People's Committee of Hanoi City
Hanoi Sewerage & Drainage Company
Socialist Republic of Viet Nam

No.

STRENGTHENING OF OPERATION AND MAINTENANCE OF SEWERAGE FACILITIES IN HANOI

Final Report

December 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS, CO., LTD.

HELS CORPORATION

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Abbreviations and Glossary

ACC	Acceleration
AFSSP	Anaerobic & Final Sludge Scraper Panel
AI/O	Analog Input/Output
BOD	Biochemical Oxygen Demand
BLT	Build-Lease-Transfer
BTL	Build -Transfer-Lease
BOO	Build-Own-Operate
BOT	Build-Operate-Transfer
BROT	Build-Rehabilitate-Operate-Transfer
BTO	Build-Transfer-Operate
CCTV	Closed-Circuit Television
CJV	Contractual or Co-Operative Joint Venture
CMBP	Channel Mixing Blower Panel
COD	Chemical Oxygen Demand
DBFO	Design –Build-Finance-Operate
DBO	Design-Build-Operate
DCP	Deodorization Control Panel
DI/O	Digital Input/Output
DISP	Displacement
DO	Dissolved Oxygen
DOC	Department of Construction
DONRE	Department of Natural Resources & Environment
DP	Deodorization Panel
DPI	Department of Planning and Investment
DWP	Dewaterer Panel
FST	Final Settling Tank
FWP	Filter Water Panel
GCP	Grit Chamber Panel
GP	Generator Panel
HAPI	Hanoi Authority for Planning and Investment
HPC	Hanoi People’s Committee
HSD-PMB	Hanoi Sewerage and Drainage Project Management Board
HSDPMU	Hanoi Sewerage and Drainage Project Management Unit
HSDC	Hanoi Sewerage and Drainage One-Member State Company Limited

ICS	Integrated Control System
IFC	International Finance Corporation of World Bank
JICA	Japan International Cooperation Agency
JSWA	Japan Sewage Works Agency
KVM	Keyboard, Video and Mouse
LP	Local Control Panel
LPP	Lift Pump Panel
LTDP	Low Tension Distribution Panel
MLSS	Mixed Liquor Suspended Solid
MLVSS	Mixed Liquor Volatile Suspended Solid
MOC	Ministry of Construction
MPMU	Major Project Management Unit for Urban Development of Hanoi
MWCI	Manila Water Company, Inc.
MWSI	Maynilad Water Services, Inc.
MWSS	Metropolitan Waterworks and Sewerage System
NH4-N	Ammonium Nitrogen
NO2-N	Nitrite Nitrogen
NO3-N	Nitrate Nitrogen
O&M	Operation and Maintenance
OJT	On-the-Job Training
ORP	Oxidation Reduction Potential
PFI	Private Finance Initiative
PI	Pulse Input
PO4-P	Phosphate Phosphorus
PLC	Programmable Logic Controller
PPP	Public-Private Partnership
PS	Pumping Station
PSP	Primary Sludge Panel
PST	Primary Settling Tank
RAS	Return Activated Sludge
ROT	Rehabilitate-Operate-Transfer
SAP	Surface Aeration Panel
SCADA	Supervisory Control and Data Acquisition
SOC	Social Overhead Capital
SPC	Special Purpose Company
SPV	Special Purpose Vehicle
SS	Suspended Solid

STP	Sludge Treatment Panel
SVI	Sludge Volume Index
SVP	Supervisory Panel
TKCM	Tirta Kencana Cahaya Mandiri
T-N	Total Nitrogen
T-P	Total Phosphorus
UDE	Urban Drainage Enterprise
UIPMU	Urban Infrastructure Project Management Unit
USD	US Dollar
VEL	Velocity
VND	Vietnamese Don
WAS	Waste Activated Sludge
WSSP	Water Supply System Panel
WTE	Wastewater Treatment Enterprise
WWTP	Wastewater Treatment Plant

Chapter 1 Background & Objectives of Study

Increasing discharge of untreated industrial and domestic sewage to public water courses accompanied by enlargement of industrialization, urbanization and a surge in urban population have worsened the urban water environment in Vietnam. Illegal dumping of solid waste into the water courses has furthered this issue.

Hanoi City, known as the capital of Vietnam and the Lake City, has old sewers of the French colonial time and recently installed sewage treatment facilities; however these facilities do not match the increase of industrial and domestic sewage. This has led to serious water pollution in lakes and water courses in the City. Further, the storm water drainage in the City has insufficient capacity to accommodate the monsoons every May to September and frequently causes inundation in low land areas of the City. Therefore, improvements of the sewerage and drainage are a priority issue of the City.

The Government of Japan has supported the City in its efforts at improving sewerage and drainage through the Hanoi City Water Environment Improvement Project since 1994. Presently, the project is proceeding to the stage of Phase 2.

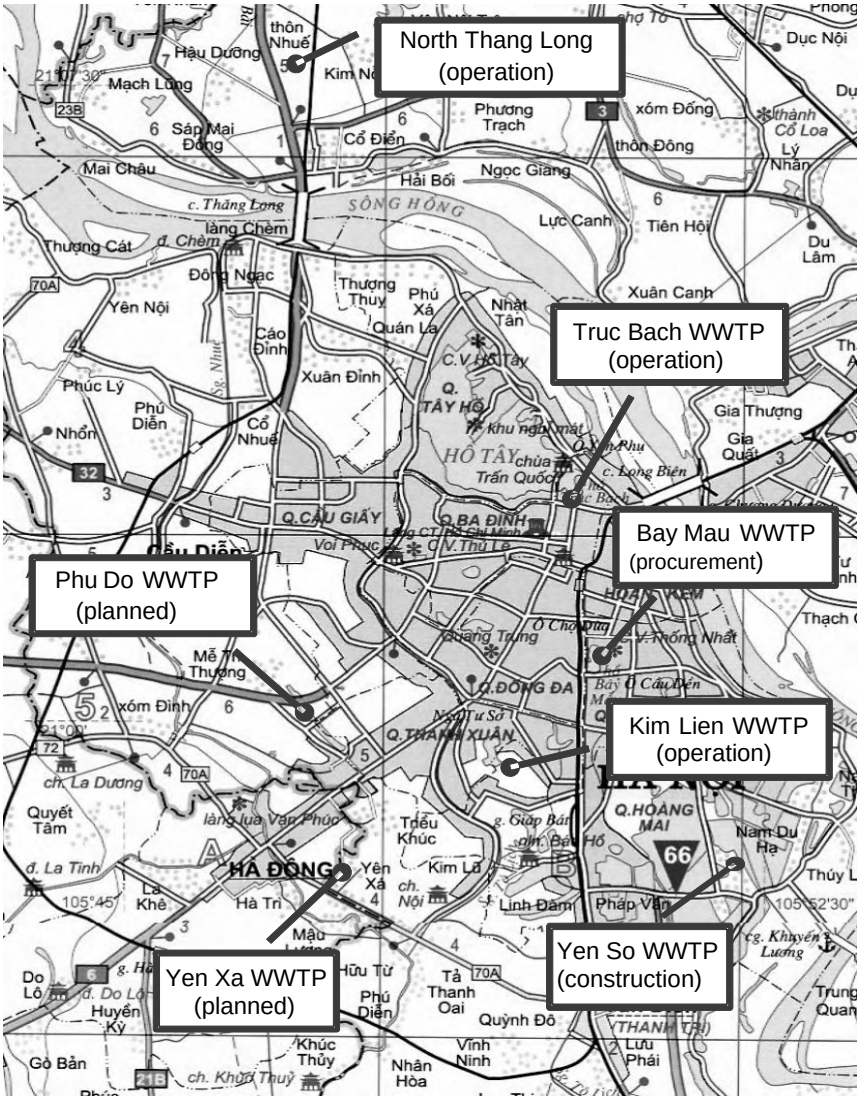
Hanoi Sewerage and Drainage One-Member State Company Limited (HSDC) has been appointed as the operation and maintenance body of sewerage and drainage in Hanoi City. Coverage of the HSDC is the entire jurisdiction including old Hanoi and its extensions. HSDC's facilities are still few and limited to small pilot-scale wastewater treatment plants (WWTP) in Kim Lien and Truc Bach and North Thang Long WWTP. Taking into account the expansion of the City sewerage and drainage in the near feature, further enhancement of HSDC's skills in operation and maintenance is indispensable to fulfill the functions of the entire system. Furthermore, HSDC is in the position to transfer their skills to other provinces in the operation and maintenance of sewerage and drainage.

This assistance (study) provides recommendations and advises HSDC in the operation and maintenance for sewerage and drainage, and supports HSDC to run technical training for the other provinces.

Chapter 2 General Information

2.1 Study Area

The study covers 3 wastewater treatment plants (WWTPs), including Kim Lien, Truc Bach and North Thang Long and Yen So Drainage Pumping Station (PS).



Source : JICA team

Figure 2.1 Study area

Table 2.1 Existing sewerage facilities in Hanoi City

	Kim Lien WWTP	Truc Bach WWTP	North Thang Long WWTP
Sewage Treatment Capacity	3,700 m^3/d	2,500 m^3/d	42,000 m^3/d
Process	A2O process	A2O process	Activated sludge process with nitrification
Service population	15,700	NA	110,000
Year constructed	2005	2005	2009
Capital source	ODA loan	ODA loan	ODA loan
O&M body	HSDC	HSDC	HSDC

Source : JICA team

2.2 Counterparts

Hanoi People's Committee (HPC)

Hanoi Sewerage and Drainage One-Member State Company Limited (HSDC)

2.3 Scope of Study

Task 1 - Review of O&M Performance and O&M Plan

Task 1.1 - Review of Conditions of Sewerage and Drainage Facilities and O&M plan

a. Review plan and actual progress on operation, maintenance and management for the sewerage and drainage services including;
   - Facility construction
   - Service area expansion
   - Promotion of house connections
   - Tariff collection
   - Legislation and guidelines relating to sewerage & drainage services

b. Conduct a performance check of existing sewerage and drainage facilities jointly with HSDC in Truc Bach WWTP, Kim Lien WWTP, North Thang Long WWTP, Yen So PS and their accompanying facilities & equipment with the following objectives;
   - Review inflow and treated water qualities of WWTPs
   - Review inflow rate of WWTPs and PS
   - Review operation and maintenance log (record) of WWTPs and PS
   - Execute a performance inspection of mechanical and electric equipment in WWTPs and PS

Task 1.2 - Review of O&M Activities

a. Check the condition of equipment and tools for operation and maintenance jointly with HSDC and analyze their adequacy and issues such as;
   - Operation manuals
   - Instructions regarding equipment
   - Tools and equipment for operation and maintenance
   - Spare parts
b. Check the organizational framework of HSDC and analyze its efficiency through consultation with HSDC.

Task 2 - Advice for Beneficial Change for Better Operation, Maintenance and Management of Sewerage and Drainage Services

Task 2.1 - Advice for Betterment and Expansion of Services in the Future

Based upon the results of Task 1, provide advice for expansion of service area with augmentation of sewerage customer numbers in the existing sewerage drainage services in particular for the service area of North Thang Long WWTP.

Task 2.2 - Advice for Remote Monitoring and Centralized Control System

Provide advice for technical introduction of the remote monitoring and centralized control system by providing a system chart, preliminary cost estimates, etc. anticipating that HSDC will adopt it in the near future.

Task 2.3 - Advice for Measures against Issues

Provide advice for the measures against the issues identified in Task 1.

Task 3 - Technical Transfer Program to Other Cities

Task 3.1 - Advice for Implementation Framework for HSDC for Technical Transfer to Other Cities

Provide administrative advice for technical transfer to other cities such as venue, transportation, accommodation, arrangement of lectures and instructors, etc.

Task 3.2 - Advice for Formulation of Technical Transfer Programs

Provide advice for formulation of HSDC's technical transfer program such as lectures, OJT, etc.

Task 3.3 - Trial Run of Technical Transfer Programs

Hold and support the HSDC's trial run of the technical transfer programs

Task 4 - O&M Anticipating Public Private Partnership

Task 4.1 – Presentation of O&M of Sewerage and Drainage Systems in Other Countries

a. Presentation of history of sewerage & drainage system development and O&M
b. Presentation of O&M models of sewerage and drainage projects
c. Presentation of issues and approach to the issues on sewerage and drainage projects

Task 4.2 – Presentation of PPP Models for Sewerage and Drainage Projects

a. Presentation of case histories and present situation of PPP
b. Presentation of required conditions and points to consider for adoption of PPP
c. Presentation of PPP models and their role-sharing between the public and private sectors

Task 4.3 - Advice for HPC and HSDC to adopt PPP Model in Sewerage and Drainage Projects

a. Propose an appropriate PPP model for sewerage and drainage projects in Hanoi
b. Propose a proper tariff-revenue mechanism for PPP in sewerage and drainage projects
c. Propose proper contract conditions for PPP in sewerage and drainage projects
d. Formulate a PPP road map in consultation with HPC and HSDC

2.4 Study Plan

2.4.1 Staffing

Name & Position	Assignment
Mr. Koichi SUZUKI Team Leader / Business Plan of Sewerage & Drainage Project	• General management of all activities and coordination with counterparts and relevant organizations • Establishment of basic policy of the study • Selection of object facilities for the study • Compilation of the study results • Write up the study report
Mr. Hiromi ONUKI Sewerage & Drainage Expert – 1 (Treatment Process)	• Performance check of sewage treatment process • Inspection of water quality in WWTPs • Check of WWTPs operation log and maintenance log • Review of O&M plan for sewage treatment process • Technical transfer plan for sewage treatment process
Mr. Kota KINOSHITA Sewerage & Drainage Expert -2 (Mechanical & Electric)	• Performance check of mechanical and electric equipment in WWTPs and Drainage Pumping Station • Check of operation log and maintenance log of WWTPs and PS • Review O&M plan for WWTPs and PS

	• Technical transfer plan for O&M of WWTPs and PS
Mr. Yoichiro ONO Technical Transfer Plan	• Setting-up of implementation framework of HSDC for technical transfer to other cities • Formulation of technical transfer program • Trial run of technical transfer program
Dr. Hyeon-Yeoul KIM Public Private Partnership	• O&M of sewerage and drainage system in other countries • PPP models for sewerage and drainage projects • Advice for HPC and HSDC to adopt PPP model in sewerage and drainage projects

2.4.2 Study Plan

Stage	Item
Stage 1-J Work in Japan -1 March 2010	1. Selection of object facilities for performance checks 2. Preparation of Inception Report
Stage 1-V Work in Vietnam - 1 April – May 2010	1. Kick-off meeting 2. Data collection 3. Task 1.1 - Review plan and actual progress on operation, maintenance and management for the sewerage and drainage services 4. Task 1.1 - Performance check of existing sewerage and drainage facilities jointly with HSDC in Truc Bach WWTP, Kim Lien WWTP, North Thang Long WWTP, Yen So PS and their accompanying facilities & equipment 5. Task 2.1 - Review of the conditions of equipment and tools for operation and maintenance jointly with HSDC 6. Task 2.2 - Review of the present monitoring and control system and equipment jointly with HSDC 7. Task 3.1 – Setting-up of implementation framework of HSDC for technical transfer to other cities 8. Task 3.2 - Preparation of technical transfer programs 9. Task 3.3 - Formulation of trial run schedule 10. Task 4.1 - Presentation of O&M of sewerage and drainage system in other countries 11. Task 4.2 - Presentation of PPP models for sewerage and drainage projects
Stage 2-J Work in Japan - 2 June 2010	1. Analysis and formulation of advice based on results of Stage 1-V 2. Task 2.2 - Conceptual design of remote monitoring & centralized control system 3. Task 3.2 - Preparation of technical transfer programs 4. Case study and preliminary design of PPP model for HPC and HSDC
Stage 2-V	1. Task 1.1 - Supplemental data collection, field work & analysis 2. Task 1.2 - Supplemental data collection and analysis

