing Reservoirs and Pumping Station in Vientiane Capital as of July 2010

Ser. No.	Sectors	Reservoir	Capacity(m3)	Pumping Station
Reservoir of Elevated Tank or Ground Tank for DMA				
1	Salakham	Salakham ET	1,500	-
2	Ban Bo O	-	-	-
5	Xaysettha	Xamkhe ET	2,000	-
6	Road No 10	-	-	-
7	Road No 13	-	-	-
8	Dongdok	Dongdok ET	660	-
		Dongdok GT	1,000	Dongdok P: Pump up to Dongdok ET, 2 x 45kw, pump specification is not sure
9	City center	Phontong ET	1,500	-
		Phonkeng ET	2,000	-
		Phonthan ET	1,500	-
10	Nongteng	-	-	-
11	Naxaithong	Naxaithong ET	1,000	-
12	Viengkham	Viengkham ET	400	-
		Nongteng GT	1,000	Naxaithong GT P: Pump up to Viengkham ET and Naxaithong ET, 2 x 151m3/h x 55m
Total		-	12,560	-
Reservoir of WTP				
		Kaoleo WTP	14,600	Distribution Pumps 4 x 354m3/h x 75m, 120kw 4 x 726m3/h x 75m, 220kw
		Chinaimo WTP	10,800	Transmission Pumps 2 x 258m3/h x 66m

			6 x 846m3/h x 56m Distribution Pumps 4 x 786m3/h x 71mx220kw
	Dongmakkai WTP	1,000	4 x 306m3/h x75m 1 pump specification is not sure
	Dongbang WTP	3,000	Pump No. and specification are not sure.
	Tha Ngon WTP GT	132	Tha Ngon GT P: Pump up to Tha Ngon ET, 2 x 60m3/h x5.5kw
	Tha Ngon WTP ET	10	Pump No. and specification are not sure.
	Thadeua WTP	200	Pump No. and specification are not sure.
	Total	29,742	
Pumping Station			
	KM 6 P	-	Pump up to Dongdok GT, 3 x 252m3/h x 28m, 30kw
	KM12 P	-	2 x 13m3/h x 50mx 5.5kw, with 10m3 pump well
	Nongteng P	-	2 x 100m3/h x 60m, 23kw

Note: ET= Elevated Tank, GT= Ground Tank, P= Pumping Station

Source: NPVC, Basic Design Study Report on the Project for the Vientiane Water Supply Development 2005, Water MP 2004

3) Water Pipe

Water pipe network shown in Table 1.3.15. Total length of pipeline, over 40 mm diameter, is about 806 km, as shown in table below. Pipelines in the downtown area of Vientiane Capital were installed in the 1960s and 1980s, at the time of construction of the Kaolio and Chinaimo Water Treatment Plants respectively.

Table 1.3.15: Existing Pipe Length of Water Network by Pipe Material in 2009

Pipe	Installation in year 2009				Total Pipe Length till end of 2009							
Diameter (mm)	DIP (m)	GSP (m)	PVC (m)	Total (m)	DIP (m)	GSP (m)	SP (m)	PVC (m)	ACP (m)	PB (m)	PE (m)	Total (m)
1000	-	-	-	-	-	-	386	-	-	-	-	386
700	-	-	-	-	1,000	-	9,685	-	-	-	-	10,685
600	-	-	-	-	1,580	-	7,774	-	-	-	-	9,354
500	1,926	-	-	1,926	2,390	-	2,919	-	-	-	-	5,309
450	-	-	-	-	13,688	-	7,296	-	-	-	-	20,984
400	18	-	-	18	11,115	-	10,875	-	-	-	-	21,990
350	-	-	-	-	4,046	-	4,264	-	-	-	-	8,310
300	-	-	-	-	26,287	-	6,607	-	-	-	-	32,894
250	-	-	980	980	22,837	-	-	15,130	-	-	-	37,967
200	4,704	-	1,020	5,724	28,059	109	-	50,547	-	-	-	78,715
150	10,375	-	4,520	14,895	31,858	276	27	65,279	1,095	-	-	98,535
100	38	-	7,847	7,885	23,664	3,429	-	102,731	200	-	-	130,024
90	-	-	-	-	-	-	3,996	-	3,000	-	-	6,996
80	-	-	-	-	-	-	-	276	-	-	-	276
75	31	-	13,304	13,335	26,769	4,103	-	136,904	-	-	-	167,776
65	-	-	-	-	-	847	-	-	-	-	-	847
50	-	289	10,014	10,303	2,870	6,632	-	113,287	-	1,000	9,000	132,789
40	-	349	9,901	10,250	-	389	-	41,694	-	-	-	42,083
Total	17,092	638	47,586	65,316	196,163	15,785	53,829	525,848	4,295	1,000	9,000	805,920

Note: DIP-Ductile Cast Iron Pipe, GSP- Galvanized Steel Pipe, PVC- polyvinyl chloride pipe, SP- Steel Pipe, ACP- Asbestos Cement Pipe, PB- Polybutylene pipe, Polyethylene pipe
Source: NPVC

(6) Water Sources

Basically main water sources for drinking water in Vientiane Capital are surface water of the Mekong River, Nam Ngum River and underground water except water on the market. There are no water rights in Lao PDR for the water sources. Some groundwater contains arsenic beyond the drinking water standard in the southern part of Lao PDR according to the WREA. Arsenic content and salty water has been found at some groundwater in Vientiane Capital according to NPVC

Three water sources in Vientiane Capital, i) Mekong River, ii) Nam Ngum River and iii) groundwater, their characteristics are described below,

1) Mekong River

a) General

The Mekong River is a water source of two major WTPs, Chinaimo and Kaoleo. As discussed earlier, the capacity of WTP is 80,000m^3/day for Chinaimo and 60,000m^3/day for Kaoleo and the total is 140,000m^3/day. In March 2010, the Mekong River water level became low as once in twenty years probability and this made it difficult to pump up water with normal intake facilities at Kaoleo WTP. The water intake was restored by installing additional floating pumps, that can pump up water even the water level is lower than the design water level, and the Kaolio WTP was restored to operate at the design capacity of 60,000m^3/day from

20,000m^3/day. Until the restoration, activities such as even hospital work in Vientiane Capital were affected.

The Mekong River originates in the Tibet Plateau, traverses the Indo-China Mountains, and drains into the South-China Sea. The catchment area size of the river at Km 4, Vientiane Capital at Muang Sisatanak is 299,000km^2. The recorded discharges of the Mekong River over the past 43 years are 22,900m^3/sec as maximum flow and 598 m^3/sec as the minimum flow. Water level and discharge of the Mekong River is shown below,

Table 1.3.16: Maximum and Minimum Water Level and Discharge of the Mekong River

	Water Level (m: above sea level)		Discharge (m3/sec)	
	Max Water Level	Min. Water Level	Max. Discharge	Min. Discharge
Maximum	170.75	158.97	22,900	1,220
Minimum	164.71	157.76	7,500	598
Average	168.767	158.48	16,120	1,010

Location: Vientiane Capital KM4 (Zero of Gauge Elevation 158.040m above MSL Ko Lak Datum
Survey term: 1960-2002
Source: The Study on Vientiane Water Supply Development Project in Lao PDR, JICA, 2004

Turbidity is recorded at the two existing WTPs, with the maximum and the minimum turbidity recorded in Chinaimo WTP since 1984 are 6,840 NTU and 2 NTU respectively. Concerning the monthly average turbidity in 2002, the highest was 1,370 NTU in August and the lowest was 13 NTU in April in Chinaimo. Meanwhile at Kaolieo, the highest was 1,407 NTU in August and the lowest was 59 NTU in April. The information is based on "The Study on Vientiane Water Supply Development Project in Lao PDR, JICA, 2004".

b) The Mekong River Commission (MRC)

MRC was formed on 5 April 1995 based on an agreement between the governments of Cambodia, Lao PDR, Thailand and Viet Nam. The four countries signed The Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin and agreed on joint management of their shared water resources and development of the economic potential of the river. In 1996 China and Myanmar became Dialogue Partners of the MRC and the countries now work together within a cooperation framework. MRC Secretariat, which is based in Vientiane Capital, Lao PDR, provides technical and administrative services to the MRC Council and Joint Committee.

The 1st MRC summit by four countries was held in Thailand in April 2010 with attendance from China and Myanmer as observers. Major items of declaration by the summit are i) intensifying risk management from flood and drought including establishment of forecasting and warning system, ii) facilitating legal framework to encourage river navigation and trade, iii) monitoring and taking measures to improve water quality, iv) sustaining the existing and future uses of water and related resources, and aquatic diversity, wetlands and forests, v) identifying and advising on challenges of hydropower and other infrastructure development, vi) continuing to improve the implementation of the procedures for data and information exchange and sharing, vii) exploring and identifying opportunities for expansion of cooperation between the organization's current dialogue partners and development partners. The MRC Summit will be held every 4 years and the next summit will be held in 2014 in Vietnam.

China, attending the committee as an observer, denied that dams in China cause a drop in the Mekong River water level although there is a opinion the dams in China affects the drop.

China also expresses that the River flow information and operation data of dams will be provided to reduce the concerns.

The MRC does not set the share of the water right to the concerns countries and there is no water right even in Lao PDR.

2) Nam Ngum River

The Nam Ngum River is utilized for a water source of Dongmakkhay WTP constructed in 2009 by Lao PDR. The capacity is 20,000m^3/day (0.23m^3/sec).

The Nam Ngum River is one of the large tributaries of the Mekong river. The catchment area of the river at Ban Tha Ngon, location of an intake for the irrigation pump, is 16,500km^2. The monthly mean discharge of the Nam Ngum river at BanTha Ngon ranges from 215 m3/sec in April to 1,790m^3/sec in September. The annual average flow is 667m^3/sec and minimum flow of 39m^3/sec was observed in May 1960.

The hydrological data of the Nam Ngum River at Ban Tha Ngon station are shown in Table below,

Table 1.3.17: Monthly Average Water Level and Discharge of the Nam Ngum River

	Water Level (m)			Discharge (m3/sec)		
	Max.	Ave.	Min.	Max.	Ave.	Min.
Average	15.79	6.47	2.94	2960	667	93

Location: Tha Ngon
Survey term: 1972-1988
Source: Basic Design Study Report on Agricultural and Rural Development Project in the Suburbs of Vientinae in Lao PDR, JICA, 2004

Source: JST

Figure 1.3.12: Intake for Irrigation used also for Dongmakkhay WTP at the Nam Ngum River

There is no water right in the Nam Ngum River.

The turbidity was surveyed in 2003 at Thangone, and the range was from 3.9 to 50 based on the Study on Vientiane Water Supply Development Project in Lao PDR, JICA, 2004.

3) Groundwater

Groundwater is used in rural area or even in some part of urbanized area to back up water of NPVC. The groundwater is taken from shallow wells or boreholes. Shallow wells, mostly used

by rural residents with depth of 5-15m, often dry up in dry season from February to April, and the shallow groundwater is easily polluted by wastewater incursion. Some deep wells are also polluted due to inappropriate construction methods such as improper sealing along casing. Using the polluted groundwater leads to a high water born disease rate and it is a serious problem in Lao PDR. Replacing the shallow wells with proper type of wells or deep boreholes, receiving water tanker of NPVC or receiving water with water network of NPVC are alternatives to prevent the problems.

Groundwater availability depends on the geological condition and it is different area-by-area. As described before, some groundwater is contaminated with arsenic or salty water.

Groundwater control is not carried out in Vientiane Capital and there is no water right on groundwater resources.

(7) Management Condition

1) Financial Condition

NPVC prepared financial data as shown in Table 1.3.18 A and it is sent to WSRC. WSRC prepared financial statement of all water supply company in Lao PDR including NPVC as shown in Table 1.3.18 B. The two financial statements are not matched as below. It is recommended that the two financial statements shall be consistent each other.

