CHAPTER 3. PILOT PROJECT

3.1 Significance and Position of Pilot Project

Bremen Overseas Research and Development Association (BORDA) is an international NGO whose head office is located in Bremen, Germany. It has been working for improving living conditions of socially disadvantaged groups in an environmentally sustainable manner since 1977. One of its typical activities is to implement community-based sanitation (CBS) projects with applying Decentralized Wastewater Treatment System (DEWATS). More than 290 CBS projects have been installed so far in Southeast Asia by BORDA.

The Lao Institute for Renewable Energy (LIRE) is a non-profit institution operating in Lao PDR, which was founded in 2006 by a number of Lao companies, organizations and agencies to establish a platform for renewable energy research in Lao PDR. Since BORDA was in partnership with LIRE in the field of energy supply sector, the two organizations established the BORDA-LIRE DEWATS Programme Cooperation in 2009, aiming at promoting decentralized sanitation through CBS and small & medium enterprises.

In the second half of FY 2009, the JICA Study Team and BORDA-LIRE (to be explained later) agreed to jointly implement new CBS/SBS programs in one village and one primary school in Vientiane. These package treatment plants aim at treating both black water and domestic wastewater. They will be adapted to local realities of the institution, environment-friendly, easy to run and maintain and seen as a model replicable to other comparable institutions in Lao PDR. Further, it was expected that the pilot project of the environment education is conducted more effectively with the implementation of construction which would actually treat water environment problems by the participation of targeted people. In addition, they will be concrete examples of Pre-F/S, which is conducted for the preparation of a model plan on extending coverage of treatment facilities to promote CBS/SBS coverage in the future of Vientiane.

Two target areas were selected, namely, 1) UNIT 12 in Thongkhankham Village; and 2) Khoualuang Primary School, with consideration on the capability of extending coverage, publicness, and the environmental education. The selection of the target areas was conducted based on the selection criteria of BORDA-LIRE and the viewpoint of environmental education with joint discussions and site surveys, where the counterparts of Lao PDR (staff members of PTI) were also involved. The following section describes selection of target area and necessary preparatory works done.

3.2 Selection of Pilot Project Sites and Preparatory Works

3.2.1 General

In the beginning, the water environmental education relating water quality improvement at the community and school in Vientiane urban area was assumed as the pilot project in Phase 2 of this Study and its preparatory activity was conducted by the JICA Study Team and PTI, the main counterpart agency, from August 2009. Meanwhile, an alliance of LIRE and BORDA also started their preparation to conduct CBS and SBS construction project in Vientiane in 2009.

As described in the preceding section, both parties agreed to implement the pilot project jointly at the same project sites, integrating the following activities:

- PTI-JICA: Water environmental education (soft component)

- LIRE-BORDA: CBS and SBS construction (hardware) including hygiene education (soft component)

Based on the agreement, both parties jointly implemented the preparatory activities of the pilot project Phase I (project location preparation) including the selection of two appropriate project sites (1 CBS and 1 SBS) from October 2009 to February 2010.

3.2.2 Project Site Selection

(1) Preliminary Screening by PTI-JICA for Environmental Education

In August 2009, before starting the cooperation with LIRE-BORDA, PTI-JICA conducted preliminarily screening to select suitable pilot project sites (villages) for "water environmental education" initially planned to be conducted independently. The screening criteria are as summarized below and the screening result is as shown in **Table 3.2.1.**

- Villages in Hong Pasak or Hong Thong drainage areas (identified as the most deteriorated water quality area in Vientiane by the Study Team);
- Existence of water environment issues
- High motivation of target people (primary school and community) for the activity
- Good partnership between primary school and village office
- Existence of previous similar sanitation or environment improvement project

(2) Preliminary Screening by LIRE-BORDA for CBS/ SBS Construction

Before starting the cooperation with JICA-PTI, LIRE-BORDA had also conducted preliminary screening to select suitable sites (villages) for "CBS and SBS construction" (DEWATS plant construction) independently. The screening result and its criteria are as shown in **Table 3.2.2**

(3) Integrated Selection of Joint Project Sites by Both Parties

After starting the joint pilot project by PTI-JICA and LIRE-BORDA from October 2009, both parties shortlisted the candidate sites to implement "CBS and SBS construction" and "water environmental with sanitary education" jointly as shown in **Table 3.2.3** by integrating the two screening results mentioned above.

(4) Final Site Selection

Both parties finally selected the following two sites located in Chanthabouly District after conducting intensive field reconnaissance and discussion based on the above **Table 3.2.3.** General location of both sites is as shown in **Fig. 3.2.1**.

- Unit 11-13, Thongkhankham Village (as CBS site in Hong Thong drainage area)
- Khoualuang primary school, Khoualuang Village (as SBS site in Hong Pasak drainage area)

Table 3.2.1 Preliminary Screening of Candidate Sites for Environmental Education by PTI-JICA

District	Drainage area	No.	Village name	Village population (2008)	General characteristics of village	Score	Public primary school	Score	Motivation		Previous relating project	Total score
									School	Village		
Chantabuly	Hong Pasak	1	Vathchan	739	Dense urban area	X	No					1
		2	Haisok	874	Dense commercial area	X	No					1
		3	Sihom	1,050	Dense urban area	X	4 teachers 47 pupils	X				2
		4	Khoualuang	2,705	Dense urban, pond & wetland Bad condition at school by inundation	X	4 teachers 87 pupils	X	XX	XX		**6**
		5	Thongtoum	1,367	Dense urban area Small school with bad environment	X	3 teachers 35 pupils	X				2
		6	Hongka	2,301	Dense urban in southren area, semi urban with paddy field in northern area School with good environment condition	X	5 teachers 83 pupils	X	X			**3**
		7	Dongparlap	2,324	Wide semi rural with paddy field		Yes	X				1
		8	Savang	3,391	Wide semi rural with paddy field		Yes	X				1
	Hong Thong	9	Anou	1,101	Dense commercial area	X	Under construction					1
		10	Mysai	597	Mostly public & commercial facilities Small community far from drainage		Yes	X				1
		11	Thong Khankham	2,718	Dense urban with wide commercial area Some area with bad sanitary condition	X	5 teachers 117 pupils	X		X	X (AIT, MPWT/ DANIDA)	**4**
		12	Sisaket	894	Mostly public facilities and small community		No					0
		13	Saylom	1,079	Dense urban, many public & commercial facilities	X	No					1
		14	Hasadi Tai	878	Mostly public facilities and small community		No				X (PTI-AIT /Swiss)	1
Sisattanak		15	Kaognod	-	Mostly public facilities and small community		Yes	X				1
		16	Nong Chane	-	Semi urban with marsh		No					0

Note: In score level, X has a significant advantage, and XX has a more significant one.

Table 3.2.2 Preliminary Screening of Candidate Sites by LIRE-BORDA

No.	1	2	3	4	5	6	7	8	9	10
Village Name	Thapalanxay (Sisattanak)	Khoualuang (Chanthabouly)	Thongkhankham (Chanthabouly)	Thongtoum (Chanthabouly)	Hongka (Chanthabouly)	Nong Douang Thong (Sikhottabong)	Nong Douang Neua (Sikhottabong)	That Luang Thay (Xaysetha)	Viengchalen (Xaysetha)	Sihom (Chanthabouly)
Criteria	Score of each village									
Available land is feasible for DEWATS Plant	X	X	X	X	X	X	X	X		X
Level of water surface is feasible for discharging the effluent from DEWATS Plant		X	X	X	X		X		X	
Do not have any potential of flooding in the area and effecting DEWATS Plant	X	X	X	X	X	X	X	X	X	
Appropriate condition for CBS. Poor sanitation facilities and bad environment condition; or dense area.			X			X	X			
Meets the minimum requirement for elevation/slope 0.8 %		X		X	X					
Uncomplicated condition for piping/house connections		X		X	X	X	X			
Easy for material mobilization	X	X	X	X	X	X	X	X	X	X
Total Score	3	**6**	**5**	**6**	**6**	**5**	**6**	3	3	2

Note: In score level, X has a significant advantage, and XX has a more significant one.

Table 3.2.3 Integrated Selection of Candidate Sites for Joint Pilot Project

Village name (district)	Drainage area	Score in each preliminary screening		Total score	Remarks
		PTI-JICA (Environment education)	LIRE-BORDA (CBS/ SBS construction)		
Khoualuang (Chanthabouly)	Hong Pasak	6	6	12	Suitable for both SBS and CBS
Hongka (Chanthabouly)	Hong Pasak	3	6	9	Suitable for CBS
Thongkhankham (Chanthabouly)	Hong Thong	4	5	9	Suitable for CBS
Thongtoum (Chanthabouly)	Hong Pasak	2	6	8	Suitable for CBS
Nong Douang Thong (Sikhottabong)	Hong Wattay	-	5	-	Outside of objective Hong Pasak/ Hong Thong drainage areas
Nong Douang Neua (Sikhottabong)	Hong Wattay	-	6	-	

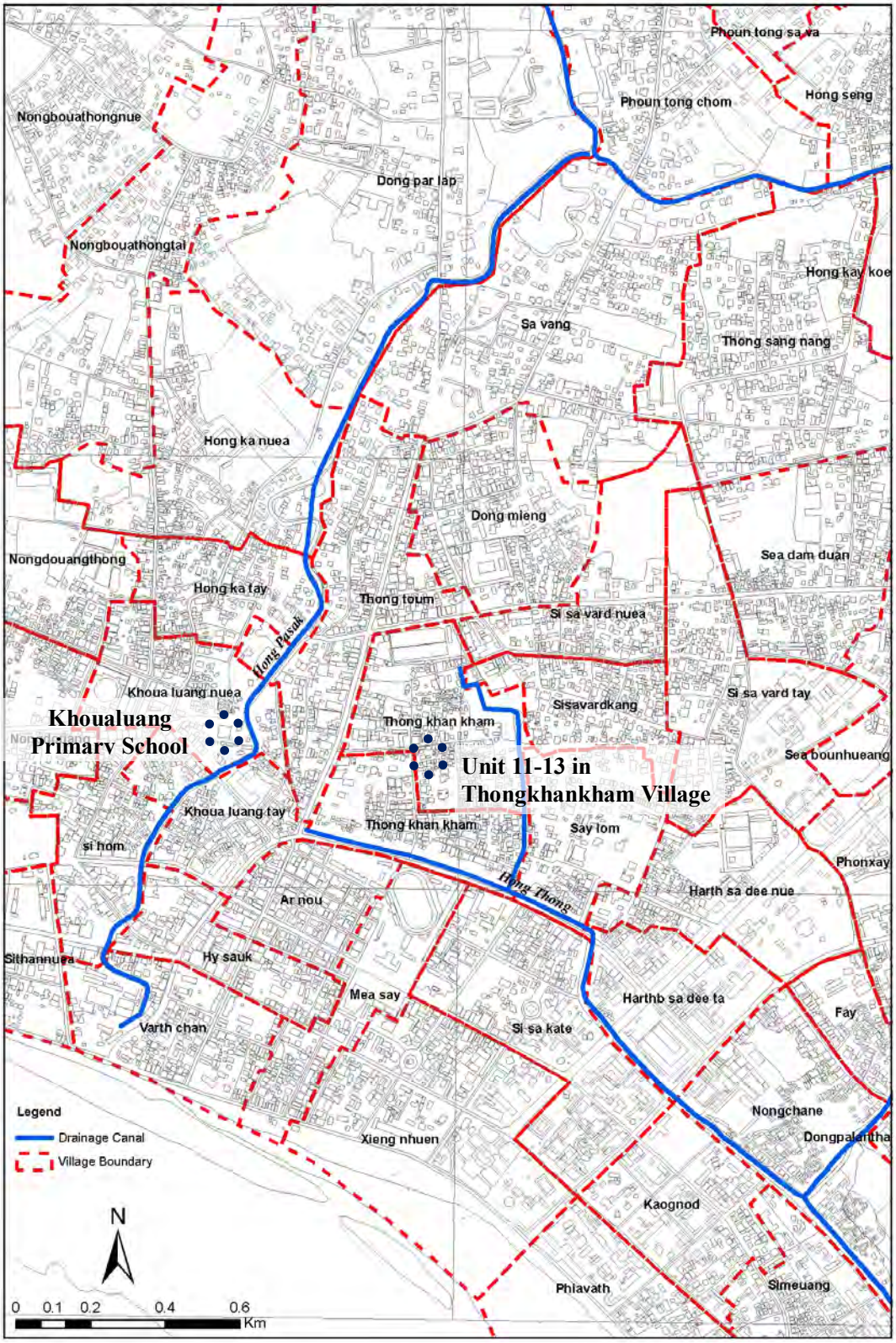


Fig. 3.2.1 Location of Two Selected Pilot Project Sites

(5) Approval of Pilot Project by Competent Authorities

In parallel with the site selection and the preparatory activities, both parties discussed with the following competent authorities and gained approval and cooperation on pilot project implementation at the two selected sites:.

- PTI, MPWT (main counterpart agency)
- DPWT (DPWT implemented extensive sewerage project in wide areas including Thongkhankham Village with the cooperation of DANIDA around 2004)
- Chanthabouly District Office (to manage the district where the two sites are located). <Note: A JOCV (Japan Overseas Cooperation Volunteers) was dispatched to the environmental division of the office to conduct "Environmental Education" for two years from February 2010.>
- Department of Education, Vientiane (to manage nine district educational offices)
- Chantabury District Educational Office (to manage primary and lower secondary schools in the District)
- Thongkhankham Village Office (to manage the village including the objective site)
- Khoualuang Village (to manage the village including Khoualuang Primary School)

3.2.3 Preparatory Activities at Selected Sites

PTI-JICA and LIRE-BORDA conducted the Phase I preparatory activities on 1) DEWATS plant construction; and 2) water environment and hygiene education jointly at selected pilot CBS and SBS sites from November 2009 to February 2010.

(1) Preparatory Activities at Unit 11-13, Thongkhankham Village

In Units 11, 12 and 13 with 22 objective households selected as pilot CBS site, various preparatory activities including preliminary survey and interview with community residents were conducted (refer to **Photo 3.2.1**).

It was confirmed that drainage by gravity is possible from the candidate construction place of the DEWATS plant to the nearest drainage canal. Some drainage improvement works was confirmed necessary as ancillary works to protect the plant from flooding, since this site had sometimes experienced flooding for one hour with 10 cm submerged depth. As a result of discussions, the related community resident agreed to lease the land for the plant.

(2) Preparatory Activities at Khoualuang School, Khoualuang Village

In Khoualuang Primary School (87 students, 4 teachers) which was selected as pilot SBS site, various preparatory activities including preliminary survey and questionnaire survey with the school teachers and pupils were conducted (refer to **Photo 3.2.2**).

It was confirmed that Khoualuang Primary School and the Khoualuang village office have high willingness to participate in the Project. It was also confirmed that drainage by gravity is possible from the candidate construction location of the DEWATS Plant to Hong Pasak with around 80 m in length. Drainage improvement works was confirmed necessary as ancillary works to protect the plant from prolonged flooding because this site has been flooded frequently during heavy rains of three hours with 30 cm submerged depth.

Kickoff workshop for objective villagers at Thongkhankham village office on November 27, 2009

F/S at Unit 11-13 with objective 22 households on December 8, 2009

Measurement at candidate DEWATS plant construction location by the F/S

Interview survey with objective villagers during F/S

Interview survey with objective villagers during F/S

Gravitational drainage is possible from DEWATS Plant to the drainpipe underneath the road.

Photo 3.2.1 Preparatory Activities at Unit 11-13, Thongkhankham Village

School area is 2,060 m^2. The building is of the piloti type because of frequent flooding.

14 toilets are insanitatary - toilet bowls are dirty and water on floor is not drained.

F/S in December 3, 2009. Gravity drainage can be installed easily from DEWATS to Hong Pasak

F/S with leveling, topographical survey, interview survey, etc.

HIA (health impact assessment) with 27 students was conducted in January 25, 2010 to identify the sanitary issue in the school.

HIA was also conducted with 4 school teachers.

Photo 3.2.2 Preparatory Activities at Khoualuang Primary School

3.3 Construction of Community Based Sanitation and School Based Sanitation

3.3.1 Background

The Study Team and BORDA-LIRE confirmed their intention to jointly implement new CBS programs in Thongkhankham Village and Khoualuang Primary School in Chantabury District of Vientiane. Thesespackage treatment plants aim at treating domestic wastewater as well as human waste. They will be adapted to local realities of the institution, environment-friendly, easy to run and maintain and seen as a model replicable to other comparable institutions in Lao PDR. Further, it was expected that the pilot project of the environment education was conducted more effectively with the implementation of construction which would actually treat water environment problems by the participation of targeted people.

Following site selection and preparatory works, both parties implemented Phase II (CBS/SBS project implementation) of the pilot project succeedingly at two selected sites from June 2010 to March 2011. The Phase II activities consist of DEWATS plant construction and water environment and hygiene education as shown below. The major joint events and meetings in Phase II are as summarized in **Table 3.3.1**.

- DEWATS plant construction for CBS and SBS (structural measures): Detailed engineering design and construction work
- Water environment and hygiene education for primary school (teachers and higher-grades pupils) and community residents (non-structural measures)
  - Development, publication and dissemination of educational side reader
  - TOT (training of trainers) workshop at project sites

Technical matter and management structure on the CBS and SBS (School Based Sanitation or CBS installed in a school) are mainly described in the following sections.

Table 3.3.1 Joint Activities and Meetings with LIRE-BORDA in Phase II

DATE	VENUE	CONTENTS
June 22, 2010	PTI	Discussion on joint activity schedule and the contract on DEWATS construction to LIRE
June 23	LIRE office	Contract on DEWATS construction to LIRE
June 29	Thongkhankham Village office	Briefing and consensus formation to the village head and deputy village head towards the CBS Committee establishment for the commencement of DEWATS construction
June 30	Khoualuang Primary School	Briefing and consensus formation to the teachers towards the SBS Committee establishment for the commencement of DEWATS construction
July 6	Thongkhankham Village	Project briefing to objective Unit 11-13 residents
July 7	Khoualuang School	Discussion on the SBS committee establishment with village head, teachers and a monk representative of the adjacent temple
July 16	Khoualuang School	Briefing on technical issue (DEWATS service area and its designing) and consensus formation on the SBS committee establishment with village head, teachers and a monk representative
July 19	Thongkhankham Village	Re-request to the village head on the CBS committee establishment
July 20	LIRE office	Discussion on TOT workshops on water environment, hygiene and sanitation at 2 sites and drafting of the side reader
July 21	Khoualuang School	SBS stakeholder meeting: Discussion on the SBS committee establishment and the agreement on DEWATS service area with teachers and monk
August 2	Thongkhankham Village	CBS stakeholder meeting on the briefing of CBS
August 9	Khoualuang School	SBS stakeholder meeting on the final selection of the SBS committee members and the confirmation of each member's role
August 10	Thongkhankham Village	CBS stakeholder meeting on the briefing of the CBS construction works and the necessity of the CBS committee establishment
August 24	Thongkhankham Village	CBS stakeholder meeting on the selection of the CBS committee members and the operation and maintenance
August 31	Thongkhankham Village	CBS stakeholder meeting on the final confirmation of the CBS committee members and the consensus formation on the reserve fund for the operation and maintenance
September 28	LIRE office	Discussion on the progress of the DEWATS construction and the treatment of buried facilities by former DANIDA-DPWT project
October 5	LIRE office	Discussion on the preparatory works for the TOT workshops at 2 pilot project sites on water environmental and hygiene education and the preparation of the side reader
October 8	Khoualuang School	Discussion on the preparation of the TOT workshops
October 8	Thongkhankham Village	Discussion on the preparation of the TOT workshops
October 8	LIRE office	Weekly meeting on the DEWATS construction progress
October 12	Thongkhankham Village	The 1st community TOT workshop on water environmental and hygiene education at Unit 11-13
October 15	PTI	Weekly meeting on the DEWATS construction progress
October 15	Khoualuang School	The 1st school TOT workshop on water environmental and hygiene education
October 19	Thongkhankham site	The 2nd community TOT workshop
October 22	LIRE office	Weekly meeting on the DEWATS construction progress
October 26	Khoualuang School	The 2nd school TOT workshop
October 29	PTI	Weekly meeting on the DEWATS construction progress
October 29	Thongkhankham site	The 3rd community TOT workshop
November 2	Khoualuang School	The 3rd school TOT workshop
November 4	LIRE office	Discussion on the final editing of the side reader for printing works
November 5	LIRE office	Weekly meeting on the DEWATS construction progress
November 23	PTI	Discussion on the final editing of the side reader before printing work

3.3.2 Objectives and Beneficiaries

The CBS and SBS shall be implemented with similar objectives, namely;

- To improve the sanitary conditions and water environment at densely urban settlements or schools in Vientiane;
- To provide an alternative solution for wastewater treatment system to communities or schools;
- To implement a pilot project of the Decentralized Wastewater Treatment System (DEWATS) in Lao PDR; and
- To provide health and hygiene education program as well as water environment training for community residents or students and teachers.

In the pilot project, beneficiaries are as summarized below.

Table 3.3.2 Beneficiaries of CBS and SBS

	CBS: Thongkankam Village	SBS: Khoualuang Primary School
Location	Thongkankam Village, Chanthabouly District	Khoualuang Village, Chanthabouly District
Drainage Basin	Hong Thong	Hong Pasak
Number of User	146 people of 22 house holds	116 people in total 87 pupils 4 teachers 25 monks

3.3.3 Designing of CBS and SBS

(1) Participatory Approaches for CBS and SBS

After selection of suitable sites for CBS and SBS construction, both the JICA Study Team and LIRE started to obtain the approval of competent governmental agencies, such as MPWT, DPWT, Department of Education, District Office and village offices, for CBS and SBS. Finally, both construction works were approved by the governmental agencies in July 2010.

Apart from detailed designing of both CBS and SBS, the following activities were taken mainly at the project sites. The table includes preparatory works conducted in 2009.

Table 3.3.3 Participatory Approaches for CBS and SBS

	CBS: Thongkankam Village	SBS: Khoualuang Primary School
Rapid Participatory Assessment	Nov. 2009	Nov. 2009
Discussion on Community/School Action Plan	Nov. 2009	Jun. to Jul. 2010
Health Impact Assessment	Aug. 2010	Jan. 2010
DEWATS Information and Technology Presentation	Jul. to Aug. 2010	Jul. 2010
Establishment of CBS/SBS Committee	Aug. 2010	Aug. 2010
Determination of Contribution and O&M Fees	Aug. 2010	Aug. 2010

(2) Engineering Designs of CBS and SBS

In parallel with the above approaches, engineering design proceeded after the completion of feasibility study in December 2009 at both sites. The basic conditions for the engineering design of DEWATS are summarized in **Table 3.3.4**.

Table 3.3.4 Design Conditions for CBS and SBS

	Unit	CBS: Thongkankam Village	SBS: Khoualuang Primary School
Number of Users	people	146	116
Hydraulic Retention Time	days	2	2
Daily Wastewater to be treated	m^3	11.2	7
Inflow COD_{Cr}	mg/l	970	970
Inflow BOD	mg/l	540	540
Outflow COD_{Cr}	mg/l	80	65
Outflow BOD	mg/l	28	23
Land Requirement	m^2	30	21
Volume of Wastewater Treatment Plant	m^3	23.76	20.77

Based on the above conditions, CBS and SBS facilities are designed as presented below.

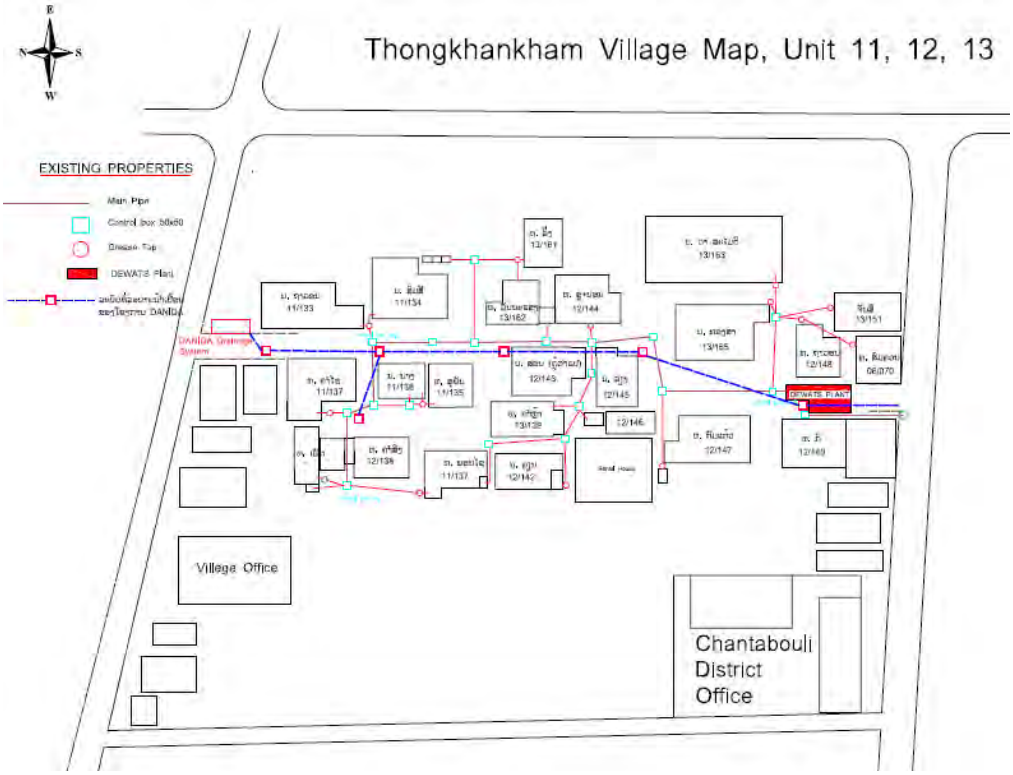


Fig. 3.3.1 Layout of CBS Sewer Network Plan

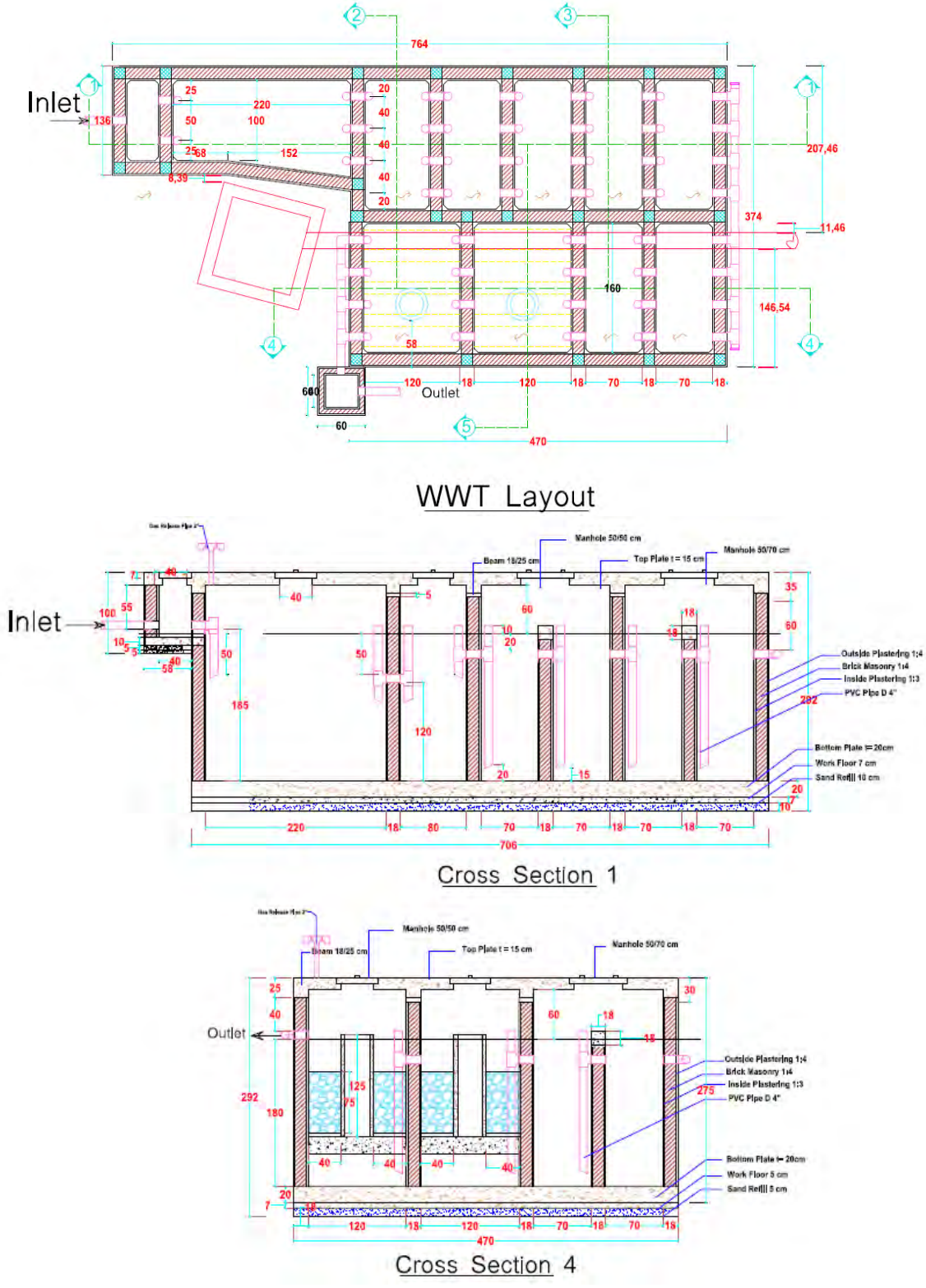


Fig. 3.3.2 Structural Design of CBS for Thongkhankham Village

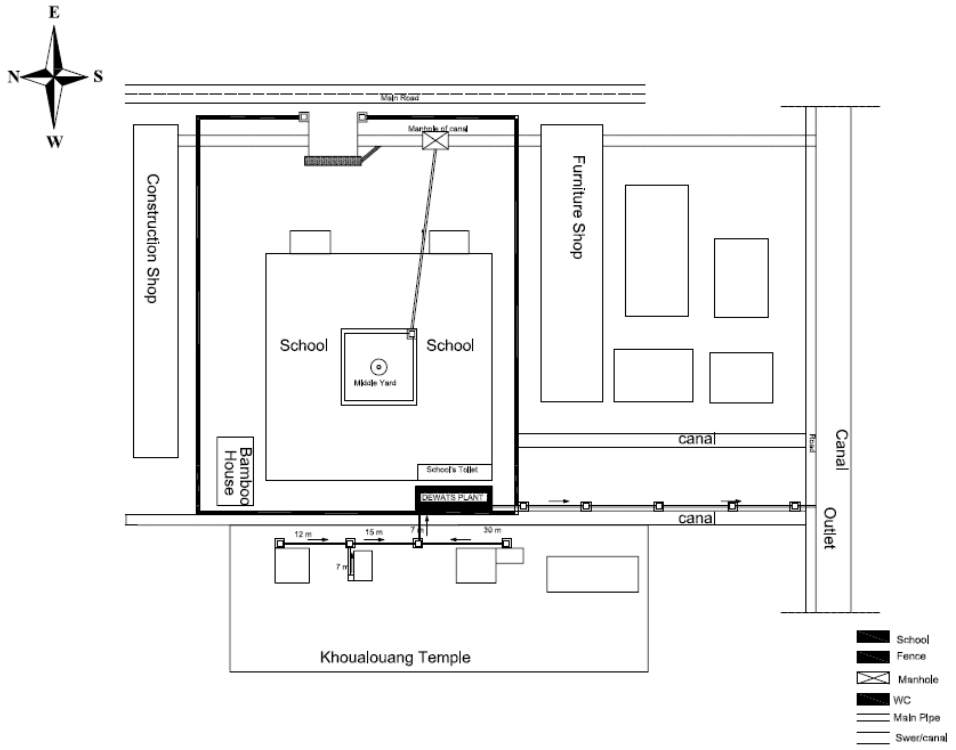


Fig. 3.3.3 Layout of SBS Sewer Network Plan

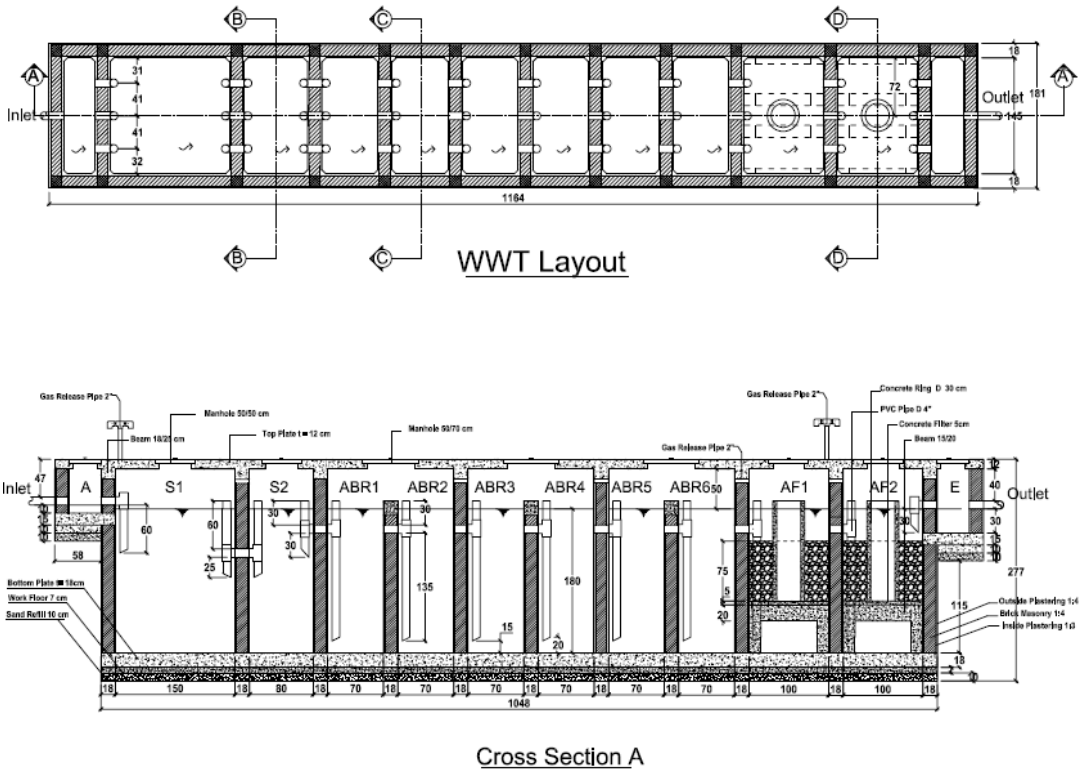


Fig. 3.3.4 Structural Design of SBS for Khoualuang Primary School

The estimated cost is 38,127 USD for CBS and 41,593 USD for SBS including design, supervision, system guarantee, and 3-months operation and maintenance cost which is equivalent to 15% of the net construction cost.