Stage	Item
Work in Vietnam - 2 July 2010	3. Task 2.1 - Supplemental data collection, field work & analysis 4. Task 2.2 - Supplemental data collection, field work & analysis 5. Task 3.1 - Supplemental discussions 6. Task 3.2 - Advice for technical transfer programs 7. Task 3.3 - First trial run of technical transfer programs 8. Task 4.3 - Discussions regarding appropriate PPP models for HPC and HSDC 9. Interim meeting
Stage 3-J Work in Japan - 3 August 2010	1. Task 1.1 – Compilation of review results 2. Task 1.2 – Compilation of review results 3. Task 2.2 – Review of the conceptual design and cost estimate of remote monitoring & centralized control system 4. Task 2.3 – Formulation of advice for measures against issues on O&M and management 5. Task 3.3 – Preparation of trial run of technical transfer programs 6. Task 4.3 - Preparation of appropriate PPP models for HPC and HSDC
Stage 3-V Work in Vietnam - 3 September 2010	1. Task 2.3 – Presentation of advice 2. Task 3.3 – Trial run of technical transfer programs 3. Task 4.3 – Advice for HPC and HSDC to adopt PPP model in sewerage and drainage projects 4. Wrap-up meeting
Stage 4-J Work in Japan - 4 November 2010	1. Formulation of Draft Final Report

2.4.3 Reporting Schedule

Title	Contents	Submittal period	Language	Number of copies
Inception Report	a Objectives of the Study b Terms of Reference c Study Plan	April 2010	English	10
Final Report	a. Results of review of O&M performance and O&M plan b. Advice for beneficial change for better operation, maintenance and management of sewerage and drainage services c. Technical transfer programs to other cities d. Proposal for O&M anticipating PPP	December 2010	English & Vietnamese	Hardcopy – 10 copies each CD – 5 copies each

2.4.4 Implementation Structure

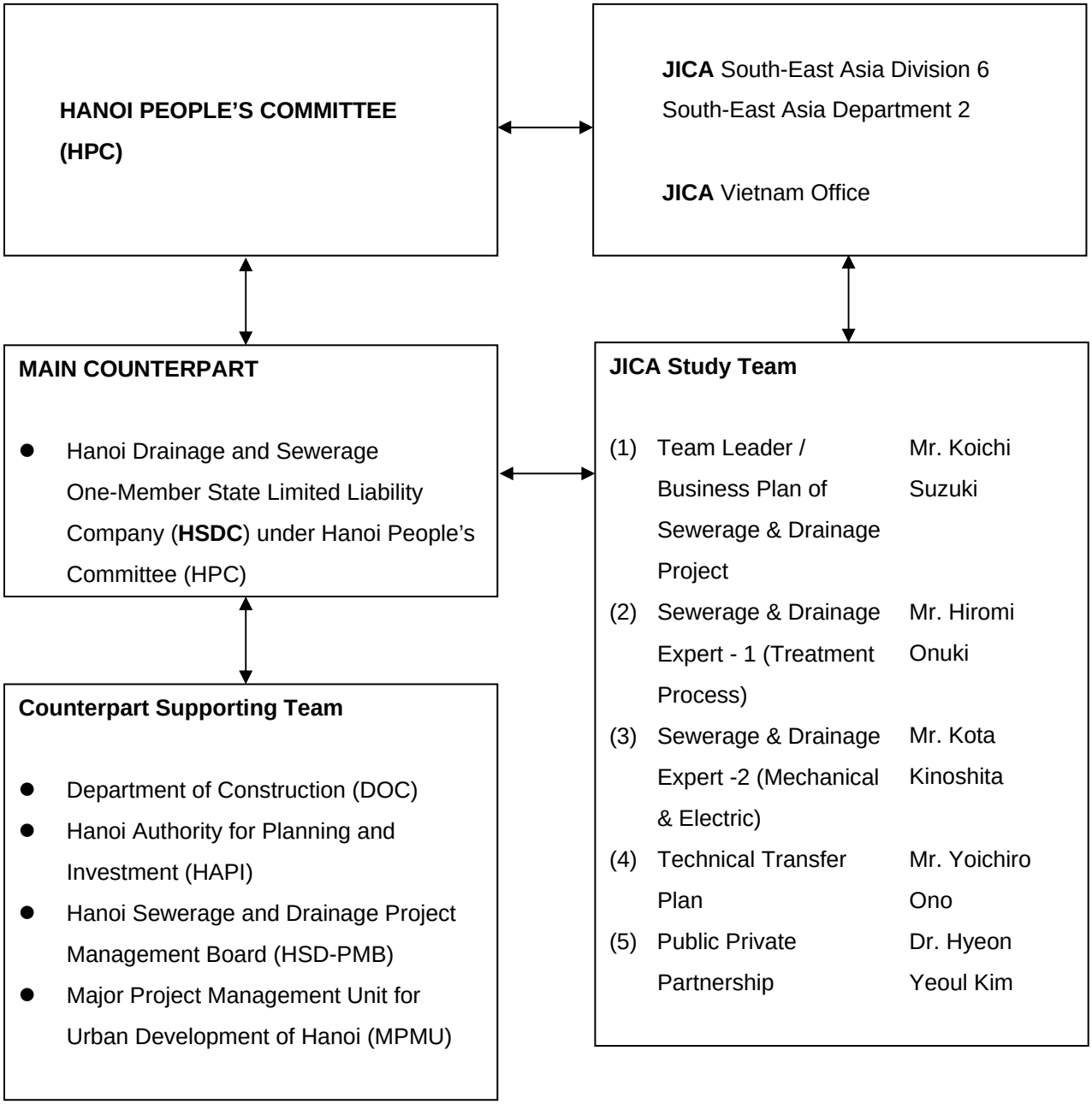


Table 2.2 Assignment schedule

		Position/Expertise	Name	Organization	2010										M/M	
					3	4	5	6	7	8	9	10	11	12	Viet Nam	Japan
Field Work in Viet Nam	1	Team Leader / Business Plan of Sewerage & Drainage Project	Koichi SUZUKI	OC		4/11 7	5/9 8	6/27 11 4			9/2 12 10 3				1.73	
	2	Sewerage & Drainage Expert - 1 (Treatment Process)	Hiromi ONUKI	HELS		4/11 11	5/6 29	6/30 12 11			8/31 30				2.73	
	3	Sewerage & Drainage Expert -2 (Mechanical & Electric)	Kota KINOSITA	HELS			5/6 29	6/30 23			8/31 30				1.73	
	4	Technical Transfer Plan	Yoichiro ONO	OC (ORIX)			5/6 15	6/30 23			8/31 30				2.27	
	5	Public Private Partnership	Hyeon-Yeoul KIM	HELS		4/11 11	5/6 15	6/30 22			8/31 30				2.60	
					Total M/M in Viet Nam										11.06	
Work in Japan	1	Team Leader / Business Plan of Sewerage & Drainage Project	Koichi SUZUKI	OC								10/25 5				0.17
	2	Sewerage & Drainage Expert - 1 (Treatment Process)	Hiromi ONUKI	HELS	3/22 5			6/21 5		8/24 5		10/12 5				0.67
	3	Sewerage & Drainage Expert -2 (Mechanical & Electric)	Kota KINOSITA	HELS				6/14 5								0.17
	4	Technical Transfer Plan	Yoichiro ONO	OC (ORIX)				6/16 5		8/3 3	8/23					0.33
	5	Public Private Partnership	Hyeon-Yeoul KIM	HELS		4/22 5		6/21 5		8/23 5		10/25 5				0.67
																2.01
Reports / Meetings						△ ICR			△ Interim Meeting			△ Wrap-up Meeting		△ FR		

15 Contracted Period

15 Period at Own-expenditure

Chapter 3 Review of O&M Performance and O&M Plan

3.1 Sewerage and Drainage Service Network and Framework

3.1.1 Sewerage and Drainage Service

1) Outline of sewerage and drainage facilities in Hanoi

There are 3 wastewater treatment plants with a capacity of 48,200 m3/day in total and 23.9 km of sewer lines in Hanoi. These facilities were constructed by the Hanoi Drainage Project for Environmental Improvement under Japanese ODA in 1997-2005. In addition, Yen So WWTP is under construction, Bay Mau Lake WWTP is under procurement and two more WWTPs, Yen Xa WWTP and Phu Do WWTP, will be constructed in the near future. Operating, on-going and planned WWTPs in Hanoi are shown in Figure 3.1.1, Tables 3.1.1 and 3.1.2.

Source: The study on sewerage operation and maintenance know-how transfer (June, 2009), JICA

Figure 3.1.1 Distribution of WWTPs in Hanoi

Table 3.1.1 Outline of operating WWTPs and major pumping station in Hanoi

	WWTP			Yen So Pumping Station
	Kim Lien	Truc Bach	North Thang Long	
Capacity(m3/day)	3,700	2,500	42,000	90 m3/sec
Treatment Method	A2O with Media	A2O with Media	Conventional Activated Sludge	-
Sewered Population (persons)	15,700	-	110,000	-
Operation Year	2005	2005	2009	1999
Financial Source	Yen Loan	Yen Loan	Yen Loan	Yen Loan
O&M Body	Hanoi Sewerage and Drainage Company(HSDC)			Yen So Pumping Station Controlling Enterprise

Source: JICA team

Table 3.1.2 Outline of on-going and planned WWTPs in Hanoi

	Under Construction	Under Procurement	Planned	
	Yen So	Bay Mau	Yen Xa	Phu Do
Capacity(m3/day)	200,000	14,000	270,000	84,000
Treatment Method	Conventional Activated Sludge	Nitrification Activated Sludge	Nitrification Activated Sludge	Nitrification Activated Sludge
Sewered Population (persons)	15,700		-	110,000
Prospective Operation Year	2012	2012	-	-
Financial Source	BT	Yen Loan	Yen Loan (Candidate)	Yen Loan (Candidate)
O&M Body[1)]	Not decided yet			

Note 1) O&M for the Yen So WWTP will be transferred to HPC after one year of operation by the contractor

Source: JICA team

2) Sewerage charges and O&M cost of sewerage facilities

(1) Current sewerage charges

Current sewerage charge in Hanoi is set at 10% of the water supply charge and collected as an environmental protection charge regardless of whether the customer lives in or out of the sewerage area. This charge system is according to Decree No.88/2007/ND-CP.

The water supply charge system, as a basis of sewerage charge, is classified into household, commercial, and industrial divisions: while commercial and industrial divisions are fixed amount systems, the household division is further classified into 2 charge rates (described in Table 3.1.3).

In 2009, the total amount of environmental protection charges for wastewater was about 43,500 million VND. (Refer to Table 3.1.4, Figure 3.1.2)

Table 3.1.3 Sewerage charge system in Hanoi

Category	Rate
Water Supply	
○ Domestic	
- unmetered	VND 30,000/month
- metered user	VND 2,800/m3 : up to 16m3
	VND 3,500/m3 : 17-20m3
	VND 5,000/m3 : 21-35m3
	VND 7,500/m3 : more than 36m3
○ Industry	VND 4,500/m3
○ Commercial & Service	VND 7,500/m3
○ State agencies & Public Institutions	VND 4,000/m3
Sewerage	
○ Environmental Protection Fee	10% of Water Supply Charge

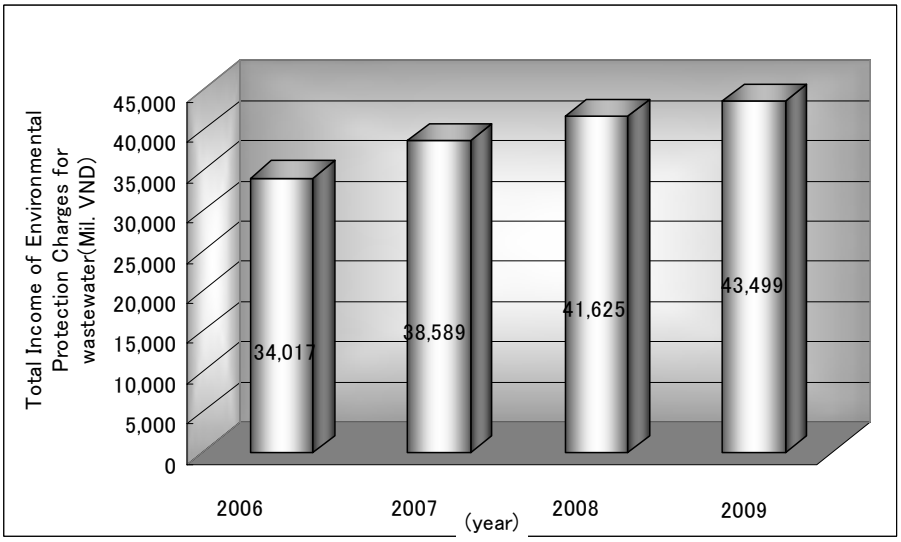
Source: HSDC

Table 3.1.4 Income from sewerage charges

(Unit:1,000VND)

No.	Year	Wastewater Charge	Paid to State Budget	Retained at Water Co.
1. Hanoi Water Corporation				
	2005	26,943,482	24,549,130	2,394,352
	2006	31,616,104	29,086,809	2,529,295
	2007	35,709,619	32,852,850	2,856,769
	2008	38,437,879	35,362,776	3,075,103
	2009	39,538,451	36,375,335	3,163,116
2. Hanoi Water Company 2				
	2006	2,400,555	2,208,511	192,044
	2007	2,879,408	2,649,055	230,353
	2008	3,187,237	2,932,258	254,979
	2009	3,960,070	3,643,264	316,806

Source: HSDC



Source: HSDC

Figure 3.1.2 Income from sewerage charges

(2) Current O&M cost of sewerage and drainage facilities by HSDC

In 2008, the total O&M Cost for the wastewater treatment in Kim Lien WWTP and Truc Bach WWTP was about 10.9 billion VND. In 2009, the operation of North Thang Long WWTP was started and the total O&M costs for the 3 WWTPs became 26.7 billion VND. (Refer to Table 3.1.5, Figure 3.1.3)

Table 3.1.5 Annual turnover and sewerage treatment cost of HSDC

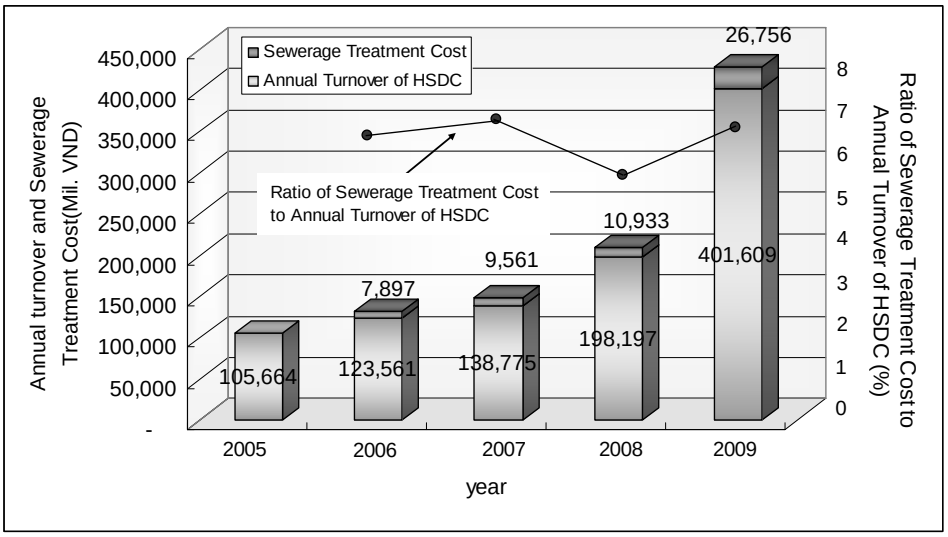
(Unit: VND)

No.	Item \ Year	2005	2006	2007	2008	2009
1	**Annual turnover**	**105,663,644,496**	**123,561,308,228**	**138,775,260,414**	**198,197,412,403**	**401,608,914,102**
2	**Average income (vnd/person/month)**					
	Number of employees	2,000	2,000	1,982	2,100	2,873
	Average salary (vnd/person/month)	1,906,158	2,550,759	3,294,549	3,688,830	4,738,573
	Average income (vnd/person/month)	2,136,481	2,832,968	3,617,709	3,964,917	5,003,289
3	**Sewerage treatment costs**		**7,896,745,808**	**9,561,018,744**	**10,933,495,821**	**26,756,058,597**
4	**Presumed Drainage Works costs(1−3)**		**115,664,562,420**	**129,214,241,670**	**187,263,916,582**	**374,852,855,505**

Note: 1. Annual turnover: This is annual turnover of HSDC (income) from all business and service fields.