Table 1.3.18-1: Financial Statement of Vientiane Capital prepared by NPVC

Description	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Remark
Financial Statistics												
Total Revenue	**Million Kip**	**12,272**	**16,002**	**19,978**	**20,961**	**47,635**	**46,418**	**42,167**	**94,624**	**56,931**	**105,612**	
Water Sale	Million kip	6,410	10,299	15,527	16,141	24,069	28,203	27,895	39,920	45,982	74,939	
New Connection	Million kip	1,889	2,070	1,990	2,093	2,392	4,781	4,150	6,649	6,887	9,424	
Other	Million kip	3,973	3,633	2,461	2,726	21,174	13,435	10,122	48,055	4,063	21,249	Project Income
Total Expenses	**Million Kip**	**14,652**	**17,222**	**19,200**	**18,786**	**43,103**	**43,359**	**49,896**	**98,629**	**58,143**	**99,191**	
Direct Operating Expenses	Million kip	7,498	9,876	12,306	11,210	16,450	19,770	21,936	27,161	32,058	49,443	
Depreciation & Amortization	Million kip	1,755	1,981	2,725	3,373	3,172	6,021	14,092	16,018	11,553	19,699	
Interest Payable&Commitment Charges	Million kip	1,070	1,001	959	943	3,099	2,360	2,919	3,216	3,962	4,666	
Non Operating Expenses	Million kip	4,188	4,048	3,015	3,138	20,157	14,987	10,935	52,185	10,541	25,371	
P/L on Foreign Exchange Rates	Million kip	141	315	196	121	225	221	14	49	29	13	
Operating Income	**Million Kip**	**(2,380)**	**(1,220)**	**778**	**2,175**	**4,532**	**3,059**	**(7,730)**	**(4,004)**	**(1,211)**	**6,421**	
Net Income	Million kip			506	1,414	2,946	1,989	-	-	-	4,174	
Tax/Other paid	Million kip	995	621	1,486	2,143	4,492	4,552	3,303	8,486	3,733	7,952	
Total Assets	**Million Kip**	**33,320**	**33,861**	**38,973**	**38,828**	**55,962**	**108,748**	**175,734**	**183,493**	**172,506**	**435,210**	Included thaNgon
Current Assets	Million kip	9,878	11,573	16,404	16,631	35,416	44,689	62,554	76,130	68,942	101,833	
Fixed Assets	Million kip	23,441	22,288	22,569	22,196	20,546	64,059	113,180	107,364	103,563	333,377	
Total Liabilities	**Million Kip**	**33,320**	**33,861**	**38,973**	**38,828**	**55,962**	**108,748**	**175,734**	**183,493**	**172,506**	**435,210**	
Current Liabilities	Million kip	3,496	5,055	5,363	4,792	17,929	17,999	20,206	33,030	18,474	34,150	
Long Term Liabilities	Million kip	22,641	23,325	22,810	21,639	22,022	27,260	79,292	77,388	77,824	79,789	
Owners Capital	Million kip	7,183	5,481	10,800	12,396	16,012	63,489	76,237	73,075	76,207	321,271	
Performance Ratios												
Ratios :												
Collection rate Current Year	%	47	53	49	50	44	46	46	38	34	23	
Collection Efficiency	%	102	94	94	94	90	97	105	89	99	78	
Operating Ratio	%	138	113	94	86	79	90	126	106	93	92	
Return on Total Assets	%	-	-	1	4	5	2	-	-	-	1	
Return on Capital	%	3	3	4	6	11	4	2	2	2	2	
Net Profit Margin	%	-	-	3	7	6	4	-	-	-	4	
Total Assets Turnover	times	0.37	0.47	0.51	0.54	0.85	0.43	0.24	0.52	0.33	0.24	
Current Ratio	times	2.83	2.29	3.06	3.47	1.98	2.48	3.10	2.30	3.73	2.98	
Quick or Acid Test Ratio	times	2.01	1.58	2.28	2.64	1.61	1.92	2.04	1.82	2.74	2.29	
Debt Ratio	%	78	84	72	68	71	42	57	60	56	26	
Debt Service Coverage Ratio	times	-	-	0.5	1.5	1.0	0.8	-	-	-	0.9	
Production Cost of NRW (X million)	Kip	4,481	4,827	6,821	5,893	9,198	11,014	14,292	17,681	17,755	35,070	
Opportunity Cost of NRW (X million)	Kip	2,200	4,081	6,895	6,840	12,085	11,744	11,173	16,362	16,324	25,636	
Account Receivable	days	64	61	65	87	83	90	73	74	82	172	
Ratio Water Sales/Production	%	69	73	70	72	71	72	73	72	73	68	
Manpower's (Employee/1000C)	Emp/1000C	12	10	10	9	9	8	9	8	8	7	
Connection per Employee	Con/emp	86	96	100	114	115	125	116	128	131	141	
Water Loss per km per day	m3/km/day	28	24	28	26	25	21	18	19	18	24	AVG 20 m/conn
Number pipe break per km	No/km	19	11	9	8	7	6	5	5	6	9	
Water loss per connection	m3/con	286	251	291	269	267	237	210	227	213	272	

Source: NPVC

Table 1.3.18-2: Financial Statement of Vientiane Capital prepared by WSRC

Profit and Loss Statement — Unit: 1000kip

Year	2006	2007	2008
Turnover	41,475,165	49,447,727	56,138,563
Operation costs	32,288,831	33,999,105	43,646,201
Net operation income	9,186,334	15,448,622	12,492,362
Depreciation	15,095,366	15,389,396	16,088,098
Interest on long term loans	2,429,417	3,293,442	3,257,556
Pre-tax profits	-8,338,449	-3,234,216	-6,853,292
Taxation on profits	-	-	-
Net post-tax profit	-8,338,449	-3,234,216	-6,853,292

Balance Sheet

Year	2006	2007	2008
Fixed assets	307,578,286	359,049,401	320,896,190
Net current assets	42,370,081	43,137,568	49,934,771
Total net assets	349,948,367	402,186,969	370,830,961
Long term loan	79,291,655	77,388,350	77,823,905
Equity	270,656,712	324,798,619	293,007,057
Total liabilities	349,948,367	402,186,969	370,830,961

Key Indicators

Year	2006	2007	2008
Accounts receivable (days turnover)	76	94	86
Depreciation recovery	60.9%	100.0%	77.7%
Return on capital	-1.7%	0.0%	-1.0%
Return on equity	-3.1%	-1.0%	-2.3%
Gearing (debt/(equity + debt)	22.7%	19.2%	21.0%
Debt service coverage	1.44	2.16	1.75

Source: Lao PDR, Annual urban Water Sector Performance Report 2008, The Water Supply Regulatory Committee (WSRC)

2) Water Tariff

NPVC implied new water tariff for Domestic and Non Domestic Customers on 11 May 2009 as follows (reference to the agreement of Mayor of the NPVC Number 170/vco; dated 21 April, 2009).

Table 1.3.19: Water Tariff applied in May 2009 to Vientiane Capital

	Water Consumption	Water Rate
(i)	0 to 10 m^3	500 kip/m^3
(ii)	11 to 30 m^3	1,000 kip/m^3
(iii)	31 to 50 m^3	2,500 kip/m^3
(iv)	> 50 m^3	5,000 kip/m^3

Source: NPVC

The above average implied tariff was about 2,800 Kip / m3 based on weighted real water consumption.

The water tariff is revised as follows in September 2009 due to claim rose from users.

Table 1.3.20: Water Tariff revised in September 2009 to Vientiane Capital

	Water Consumption	Water Rate
(i)	0 to 10 m^3	500 kip/m^3
(ii)	11 to 30 m^3	1,000 kip/m^3
(iii)	31 to 100 m^3	1,350 kip/m^3
(iv)	> 100 m^3	2,700 kip/m^3

Source: NPVC

The above average implied tariff was about 1,500 Kip / m3 based on weighted real water consumption.

(8) Human Resource Development

In the NPVC, an independent training facility is established within the compound of the Chinaimo water treatment plant. Most staff training is conducted at this centre. According to the Prime Minister's proclamation (37/PM), the NPVC is required to offer technology development, courses and workshops for the training of all water supply enterprises in Lao. In addition, the NPVC is given the responsibility to spread information about training, manuals and staff development methods.

AFD constructed a training center at Chinaimo WTP in 2010.

(9) Social Condition

Tariff was once raised in June 2009 but it was revised in September 2009 as shown in above. Users' understanding to raise the water tariff was not obtained due to a sharp increase, although the tariff in Vientiane Capital is not high compared to other provincial water tariff.

(10) Major Development Projects related to Water Supply and other infrastructures

Identified two major projects, Industrial Zone at Vientiane and Vientiane Logistics Park related water supply is described below,

1) Industrial Zone at Vientiane

Following demand is estimated by the JST of Preparatory Survey on Industrial Zone Development in Lao PDR in December 2009. The Plan is prepared till 2025, so temporally demand till 2030 is estimated to be same with the 2025. The demand shall be revised based on the future condition.

Table 1.3.21: Demand at Industrial Zone at Vientiane

Item	Unit	2014	2015	2016	2017	2018	–	2025	–	2030
Item	Unit	7,000	22,300	37,600	47,800	58,000	58,000	58,000	58,000	58,000
Water Supply	m3/day	5,600	17,840	30,080	38,240	46,400	46,400	46,400	46,400	46,400
Wastewater	m3/day	175	573	970	1,235	1,500	1,500	1,500	1,500	1,500
Solid Waste	ton/day	28	64	100	124	148	148	148	148	148
Power Supply	MW	72	353	635	822	1,010	1,010	1,010	1,010	1,010

Source: Preparatory Survey on Industrial Zone Development in Lao PDR in December 2009, JICA

The Industrial Zone is expecting to get potable water from NPVC and especially from Dong Bang WTP, that is under construction at present March 2010, expecting to completion, WTP 10,000m^3/day in June 2010..

The project is preparing their own wastewater management plans to harmonize regulation.

2) Vientiane Logistics Park (VLP)

Water demand, consisted of domestic use for staff, washing uses for container and trucks, is estimated by the JST of VLP in Lao PDR. The estimated average total water consumption is 115m^3/day and water demand is estimated 173 m^3/day including leakage and daily peak factor.

The location of VLP is near the railway station of Thanaleng, and the project is expecting get water from NPVC from a transmission main between Chinaimo WTP and Thadeua area.

The project is preparing their own wastewater management plans to harmonize regulation.

(11) Rural Water Supply in Vientiane Capital

Wells and bore holes are used at rural area in Vientiane Capital. They are constructed by residents itself for their uses.

Groundwater quality in Vientiane Capital is not polluted by arsenic based on the Nam Saat information, but not by NPVC.