3.3.4 Construction Schedule of CBS and SBS

The original and actual construction schedules of CBS and SBS are shown in **Table 3.3.5**. The construction of CBS was delayed due to the appearance of old pipelines installed by DANIDA. Details of the original construction schedule are given in **APPENDICES**.

Table 3.3.5 Construction Schedule of CBS and SBS

		Original	Actual
CBS: Thongkankam Village	Start	September 7, 2010	September 7, 2010
	End	November 20, 2010	December 25, 2010
SBS: Khoualuang Primary School	Start	September 1, 2010	September 1, 2010
	End	November 20, 2010	December 20, 2010

3.3.5 Management Structure for CBS and SBS

Committees for CBS and SBS have been established for their smooth operation and maintenance. The management structures are as presented below.

(1) CBS Committee

The CBS Committee was established mainly among the users of Thongkhankham Village in August 2010. A Chairperson tops the CBS Committee, and two Deputy Chairpersons were selected under him. Under the Deputy Chairperson, three units were set up, namely, (i) the Financial and Contribution Unit, (ii) the Operation and Maintenance Unit; and (iii) the Mass Organization Unit. For the three units, two or three residents were assigned as responsible persons.

(2) SBS Committee

The SBS Committee was established among the teachers, monks and janitors living in the school in August 2010. A Chairperson tops the CBS Committee and a Deputy Chairperson was selected. Under the Deputy Chairperson, one unit for operation and maintenance has been set up.

3.3.6 Operation and Maintenance

After the construction of both the CBS and SBS, operation and maintenance were planned to guarantee full functioning of the system. The operation and maintenance includes the budgetary and maintenance schedule. The O&M budget is 110,000 KIP/month paid by 22 households (5,000 KIP/month for each household) for CBS, while it is 50,000 KIP/month for SBS paid by the school. Besides, according to the study by BORDA-LIRE, Thongkhankham villages belong to the middle to low income urban area in the city center. Thus, their average income can be presumed as 1,000,000 KIP/month, which is the first quartile in the income survey of Pre-F/S. Therefore, the O&M cost borne by the village families amounts to 0.5% of their income.

3.3.7 Evaluation of Functions of CBS and SBS

Water quality monitoring for the CBS and SBS was made on 25 May 2011 to verify the treatment effects of both facilities. Both of these facilities were completed in the end of December 2010, and they have been operated for almost 5 months. Thus the sludge in the treatment tank might be

already stabilized so that their treatment effects could appear properly. Wastewater sampled and testing results are as presented below.

CBS: From the right, inflow tank, intermediate tank and outflow tank

SBS: From the left, inflow tank, intermediate tank and outflow tank

Photo 3.3.1 Wastewater Sampled from CBS/SBS on 25 May 2011

Table 3.3.6 Results of Water Quality Test

Parameter	Unit	Inflow Tank	Intermediate Tank	Outflow Tank
CBS				
pH		6.7	6.7	6.9
Water Temperature	^oC	28.4	28.7	28.8
NH_4^+-N	mg/l	42.6	34.5	37.6
BOD_5	mg/l	82	41	36
TSS	mg/l	168	40	13
Fecal Coliform	Colonies/100ml	5,370,000	2,685,000	2,369,000
SBS				
pH		6.7	7.0	7.2
Water Temperature	^oC	27.7	28.1	27.7
NH_4^+-N	mg/l	83.7	36.7	55.8
BOD_5	mg/l	99	38	32
TSS	mg/l	294	29	11
Fecal Coliform	Colonies/100ml	2,580,000	1,765,000	1,115,000

From the results, while outflow of BOD_5 slightly exceeds the standard value of wastewater discharge of 30 mg/l, outflow of TSS meets the one of 40 mg/l. Although the sludge inside is stabilizing even for 5 months after completion, further testing in succeeding sampling shall be necessary since the treatment efficiency had been increasing for 2 years after completion referring to an example in the Philippines.

Regarding removal ratios, they are 56% in BOD_5, 92% in TSS, and 56% in Fecal Coliform monitored in CBS, while they are 68% in BOD_5, 96% in TSS, and 57% in Fecal Coliform monitored in SBS. As recognized in the photos, removal effects of suspended solids are significant. On the other hand, the effects of BOD_5 and Fecal Coliform would increase as the sludge stabilizes in future.

3.4 Water Environment and Hygiene Education

3.4.1 Development and Dissemination of Side Reader

(1) Development of Side Reader

As a part of the pilot project Phase II, PTI-JICA and LIRE-BORDA jointly developed and published an educational side reader "Let's Learn Water Environment, Hygiene and Sanitation" (23 pages, both Laotian and English versions). The basic development policy is as given below:

- Target:
  - 4-5 grades primary school pupils (considering minimum learning competency)
  - community residents
- Integration of water environmental module (PTI-JICA) and health & hygiene module (LIRE-BORDA)
- Optimization and localization of the contents through the discussion with the participants of TOT workshops (refer to the following Subsection 3.2.5)
- No technical term; the reader is written with easy wordings for the target people to understand
- Consideration of TCP (Teacher - Children - Parent) approach
- Combination of (1) classroom lecture and (2) participatory indoor & outdoor activities (Most important factor to be considered is to "Learn with Pleasure".)
- Lecture at school to be principally conducted using extracurricular activities other than the seven regular subjects

The table of contents is shown in **Table 3.4.1** and the contents (abstract) are shown in **Fig. 3.4.1**.

Table 3.4.1 Table of Contents of the Developed Side Reader

Title: Let's Learn Water Environment, Hygiene and Sanitation
(for Primary School and Community)

Introduction
Table of Contents

1 Let's Learn about Water Pollution
1) If water is polluted, what will happen?
2) What is the cause of water pollution?
3) Does only human being use water?
4) Where does tap water come from and wastewater go?

2 Let's Learn How to Make Household Wastewater Clean

3 Let's Check around Your School/ Community
1) Let's check where polluted water is around you
2) Let's clean around your school or community together
3) Let's reconfirm proper quantity of detergent in laundry
4) Let's go to see new facilities to clean wastewater

4 Let's Wash Hands with Soap

5 Let's Learn Good and Bad Hygiene Behaviors

6 Let's Keep Clean Environment through Housekeeping
1) Keep your bathroom and toilet clean!
2) Keep your environment and surrounding clean!

Afterward

Note: Chapter 1-3 were developed by PTI-JICA and Chapter 4-6 were developed by LIRE-BORDA

1 Let's Learn about Water Pollution

1) If water is polluted, what will happen?

Water is a source of life. What happens if few lives can survive because of the pollution of canals in Vientiane City?

The surrounding water in ditch or canal become muddy black, bad smell is released, and you cannot bear any longer. You do not want to play in a canal, because dirty germ-laden water might cause sick.


Night soil might leaks underground and pollutes groundwater if toilet has no tank or cracked tank. Polluted germ-laden groundwater may produce disease if you use the groundwater.


Life in water may disappear from canal. Nobody wants such polluted water. That's why you need to get more interested in the pollution of water.

1

2 Let's Learn How to Make Household Wastewater Clean

Let's make efforts not to drain polluted water from your house to clean environment around you and the canal and river downstream. Drain household wastewater after cleaning as much as possible as below:

- Don't pour away oil as it is. (After infiltrating it into paper or old cloth, throw away together with kitchen garbage.)

- Don't drain kitchen garbage (food scraps /leftovers) away.

- Wash unclean plate after wiping off by toilet paper or unnecessary paper.

- Don't use detergent too much in laundry and washing plates. (Washing power will not be raised even if you use it too much.)

- Don't use soap or shampoo to much in taking shower.

- Don't throw away garbage in canal.

6

3 Let's Check around Your School/ Community

3) Let's reconfirm proper quantity of detergent in laundry.

How are you or your mother using detergent when washing? You do not use detergent too much?

Please understand that the omission condition of the dirt of clothes does not become good even if you use detergent too much. Too much detergent will pollute canal and river.

So, let's measure the quantity of detergent exactly! Please use a measuring spoon as much as possible!

10

4 Let's Wash Hands with Soap.

We share close contact with other people at school, at work or at home all day, every day. We can bring illnesses home with us and can infect family members.

The single most important thing we can do to keep from getting sick and spreading illness to others is to clean our hands.

We should clean our hands…

- After we use the bathroom/ toilet
- Before we eat
- Before, during and after we prepare food
- When our hands are dirty
- After handling animals or animal waste
- After changing babies' nappies
- More frequently when we, or someone with whom we come in contact, is sick.

What happened when we have washed our hands with soap?

Washing hands with soap works by interrupting the transmission of disease.

Do we have to use soap to wash our hands?

'YES!'

2

Fig. 3.4.1 Contents of the Developed Side Reader (Abstract)

(2) Publication and Dissemination of Side Reader

It is necessary to promote and disseminate the water environment and hygiene education from the two pilot project sites to the whole area of Vientiane from now on. For this purpose, PTI-JICA and LIRE-BORDA printed and distributed 7,200 copies of the Laotian side reader to all the 353 public primary schools (complete school with 4-5 grades only) in Vientiane and related agencies from January to March 2011 in cooperation with the Department of Education and nine district educational offices in Vientiane, as shown in **Table 3.4.2**. In addition, five JOCVs in charge of environmental education and working in the Environment Management Division of four urban districts and Xaythany district offices also cooperated in the dissemination activity in their districts.

Table 3.4.2 Dissemination of Side Reader to Related Agencies

Name of organization		Name of district	Number of school/ office	Number of copy disseminated	Total
Department of Education		-	1	80	80
District Educational Office		-	9	40	360
Public primary schools in urban districts	1	Chanthabouly	22	40	880
	2	Sisattanak	22	40	880
	3	Xaysetha	39	40	1,560
	4	Sikhottabong	37	40	1,480
Public primary schools in suburban districts	5	Xaythany	83	5	415
	6	Hatxaifong	43	5	215
	7	Naxaithong	40	5	200
	8	Parkngum	38	5	190
	9	Sungthong	29	5	145
				Total	6,405
District Offices in urban central area			5	160	800
				Total	7,205

3.4.2 TOT Workshop at Project Sites

(1) General

As a part of the pilot project Phase II (CBS project implementation) activities, PTI-JICA and LIRE-BORDA jointly conducted the TOT (training of trainers) workshops on water environment and hygiene education for pupils, teachers and residents at two pilot project sites in October and November 2010 together with the development of the side reader. A series of workshops were conducted as the Phase 1 of the "Activity Promotion Roadmap" as priority activity of the Master Plan (refer to Subsection 4.4.4 in the next chapter).

- 3 school TOT workshops (Khoualuang Primary School): October 15 and 26 and November 2, 2010
- 3 community TOT workshops (Unit 11-13, Thongkhankham Village): October 12, 19 and 29, 2010

Several appropriate trainees as candidate trainers were selected out of the representatives of the CBS/SBC committees in Unit 11-13. Four teachers at the SBS site and five community representatives at CBS site were finally selected as trainees. PTI-JICA and LIRE-BORDA trained the trainees through the workshops so that they could present lectures for their pupils or residents by themselves (refer to **Tables 3.4.3 and 3.4.4**).

All the TOT workshops were successfully completed with positive participation of the teachers, pupils and community residents and also with practical side reader development by eager discussion among the participants.

(2) School TOT Workshop (Khoualuang Primary School)

School TOT workshops on water environment and hygiene education were conducted three times at Khoualuang Primary School in October and November 2010. The contents, program and scenery of the workshops are shown in **Fig. 3.4.2**, **Table 3.4.3** and **Photo 3.4.1**, respectively.

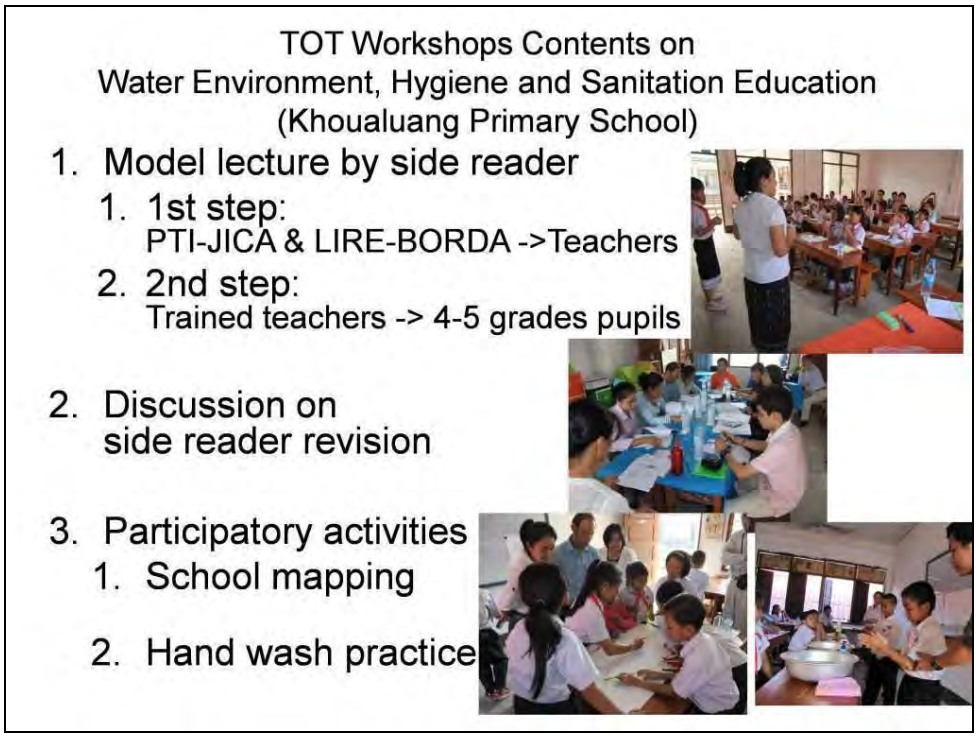


Fig. 3.4.2 Contents of School TOT Workshop

Table 3.4.3 Program of School TOT Workshop

No.	Date	Program	Trainer	Trainee
1	Oct 15, 2010 (1:30-4:30 pm)	Model lecture with side reader	PTI-JICA & LIRE-BORDA staff	4 school teachers
		Discussion on side reader revision	All the trainers and trainees	
2	Oct 26, 2010 (1:30-4:30 pm)	Model lecture with side reader (hygiene and sanitation)	"Trained" 4 teachers	4-5 grade: 23 pupils
		Participatory activities (School mapping)	PTI-JICA staff	4 school teachers
		Participatory activities (Hand-wash practice)	LIRE-BORDA staff	
3	Nov 2, 2010 (1:30-4:30 pm)	Model lecture by side reader (water environment)	"Trained" 4 teachers	4-5 grade: 23 pupils
		School mapping		
		Hand-wash practice		

First Workshop: Discussion, review and revision on the side reader to make the contents easier to understand by reflecting the opinion of teachers

Second Workshop: Model lecture by ~~t~~rained" teachers for 4-5 grade pupils on the side reader

Third Workshop: School mapping by 4-5 grade pupils guided by ~~t~~rained" teachers (field walking around the school to investigate where the dirty places are located)

Third Workshop: School mapping by 4-5 grade pupils (mapping of field walk result by pupil groups guided by ~~t~~rained" teachers)

Third Workshop: School mapping by 4-5 grade pupils (presentation of completed maps by each pupil group representative)

Third Workshop: Practical training on hand-washing with soap guided by ~~t~~rained" teachers

Photo 3.4.1 Scenery of School TOT Workshop (Khoualuang Primary School)

(3) Community TOT Workshop (Unit 11-13, Thongkhankham Village)

Community TOT workshops on water environment and hygiene education were conducted three times at Unit 11-13, Thongkhankham Village, in October 2010. The contents, program and scenery of the workshops are shown in **Fig. 3.4.3**, **Table 3.4.4** and **Photo 3.4.2**, respectively.

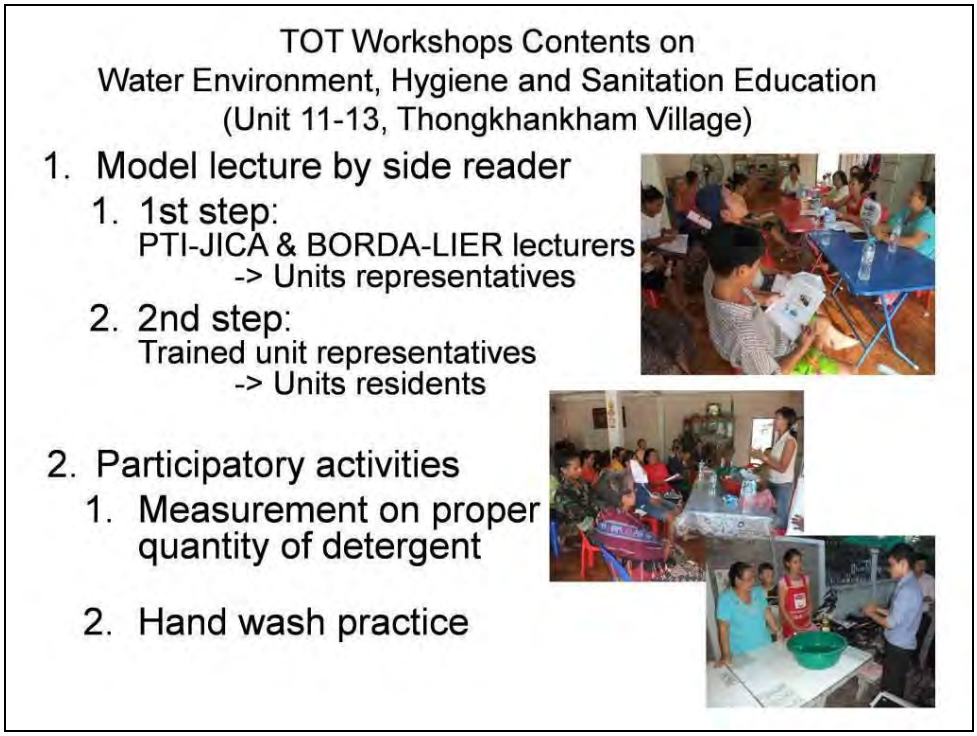


Fig. 3.4.3 Contents of Community TOT Workshop

Table 3.4.4 Program of Community TOT Workshop

No.	Date	Program	Trainer	Trainee
1	Oct 12, 2010 (2-5 pm)	Model lecture with side reader	PTI-JICA & LIRE-BORDA staff	5 representatives of Units 11-13
2	Oct 19, 2010 (3-6 pm)	Model lecture with side reader	"Trained" unit representatives	Units 11-13 residents (22 households)
		Participatory activities (Proper usage of detergent)	PTI-JICA staff	3 representatives of Units 11-13
		Participatory activities (Hand-wash practice)	LIRE-BORDA staff	
3	Oct 29, 2010 (3-5 pm)	Proper usage of detergent Hand-wash practice	"Trained" unit representatives	Units 11-13 residents (22 households)

First Workshop: Training for unit representatives as potential trainers on the lecture method using the side reader

Second Workshop: Model lecture by ~~t~~rained" unit representatives for unit residents using the side reader

Third Workshop: Lecture on the measurement of proper quantity of detergent by ~~t~~rained" unit representatives to unit residents

Third Workshop: Demonstration on the measurement of detergent by unit residents as trainees guided by ~~t~~rained" representatives

Third Workshop: Lecture on hand-washing with soap by ~~t~~rained" unit representatives to unit residents

Third Workshop: Practice of hand-washing by unit residents as trainees guided by ~~t~~rained" representatives

Photo 3.4.2 Scenery of Community TOT Workshop (Unit 11-13, Thongkhankham Village)

3.4.3 Workshop and Lecture at University for Dissemination Promotion

As the wrap-up dissemination promotion activity, PTI-JICA and LIRE-BORDA jointly conducted a series of workshops and lectures at a university in June 2011 with the cooperation of related agencies. The objective of those dissemination activities is to encourage future sustainable implementation of the "Water Environment and Hygiene Education Promotion Plan" which is one of the components of the JICA Master Plan. The contents are shown in **Table 3.4.5** and **Table 3.4.6**.

Table 3.4.5 Workshops on Side Reader Usage for Primary School Heads in Urban Districts

Venue (District Educational Office)	No. of Public Primary Schools	Date/Time	Theme	Object Person	Lecturer
Chanthabouly District	22	June 7/ 09:00 - 10:30	Instructions on side reader usage	Public primary school heads & District educational office staff	PTI-JICA, LIRE-BORDA (with 4 JOCVs)
Sikhottabong District	37	June 7/ 13:30 - 15:00			
Sisattanak District	22	June 8/ 09:00 - 10:30			
Xaysetha District	39	June 8/ 14:00 - 15:30			

Table 3.4.6 Special Lecture at National University of Laos

Venue	Date/ time	Theme	Object person	Lecturer
Lecture room in Faculty of Environment Science	June 13 (90 minutes)	Introduction of: 1) Pilot environmental/hygiene education by side reader and TOT workshops (60 minutes) 2) A series of environmental lectures at 8 primary schools in Xaythany District by SEED and JOCV (30 minutes)	4-year students of the Faculty of Environment Science (around 40 students)	1) PTI-JICA, LIRE-BORDA 2) SEED

3.5 Lessons Learnt through the Pilot Project

As the pilot project, sanitary improvement facilities were constructed in a community of Thongkhankham Village and in Khoualuang Primary School, and environmental education as well was conducted in cooperation with LIRE of Lao NGO. Lessons learnt through these activities of construction CBS/SBS in the community and the primary school are summarized in the followings.

(1) Treatment Effects of CBS/SBS and Necessity of Continuous Monitoring Activities

According to the water quality sampling and testing made in the end of May, 2011, outflow of BOD_5 slightly exceeded the standard value of wastewater discharge of 30 mg/l, while outflow of TSS met the one of 40 mg/l. Although the sludge inside is stabilizing even for 5 months after completion, further testing in succeeding periodical sampling shall be necessary since the

treatment efficiency had been increasing for 2 years after completion referring to an example in the Philippines.

On the other hand, organized proper understandings to the CBS/SBS by communities and schools and necessary operating and maintaining activities shall be indispensable for their proper operation and maintenance. Thus continuous activities shall be necessary on education to deepen their understandings to the facilities and on monitoring to their organizational and social activities, in addition to water quality monitoring.

(2) Future Extensibility of CBS/SBS and their Issues

Wastewater treatment effects of CBS/SBS are already verified in the preceding part as a pilot project. On the other hand, installation ratio of sanitary facilities to the individual houses/buildings in the urban areas of Vientiane is quite high as clarified through the Pre-F/S, so that needs of improving sanitary facilities in the communities might not be high as a whole. Even though numbers of the suitable sites for CBS in the impoverished communities are small in the urban areas of Vientiane, CBS could be effective in such areas as well as in new developments in the suburban areas and new developments at relocation sites by some projects. The communities, where the decentralized and small-scale sanitation improvement facilities will be installed, shall solve the following issues through participatory agreement.

- CBS steering committee shall be established for operation and maintenance by themselves of community members, utilizing existing organization of resident self-governance.
- For proper maintenance of CBS, necessary budget collection and allocation system shall be established and properly operated through participatory agreement. The budget shall be used for periodical extraction works of grease, desludging of septage once in a few years, repair works to the damaged parts.

Regarding the SBS constructed in Khoualuang Primary School, there was enough space to construct the SBS, so that pupils and teachers are enjoying the new facilities including the renovated toilets. Furthermore, the SBS receives black and gray water from the neighboring monks' dormitory in the Khoualuang Temple. The SBS to be constructed in a large dormitory, for instance, the Pakpasak Technical College as proposed in the Pre-F/S, would be effective for improvement of water environment. Some extended SBSs, which treat not only their own wastewater but also wastewater from neighboring communities, would be more effective.

(3) Sustainable Extensibility of Environmental Education

Environmental education has been made in a community of Thongkhankham Village and the Khoualuang Primary School in relation to the construction of CBS and SBS. Considering deterioration of surface water at present mainly due to domestic wastewater inflow without any treatment, water environment is closely influenced by the daily life of residents. Thus enhancement of people's awareness for conservation of their environment could strongly boost improvement of the environment. In this context, proper combination of continuation of the above enhancement and implementation of structural improvement works are crucial.

The remaining issue was how to keep the sustainability and extensibility of the educational works in the communities, after completion of pilot project of environmental education. It may be physically difficult to continuously hold workshops in each community, so that its sustainability also will not be secured in future. Meanwhile, some sustainable extensibility can be expected in environmental education in the primary schools due to strength of governmental organization.

- The Department of Education (DOE) in Vientiane, as the top organization, well organized the education office in the districts, and the primary schools in the district are managed by the office. In principle one primary school is placed in one village, so that the results of environmental education could possibly be conveyed from pupils to parents.
- After technology transfer on the side-reader of environmental education and the methodologies of education to the district education offices, workshops shall be held in the district offices for the teachers concerned. This process could contribute to enhance people's awareness in environment through their children.

In parallel with this kind of steady efforts, more sustainable extensibility of people's environmental awareness could be practically attained through site visit to improved water and canals by the improvement projects.

CHAPTER 4. DRAFT MASTER PLAN FOR WATER ENVIRONMENT MANAGEMENT

Basic Approach and Composition of the Master Plan

The master plan has been formulated, taking into consideration the interactions among the plan components; namely, (1) structural water environment improvement plan; (2) institutional and legal improvement plan; and (3) environmental education/hygiene education promotion plan.

In the structural water environment improvement plan, the future development scenario describes how the water environment changes in the target year 2020 based on the projected rapid urban development. To cope with water quality deterioration, alternatives include cases of (1) environmental deterioration without any actions, (2) conventional sewage treatment approach; and (3) realistic wastewater treatment measures, for selection of the optimum strategy. Alternative (3) has been selected as the optimum strategy through such comparative study as minimum cost, easy maintenance and operation, future sustainability and expandability of technology to the other urban areas, considering the compliance with future socioeconomic development in Vientiane.