2. Sewerage treatment costs: This is actually operation and maintenance cost including labor cost for sewerage treatment. We all understand HSDC is not collecting sewerage treatment fee. Annually, they calculate necessary cost for operation and maintenance of sewerage system and requesting Hanoi People's Committee to allocate budget.

Source: HSDC



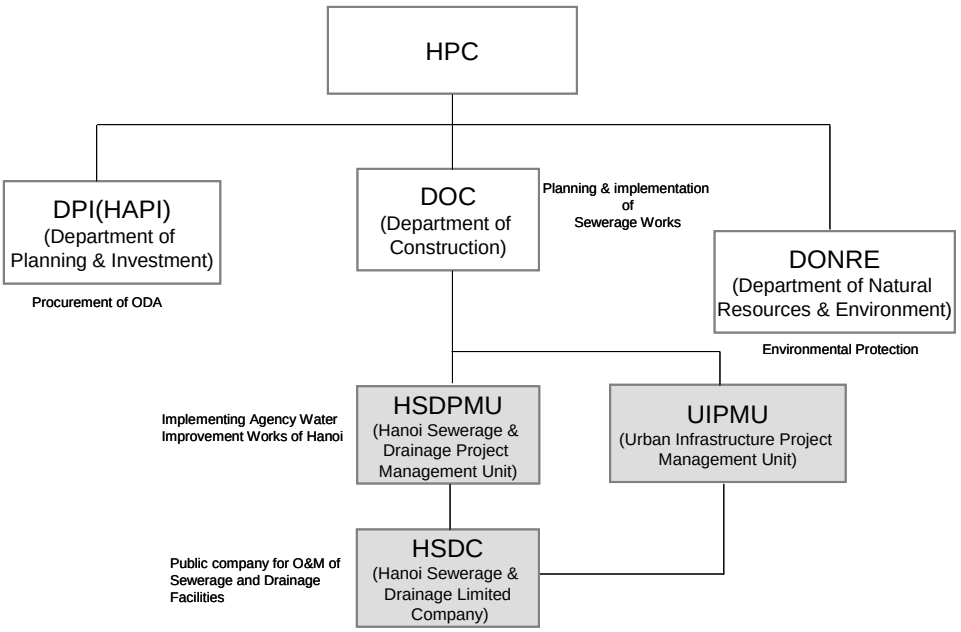
Source: HSDC

Figure 3.1.3 Annual turnover and sewerage treatment cost of HSDC

3.1.2 Framework

1) Hanoi City

Implementation of the sewerage and drainage works in Hanoi is managed by the Department of Construction (DOC). Planning and funding of the sewerage and drainage works is controlled by the Hanoi Authority for Planning & Investment (HAPI). Under DOC, HSD-PMB (Hanoi Sewerage & Drainage Project Management Board) is in charge of the sewerage & drainage project management until the beginning of the O&M of the facilities. After the construction, HSDC will undertake the O&M of sewerage and drainage facilities from DOC.



Source: JICA team

Figure 3.1.4 Organizations for sewerage and drainage in Hanoi

2) Hanoi Sewerage and Drainage Company (HSDC)

HSDC is a one-member limited liability company for operation and maintenance of sewerage and drainage facilities established by Hanoi city, and that organization is shown in Figure 3.1.5.

HSDC is organized with 1 general director, 2 deputy directors and 6 departments as shown in Figure 3.1.5. In addition, HSDC has 10 subsidiary enterprises Including 6 Water Drainage Enterprises (No.1 to No.6), a Water Treatment Enterprise (WTE), Construction and Installation Enterprise, Yen So Pumping Station Controlling Enterprise and Surveying and Designing Enterprise.

Total number of employees of HSDC including the subsidiary enterprises is around 1690 persons.

3) Wastewater Treatment Enterprise (WTE)

The Wastewater Treatment Enterprise (WTE) is one of the HSDC's subsidiary companies in charge of O&M works for 3 WWTPs, Kim Lien WWTP, Truc Bach WWTP and North Thang Long WWTP.

WTE is organized with 1 director, 2 vice directors, 4 departments and 5 working team as shown in Figure 3.1.6. The working teams are composed of sludge transportation and operation teams of 3 WWTPs, operation team of North Thang Long PS and 2 Maintenance teams. Total number of employees is 126 persons.

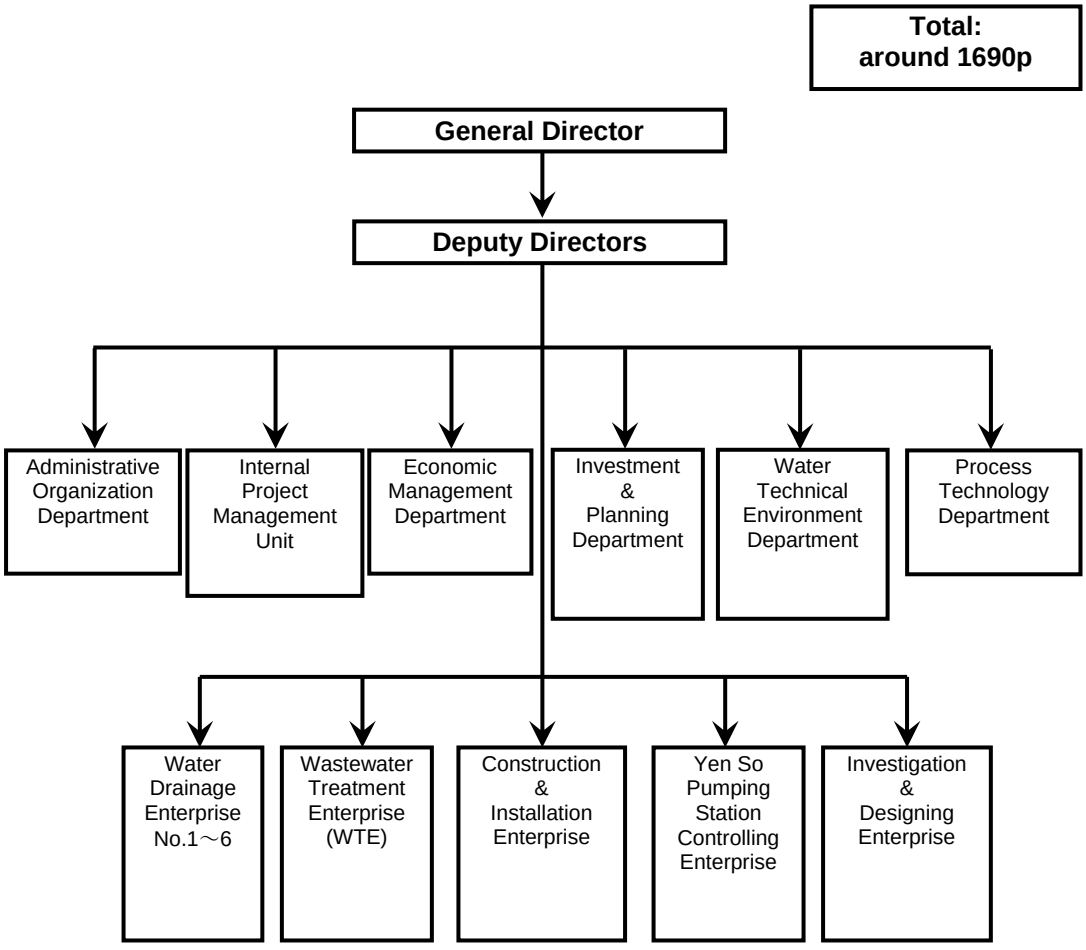
These maintenance teams are supporting the existing 3 WWTPs in Hanoi. When Trouble arises, either of 2 maintenance teams adresses the trouble. This system of 2 maintenance teams is very effective.

4) Yen So Pumping Station Controlling Enterprise

Yen So Pumping Station Controlling Enterprise is in charge of O&M of Yen So PS, 10 rubber dikes, 5 equalization lakes and channels which are very important facilities against flooding in Hanoi.

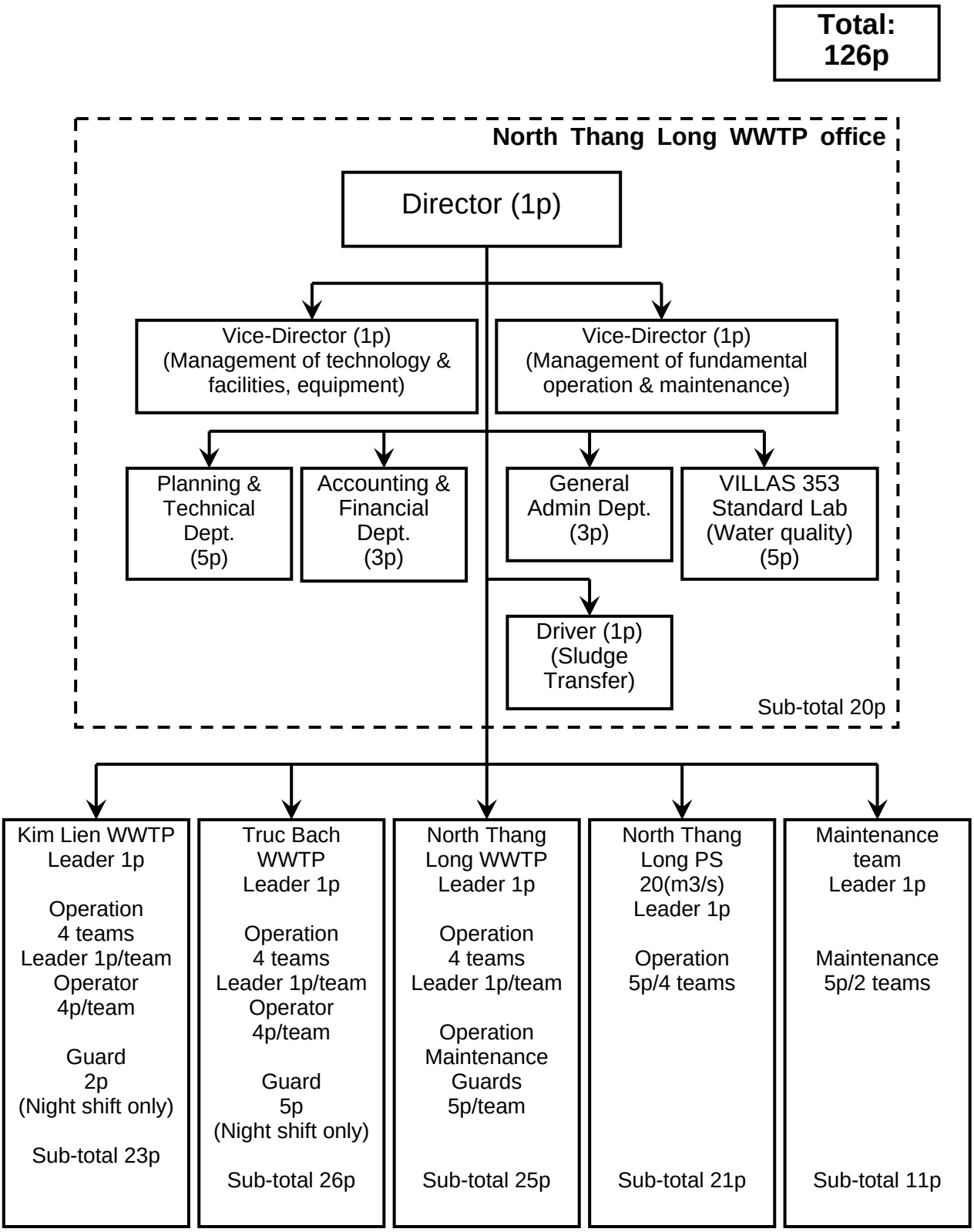
Yen So Pumping Station Controlling Enterprise is also operating a landfill site to dispose of sludge from the WWTPs. Yen So Pumping Station Controlling Enterprise is organized with 1 director, 2 vice-directors, 12 office workers, 4 operation teams, 4 guard teams and 48 persons for operating gates.

Total number of employees is 108 persons as shown in Figure 3.1.7.



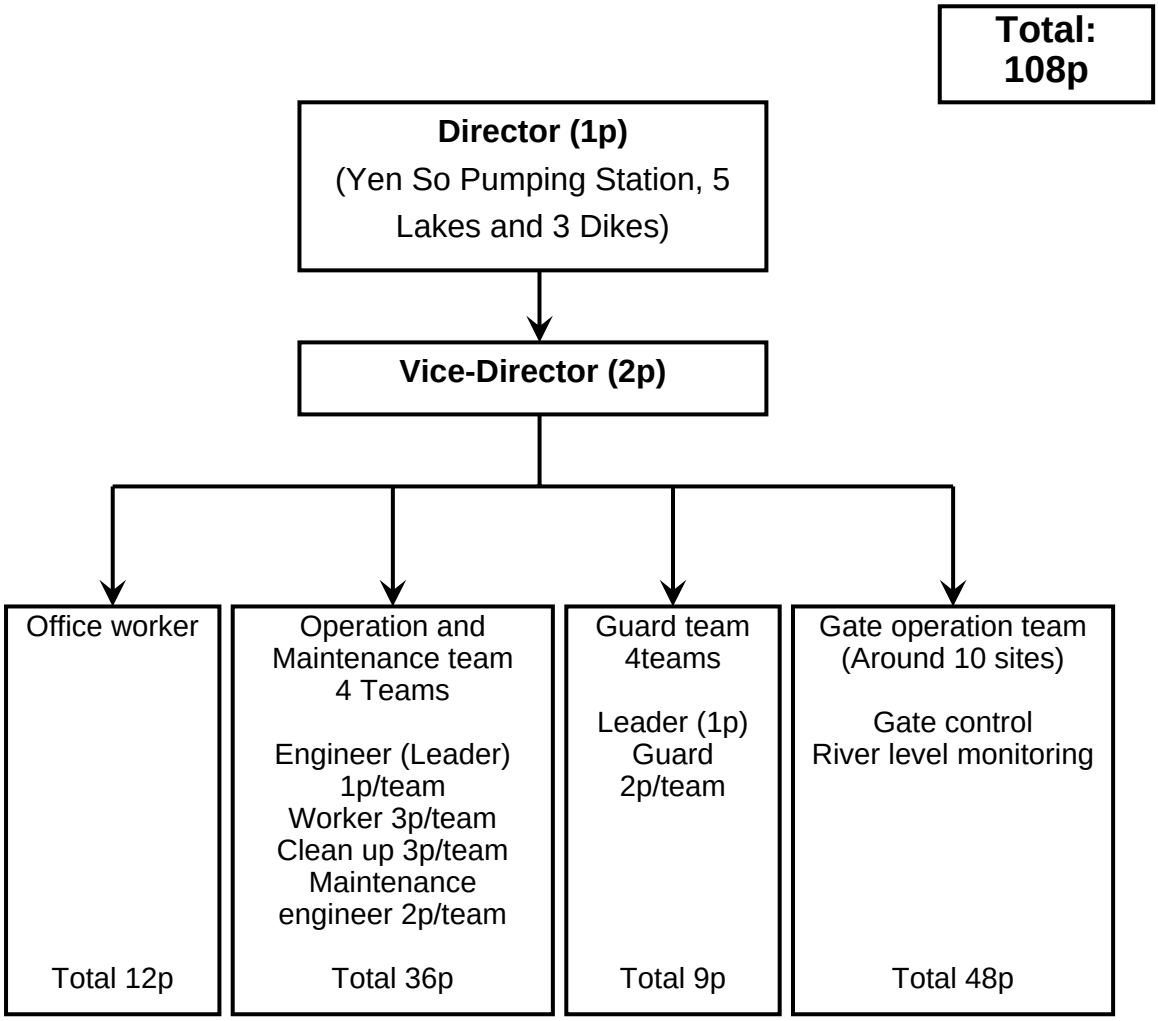
Source: JICA team

Figure 3.1.5 HSDC Organization



Source: JICA team

Figure 3.1.6 WTE Organization



Source: JICA team

Figure 3.1.7 Yen So Pumping Controlling Enterprise Organization

3.2 Findings in Inspection of Existing Facilities

3.2.1 Kim Lien WWTP

1) Facility outline

Kim Lien WWTP has been operated since Sep. 2005. The wastewater treatment process is the carrier-added activated sludge process with anaerobic-anoxic-oxic (A2O Process). This process removes nitrogen and phosphorus biologically.