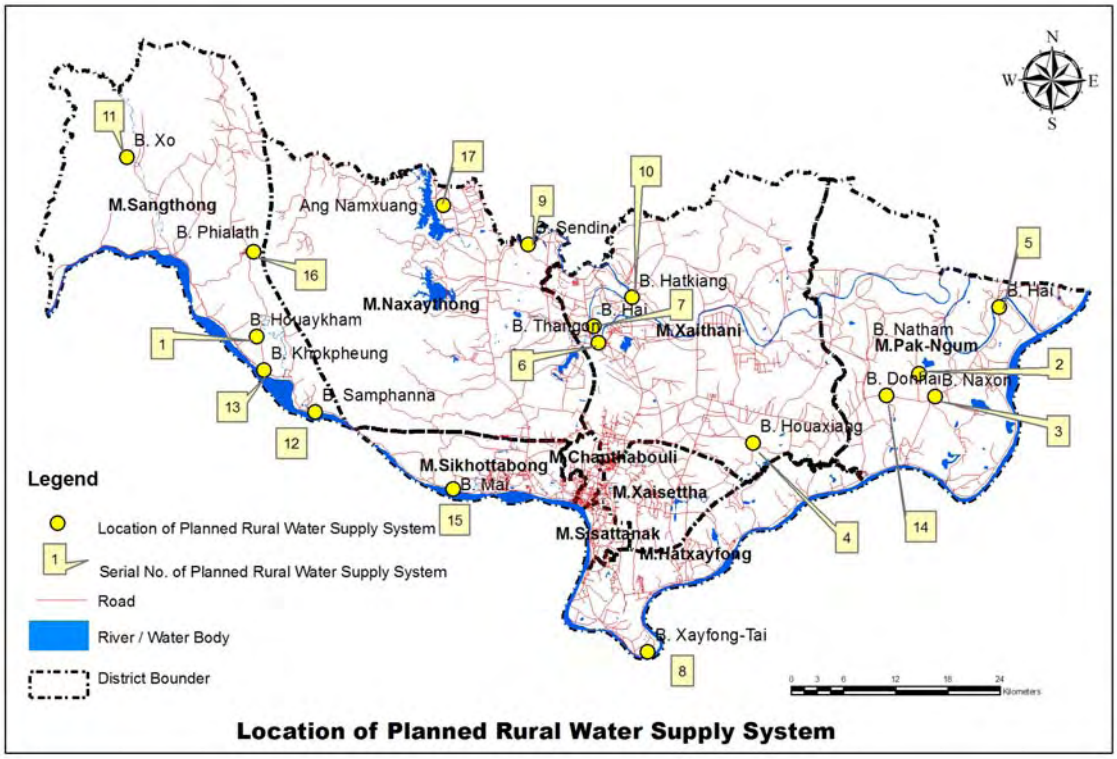
It is estimated that 51% of population in Vientiane Capital is using wells/boreholes in 2009 as the served population of water supply by NPVC is 49% in 2009.

NPVC has established the rural water supply system development plan (2010 – 2015) in 2010 as shown in Table and Figure below,

Table 1.3.22: Rural Water Supply Development Plan in Vientiane Capital (2010 – 2015)

No	Name of Project	Note	Water Resource	Population (2009)	CapacityC Capacity (m3/day)	Related Organization	Implementation Year	Remark
1	B.Houaykham	-	Surface + Dam	860	240	AIMF	2009-2010	Construction finished in 2010
2	B.Natham (M.Pak¬Ngum)	-	Borehole	1,778	300	AIMF	2011	FS finished, DD and construction will be done.
3	B.Naxon	-	Borehole	1,576	270	AIMF	2012	FS finished, DD and construction will be done.
4	B.Houaxiang	-	Borehole	1,700	350	AIMF	2013	FS will be done.
5	B.Hai	-	Borehole +Namngum	6,353	3,500	GRET-MIREP	2009-2010	Done by PPP
6	B.Thangon	One of 6,7,10 is applied.	Namngum	-	60,000	JICA	2012-2014	Contacting with Japanese Government
7	B.Hai	One of 6,7,10 is applied.	Namngum	62,518	20,000	CHINA	2013-2015	FS finished, DD and construction will be done.
8	B.Xayfong¬Tai	If pipeline is extended to the village, the WTP is cancelled and a WTP at east side of Hatxayfong district will be studied.	Mekong River	58,257	15,000	KWATER	2010-2012	FS finished, DD and construction will be done.
9	B.Sendin	One of 9 and 17 is applied.	Namngum	85,328	20,000	KWATER	2012-2014	FS finished, DD and construction will be done.
10	B.Hatkiang	One of 6,7,10 is applied.	Namngum	1,226	-	DPWT	2009-2010	FS will be done.
11	B.Xo	-	Small River	1,850	-	VWSSE	2009-2010	Detail investigation plan will be prepared.
12	B.Samphanna	-	Borehole	2,862	375	DPWT	2009-2010	FS will be done.
13	B.Khokpheung	-	Borehole	1,600	-	DPWT	2009-2010	FS will be done.
14	B.Donhai	-	Borehole	1,712	-	DPWT	2009-2010	FS will be done.
15	B.Mai	-	Borehole	1,778	290	DPWT	2009-2010	FS will be done.
16	B.Phialath	Waiting for an aprovement from Vientiane Capital Governor	Borehole	1,700	-	-	2010-2012	Improvement of present system
17	Ang Namxuang	One of 9 and 17 is applied. This looks difficult as the lake is used for irrigation.	Lake	-	20,000	-	2009-2011	-
18	FS Water Supply for 15 Villages	-	-	-	-	DPWT	2010-2011	-
Grand Total		-	-	231,098	140,325	-	-	-

Source: NPVC



Source: NPVC

Figure 1.3.13: Location of Rural Water Supply Development Plan (2010-2015)

1.3.3 Sewerage/Wastewater

(1) Plan and Policy

The Lao government is trying to improve and implement the wastewater management to the country for the future environmental improvement especially in Vientiane Capital which is going to celebrate its 450 years in 2010. One of the visions in the celebration is concerning the "Green" city in which the wastewater problem is one of the issues to be improved. Therefore a new regulation on wastewater discharge from various kinds of buildings has just been formally announced, even though monitoring and control as well as the laboratory analysis support on the data verification are generally poor or in shortage. At the same time several pilot projects on wastewater treatment plant are on-going or staring with more concentration in simple system and low maintenance selection such as community based sanitation system (CBS) or decentralized wastewater treatment system (DEWATS), waste stabilization pond and wetland system from supporting fund of various donors.

(2) Organization and Regulation

1) Organization

The sewerage system in Lao PDR is generally included in the sanitation sector, where several organizations are in operation. The important organizations in the sewerage work in Vientiane Capital are:

a) DHUP of MPWT

MPWT has an overall responsibility for water and wastewater management systems in urban areas throughout the country. MPWT is also responsible for broader water management issues such as protection of river banks and flood control. Urban Development Division within DHUP is responsible for the management, control and implementation of basic urban infrastructure and environmental plans, including drainage, wastewater and solid waste. The government is planning to transfer the responsibility for rural water supply and sanitation from the Ministry of Health to MPWT in the near future.

b) DPWT of Vientiane Capital

DPWT has the responsibilities for the administrative works in overall infrastructure works and for the large or special projects, which is not in the VUDAA's jurisdiction, including remaining 391 Villages of Vientiane Capital. There is Housing and Urban Planning Division under DPWT in which a sub-division in Environmental Protection is also in charge of water supply, drainage and wastewater.

c) PTI of MPWT

PTI is the main counterpart agency of the most of the planning studies including this Urban Development Master Plan in Vientiane Capital. The agency is a main technical arm for urban planning in Lao PDR and it offers services for studies and evaluation on urban planning as well as trainings on environmental management.

d) VUDAA

VUDAA was established to promote local administration by the recommendation of ADB. VUDAA plays an important role in sanitation and drainage operation and maintenance work only for urban area in Vientiane Capital, consisting of 189 Villages belonging to four Districts, namely, Chanthabouly, Sikhottabong, Xaysetha and Sisattanak. Under the control of the Governor of Vientiane Capital, VUDAA offers various administrative services, management, formulation, implementation, operation and maintenance of urban infrastructures such as road, street lighting, drainage channel, wastewater treatment facility, and partly solid waste collection and dump site operation.

e) WREA and DOE

The main duty of WREA is to follow up on the formulation of policies and plans on water resources and environment. The important task is to issue the National Environment Standard for regulation in the whole country and in line with other regulatory body that has been issued. WREA should also be the monitoring and enforcement agency in environment but due to limited staff this duty has not been done much.

f) Department of Industry of MOIC / Department of Industry and Commerce of Vientiane Capital

Industrial Environment Division under Water Pollution Unit within Department of Industry has the responsibility in water environmental management and monitoring from the industry or factory sources according to the regulation.

2) Law and Regulation

The laws and regulations related to the wastewater in Lao PDR are as follows:

a) Environmental Protection Law

The law stipulates the framework of environment management and the responsibilities of related organizations, of which the central duty is borne by Science, Technology and Environment Agency (STEA, restructured to WREA in 2007). It specifies necessary principles, rules and measures for managing, monitoring, restoring, and protecting the environment in order to protect public, natural resources and bio diversity, and to ensure the sustainable socio-economic development of Lao PDR.

b) Decision on National Environmental Standard for Lao PDR

The Decision on National Environmental Standard was prepared by WREA (previous part of STEA) which includes all the standards and limitations from concerned activities such as water supply source, wastewater discharge from different types of buildings, commercial areas and agricultural production, which may have an impact on the environment, quality of natural water, and the public health, air pollution, noise pollution as well as industrial wastewater discharge.

The Decision describes various quality parameters for wastewater discharge. It also defines categories of buildings according to the stipulated wastewater production and necessary treatment standards for discharge into the natural environment and the testing methods to be

applied. The owner of the facility is responsible to make sure that appropriate treatment is applied prior to discharge, and failure to do so can result in punishments.

c) Wastewater Effluent Standard from Domestic Use

Table 1.3.23 and 2.4.24 illustrate the required standard on effluent parameters from each type of building.

Table 1.3.23: Wastewater Effluent Standard Parameters

Parameters		Allowable Pollutant Load from each category type in mg/l (not more than)				
		A	B	C	D	E
1	Biochemical oxygen demand (BOD)	20	30	40	50	200
2	Suspended solids	30	40	50	50	60
3	Settable solids	0.5	0.5	0.5	0.5	-
4	Total dissolved solids (TDS)	3000	2300	2000	1500	
5	Chemical oxygen demand (COD)	120	130	150	350	400
6	Sulfide	1.0	1.0	3.0	4.0	
7	Total Kjeldahl Nitrogen (TKN)	35	35	40	40	
8	Fat oil and grease	20	20	20	20	100
9	Temperature (Celsius)	40	40	40	40	40
10	pH-value	6-9.5	6-9.5	6-9.5	6-9.5	6-9.5

Source: Lao National Environmental Standard by WREA, 2010

Table 1.3.24: Wastewater Effluent Standard Categories

	Building Categories	A	B	C	D	E
1	Condominium/Apartment: Number of rooms		> 501	101 - 500	< 100	
2	Hotels/Guest House: Number of Rooms		> 201	61 - 200	< 60	
3	Housing/Dormitories: Number of bedroom		> 251	51 - 250	10 - 50	
4	Clinic, Public Health Center, Hospital: Bed	> 31	1 - 30	Provide examination only		
Building according to usable area						
5	Residential Building, Religious place: Area (m^2)			> 10001	5000 - 10000	
6	Entertainment, Health Club, Swimming Pool, Sport Center: Area (m^2)		> 5001		1000 - 5000	
7	School, College, University: Area (m^2)	> 25001	5000 - 25000			
8	Office (Government, Private, Foreign), State Enterprises, Play Theater: Area (m^2)	> 55001	10001 - 55000	5000 - 10000		
9	Shopping Center, Super Market: Area (m^2)	> 25001	5000 - 25000			
10	Market: Area (m^2)	> 25001	1501 - 2500	1001 - 1500	500 - 1000	
11	Restaurant: Area (m^2)	> 2501	1501 – 2500	1001 - 1500	500 - 1000	< 100
12	Car Care (car, motorcycle): Area (m^2)	> 2501	1501 – 2500	1001 - 1500	500 - 1000	
13	Bus Station, Airport: Area (m^2)	> 55001	10001 - 55000	5000 - 10000		
14	Animal Cage in city: Area (m^2)	> 2501	1501 – 2500	1001 - 1500	500 - 1000	

Source: Lao National Environmental Standard by WREA, 2010

d) MPWT Ministerial decision on Management of wastewater drainage in towns/ municipalities, drafted by DHUP

A MPWT Ministerial decision on Management of wastewater drainage in towns/ municipalities was drafted by DHUP. The draft relates to the management, control of

wastewater discharge and drainage from buildings, commercial areas and industry in towns and municipalities. The draft decision defines two ways of treatment i) treatment on the site by the owner of the facility and ii) centralized wastewater treatment. The discharged shall be controlled prior to approval by authorized agency and the draft decision defines wastewater discharge management agencies and O&M. The draft decision was put aside tentatively, but MPWT intends to revise it so as to issue it as a Ministerial regulation in accordance with the Decree on implementation of EPL after approval of the Urban Wastewater Strategy and Investment Plan (UWSIP). In that case it needs to be coordinated with regulation of wastewater discharge, management and handling which has been issued, or being drafted by other ministries such as Ministry of Health, MOIC and Ministry of Energy and Mines.

e) Decision of the District Governor (Chief) on Sanitation Management in District Towns

A general format for a Decision of the District Governor (Chief) on Sanitation Management in District towns was drafted under the Northern and Central Regions Water Supply and Sanitation Sector Project (NCRWSSP), which includes a component on local regulation on sanitation management. The Decision intended to enhance, promote and ensure management and supervision of sanitation in districts and towns included in water supply development projects. It covers both greywater (baths and kitchen wastewater) and blackwater (from toilets and latrines). The decision describes design standards, construction and inspection of facilities including latrines, drainage and wastewater treatment from houses, offices and public and private sites, and a final treatment site. It also proposes appropriate technologies.

f) Decision on Processing Industrial Factory Wastewater Discharge by MOIC

The composition of industrial and commercial wastewater usually differs from that of domestic wastewater. This can cause pollution to water catchments or influence treatment processes and cause a different output than expected. The MOIC Decision on Processing Industrial Factory Wastewater Discharge sets out regulations regarding wastewater and grey water discharge from processing industries. The regulations specify the duties on the individual industrial entity and a system for issuing licenses for a fee. Industrial and commercial waste containing pollution which exceeds the concentrations issued in discharge standard shall have a local on-site treatment prior to discharge into water ways or any wastewater handling system.