Structural Water Improvement Plan

There are two distinct seasons; the dry and wet seasons. The most urgent issue in the water environment is water quality deterioration in the dry season, since domestic wastewater is directly discharged without any treatment through the open sewer system in Vientiane. Water pollution in the dry season could be regarded as one of the serious urban environment improvement issues of Vientiane.

The master plan proposes comprehensive countermeasures in accordance with causes of pollution and applicability of countermeasures. These are mainly (1) administrative instruction to control highly polluted effluents from the slaughterhouses in Hong Wattay in particular; (2) installation of simple small-scale wastewater treatment plants with local interceptors along the drainage canals of Hong Pasak, Hong Khoua Khao and others; (3) installation of in-stream treatment plant along the bank of Nong Chanh against highly polluted water of Hong Thong; and (4) sanitary improvement in individual house or community level through installation of CBS or septic tank at the time of rebuilding or building ne houses. These countermeasures for sanitation and water environment improvement shall be carried out parallelly in an integrated manner toward the target year 2020.

Institutional and Legal Improvement Plan

Various international donors, such as ADB and SIDA, proposed or finalized several kinds of policy measures for water environmental conservation including environmental education, environmental information, national land use plan, and public expenditure policy in addition to direct regulation. There are still needs to develop regulations and guidelines for effective and smooth implementation of various laws and bylaws established.

In the master plan, draft guidelines and regulations are proposed focusing on drainage management and sanitary improvement. The "Draft Guidelines of Wastewater Management of Vientiane City" includes promotion of septic tank installation, proper septage management accumulated in the Septic tank, effluent control of industrial wastewater, and proper management open sewer canal. On the other hand, the "Draft Regulations on Desludging/Hauling Business Control" describes the management of business for desludging/hauling of septage.

Environmental Education/Hygiene Education Promotion Plan

Actions only by administrative bodies are not enough for preventing deterioration of water environment due to wastewater discharged from Vientiane urban areas, which will cause irreversible destruction of the environment. Thus, it is aimed to make citizens (in particular community people and children) able to take part in water environment conservation by cooperating with administrative bodies through raising awareness on environment conservation by environmental education.

Targeting pupils in a primary school and general residents in the communities, environmental education activities has been made in parallel with the pilot project of construction of community/school based sanitation (CBS and SBS). Based on the experiences conducting the above pilot projects, the master plan proposes the following virtuous cycle: (1) distribution of side-readers prepared the study to the related urban districts: (2) conducting TOT (training of trainers) for primary school' teachers and afterwards carrying out curriculum-based environmental education to their pupils; and (3) enhancement of people's awareness on environment through parent-child dialogue.

4.1 Planning Considerations

4.1.1 Setting Framework for the Target Year (2020)

(1) Population Increase and Expansion of Urban Area

The population in Vientiane has been projected up to 2020, keeping consistency with that of the "Preparatory Survey on Industrial Zone Development in the Lao People's Democratic Republic, Progress Report, 2009, JICA" (hereinafter referred to as the "Preparatory Survey on Industrial Zone"), which increases at slightly less than 3% steadily.

Table 4.1.1 Population Projection in Vientiane

Year	2005[1)]	2006	2007	2008	2009	2010	2011	2012
Population (000 Person)	692	713	734	755	778	801	825	849
Year	2013	2014	2015	2016	2017	2018	2019	2020
Population (000 Person)	874	900	927	955	983	1,013	1,043	1,074

Note: [1)] Population in 2005 is a data from Statistic Survey.
Source: Preparatory Survey on Industrial Zone Development in the Lao People's Democratic Republic, Progress Report, 2009, JICA

Population distribution or difference in population density can be an indicator of urbanization of the area. The following figures show the population density of the villages located in the Study Area in 2005 and 2020.

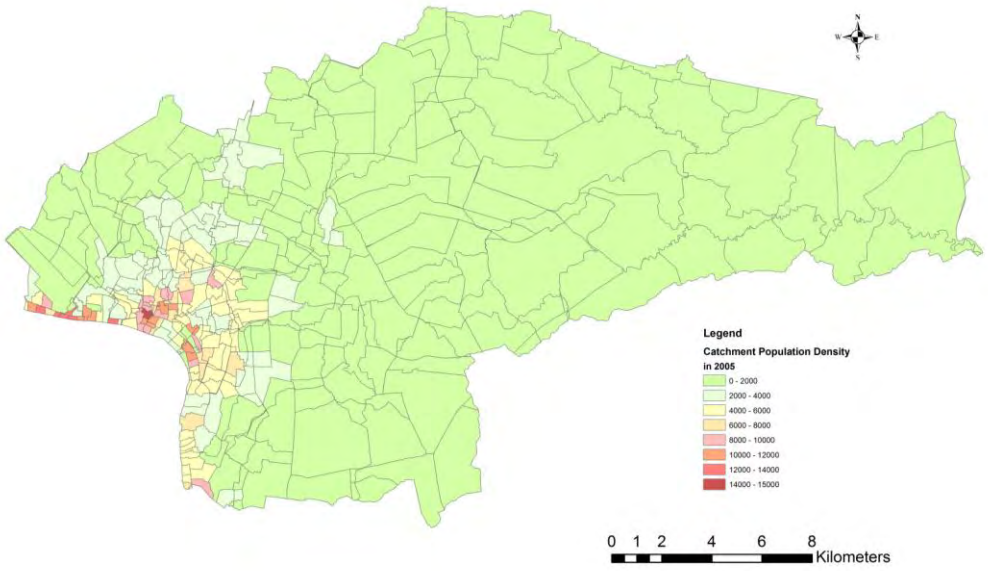


Fig. 4.1.1 Population Density in the Study Area in 2005

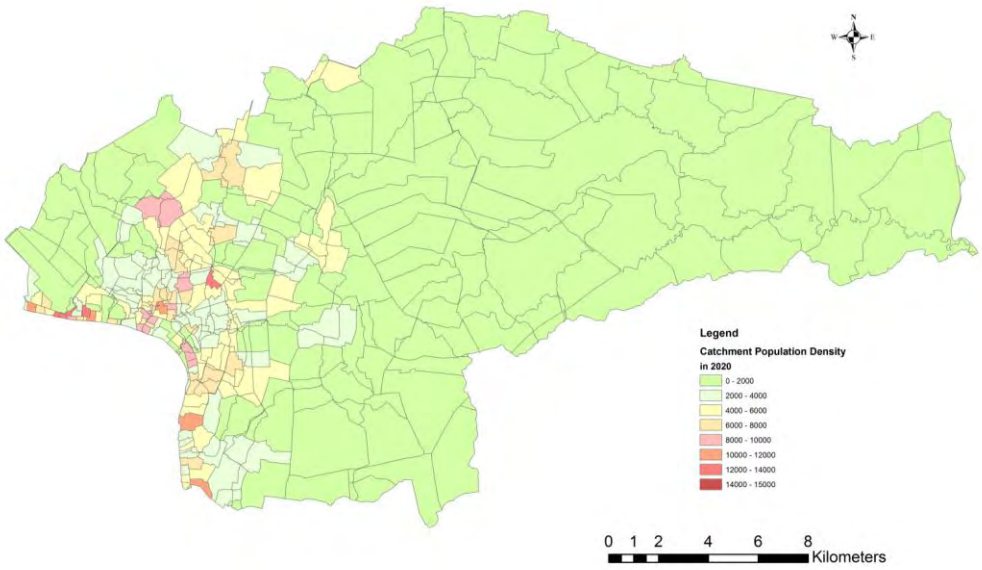


Fig. 4.1.2 Population Density in the Study Area in 2020 (Projection)

By comparing the above two figures, it can be said that the high density area, which is a city center, will expand outward especially along the Hong Xeng.

(2) Economic Development of Vientiane

The Gross Regional Domestic Product (GRDP) shows the scale of economic activities of the area. It is estimated that GRDP in Vientiane increases not only in terms of amount but also in terms of the share in the country, according to the "Preparatory Survey on Industrial Zone." Situations of Vientiane as the capital are expected to be more important and significant in the future.

Table 4.1.2 Estimated GRDP in Vientiane

(Unit: constant in 2008 price, billion KIP)

Year	2008	2009	2010	2011	2012	2013	2014
GDP	46,215	49,449	52,908	56,610	60,571	64,809	69,344
GRDP in Vientiane	10,574	11,391	12,272	13,220	14,242	15,343	16,529
Share	22.9%	23.0%	23.2%	23.4%	23.5%	23.7%	23.8%
Year	2015	2016	2017	2018	2019	2020	
GDP	74,196	79,575	85,344	91,531	98,167	105,284	
GRDP in Vientiane	17,807	19,176	20,650	22,238	23,948	25,789	
Share	24.0%	24.1%	24.2%	24.3%	24.4%	24.5%	

Source: Preparatory Survey on Industrial Zone Development in the Lao People's Democratic Republic, Progress Report, 2009, JICA

GDP/GRDP shows the scale of the economy or its impact while per capita GDP/GRDP shows economic development or pecuniary richness. The estimation of per capita GRDP of Vientiane can be made with the data in **Tables 4.1.1** and **4.1.2**. It increases at 4.5% to 4.7% annually. It is generally thought that consumption of each person increases as the economy develops. It means that the consumption of the Vientiane people is expected to increase and environmental load per person is also expected to increase.

Table 4.1.3 Estimated Per Capita GRDP in Vientiane

(Unit: constant in 2008 price, thousand KIP)

Year	2008	2009	2010	2011	2012	2013	2014
GRDP per capita	14,005	14,641	15,321	16,024	16,775	17,555	18,366
Growth Rate	-	4.5%	4.6%	4.6%	4.7%	4.6%	4.6%
Year	2015	2016	2017	2018	2019	2020	
GRDP per capita	19,209	20,080	21,007	21,953	22,961	24,012	
Growth Rate	4.6%	4.5%	4.6%	4.5%	4.6%	4.6%	

Source: Preparatory Survey on Industrial Zone Development in the Lao People's Democratic Republic, Progress Report, 2009, JICA

4.1.2 Projection of Water Quality for the Target Year (2020)

Water quality of Mak Hiao River basin for the target year 2020 is projected using the water quality model constructed in the section 2.5.

(1) Pollution Load Generation in 2020

Table 4.1.4 and **Fig. 4.1.3** show pollution load generation in 2020 by category, with the values of 2009 as a reference. As shown in **Table 4.1.4,** total pollution load generation in 2020 reaches 45,081 kg/day (1.43 times of 31,485 kg/day in 2009). By category, pollution load of domestic and commercial accounts for 26,186 kg/day or 58.1% of the total, followed by livestock, 17,245 kg/day or 38.2%. Industrial pollution load (1,040 kg/day) is generated from Vientiane Industrial Park out of the total industrial load of 1,340 kg/day.

Table 4.1.4 Pollution Load Generation by Category (2009 and 2020)

		Pollution Load Generation (kg/day)		(2)/(1)
		2009 (1)	2020 (2)	
1	Domestic	16,326	22,451	1.38[1)]
2	Commercial	2,441	3,735	1.53[1)]
3	Industrial	300	1,340	4.47
4	Livestock	12,107	17,245	1.42
5	Non-point	309	310	1.00
	Total	31,485	45,081	1.43

Note [1)] The value of (2)/(1) for commercial is bigger than that of domestic, because the number of people to which the drinking water is serviced by pipe-pile increase year by year (in this Study, the commercial wastewater is supposed to originate from the area where the drinking water is supplied by pipe-line.).

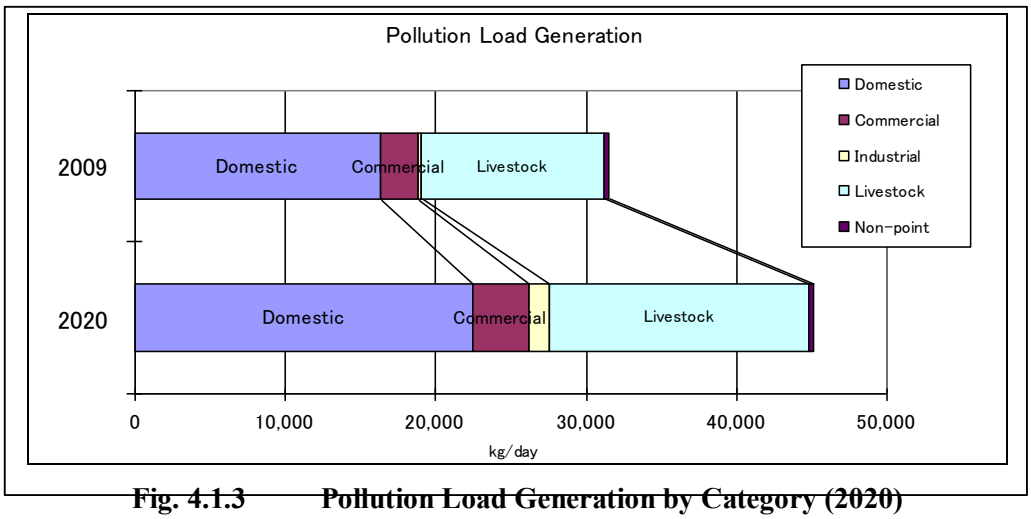


Fig. 4.1.3 Pollution Load Generation by Category (2020)

Pollution load generation by basin is shown in **Table 4.1.5.** Total pollution load in Hong Ke and Hong Xeng basins accounts for 12,700 kg/day or 28.2% of the total, indicating that the basins remain a major pollution source in Mak Hiao River basin. By category, Hong Ke and Hong Xeng are dominated by domestic and commercial load (Hong Xeng: 86.1%, Hong Ke: 91.9% of the total).

Pollution load from other areas are also big in amount (32,381 kg/day), but considering the pollution load by category, large portion (49.3%) of the load are generated from livestock (see **Table 4.1.6**).

Table 4.1.5 Pollution Load Generation by Basin (2020)

Basin	Area (km^2) 2020	Pop. (person) 2020	Pop. density (per./km^2) 2020	BOD load (kg/d)		Percentage (%)	(2)/(1)
				2009 (1)	2020 (2)		
Hong Xeng	**56.6**	**163,852**	**2,896**	**7,574**	**10,106**	**22.4**	**1.33**
- Nam Pasak	30.4	47,077	1,548	2,378	3,070	6.8	1.29
- Wattay	9.3	33,698	3,630	1,877	2,281	5.1	1.22
- Pasak	2.2	10,931	4,891	759	616	1.4	0.81
- Others	14.6	72,146	4,929	2,561	4,139	9.2	1.62
Hong Ke	**9.5**	**44,173**	**4,631**	**2,900**	**2,594**	**5.8**	**0.89**
Other areas	346.8	290,897	839	21,011	32,381	71.8	1.54
Total	412.9	498,922	1,208	31,485	**45,081**	100.0	1.43

Table 4.1.6 Pollution Load Generation by Basin and Category (2020)

Basin	Upper: Pollution load (kg/day), Lower: Percentage (%)					
	Total	Domestic	Commer-cial	Industrial	Livestock	Natural Pollutant
Hong Xeng	10,106	7,373	1,324	300	1,066	42
	(100.0)	*(73.0)*	*(13.1)*	*(3.0)*	*(10.5)*	*(0.4)*
- Nam Pasak	3,070	2,118	273	0	655	23
	(100.0)	*(69.0)*	*(8.9)*	*(0.0)*	*(21.3)*	*(0.8)*
- Wattay	2,281	1,516	303	300	154	7
	(100.0)	*(66.5)*	*(13.3)*	*(13.2)*	*(6.8)*	*(0.2)*
- Pasak	616	492	98	0	24	2
	(100.0)	*(79.9)*	*(16.0)*	*(0.0)*	*(3.9)*	*(0.2)*
- Others	4,139	3,247	649	0	232	11
	(100.0)	*(78.4)*	*(15.7)*	*(0.0)*	*(5.6)*	*(0.3)*
Hong Ke	2,594	1,988	398	0	202	7
	(100.0)	*(76.6)*	*(15.3)*	*(0.0)*	*(7.8)*	*(0.3)*
Others	32,381	13,090	2,013	1,040	15,977	260
	(100.0)	*(40.4)*	*(6.2)*	*(3.2)*	*(49.3)*	*(0.9)*
Total	45,081	22,451	3,735	1,340	17,245	310
	(100.0)	*(49.8)*	*(8.3)*	*(3.0)*	*(38.3)*	*(0.6)*

(2) Projection of Water Quality Deterioration from 2009 toward 2020

The projection of water quality change is shown in **Fig. 4.1.4** with BOD values of 2009 and 2020. Water quality in 2020 is projected under the condition of "No action" (in "No action", only natural increase in septic tank installation rate is assumed).

Compared to that in 2009, the water quality in 2020 worsens in the entire basin. In particular, BOD exceeds 30 mg/l in almost the entire Hong Ke and Hong Xeng basins mainly due to increase of runoff coefficient as a result of expected secondary drainage improvement works. At the middle-stream of Mak Hiao River (MP4 and MP5), BOD ranges from 8.5 to 8.6 mg/l, almost double of 2009's. The water quality deterioration at the stretch is brought about by the

deterioration in Hong Ke and Hong Xeng basins, as well as treated water discharged from large-scale development area such as Vientiane Industrial Zone. On the other hand, at the downstream end of Mak Hiao River (MP6), BOD remains about 3 mg/l mainly due to the purification function in the downstream stretch of Mak Hiao River.

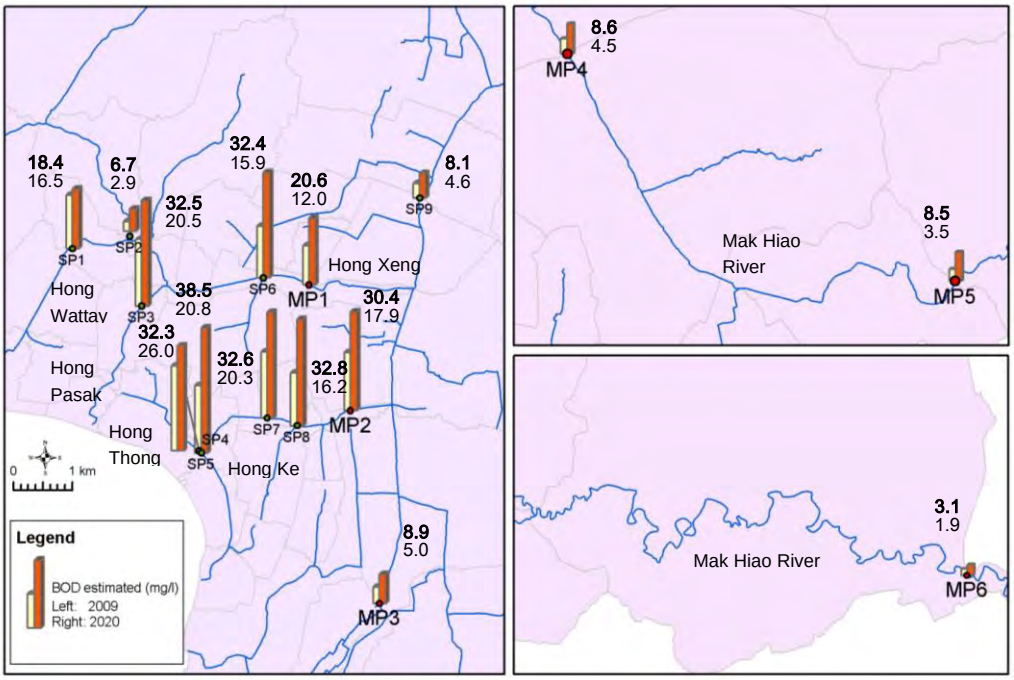


Fig. 4.1.4 Projection of Water Quality Change from 2009 toward 2020

4.1.3 Present and Future Issues for Improvement

Various issues related to water environment have been encountered in the course of the study. It is crucial to clarify them for smooth preparation of the improvement strategy and master plan in water environment. Based on the survey results and future projections, improvement issues in water environment are categorized into technical and institutional areas, and are summarized below.

(1) Water Environment in the Study Area

(a) Present and Future Water Environmental Conditions in Urban Drainage System

The surface water along the urban drainage canals has been deteriorating mainly due to domestic organic pollutants. Furthermore, it would much worsen in future according to the simulation results. Among the urban drainage canals, water quality in Hong Thong and Hong Pasak, which receive wastewater discharge from the urban center of Vientiane, is seriously deteriorated. Their BOD values are 20 to 30 mg/l at present. In future, the more worsened BOD concentrations exceeding 30 mg/l could be projected in the entire stretches of urban drainage system covering Hong Ke and Hong Xeng.

(b) Aquatic Lives in Urban Drainage Canals

The urban drainage canals are combined open sewers conveying both rainwater and wastewater generated in the urban areas of Vientiane. They consist of two major systems: 1) starting from Hong Wattay and Hong Pasak connecting to Hong Xeng: and 2) starting from Hong Thong and Hong Khoua Khao connecting to Hong Ke. These two drainage systems finally empty into the That Luang Marsh.

Various fishes go upstream through these canals in the rainy season, and people enjoy fishing and catching fishes using a net, being not so much popular as in previous times. Conserving the still existing rich water environment for future generations and improving the water environment could be an urgent issue since fishes could make their habitat even in the dry season.

(c) Prevention of Concrete Covering on the Drainage System

Hong Thong receives wastewater and rainwater from the most congested areas of Vientiane similar to Hong Pasak. Hong Thong joins with Hong Khoua Khao near the Nong Chanh Marsh, and changes its name to Hong Ke. Hong Thong has been covered with concrete slabs in almost all its stretch. Although this kind of measure is one of the alternatives to make people look away from offensive odor and deteriorated scenery of worsened water quality, the difficulties of improvement on water environment will come out due to invisibility of existing conditions on water quality and inability of conducting improvement works and monitoring their effects. Conducting the possible improvement measures on the water environment in a step-by-step manner would rather be recommended than removing the deteriorated environment from the urban residents.

(d) Sanitary Conditions in Community and Household Level

In order to clarify the actual sanitary conditions in individual houses of Vientiane, a pre-feasibility study was conducted under the master plan study in 2010. In parallel, rapid assessment was also conducted under WSP (Water and Sanitation Program) of WB (World Bank) for similar purposes. The survey results revealed that more than 95% of households and buildings in the survey areas had installed their sanitary facilities of septic tank or soak pit. They also, however, made it appear that maintenance works of desludging of septage was not properly and periodically done. In addition, these facilities receive only night soils so that domestic wastewater has been discharged without any treatment, resulting in the major source of water contamination in the canals.

One CBS (Community-Based Sanitation) was constructed in the urban village as a pilot project under this master plan study. As the result of the pilot project as well as the pre-feasibility study, the possibility of further expansion of coverage by such CBS facilities could not be found in the urban area of Vientiane due to high installation ratio of individual sanitation facilities and difficulties of securing the lands for installation of CBS.

(e) Conservation of Marshes/Wetlands

Wastewater discharged from the urban areas flows down through the drainage system, and empties into the That Luang Marsh. The Mak Hiao River receives the surface water from the marsh, runs through the Na Khay Marsh and various pondage stretches, and finally joins the Mekong mainstream. Due to natural purification functions of wetlands and ponds along the river course and dilution of natural runoff and irrigation tail water, BOD of 3 mg/l is computed at the rivermouth of Mak Hiao even in 2020. It could be regarded as still good water quality.

The rapid urbanization, however, has been progressing in/around the That Luang Marsh so that the marsh areas and their functions shall be conserved from the land use planning of Vientiane. Furthermore, remaining marshes in the urban areas, such as Nong Chanh, Nong Ping, Nong Bo, and Nong Tha, shall be conserved as well. Unless such conservation measures take place, similar process, in which various wide marshes had existed in the past have been reclaimed to the urban areas, would occur in the remaining marshes mentioned above.

(2) Issues on Institution/Regulation and Implemetation System in Water Environment Management

(a) Weakness of Institutional Management on Environment

Capability of institutions is not sufficient for proper management not only on water environment but also on entire environment. This might be due to shortage of practically experienced staff in the central government as well as local governments, and budgetary constraints for governmental services on water quality monitoring and drainage maintenance. Furthermore, unless capability on water quality testing is strengthened in WERI-WREA, WERI would lose its reputation as the center of environment management in Lao PDR.

(b) Development Needs on Regulations and Guidelines

International donors such as SIDA and ADB assisted improvement and establishment of environmental legal system; basic laws and important bylaws. Furthermore, additional administrative instructions and guidelines shall be prepared for smooth implementation and effective regulation based on these laws.

(c) Necessity of Practical Water Quality Standard

Present surface water quality standards stipulate that BOD concentration shall be less than 1.5 mg/l in any surface water. Its level of BOD concentration would be over-strict for any kind of public water bodies. Requirements of water quality in the other countries are normally designated in accordance with usage of its water. If such standards would be established, various practical approaches could be applied for the improvements.

(d) Strengthening/Establishing Implementing/Coordinating Agencies for Integrating the Related Governmental Agencies and Donors/NGOs

There are various donors and NGOs as well as government agencies involved in the water environmental improvement activities. There is no integrative agency/organization to coordinate them focusing their activities on clear and concrete direction. This kind of organization or network is indispensable for comprehensive approach since wastewater management is reflected from socio-economic conditions and is complicated.

(e) Disclosure and Dissemination for Awareness Development of the People

To solve problems caused by general public, such as water quality deterioration by domestic wastewater, awareness of the people is very important. Disclosure of environmental information is the key to dissemination and public awareness on environment. Presently, there is no such organization or institution that can disclose enough information which people can easily access. Low awareness of the people will in turn become an obstacle to the appropriate and timely actions by the authorities.

4.2 Strategy on Water Environment Improvement

Based on the discussion on planning conditions and encountered issues in the preceding section, water environment improvement strategy shall be discussed in this section for formulation of the water environment master pan. Those are planning goal and objectives, water quality targets, and approach to solve the issues.

4.2.1 Goal and Objectives

(1) Goal

The National Urban Development Strategy and Investment Plan (NUDSIP) has the same target year 2020 as the water environment master plan. The NUDSIP vision is "*Lao PDR shall develop modern urban centers that are clean and beautiful, and that provide safe and secure living conditions, protect cultural heritage and architecture, and protect the environment and human health*." Supporting this vision, The Draft Urban Wastewater Strategy and Investment Plan (UWSIP), proposed the vision by 2020, "*Lao PDR shall manage the wastewater sector appropriately and provide good wastewater services to the urban population to protect human health and the environment and to facilitate social and economic development in urban centers*."

The water environment master plan should also support the above national visions and facilitate achievement of the preferable situations mentioned above. Thus the goal of the master plan shall be "***to support increased access to sustainable wastewater facilities and services in the urban areas of Vientiane Capital***" in line with the UWSIP Goal.

(2) Objectives

The target area of the water environment master plan is the Mak Hiao River basin which originates from the most congested area of urban center of Vientiane. Two trunk open combined sewer canals, which contain mainly domestic wastewater discharging from the urban center, empty into the That Luang Marsh. Taking such situations into account, the concrete objectives of the master plan can be enumerated as below.

- To conserve the existing water environment in the entire Mak Hiao River basin, in particular functional natural water purification in the That Luang Marsh, the Nakhai Marsh and lower reaches of the Mak Hiao River;
- To restore the lost water environment in the urban drainage canal system; namely, Hong Ke and Hong Xeng system, for conserving and increasing inhabitable environment of aquatic life along the canal system; and
- To treat the wastewater discharged from the urban households in Vientiane, as a dominant source of surface water deterioration, and to improve the water environment in the drainage canal system.

4.2.2 Overall Targets on Water Quality

(1) Water Quality Standards/Guidelines

In general, water quality criteria could be closely related to water usage (beneficial use), so that many countries established relationship between water usages and water quality classification in their water quality standards/guidelines. Water usages could be usually categorized into the following, in order of cleaner water quality.

- Public water;
- Fishery water;
- Industrial water; and
- Agriculture, irrigation and livestock water.

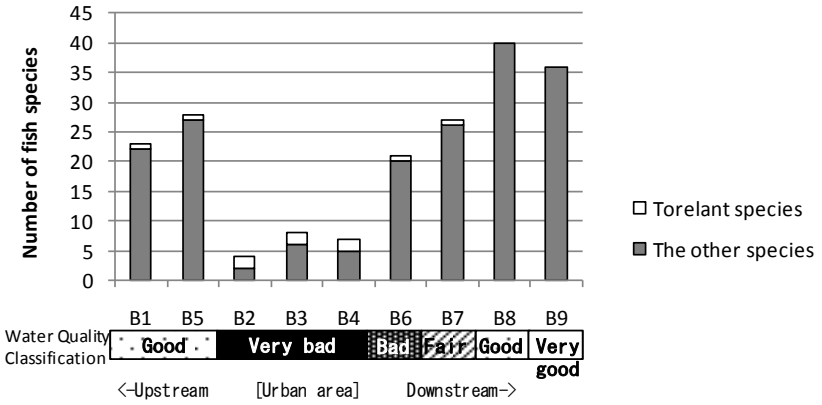
In due consideration of the situation of the study area for setting of the target water quality, fishery water could be most suitable for conservation of aquatic life as well as beneficial use to the study area of the Mak Hiao River basin. The following standards are typical water quality criteria for fishery in the Asian countries.

Table 4.2.1 Surface Water Quality Standards for Fishery in the Asian Countries

Country / Parameters	Japan	Philippines	Malaysia
Standards/Guidelines Name and Class	Environmental standards for conservation of living environment (Water quality in river) : Class C	Revised water usage and classification/water quality criteria : Class C	National water quality standards : Class III
Beneficial Use	Fishery for carp and crucian	Fishery water for the propagation and growth of fish and other aquatic resources	Fishery water to protect common and moderately tolerant aquatic species of economic value
BOD	≤ 5 mg/l	≤ 7 mg/l	≤ 6 mg/l
DO	≥ 5 mg/l	≥ 5 mg/l	≥ 3 mg/l
pH	6.5-8.5	6.5-8.5	5-9
SS	≤ 50 mg/l	-	≤ 150 mg/l

(2) Aquatic Biologic Survey Results

As tabulated above, the criteria in the Asian countries show suitable BOD for fishery water ranging from 5 mg/l to 7 mg/l. Meanwhile, the present conditions on existing fish species clarified through the aquatic biological survey are presented in **Fig. 4.2.1**, and the locations of the survey sites are depicted in **Fig. 4.2.2**. These figures indicate that numerous fish species make their habitat in the uppermost part and the lower part of the river system in which water quality monitored are observed also in fair to very good conditions.



Surey frequency: Eight times excepting B9. B9 is seven times since it was not explored in July 2009 due to high water level.