The Kim Lien WWTP is located in Kim Lien District with a capacity of 3700 m3/d in an area of 33.9 ha. Sewage of Kim Lien WWTP is collected from adjacent houses and shops, and then transferred through a relay pumping station.

Treated sewage effluent is discharged into Lu River. During the dry season, the effluent contributes to lake water quality by diluting pollution load.

Since the WWTP is located in the city center, the area of the site is limited and its facilities are easily accessible. All equipment and facilities are operated on-site. As the monitoring instruments for the treatment process and flow rate are very scarce, treatment performance is dependant on the operator's skills.

Source: JICA team

Figure 3.2.1 Kim Lien WWTP

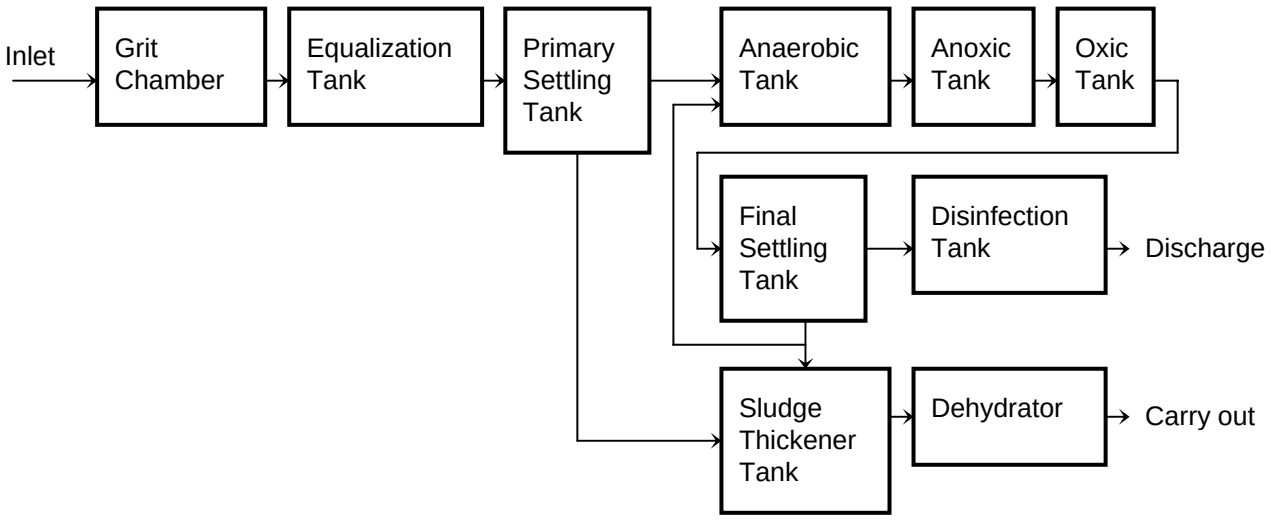
Source: JICA team

Figure 3.2.2 Kim Lien WWTP

Table 3.2.1 Kim Lien WWTP specifications

Item	Specifications	Remarks
Construction Completion	2005	
Operation Start	2005.9	
Design Sewer Population (person)	15,000	
Treatment Capacity (m3/day)	3,700	
Current Inflow Rate (m3/day)	3,700	

Source: JICA team



Source: JICA team

Figure 3.2.3 Treatment process block diagram of Kim Lien WWTP

2) Working condition

The Kim Lien WWTP office is organized with 1 leader and 4 operation teams. Each team has 1 team leader and 4 operators and works 3 shifts. At the transition between shifts, the operation diary is handed over to the next team. (Refer to Tables 3.2.2, 3.2.3 and 3.2.4).

Their duty is operation of the treatment process, daily checks, and repairs limited to small trouble. When major trouble occurs, the maintenance team stationed comes from North Thang Long WWTP and supports them to repair the problem.

Two watchmen are stationed in Kim Lien Relay Pumping Station.

Table 3.2.2 Kim Lien WWTP Organization

Roles	Numbers	Notes
Leader	1 person	
Operation Team	4 teams For each team, 1 leader and 4 operators	Sub-total 20 persons
Security	2 watchmen	stationed
Guard	2 guards	Night shift only

Total : 25 persons

Source: JICA team

Table 3.2.3 Example of work shift for Day 1

Team	6:00-14:00	14:00-22:00	22:00-6:00	Off	Notes
Team 1	○				
Team 2		○			
Team 3			○		
Team 4				○	

Source: JICA team

Table 3.2.4 Example of work shift for Day 2

Team	6:00-14:00	14:00-22:00	22:00-6:00	Off	Notes
Team 1		○			
Team 2			○		
Team 3				○	
Team 4	○				

Source: JICA team

3) Current situation of operation

(1) Operation status

Current inflow of Kim Lien WWTP is 3,700m3/day as daily average flow which is equal to the design capacity. This plant is constructed semi-underground. So far the process operation is fixed regardless of fluctuation of inflow quality due to intermittent inflow of rainwater.

(2) Operation of wastewater treatment facilities

a. Grit removal and screen

2 Grit chambers with submergible aerators are installed. The submergible aerators are operated once a day for grit removal and cleaning of the chambers. This operation is based on the operator's intuition and not complied in the manual.

Source: JICA team

Figure 3.2.4 View of cleaning grit chamber

b. Equalization tank

The design retention time of the equalization tank is 2hrs. However the pumps are in almost non-stop operation because the actual inflow is always the maximum design flow at 40min/hr.

c. Primary settling tank

One Primary Settling Tank is installed. Bubbles were floating inside the tank, hence it indicates retention of sludge inside the tank is too long. Drawing out of sludge is needed more frequently because of the following reasons (Figure 3.2.5);

- Settled sludge decays in the Tank. Decayed sludge makes the quality of treated water worsen.
- Accumulation of sludge in the tank increases the loading rate of the sludge collector and reduces the lifetime of the sludge collector.

The power unit of the sludge collector is emitting a slight abnormal noise; there is concern about trouble in the power unit.

There is a small amount of detergent oriented scum in the center well. (Refer to Figure 3.2.6)

Source: JICA team

Figure 3.2.5 Surface water of tank

Source: JICA team

Figure 3.2.6 Bubble of center well

d. Reaction tank

- Screen and distribution well

  Outflow from the primary settling tank passes through a mechanical screen. It is then divided into 2 lines (Line A & B) by a distribution well and then flows into an anaerobic tank. Checking distribution balance of flow is difficult because the maintenance manhole cover of the distribution well is too heavy to open.

- Anaerobic tank and anoxic tank

The maintenance manhole cover of the Line B anaerobic tank is fixed, so inspection inside the tank can't be done. Conditions of the mixers installed in the Anaerobic tanks and Anoxic tanks are good.

- Oxic tank

Nitrification medias are put in the Oxic tank for supporting nitrification. The input volume of the medias is 16% of tank volume. A total of 10% of the nitrification media is consumed by aeration every year.

Aeration is controlled by adjusting an air-valve, however the dissolved oxygen meter is not calibrated for a long term. Therefore the aeration control is based on the intuition of the operator.

A chemical feeding system for removal of phosphorus is operating based on the intuition of the operator as well.

Source: JICA team

Figure 3.2.7 Media for nitrifying bacteria

- Final settling tank

The return sludge volume is controlled based on the intuition of the operator because there is no instrumentation to control the return sludge.

- Disinfection tank

The disinfection process uses Sodium Hypochlorite. The dosing rate is not often adjusted.

e. Discharge point

Transparency of discharged water is over 60 cm which is better than the river water.

Source: JICA team

Figure 3.2.8 Discharge point

(3) Operation of sludge treatment facilities

a. Gravity thickener

Draw-off of thickened sludge should be controlled based on the thickness of the cumulated sludge; however this plant does not measure the sludge thickness.

b. Dehydrator

The dehydrator is the belt press type. Leakage of sludge from the dehydrator occurred several times during our investigation. The moisture content of dewatered sludge cake seems to be more than the 85% which is the target of moisture content commonly used for transportation of dewatered sludge. In order to control the moisture content of the dewatered sludge, the operation manual is required to strengthen.

Source: JICA team

Figure 3.2.9 Sludge side leak

Source: JICA team

Figure 3.2.10 Sludge condition

c. Filtrate return pit

The surface of the filtrate return pit is covered by thick scum, so filtrate mixer is required. As there is no trouble in the Filtrate Return Pit so far, the pit cover is never opened.

To avoid future trouble, minor maintenance work in the Filtrate Return Pit is recommended as follows;

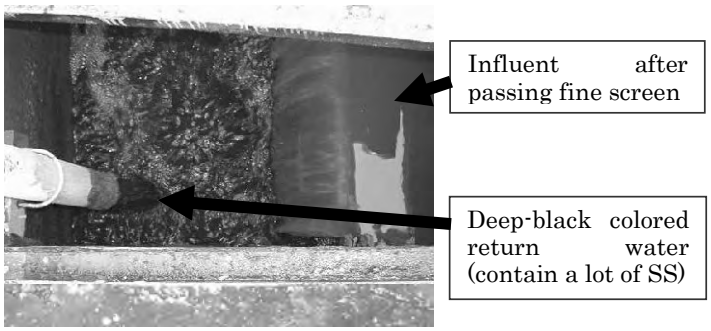
Source: JICA team

Figure 3.2.11 Filtrate return pit

- Empty in the pit once a day using a submersible type pump,
- Check the scum volume periodically and Remove the scum with a vacuum pump

d. Filtrate and supernatant return water

Figure 3.2.12 shows mixing of water returned from the filtrate return pit and raw sewage after the fine screen at the outlet. The suspended solid (SS) concentration of the returned water is high. In case SS concentration of the return water is as high as thousands mg/L, treatment process will be influenced even if the amount of filtrate water is small. Hence the mixed SS in this pit must be monitored.



Source: JICA team

Figure 3.2.12 Outlet of return water

(4) Process control and water quality

a. Influent and discharge water

- Water quality of raw sewage and treated sewage for verifying the design inflow quality and discharge standard. (Refer to Table 3.2.5).
- Transparency of treated sewage has often fluctuated. Figure 3.2.13 shows the mechanism of deterioration of transparency.
- Based on the water qualities in the treatment process that were checked by the JICA team as shown in Figure 3.2.14., the plant performance has no critical issue at present.

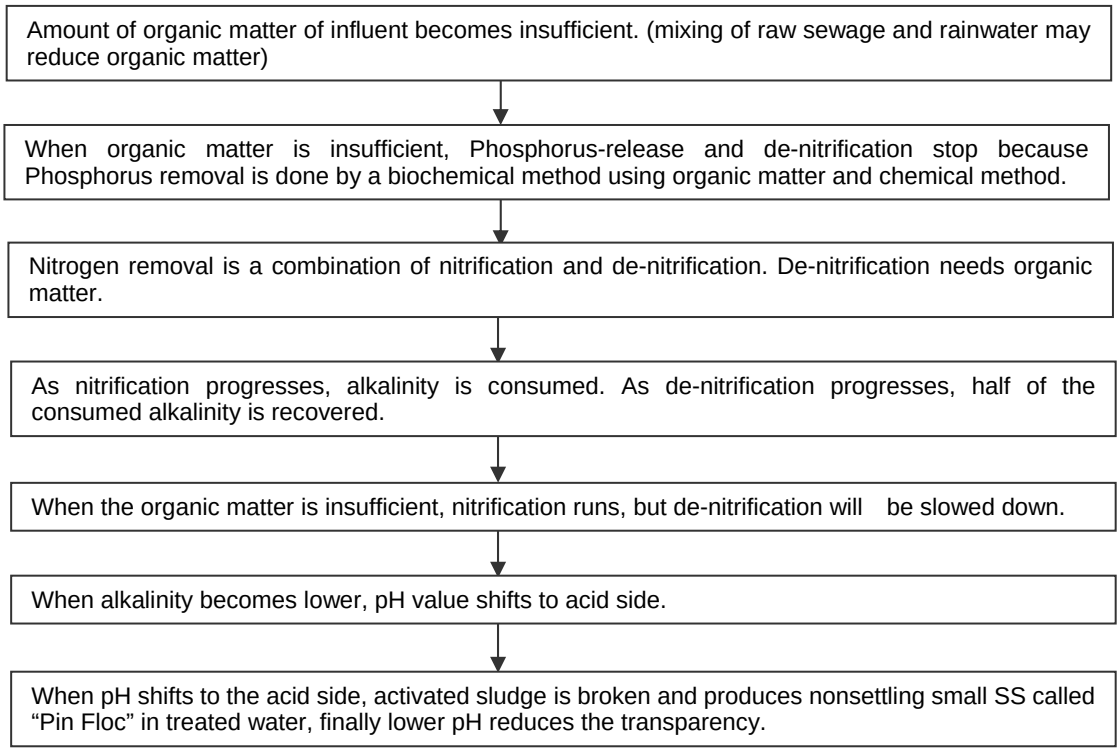
Tables 3.2.6 and 3.2.7 are the results of instrumental measurement of indicators of plant function. Based on the results, the plant performance is diagnosed preliminary as follows;

- Water temperature provides good condition for microorganisms.
- The pH of the water flowing from the anaerobic tank to the oxic tank is low. Alkalinity is also seemed to be insufficient for nitrification.
- ORP must be little higher than the general value in Japan.
- Sludge Volume Index (SVI) of the activated sludge was 88 mg/L, this is a good condition for sludge settling. MLVSS/MLSS ratio was 70%, this is lower than the general average in Japan.