(3) WasteWater Generation

Most of the wastewater generated in Vientiane Capital is from domestic household and commercial buildings, only some part is from the industrial factory as well as household factory in which the pollution source is small in comparison with the domestic wastewater. Since most of the large scale factory has its own wastewater treatment system or located in the industrial zone where special wastewater treatment plant has to be installed according to the regulation from MOIC that has some control function.

The number of population in Vientiane Capital in year 2009 is approximately 787,000 persons, whereas more than half live in the urban center area which generates high pollution. Approximately 70,000 m^3 of wastewater from the urban area is drained to the public waterways every day, only about half of which is treated and reduced their pollution by the current on-site treatment system. The pollution load generation calculated by the JICA study - "The Study on Improvement of Water Environment in Vientiane City" from various activities in Vientiane Capital urban area is approximately 31,185 kg.BOD/day, which is mainly from domestic waste and livestock waste.

However due to natural purification and dilution from existing water channels, ponds and rivers comparing to the number of current population, the water quality in the natural waterway is still not severe, only some points in the water channel in the urban area can be noticed with dark color in the dry season. But the deterioration will increase upon the increasing of the population and development especially inside the urban area hence proper waste management planning is essential.

(4) Facility in Sewerage System

1) Sanitation Facility

According to the National statistics in 2005, approximately 90% of households in Vientiane Capital have access to proper toilet facilities. This shows that sanitary coverage is relatively good, but methods adopted for treatment are generally not satisfactory and maintenance is poor. The Study Team has made a social survey to the 3,000 households in the whole Vientiane Capital and the result on questionnaire in sanitation facility for the sample households can be summarized in the Table 1.3.25 below.

Table 1.3.25: Result on Survey in Sanitary Facility for Sample Households

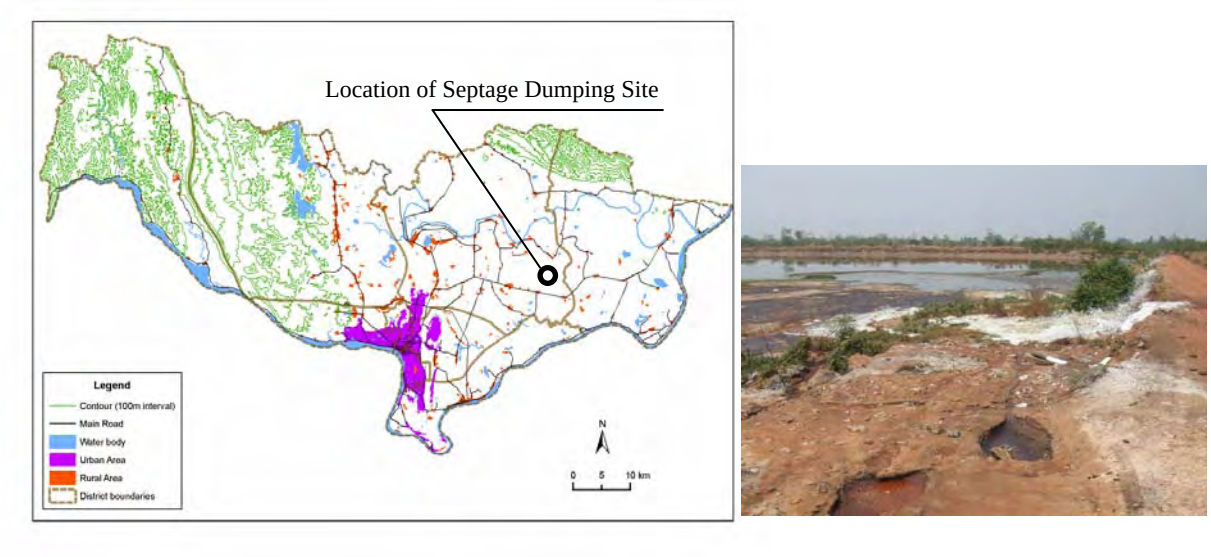
District Name	Household Total	Flush Toilet		Septic Tank		Pit Latrine	
		Number	Percentage	Number	Percentage	Number	Percentage
Chanthabouly	300	177	59.0	168	56.0	37	12.3
Sikhottabong	450	110	24.4	340	75.6	84	18.7
Xaysetha	400	88	22.0	309	77.3	67	16.8
Sisattanak	300	88	29.3	169	56.3	99	33.0
Naxaithong	250	17	6.8	190	76.0	14	5.6
Xaythany	650	75	11.5	545	83.8	61	9.4
Hadxaifong	350	69	19.7	241	68.9	150	42.9
Sangthong	100	1	1.0	29	29.0	62	62.0
Mayparkngum	200	23	11.5	192	96.0	1	0.5
TOTAL	3,000	648	21.6	2,183	72.8	575	19.2

Source: JST

2) Wastewater Collection System and Wastewater Treatment Plant

Currently as there is no separate wastewater collection system in Vientiane Capital or in other provinces of Lao PDR, the combined collection pipe between wastewater and rain/drainage water is provided throughout the country. Most of the buildings have their own on-site treatment facility like septic tank, soak pit, or cesspool which then discharging the overflow to the natural drainage, either to drainage pipe, channel, canal or river. The current use on-site treatment system has problem in certain areas that are exaggerated by flat terrain, high water table and low soil permeability, lack of maintenance, resulting in failure of the systems, overflow of effluent and pollution of surface waters and drains.

Wastewater from other usage such as shower, laundry, food preparation, etc. is generally direct discharge to the storm water drainage system without any treatment. No grease trap is installed to pretreatment of grease and oil from cooking activity. Most of the households do not pay attention to the regular desludging from their septic tank system. Desludging of sludge from septic tank is carried out not regularly and the removed sludge called septage is dumped at Landfill site No.32 located at eastern part of Vientiane Capital as shown in Figure 1.3.14.



Source: JST

Figure 1.3.14: Location Map and Picture of Septage Dumping Site

There is neither separate sewer pipe nor centralized wastewater treatment plant for the urban Vientiane. Only some sewerage pilot projects had been constructed on a small scale basis. The service area is a center of urban Vientiane city around the Nong Chan marsh. Some of the area downstream end of Hong Ke drainage channel, around the northwestern part of That Luang Marsh, was used to be a pilot stabilization pond (140m x 410m) that is suitable wastewater treatment system for hot climate area as it needs less maintenance, by the EU/DANIDA in year 1994/2004 as shown below. But due to a failure in the pumping stations in 2008, the plant has stopped the operation and the facilities have been devastated. The treatment system of stabilization pond is almost maintenance free so it is appropriate in Lao PDR, but the sewage collection system comprises of pumping stations and reducing the mechanical system is recommended for easy maintenance.

A problem of bad smell and urbanization near the area was making it difficult to keep the plant there in operation unless there will be proper rehabilitation and urban development. Renovation and expansion of the pilot sewerage facilities would be one of the options for the Vientiane Capital to improve the environmental condition.

Natural marsh or ponds are mostly used as a natural wetland treatment system. Especially That Luang Marsh was mentioned to be a good wetland and flood retention pond by several studies since it is a very large marsh next to the Vientiane Capital urban area.

Recently there are efforts to implement several pilot communal treatment plants or a decentralized system in community with foreign assistance, such as the pilot project in Thongkankham community by Asian Institute of Technology (AIT) and a decentralized wastewater treatment system (DEWATS) for treatment of wastewater from the dormitory of the Faculty of Engineering in National University of Laos in Vientiane Capital by the Lao Institute for Renewable Energy (LIRE) as shown in Figure 1.3.16. The result of implementation is still in the evaluation stage.

Source: JST

Figure 1.3.15: Pictures of the EU Ponds and the Layout of the Pilot Sewerage Project

Source: JST

Figure 1.3.16: Pilot DEWAT System for Dormitory in Faculty of Engineering and Effluent Water

(5) Management

The management in sewerage /wastewater system in Vientiane Capital has just been improved a few years ago from the fact that:

- The Government has a recent reform in the organizations in charge of the water supply sector,
- Institutional framework is currently under development,
- There are concerns and commitment from the Government to improve the wastewater situation in the country,
- There are new large development plan in 4 areas in the Vientiane Capital i.e. That Luang, Dong Phosy, SEA Games Stadium and Vientiane Industrial Zone, each of which will generate substantial amount of wastewater to the existing natural water environment,
- It is still early to foresee urbanization process under the Draft National Urban Sector Development Strategy and Investment Plan (NUSDSIP), prepared by Ministry of Public Works and Transport in 2009, to provide an overall direction for urban development including wastewater.

The responsible authorities are aware of the wastewater management issue and are making serious efforts to solve the problem. Preparation and revision in proper organization, institution and regulation in the wastewater sector are ongoing and need a few years to become fully implementable.

(6) Human Resource Development

There is a limited number of experienced staff in environmental sector in Vientiane Capital. Only a few staff in each government office with environmental education background, which make it difficult to cope with different kinds of works that should be done. Some of the operation and maintenance works need to be outsourced to private companies where there are also limited resources and might need some foreign assistance in budgeting and training.

(7) Social Condition

Most of the people are not much aware of the wastewater pollution from their households as well as from their activities. Public awareness to communities and schools on sanitation and environmental pollution is one of the important activities which several foreign donors have been supported as it will be important for the sustainable wastewater management in the future. In Lao PDR the power of local level community chiefs such as the village head or district head is quite strong, therefore some environmental implementation projects can be put through the community based level which may provide stronger support and cooperation but it might take some time for several public meetings and workshops prior to actual implementing.

1.3.4 Drainage

(1) Plan and Policy

A good drainage system with no flooding in the urban area is the goal of the Government policy in infrastructure improvement. The drainage system in Vientiane Capital has been studied, planned and improved with various foreign support including the installation of new drainage pipes and channels along the improved roads which help reducing the flood problem in the city, especially in urban area. At present as the drainage situation is very much better than ten years ago, flooding seldom occurs and when it does, it lasts a shorter period.

(2) Organization and Regulation

Most of the organization and regulation in drainage system in Vientiane Capital is the same as the one for sewerage / wastewater system mentioned earlier since the works in sewerage and drainage are linked together. In addition, the Mekong River Commission (MRC) is involved in activities including water quality monitoring and flood control in the countries along the Mekong River.

The regulations concerned are more concentrated in controlling of surface water quality standard and pollution discharge to the natural wetland, marsh and river which could be affected by the wastewater discharge and drainage from the city area.