Fig. 4.2.1 Total Number of Fish Species Observed in Eight-times Survey from 2009 to 2010

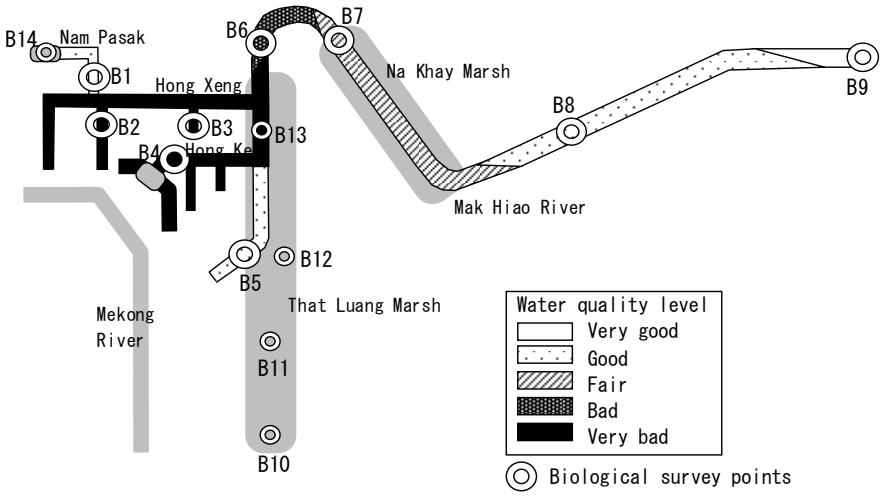


Fig. 4.2.2 Schematic Diagram of Water Quality Classification along the Mak Hiao River System

In addition, the following figure illustrates the relationship between water quality classification from aquatic biology and actual water quality monitoring results. The figure indicates that the water quality classification could be easily categorized using a parameter of BOD.

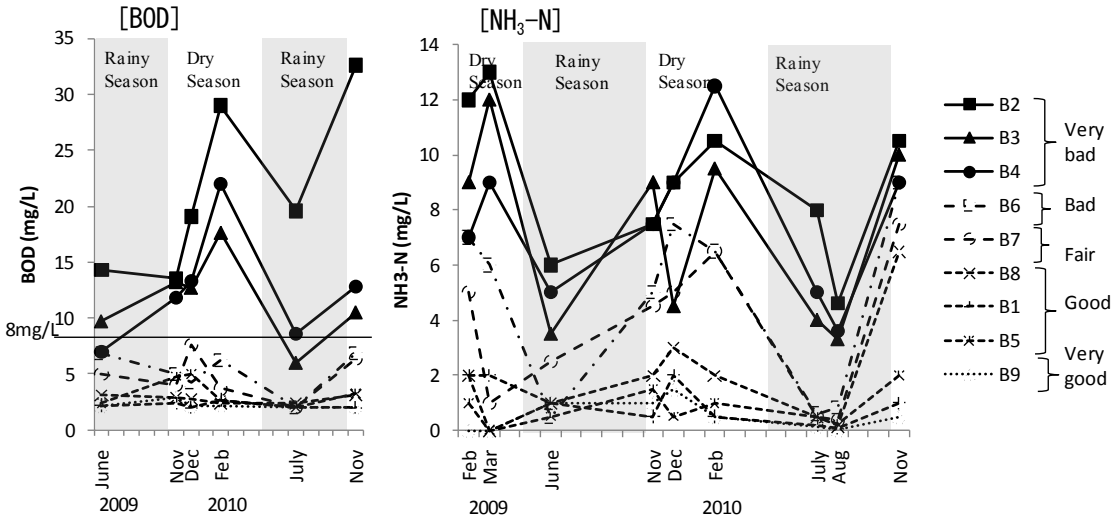


Fig. 4.2.3 Relationship between Water Quality Classification from Aquatic Biology Survey and Monitored Water Quality

(3) Water Quality Target

Since February 2009, the team had conducted water quality monitoring. No or trace amount below the criteria of toxic materials and heavy metals have been detected in the course of the monitoring. This fact indicates that industrial wastewater has no significant effect on the water contamination in the study area.

Furthermore, the domestic and livestock origin of the estimated BOD loads would be dominant sources in the target year 2020, and they are projected at 50.1% and 38.5% out of the total BOD loading, respectively. In other words, the organic pollutant is considered dominant in water deterioration in the Vientiane urban areas. Thus, BOD could be selected as a suitable indicator of water quality in the master plan.

Regarding planning targets of BOD, the following criteria of water quality shall be set up based on the water quality criteria in other countries as tabulated in **Table 4.2.1** and the aquatic biologic survey results as presented in **Figs. 4.2.1** to **4.2.3**.

Table 4.2.2 Planning Water Quality Target

River/Canal Stretch	Water Quality Requirements in BOD	Remarks
Down-most Stretch of Mak Hiao River (Near Rivermouth)	≤ 5 mg/l	Best requirement for fishery water
Middle Stretch of Mak Hiao including That Luang Marsh	≤ 8 mg/l	Allowable lowest requirement for sustaining fishery water
Urban Drainage System: Hong Xeng and Hong Ke	8 – 12 mg/l	Expected requirement for restoration of inhabitable environment for fish

Even though urban drainage system, Hong Xeng and Hong Ke, is combined open sewer to convey storm water and wastewater, water quality requirement should be set up to improve water environment through enhancement of water quality and to provide minimum habitats for coming-back fish species as well as existing ones. If these efforts could be successfully attained, the preferable urban water environment of drainage network would be restored as it had been previously.

4.2.3 Needs of Comprehensive Approach

There are several means of water environment management, which includes structural measures, bio-engineering measures and management practices in legal system and institutional mechanism. Structural measures are hardwares involving application of technologies and implementing infrastructures. Bio-engineering measures are the application of biological process and engineering in environmental enhancement. Management practices encompass non-structural approaches such as regulations, laws and institutional strengthening.

From viewpoints of physical process of wastewater generation through discharging it into public water body up to downstream end of river system, there are several institutions as well as several wastewater treatment facility mechanisms involved. Those institutions are building/house owners, sanitation, drainage and river administrators in institutions, while those facility mechanisms are on-site, communal and centralized wastewater treatment facilities, and natural purification by wetland and dilution by river stream flows. Numerous stakeholders are involved in water environment management process from its generation to the treatment end. Efforts must be applied not only by the governments but also by the private sectors and the communities as a whole, to restore the urban drainage system at least to the level of what it has been previously considered for its beneficial use. Thus comprehensive approach involving various measures and wider stakeholders should be taken in wastewater management for water environment improvement.

In addition to the management of water quality mentioned above, improvement works had been implemented for stormwater drainage by many donors including ADB from 1991 to 2008 following the JICA study in 1990, which is described in Section 2.4. As a result, situations have improved to the extent that damage due to drainage overflow does not occur in the rainy season. It can be said that the prevention of such inundation damage attributes the storage function and the flood retarding function of existing marshes mentioned in Subsection 2.4.2. It is required that existing marshes be conserved continuously from the viewpoints of water quality improvement and stormwater drainage. It is further preferable that future expansion of urban area outside Hong Ke and Hong Xeng drainage areas be accompanied with stormwater drainage system construction which is consistent with the city planning.

4.3 Alternative Study of Structural Water Improvement

4.3.1 Structural Alternatives

Structural measures are infrastructures meant to improve water quality, and there are various levels of wastewater treatment. These are possible options in waste water management scenarios. These are based on the results of the pilot project and the pre-feasibility study.

(1) On-site Wastewater Treatment

(a) Septic Tank and Soak Pit

Most of the residents and businesses in Vientiane manage their excreta (black water) by the septic tank or soak pit, as on-site sewage management. This fact has been clarified for the first time with a statistics-like methodology by the Pre-F/S of this Study and the Rapid Assessment of WSP, which were conducted almost parallelly in 2010. They revealed that 95 to 99% of households had some kind of human waste treatment facility. Septic tank is a traditional measure to treat wastewater on site over the world.

(b) Combined Individual Sewer System

Combined individual sewer system, "Johkaso" in Japanese, is commonly applied in Japan as a typical household excreta and domestic wastewater combining treating system. It is adopted in individual houses, housing estates and public facilities where public sewer system is not available. There are basically five functional chambers in a tank; namely, (i) sedimentation, (ii) anaerobic, (iii) aeration, (iv) storage and (v) disinfection. An anaerobic and aerobic combined biological process with high efficiency has been commonly employed as an on-site wastewater treatment system for over 30 years in Japan. Since initial costs for installation and operation/maintenance consts, which consist of electricity for aeration, chlorine dosing into disinfection and high frequency of desludging of septage, are considerable high, it might not be an appropriate technology for low-income households, but might be feasible as communal facility.

(2) Water Environment Improvement in Community Level

(a) CBS (Community Based Sanitation)

One of the options to deal with domestic wastewater is to treat it in community level in between on-site and centralized systems. It is called Decentralized Wastewater Treatment System (DEWATS). The DEWATS requires no energy input which has been the bane of conventional wastewater treatment systems. This system has an advantage of treating wastewater as close as possible to where it is generated and to where its potential beneficial reuse is located.

A typical system for domestic households basically consists of a primary treatment system of a settling and sedimentation tank, a secondary treatment system of an up-flow type baffled reactor which digests wastewater anaerobically. If extra space is available and high level treatment is required, it additionally has a tertiary treatment in subsurface horizontal flow through sand filters with reed beds, and finally a polishing pond for oxygenation and UV disinfection from the sun's rays.

Since the baffled reactors work anaerobically, sludge production is minimal and desludging is needed only if excess sludge is generated. The quality of treated wastewater that emerges into polishing pond is good enough for landscape applications. DEWATS can attain 80 to 85% reduction in BOD and COD, 80% reduction in Phosphates and 60%

reduction in ammonia. (Source: Materials prepared by BORDA. An example is shown in http://www.borda-sadc.org/)

Suitable areas for CBS are the communities with very poor sanitary environment, where they cannot install human waste treatment facilities such as toilets. At the beginning, it was expected that CBS could be applied to communities due to the scarcity of information on prevalence of sanitary facilities in urban areas of Vientiane. As mentioned in (1) On-site Wastewater Treatment, however, the prevalence of sanitary facilities such as septic tank is so high that it can be concluded that application of CBS to urban areas is difficult since the needs of sanitary improvement in communities are low. In addition, these existing urban areas are almost privately owned so that it is difficult to acquire the area for CBS.

On the other hand, CBS can be still applicable enough to the communities in newly developed suburban areas where enough space is available, as well as public buildings including schools and dormitory houses, for the purpose of sanitation improvement.

(b) Local Wastewater Treatment System

Even though the installation ratio of sanitary facilities is high, its effect is limited to storing and treatment of night soils, and domestic wastewater is discharged into the public water bodies, in particular drainage canals, without any treatment. This process is a major cause of water quality deterioration. The secondary drain system such as roadside drain is already installed, and conveys wastewater to the trunk drainage canals. The maintenance of the secondary drains, however, is poor so that stagnant water could often be seen at various places inside of the town.

Based on the above situation, decentralized wastewater treatment approach in the local level could be proposed such as intercepting the wastewater at the outlets of secondary drains. The feasibility was examined in the pre-feasibility study as an alternative measure of CBS. As the results of the study, the possibility of wastewater treatment from the secondary drains through installation of small-scale interceptors and construction of simple treatment plants like CBS mainly utilizing the public lands along the canals was clarified.

(3) Centralized Wastewater Treatment System

(a) Combined Sewer System and Wastewater Treatment Plant

Wastewater in many places flows through storm drains. In a combined sewer system, two types of wastewater treatment approaches could be proposed.

In the first type, the wastewater conveyed through canals will be pumped up to the treatment plant and treated water will be discharged back to the canals. The treatment plant is normally constructed at the downstream end, and water volume shall be determined from the dry-season flow. Thus surface water quality in the canals will not be improved until the the water is treated in the treatment plant.

In the second type, the wastewater will be intercepted just before discharge into trunk canals, and the intercepted wastewater will be conveyed to a treatment plant. In the dry season, most of the flow is wastewater. Combined trunk or main sewers are designed to convey storm water of around 2-year return period. Intercepting sewers or interceptors, built for the purpose of diverting wastewater from the trunk sewer to treatment plants, are

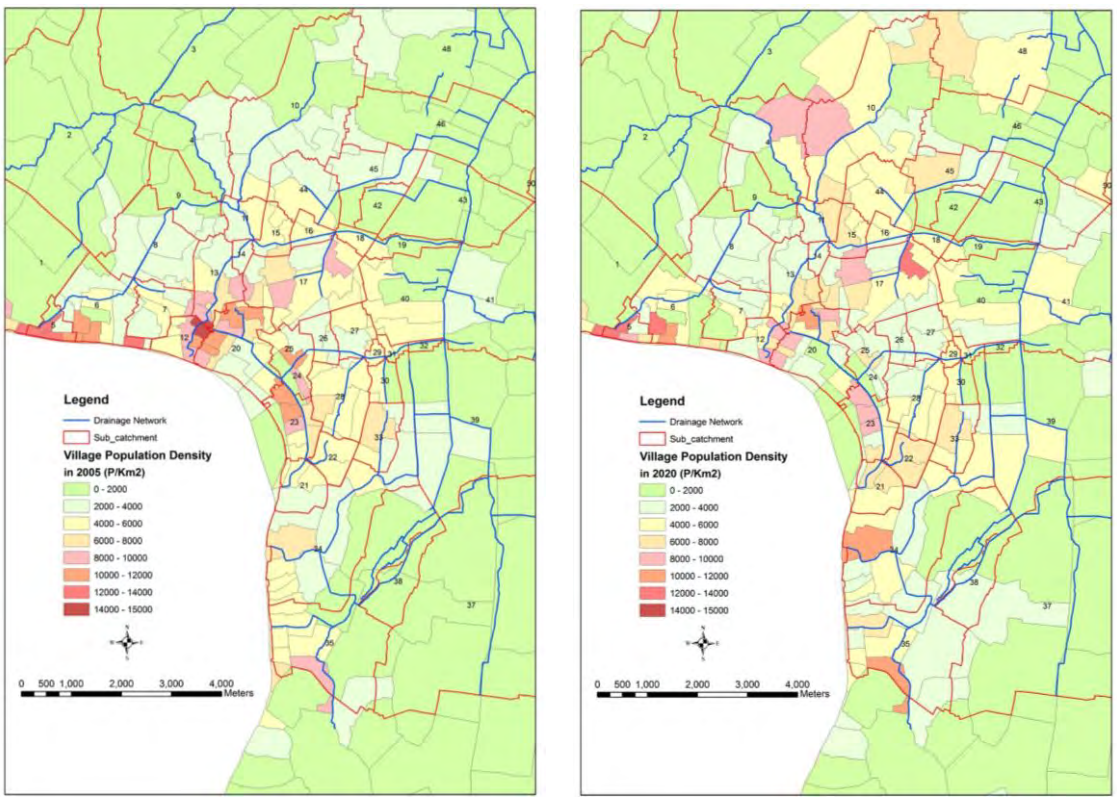
commonly designed for two to four times the average dry-season flow rates. In this approach, a new issue on the dry-up of canals will arise in the dry season.

(b) Conventional Sewerage System

The conventional sewerage system includes household connections, conveyance pipeline, lift stations if necessary, and sewage treatment plant. In the conventional sewerage system, water is necessary to transport the waste to the treatment plant. Reliable water supply and a consumption of 100 l/capita/day or more are basic requirements for problem free operation of conventional sewerage systems. Conventional sewerage is not appropriate for small communities. Often, storm water is mixed with wastewater, thus resulting in the need for larger treatment works. The centralized management removes the wastewater several distances from the generation area to the treatment plant. This practice significantly increases the cost. In addition, wastewater must be often pumped from various drainage basins to the central treatment plant through long and large trunk sewers. In this approach, a new issue on the dry-up of canals will also arise in the dry season.

4.3.2 Combination of Structural Alternatives

Based on the above considerations, the combination of possible structural measures shall be considered as alternatives in suitable space and time. In the first step, the study area shall be categorized into spatial differences, such as built-up area, new large-scale development area, rural-type aggregated community, and rural villages. **Fig. 4.3.1** depicts the existing and projected population density by village in 2005 and 2020.



Year 2005 Year 2020

Fig. 4.3.1 Existing and Projected Population Density by Village in the Urban Area of Vientiane

From this figure the study area could be concretely categorized into three areas for the planning as follows:

(i) Hong Ke and Hong Xeng drainage area: Urban areas as built-up areas and surrounding rural-type aggregated community;
(ii) Large-scale development areas: Vientiane Industrial Zone and New City Development; and
(iii) Others: Newly expanded built-up areas, rural villages.

The suitable structural measures for wastewater treatment shall be selected in accordance with an expected future urbanization pattern classified by the above-mentioned town/village types. For the next step, the planning time frame shall be considered step-wise, that is, (1) until the year 2020 as the master plan target; and (2) 10 to 20 years after the master plan target as the long-term target. There are two types of step-wise improvement works as follows:

(i) To continue the selected measures beyond the target year 2020; and
(ii) To upgrade the selected measures in parallel with economic growth; for instance, septic tank to individual sewer system, and wastewater treatment plant in combined sewer system to conventional centralized sewerage system.

Based on the above spatial and temporal divisions, the applicable structural measures are as tabulated below. This is based on the idea that the environmental foundation of a city shall be changed according to the characteristics of the land at the time of new construction and renewal of houses in a long run. It can be paraphrased as follows:

(1) Built-up area: CBS construction shall be promoted in the area where sanitary facilities such as toilet are not enough and extra space is available. For the areas where extra space is not available, septic tank shall be promoted at the time of new construction and renewal of houses in a short-time and *jokaso* shall be promoted in a long-time with the assumption that the society would be affluent.

(2) Rural-type aggregated community: For rural agricultural communities, where houses are scattered, on-site treatment facilities shall be basically promoted. Septic tank shall be promoted at the time of new construction and renewal of houses in a short-time and *jokaso* be promoted in a long-time.

(3) Newly expanded built-up area and rural villages: Same as above.

In terms of drainage canal, two alternatives, namely, centralized type and decentralized type, are proposed and compared.

Table 4.3.1 Possible Structural Alternatives

Mak Hiao River Basin		Alternatives in time frame	
Divided area	Sub-areas	M/P (Until the year 2020)	10 – 20 years after M/P
Hong Ke and Hong Xeng drainage areas	Storm water drainage		
	Remaining marshes & drainage canal system	Conservation and improvement of remaining marshes for flood retarding	Canal improvement for increasing draining capacity, if necessary
	Wastewater management		
	Built-up area	(1) Installation of wastewater treatment plant in combined sewer system	(1) Construction of conventional centralized sewerage system, if necessary
		(2)-1 Villages with available spaces and without proper sanitation facilities: installation of CBS (2)-2 Villages without available spaces: installation of septic tank at the time for rebuilding or newly building	(2)-1 Villages with available spaces and without proper sanitation facilities: installation of CBS (2)-2 Villages without available spaces: installation of combined individual sewer system at the time for rebuilding or newly building
	Rural-type aggregated community	Installation of septic tank at the time for rebuilding or newly building	Installation of combined individual sewer system at the time for rebuilding or newly building
	Drainage canal	(1) Introduction of centralized treatment facility Construction of treatment plants with combined sewer system	Construction of conventional type of treatment plants (if necessary)
		(2) Introduction of decentralized treatment plants - Installation of decentralized simple treatment plants with interceptors - Installation of in-stream contact aeration treatment facilities - Application of vegetation measures for strengthening natural purification functions	
	Conservation of existing marshes	Conservation of remaining marshes in drainage areas including Nong Bo, Nong Tha, Nong Chanh (conservation of natural purification function as well as flood retarding mentioned above)	
New large-scale development	Industrial estate and new city development	Storm water drainage	
		Construction of storm drainage system	
		Wastewater management	
		Construction of wastewater treatment facilities at the downstream end of the developing areas or inside the individual factories	
Other areas	Newly expanded built-up area	Storm water drainage	
		Construction of storm drainage system, if necessary	
		Wastewater management	
		Installation of CBS or septic tank at the time for rebuilding or newly building	Installation of combined individual sewer system at the time for rebuilding or newly building
	Rural villages	Wastewater management	
		Installation of septic tank at the time for rebuilding or newly building	Installation of combined individual sewer system

4.3.3 Comparative Study on Alternatives with Water Quality Simulation

Based on the possible structural alternatives tabulated in **Table 4.3.1**, the feasibility shall be examined focusing on the urban drainage system of Hong Ke and Hong Xeng, since other areas have no significant alternatives except for septic tank or CBS application or wastewater treatment plants in the large-scale development areas, and good water quality is still predicted in the lower reaches of the Mak Hiao River. Hence, the comparative study shall be made in the following manner:

- Structural alternatives shall be set in the urban drainage system, Hong Ke and Hong Xeng.
- Evaluation of effects on water quality shall be made in the entire basin encompassing the urban drainage basin to the Mak Hiao rivermouth.
- The natural water purification functions shall be preserved in the development projects for the existing remaining marshes of Nong Bo (in the Nong Ping Development Area) and Nong Tha.

Vientiane is now promoting a development plan for Nong Ping and a Vietnamese developer is promoting a development plan for Nong Tha. The JICA Study Team had to consult with Vientiane and the counterparts on conserving the existing waterfront and at least preventing quality deterioration of water outflowing from the area. Therefore, this study assumes that the quality of wastewater outflowing from both development areas would not deteriorate from the present level.

The comparative study process is summarized below. The comparative study results based on the simulation model described in Section 2.5 are tabulated in **Table 4.3.2** and illustrated in **Fig. 4.3.2**. In addition, the summary of each alternative is as presented at the end of this section.

As to treatment method, standard sewage treatment such as the activated sludge method is not suitable, considering the water quality of more or less 30 mg/l in BOD in Hong Ke and Hong Xeng basins projected in 2020. Rather more applicable is 1) combined sewer systems collecting wastewater through existing lateral drains and main drainages, and treatment systems such as contact aeration method with some biofilm, considering not so high BOD values projected for 2020, or 2) decentralized system consisting of interceptors and simplified treatment facilities using anaerobic treatment method combined with treatment facilities using contact aeration method. Thus, the following alternatives are proposed.

- Alternative 1: Construction of wastewater treatment plants (contact aeration facilities) using existing combined sewer system

- Alternative 2: Construction of decentralized simplified treatment systems and construction of in-stream contact aeration facilities

In Alternative 1, three wastewater treatment plants (contact aeration facilities) shall be installed at the lower reaches of Hong Pasak, Hong Kai Keo, and Hong Ke. These three plants collect wastewater using existing drainage canals.

(1) No Action

If all of the sectors concerning wastewater do not take any action to improve water environment, it indicates how the water quality represented by BOD will deteriorate in the target year 2020. In other words, the future water quality conditions without improvement are simulated in this case. Compared to the present water quality, the ~~"n~~o action" option would make it worse in the entire stretch far above the target BOD.

(2) Alternative 1

This alternative is the conventional way to install wastewater treatment plants to introduce wastewater into the plants utilizing the existing combined sewer system. This improvement might be the fastest way among the installation of plants. The lower reaches of Hong Pasak, Hong Kai Keo, and Hong Ke are possible points for the construction of treatment plants considering the deteriorated quality of water to be treated and the possibility of land acquisition. Since BOD of the target wastewater is more or less 30 mg/l, the contact aeration type treatment facility would be appropriate, which is assumed to reduce 70% of the pollution load. Furthermore, administrative guidance shall be made by the Department of Industry and Commerce of Vientiane, applying the Regulation of Industry Wastewater and the Water Quality Standards to install wastewater treatment facilities against highly polluted wastewater discharged from slaughterhouses in Hong Wattay. Although the results of simulation meet the target BOD in lower stretch of the plants, water quality in the upper reaches will exceed the target BOD due to the nature of sewerage treatment and the utilization of existing combined sewer system.

(3) Alternative 2

This alternative is to cope with water environmental deterioration in accordance with the characteristics of wastewater sources and the particular features of the canals. This alternative is composed of the following measures:

- Hong Wattay: the same as Alternative 1, installation of wastewater treatment facilities against highly polluted wastewater discharged from slaughterhouses through administrative guidance by the Department of Industry and Commerce of Vientiane;
- Hong Pasak: installation of local interceptors and simple wastewater treatment plants along the canal to treat the domestic wastewater inflow;
- Hong Khoua Khao, Hong Kai Keo, Hong Ouay Louay and Hong Phone Thanh: similar manner as in Hong Pasak, utilizing the available spaces along the canal; and
- Hong Thong: construction of in-stream wastewater treatment plant utilizing the open space of south bank of the Nong Chanh Marsh, by pumping up wastewater from the canal.

The structural countermeasures which make up the above alternatives and the drainage areas to be covered by the measures are tabulated in the following table. Although CBS is constructed where it is possible in principle, septic tank is firstly considered for the countermeasures for the convenience of consideration.

Regarding suitable type of contact media for contact aeration type facilities proposed, string type of contact media was selected due to advantages against clogging of generated sludge, based on the experiences through various substantive tests in Japan.

Table 4.3.2 Outline of Alternatives

No	Area	Drainage Area	Counter-measure Works	Alternative	
				1	2
1	Hong Ke and Hong Xeng area	Hong Ke	Major facilities	Contact aeration plant - Downstream end of Hong Ke	Decentralized treatment system - Hong Khoua Khao - Hong Ouay Louay - Hong Phone Thanh Contact aeration plant - Downstream end of Hong Thong
			Septic tank	Installation rate: 95%	
2		Hong Xeng	Major facilities	Contact aeration plants - Downstream end of Hong Pasak - Downstream end of Hong Kai Keo	Decentralized treatment system - Hong Pasak - Hong Kai Keo
			Septic tank	Installation rate: 95%	
3	Other areas	Newly expanded built-up area	Septic tank	Installation rate: 95%	
4		New large scale development area	Major facilities	Sewage Treatment Plant installed by the developer	
5		Rural villages	Septic tank	Installation rate: 95%	

Water quality simulation results are shown in **Table 4.3.3** and **Fig. 4.3.2** for Alternative 1, 2 and No Action. The simulation result for present conditions is also shown in **Table 4.3.3**. "No action" here means that the natural increase in septic tank installation is only assumed.

As shown in **Table 4.3.3**, in the mainstream of the Mak Hiao River, although water quality deteriorates compared with the present situation, no big difference in BOD values can be found in both Alternatives, indicating that BOD values are generally 9 mg/l or less in all the reaches due to natural purification effects of the Mak Hiao River. On the other hand, in the drainage areas of Hong Ke and Hong Xeng, BOD values exceed 20 mg/l for No Action, with the maximum 31.6 mg/l at the downstream end of Hong Pasak. Alternative 1 shows a high effect at the downstream end of Hong Ke. Both alternatives achieve almost the same effect at the downstream end of Hong Xeng.

Table 4.3.3 Results of Comparative Analysis

Alternatives	Outfall of Urban Drainage System				Mak Hiao River			
	Hong Wattay	Hong Pasak	Hong Xeng	Hong Ke	That Luang Marsh Downstream End	Na Khay Marsh Upstream End	Na Khay Marsh Downstream End	Rivermouth
Target BOD	8-12				8			5
Present	16.0	19.7	11.7	17.2	4.6	4.5	3.5	1.9
No Action	18.6	31.6	20.1	29.1	8.1	8.6	8.5	3.1
Alternative 1	11.0	9.0	10.0	8.3	5.3	6.6	7.5	2.9
Alternative 2	11.0	11.4	10.2	11.2	5.5	6.7	7.5	2.9

Unit: mg/l
Present: Simulation results under the conditions in 2009
Alternative 1: Construction of contact aeration plants in the downstream ends of Hong Pasak, Hong Kai Keo and Hong Ke
Alternative 2: Installation of small-scale wastewater treatment plants and in-stream contact aeration plant in the downstream ends of Hong Thong

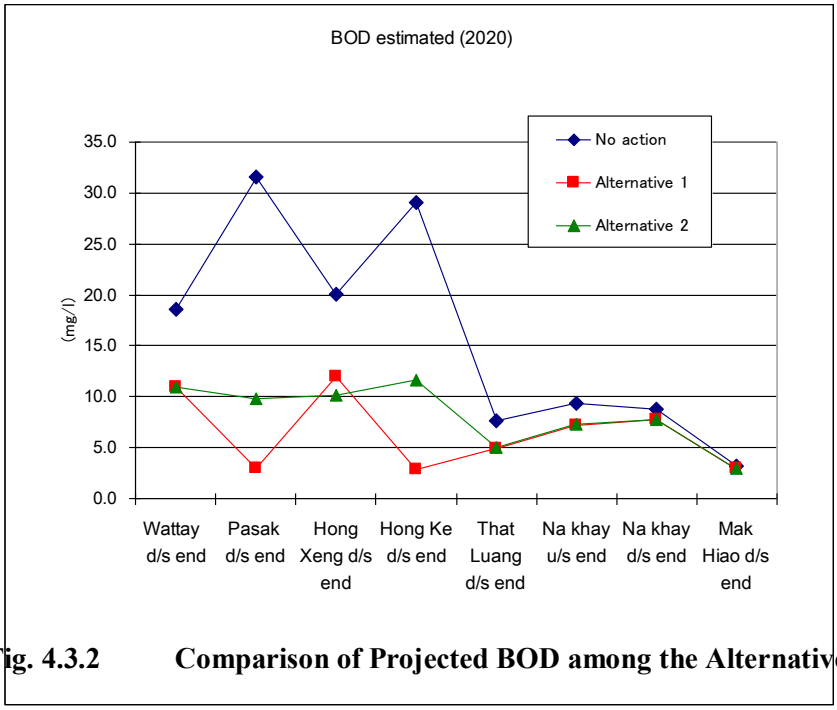


Fig. 4.3.2 Comparison of Projected BOD among the Alternatives

4.3.4 Preliminary Facility Plan of Alternatives and Comparative Study

(1) Facility Specifications of Alternatives

Facility specifications are summarized for Alternative 1 and 2 as follows.

(a) Alternative 1

Outlines of three contact aeration plants in Alternative 1 are shown in **Tables 4.3.4** and **4.3.5**. The contact aeration plant consists of 1) grit chamber and pump, 2) contact aeration reactor, 3) sedimentation tank, and 4) vegetation pond. The size of the plant shall be planned based on the maximum daily wastewater volume. Sludge accumulating in the reactor shall be desludged and be transported to the dumping site for human waste by a vacuum truck.

Construction sites are farmland at the downstream end of drainage canals for Hong Pasak and Hong Kai Keo, and the land which is presently used by the EU pond for Hong Ke. Plan views of the three plants are shown in **Figs. 4.3.3** to **4.3.5** with the conditions mentioned above. The typical cross section of the contact aeration plant is shown in **Fig. 4.3.6**.