Table 3.2.5 Water quality of influent and discharged water (Unit:mg/L)

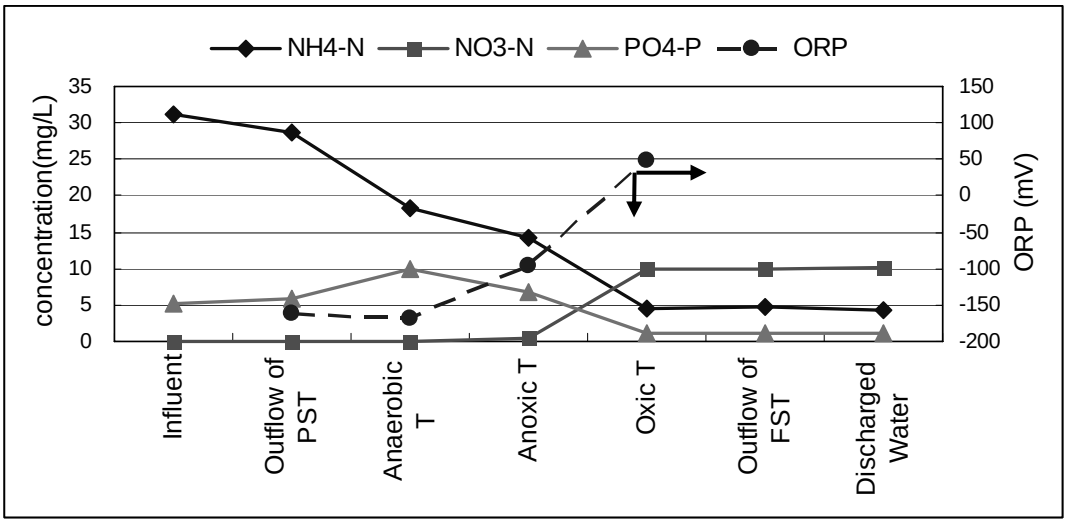
	Influent					Effluent				
	COD	BOD	SS	T-N	T-P	COD	BOD	SS	T-N	T-P
Authorized Regulation Value						48	30	60	18	3.6
Design Criteria	225	150	180	40	5.0	35	20	20	15	1.0
HSDC data average	189	94	86	44	6.2	22	11	6	16	1.4
JICA team data average	202	NA	73	41	6.1	35	NA	9	16	2.0

Source: JICA team



Source: JICA team

Figure 3.2.13 Outlet of return water



Source: JICA team

Figure 3.2.14 Behavior of NH4-N, NO3-N,PO4-P, ORP in WWTP

Table 3.2.6 Instrumental measurement of process unit in water treatment

		Temp. (deg)	pH	DO (mg/L)	ORP (mV)	Trans. (cm)	SV (%)
Before coarse screen		28.1	6.7			4.2	
Grit chamber		28.0				3.6	
After fine screen		28.1				3.5	
Distribution tank		28.0	6.5			2.1	
Primary settling tank outflow		28.0	7.0	0	-174	2.6	
A	Anaerobic tank	28.1	-	0	-164		
	Anoxic tank	28.2	6.6	0	-94		
	Oxic tank	28.3	6.5	2.1	54		22
	Final settling tank	28.3	6.4			>30	
B	Anaerobic tank	-	-	-	-		
	Anoxic tank	28.2	6.7	0	-96		
	Oxic tank	28.3	6.4	1.7	38		26
	Final settling tank	28.3	6.4			>30	
Discharge water		28.4	6.6			>30	
Note: parameter temp. is temperature, trans. is transparency.							

Source: JICA team

Table 3.2.7 Water quality of process unit in water treatment facility (Unit:mg/L)

	Influent	Outflow of PST	A line			Outflow of FST	Discharge water
			Anaerobic T	Anoxic T	Oxic T		
T-COD	186					63	35
D-COD	86					34	
T-N	41					16	16
NH4-N	31.3	28.7	18.3	14.2	4.5	4.8	4.2
NO3-N	0	0.1	0.1	0.4	9.9	10.0	10.2
T-P	6					2	2
PO4-P	5.27	5.86	9.99	6.87	1.02	1.15	1.22
SS	73					12	9
MLSS					2,500		
MLVSS					1,750		

Note: parameter unit is mg/L.
PST is primary settling tank, T is tank, FST is final settling tank

Source: JICA team

b. Evaluation of plant performance

- Treated water of Kim Lien WWTP is discharged into Lu River. The main water quality standards of this river are COD 48mg/L, BOD 30mg/L, T-N 18mg/L, T-P 3.6mg/L by TCVN5945-2005. There is not a big difference between design criteria and the actual data of the influent. Influent is mainly domestic wastewater and contains very little industrial waste. Therefore, the organic matter is easily biodegradable.
- It is not hard to remove COD and BOD to produce levels that are less than regulation standards in advanced treatment. In biological nitrogen and phosphorus removal, organic matter is utilized for de-nitrification and phosphorus release. Both COD and BOD in the influent are at lower concentrations against T-N and T-P, therefore, the quantity of organic matter may not be adequate.
- The sewage collection system is a combined system. Wastewater is diluted by rain water in the rainy season and on rainy days. When rainwater is mixed into the sewage, efficiency of the biological treatment process of the sewage, especially phosphorus removal, is reduced. So the plant operators should pay attention to T-P and T-N concentration of treated sewage and ORP meter reading for regulating quality of treated sewage effluent when it is in the rainy season and on rainy days.

- For reducing phosphorus, this plant has a chemical feed system for removing phosphorus, and the system is usually operating. When the biological function in plant is slowed, the chemical feeding system makes up the plant function instead of the biological treatment system.
- Regarding nitrogen removal, it is hard for this plant to maintain the authorized maximum nitrogen concentration of 18mg/l. Average nitrogen concentration of actual influent is 44 mg/l which is over the design value. In addition, BOD in influent is about 60% of design value. The nitrogen removal process is a combination of nitrification and de-nitrification. Both nitrification and de-nitrification need the activated sludge. The activation of the sludge needs organic matter. Therefore, it is hard to remove nitrification as per the regulation.

c. Altered operation of equipment

Three blowers are equipped in Kim Lien WWTP. So far, cumulated operation times of two of the blowers are not equal. In order to prolong the life-time of the equipment, control of working time is very important. For instance in Japan, allocation of time for stand-by and duty is included in the operation plan of the equipment.

An operation time counter would be helpful for controlling working time of the equipment.

4) Current situation of equipment and maintenance

(1) Mechanical equipments

a. Rust of outdoor equipment

Rust is observed in outdoor equipment. For example, parts of the PST sludge pump and sludge return pumps are covered with rust, especially it is around grand-packing (refer to Figure 3.2.15).

Source: JICA team

Figure 3.2.15 PST sludge pump

b. Motor noise of sludge scraper

The PST sludge scraper's motor omits noise, thus damage or attrition of the bearing is suspected.

c. Pressure gages

A lot of the pressure gauges and manometers are malfunctioning in Kim Lien WWTP.

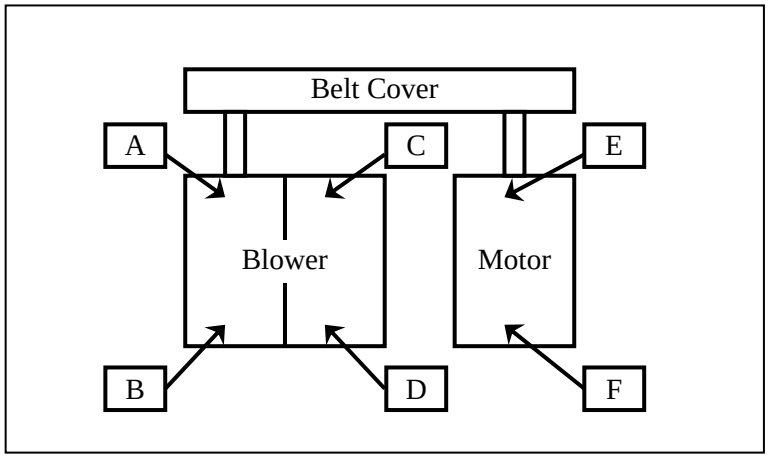
The above-mentioned current situations implicate HSDC's lack of concern about prolongation of equipment life-time through day-to-day inspection and maintenance.

d. Vibration measurement

The blower vibration level was measured by the JICA team, because the aeration blower is the one of the main pieces of equipment for water treatment. The measuring points are shows in Figure 3.2.16.

As shown in Table 3.2.8, the vibration levels at ACC (OA), ACC (PEAK), VEL and DISP area relative values. Absolute value is just for reference. For the vibration diagnosis, relative values are used because they are more important than absolute values.

Based on the measured results, the blower bearing already seems to be damaged and deteriorated, and needs to be replaced. For prolongation of equipment life-time and avoiding this kind of trouble, the current equipment maintenance program shall be strengthened as soon as possible.



Source: JICA team

Figure 3.2.16 Measuring points for blower

Table 3.2.8 Simple vibration diagnosis results for blower (KBW1A point C)

	Mode	Standard		Results	
		Attention	Danger	Value	Judge
Relative Value Diagnosis	ACC(THRU,OA) [G]	1.00	4.00	1.910	Attention
	ACC(OA) [G]	1.00	4.00	1.065	Attention
	ACC(PEAK) [G]	3.00	12.00	3.596	Attention
	VEL [cm/s]	0.40	1.00	0.684	Attention
	DISP [μ m]	30	100	72.2	Attention
Absolute Value Diagnosis	ACC(OA) [G]	0.41	1.64	1.065	Attention
	VEL [cm/s]	0.40	1.00	0.684	Attention

1G=9.8m/s2
Source: JICA team

(2) Electric equipments

a. Dust inside panels

Control panels in Kim Lien WWTP are very clean even though they are located outside. However, there is a lot of dust inside the panels. (See Figure 3.2.17)

b. Rust inside dehydrator control panel

The dehydrator control panel has rust marks inside. (See Figure 3.2.18) This shows that the panel got wet, probably for cleaning. Since the dehydrator control panel is installed indoors, it doesn't have water proofing as do the outdoor panels Therefore, cleaning inside the panel should be done more carefully regarding using excessive moisture.

c. Electrode level switch

The electrode level switches installed in the chemical tank are tangled with trash as shown in Figure 3.2.19. This may cause operation error, so it needs routine cleaning to avoid this trouble.

d. Damage to float type level switch

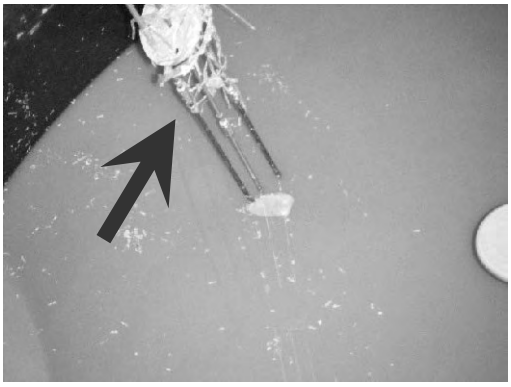
Dog bite marks are found on the float type level switch. (See Figure 3.2.20) This could cause failure of the control system and also injure the dog. The dog that is kept on-site should be limited in the areas that it can access.

Source: JICA team

Figure 3.2.17 Dust in panel

Source: JICA team

Figure 3.2.18 Rust marks in dehydrator control panel



Source: JICA team

Figure 3.2.19 Electrode switch

Source: JICA team

Figure 3.2.20 Dog bite marks

3.2.2 Truc Bach WWTP

1) Working conditions

Truc Bach WWTP has been operated since 2005. The wastewater treatment process is the carrier-added activated sludge process with anaerobic anoxi -oxic (A2O Process). This plant has no monitoring or control system, therefore the plant operation is dependent on the operators' skills.

Table 3.2.9 Truc Bach WWTP specifications

Item	Specifications
Construction Completion	2005
Operation Start	2005.9
Design Sewer Population (person)	-
Treatment Capacity (m3/day)	2,500
Current Inflow Rate (m3/day)	2,500

Source: JICA team

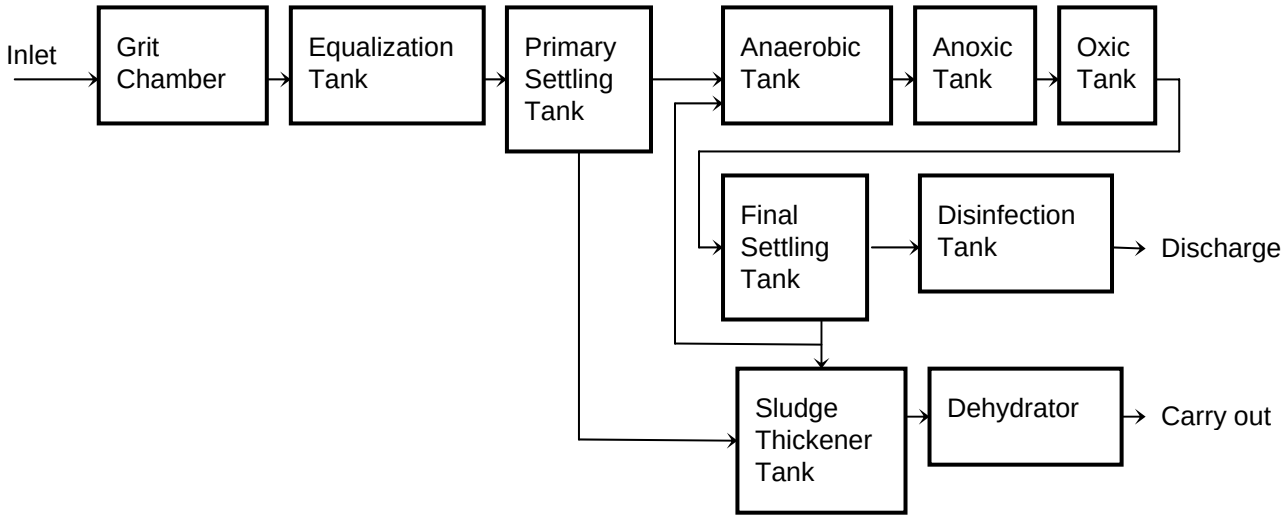
Source: JICA team

Figure 3.2.21 Truc Bach WWTP

Source: JICA team

Figure 3.2.22 Truc Bach WWTP

This WWTP is located beside Truc Bach Lake in the center of the city. Effluent is discharged into Truc Bach Lake. This area is very susceptible to flooding. During our inspection period, the plant was flooded twice, once in May and once in July. Due to frequent flooding, a lot of trash is trapped in the pipes.



Source: JICA team

Figure 3.2.23 Treatment process block diagram of Truc Bach WWTP

2) Organization

As shown in Table 3.2.10, Truc Bach WWTP is organized with 1 leader and 4 operation teams. Each team has 1 team leader and 4 operators. Work shifts, work items and system (diary, etc) are the same as Kim Lien WWTP. Truc Bach WWTP doesn't have a relay pumping station. Five watchmen work at night.

Table 3.2.10 Truc Bach WWTP Organization

Roles	Numbers	Notes
Leader	1 person	
Operation Team	4 teams For each team, 1 leader and 4 operators	Sub-total 20 persons
Guard	5 guards	Night shift only

Total : 26 persons

Source: JICA team

3) Current situation of operation

(1) Operation status

The design capacity of Truc Bach WWTP is 2,300m3/day. Actual inflow is almost the same as the design capacity regardless of weather.

(2) Operation of wastewater treatment facilities

a. Grit removal and screening facilities

The design and operation methods of the grit chamber and screen are the same as Kim Lien WWTP.

Source: JICA team

Figure 3.2.24 Grit chamber

b. Equalization tank

Inflow into the equalization tank is regulated by the inflow pump and is always the same as the capacity of WWTP. When inflow is greater than the capacity of the WWTP, excess flow is diverted to Truc Bach Lake without treatment. In other words, the function of equalization is hardly utilized.

Source: JICA team

Figure 3.2.25 Equalization tank

c. Primary settling tank

The design and operation methods are the same as Kim Lien WWTP. There is no scum in the center well of the settling tank.

d. Reaction tank

- Screen and distribution well, anaerobic tank and anoxic tank

The design and operation methods are the same as Kim Lien WWTP. This is the same situation as Kim Lien WWTP.

- Oxic tank

Nitrification media is in the oxic tank for supporting nitrification. Input volume of the media is 16% of tank volume. Other specifications are the same as Kim Lien WWTP.

- Final settling tank, disinfection tank

The design and operation methods are the same as Kim Lien WWTP. This is the same situation as Kim Lien WWTP.

(3) Operation of sludge treatment facilities (gravity thickener, dehydrator, filtrate return pit)

The design and operation methods are the same as Kim Lien WWTP. This is the same situation as Kim Lien WWTP.

(4) Process control and water quality

a. Influent and discharged water

Quality of influent and treated sewage conforms to the authorized effluent standards as shown in Table 3.2.11.