(3) Facilities of Drainage System

The facilities in the drainage system for Vientiane Capital include the drainage network i.e. pipe, channel, canal, river and marsh to convey and discharge all the rain water from the city area to the Mekong River. Also included are flood prevention facilities and river bank protection works within the Vientiane Capital which was improved to prevent seasonal flooding from the Mekong River that maximum water level records around July and August.

JICA Study Team has made a social survey to the 3,000 households in the whole Vientiane Capital and the result of questionnaires concerning the drainage system for the sample households can be shown in the Table 1.3.26 and 2.4.27 below. It can be noticed from the survey data that most of the urban areas in Vientiane Capital are provided with drainage ditch and flooding seldom occurs in Sisattanak and Hadxaifong Districts where rain water drainage is discharged to the Mekong River.

Table 1.3.26: Drainage Facility for the Sample Households

District Name	Household Total	Present Drainage Facilities Around the Household							
		Ditch(protected=Concrete,etc		Ditch(Natural)		No Ditch		Other	
		Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Chanthabouly	300	128	42.7	57	19.0	82	27.3	33	11.0
Sikhottabong	450	84	18.7	103	22.9	220	48.9	43	9.6
Xaysetha	400	90	22.5	138	34.5	149	37.3	23	5.8
Sisattanak	300	82	27.3	35	11.7	165	55.0	18	6.0
Naxaithong	250	3	1.2	141	56.4	83	33.2	23	9.2
Xaythany	650	31	4.8	214	32.9	275	42.3	130	20.0
Hadxaifong	350	20	5.7	30	8.6	123	35.1	177	50.6
Sangthong	100	1	1.0	8	8.0	91	91.0	0	0.0
Mayparkngum	200	0	0.0	97	48.5	91	45.5	12	6.0
TOTAL	3,000	439	14.6	823	27.4	1,279	42.6	459	15.3

Source: JST

Table 1.3.27: Frequency of Flood for the Sample Households

District Name	Sample Household Total	Flooding 10cm or less (from Rivers/ Drainage) Households					
		Seldom		More than 1 time a		Never flooded	
		Number	Percentag	Number	Percentag	Number	Percentage
Chanthabouly	300	4	1.3	1	0.3	295	98.3
Sikhottabong	414	9	2.2	2	0.5	403	97.3
Xaysetha	390	8	2.1	0	0.0	382	97.9
Sisattanak	300	20	6.7	0	0.0	280	93.3
Naxaithong	250	0	0.0	0	0.0	250	100.0
Xaythany	650	2	0.3	8	1.2	640	98.5
Hadxaifong	350	113	32.3	0	0.0	237	67.7
Sangthong	96	0	0.0	0	0.0	96	100.0
Mayparkngum	176	0	0.0	0	0.0	176	100.0
TOTAL	2,926	156	5.3	11	0.4	2,759	94.3

Source: JST

(4) Drainage System

From a hydrological analysis, monthly rainfall records in Vientiane Capital can be illustrated in the Table 1.3.28. Two distinct seasons could be defined from the monthly rainfall as the Rainy Season: from May to September and Dray Season from October to April. The rainy season, which is influenced by the southwestern monsoon, starts sometime in April and ends in mid-October, in which heavy rain occurs mainly in August and September. An approximate annual rainfall is 1,600 mm./year on an average of 30 years in Vientiane Capital.

Table 1.3.28: Meteorology in Vientiane Capital

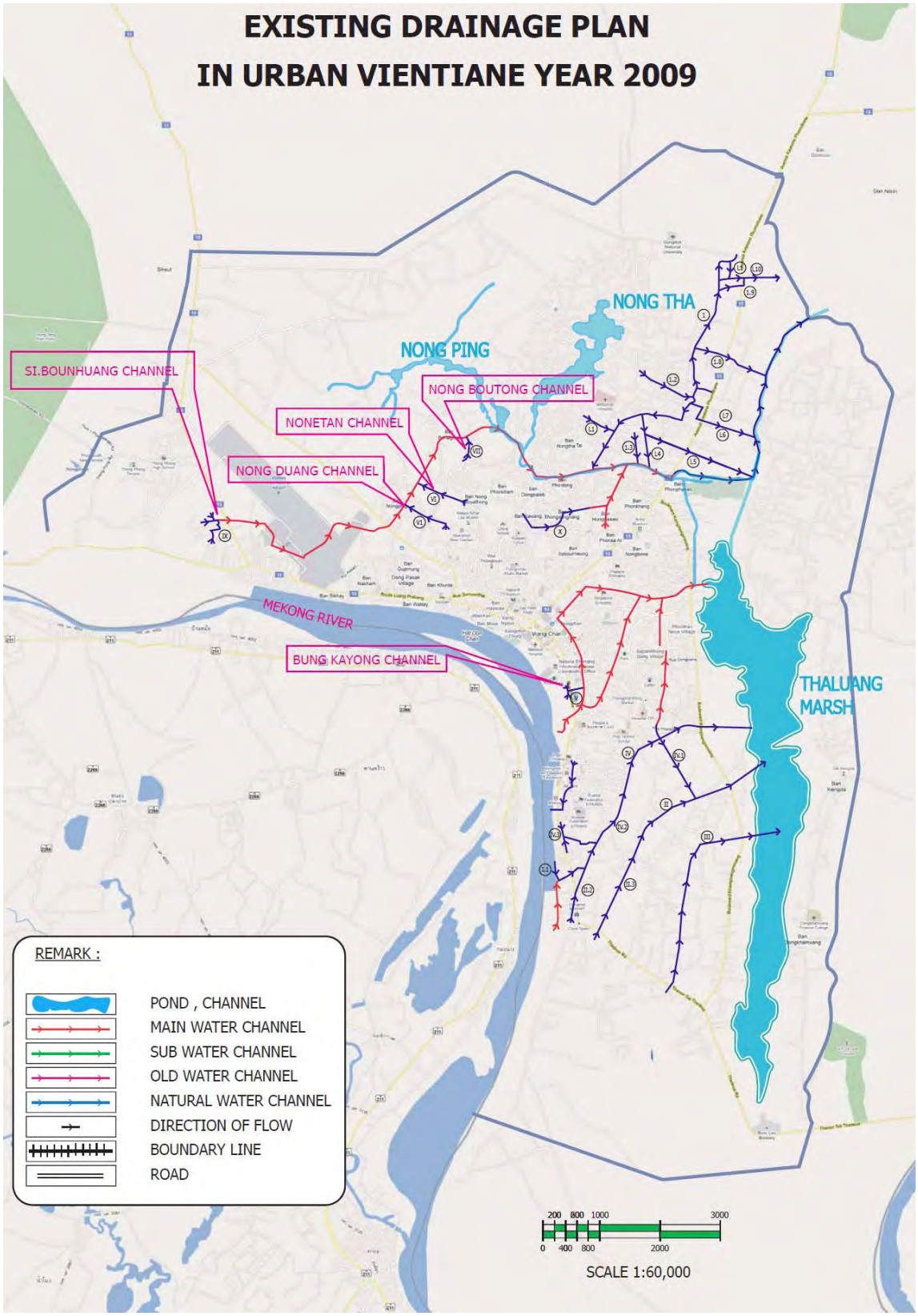
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum Temperature	℃	28.3	30.4	33	34.3	32.9	31.8	31.3	30.9	30.9	30.8	29.8	28.1
Minimum Temperature	℃	16.3	18.5	21.5	23.8	24.6	24.9	24.8	24.6	24.1	22.9	19.9	16.5
Mean Temperature	℃	22.3	24.1	27.2	29	28.7	28.4	28.1	27.8	27.5	26.9	24.8	22.3
Average Temperature	℃	25.2				28.1					25.2		
Rainfall	Mm	7.2	13.1	33.6	85.3	245	279	275	331	307	77.5	11.2	2.8
Ratio to Annual Precipitation	%	14				86					14		
Relative Humidity	%	75-80				65-70					75-80		

Source: National Statistics Center [2005], Statistics 1975-2005

Topography of Vientiane Capital is quite flat with slightly high elevations along the Mekong River bank; therefore the drainage in the central part of Vientiane Capital cannot be directly drained to the Mekong River. The main rivers in Vientiane Capital are the Mekong, the Nam Ngum and the Houei Mak-Hiao.

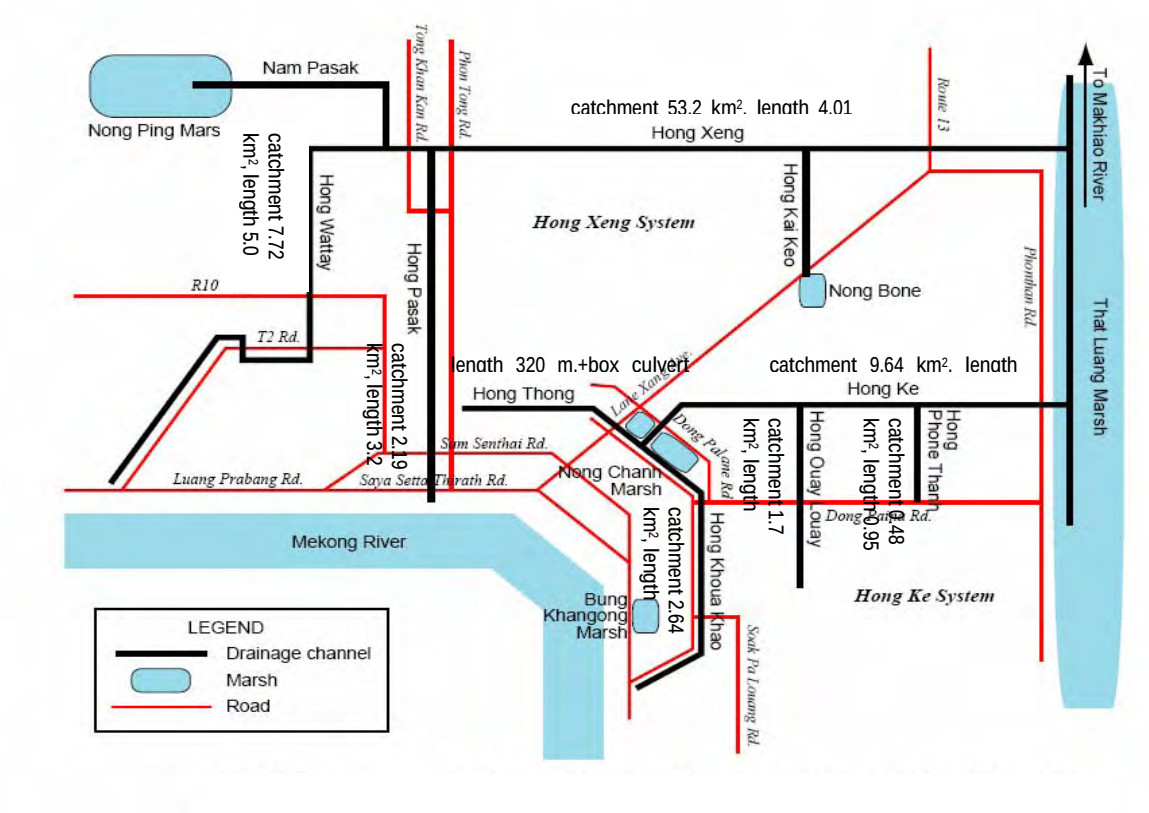
The Mekong, which bounds the City area on the west and south, is a water source for the water supply and irrigation. The Nam Ngum is a tributary of the Mekong which discharges in the eastern part of the Vientiane Capital. The Houei Mak-Hiao, a minor tributary of the Mekong, is a river that drains lower areas between the Mekong and the Nam Ngum. The Mak-Hiao River flows into the Mekong near Ban Kak-Hiao village. The confluence of the Mak-Hiao River with the Mekong is located about 64 km downstream of Vientiane Capital along the Mekong. The Mak-Hiao River has the drainage area of 441km^2 at the outlet to the Mekong.