Table 4.3.4 Facility Specifications of Alternative 1 (Basic Specifications)

Drainage Canal	Population		Wastewater		BOD			Sludge volume (m^3/d)
	Total	Treated	daily avg. (m^3/d)	daily max. (m^3/d)	in (mg/l)	out (mg/l)	removal rate (%)	
Pasak	10,931	10,931	2,230	2,973	31	9	70	1.170
Ke	44,173	44,173	9,012	12,016	31	9	70	4.727
Kai Keo	16,499	16,499	3,366	4,488	31	9	70	1.766
Total	71,603	71,603	14,608	19,477				7.663

Table 4.3.5 Facility Specifications of Alternative 1 (Specifications of Contact Aeration Plant)

Drainage Canal	Wastewater daily max. (m^3/d)	Pumphouse & Grit Chamber			Contact Aeration Reactor					
		Width (m)	Length (m)	Area (m^2)	Width (m)	Length (m)	Depth (m)	No.	Volume (m^3)	HRT (hr)
Pasak	2,973	19.5	9.5	185	4.5	68.0	2.5	4	3,060	24.7
Ke	12,016	79.5	9.5	755	4.5	69.0	2.5	16	12,420	24.8
Kai Keo	4,488	39.5	9.5	375	4.5	51.0	2.5	8	4,590	24.5

Drainage Canal	Sedimentation Tank					
	Width (m)	Length (m)	Depth (m)	No.	Volume (m^3)	HRT (hr)
Pasak	19.5	15.5	2.5	1	756	6.1
Ke	79.5	15.0	2.5	1	2,981	6.0
Kai Keo	39.5	11.5	2.5	1	1,136	6.1

Drainage Canal	Vegetation Pond				
	Width (m)	Length (m)	Depth (m)	No.	Area (m^2)
Pasak	19.5	14.5	1.0	1	283
Ke	79.5	14.5	1.0	1	1,153
Kai Keo	39.5	14.5	1.0	1	573

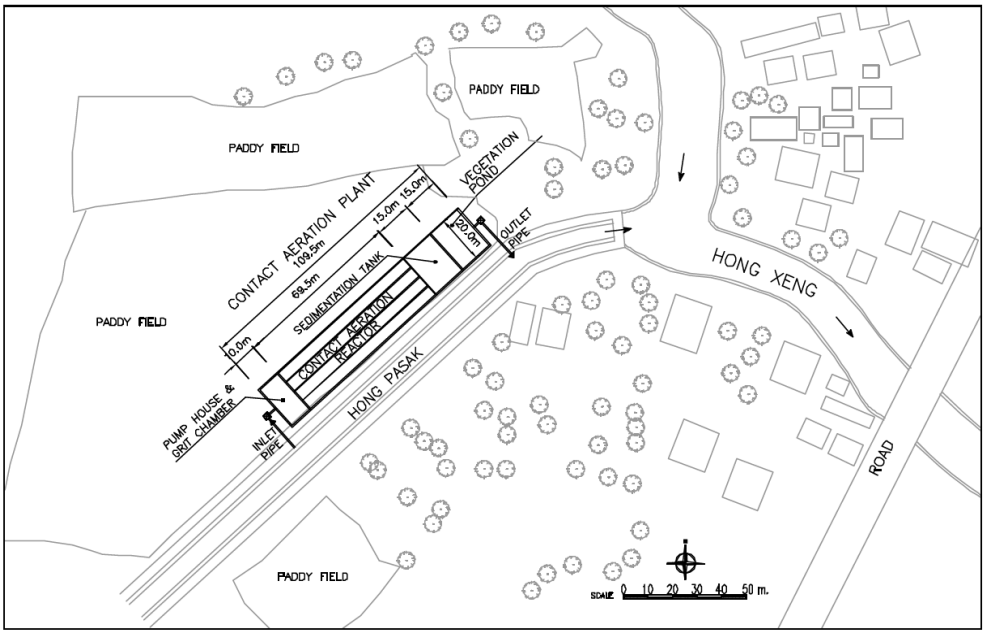


Fig. 4.3.3 Plan of Contact Aeration Plant at Downstream End of Hong Pasak

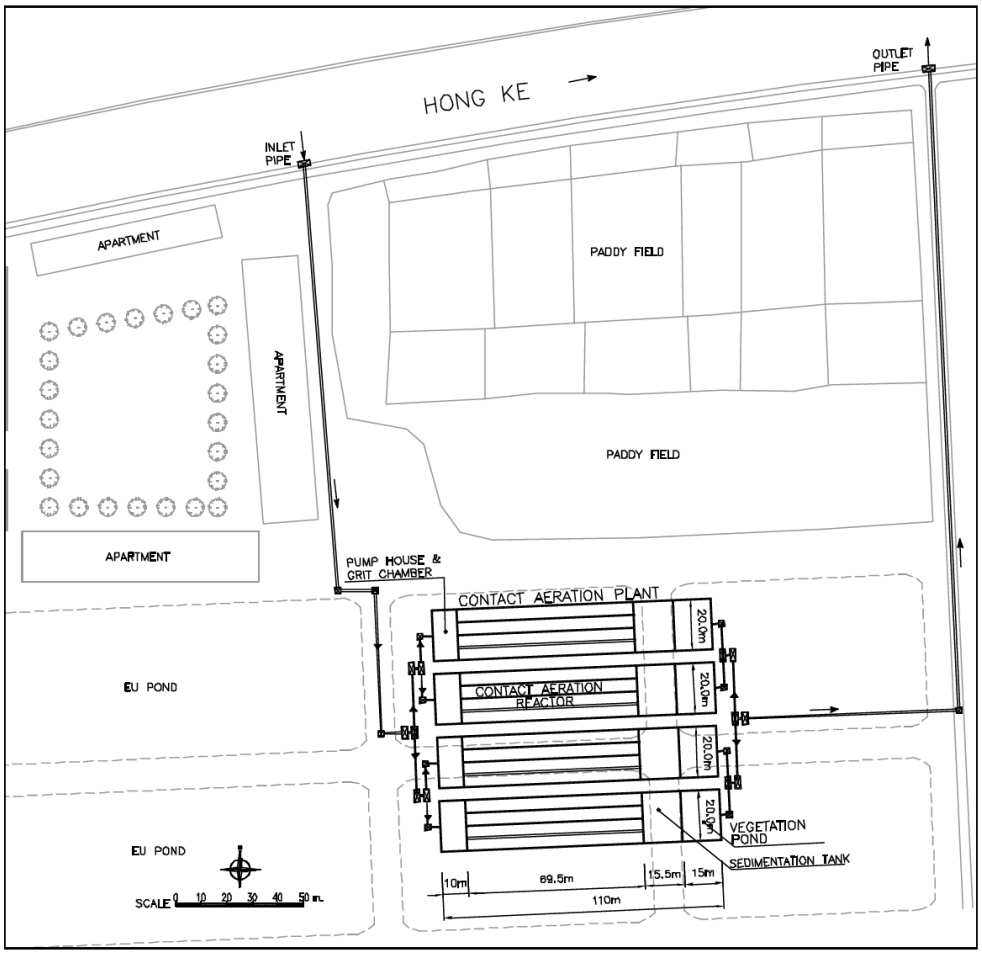


Fig. 4.3.4 Plan of Contact Aeration Plant at Downstream End of Hong Ke

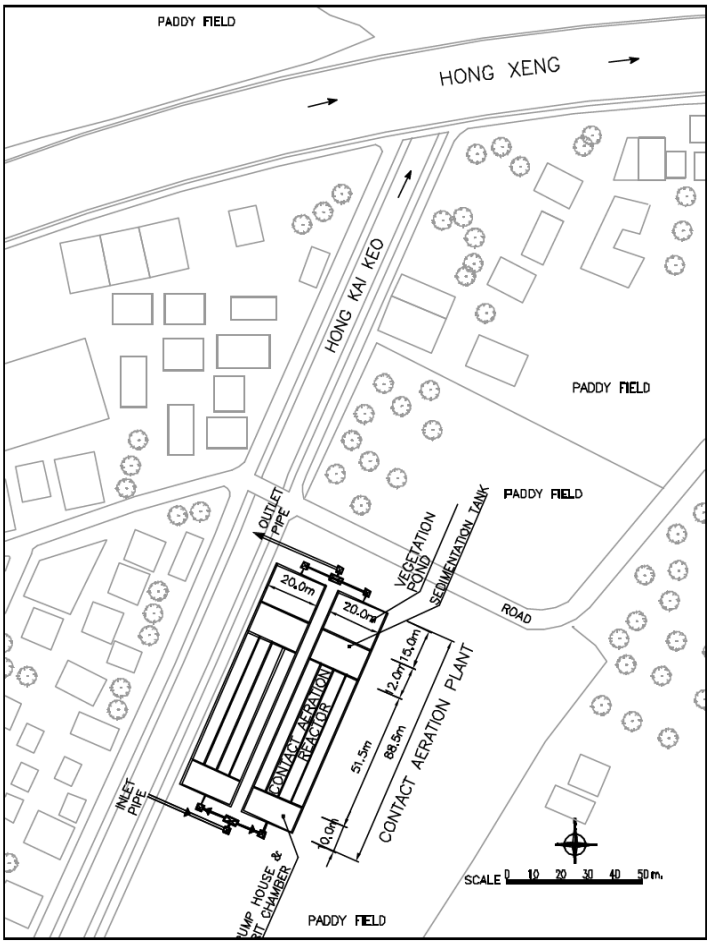


Fig. 4.3.5 Plan of Contact Aeration Plant at Downstream End of Hong Kai Keo

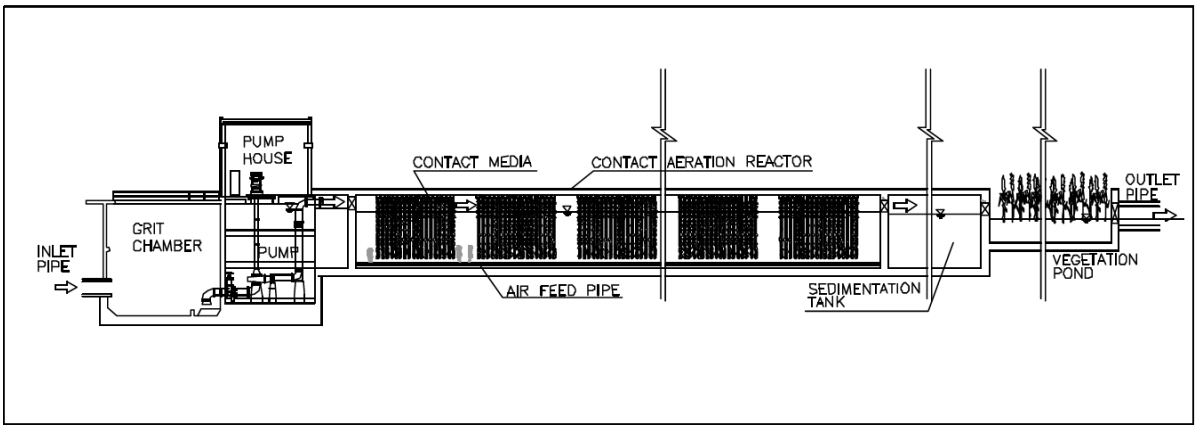


Fig. 4.3.6 Typical Cross Section of Contact Aeration Plant

(b) Alternative 2

Specifications of decentralized treatment systems and in-stream contact aeration plants in Alternative 2 are shown in **Tables 4.3.6** and **4.3.7**. The size of the plant shall be planned based on the maximum daily wastewater volume. Sludge accumulating in the reactors of

decentralized treatment systems and contact aeration plants shall be transported to the dumping site for human waste by a vacuum truck.

Detailed explanation and plan/cross section of the decentralized treatment system at the upstream of Hong Pasak are presented in **Chapter 5, Pre-feasibility Study**. One example is shown in **Fig. 4.3.7**. Further, only the served populations are shown for decentralized treatment systems at the downstreams of Hong Pasak, Hong Kai Keo, Hong Khoua Khao, Hong Ouay Louay and Hong Phone Thanh, since their drainage areas are outside of the target area of the Pre-feasibility Study.

In addition, components of the decentralized treatment system are same as described in 4.3.1(2)(a) CBS' and it includes until secondary system in it. A removal rate is set at 70 % so that field check through proper monitoring will be necessary after completion of the facilities. If the removal rate will not be satisfactory, tertiary treatment in subsurface horizontal flow through sand filters with reed beds and a polish pond for oxygenation and UV disinfection from sun's rays should be additionally installed.

Plan of in-stream contact aeration facility at the end of downstream of Hong Thong is shown in **Fig. 4.3.8** with the conditions mentioned above. The typical cross-section of the contact aeration plant is the same as shown in **Fig. 4.3.6**.

Table 4.3.6 Facility Specifications of Alternative 2 (Basic Specifications)

	Total Population	Name of Plant	Population treated	Wastewater		BOD			Sludge Volume (m^3/day)
				Daily Avg. (m3/d)	Daily Max. (m3/d)	In (mg/l)	Out (mg/l)	Removal Rate (%)	
1. Wastewater Treatment Plant (anaerobic treatment plant)									
Pasak upstream	4,254	T1	585	101	135	31	9	70	0.015
		T2	293	59	79	31	9	70	0.009
		T3	182	37	49	31	9	70	0.005
		T4	244	50	66	31	9	70	0.007
		T5	247	50	67	31	9	70	0.007
		T6	159	32	43	31	9	70	0.005
		T7	98	20	26	31	9	70	0.003
		T8	308	62	83	31	9	70	0.009
		Total (T2-T8)	1,531	310	413				0.045
		Others	-	60	80	31	9	70	0.009
	Sub-total		2,116	471	628				0.069
Pasak downstream	6,677	-	3,172	647	863	31	9	70	0.095
Kai Keo	16,499	-	8,250	1,683	2,244	31	9	70	0.247
Khoua Khao	16,011	-	8,006	1,633	2,177	41	12	70	0.316
Ouay Louay	7,800	-	3,900	796	1,061	31	9	70	0.117
Phone Thanh	1,525	-	763	156	208	21	6	70	0.016
Sub-Tota l	52,766		26,207	5,386	7,181				0.860
2. Contact Aeration Plant									
Hong Thong	10,342	-	10,342	2,110	2,813	31	9	70	1.107
Total			36,549	7,496	9,994				1.967

Table 4.3.7 Facility Specifications of Alternative 2 (Specifications of Contact Aeration Plant)

Drainage Canal	Wastewater Daily Max. (m^3/d)	Pumphouse & Grit Chamber			Contact Aeration Reactor					
		Width (m)	Length (m)	Area (m^2)	Width (m)	Length (m)	Depth (m)	No.	Volume (m^3)	HRT (hr)
Hong Thong	2,813	19.5	9.5	185	4.5	64.5	2.5	4	2,903	24.8

Drainage Canal	Sedimentation Tank					
	Width (m)	Length (m)	Depth (m)	No.	Volume (m^3)	HRT (hr)
Hong Thong	19.5	14.5	2.5	1	707	6.0

Drainage Canal	Vegetation Pond				
	Width (m)	Length (m)	Depth (m)	No.	Area (m^2)
Hong Thong	19.5	14.5	1.0	1	283

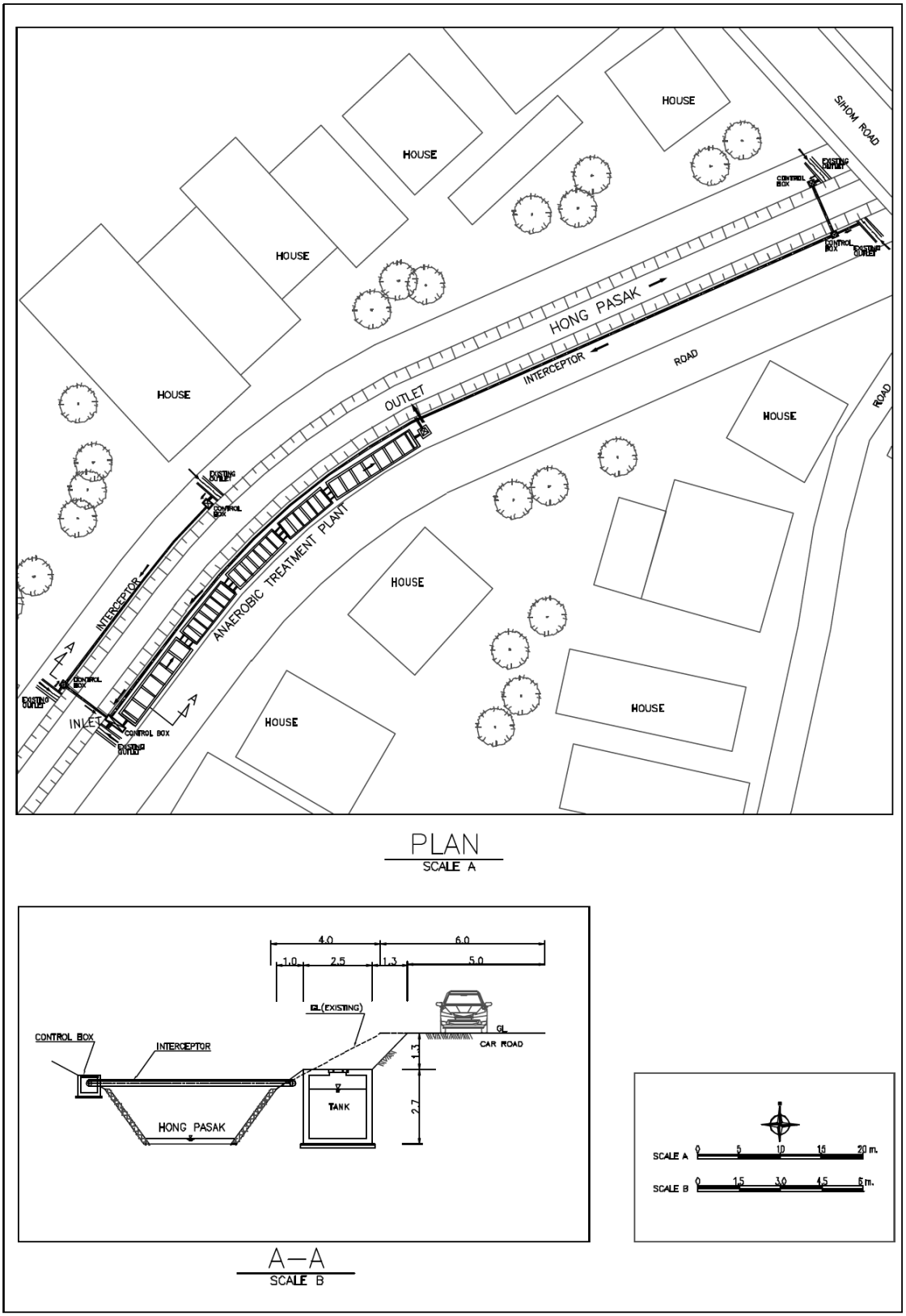


Fig. 4.3.7 Example of Decentralized Treatment System (T5) (Plan and Typical Cross-Section)

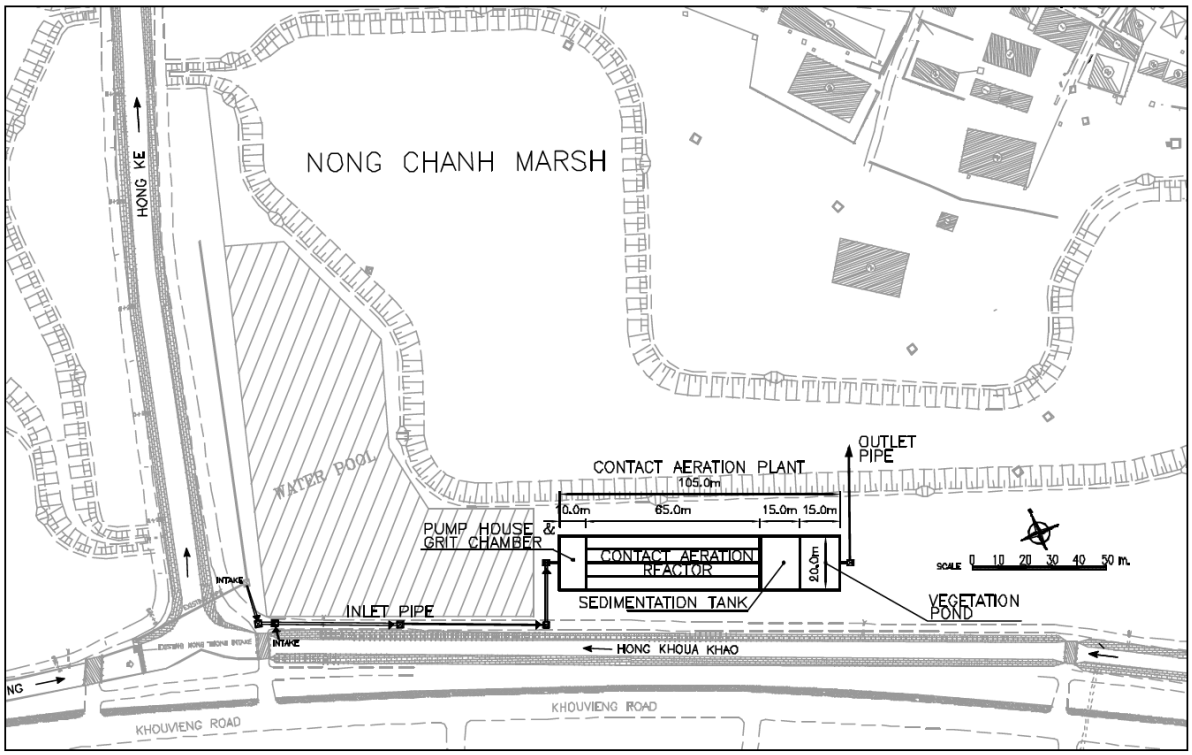


Fig. 4.3.8 Plan of Contact Aeration Plant for Canal at Nong Chanh Marsh

(2) Cost Estimates

Cost estimates and yearly O&M cost of the two alternatives are shown in **Table 4.3.8**. Alternative 1 is highest in terms of both construction cost and O&M cost.

Construction cost for Alternative 1 includes that of sewerage treatment plants (contact aeration method) including discharge pumping stations. For Alternative 2, construction cost includes decentralized treatment systems along the canals and in-stream contact aeration plants at the end of downstream of Hong Thong.

As for O&M cost, Alternative 1 includes electricity cost for the operation of contact aeration plants, as well as sludge disposal cost. Alternative 2 includes sludge disposal cost accruing from decentralized treatment plants and in-stream contact aeration plants as well as electricity cost for the operation of contact aeration plant.

Table 4.3.8 Cost Estimation for the Alternatives

	Construction Cost (Mil. US$)			O&M Cost (Mil. US$) per year		
	Decentral-ized system	Contact aeration	Total	Decentral-ized system	Contact aeration	Total
Alternative 1	-	21.86	21.86	-	0.17	0.17
Alternative 2	14.65	3.07	17.72	0.01	0.03	0.04

Since the details of the governmental budget were not obtained, no detailed financial analysis could be conducted. It can be said, however, that it is difficult for the government to bear the construction cost, considering other project cases. Thus, it should be expected that the construction cost be covered by a foreign donor. On the other hand, burden of O&M cost on a household and the percentage to its total income were calculated, assuming that the polluters (treatment target residents) should pay the O&M cost shown in the following table.

Table 4.3.9 Comparison of O&M Costs to Treatment Target Household for the Alternatives

	O&M Cost for 1 month (KIP)	% of Total Income for O&M Cost
Alternative 1	9,120	0.18
Alternative 2	4,160	0.08

(Note)
Median of total monthly income of household in urban area: 5,000,000 KIP (Source: Pre-F/S of this Study)
O&M cost of Alternative 1: US$ 0.17 million per year
Population in the drainage basins of the facilities in Alternative 1: 72,000 persons
O&M cost of Alternative 2: US$ 0.04 million per year
Population in the drainage basins of the facilities in Alternative 2: 37,000 persons
Average household size in Urban Area: 5.8 (Source: National Statistical Center, Lao Expenditure and Consumption Survey 2002/03. 2004)
9,120 (KIP/household/month) = 1.14 (US$//household/month) = 0.17 (US$ million) ÷ (72,000 ÷ 5.8) (households) ÷ 12 (months)
4,160 (KIP/household/month) = 0.52 (US$//household/month) = 0.04 (US$ million) ÷ (37,000 ÷ 5.8) (households) ÷ 12 (months)

According to the World Bank, benchmarks of household's maximum affordability for water supply and sewerage services are 4% and 1% of the services' disposable income respectively. A household spends 0.35% of its total income for desludging its toilet according to the "Rapid Assessment of Household Sanitation Services in Vientiane City" by WSP [See Subsection 5.2.6(4)]. Thus, its cost for the sum of wastewater charge (the O&M cost) and the desludging cost of its toilet amounts to 0.53% (= 0.18% + 0.35%) in Alternative 1 and 0.43% (= 0.08% + 0.35%) in Alternative 2 of its total income. It can be presumed that this can fully be borne by a household, considering the average household.

(3) Comparative Study on Alternatives

Comparative study results are summarized in the following table and Alternative 2 is considered the most recommendable option for appropriate direction of water environment improvement in Vientiane. The decentralized simple wastewater treatment plants could improve surface water in the stretches required to improve their water quality in the drainage system, and their operation and maintenance could be much easier than the others. Furthermore in-stream treatment facilities could improve the local water quality in a certain stretch if the site space is available.

Table 4.3.10 Comparative Evaluation among the Alternatives

Evaluation Item	Alternative 1 Sewage Treatment Plants	Alternative 2 Decentralized Simple Treatment Plants & In-stream Treatment Plant
(1) Initial Cost	High	CA: Low
(2) O&M Cost	High	CA: Low
(3) Easiness of O&M	Experience is required for O&M	Contact aeration type is the same with Alternative 1. O&M is easy for simple treatment facility but it would become complicated when the number of installation is increased.
(4) Effects on Water Environment	It only improves water quality at downstream part of the plants but does not contribute to that at upstream.	CA: Improvement of water quality over the entire drainage stretch
(5) Sustainability	It requires mass of land. Land acquisition should be made in advance.	CA: O&M is easy and its space is spared along the canals (canal area). High sustainability is expected for the future; it can be constructed where it is required.
(6) Necessity of technology transfer to other areas/canals and its expandability	Technology transfer of small type of contact aeration treatment facility is necessary; contact medium which can be acquired locally should be developed.	CA: Contact aeration type is the same with Alternative 1. Technology transfer of a simple treatment facility including CBS/SBS is necessary and its expandability is high.
(7) Others	It is time taking and costly process to install lateral piping system over the drainage basin, if upgrading the separated sewerage system.	CA: Relatively short time is necessary for completion of system installation.
Overall Judgment	Low advantage at present	High advantage

Note: CA: Comparative Advantage

Fig. 4.3.9 illustrates water quality predictions among the status at present, with no-action and with the optimum plan in future.

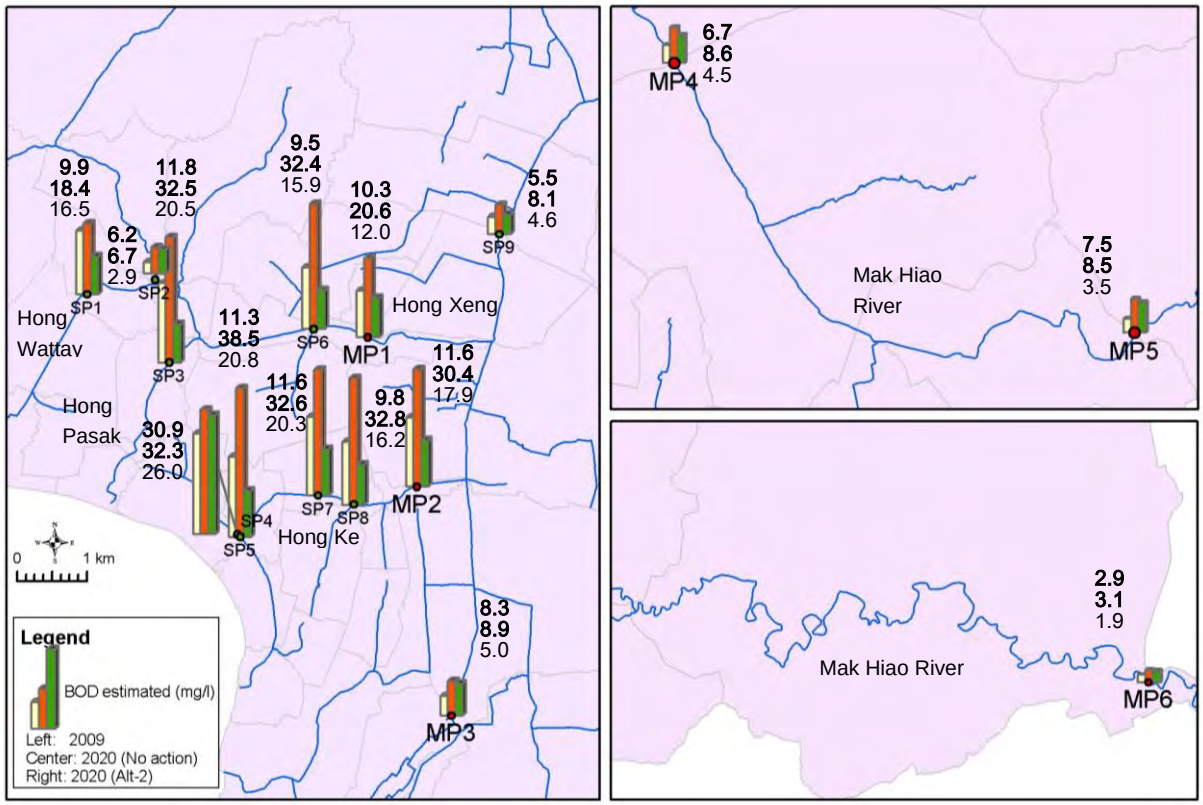


Fig. 4.3.9 Projected BOD at Present, with No-Action in Future, and with Optimum Plan in Future

Alternative 1

Treatment Facilities (Newly constructed)

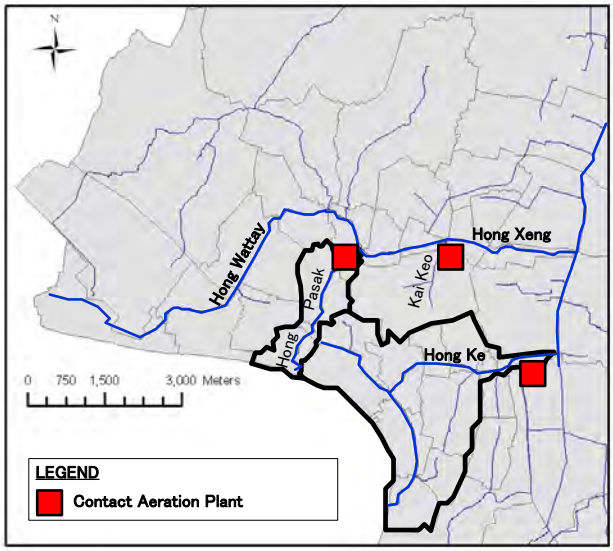
■ Contact Aeration Plants

1. Location

- Downstream end of Hong Pasak
- Downstream end of Hong Kai Keo
- Downstream end of Hong Ke
-

2. Capacity (daily average)

- Hong Pasak (2,230 m^3/day)
- Hong Ke (9,010 m^3/day)
- Hong Kai Keo (3,370 m^3/day)



LOCATION MAP

BOD VARIATION

Pros and Cons

■ Pros

- Best option for reduction of pollution load at downstream end of Hong Pasak and Hong Ke

■ Cons

- Construction and O&M costs will be higher than Alternative 2
- Water environment from the pollution source to the STPs cannot be improved (drainage channels in the basin remains untreated).