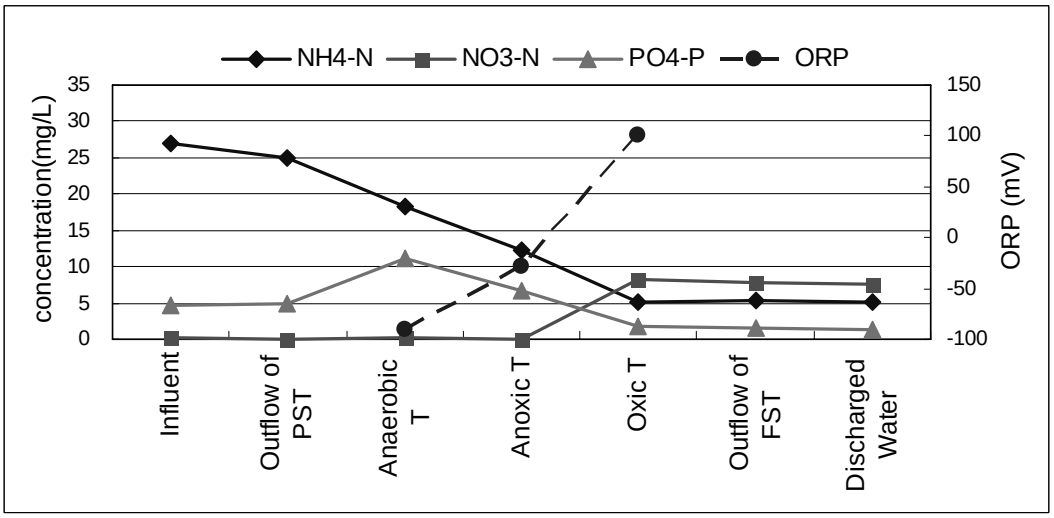
Table 3.2.11 Water quality of influent and discharged water (Unit:mg/L)

	Influent					Discharged water				
	COD	BOD	S S	T-N	T-P	COD	BOD	S S	T-N	T-P
Water quality standards						48	30	60	18	3.6
Design criteria	225	150	180	40	5	35	20	20	15	1.0
HSDC average	191	94	91	39	5.6	24	12	5	15	0.9
JICA team average (Investigation results)	181		61	40	5.4	24		2	14	1.9

Source: JICA team

b. Water quality in the process tanks

We measured the water quality of each tank in order to check the operating condition. The results are in the following Figure 3.2.26 which shows the average data of each tank in the plant. According to these data, no critical issue is found in the plant performance.



Source: JICA team

Figure 3.2.26 Behavior of NH4-N, NO3-N, PO4-P and ORP in WWTP

Table 3.2.12 Instrumental measurement of process units in water treatment

		Temp. (deg)	pH	DO (mg/L)	ORP (mV)	Trans. (cm)	SV (%)
Before coarse screen		28.0	7.1			8.0	
Grit chamber		28.1				8.1	
After fine screen		28.2				7.1	
Equalization tank		28.3				6.7	
Primary settling tank outflow		28.5				6.3	
A	Anaerobic tank	28.8	6.8	0	-87		
	Anoxic tank	29.0	6.8	0	-27		
	Oxic tank	29.0	6.6	3.0	103		23
	Final settling tank	29.1	6.7			>30	
B	Anaerobic tank	28.8	6.9	0	-96		
	Anoxic tank	29.0	6.7	0	-29		
	Oxic tank	29.1	6.6	2.5	100		23
	Final settling tank	29.1	6.7			>30	
Discharge water		29.1	6.8			>30	
Note: parameter temp. is temperature, trans. is transparency.							

Source: JICA team

Table 3.2.13 Water quality of process units in water treatment facility (Unit:mg/L)

	Influent	Outflow of PST	A line			Outflow of FST	Discharge water
			Anaerobic T	Anoxic T	Oxic T		
T-COD	181					28	24
D-COD	96					24	
T-N	40					14	14
NH4-N	27.0	25.1	18.2	12.3	5.2	5.3	5.1
NO3-N	0.1	0.1	0.1	0	8.1	7.7	7.6
T-P	5.4					1.9	1.7
PO4-P	4.7	5.0	11.1	6.7	1.8	1.5	1.3
SS	61					16	2
MLSS					1620		
MLVSS					1140		

Note: parameter unit is mg/L.

PST is primary settling tank, T is tank, FST is final settling tank

Source: JICA team

c. Evaluation of plant performance

Because the design and operation methods are the same as Kim Lien WWTP, the evaluation results of plant performance are in common with Kim Lien WWTP.

4) Current situation of equipment and maintenance

(1) Mechanical equipments

a. Rust

Similarly to Kim Lien WWTP, Truc Bach WWTP also has a lot of rusted pit covers. Figures 3.2.27 and 3.2.28 shows badly rusted pit covers. This situation creates a danger that the operator could fall into the pit and be injured.

Source: JICA team

Figure 3.2.27 Grit chamber pit cover

Source: JICA team

Figure 3.2.28 PST cover

b. Pump guide rail

Figure 3.2.29 shows where a pump guide rail is missing, but the pump is in operation. If operation continues without the guide rail, the pump would break down.

Source: JICA team

Figure 3.2.29 Pump guide rail

Source: JICA team

Figure 3.2.30 Blower room

c. Vibration level

Vibrations of blowers were measured the same as at Kim Lien WWTP. Based on the measurement results shown in Table 3.2.14, these blowers are assumed to be damaged. Especially, blower A (TBW1A) is obviously damaged because blower A generates a lot of noise during duty condition. Noise was measured in May and July 2010. In June, HSDC did maintenance work on the blowers, consequently the noise level was improved a little however the condition of the blowers is not enough good, hence more attention must be paid to the blower condition.

Table 3.2.14 Simple vibration diagnosis results for blower (TBW1A point A) in 2010

	Mode	Standard		Results (May)		Results (July)	
		Attention	Danger	Value	Judge	Value	Judge
Relative Value Diagnosis	ACC (THRU,OA) [G]	1.00	4.00	3.654	Attention	2.741	Attention
	ACC (OA) [G]	1.00	4.00	1.942	Attention	1.438	Attention
	ACC (PEAK) [G]	3.00	12.00	5.055	Attention	4.092	Attention
	VEL [cm/s]	0.40	1.00	0.789	Attention	0.506	Attention
	DISP [μm]	30	100	37.2	Attention	38.4	Attention
Absolute Value Diagnosis	ACC (OA) [G]	0.41	1.64	**1.942**	**Danger**	1.438	Attention
	VEL [cm/s]	0.40	1.00	0.789	Attention	0.506	Attention

1G: 9.8m/s2

Source: JICA team

(2) Electric equipment

a. Rust in panel

In general, the condition of the electric equipment is good. However, several pieces of electric equipment are deeply rusted similarly to the mechanical equipment. Figure 3.2.31 shows one control panel's rust. This means they may fail to operate if lack of adequate maintenance continues. To prevent the problem, paint repair is needed.

b. Level sensor

Figure 3.2.32 shows the indication of error code (E040) of the level sensor. This will cause errors in operation. They should recover and repair the level sensor and/or converter.

Source: JICA team

Figure 3.2.31 Deep rust on the panel

Source: JICA team

Figure 3.2.32 Level sensor error

c. Cable conduit

Figure 3.2.33 shows one level switch terminal box. This cable connector socket appears ready to fall off. This situation threatens to cut the control cable. This is the same as Kim Lien WWTP's dog bite case, in the worst case, the control system will malfunction.

d. Manometer

Figure 3.2.34 shows one manometer. In Truc Bach WWTP (Kim Lien WWTP also), almost every manometer is malfunctioning. It is really difficult to determine how much volume is flowing.

Source: JICA team

Figure 3.2.33 Terminal box

Source: JICA team

Figure 3.2.34 Manometer

e. Pressure gauge

Most pressure gauges are malfunctioning. For maintaining water quality, these manometers and/or gauges are important pieces of equipment to understand the nature of any fluctuations in the process.

f. Operation time counter

Similarly to Kim Lien WWTP, there is no operation time counter. This is one of the facilities' issues.

3.2.3 North Thang Long WWTP

1) Facility outline

North Thang Long WWTP was constructed in 2005, and the operation started from Feb. 2009. Wastewater treatment capacity is 42,000m3/day with Activated Sludge Treatment. North Thang Long WWTP Specifications are shown in Table 3.2.15. Figure 3.2.36 shows the process block diagram of North Thang Long WWTP.

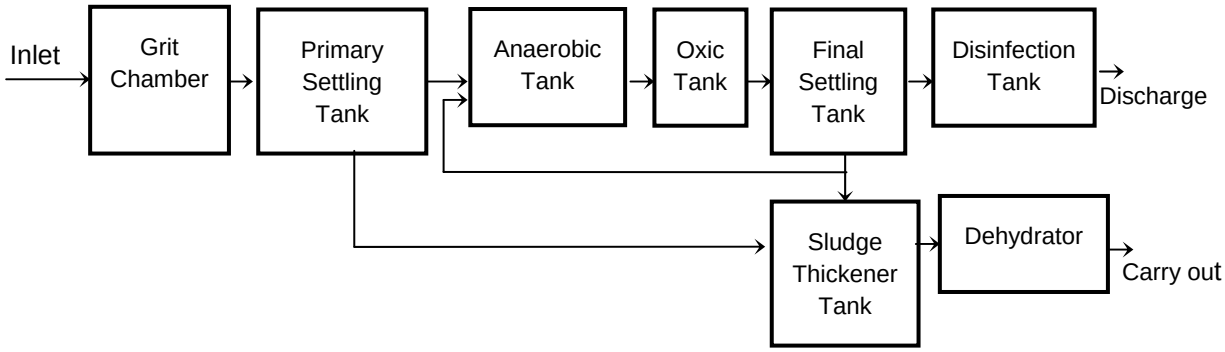
Source: JICA team

Figure 3.2.35 North Thang Long WWTP

Table 3.2.15 North Thang Long WWTP specifications

Item	Specifications	Remarks
Construction Completion	2005.8	
Operation Start	2009.2	
Design Sewer Population (person)	110,000	
Treatment Capacity (m3/day)	42,000	Sewage 38,000 m3/day, Infiltrated water 4,000 m3/day
Current Inflow Rate (m3/day)	3,700	All sewage is discharged from Thang Long Industrial Park without households.

Source: JICA team



Source: JICA team

Figure 3.2.36 Activated sludge treatment process block diagram

2) Working conditions

Table 3.2.16 shows North Thang Long WWTP organization. In North Thang Long WWTP, there are 1 leader and 4 operation teams. Each team has 1 team leader and 5 operators. The same as the other WWTPs, 3 work shifts and an operation diary system are adopted.

Table 3.2.16 North Thang Long WWTP organization

Roles	Numbers	Notes
Leader	1 person	
Operation Team	4 teams For each team, 1 leader and 5 operators	Sub-total 24 persons Guard included
Guard	0	

Total : 25 persons

Source: JICA team

3) Current situation of operation

(1) Operation status

Design capacity of the North Thang Long (Van Tri) WWTP is 38,000m3/day. Current inflow into the North Thang Long WWTP is about 7000 m3/d which are coming from the North Thang Long Industrial Park. Incoming sewage is a mixture of domestic and industrial sewage. Industrial sewage is pretreated in the Industrial Park WWTP before transmitting to the WWTP. Inflow rate is stable 24 hours a day. There are 6 lines consisting of primary settling tank – reaction-tank – final settling tank in this plant. Among these, current operation uses 1 line consisting of a reaction tank and 2 final settling tanks.

(2) Operation of wastewater treatment facilities

a. Grit removal and screening facilities

This plant has 2 pre-treatment lines. Currently, there is very little incoming grit because the influent is pretreated. Composition of grit is mainly plastics.

Source: JICA team

Figure 3.2.37 Grit removal facility

Source: JICA team

Figure 3.2.38 Removed grit

b. Primary settling tank

Because of low SS, the treatment process is skipping the primary settling tank at present.

c. Reaction tank

- Anaerobic tank

The purpose of this process unit is prevention of activated sludge bulking. ORP value was under zero in the tank, this was a good condition for prevention of bulking.

Source: JICA team

Figure 3.2.39 Under operation of aerator

d. Aeration tank 1st and 2nd

The aerators are the surface type. The aerators are operated intermittently at 30 min intervals of ON & OFF. The process uses 2 lines of aeration tanks alternately. It was found in our inspection at the stoppage of the aerator that inflow to the aeration tank passes through a shallow part of the tank to the next tank without aeration. (Figure 3.2.40)

Source: JICA team

Figure 3.2.40 Surface at aerator stop timing

e. Final settling tank

There is no equipment in the final settling tank except for the sludge collector.

f. Disinfection tank

The treated sewage has high transparency. A lot of bubbles occurred in the channel of the disinfection tank. The cause of the bubbles is settlement that accumulated in the disinfection tank, hence, cleaning of settled sludge is recommended once a year.

(3) Operation of sludge treatment facilities

a. Gravity thickener

No thickening equipment is installed in this plant.

b. Dehydrator

A belt filter press is installed for sludge dewatering. SS concentration of incoming sludge seems to be around 8,000mg/l to 10,000mg/l which is the same as the SS concentration of the return sludge. Ferric chloride is used as a coagulation agent. Current moisture content of the dewatered sludge cake is much higher than the target which is less than 85%.

c. Sludge hopper

Capacity of the sludge cake hopper is 10m3. As the height of the hopper is not adequate for a 10Ton dump truck, sludge cake is pile up on the floor and taken out manually from time to time.

d. Deodorization equipment

Deodorization is by a chemical scrubbing system using NaClO and NAOH. Odorous air from inlet equipment, water treatment equipment and sludge treatment equipment is transported to the chemical scrubber by a suction fan for chemical washing.

(4) Process control and water quality

a. Influent and discharge water

As raw sewage is pretreated, BOD and SS of influent are much lower than design criteria. Consequently, effluent water quality is also better than water quality standards.

Table 3.2.17 Water quality of influent and discharge water (Unit:mg/L)

	Influent					Effluent				
	COD	BOD	S S	T-N	T-P	COD	BOD	S S	T-N	T-P
Water quality standards						50	20	50	30	4.0
Design criteria		220	190				20	20		
HSDC average	115	60	57	44	5.2	17	9	5	13	1.0
JICA team average	110		65	36	5.4	27		8	17	1.4

Source: JICA team

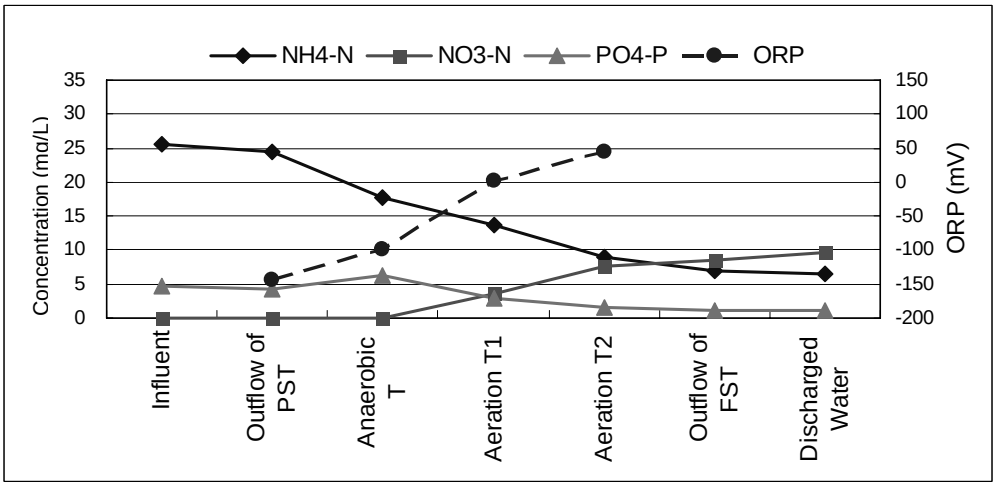
b. Water quality in the process tanks

The treatment process of this plant is an advanced conventional activated sludge process.