Urban area of Vientiane Capital is covered by 2 main catchment areas: (a) Hong Xeng system consisting of Hong Xeng and its tributaries, Hong Kai Keo, Hong Pasak, Hong Wattay and Nam Pasak (b) Hong Ke system consisting of Hong Ke and its tributaries, Hong Phone Thanh, Hong Ouay Louay, Hong Thong and Hong Khoua Khao, these areas are a sub-catchment of the Mak-Hiao River. The existing drainage system and retarding basin in Vientiane Capital urban area is shown in Figure 1.3.17 with the schematic layout in Figure 1.3.18 and summary drainage catchment area in Table 1.3.29.



Source: VUDAA

Figure 1.3.17: Existing Drainage System in Urban Vientiane Capital



Source: Modify from Interim Report-The Study on Improvement of Water Environment in Vientiane

Figure 1.3.18: Schematic Layout for Drainage System in Urban Area of Vientiane City

Table 1.3.29: Summary of Drainage Catchment Area in Urban Vientiane Capital

Item	Name	Catchment Area	Length	Width	Riverbed Slope	Existing carrying Capacity	Marsh/Pond
		km^2	km.	m.		m^3/s	ha.
1	***Hong Xeng System***	***71.18***					
1.1	Hong Xeng	56.57	4.01				225
1.2	Hong Kai Keo	3.09	1.36	11 - 13	1/2,500	25.0 - 9.0	Nongbon 7.53
1.3	Hong Pasak	2.24	3.2		1/2,500		Nong Ping/ Nongtha
1.4	Hong Wattay(formerly irrigation canal)	9.28	4.2		1/4,760 - 1/5,000	25.0 - 7.0	
2	***Hong Ke System***	***14.28***					
2.1	Hong Ke	9.54	3.65	39.4	1/3,330	66	Nong Chan
				20.6 - 16.0	1/2,500	38.0 - 24.0	
2.2	Hong Phone Thanh	0.48	0.95				
2.3	Hong Ouay Louay	1.66	1.8		1/1,950 - 1/2,500		
2.4	Hong Khoua Khao	2.6	2.56		1/1,670	16.0 - 7.0	
2.5	Hong Thong(channel + box culvert)		1.75		1/1,670		

Source: Summary from Interim Report-The Study on Improvement of Water Environment in Vientiane City

At present, the top level of the dykes at Chinaimo is MSL+170.8m, which is just above the 10 year flood level of the Mekong River. Storm water is collected by road drainage, consisting of culverts and canals constructed along road network and flow into urban streams/channels. The urban streams/rivers that function as main drainage, such as Hong Thong, Hong Khua Khao and Mak-Hiao Stream, are designed for a 10-year probability rainfall. The road drainages are designed for a 2-year probability rainfall. That Luang marsh with MSL166.0 m of high water level functions as a retention pond for the city.

According to the Study on Improvement of Water Environment in Vientiane Capital, it can be concluded that most of the flow capacity of Hong Ke drainage system can exceeds a 2-year flood discharge which equals a heavy rainfall with the intensity of 46.5 mm for the peak duration of one hour. In Hong Xeng drainage system, a trunk canal of Hong Xeng and downstream parts of Hong Wattay and Hong Kai Keo have insufficient flow capacity of less than a 2-year flood discharge. However no severe flooding has been experienced recently as the open space including remaining marshes and wetlands are still well functioning as a storm water retention and flood retarding pond. Figure 1.3.19 shows the existing retarding pond in Vientiane Capital.

Nong Duang

Nong Ping

Nongtha

Source: JST

Figure 1.3.19: Existing Water Retarding Pond in Vientiane Capital

(5) Management

The current drainage system in Vientiane Capital is quite well implemented and managed with assistance from a few foreign donors such as JICA, ADB, Thai, Korean, etc. DHUP and DPWT are the main agencies that control overall planning and management of drainage, whereas VUDAA plays an important role in operation and maintenance in the urban area.

(6) Human Resource Development

The staff in the Government agencies in charge of drainage work generally have sufficient knowledge in the system and equipment used, but the number of the staff in planning, operation and maintenance are still limited due to the restricted budget provided, and most of them lacks in knowledge of system planning and water quality as well as laboratory tests for water quality analysis. More staff and laboratory equipment are needed for monitoring of the water quality.

(7) Social Condition

Public awareness in keeping the water resources clean is essential for sustainable conservation of all marsh, wetland and rivers. Discharging wastewater and dumping garbage can be seen in open drainage channels in the whole city, especially in urban area, even the concerned agencies are trying to file some campaigns to call for public participation and awareness.

1.3.5 Solid Waste

There are two approaches for the solid waste treatment of Vientiane Capital for the Study. The one is a management matter and the other is a technical matter. Four (4) processes are focused in the flow of the solid waste treatment. Those processes are: i) Generation of Solid Waste; ii) Collection and Transportation; iii) intermediate Treatment; and iv) Final Disposal.

(1) Management matters

1) Legal System

MPWT/DHUP is preparing the Ministerial Decision on Municipal Solid Waste Management on the national level and the decision is ready to be promulgated. This stipulates principles, rules and measures relating to the organization, mobilization and management of municipal solid waste including the solid waste collection and disposal services in order to promote the municipal solid waste management in an orderly manner. The decision applies to the implementation of municipal solid waste management in the urban area but not covers hazardous and industrial wastes.

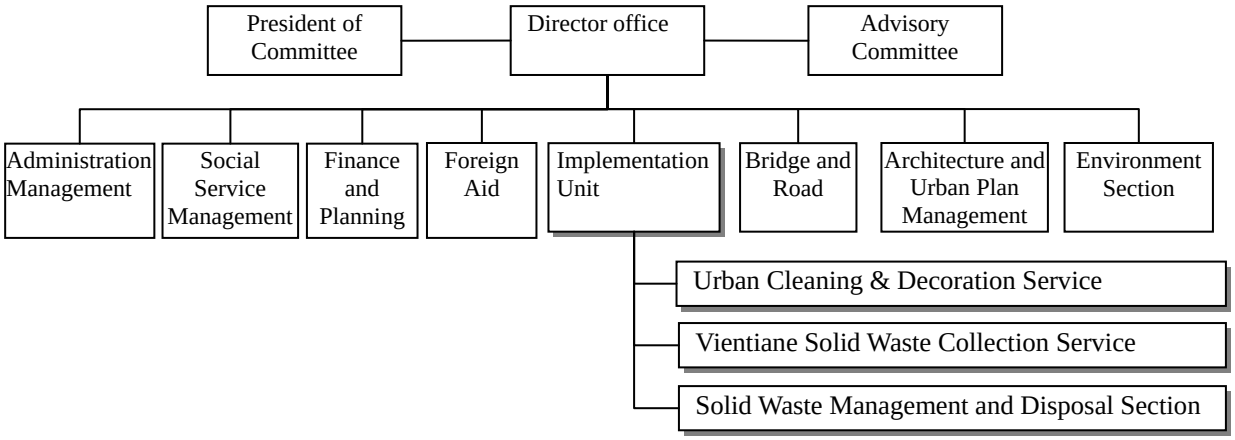
There are no clear legislations or written policies to discharge, collect and dispose solid waste according to definitions of those types. Even internal guidelines in VUDAA how to treat the solid waste are unclear. There is a rule to cover the back side of the truck with a plastic sheet when it transports the solid waste to the KM32 landfill site, but not all trucks follow this rule. VUDAA is now preparing a Guideline on Domestic Solid Waste Management in Vientiane Capital. The guideline would be approved soon. Besides, WREA is also preparing a guideline on solid waste management in Lao PDR for hazardous and industrial wastes.

2) Organization

VUDAA has an implementation division consisting of three sections to manage the solid waste treatment. These sections are Urban Cleaning & Decoration Service (UCDS), Vientiane Solid Waste Collection Service (VSWCS) and Solid Waste Management and Disposal Section (SWMDS). UCDS manages and maintains parks and street trees/plants and conducts cleaning, solid waste collection and sprinkling of water. They transport the solid waste collected from parks and streets to the final disposal site every day.

The other two sections take main roles of the solid waste collection service and management of the final disposal site. VSWCS is in charge of collecting solid waste and transporting to the final disposal site. Seven (7) districts are covered by this service section with five (5) private companies under permission from VUDAA for collection and transportation of the solid wastes in the Vientiane Capital. This section covers 5 districts of the core urban area and its surroundings, namely Sikhottabong, Chanthabouly, Xaysetha, Sisattanak and Hadxaifong.

SWMDS manages the final disposal site located at the point KM32 in Naphasouk Village, 2.5 km away from the National Road No.13 South. The landfill site has been operated since February 2008 with the Governmental budget. The former landfill site, the KM18 landfill site, was closed when the SEA Game stadium was decided to be built in the vicinity.



Source: VUDAA

Figure 1.3.20: Organization Chart of VUDAA and Solid Waste Management

3) Finance

VSWCS and SWMDS manage their activities on their own account. VUDDA provides only salaries for 9 staff of VSWCS and 5 staff of SWMDS. They have finance sources from solid waste collection fees and disposal fees. VSWCS has contracts with village offices by the truck and container and individuals by the basket. The individual subscribers include restaurants, markets, offices, factories, schools, hospitals, hotels and households. The collection fees are:

- LAK 600,000 /truck trip (5 m^3),
- LAK 300,000 /container (2 m^3), and
- LAK 6,000 /basket (25kg).

SWMDS charges every truck by the ton of solid waste in the KM32 landfill site and these disposal fees are the major income source for them. The disposal fees are at LAK 15,000 /ton from the contracted collection companies and any individuals who bring the solid waste in the landfill site. Besides the section charges LAK 10,000 for every tank truck to transport night soil.

- Disposal fee: LAK 15,000 /ton, LAK 10,000/tank truck (for night soil)

The collection service office can raise the fees in accordance with an increase in the cost of transportation (price of gasoline) through meetings with the private collectors. If VSWCS and SWMDS expect some shortage of financial resources, they may decrease their activities and consequently the lower performances of services may affect the sanitation condition of Vientiane Capital. Meanwhile, UCDS is financially directly under VUDDA because they are responsible to clean the public spaces.

4) Subcontracting and privatization

Five (5) private companies are operating for the solid waste collection service through a contract with village offices and individuals. VUDAA gives them permission to go into the collection service business and allocate the coverage area. However, they have no clear criteria to evaluate applications and nor they have a monitoring system of these private

collector's activities. VUDAA has meetings with them or just instructs them when the subscribers complain on their activities to VUDAA, especially in the case they do not collect solid waste according to the schedule. The private collectors charge the equal amount as the collection fees of VSWCS.

5) Large scale waste discharging sources

Six (6) solid waste collectors also have a contract with some of the large-scale waste generating sources such as markets, schools, offices, factories, hospitals, and hotels. For waste materials and surplus soil generated from construction sites, a method disposal is not clear. No one brings those wastes to the KM32 landfill site because those wastes are weighty and costly to transport and dispose of in the KM32 landfill site.

(2) Technical matters

1) Generation of Solid Waste

The coverage rate of the households with a contract for the waste collection is still under 40%, while the remaining more than 60% of households dispose of the solid wastes without the collection service. They probably burn and bury the solid wastes. Marks after burning solid wastes can be seen everywhere as well as to a lesser extent in the urban areas with waste collection service covers. Some drain gutters are clogged with litter. Illegal dumping can be seen especially on the river banks and road sides in the suburban area. VUDDA points out the low awareness of the local citizens in the solid waste treatment as a main reason for such problems.