Construction Cost

US$ 21.9 mil.

O&M Cost

US$ 0.17 mil. per year

Pop. in the drainage basins of the facilities

Approx. 72,000 persons

Fig. 4.3.10 Outline of Alternative 1

Alternative 2

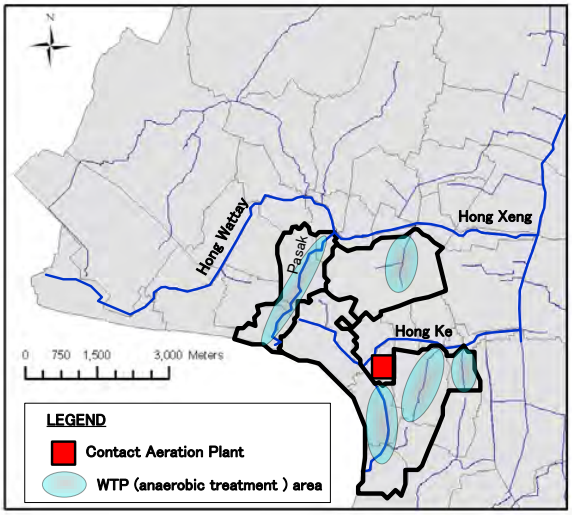
Treatment Facilities (Newly constructed)

■ WTP (capacity, daily average)

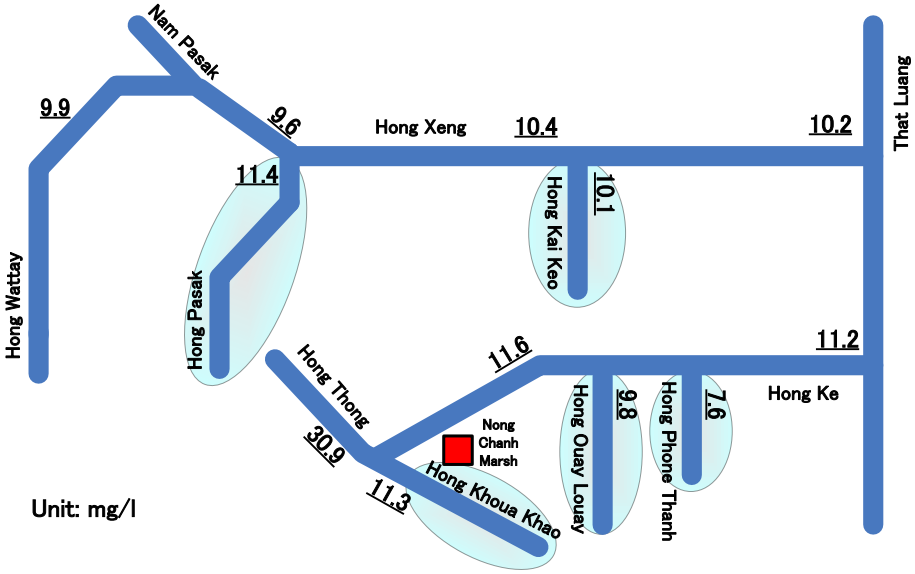
- Hong Pasak (1,120 m^3/day)
- Hong Kai Keo (1,680 m^3/day)
- Hong Khoua Khao (1,630 m^3/day)
- Hong Ouay Louay (800 m^3/day)
- Hong Phone Thanh (160 m^3/day)

■ Contact Aeration Plant (capacity, daily average)

- Hong Thong (neighboring area of Nong Chanh Marsh) (2,110 m^3/day)



LOCATION MAP



BOD VARIATION

Pros and Cons

■ Pros

- Sanitation condition in the communities and water environment of the drainage channels in the basin can be improved.
- Construction and O&M cost will be lower than that of Alternative 2

■ Cons

- BOD can be relatively higher than that of Alternative 1.

Construction Cost

US$ 17.7 mil.

O&M Cost

US$ 0.04 mil. year

Pop. in the drainage basins of the facilities

Approx. 37,000 people

Fig. 4.3.11 Outline of Alternative 2

4.4 Master Plan for Water Environment Management

4.4.1 Master Plan Structure

As described in **Section 4.2** on the strategy of water environment management, comprehensive approach, which includes the following concepts, is necessary in order to attain a sound water environment:

- To integrate engineering and biological technologies and management practices;
- To involve all stakeholders related to wastewater generation and management, including private and business sectors as well as government agencies; and
- To cover sanitary improvement in individual houses and communities in order to attain water quality improvement in public water bodies.

Thus master plan components were divided into three areas, namely; (i) structural water improvement; (ii) institutional and legal improvement; and (iii) environmental education. The following figure depicts the relationship among those components.

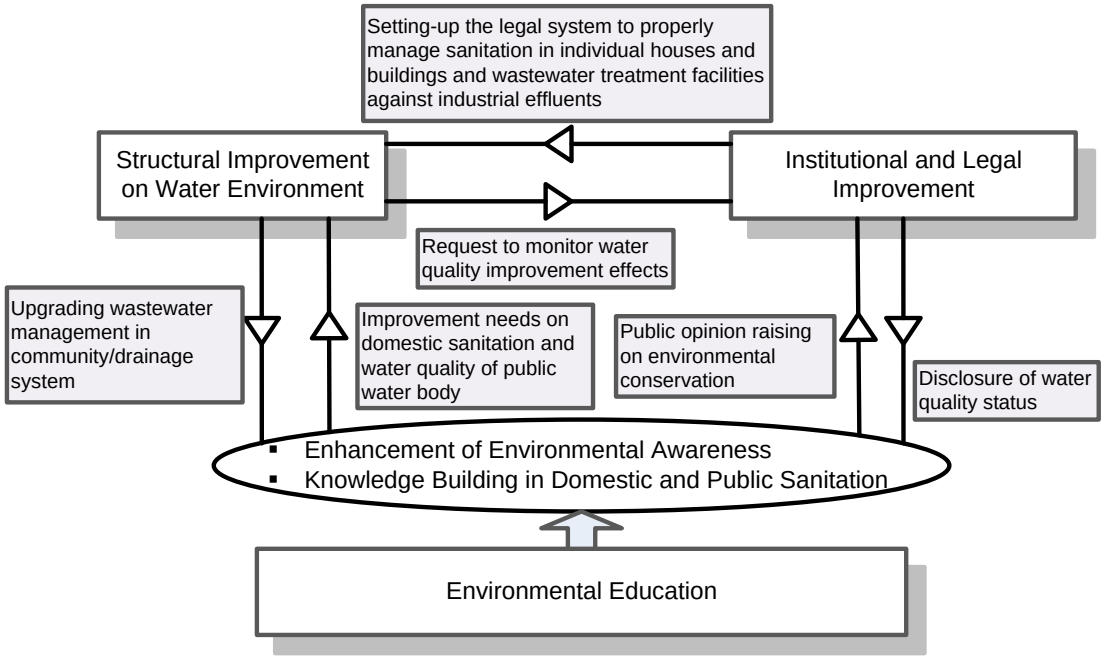


Fig. 4.4.1 Interaction among Three Master Plan Components

4.4.2 Structural Water Improvement Plan

(1) Improvement Concept

As described in **Subsection 4.3.2, Combination of Structural Alternatives**, the water improvement plan shall be formulated taking spatial and time features into consideration. Based on the comparative study results, the structural water improvement components are as summarized in the following table.

Table 4.4.1 Structural Water Quality Improvement Components

Mak Hiao River Basin		Alternatives in time frame	
Divided area	Sub-areas	M/P (Until the year 2020)	10 – 20 years after M/P
Hong Ke and Hong Xeng drainage areas	Storm water drainage		
	Remaining marshes & drainage canal system	Conservation and improvement of remaining marshes for flood retarding	Canal improvement for increase draining capacity, if necessary
	Wastewater management		
	Built-up area	(1) Villages with available spaces and without proper sanitation facilities: installation of CBS (2) Villages without available spaces: installation of septic tank at the time for rebuilding or newly building	(1) Villages with available spaces and without proper sanitation facilities: installation of CBS (2) Villages without available spaces: installation of combined individual sewer system at the time for rebuilding or newly building
	Rural-type aggregated community	Installation of septic tank at the time for rebuilding or newly building	Installation of combined individual sewer system at the time for rebuilding or newly building
	Drainage canal	Construction of decentralized treatment facilities - Construction of simple wastewater treatment plants collecting wastewater by local interceptors - Construction of in-stream contact aeration facilities - Application of vegetation measures for strengthening natural purification functions	
	Conservation of existing marshes	Conservation of marshes remaining in the drainage areas such as Nong Bo, Nong Tha, and Nong Chanh (natural purification function as well as flood retarding mentioned above)	
New large-scale development	Industrial estate and new city development	Storm water drainage	
		Construction of storm drainage system	
		Wastewater management	
		Construction of wastewater treatment facilities at the downstream end of the developing areas or inside the individual factories	
Other areas	Newly expanded built-up area	Storm water drainage	
		Construction of storm drainage system, if necessary	
		Wastewater management	
		Installation of CBS or septic tank at the time for rebuilding or newly building	Installation of combined individual sewer system at the time for rebuilding or newly building
	Rural villages	Wastewater management	
		Installation of septic tank at the time for rebuilding or newly building	Installation of combined individual sewer system at the time for rebuilding or newly building

(a) Storm Water Drainage

Basically for newly expanded urbanizing areas including large-scale developments, construction of new drainage canals or improvement of existing drainage canals shall be conducted in accordance with urgent necessity to attenuate flooding issues.

Regarding drainage areas of Hong Ke and Hong Xeng, remaining marshes shall be conserved and improved for their storm water retarding functions until the target year 2020. These are Nong Bo in Nam Pasak, Nong Douang in Hong Wattay, Nong Tha in Hong Xeng, and Nong Chanh in Hong Ke. A retarding capacity of stormwater of the marshes in the basin of Hong Xeng area (equivalent to 0.5 m increase in water depth) was estimated to have an effect of reducing the peak of hydrograph at 2-year return period, from 90 m^3/s to 42 m^3/s, at the downstream end.

(b) Wastewater Management in Built-up Areas

CBS receives both black water and gray water so that it has strong effects for community sanitation improvement as well as surface water improvement in the drainage system. Meanwhile septic tank receives only black water and gray water is discharged to the surrounding environment without treatment. Selection of CBS or septic tank depends on the necessity of CBS system, which is decided by the installation of existing sanitation facilities such as toilets, and the land availability for the installation. Considering the successful cases in Southeast Asia, it seems that CBS is accepted smoothly by such communities consisting of low income families which do not have toilet, where CBS applies to the needs of users. Furthermore securing of land for installation of CBS might be a significant obstructive factor to expand their installation due to private lands. According to high installation ratio of sanitation facilities in the individual houses and buildings, the necessity of CBS installation might be extremely low in the urban areas of Vientiane.

In order to upgrade such functions of the septic tank, the combined individual sewer system was invented in Japan. It can receive both black and gray water, but it needs electricity for aeration. Thus the combined individual sewer system shall be introduced for sanitation in individual houses in future when people's income could grow remarkably.

In addition some wastewater treatment plants shall be constructed in the downstream ends of the large-scale development areas or inside of factories, since their impacts to the public water environment would be quite significant.

(c) Wastewater Management in Rural Villages

Installation of septic tank at present and individual sewer system in future is recommendable for domestic sanitation improvement in the rural villages in a similar manner mentioned above.

(d) Development Project in Remaining Marshes

Development plans/projects have been progressing, targeting Nong Bo in Nam Pasak and Nong Tha in Hong Xeng. In these areas, proper wastewater treatment measures shall be carried out to the effluents of the developed areas. Furthermore, natural purification functions of the marshes shall be preserved since wastewater discharged from the drainage basin is purified by nature before the development.

(e) Water Improvement along Drainage Canals

To improve water quality of drainage flow, the following measures shall be carried out in accordance with the status of water deterioration, its causes, and feasibility of the countermeasures. Furthermore, vegetation, which naturally and thickly grows up in the canals, shall be preserved wherever possible to expect additional purification functions of vegetation against wastewater.

- Hong Wattay: Administrative instructions shall be made by the Department of Industry and Commerce of Vientiane for treatment facilities against highly polluted effluents from the slaughterhouses.
- Hong Pasak: Government sectors shall install local interceptors and simple wastewater treatment plants along the canal.
- Hong Koua Khao, Hong Ouay Louay, Hong Phone Thanh, Hong Kai Keo: Government sectors shall install same facilities step by step as applied in Hong Pasak because of available spaces along the canals. In addition, since they have natural purification function according to the field survey, installation of appropriate works shall be examined based on enough monitoring activities.
- Hong Thong: Common countermeasures could not be applied to Hong Thong due to concrete cover in almost the entire stretch of the canal so that in stream treatment facilities shall be constructed along the bank of Nong Chanh introducing wastewater from Hong Thong by pumping up through DANIDA intake near the outfall of the canal.

(2) Issues on Implementation and Points to be Noticed

In the structural water improvement plan, the major measures are local interceptors and simple wastewater treatment plants, septic tank and in-stream treatment facilities. **Table 4.4.2** enumerates responsible body in their installation and operation and maintenance, and major issues. Funding for simple wastewater treatment plants with local interceptors and in-stream treatment facilities is the most important issue, while establishment of legal system including guidance is urgently necessary in installation of septic tank.

Table 4.4.2 Responsible Body and Major Issues of Structural Measures

Structural Measures	Responsible Body in Installation	Responsible Body in Operation & Maintenance	Major Issues
Simple Wastewater Treatment Plants with Local Interceptors	Vientiane/VUDAA	Vientiane/VUDAA	Funding for installation
Septic Tank	House/Building Owner	House/Building Owner	Legal system for installation
In-stream contact aeration treatment	Vientiane/VUDAA	Vientiane/VUDAA	Funding for installation

In addition, the following points shall be considered for smooth implementation of the above structural measures:

- To expand the installation of simple wastewater treatment plants, wide-open spaces in public schools, temples and local government offices shall be utilized as installation sites for intercepting wastewater through the drainage pipes.
- To promote the use of septic tank although soak pit is popularly installed due to land availability and its low cost, plastic-made septic tank is predominant in Thailand but Lao people still find difficulty in accepting the use of plastics for human waste treatment. Furthermore, both types of traditional septic tank and plastic septic tank have almost similar cost (300 USD in an average size), but the latter one needs a smaller area for installation. Thus the plastic type may be accepted gradually in future:
- To conduct smooth construction and operation as well as maintenance of the facilities, construction of proper GIS is indispensable, integrating secondary and tertiary drainage network, information on topography and facilities installed.
- To manage the water environment improvement activities conducted by various donors and NGOs in an integrated manner, an environment and sanitation center shall be established for

formulating robust network and communication system among the actors including governmental organizations.

(3) Stepwise Plan on Structural Water Improvement

(a) Mid- and Long-Term Stepwise Plan on Structural Water Improvement of Drainage Network

Scrutinizing the present water environmental conditions and the future ones predicted, an appropriate strategy to remedy the future worsening situations shall be established for midterm and long-term time frame. **Fig. 4.4.3** could depict such process.

The target year of the midterm time frame shall be year 2020 in accordance with the water environment improvement master plan. In addition, long-term consideration shall be necessary for further improvement on water environment, since construction of sewerage system including collection pipe network needs much longer time and large investment. Thus, water environment improvement strategy could be divided into three steps:

Step I: Mid-Term Improvement (until year 2020)

Immediate and on-site applicable remedial measures for water environment shall be conducted in the most seriously deteriorated canals: Hong Xeng giving first priority to Hong Pasak, and Hong Ke giving priority to Hong Thong. The effective measures are interceptors of wastewater inflow and small-scale treatment plants along the canals, and in-stream treatment system at the outfall of Hong Thong. The small-scale treatment plant is similar in type and structural components to CBS/SBS. In addition to those measures, vegetation measures should be applied in the canals to expect their natural purification functions.

Step II: Long-Term Improvement (after year 2020)

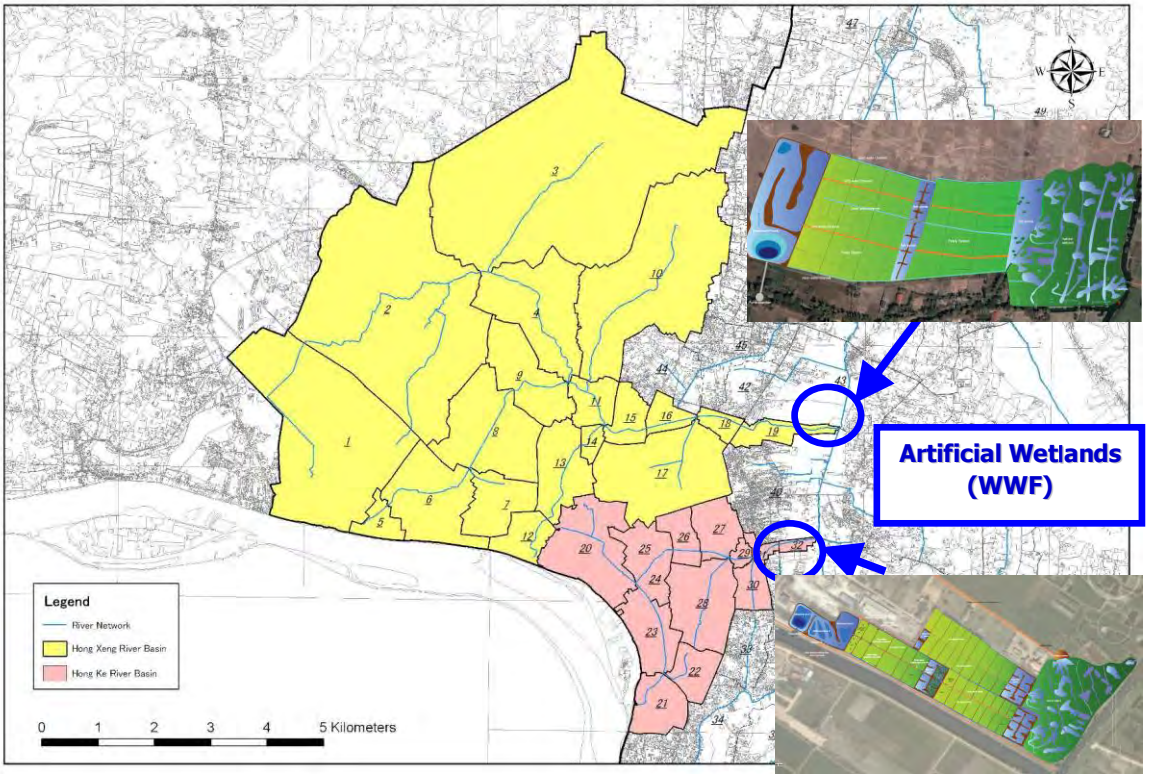
After the completion of midterm improvement works, surface water quality in the canal system is, however, expected to worsen due to the denser congestion of existing urban areas and further extension of urbanizing areas. Sewage treatment plants shall then be constructed at the downstream ends of Hong Xeng and Hong Ke. If the artificial wetlands proposed by WWF are realized, those wetlands could be expected to attain similar functions as the above treatment plants. Furthermore, these wetlands have advantages in that operation and maintenance is easier and more significant effects is expected in the treatment to the lower concentration of contaminated water through midterm improvement works. The conceptual design of artificial wetlands is presented in **Fig. 4.4.2**.

Step III: Long-Term Improvement (after Step II)

After completion of the Step II project, pipe network installation shall be started to extend the coverage of sewerage system and to improve the sanitary conditions of households unconnected to the public sewer. Underground trunk sewer pipe shall run along the trunk canal bank like interceptor collecting wastewater from lateral sewer network. In general some lift pump stations shall be constructed at the necessary intermediate points along the trunk sewer pipe.

This kind of works is the general procedure of installation of a conventional sewerage system. If the decentralized treatment approach in Step I could function well and artificial wetlands would be selected in Step II, decision-making shall be made based on enough examination of the conditions of that time when huge amounts of investment are required

for improvement of the malfunctioning secondary drain networks to connect to simple treatment facilities as well as wastewater treatment in newly expanded built-up areas.



Source: WWF

Fig. 4.4.2 Artificial Wetland Concepts proposed by the WWF

Present Conditions

Present Sewer System

Wastewater conveyance means in Vientiane

↓

Natural or manmade canal network connecting to the That Luang Marsh

↓

Combined open sewer system

Seasonal Periodical Changes of Surface Water in the Canal

Rainy season	:	• Receiving rainwater as well as domestic wastewater, water quality betters due to dilution of increased stream flow. • Aquatic species, in particular fishes, come back to the canal.
Dry season	:	• Receiving only domestic wastewater, water quality worsens due to no natural inflow. • Aquatic species move downwards to Hong Xeng and That Luang Marsh.

↓

Alternative Remedial Measures

No action (Future trend)	:	In parallel with densely urbanizing, water quality in the canal network will worsen in the rainy season as well as the dry season.

Midterm Strategy: step I (Target Year of 2020)

Simple treatment plants with local Interceptors	:	Advantage
	(1)	Improving surface water quality on site along the canal
In-stream contact aeration treatment plant	:	Advantage
	(2)	Improving surface water quality at a pinpointed site

Long-term Strategy: step II (After 2020)

Construction of sewage treatment plant with existing combined sewer system (At downstream end of Hong Ke and Hong Xeng)	:	Prerequisite
	(1)	Method, which further treats surface water whose quality is improved in Midterm Strategy, shall be employed.
	(2)	Main objectives are to conserve marshes at downstream (That Luang and Na Khay), and to protect biodiversity, etc.

Long-term Strategy: step III (After 2020 and the assumption of drastic increase in national income)

Installation of sewage system including collection pipe/drain network	:	Prerequisite
	(1)	Whether its installation is actually necessary shall be examined based on the enough analysis of the conditions at that time.
Improvement of wastewater Treatment plant	(2)	Countermeasure against the drying-up of drainage flow in the dry season
	(3)	Acceptance of long-term construction period and huge amount of investment

Fig. 4.4.3 Mid- and Long-Term Strategies of Water Environment Improvement

(b) Short- and Mid-Term Stepwise Plan of Structural Water Improvement of Drainage Network

In the preceding item, improvement directions on water environment were proposed for the midterm plan towards 2020 and the long-term plan afterwards. A stepwise plan in short terms is proposed towards the target year of 2020.

In a few years, the pilot project shall be implemented as early as possible to showcase water environment improvement in the upper reaches of Hong Pasak, based on the results of the Pre-F/S in this Study. It is appropriate that the facilities and actions for environment improvement mentioned below are to be implemented from upstream to downstream. If they are implemented starting from the uppermost, effects on water quality improvement would be quite obvious.

- SBS (School-Based Sanitation) shall be installed to collect gray and black water from the dormitories of Pak Pasak Technical College, which is located in the uppermost of Hong Pasak,
- Five (5) small-scale simple treatment plants with local interceptors of wastewater inflow shall be constructed along the canals of upper Hong Pasak.
- In parallel with water quality improvement, green corridor shall be installed along the improved stretch for restoration of riverside as a relaxation place to residents.

Afterwards, expansion of the countermeasures to the lower reaches of the Pre-F/S target area in Hong Pasak and further in Hong Khoua Kao, and construction of in-stream treatment facilities in Hong Thong shall be conducted. Water quality in the worst polluted drainage canals will be improved with these countermeasures. Meanwhile, measurement of effects of these countermeasures and water quality monitoring in the whole area shall be implemented simultaneously, appropriate countermeasures shall be considered based on the water quality of such drainages that have no countermeasures, and necessity of simple treatment facility and possibility of water purification by vegetation will be examined. The objective of these activities is to find countermeasures which can realize the largest effects through the monitoring activities, considering the present conditions in Lao PDR as well as reducing project costs. Required minimum assistance shall be extended, presenting these policies for the activities, which is expected to prepare a foundation for the counterpart to assume project implementation by themselves. For other drainage areas, however, only technical assistance shall be made with the establishment of a development policy in consultation with counterparts following a detailed survey in dry season. Details of such technical assistance include:

- Technical assistance to WREA on water quality monitoring of drainage canals, which will enable WREA to carry it out by itself in the future;
- Implementation of experiment on water quality improvement by a low cost method other than simple treatment facilities such as vegetation in collaboration with WREA, PTI, DPWT of Vientiane, VUDAA and the Lao National University in parallel with water quality monitoring; ff such countermeasure is proved to be feasible and effective, alternatives of structural measures which can be carried out by the Lao side will be expanded and cost of structural measures will be reduced;
- Continuation of technical assistance on governmental guidance to the slaughterhouse at Hong Wattay, which is still pending; and
- Enough consultation with counterparts on whether newly developed areas of Nong Ping and Nong Tha fulfill the water quality requirement that water quality shall not be worse than that before the development as well as on the guarantee of its enforcement.

Based on the activities mentioned above, the short- and mid-term stepwise development plan is formulated as follows:

Table 4.4.3 Short- and Mid-term Stepwise Plan on Structural Water Improvement of Drainage Network

Year	Improvement Target	Rainy Season (Apr. to Sep.)	Dry Season (Oct. to Apr.)
2011/2012	Formulation of the total plan	Examination of the water quality improvement policy and consultation with counterpart agencies	
2012/2013	Examination of present conditions and appropriate improvement direction	Detailed examination of water quality: development policy for each target drainage canal	
2013/2014	Water quality improvement in the upper reaches of Hong Pasak	F/S and D/D based on field survey	Construction from upstream end to downstream end
2014/2015	Water quality improvement in the upper reaches of Hong Pasak	Water quality monitoring, continuous F/S and D/D	- Same as above - Detailed examination of suitability on countermeasures in other drainage canals
2015/2016	Construction of in-stream treatment plant in Hong Thong	D/D on in-stream treatment plant in Hong Thong	Construction of in-stream treatment plant in Hong Thong
2016/2017 to 2020/2021	Selection of drainage canals to be improved and their appropriate measures, and implementation of them through water quality monitoring	Selection of canals to be improved and examination of appropriate measures: lower reaches of Hong Pasak, Hong Kai Keo, Hong Ouay Louay, Hong Phone Thanh	Implementation of appropriate measures and examination of their effects through water quality monitoring

Since human resources and budget of DPWT in Vientiane as an administrator of the drainage network and related organizations are limited, the work items mentioned in the above table could be categorized into two groups; namely self-made projects and donors' supported projects. These are summarized below.

Table 4.4.4 Work and Budgetary Allocation on the Structural Water Improvement

Responsible Agency	Projects/Works
Self-made Projects/Works	
Vientiane and PTI	Site survey along the target drainage canals Application of plants for natural water purification and its monitoring Dredging of accumulated sediment if necessary
WREA	Periodical water quality monitoring in the drainage network
Donor Supported Projects/Works	
Vientiane and PTI	Establishment of detailed improvement directions for the target canals Construction of simple wastewater treatment plants along the canals Construction of in-stream wastewater treatment plant along Nong Chanh Marsh

O&M cost may be covered eirher by the charges collected from local residents discharging wastewater into the canals based on the Polluter Pay Princilple, or by the budget of Vienticane. In addition, in case that the O&M cost is covered by the charges, a subsidy may be injected to some extent using the city budget.

4.4.3 Institutional and Legal Improvement Plan

(1) Present Capacities on Water Environment Management

The Swedish International Developing Cooperation Agency (SIDA) pointed the reasons why the responsible authority does not have enough implementing capacity on environmental management in the document, *Project Document, Strengthening Environmental Management Project Phase II, May 2005*, as follows:

- Poor support structures to facilitate effective environment management;
- Lack of capacity on environmental management at central and provincial levels;
- Weak institutional structures for environmental management;
- Unpredictable and risky financing; and
- Lack of chances on people's participation.

The Basic Study on Regulations and Institutions (**Section 2.2** of this Report) was conducted with the problem consciousness on the above-mentioned points to confirm their implementing capacity. The results of the study can be summarized as follows.

(a) Development of Institutional and Legal Structures for Environment Management

Institutional setups have been developed steadily so far as well as the development of environmental regulations with the assistances from international donors. Organizations were restructured to clarify the responsibilities and fit the present needs for environment issues. Important basic laws and key regulations were revised or are in the final process of approval. Development of guidelines or implementing regulations is required for effective implementation of basic laws and key regulations.

In addition, water quality standards were formulated in the ideal forms referring to the cases of other countries. Sometimes they set too high hurdles to comply with. For example, BOD value for the surface water standard is very severe for the water conditions of Vientiane. It may be required to set more reasonable water quality standards based on the actual usages for the water body and present water quality situations.

Details of the necessity for further development are discussed in later subsections.

(b) Lack of Budget and Experienced Personnel

All the related authorities claimed that they have to carry out their responsibility with very limited budget and personnel. Sometimes budget is approved in a fiscal year but it is not guaranteed that it will be approved in the next fiscal year.

The Environment Protection Law (Article 30) stipulates that: "The government promotes the establishment of environmental protection funds to support activities in the field of research and study, preservation, remediation and restoration of the environment, including the protection and preservation of natural resources." The Environment Protection Fund was established in 2005 and 3.5 million USD has been spent in 5 years for projects. Considering the present and future necessity of finance for environmental matters, the fund is required to be augmented.