Figure 3.2.41, and Tables 3.2.18 and 3.2.19 show the results of the water quality tests in the North Thang Long WWTP checked in this study. Based on the results, no critical issues were found in the plant performance including sewage treatment and sludge treatment. MLVSS/MLSS ratio is relatively low at 65%. The reasons for the low MLVSS/MLSS are;

i) BOD loading is actually about half compared with design.

ii) MLSS is high value compared with general value and design.



Source: JICA team

Figure 3.2.41 Behavior of NH4-N, NO3-N, PO4-P and ORP in WWTP

Table 3.2.18 Water quality of influent and discharge water and process unit

	Temp. (deg)	pH	DO (mg/L)	ORP (mV)	Trans. (cm)	SV (%)
Inlet gate	29.0	7.1	NA	-61	5.6	NA
Inlet channel	29.0	7.0	NA	-143	8.1	NA
Anaerobic tank	29.1	7.0	0	-98	7.1	NA
1st aeration tank	29.1	7.1	0.3	1	6.7	NA
2nd aeration tank	29.1	7.0	0.5	45	6.3	49
Final settling tank 1	29.2	7.0	0.8	-3	>30	NA
Final settling tank 2	29.2	7.0	0.9	-3	>30	NA
Discharge water	29.2	7.2	0	NA	>30	NA

Source: JICA team

Table 3.2.19 Water quality of process unit in water treatment facility

(Unit:mg/L)

	Influent	Outflow of PST	Anaerobic Tank	1st Aeration	2nd Aeration	Outflow of FST	Discharge water
T-COD	127	NA	NA	NA	NA	28	27
D-COD	64	NA	NA	NA	NA	22	NA
T-N	36	NA	NA	NA	NA	16	17
NH4-N	25.6	24.5	17.8	13.7	9.0	6.9	6.6
NO3-N	0	0	0.1	3.7	7.5	8.6	9.6
T-P	5	NA	NA	NA	NA	2	1
PO4-P	4.72	4.30	6.31	2.97	1.51	1.17	1.06
SS	65	NA	NA	NA	NA	9	8
MLSS	NA	NA	NA	NA	2760	NA	NA
MLVSS	NA	NA	NA	NA	1820	NA	NA

Source: JICA team

4) Current situation of equipment and maintenance

(1) Mechanical equipment

a. FST scraper

Figure 3.2.42 shows grease trickling out of the scraper gear box. Figure 3.2.43 shows the FST scraper being repaired. The guide roller of the FST scraper is very easy to abrade, it is suggested the guide roller be replaced once a year.

Source: JICA team

Figure 3.2.42 Grease trickling out

Source: JICA team

Figure 3.2.43 FST scraper

Source: JICA team

Figure 3.2.44 PST sludge pump

Source: JICA team

Figure 3.2.45 Sludge cake hopper

b. PST sludge pump

Figure 3.2.44 shows the PST sludge pump and pump shaft that have rusted deeply. Without repair, this equipment will be broken down within 3 years.

c. Sludge cake hopper

As Figure 3.2.45 shows, the height of the sludge cake hopper does not meet the height of normal trucks.

(2) Electric equipment

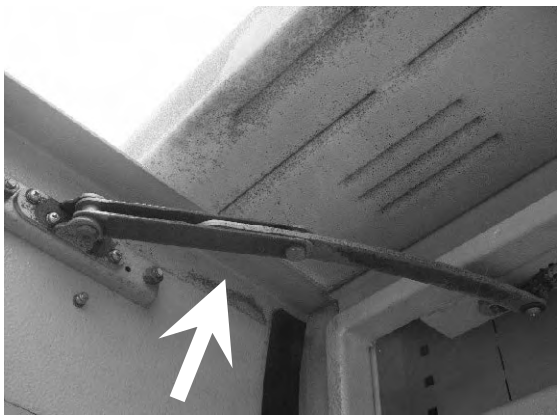
a. Rust in panel

As shown in Figure 3.2.46, rust is observed on the surface of the panel box.

There is some rust inside the panel box as shown in Figure 3.2.47. This situation fails an insulation of the control panels. If the rust damages water proof capability of the panel box, it would be extremely dangerous when loaded and/or when short circuit occurs.

Source: JICA team

Figure 3.2.46 SAP-4



Source: JICA team

Figure 3.2.47 SAP-4 inside

b. Rust in termional boxes

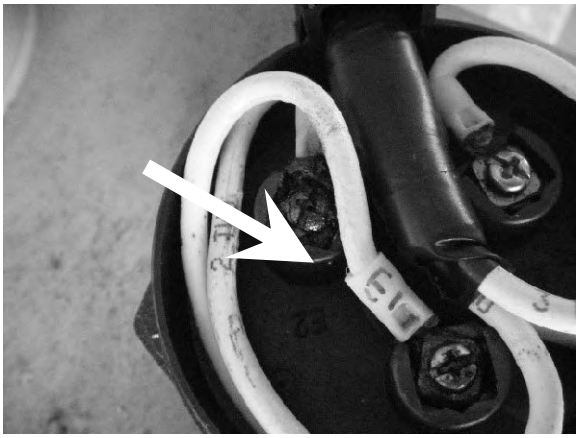
Some terminal boxes have rusted as well. Figure 3.2.48 shows one chemical dosing unit tank equiped with the level switch terminal box. Figure 3.2.49 shows the open terminal box.

c. Chemical tank

Liquid pipes are crossing on the terminal box of the chemical tank. If some liquid leaks and drops onto the terminal box, the terminal will be shorted. For preventing short circuit, the terminal box needs frequent cleaning and/or a cover.

Source: JICA team

Figure 3.2.48 Chemical tank



Source: JICA team

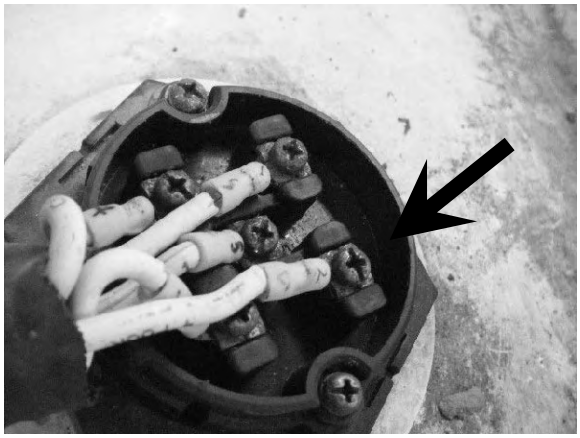
Figure 3.2.49 Chemical tank level switch terminal box

d. Water supply tank

As shown in Figures 3.2.50 and 3.2.51, this terminal is rusted.

Source: JICA team

Figure 3.2.50 Water supply tank level switch terminal box

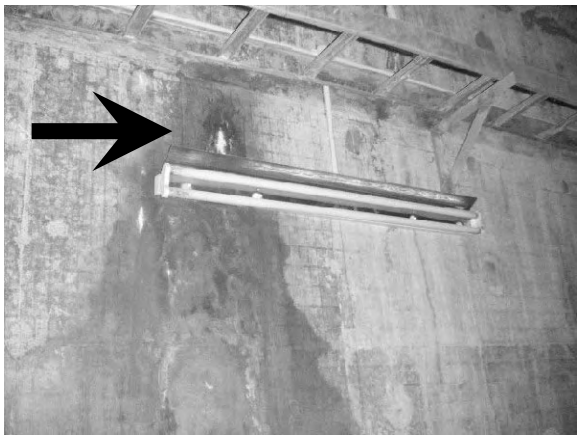


Source: JICA team

Figure 3.2.51 Water supply tank level switch terminal box

e. Leakage of water

As shown in Figure 3.2.52, water is leaking from the wall in North Thang Long WWTP. This condition is one of the reasons for electric leakage.



Source: JICA team

Figure 3.2.52 Tunnel

3.2.4 Yen So PS

1) Facility outline

Yen So PS, one of the biggest pumping stations in Hanoi city, has been operated since 1999. Storm water coming from drainage channels are pumped out to Red River at the Yen So PS.

Source: JICA team

Figure 3.2.53 Administration building

Source: JICA team

Figure 3.2.54 Yen So PS

Since Hanoi city is famous for flooding due to geographical reasons, Yen So PS is very important facility for protecting Hanoi city from flooding.

In Yen So PS, two types of pumps are installed. One is called an “Ordinary Pump” with output of 400kW x 400V x 3m3/sec. The other is called an “Emergency Pump” with output of 680kW x 6000V x 5m3/sec.

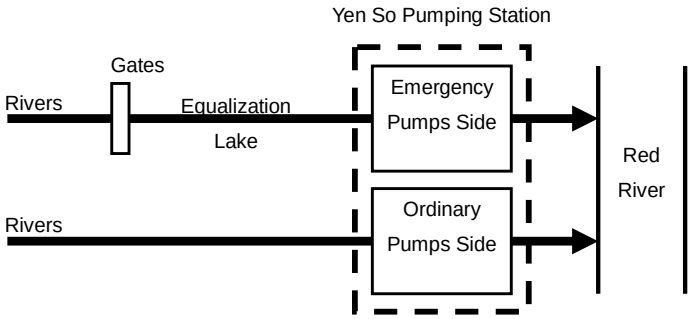
Current total capacity of the Yen So PS is 45m3/sec, and will be 90m3/sec by adding 9 more emergency pumps in the end of 2010.

Table 3.2.20 shows current and increased discharge capacity of Yen So PS.

Table 3.2.20 Yen So PS discharge capacity variation

Date	Number of Pumps	Discharge Capacity (m3/sec)
Current	Ordinary Pumps : 5 Emergency Pumps : 6	45
In the end of 2010	Ordinary Pumps : 5 Emergency Pumps : 15	90

Source: JICA team



Source: JICA team

Figure 3.2.55 Yen So PS flow

2) Working conditions

Yen So Pumping Station Controlling Enterprise is undertaking operation of Yen So PS, 10 rubber dikes, 5 equalization lakes and a channel. Table 3.2.21 shows organization of the Yen So Pumping Station Controlling Enterprise. Total number of staff is 108 persons. There are 2 major teams working in the Yen So Pumping Station Controlling Enterprise. The operation teams are in charge of O&M of the Yen So PS working 3 shifts.

The gate teams control the water level of the drainage channel by gate operation in the lakes and dykes. In emergencies, these teams will work jointly for flood prevention by operating the Yen So PS. Some daily workers will occasionally be hired to take care of gates, lakes and dikes.

Table 3.2.21 Yen So Pumping Station Controlling Enterprise organization

Role	Numbers	Notes
Director	1 person	
Vice-Director	2 persons	
Office Worker	12 persons	
Operation Team	4 teams For each team, 1 Leader (Engineer) 3 workers, 3 persons for Cleaning Up, 2 Maintenance Engineers	Sub-total 36 persons
Guard	1 Leader and 4 teams For each team, 2 Guards	Sub-total 9 person
Gate Team	48 persons for around 10 sites in Hanoi City	River level monitoring River level control with gates
		Total: 108 persons

Source: JICA team

3) Current situation of operation

Weather is the most important factor for operation of the drain pumps. Ordinarily, weather forecasts and water levels of the channel and river will be sent to the Yen So Pumping Station through HSDC. The image of river level information system is shown in Figure 3.2.56.

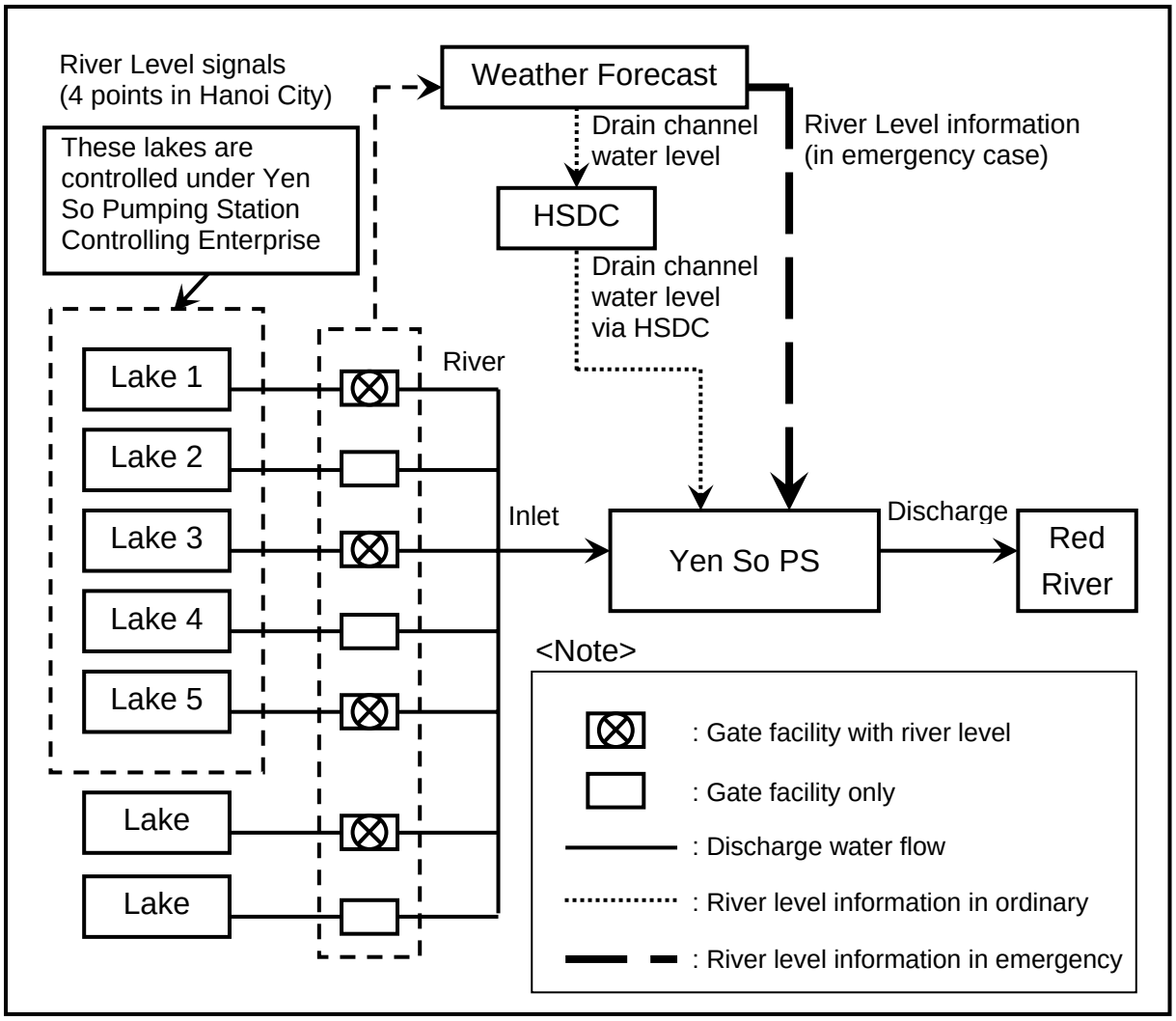
Additionally, gate teams check the river level visually. This visual checking is implemented 3 times every day. The 1st is at 7:00 am, 2nd is 1:00 pm and 3rd is 10:00 pm. This information is sent to Yen So Pumping Station by telephone.

A real time river level monitoring system is currently being installed. After it is installed, real time level signals for both rivers in Hanoi city will come to Yen So PS via the internet. One is at Thanh Liet point in Tu Lich River, and the other is at Ho Tay A point near Truc Bach WWTP. This system will be very helpful for the operation of Yen So PS in the near future.

Before the rainy season begins, a rainy season operation plan is decided in a meeting. According to the chosen plan, pump operation is implemented by river level and inlet channel level.

As the current operation plan, Ordinary pump operation level is at EL 2.4 m, and emergency pump operation level is at EL1.6 m.