Table 1.3.30: Discharge Volume by Generation Source

No.	Name of Source	Discharge Ratio	
		Volume	Unit
1	Residence	0.653	kg/day/person
2	Shop	8.958	kg/day/shop
3	Market	1.301	kg/day/shop
4	Office	0.031	kg/day/employee
5	Hospital	0.957	kg/day/bed
6	Road sweeping	58.0	kg/day/km
7	Hotel (average 30 beds)	24.0	kg/day/hotel
8	School (average 250 pupils)	1.5	kg/day/school

Source: VUDAA Environment Section based on JICA Study (The Solid Waste Management System Improvement Project in Vientiane 1992)

2) Collection and Transportation Services

(a) Coverage of the collection service

According to the data of solid waste collection provided by VUDAA, there are in all 63,312 households in the areas where VSWCS and 5 private collectors cover the solid waste collection in the Vientiane Capital. Of this only a total 23,505 households are in contract with either one of them for the garbage collection service, and the coverage ratio is calculated at 37%. The areas that they cover are the most urbanized areas in the Vientiane Capital. Even for those urbanized areas, the coverage ratio of collection service stays under the 50% mark. Main reasons for such a low rate of coverage for the subscribers are the lack of willingness-to-pay of the collection fees, lack of resident's awareness for clean environment, bad access to the

respective garbage collection points. For the VUDAA side, they have no plan nor enough budget to increase the staff and equipment to expand the collection service. They prefer to entrust more collection services to private collectors.

Table 1.3.31: Subscribers of Solid Waste Collection Service in the Vientiane Capital

No.	Name of Company	Household		Institutional Subscriber						
		Total (Village)	Subscriber	Market	Embassy	Office	Factory*	School	Hospital	Hotel/Guest House
1	Vientiane Solid Waste Collection Service	32,345	10,020	20	8	52	44	19	8	36
2	Vientiane Solid Waste Disposal Service Company	12,808	5,835	5	4	12	2	19	1	7
3	Transportation Service and Cleaning Company	5,082	3,404	3	12	23	10	13	1	10
4	Lao Kabase Company Limited	3,388	801	3	0	4	4	0	0	0
5	Chanthabouly Cleaning Company Limited	3,084	2,490	6	1	113	0	12	0	60
6	Center Service Saysetha Solid Waste Company	6,605	955	1	0	7	4	0	0	5
	Total	63,312	23,505	38	25	211	64	63	10	118

Note: * including sales offices
Source: VUDAA Environment Section

The 6 collector companies cover 6 districts; Chanthabouly, Sikhottabong, Sisattanak, Xaythany, Hadxaifong and Xaysetha, although not all villages are served in these districts. Even in the most urbanized districts of Chanthabouly, Sisattanak and Xaysetha, the collectors cover around half of total households in their villages. In other districts, about 15% of households are covered in the eastern districts, Xaythany and Hadxaihong, and about 28% of households are covered in the western district, Sikhottabong. Contract for collection service in Naxaithong is just starting in 2010 although it is only for along National Road No.13 North.

Source: VUDAA Environment Section, compilation by JST

Figure 1.3.21: Collection Service Coverage Area

Table 1.3.32: Coverage Rates of Solid Waste Collection Service by District

No.	Name of Company	Chanthabouly	Sikhottabong	Sisattanak	Xaythany	Hadxaifong	Xaysetha	Total
1	Vientiane Solid Waste Collection Service	4,302	3,327	566	1,536	289	0	10,020
2	Vientiane Solid Waste Disposal Service Company	0	0	0	0	0	5,835	5,835
3	Transportation Service and Cleaning Company	0	0	3,404	0	0	0	3,404
4	Lao Kabase Company Limited	0	0	801	0	0	0	801
5	Chanthabouly Cleaning Company Limited	2,490	0	0	0	0	0	2,490
6	Center Service Xaysetha Solid Waste Company	0	955	0	0	0	0	955
	Total Subscriber (HH)	6,792	4,282	4,771	1,536	289	5,835	23,505
	Total Household of Villages (HH)	12,433	15,472	10,194	10,526	1,879	12,808	63,312
	Coverage rate	54.63%	27.68%	46.8%	14.59%	15.38%	45.56%	37.13%

Source: VUDAA Environment Section, compilation by JST

Table 1.3.33 Number of Staff

No.	Name of Company	Management	Worker	Total
1	Vientiane Solid Waste Collection Service	19	71	90
2	Vientiane Solid Waste Disposal Service Company	6	26	32
3	Transportation Service and Cleaning Company	5	24	29
4	Lao Kabase Company Limited	5	24	29
5	Chanthabouly Cleaning Company Limited	4	19	23
6	Center Service Xaysetha Solid Waste Company	3	6	9
	Total	42	170	212

Source: VUDAA Environment Section

(b) Equipment

The private collectors use only dump trucks to collect the solid waste and transport to the landfill site. The VSWCS uses other types of vehicles such as compactor trucks and container trucks, donated by a grant aid form Japan since 1998. The vehicles they own need frequent maintenance and repair, and these costs tend to be high. Besides, they frequently outsource the repairs except routine maintenance and have to order some spare parts abroad.

Table 1.3.34: Equipment for the Solid Waste Collection

No.	Name of Company	Vehicle under Operation	Compactor Truck	Small Truck	Big Truck	Dump Truck	Container Carry Truck	Container
1	Vientiane Solid Waste Collection Service	20	9	1	4		4	60
2	Vientiane Solid Waste Disposal Service Company	6				6		
3	Transportation Service and Cleaning Company	6				6		
4	Lao Kabase Company Limited	4				4		
5	Chanthabouly Cleaning Company Limited	3				3		
6	Center Service Xaysetha Solid Waste Company	2				2		
	Total	42	9	1	4	21	5	64

Source: VUDAA Environment Section

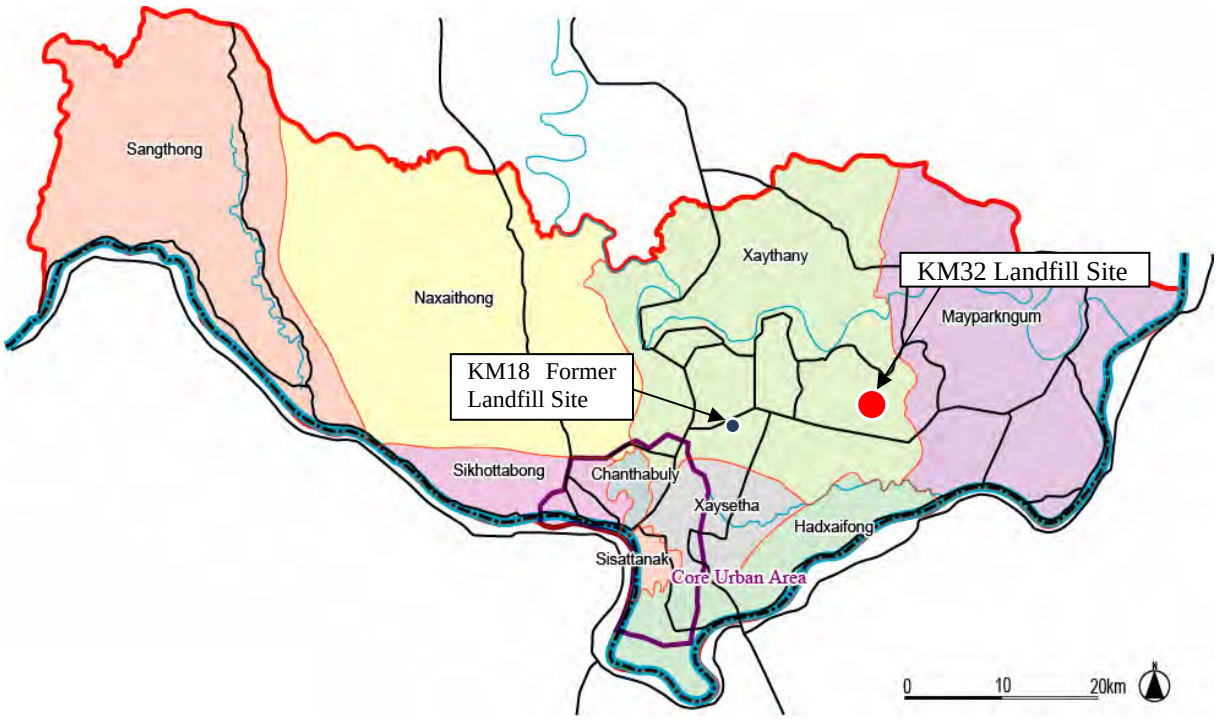
3) Intermediate Treatment

There is no intermediate treatment system to reduce the volume and weight and for stabilization (from decay and toxicity) in the Vientiane Capital. VUDAA has no incinerator, crusher or compaction treatment facilities. They have no plans to provide any intermediate treatment system. The intermediate treatment system may be premature to be provided in the short and medium terms. The capacity of the final disposal site should be considered according to the future increase of population and economic development, but the increase in the collection service coverage will be a primary factor to consider an intermediate treatment in the Vientiane Capital. Moreover, the intermediate treatment facilities require higher costs and techniques for construction, operation and maintenance.

4) Final Disposal

(a) KM32 landfill site

The present final disposal site, the KM32 landfill site, was constructed with local design under cooperation with VUDDA, MPWT and LMA. They selected the location in consideration of the distances from rivers and residential areas, and easiness for land acquisition (vacant lands or agricultural land with no buildings). They constructed the landfill site in a short period about 4-5 months without EIA and a master plan. The site has total 748 ha of land although the boundary is unclear, and approximately 100 ha are available for use at present. However, the area outside of the landfill site was not acquired yet, but the government limits activities in the area.



Source: JST

Figure 1.3.22: Location of KM32 Landfill Site

They planned 6 pits with a size of 200m x 200m x 3m in the area of about 40ha, of which 4 pits are for ordinary garbage, 1 pit is for hazardous disposal and the other 1 is waste water from the pits. However, drainage system does not work properly, and the rain water stagnates in the pits. Consequently, capacity of the pits cannot be used to the full. There is another pit to discharge and store night soil/fecal sludge (with a size of 150m x 100m x 3m).

Some of the equipments that were used in the former KM18 landfill site had been transferred and used here since 1998. They are not in good condition and costs for frequent maintenance and repair are increasing. The electronic weighbridge and the caterpillar loader is in working condition, but the wheel loader is broken and under repair.

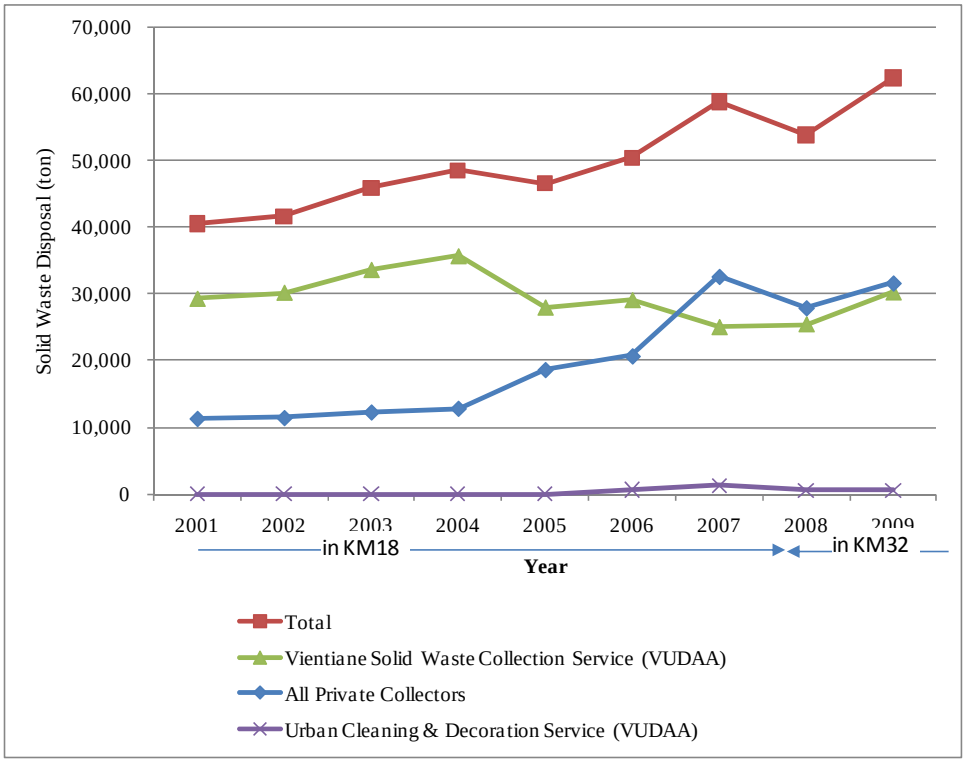
The other specific conditions are as follows.