The limited number of personnel is also a problem. Even if young staff members need more experience to practice their work appropriately, skilled senior staff is not necessarily

assigned to train them. In addition, a training master plan or career building programs for staff members is required.

(c) Necessity of Participatory Approach

It is expected that the lack of budget and personnel can be covered by the people's participation to a certain extent. It takes time to mobilize people to join in a well-organized manner. It is indispensable to make the people aware and understand water environment problems by education and improvement of accessibility to the environmental information. If the people know more and more, they will be aware and understand more and more.

It is expected that the lack of budget and personnel can be covered by the people's participation to a certain extent. It takes time to mobilize people to join in a well-organized manner. It is indispensable to make the people aware and understand water environment problems by education and improvement of accessibility to the environmental information. If the people know more and more, they will be aware and understand more and more.

(2) Consideration on Further Development of Regulations/Guidelines

Keeping in mind that the present capacity of implementing water environment management, the development of regulations/guidelines required to be considered in the specialized fields are summarized in the following table. Items stipulating only general activities of authorities should be developed in the form of regulations while those stipulating detailed activities of authorities as well as activities of the people or private companies should be developed in the form of guidelines in the first step.

Table 4.4.5 Menu of Regulation/Guideline Development to be Considered

Specialized Field / Objective	Items to be Developed	Main Contents	Responsible
(0) General ♦ To support the implementation of water environmental management	• Regulation on environmental information disclosure	➢ Easy access to water environmental information ➢ Annual report on water environment ➢ Water environment database	➢ WREA
	• (Expansion of the Environment Protection Fund)	➢ (Expansion of the fund)	➢ EPF
	• Guideline on training master plan on technical staffs in government officials	➢ Clarify requirements to posts ➢ Career build-up model	➢ Prime Minister's Office
(1) Water Quality Monitoring ♦ Basic data of water quality in the target area should be collected and accumulated by Lao engineers themselves, which will be the basis for the management and planning. ♦ Water quality monitoring network system (WQMNS) should be established to produce data accumulation. ♦ Capacity of WREA Lab should be developed to carry out its responsibility in the WQMNS.	• Regulation on water quality monitoring	➢ Periodical monitoring ➢ Linkage between DOE-WREA and WREO ➢ Linkage between WREA and DI-MIC ➢ Clarify the responsibility of WREA Lab ➢ Water quality database ➢ Disclosure of the data	➢ WREA
	• Guideline on water quality monitoring	➢ Monitoring method ➢ Establishment of WQMNS ➢ Management of WQMNS ➢ Training on monitoring	➢ WREA
	• Guideline on water quality analysis	➢ Analyzing method ➢ Management of laboratory ➢ Analyzing service to customers ➢ Training on analysis	➢ WREA
(2) **Water Quality Standards** ♦ BOD value for the surface water standard was set at very severe level for the actual conditions without setup water quality classes.	• Guideline on water quality standard application in Vientiane	➢ Setup of more realistic targets of water quality ➢ Setup of water quality classes	➢ WREA
(3) Development of Drainage Network	• Guideline on the maintenance of drainage network	➢ Monitoring of drainage network ➢ Maintenance requirements	➢ MPWT
(4) Conservation of Wetland ♦ It is required not only to conserve the functions of wetland but also to disseminate information to the public.	• Regulation on wetland conservation	➢ Monitoring of wetland (water quality, biodiversity, etc.) ➢ Regulation on development at the periphery of wetland ➢ Annual report on wetland ➢ Establishment of a wetland conservation center	➢ WREA
(5) Water Quality Improvement (Drainage Canals) ♦ Presently, there is no regulation for domestic wastewater.	• Guideline on the wastewater management of drainage canals (Details of the guideline is shown in the later subsection.)	➢ Dredging requirements ➢ Requirements of water quality monitoring ➢ Development of database ➢ Cooperation with DOE-WREA and MIC-DI	➢ MPWT
(6) Sanitary Improvement ♦ Septic tanks should be promoted in Vientiane. ♦ Appropriate management is indispensable for effective function of septic tanks.	• Guideline on septage management (Details of the guideline is shown in the later subsection.)	➢ Monitoring of installations in the buildings ➢ Performance requirements ➢ Requirements for administration and management ➢ Requirements for construction, installation and operation ➢ Education and dissemination	➢ MPWT
(7) Economic Regulation ♦ Study of its applicability to Lao PDR in the future	• (Model Guideline of economic regulations)	➢ Effluent charges to factories' wastewater ➢ Subsidies for the installation of treatment plants by factories	➢ WREA

The following figure illustrates the relation among the regulations/guidelines to be considered.

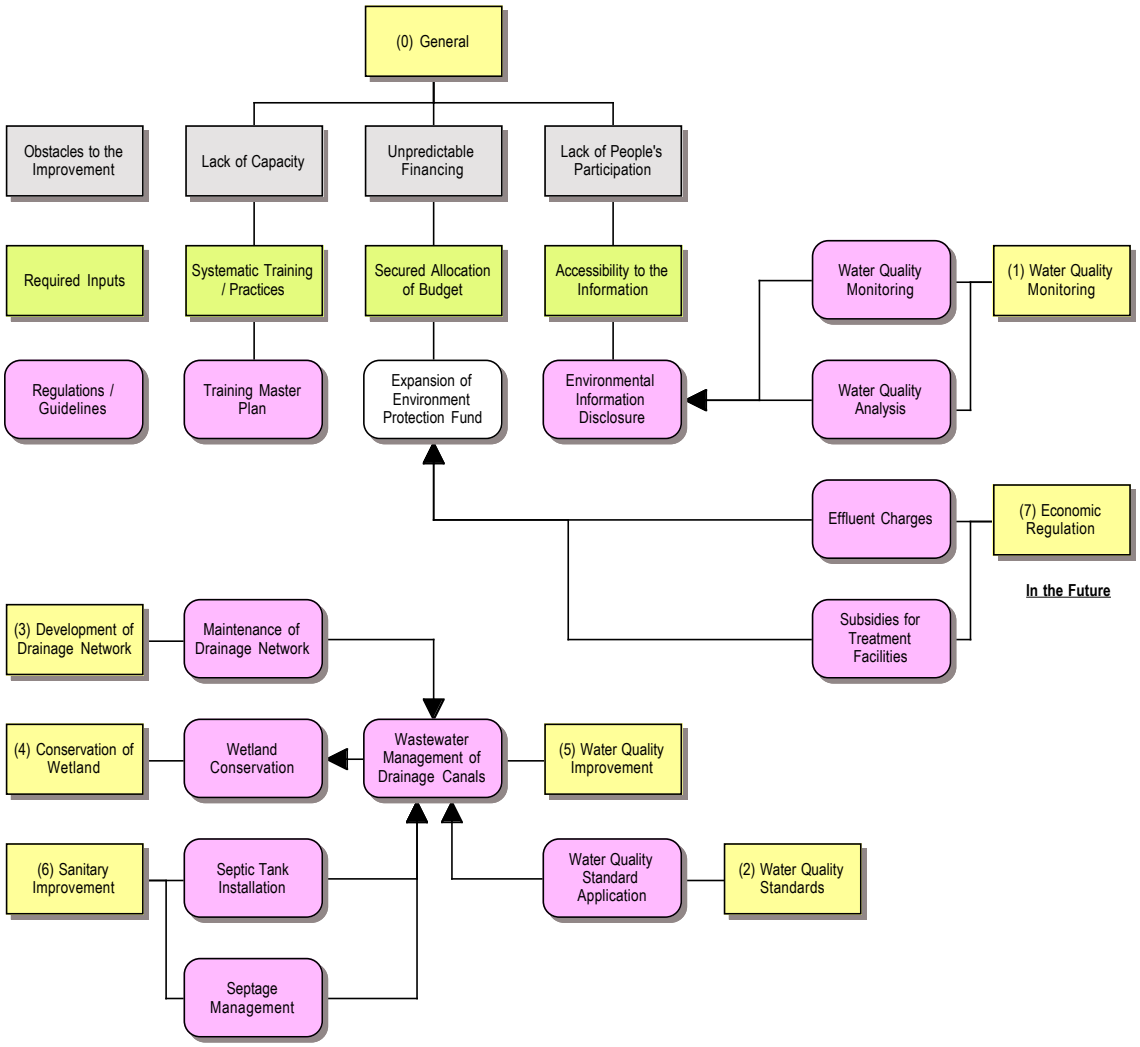


Fig. 4.4.4 Relation among the Regulations/Guidelines

(3) Management of Wastewater in the Drainage Canals

According to the Study results, the surface water along the urban drainage canals is deteriorating mainly due to domestic organic pollutants in the gray water or sometimes the black water flowing into the drainage canals without any treatment. The most realistic and quick solution to the problem is to expand the use of septic tanks and to promote the proper management of domestic wastewater and septic tanks. Presently, the management framework for domestic wastewater and/or septage (the combination of scum, sludge and liquid that accumulates in septic tanks) is not developed yet. On the other hand, some industrial effluents at a certain point cause the high value of COD/BOD in the drainage canals and this situation has been left for a long time even though the legal system is already in place to a certain extent. In this case, the most important issue is how to enforce the laws/regulations.

This section discusses the proper framework for the management of domestic wastewater and septage as well as the effective enforcement of industrial effluent regulations.

(a) Existing Laws/Regulations on Wastewater

Existing laws and regulations related to wastewater and effluent management are as follows:

Table 4.4.6 Existing Laws/Regulations on Wastewater

Classification	Title	Description
Basic Law	Environmental Protection Law	–
EIA	Decree of Environmental Impact Assessment	–
Water Quality Standard	The Agreement on National Environmental Standards in Lao	It contains Surface Water Quality and Wastewater Discharge standards.
Industrial Effluent	Regulation on the Wastewater Discharge from Industrial Processing Factories	It prohibits discharging directly or indirectly into public water body, wastewater that may have adverse impacts on ecology of water body, health of people or use of water.

In terms of the solid waste management, which is closely related and similar to septage management, the following regulations and guidelines have been promulgated:

1) Regulation on Business Registration of Solid Waste Transportation Service in Vientiane
2) Ministerial Regulation on Landfill Management for Public Health
3) Guideline on Household Solid Waste Management in Vientiane

If a transport company is reported to have done a violation, it is asked to appear at VUDAA and warned. In the third time of warning, the business license of the company is canceled. This penalty is conducted at the discretion of the Chief of the Solid Waste and Landfill Management, the responsible section of VUDAA.

As of February 2011, the building control code is being drafted by the Housing Division of DHUP. The draft is different from Ministerial Decision No. 7681 dated 29 June 2005. The Ministerial Decision stipulates land use and zoning. Both regulations will comprise the building code. As many large buildings have been constructed so far, the Draft is required to be finalized in two years. This draft focuses on fire protection and structure of large buildings and even existing buildings should follow this Draft whenever they build extensions, functional changes, and repair. After this draft is approved, detailed guidelines and standards will be prepared. Since no stipulations on domestic wastewater and toilet management are included, JICA Study Team asked PTI to promote their inclusion in the draft.

(b) Problems on Wastewater

[Domestic Wastewater]

Presently, domestic wastewater is discharged from buildings to the canals virtually without any treatment although it is considered to be the main reason of water quality deterioration of the canals. Large buildings (hotels, restaurants, apartment houses, schools, government offices, etc.) can construct onsite treatment facilities for domestic wastewater, but it is not realistic to require private houses to construct such facilities since they do not have enough land space for them and it is also not realistic to inspect each house for proper management. Thus, domestic wastewater from large buildings should be managed by themselves and that from private houses collectively by the government. In addition, the government should promote the education and dissemination for the general people on proper management of domestic wastewater at the source from the long-term viewpoint.

[Septage]

A standard design of septic tanks was approved in 1991 and included in DHUP's –Manual on Construction Regulations (1992)." This manual is used as the standard design of septic tanks. It has three chambers and its size depends on the number of users. The same design standard is used for hotels, offices, dormitories, hospitals, etc., although the wastewater discharge standard is different. According to WSP, the manual is not necessarily effective for the installation of septic tanks due to the following reasons:

- The manual is not applied for the improvement of an existing building;
- The manual has the standard for construction design but not for operation and maintenance. Proper operation and maintenance are indispensable for the effective work of septic tanks; and
- There is no system for enforcing this decision to be complied by building owners such as inspection during or after the construction.

The problems on the operation and maintenance of septic tanks are:

(1) Some house owners do not properly desludge their septic tanks. Sometimes they use the toilet without desludging for many years. Thus, black water flows into the drainage without any treatment. WSP reported that a significant majority of the septic tanks surveyed had at most one 6" diameter desludging hole. It is assumed that this is done because of ease of construction and a subsequent reduction in construction cost. Thus, it is difficult for house owners to check the sludge accumulation in their septic tanks; and

(2) Concerning the transport of septage, there is no regulation even though desludging companies are required to register their business at District Offices. A company owner said that septage was illegally dumped in a public area because the dumping site had been moved to a very far place from the city center. WSP reported that there was evidence of indiscriminate and illegal dumping of septage in rural villages in the vicinity of Vientiane.

Effective management framework is now required to be established including the development of regulations/guidelines as well as clarification of responsibilities of parties involved.

[Industrial Effluent]

In terms of the laws/regulations on industrial effluent, the Decree on EIA requires certification showing that the Environmental Management and Monitoring Plan (EMMP) have been approved. In addition, the Regulation on Wastewater Discharge from Industrial Processing Factories stipulates water quality standards, inspection and penalty by the authorities concerned. Therefore, it can be said that the legal system is already developed to a certain extent and the main issue is how the laws/regulations can effectively be enforced.

(4) Proposed Domestic Wastewater Management Framework

Considering the problems mentioned above, the framework of domestic wastewater management is summarized in the following table.

Table 4.4.7 Proposed Domestic Wastewater Management Framework

Responsible	Objectives	Activities
Private house owners	To reduce the discharge of wastewater.	To save on water use at each house.
Large building (hotel, restaurant, apartment house, school, government office, etc.) owners	To treat domestic wastewater at source point.	To construct an onsite wastewater treatment system (CBS/SBC, for example).
DPWT/VUDAA	To improve the awareness of the general oublic on water quality.	To promote environmental dissemination and education.
	To improve the water environment of canals.	To dredge the canals periodically; To construct clustered treatment facilities for domestic wastewater from private houses.
	To enforce the regulation on the onsite wastewater treatment systems.	To require an onsite wastewater treatment system upon issuing a building permission. To conduct inspections of onsite wastewater treatment systems.
MPWT	To promote the construction of onsite wastewater treatment systems.	To issue regulation on onsite wastewater treatment systems.

(5) Proposed Flow of Septage Management

Septage management relates to many authorities as well as desludging/hauling companies and users. Activities and responsibilities of all the parties should be clarified at each step from desludging to final disposal for the effective management. A proposed flow for septage management is shown in **Fig. 4.4.5**.

[Notes on Fig. 4.4.5]

Dissemination of Information on Septic Tanks by DPWT/VUDAA. It is not realistic to force all houses in Vientiane, either newly build or existing, to install a septic tank, considering the present standard of living and the manpower capacity of the authorities concerned. Even if the regulation is developed, it is unlikely that the regulation would be enforced effectively. The promotion of septic tanks should be started with the improvement of awareness of the people or information dissemination. The appropriate O&M of septic tanks should also be disseminated. Subsidy or soft loan to the house owners should be taken into consideration regarding the installation of septic tanks in the future.

Guidelines on Septic Tank Design. One of the major reasons why some house owners use toilets without desludging for many years is that it is very difficult to check the sludge accumulation in the prevailing design of septic tanks. An appropriate design which is easier to check should be devised.

Certification and Inspection of Desludging/Hauling Companies. Desludging/hauling companies should be registered and their work results should also be recorded in the database of the authorities concerned. If it is reported that a company conducts an illegal activity, it should be inspected by DPWT/VUDAA. Building owners can select a good company from the database. It is expected that the bad providers will finally be excluded from the business.

Water Quality Monitoring. WREA Lab should monitor the quality of water in the drainage canals periodically to evaluate the effect of the management system. Support of foreign donors is required to conduct the periodical water quality monitoring, considering the present capacity of WREA Lab.

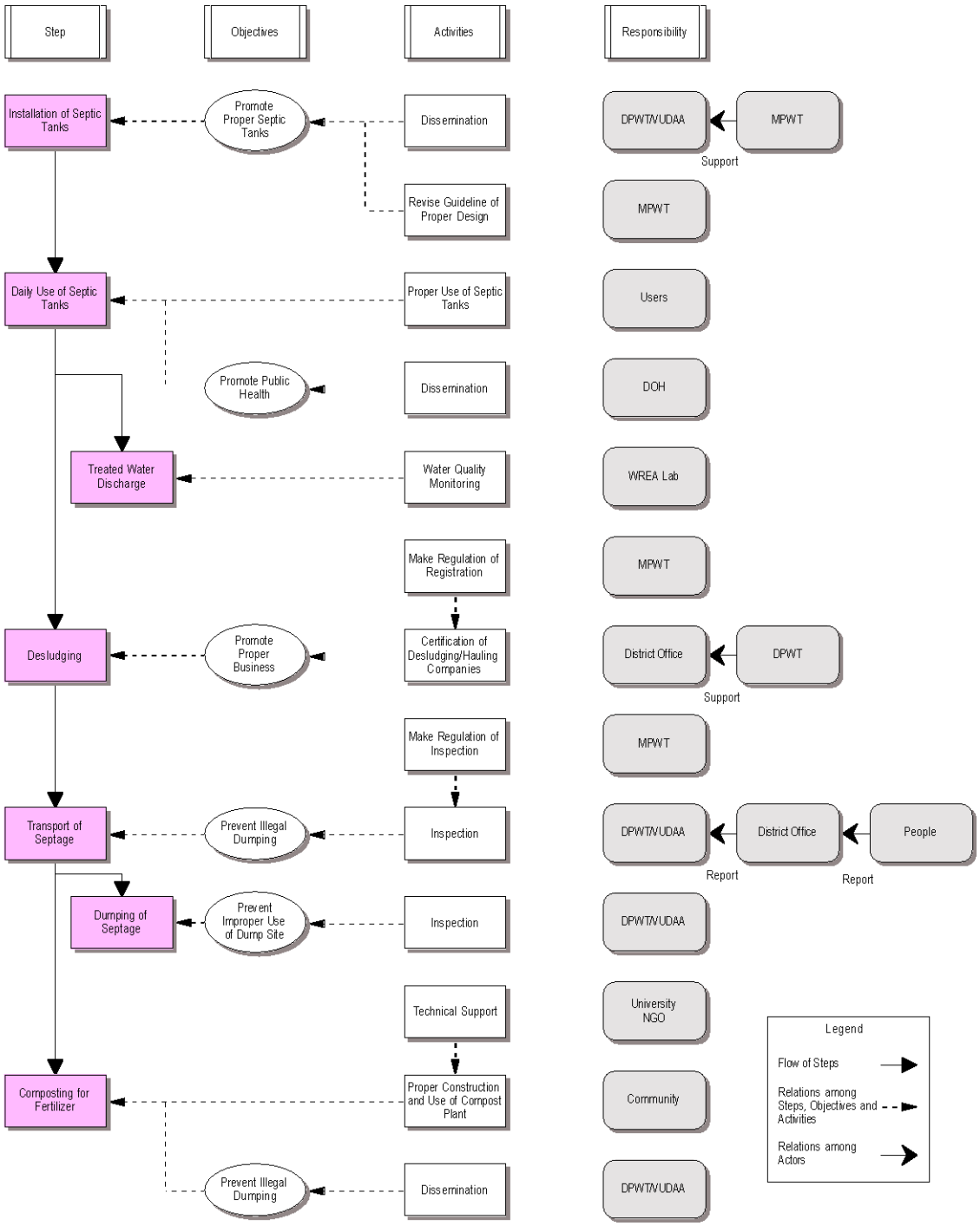


Fig. 4.4.5 Proposed Flow of Septage Management

Compost Plant. It has been reported that the desludging companies dump septage on a public area or sell them to farmers as fertilizer. Even if the septage is used as fertilizer, it should be processed and managed properly. Otherwise, the septage would cause a hygienic problem. Compost can be a solution for sanitary use of septage as fertilizer as well as for preventing illegal damping. Compost plants should be promoted with information disseminated by DPWT/VUDAA and technical support by universities and NGOs.

(6) Enforcement of Industrial Effluent Laws/Regulations

Comparison of actual cases which recently caused a water pollution problem is useful for considering the effective way to enforce laws and regulations.

(a) Two Cases

[Cassava Flour Factory Case]

The cassava flour factory was promoted by the Ministry of Planning and Investment for the development of agriculture, whose product was expected to be exported. An EIA was conducted for the factory and an environment management plan was made, which requires the periodical monitoring of effluent.

(1) Although the reason is not known, the factory started operation in February or March in 2009, when the treatment facility was not yet constructed. In dry season, its effluent was retained in the clogged canal, which was located between the factory and Nong Han wetland.

(2) On 18th May 2009, a heavy rain came and the effluent poured into Nong Han wetland and 2.5 tons of fish died.

(3) On 19th May 2009, Morning, this incident was reported by the mass media.

(4) DOE reported the incident to the Minister of WREA and the Minister reported it to the Prime Minister (PM). The PM directed the Minister to take an emergency measure. This decision was made in two hours after the incident was reported.

The government group (PM Office, DOE-WREA, WREO, District Mayor and Head of Village) and the factory negotiated and made an agreement on the following:

- The factory will construct treatment facilities in order to continue operating the business;
- The factory will pay 15,000 KIP per 1 kg of dead fish to the fishermen; and
- The factory will release young fish into the wetland for five years in order to recover the ecology of the wetland.

The factory constructed enough facilities for treating its wastewater. The government did this measure based on EPL although they do not have regulations for implementation.

[Slaughterhouse Case]

Local people complained that the Nong Duan produced bad smell and huge number of flies. On the 11th day of January 2010, the government group (DPWT, WREO, and VUDAA) made an agreement with the slaughterhouse that the slaughterhouse will construct a treatment facility and clean the canal by April 2010. The staff of the Pollution Control Division of DOE knew the result of the water quality monitoring done by the JICA Study Team which shows that the factory has not taken enough measures against the effluent as of November 2010.

The staff of the Pollution Control Division of DOE complained that it was very difficult to do something by themselves, because:

- The Municipal WREOs have no regulatory body for water quality;
- There is no sub-regulation or guidelines for the implementation of EPL; no detailed procedure is depicted anywhere; and
- Responsibility demarcation between the Department of Industry and Commerce and the DOE is not clear.

Sequel to the Case

DOE-WREA and the WREO of Vientiane jointly conducted and inspection of the slaughterhouse in February 2011 to see how they were managing the wastewater. Although the slaughterhouse had constructed a stabilization pond in June 2010, it was filled fully with sludge and could not work for any wastewater treatment. The government authority is required to guide the slaughterhouse in the employment of an appropriate measure to meet the water quality standards. Presently, many private houses are being built near the slaughterhouse although the slaughterhouse was build when almost no house was located near it. New treatment facilities should be constructed with an appropriate design. Since environmental problems caused by the slaughterhouse concern not only water quality but also a lot of flies and bad odor emitted from the excreta of cattle waiting to be slaughtered, more drastic and fundamental solutions should be considered to solve all such problems.

(b) Lessons from the Two Cases

Some lessons could be learned from the two actual cases: the case where countermeasure was quickly taken and the other case where the measures provided were not enough. The most significant issue between the two is the presence of strong leadership in the government. Therefore, the first key to the enforcement of laws and regulations should be how to get the top of government to take a strong leadership. The second key is how to get the government staff to start working voluntarily even if the leadership of the top of government is not so strong. Possible measures can be summarized as follows:

- To improve the awareness of people on environmental issues by information dissemination and education: If the awareness of people is improved, it would be easier for the top of government to take the leadership and also for the staff to start working. In addition, the mass media tend to carry the news as the news value increases.
- To develop detailed procedures, guidelines or manuals for the execution of laws and regulations: If such detailed manuals are developed, the government staff can start working without asking their superiors for every step of the work. Such manuals should be reviewed everytime it is applied, to improve the description and to avoid mismanagement.
- To evaluate the performate of staff properly and to promote a staff based on the evaluation result: If the staffs believe they will be promoted due to the work results, they are expected to have the motivation and the confidence on their work.
- Not only to document the results of the cases but also to share it by all the government staff: the most significant problem here is that the lesson of the successful cassava case was neither analyzed enough nor communicated for coping with the other cases such as slaughterhouse case.

(7) Proposed Regulations/Guidelines

As mentioned so far, the main causes of the water quality deterioration in the urban drainage canals are wastewater discharged by ordinary households, which is almost not treated as well as human waste in toilet tanks, which is improperily maneged. In addition, such wastewater discharged by some food processing factories with exceeding the water quality standards is also a problem. Since the maneagement of wastewater relates to a number of stakeholders, its regulation/guideline should be drafted in an integrated manner considering the relation amonog them without devising regulations/guidelines one by one, which are listed in **Table 4.4.5** in order to implement them effectively. Compared with the present legal development and the proposed domestic wastewater management framework, the proposed septage management flow, as well as ideas of effective enforcement on industrial wastewater control, it has been clarified that drafting

of the following guidelines and regulations should be prioritized to improve the water environment:

- Guideline on Wastewater Management by Vientiane
- Regulations on the control of desludging/hauling business by Vientiane

These guideline and regulations shall be enacted by MPWT.

(a) Outline of the Draft Guidelines on the Wastewater Management of Vientiane

(The full text of the draft guidelines is given in **Annex 1**.)

Chapter 1 [Objectives of the Guideline]: Although the water environment of drainage canals in the center of Vientiane has deteriorated with canal water turning dark or black and emitting bad odor, there is presently no regulation on wastewater management. This guideline aims to contribute to the improvement of water environment of drainage canals before necessary laws or regulations are developed.

Chapter 2 [References]: There are several policies, laws and regulations concerning environment and water quality which have been already enacted in Lao PDR. Since the guidelines were compiled considering these existing laws and regulations, it is required to refer to these laws and regulations when the application or meaning is not clear.

Chapter 3 [Domestic Wastewater]: Domestic wastewater is the main pollution source of water quality in the canals. Therefore, the management of domestic wastewater is indispensable for the improvement of water environment of Vientiane. Persons living in private houses should reduce water use for various living scenes in various ways to reduce wastewater. Owners of large buildings (offices, schools, shops, markets, hospitals, theaters, residences, hotels, or restaurants) should be required to install a wastewater treatment system at their building sites. On the other hand, the DPWT/VUDAA should be required to have a plan, and to manage the construction of clustered wastewater treatment systems to treat the domestic wastewater discharged from private houses.

Chapter 4 [Septic Tank and Septage]: Septic Tank is recommended for the black water treatment system, considering the present economic and social situations of Vientiane. Since poor management of septic tank and septage is also causing the deterioration of water quality in the drainage canals, the promotion of appropriate management of septic tanks and septage is also important to the improvement of water environment in the drainage canals.

Chapter 5 [Industrial Wastewater]: The legal system is already developed to a certain extent. The main issue here is how the laws/regulations can be enforced effectively. Therefore, the responsibilities and activities of relevant agencies are clarified, and inspection, sanctions and public relations are stipulated.

Chapter 6 [Drainage Canals]: Accumulated sludge in drainage canals causes water quality deterioration and bad odor in addition to some inundations in the vicinity, Thus, periodical dredging is one of the key points of the management of drainage canals in the city center. Since dredging by government authorities is not satisfied due to the shortage of budget and manpower, the participation of people should be considered.

Chapter 7 [Wastewater Management Committee]: Various stakeholders are related to the wastewater management; therefore, a committee shall be established to share the information and to conduct the management in an integrated manner among the stakeholders.

Chapter 8 [Glossary]: Important technical terms are explained here collectively for easier understanding of the contents.

(b) Outline of Draft Regulation on Desludging/Hauling Business Control by Vientiane

(The full text of the draft regulation is fiven in **Annex 2**.)

Chapter 1 [General Principles]: This regulation aims to improve the sanitary and water environment of urban areas with the proper control of desludging/hauling businesses as well as the promotion of sound development of desludging/hauling businesses to provide suitable services to users.

Chapter 2 [Business Certificate]: A desludging/hauling business entity is required to obtain a business certificate from the District Office having jurisdiction over the area where the entity plans to do its main business.

Chapter 3 [Illegal Dumping]: Any person may report in writing to the government authority concerned if he/she finds any illegal dumping of waste. The government authority may inspect the business entity and ask for the submission of hauling track records of all its vehicles for the purpose of verifying the illegal dumping reported.

Chapter 4 [Punishment and Compensation]: If it is verified in the hauling track record that a desludging/hauling business entity commits illegal dumping, the business certificate of the desludging/hauling business entity shall be terminated and the renewal of business certificate shall not be permitted for one month. A desludging/hauling business entity which commits illegal dumping shall compensate the damage caused by the illegal dumping.

Chapter 5 [Database and Data Share]: The Department of Public Works and Transport shall maintain a database of desludging/hauling business entities certified by the District Offices in the City.

Chapter 6 [Disclosure]: The Department of Public Works and Transport shall disclose the database of desludging/hauling business entities to those who intends to ask desludging/hauling services. (Building owners can select a maintenance service provider through the database. It is expected that improper business entities will finally be excluded from doing business.)

(8) Implementation Schedule

Items listed in the "Menu of Regulations/Guidelines Considered" should be implemented on a stepwise basis. It is recommended implementation shall follow the schedule shown below. Prioritized regulations/guidelines and those supporting support such measures, including the expansion of environment protection fund, training master plan and disclosure, should be developed. In addition, those related to monitoring and the WREA Lab also should be developed in the early stage of the master plan since they are the basis of all other water environment management activities.

Table 4.4.8 Implementation Schedule

Item	Time Frame		
	M/P (Until the year 2015)	M/P (Until the year 2020)	10 – 20 years after M/P
Budget	Expansion of the environment protection fund	Expansion of the environment protection fund	Expansion of the environment protection fund
Human Resources Development	Development of guideline on training master plan for related agencies Making a training master plan of WREA Lab	Making training master plans of other related authorities Execution of the training master plan of WREA Lab	Execution of the training master plan of other related authorities
Regulations / Guidelines	Development of the prioritized regulation / guideline Development of the regulation and guideline on water quality monitoring, guideline on water quality analysis	Development of the other regulations / guidelines	Examination of economic approaches or indirect approaches
People's Participation	Development of the regulation on environmental information disclosure	Execution of activities stipulated in the regulation such as establishment of database, issuing annual report, etc.	Expansion of the people's participation activities

ANNEX 1: GUIDELINES ON WASTEWATER MANAGEMENT BY VIENTIANE (DRAFT)

1. Objectives

Although the water environment of drainage canals in the center of Vientiane has deteriorated with canal water turning dark or black and emitting bad odor, there is presently no regulation on wastewater management. This guideline aims to contribute to the improvement of water environment of drainage canals before necessary laws or regulations are developed. The following are the key policies fully considered in devising the articles of the Guidelines:

- To clarify the responsibilities of actors relevant to the activities;
- To cover all the flow of activities in order to avoid the vacancy of responsibilities; and
- To utilize the existing rules and customs by putting them at appropriate places of the activity flow to enhance the enforcement power as much as possible.