However, pump operation is manual only. Taking into account the essential nature of flood protection for Hanoi, automatic operation with a fail-safe system is strongly recommended.



Source: JICA team

Figure 3.2.56 Image of river level information system in Hanoi City

4) Current situation of equipment and maintenance

(1) Mechanical equipment

The current situation of the mechanical equipment and maintenance plan is good. They already have an overhaul plan and periodic overhaul was implemented last year (2009).

And they often clean up inside of pump casings by themselves. Incoming trash that accumulates in the pump casing causes pumps damage. Figure 3.2.57 shows their cleaning activities.

Source: JICA team

Figure 3.2.57 Cleaning

(2) Electric equipment

The current situation of electric equipment and maintenance plans is also good. Now, they plan an investigation every 5 years, especially for incoming power facilities. The latest one was implemented in July 2010. This investigation was implemented by a private company.

3.3 Findings of Sewer Inspection and River Condition Survey

3.3.1 Sewer Inspection

1) General

The JICA team inspected the sewer pipes at 11 points around Kim Lien WWTP and collected 4 water samples at Manhole nos. 1,2,6 and 11. (See Figure 3.3.1) The purposes of the pipe inspection are as follows;

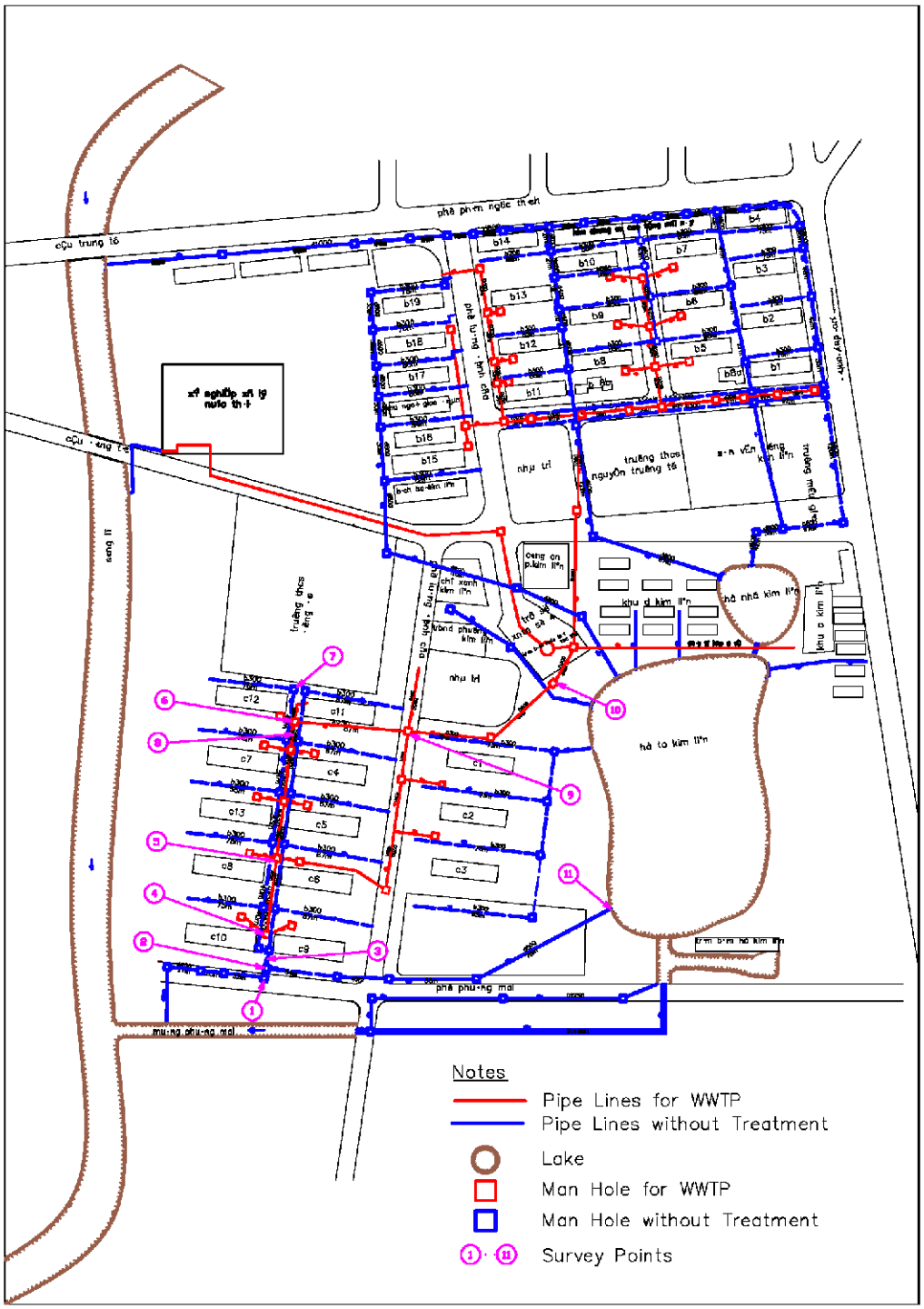
(1) Checking deterioration of pipes

(2) Checking sedimentation inside pipes

(3) Checking pipe connections

(4) Checking storm water inflow to the WWTP

(5) Checking water quality of raw sewage.



Source:HSDC

Figure 3.3.1 Survey points of pipes around Kim Lien WWTP

Source: JICA team

Figure 3.3.2 Sewer survey with mirror

Source: JICA team

Figure 3.3.3 Sampling

2) Result of survey

(1) Need of cleaning of man-holes, sewers and ditches

Sewerage system in Hanoi is mixture of the combine sewer system and separate sewer system. Man-hole for only sewage is relatively clean as shown in Figure 3.3.4, but, man-holes for rainwater and sewage are clogged with garbage as shown in Figure 3.3.5. Such clogging is main reason of overflow of sewage during heavy rain. Therefore, it is urgent to clean up man-holes to prevent flooding.

There are many broken manhole covers. This situation is dangerous for passengers and vehicles passing on them, and therefore the broken covers need to repaired immediately. (Figures 3.3.6, 3.3.7)

Inside of sewers and ditches as well as manholes are clogged with garbage and in serious conditions. Periodic checking and cleaning are required. CCTV inspection tool is recommendable for the checking inside sewers and ditches. Sewer cleaning equipment owned by HSDC shall be used effectively. (Refer to Figures 3.3.8 and 3.3.9)

Source: JICA team

Figure 3.3.4 Man-hole for sewage

Source: JICA team

Figure 3.3.5 Man-hole for rainwater

Source: JICA team

Figure 3.3.6 Man-hole with bad condition

Source: JICA team

Figure 3.3.7 Man-hole with good condition

Source: JICA team

Figure 3.3.8 Ditch covered with garbage

Source: JICA team

Figure 3.3.9 Ditch covered with sludge

(2) Infiltration/inflow

Table 3.3.1 is the result of water quality tests of the sewers at 4 points. Sampling time was around 10:30 to 12:00.

Water with low COD such as point 1 is assumed to be rainfall with raw sewage, water with high COD such as Point 2 & 6 is assumed to be sewage.

The data of each point are similar regardless of upstream and downstream except for COD. Therefore infiltration of groundwater into sewage is assumed to be small.

The survey by the JICA Study team covered only 300m length. When Hanoi city expands its sewer network, it is recommended to apply a CCTV inspection tool and periodic water sampling for checking infiltration and condition inside sewers.

Table 3.3.1 Water quality of each sampling point

	COD (mg/L)	NH4-N (mg/L)	NO3-N (mg/L)	PO4-P (mg/L)
Point 1	124	38	<0.5	3.6
Point 2	218	36	<0.5	3.3
Point 6	216	43	<0.5	4.0
Point 10	152	41	<0.5	3.1
Influent of WWTP	195	36	0.2	3.4

Source: JICA team

3.3.2 Water Quality Survey of Major Water Courses

1) Purpose of survey

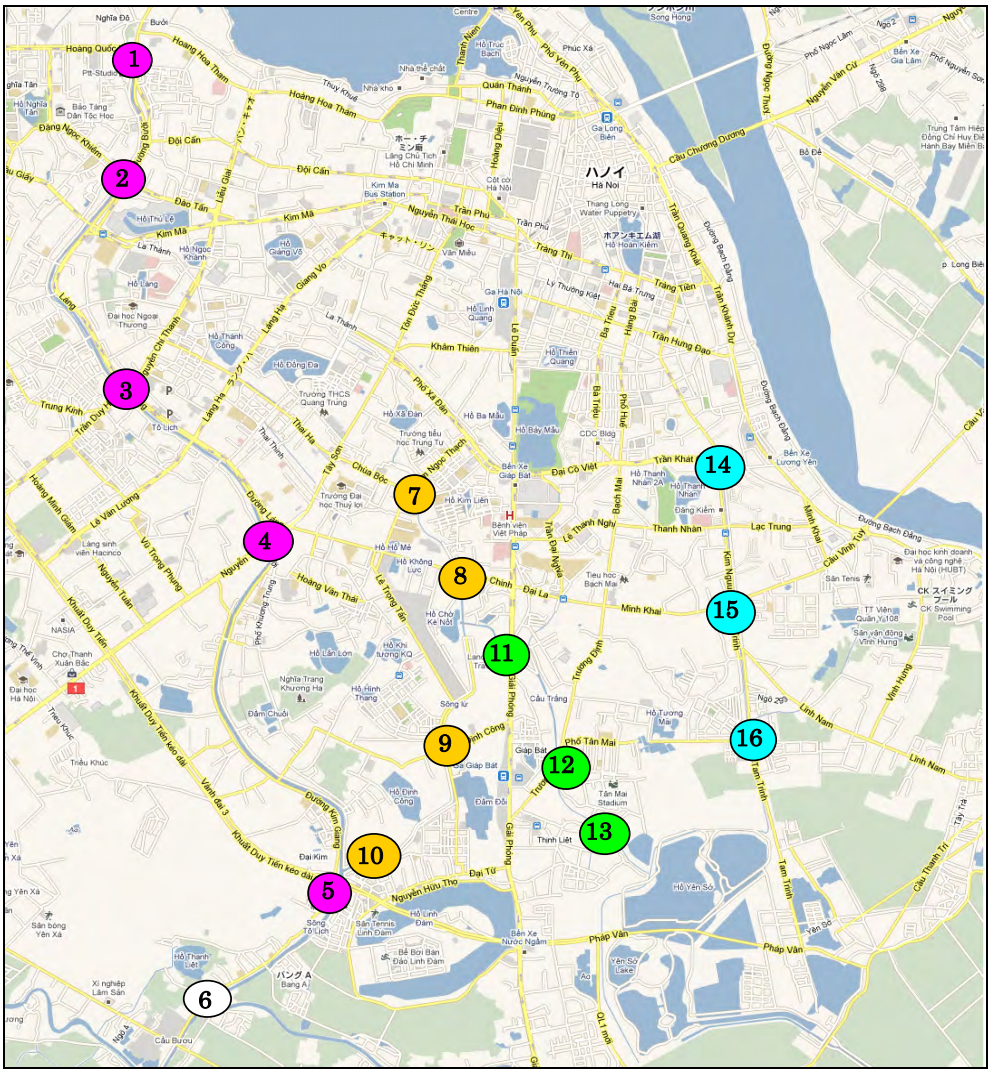
The purpose of the water quality survey is to understand pollution distribution due to urbanization.

2) Sampling points

A total of 16 points along water courses running in the center of Hanoi were selected and six parameters (T-N, T-P, NH4N, PO4-P, NO3-N and COD) were checked in the laboratory. The sampling points are shown in Figure 3.3.10.

3) Survey results

- The results of the laboratory tests are shown in Figure 3.3.11 by presenting water quality changes in each water course from upstream to downstream.
- All samples indicate contamination of sewage exceeding the environmental standard for water quality. In general, water downstream is more polluted by sewage than upstream.
- It is in common to all sampling data that NH4-N concentrations are very high, but NO3-N concentrations are very low or zero. This means that the water courses are in an anaerobic condition that is ecologically harmful for aquatic species as well as human living. Improvement of the water environment is required.
- There was a lot of garbage in the water courses. From a flood protection point of view and water environment point of view, it is necessary to eliminate illegal dumping of garbage into the water courses.

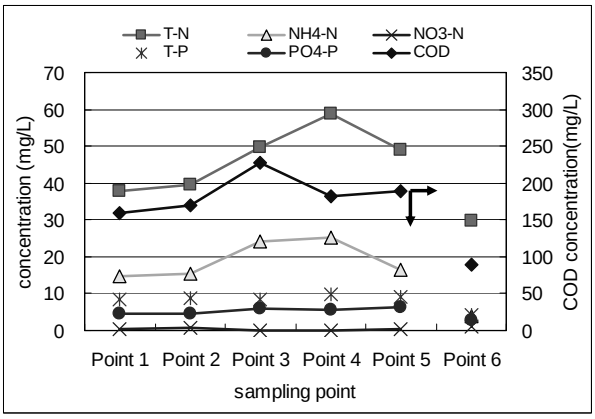


Sampling points

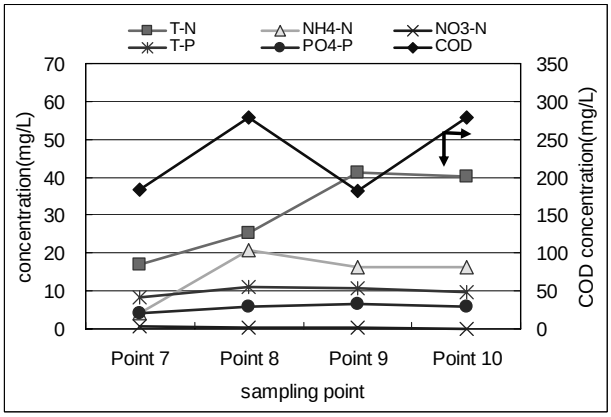
To Lich River : 1,2,3,4,5
Set River : 11,12,13
Nhue River(Ref) : 6
Lu River : 7,8,9,10
Kin Nguu River : 14,15,16

Source: JICA team

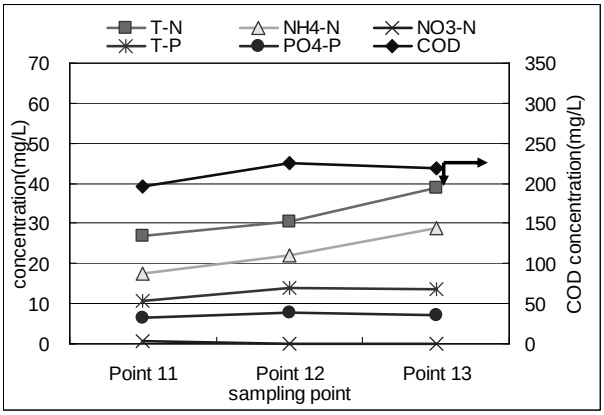
Figure 3.3.10 Sampling points of rivers



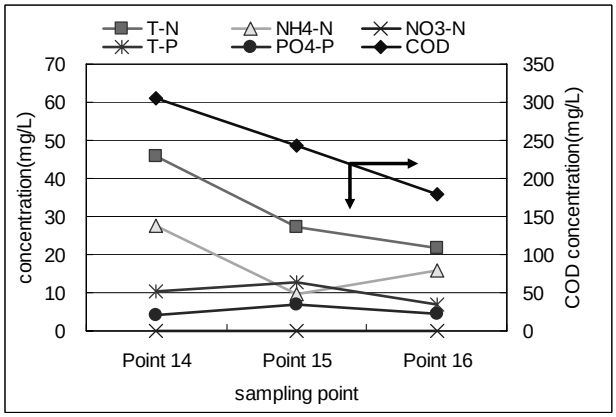
To lich river & point 6 Nhue river



Lu river



Set river



Kim Nguu river

Source: JICA team

Figure 3.3.11 Water quality of each river