- The transportation distance doubled from KM18 to KM32 (resulting in more transportation time and cost).
- Hazardous waste including medical waste is dumped in a separate pit at a distance of 500m from other pits without any treatment.
- Industrial wastes are also dumped in the same pit of the medical waste
- No master plan was made and unclear process to study the location and boundary (for 748ha)
- No phasing plans and layout of landfill plots or pits are provided.
- No bottom linings, proper drainage system and a water treatment facility are provided.
- No soil cover is applied on top of the dumped solid waste.

(b) Volume of solid waste disposal

With an increase of the private collectors, the annual volume of solid waste disposal is increasing every year. Total 68,089 tons of solid wastes were disposed of in 2009, which means that about 187 tons are carried daily into the site in approximately 50 truck-trips. The volume transported by VSWCS generally continues to be stable, but the private collector's volume has been sharply increasing since 2005 because new private collectors started the collection service.

The private collectors carry solid waste on an average of about 4.5 tons to 6.5 tons per one truck-trip, which is larger than the average volume of VSWCS at about 3.5 tons. They use dump trucks both for collection in the urban area and transportation to the landfill site. It is supposed that they maximally collect and carry the solid waste in one trip.



Source: VUDAA Environment Section, compilation by JST

Figure 1.3.23: Annual Volume of Solid Waste Disposal of KM32 Landfill Site

Table 1.3.35: Solid Waste Disposal of KM32 Landfill Site (1/2)

	Name of Company	2001		2002		2003		2004		2005	
		Trip	Volume (ton)	Trip	Volume (ton)	Trip	Volume (ton)	Trip	Volume (ton)	Trip	Volume (ton)
Collection	1. Vientiane Solid Waste Collection Service (VUDAA)	11,274	29,254	11,268	30,172	12,361	33,625	12,464	35,694	9,267	27,933
	2. Vientiane Solid Waste Disposal Service Company									1,688	5,093
	3. Transportation Service and Cleaning Company									1,793	5,399
	4. Lao Kabase Company Limited	1,746	4,530	1,713	4,585	2,650	7,209	2,683	7,683	2,448	7,384
	5. Chanthabouly Cleanning Company Limited	2,611	6,780	2,562	6,856	1,867	5,077	1,799	5,153	254	766
	6. Center Service Saysetha Solid Aaste Company										
	7. Urban Cleaning & Decoration Service (VUDAA)										
	Collection Service Sub-total	15,631	40,564	15,543	41,613	16,878	45,911	16,946	48,530	15,450	46,575
Others (including carried-in)	Beer Brewage Processing Waste										
	Night Soil/Fecal Sludge										
	Domestic Waste										
	Medical Waste										
	Australian Laboratory Service										
	Others	353	925	2,183	5,861	426	1,156	315	897		
	Others Sub-total	353	925	2,183	5,861	426	1,156	315	897	0	0
Total		15,984	41,489	17,726	47,474	17,304	47,067	17,261	49,427	15,450	46,575
Average per month		1,332	3,457	1,477	3,956	1,442	3,922	1,438	4,119	1,288	3,881
Average per day		44	114	49	130	47	129	47	135	42	128
Average per trip (ton/trip)			2.60		2.68		2.72		2.86		3.01

Source: VUDAA Environment Section, compilation by JST

Table 1.3.36: Solid Waste Disposal of KM32 Landfill Site (2/2)

	Name of Company	2006		2007		2008		2009		
		Trip	Volume (ton)	Trip	Volume (ton)	Trip	Volume (ton)	Trip	Volume (ton)	(ton/trip)
Collection	1. Vientiane Solid Waste Collection Service (VUDAA)	9,142	29,058	11,051	24,979	9,186	25,403	8,527	30,223	3.54
	2. Vientiane Solid Waste Disposal Service Company	2,258	7,179	1,424	12,553	1,816	8,351	2,306	10,573	4.58
	3. Transportation Service and Cleaning Company	1,458	4,634	1,329	7,445	1,508	7,685	1,688	8,028	4.76
	4. Lao Kabase Company Limited	1,017	3,232	1,053	3,288	759	2,894	526	2,397	4.56
	5. Chanthabouly Cleanning Company Limited	1,438	4,570	1,261	7,001	1,162	6,824	1,243	8,140	6.55
	6. Center Service Saysetha Solid Aaste Company	339	1,080	480	2,334	426	2,160	491	2,496	5.08
	7. Urban Cleaning & Decoration Service (VUDAA)	203	647	470	1,239	165	497	145	569	3.92
	Collection Service Sub-total	15,855	50,400	17,068	58,839	15,022	53,814	14,926	62,426	4.18
Others (including carried-in)	Beer Brewage Processing Waste					124	433	359	879	2.45
	Night Soil/Fecal Sludge					824	1,727	1,718	3,520	2.05
	Domestic Waste					616	1,016	1,257	1,097	0.87
	Medical Waste					25	43	82	128	1.56
	Australian Laboratory Service							11	39	3.55
	Others									
	Others Sub-total	0	0	0	0	1,589	3,219	3,427	5,663	1.65
Total		15,855	50,400	17,068	58,839	16,611	57,033	18,353	68,089	3.71
Average per month		1,321	4,200	1,422	4,903	1,384	4,753	1,529	5,674	
Average per day		43	138	47	161	46	156	50	187	
Average per trip (ton/trip)			3.18		3.45		3.43		3.71	

Source: VUDAA Environment Section, compilation by JST

(c) Management of the KM32 landfill site

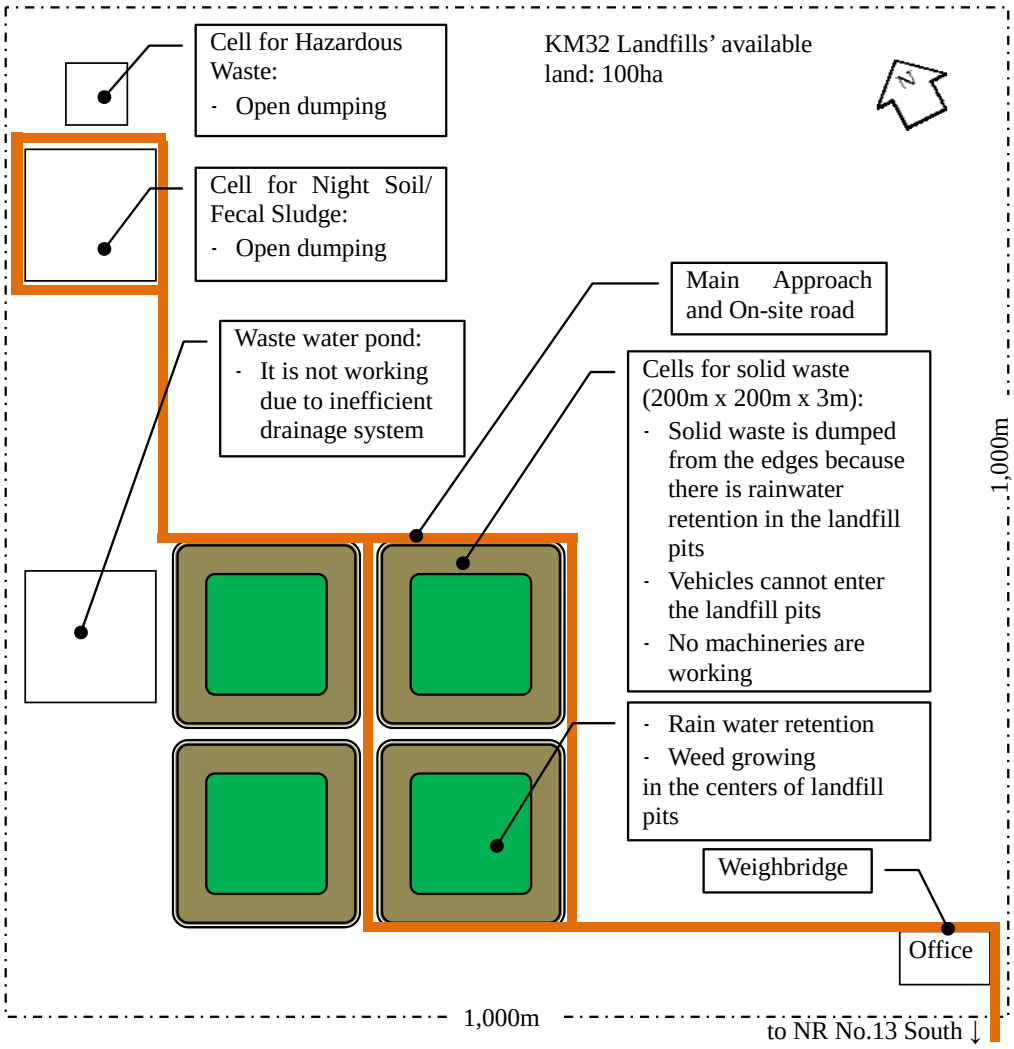
SWMDS consists of four units, planning/finance, administration, equipment, and waste recycle. The section has total 17 permanent staff and 13 temporary staff. Five of them are paid by VUDDA.

The waste recycle unit buys recycle materials (mainly plastic and PET bottles) from the waste pickers who live in and around the landfill site (there are more than 100 waste pickers). The unit sells the selected waste to private recycle companies in the Vientiane Capital. This income is one of the financial sources of the division. The division financially manages the operation and maintenance by themselves except for the salaries for 5 members of the staff paid by VUDAA.

The KM32 landfill has not been properly designed and operated as a sanitary final disposal site. The site has been operated mostly like an open dumping site since tits establishment in 2008. The management office weighs the waste collection vehicles and separately dumps medical waste at least. Therefore, the following adverse effects are identified.

- Difficulty to study the future improvement, operation and management as there is no integrated plan and the lack of deliberate operation
- Inefficient land use to limit the capacity due to a simple dumping method without enough compaction (push the dumped waste down into the landfill pits from those edges)
- Litter, offensive odor and vermination (especially mass generation of flies are seen in the rain season at KM32) are expected to take place due to no soil cover on the dumped garbage, nor any fences and buffer zones around the site

- Spontaneous fire with methane gas generated in the solid waste is expected to happen due to no gas venting facilities
- Leachate from the solid waste can negatively affect the quality of surface and ground water due to no bottom lining (waterproof sheet) for seepage control works, drain gutters and purification system (Rain water can easily be stored in the pits without the drain system or cover soil, and it will cause more leachate.)



Source: Solid Waste Management and Disposal Section, compilation by JST

Figure 1.3.24: Existing Layout and Conditions of KM32 Landfills

(d) Financial condition

SWMDS has its own-accounting system. Their income is mainly from the solid waste disposal charge to the subscribers and carried-in wastes. Almost half of the expense was for fuel/oil of machineries and equipment working in the landfills and 20% was for their repairing. The revenue merely covers operation and maintenance costs. However, they were not able to do necessary works due to insufficient constructions of disposal cells and frequent repair of the equipments. They have been using the equipments all granted by JICA in 1998, but they

cannot earn enough fund to cover necessary budgets to repurchase or even repai the equipments.

(e) Closing the former final disposal site (KM18)

The former landfill site was located at KM18 on the National Road No.13 South. The KM18 landfill site was improved by a grant aid program from Japan in 1998 and was closed after about 10 years of operation. SEA Game Stadium was constructed near the site in 2009. Part of land after the landfill is used for a golf course at present. The other part is still a vacant land. The land is covered by soil but litter and leachate can be seen from the surface of slope in the drain gutter located between the landfill site and the golf course.

Several environmental parameters should be monitored after closing the site to minimize the negative impacts on the environment, to conserve and re-use the land for other purpose. The specific parameters that should be monitored are consolidation, settlement/subsidence, gas, leachate, and surface and ground water qualities. However, no monitoring system has been established yet although VUDAA does some monitoring activities. They check on the site every two months.