2. References

There are several policies, laws and regulations concerning environment and water quality which have been enacted in Lao PDR as listed below. Since this guideline was compiled considering these existing laws and regulations, it is required to refer to them carefully when this guideline is applied and/or construed.

- National Strategy on Environment
- Environmental Protection Law (EPL)
- Decree on Environmental Impact Assessment
- Regulation on Wastewater Discharge from Industrial Processing Factories
- The Agreement on National Environment Standards
- Ministerial Decision for Building Control

3. Domestic Wastewater

3.1 Objectives

Domestic wastewater or gray water is presently discharged untreated into drainage canals, which is the main pollution source of the water quality in the canals. Since most of the main canals in the center of Vientiane are open, deterioration of the water environment is obvious to everyone walking along the canals with the color and odor of the water flow. Therefore, the management of domestic wastewater is indispensable for the improvement of water environment in Vientiane.

3.2 Activities and Responsibilities

3.2.1 Source Control (Private House Owners)

Since it is not realistic to require all private houses in the city center to install a wastewater treatment facility considering the present standard of living and space, it is recommended that houses should control the sources of wastewater by enhancing the effects of the natural treatment system.

3.2.1.1 Minimize Water Use

Persons living in private houses are enjoined to reduce the water use in various living scenes with various ways to reduce wastewater. Examples of water use are cooking, clothes washing, bathing, car/motorcycle washing, gardening, etc.

3.2.1.2 Avoid Discharge of Problematic Substances

Solid content and fat/oil in the wastewater would reduce the effect of natural treatment system and disinfectants such as chlorine bleach would damage such effect. Discharge of such substances should be avoided as much as possible.

3.2.1.3 Participate in Training and Dissemination

Training and dissemination are indispensable to promote source control by people although it takes a long time to realize the effects. People should be encouraged to participate in the occasions of training and dissemination activities for promoting source control activities. Children should be encouraged to participate in classes or activities of environmental education and discuss with their parents at home.

3.2.2 Onsite Wastewater Treatment System (Large Building Owners)

3.2.2.1 Installation

The owner of a building having the function of office, school, shop, market, hospital, theater, residence, hotel, or restaurant as categorized under the Building Categorization of the Agreement on National Environment Standards (hereinafter referred to as a "Large Building") shall install a wastewater treatment system on its building site. All the domestic wastewater from the building shall be treated by the wastewater treatment system and then discharged to a drainage system.

The wastewater treatment system shall be designed to have a capacity to treat all the domestic wastewater discharged and meet the Standards of the Wastewater Discharge in Urban Area of the Agreement on National Environment Standards (hereinafter referred to as the "Wastewater Standards"). Large building owners shall maintain the wastewater treatment system to keep its treatment capacity.

This guideline does not prevent a large building owner from installing a system which treats both black water and domestic wastewater.

3.2.2.2 Building Permit

Large building owners shall submit their domestic wastewater treatment plans together with other required documents when applying for a building permission. The domestic wastewater treatment plan shall include a layout drawing together with the connection to a drainage system, a certificate of the treatment capacity issued by an authorized engineer, and a maintenance plan of the wastewater treatment system.

3.2.2.3 Inspection

The Department of Public Works and Transport of Vientiane (DPWT) or the Vientiane Urban Development and Administration Authority (VUDAA) shall inspect the installation of a wastewater treatment system during or after the construction of the said building. If the wastewater treatment system is not installed in the same way as the domestic wastewater

treatment plan without due reason(s), the Mayor of Vientiane may request a corrective action by the Large Building owner.

3.2.2.4 Monitoring

The DPWT/VUDAA shall monitor the capacity of the wastewater treatment system of the Large Building every two years after its construction with the collaboration of the Department of Environment, Water Resources and Environment Administration (WREA). The DPWT/VUDAA shall prepare a monitoring plan and keep records of monitoring results. If the discharged wastewater from the building does not meet the Wastewater Standards without due reason(s), the Mayor of Vientiane may request a corrective action by the Large Building owner.

3.2.3 Clustered Wastewater Treatment System

The DPWT/VUDAA shall formulate a plan of clustered wastewater treatment system which will treat the domestic wastewater discharged from private houses with the collaboration of the Public Works and Transport Institute, Ministry of Public Works and Transport. The plan shall include a financial sub-plan, a construction sub-plan and a maintenance sub-plan.

The DPWT/VUDAA shall manage the construction of the system. The construction cost may be financed by the national budget and/or foreign aid. The DPWT/VUDAA shall maintain the system after the completion of construction.

3.2.4 Water Environment Education and Dissemination

The DPWT/VUDAA shall establish a plan of education and dissemination of water environment information with the collaboration of the Department of Education of Vientiane and NGOs. Side reader developed by the Pilot Project of the JICA Study shall be utilized for the education and dissemination of water environment information.

Mass media such as TV programs and newspapers shall be used for the effective improvement of awareness of the people.

4. Septic Tank and Septage

4.1 Objectives

Septic Tank is recommended for the black water treatment system, considering the present economic and social situations of Vientiane. Besides, poor management of septic tanks and septage is also causing the deterioration of water quality in the drainage canals, so that the promotion of appropriate management of septic tanks and septage is also important for the improvement of the water environment in the drainage canals. Since the management of septic tanks and septage is related to a variety of people and organizations, necessary activities and responsibilities should be clarified step by step in the flow of management. This guideline, however, does not prevent a building owner from installing a black water treatment system with higher technologies which meets the water quality standards of wastewater discharged. In addition, it does not prevent a large building owner from installing a system which treats both black water and domestic wastewater.

4.2 Activities and Responsibilities

4.2.1 Design of Septic Tanks

The Ministry of Public Works and Transport shall issue standard designs of septic tanks for private houses and large buildings. Standard designs shall include the conventional type which treats only black water and the integrated type which treats both black water and gray water. Their requirements shall include the following:

- The design shall meet the water quality standards on wastewater discharge; and
- The designed septic tank shall be easy to maintain.

4.2.2 Installation of Septic Tanks

4.2.2.1 Building Permission

A building owner shall submit a septic tank plan with other required documents when he/she applies for a building permission. The septic tank plan shall include a layout drawing together with the connection to a drainage system and the maintenance plan. Large building owners shall additionally submit a certificate of the treatment capacity issued by an authorized engineer.

4.2.2.2 Inspection

DPWT/VUDAA shall inspect the installation of a septic tank during or after the construction of the Large Building. If the septic tank is not installed in the same way as the septic tank plan without any due reason(s), the Mayor of Vientiane may request a corrective action by the Large Building owner.

4.2.2.3 Monitoring

The DPWT/VUDAA shall monitor the capacity of the septic tank of the Large Building every two years after its construction in collaboration with the Department of Environment, WREA. The DPWT shall make a monitoring plan and keep records of monitoring results. If the discharged wastewater from the building does not meet the Wastewater Standards without due reason(s), the Mayor of Vientiane may request a corrective action by the Large Building owner.

4.2.3 Maintenance of Septic Tanks

Building owners shall maintain the septic tank in accordance with the maintenance plan. Maintenance shall include the following:

- To keep tank load at an appropriate level for keeping its treatment capacity;
- To keep all the treated wastewater discharged to the drainage; and
- To avoid discharge of problematic substances such as solid content, fat/oil and disinfectants that would reduce or damage the effect of the treatment system.

Large building owners shall keep records of maintenance and shall present them when he/she is monitored by the DPWT/VUDAA.

4.2.4 Desludging and Hauling

A building owner shall ask one of desludging/hauling business entity certified by a District Office to desludge the septic tank before it exceeds the limit of tank load for keeping its treatment capacity.

The desludging/hauling business entity shall desludge the septic tank with careful consideration on the hygienic condition of the environment and the desludging workers, and shall haul the septage to the dumping site designated by the VUDAA. Recycled septage can be recommended for fertilizer when the conditions mentioned below (**Subsection 4.2.7, Recycling**) are met.

4.2.5 Desludging/Hauling Business Entities

A desludging/hauling business entity is required to be certified by the District Office located in the area where it mainly conducts its business. District offices shall keep records of desludging/hauling business entities. Detailed regulations for the control of desludging/hauling business entities shall be devised by the Ministry of Public Works and Transport.

4.2.6 Disposal Site

The VUDAA shall maintain the septage disposal site and shall control the desludging/hauling business entities, which haul septage to the site.

When the VUDAA outsources the maintenance of the disposal site and/or the control of desludging/hauling business entities which hauls septage to the site, the VUDAA shall prepare a guideline for outsourcing the maintenance of the disposal site and/or control of the desludging/hauling business entities. The VUDAA shall not be immune from the responsibility of maintenance and/or control even if the business is outsourced.

Since no wastewater treatment facility has been developed so far, the VUDAA shall construct a septage disposal site with stabilization ponds and water supply facilities for cleaning vacuum trucks, as well as prepare a regulation for the management of septage disposal site.

4.2.7 Recycling

Since fecal sludge collected by vacuum trucks of the desludging/hauling business entities contains high concentrations of excreted pathogens (bacteria, viruses, protozoa, and helminth that causes gastrointestinal infections), it can be used for fertilizer after it is treated in order not to have impacts on the environment and public health.

Composting plant is recommended for the treatment of the fecal sludge as it dries the sludge to reduce pathogens in a sustainable way. Universities and NGOs are expected to support the community in constructing the compost plant and the DPWT/VUDAA shall disseminate and promote it.

4.2.8 Hygiene Education and Dissemination

The DPWT/VUDAA shall establish a plan of education and dissemination of hygiene in collaboration with the Department of Health, the Department of Education of Vientiane and the NGOs. The side reader developed by the Pilot Project of the JICA Study shall be utilized for the education and dissemination of hygiene.

Mass media such as TV programs and newspapers shall be used for the effective improvement of awareness of the people.

5. Industrial Effluent

5.1 Objectives

The Decree on EIA requires a certification showing that the Environmental Management and Monitoring Plan (EMMP) has been approved. Besides, since the Regulation on the Wastewater Discharge from Industrial Processing Factories stipulates water quality standards, inspection and penalty by the authorities concerned, it can be said that the legal system is already developed to a certain extent. The main issue here is how the laws/regulations can be effectively enforced. Major reasons of this issue are:

- Detailed procedures on the enforcement of regulations are not developed yet;
- Environmental authorities are not fully developed yet in local levels; budget, manpower, skills are not enough to achieve the mandate of the authorities;
- Demarcation of responsibilities among relevant authorities are not clear in existing laws; and
- The strong leadership of top government officials is the key to start timely actions toward the solution.

Thus, articles in the following sections are stipulated considering the reasons mentioned above.

5.2 Responsibilities and Activities

5.2.1 Rule Making

The WREA shall develop detailed procedures, guidelines or manual for the execution of laws and regulations in collaboration with the Ministry of Industry and Commerce. After these sub-rules are developed, they shall be reviewed every time they are applied to improve the description and to avoid mismanagement.

5.2.2 Inspection

The Department of Industry and Commerce of Vientiane (hereinafter referred to as the "DIC") shall inspect factories to check whether their industrial effluents meet the standards in collaboration with the WREA, WREO of Vientiane and the relevant District Office. When found by WREA that a factory's effluent causes an environmental problem, WREA shall inform the DIC of the matter immediately. The Agreement on National Environment Standards shall be applied to the results of inspection. In case the application of a standard is not clear, the WREA shall decide. The DIC shall keep records of inspection.

5.2.3 Sanctions

If it is clarified by the results of inspection that the factory effluent does not meet the standards, the DIC shall take the necessary action(s) for the said factory to meet the standards, applying "Part V, Rights and Authorities of Industry Sector" and "Part VI, Fines and Punishment of Regulation on the Wastewater Discharge from Industrial Processing Factories." The DIC shall present the results of inspection to the said factory upon request.

5.2.4 Public Relations

The first key to the enforcement of regulations is how to get the top of government to take a strong leadership. The second key is the awareness of people on environmental issues by dissemination and education. If the awareness of the people is improved it is easier for the top of government to take the leadership and also for the staff to start working. In addition, mass media tend to carry the

news as the news value increases. Therefore, the WREA shall promote public relations activities through the mass media, websites, etc.

6. Drainage Canals

6.1 Objectives

Accumulated sludge in drainage canals causes water quality deterioration and bad odor in addition to some inundation in the vicinity. Thus, the dredging of sludge is one of the key points on the management of drainage canals in the city center. Since the dredging exercise by the government authorities is not satisfied due to the shortage of budget and manpower, participation of the residents should be considered.

6.2 Activities and Responsibilities

6.2.1 Maintenance Plan

The DPWT/VUDAA shall prepare a maintenance plan of the drainage canals. The plan shall include a monitoring plan and a dredging plan with the designation of priority areas in Vientiane.

6.2.2 Monitoring

The DPWT/VUDAA shall monitor the drainage canals in accordance with the maintenance plan. Regardless of this monitoring by the DPWT/VUDAA, the Village Chief shall report to the District Office if he/she deems that dredging is required.

6.2.3 Dredging

The DPWT/VUDAA shall execute the maintenance work in accordance with the plan. The DPWT/VUDAA shall hire private companies for the maintenance work, if necessary. If an extra drainage work is required, the DPWT/VUDAA shall coordinate the work with other works planned in the maintenance plan, considering the budge limitation.

6.2.4 Participation of the Residents

The DPWT/VUDAA shall promote the participation of the village residents as much as possible for the exercise of dredging in cooperation with the Village Chief. The DPWT/VUDAA shall supervise the work and shall consider the budgetary assistance if the work is exercised with the participation of the village residents.

7. Wastewater Management Committee

7.1 Objective

Since various stakeholders are related to the wastewater management, a committee shall be established to share the information and to conduct the management in an integrated manner among the stakeholders.

7.2 Committee Members

The chairperson of the committee shall be the Director-General of the DPWT and its secretariat shall be Housing, Town and Environment Office of the DPWT. Members are as follows:

- MPWT

- VUDAA
- Department of Environment, WREA
- WREA Lab
- Water Resources and Environment Office of Vientiane
- Department of Health of Vientiane
- Department of Industry of Vientiane
- Representative of villages, which shall be nominated by the secretariat and approved by the chairperson
- Representative of universities/NGOs, which shall be nominated by the secretariat and approved by the chairperson
- Representative of private house owners, which shall be nominated by the secretariat and approved by the chairperson
- Representative of large building owners, which shall be nominated by the secretariat and approved by the chairperson
- Representative of desludging/hauling companies, which shall be nominated by the secretariat and approved by the chairperson

7.3 Activities and Responsibilities

The following agenda shall be discussed and the relevant information shall be exchanged among the members:

- Present situations of water environment in drainage canals;
- Action plan for the improvement water environment; and
- Summary of activities of members in the previous period.

Relevant governmental agencies shall reflect the discussions of the committee on their future activities.

8. Glossary

Septage:	A combination of scum, sludge, and liquid that accumulates in septic tanks.
Gray water:	Wastewater from baths, showers, hand basins, washing machines and dishwashers, laundries and kitchen sinks.
Fecal sludge:	Sludges of variable consistency collected from so-called on-site sanitation systems; viz. latrines, non-sewered public toilets, septic tanks, and aqua privies.
Domestic wastewater:	Same as Gray water.
Onsite wastewater treatment system:	A system relying on natural processes and/or mechanical components to collect, treat, and disperse or reclaim wastewater from a single dwelling or building.
Clustered wastewater treatment system:	A wastewater collection and treatment system under some form of common ownership that

collects wastewater from two or more dwellings or buildings and conveys it to a treatment and dispersal system located on a suitable site near the dwellings or buildings.

Septic tank: A buried, watertight tank designed and constructed to receive and partially treat raw wastewater. The tank separates and retains settle-able and floatable solids suspended in the wastewater and discharges the settled wastewater for further treatment and dispersal to the environment.

Stabilization pond: A man-made pond (treatment unit) in which wastewater is allowed to stand for time, under the influence of microorganisms and the forces of nature, so that it is converted into an effluent that meets the quality standards established for final disposal or reuse.

Supplementary Table: Wastewater Management Framework

Responsible Entity	Objectives	Activities
Private house owners	To reduce the discharge of wastewater	To save on water use at each house
	To improve sanitary conditions	To install a septic tank and keep appropriate management
Large building owners (hotel, restaurant, apartment house, school, government office, etc.)	To improve sanitary conditions	To install a septic tank and keep appropriate management
	To treat domestic wastewater at point source	To construct an onsite wastewater treatment system (CBS/SBC, for example) and keep appropriate management
DPWT/VUDAA	To improve the awareness of the general people on water quality	To promote environmental information dissemination and education
	To improve the water environment of canals	To dredge the canals periodically; To construct clustered treatment facilities for domestic wastewater from private houses; To require a septic tank on issuing a building permission; and To conduct inspection/monitoring of septic tanks of large buildings.
	To enforce the regulation for onsite wastewater treatment systems	To require an onsite wastewater treatment system on issuing a building permission; and To conduct inspection/monitoring of onsite wastewater treatment systems;
VUDAA	To improve the sanitary conditions of the disposal site	To manage the disposal site and construct a stabilization pond and water supply facilities;
MPWT	To promote the construction of onsite wastewater treatment systems	To issue the regulation for onsite wastewater treatment systems;
DIC	To control industrial effluent	To inspect the industrial effluent; and To impose a sanction to a factory violating the standard;
WREA	To assist other agencies on water quality matters	To conduct water quality measurement

ANNEX 2: REGULATIONS ON THE CONTROL OF DESLUDGING/ HAULING BUSINESSES BY VIENTIANE (DRAFT)

1. General Principles

1.1 Objectives

This regulation aims to improve the sanitary and water environment of urban areas with the proper control of desludging/hauling businesses as well as promote the sound development of desludging/hauling businesses to provide suitable services to users. This regulation shall not be construed and applied in a way to disturb the sound activities of a desludging/hauling business.

1.2 Definition

Desludging/hauling business: This is a business activity where services are provided regarding the collection of sludge from toilet tanks and transporting it to a designated place. Sludge is fecal waste or the mixture of fecal waste and residual of treated domestic wastewater. Either desludging or hauling business shall be considered as desludging/hauling business.

2. Business Certificate

2.1 Application for Business Certificate

(1) A desludging/hauling business entity is required to obtain a business certificate from the District Office which has jurisdiction over the area where the entity plans to do its main business (hereinafter referred to as "Certification Office").

(2) Necessary information for the application of a business certificate shall include:

- Name and address of the representative;
- Number of employees;
- List of equipment and vehicles to be used for the business; and
- Outline of business history including award and punishment concerning the business in last five years.

(3) A business certificate shall be valid for one year after its issue date.

(4) The business entity shall pay the application fee to the Certification Office. The amount of the application fee shall be decided by the Mayor of the City of which the Certification Office is under the jurisdiction.

2.2 Responsibilities of Business Entities

The business entity shall:

(1) Keep its equipment and vehicles clean at all times;

(2) Keep the working conditions of its employees hygienic; and

(3) Keep the hauling track records (time/date and destinations) of each hauling vehicle.

The business entity is prohibited from:

(1) Dumping the sludge in a place other than those designated by the City authority (hereinafter referred to as "illegal dumping");

(2) Making material misstatement or falsification in the hauling track record(s); and

(3) Conducting desludging/hauling business without a certificate or with an invalid certificate.

2.3 Termination of Business Certificate

The business certificate shall be terminated when:

(1) One year has passed after its issue date; or

(2) The business entity violates items (1) and/or (2) of the prohibited activities in Section 2.2, Responsibility of Business Entities.

2.4 Repeal of Business Certificate

(1) When the information provided by the business entity on the application of the business certificate proves of material misstatement, its business certificate shall be repealed. If the business certificate is repealed, it shall be deemed invalid from the issue date.

(2) Despite the previous clause, the rights and duties of a bona fide counterpart in the contract with the said business entity shall be valid.

3. Illegal Dumping

3.1 Reporting

Any person may report in writing to a District Office if he/she finds that an illegal dumping has been made.

3.2 Confirmation

The District Office which receives the report of illegal dumping shall confirm the fact of the illegal dumping reported.

3.3 Inspection

The District Office may inspect a business entity and ask for the presention of the hauling track records of all the entity's vehicles for the purpose of clarifying the fact of the illegal dumping reported.

4. Punishment and Compensation

4.1 Punishment

4.1.1 Illegal Dumping

If it is clarified from a hauling track record that a desludging/hauling business entity commits illegal dumping, the business certificate of the desludging/hauling business entity shall be terminated and renewal of the business certificate shall not be permitted for one month.

4.1.2 Misstatement/Falsification of Hauling Track Record

The same penalty as in the preceding Subsection 4.1.1 shall apply to a desludging/hauling business entity which makes a material misstatement or a falsification of its hauling track records.

4.1.3 Business Conducted without Certificate

A person who has conducted desludging/hauling business without a certificate or with an invalid certificate shall be fined ten (10) times of the application fee for the business ceritificate.

4.2 Compensation

A desludging/hauling business entity which commits illegal dumping shall compensate the damage caused by its illegal dumping.

5. Database and Data Share

The Certification Office shall keep the documents submitted for the application of business certificate for three years. The Department of Public Works and Transport shall make a database of desludging/hauling business entities certified by the Certification Office in the City.

6. Disclosure

The Department of Public Works and Transport shall disclose the database of desludging/hauling business entities to those who intend to ask for desludging/hauling services.

4.4.4 Water Environment and Hygiene Education Promotion Plan

(1) Setup of Planning Objective

The planning objective of the water environment and hygiene education promotion plan (target year: 2020) as a component of the Master Plan was setup as follows:

Counterpart (C/P) agencies will implement water environment and hygiene education sustainably and broadly in the Vientiane urban area with the cooperation of related organizations so that the awareness of citizens will be raised to behave in a good manner in their daily lives.

Coordination with the following subjects was considered in the setup:

- The strategy of the Master Plan on water environment improvement; and
- ―National Strategy on Environmental Education and Awareness to the years 2020 and Action Plan for the years 2006 to 2010" issuedin 2004 by STEA, the predecessor of WREA, with the support of SIDA.

(2) Formulation of Activity Promotion Roadmap

A practical activity promotion roadmap has been formulated as shown in **Tables 4.4.9** (summary) and **4.4.10** (detail) to accomplish the planning objective noted above taking the following subjects into consideration. Responsible/implementing agencies in these activities are primarily district educational offices, and primary schools' teachers shall substantially make those activities in cooperation with experienced PTI officials.

- Consistency with the phasing and alternatives of the structural measures in the Master Plan;
- Synergistic effect of the software and hardware by carrying out water environment and hygiene education (non-structural measures) for students and residents in line with the construction of wastewater treatment facility (structural measures); and
- Verifying its effectiveness, appropriateness, sustainability and potentiality by reflecting the experience and lessons learned from the implementation of the pilot project.

Table 4.4.9 Activity Promotion Roadmap on Environmental Education (Summary)

Phase	Activities	Target Area
Phase 1 (2010-2011)	- TOT (training of trainers) based activities are conducted for the teachers, students and villagers in the first pilot school and community in line with SBS/ CBS construction.	Hong Pasak and Hong Thong drainage areas
Phase 2 (2012-2015)	- The second pilot schools and communities will be selected. They will have TOT by trained trainers of the first pilot school and community to disseminate the activities in line with the construction of wastewater treatment facility.	Hong Ke and Hong Xeng drainage areas
	- Relating organizations will monitor and assist the activities as well as carry out public relations.	
Phase 3 (2016-2020)	- Pilot schools and communities will gradually be increased, so that the activities will be implemented and expanded sustainably and broadly in line with the dissemination of wastewater treatment facilities.	Hong Ke and Hong Xeng drainage areas and other Vientiane urban areas
	- Related organizations will monitor and assist the activities as well as carry out public relations.	

Table 4.4.10 Activity Promotion Roadmap on Environmental Education

Planning Objective to year 2020		Counterpart (C/P) agencies will implement water environmental and hygiene education sustainably and broadly in Vientiane urban area with the cooperation of related organizations so that the awareness of the citizens will be raised to behave in a good manner in their daily lives.	
Phasing		Activities	Target Area
Master Plan (until the year 2020)	Phase 1 (2010-2011)	1) The cooperation with the C/P agencies and related organizations will be established through conducting the following activities in line with "National Strategy on Environment Education and Awareness to the year 2020 (2004)".	Hong Pasak and Hong Thong drainage areas (built-up Vientiane urban center with the most deteriorated water quality)
		2) The 1st pilot school and community will be selected and awareness raising activities are conducted for the teachers, students and villagers there in line with SBS and CBS cnstruction.	
		3) TOT (training of trainers) workshops with model classroom lectures and participatory activities will be conducted at the 1st pilot school and community to train potential trainers who are expected to promote the activities continuously.	
		4) Through above TOT workshops, an educational side reader will be developed.	
		5) PR activities by distributing the side reader will be conducted to disseminate the activity widely.	
		6) The lessons learned from Phase 1 activity will be reviewed in order to implement next Phase 2 smoothly and sustainably.	
		7) The capacity of the C/P to promote Phase 2 by themselves will be enhanced through above activities.	
		8) The cooperation with the C/P agencies and related organizations will be strengthened through conducting above collaborative activities.	
	Phase 2 (2012-2015)	1) The 1st pilot school and community established will continue the activity regularily with the assistance of related organizations.	Hong Ke and Hong Xeng drainage areas (built-up Vientiane urban areas)
		2) The 2nd pilot schools and communities will be selected to disseminate the activities widely in line with the construction of wastewater treatment facility.	
		3) The 2nd pilot schools and communities (primary school teachers and key villagers) will be trained by the trained teachers and villagers of the 1st pilot school and communitiy.	
		4) Above newly trained trainers will promote activities in their 2nd pilot schools and communities.	
		5) The relevant agencies will monitor and assist the above activities as well as conduct PR activity in collaboration with the relevant organizations.	
	Phase 3 (2016-2020)	1) Pilot schools and communities will gradually be increased in a strategic manner with the same methodology in the Phase 2, so that the activities will be implemented and expanded sustainably and broadly in line with the construction of wastewater treatment facility.	1) Hong Ke and Hong Xeng drainage areas 2) Other surrounding urban areas to be developed
		2) The relevant agencies will monitor and assist the above activities as well as conduct PR activity in collaboration with the relevant organizations.	
10 - 20 years after Master Plan		1) The activity achievement and the lessons learned until 2020 will be reviewed in order to start next step activity smoothly and sustainably.	All the built-up Vientiane urban areas
		2) Pilot schools and communities will continuously be increased so that the educational activities will be implemented and disseminated sustainably and broadly in the target area.	

(3) Selection of Pilot Project

As the priority promotion activity, Phase 1 of the roadmap formulated above was selected as the environmental education component of the pilot project. As described in **Chapter 3**, the pilot project was jointly implemented with LIRE-BORDA at two selected SBS/CBS construction sites from October 2009 to March 2011.

4.4.5 Action Plan

Two-phased 5-year action plans shall be formulated for the smooth implementation of the master plan components, and the rolling plan system is employed. After completion of the first phase action plan, its results shall be evaluated and some modifications shall be made in the second phase action plan based on the evaluation due to rapid changes of socio-economic situations surrounding the projects. The following table summarizes a phased action plan.

Table 4.4.11 Water Environment Management Action Plan

Components	First Phase Action Plan	Second Phase Action Plan
Structural Water Improvement	(1) Finding funding donors for installation of SWTP with local interceptors (2) Detailed design and installation of simple wastewater treatment plants (SWTP) with local interceptors in Hong Pasak (3) Finding funding donors for in-stream treatment facilities (4) Implementation of in-stream treatment plant construction in Nong Chanh (5) Detailed survey and study on appropriate countermeasures for water quality improvement in other drainage canals	(1) Review of appropriate countermeasures for remaining drainage canals based on monitoring results (2) Installation or application of appropriate measures for drainage canals, if necessary (3) Implementation of conservation of remaining marshes, if necessary
Evaluation of Progress	(1) Checking of progress in SWTP installation (2) Periodical monitoring of drainage canals and remaining marsh situations	(1) Checking of operational status of SWTP (2) Checking status of water quality improvement from monitoring results
Implementation Agencies	PTI, DPWT,WREA	
Institutional and Legal Improvement	(1) Expansion of regulation on environment protection fund (2) Development of guideline on training master plan for related agencies (3) Formulation of training master plan of WREA Lab (4) Development of prioritized regulations/guidelines (5) Development of regulations/guidelines on water quality monitoring, and guidelines on water quality (6) Development of regulations on environmental information disclosure	(1) Expansion of environment protection fund (2) Formulation of training master plans of related agencies (3) Training activities for the WREA Lab (4) Development of the regulations/guideline on other measures (5) Execution of activities stipulated in the regulations such as establishment of database, issuing annual report, etc.
Evaluation of Progress	(1) Checking of development process in above system	(1) Checking osdevelopment process in above system
Implementation Agencies	MPWT, WREA	
Environmental Education	(1) Environmental education activities as pilot project (2) Conducting training of trainers (TOT) (3) Environmental education activities in increased model communities in line with the construction of wastewater treatment facilities	(1) Conducting training of trainers (TOT) (2) Environmental education activities in increased model communities in line with the construction of wastewater treatment facilities
Evaluation of Progress	(1) Monitoring of progress of people's awareness and participation	(1) Monitoring of progress of people's awareness and participation
Implementation Agencies	PTI, District Education Offices	

All of the related governmental agencies can recognize the importance of water environment improvement. The situations in budgetary allocation, however, are not favorable, in particular budgetary constraints to construct necessary facilities. Thus the budget related to water environment improvement shall be allocated effectively to the core agencies/actors, such as PTI, MPWT and so on. Furthermore, various donors and international NGOs have keen interests to support environment improvement activities and projects so that these governmental agencies shall implement effectively related projects with referring the above action plan and avoiding the overlapping among the projects, and shall conduct monitoring activities and legal system improvement in parallel.