No.

JAPAN INTERNATIONAL COOPERATION AGENCY

THE REPUBLIC OF KAZAKHSTAN

THE STUDY
ON
SEWERAGE OPERATION AND MAINTENANCE
KNOW-HOW TRANSFER

FINAL REPORT

JUNE 2009

NIPPON KOEI CO., LTD.

NIHON HELS INDUSTRY CORPORATION

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June 2009

Mr. Yoshihisa UEDA
Vice-President
Japan International Cooperation Agency

Dear Sir,

Letter of Transmittal

We are pleased to submit herewith the Final Report of ‘‘The Study on Operation and Maintenance Know-how Transfer for the Republic of Kazakhstan’’.

The Study was carried out by the Joint Venture (JV) of NIPPON KOEI CO., LTD, and NIHON HELS INDUSTRY CORPORATION under the contract with your Agency for the five-month period from February 2009 to June 2009.

The Study aimed to summarize know-how on sustainable financial management and operation and maintenance of facility, which could be applied to Indonesia, Vietnam and Astana City, through scrutinizing experiences and practicable technologies obtained by the field survey.

Finally, we genuinely wish that the report will be transferred to sewerage system development and financial improvement in developing countries.

Yours very sincerely,

Yakuro INOUE
Team Leader,
Operation and Maintenance Know-how Transfer for the Republic of Kazakhstan

SUMMARY

Astana City in Kazakhstan has developed with a remarkable population growth since it officially became the capital city in 1997. Its water supply and sewerage systems constructed during the 1960_S have been severely degraded. The Astana Water Supply and Sewerage System Project (under the 2003 Loan Agreement) involves the implementation of rehabilitating the facilities.

Sewerage works in developing countries generally lack know-how in terms of practicability of operations. Hence, degradation of related facilities seriously affects the public due to consequent water supply and wastewater tariff hikes. Although rehabilitation of sewerage system requires a costly amount, it eventually contributes to environmental sanitation improvement, conservation of water environment and water resource and sound urban development through sustainable operation and maintenance (O&M). Sewage works seem non-marketable since the public could not easily afford sustaining wastewater management. Therefore, it is important for the sewerage project scheme to consider a sustainable O&M.

The study aims to propose the Astana sewerage works as a case study to evaluate applicability of the typical know-how in sewerage financing, administration and O&M, which is studied through analysis on existing water supply and sewerage bodies in Southeast Asia countries where sewerage development is implemented in advance funded by the Japanese ODA loans, such as Indonesia and Vietnam. Considerations include public and private water supply and sewerage utilities in Jakarta, Yogyakarta, Hanoi and Ho Chi Minh.

Field studies of operation, as well as analysis of O&M plan, financial plan and tariff system, are executed to realize the most appropriate method. It is noted that such expertise and experiences in Japan are also proposed to be applied for the sewerage systems in Indonesia and Vietnam.

As for the Astana sewerage, the most practical O&M procedure is proposed through home study activities, in view points of engineering, financing and administration. Regarding public-private-partner ship (PPP) scheme, issues and methodology of project implementation are classified.

Sewerage system in Jakarta only serves Setia Budi and Kuningan city center district, which is only 2.8% of the total population. Its level of sewerage service is the least among the Asian capital cities. Its waste water treatment plant (WWTP) temporarily utilize excess capacity of storm water reservoir. Water treatment performance is at the modest level due to lack of aeration and retention time. As for the sludge treatment, two organizations involved in storm water management and wastewater management are responsible in various process of desludging. Therefore treatment performance is cautioned by the environmental sector. PD PAL JAYA DKI Jakarta, the public enterprise of sewerage works, acknowledges the poor practicability of the present treatment process. Hence, they express eagerness in implementing a sophisticated sewerage system in the city center.

While the water supply service coverage rate in Jakarta is approximately 50%, the sewerage service covers only 2.8% in population. The most remarkable characteristic in Jakarta is the sewerage

service operation is separated from the water supply services which provided by private companies. In this regards, sewerage tariff applies a floor area rate as tariff indicator since metered water and water charge collection system are not available in the sewerage service provider. Tariff structure of household is classified into four groups based on electricity consumption which applies 1.76 times of progressive rate. Tariff structure of commercial sector is classified into small and large facilities, applying progressive rates to be 1.5 to 2.0 times and 5 to 8 times, of household tariff respectively. There are totally five tariff groups which cover the public and industry sectors.

The financial characteristics of Jakarta sewerage is in terms of floor area rate indicator with cross subsidy ranging from high income/commercial to low income. Household only shares 0.7% of revenue in spite of 3.0% of floor rate and 86.5% of connections. On the other hand large industries shares 90.4% of revenue (96.8% in excluding connection charge and land lease) in spite of 91% of floor rate and 10.6% of connections. This tariff system causes 3,600 IDR/m^3 of revenue which is higher than the 2,314 IDR/m^3 O&M cost and the 36% profit (in 2008). Household tariff rate of 10,000 IDR/month is affordable and is lower than 20,000 IDR/month of the willingness to pay determined in the study.

Jakarta sewerage has potential to operate conventional activated sludge process which requires 2,500-3,000 IDR/m^3 O&M cost. There are about 560 high-rise and medium-rise buildings in Jakarta located in its commercial district. Hence, a sewerage project similar to that in Setia Budi and Kuningan, where about 140 commercial buildings exist, can be implemented to improve the environment.

Sewerage system in Yogyakarta, which intakes river water to utilize sewer flushing, was constructed in 1936 during Dutch colonial era. Before the WWTP (aerated lagoon process with treatment capacity of 15,500 m^3/day) and interceptor were constructed under JICA's grant project, wastewater was being discharged to river without treatment. WWTP has been operational since 1996 consequently improving the quality of river water in the city. The effluent water quality of 13mg/L of BOD, 44.0-54.7mg/L of COD and 7.6-9.7mg/L of SS, complies with the standards for well performed treatment.

Yogyakarta City government is promoting water related public education through PROKASIH (river cleansing program) and SANIMAS (sanitation for public). Sewon WWTP treats septage and operates as the center for wastewater management in the city.

Yogyakarta City (Kota Yogyakarta) forms Yogyakarta Metropolis with Sleman (Kabpaten Sleman) and Bantul (Kabpaten Bantul). Public service infrastructure management is locally executed by municipality government respectively, through the decentralization political reforms. However, it is rational for all the municipalities to execute regional economic development, urban planning and infrastructure management of airport and transportation, storm water drainage, water supply and wastewater management, and solid waste management through coordination and collaboration each other. In order to enhance regional development comprehensively, KARTAMANTUL was established as a coordination body for infrastructure planning and development.

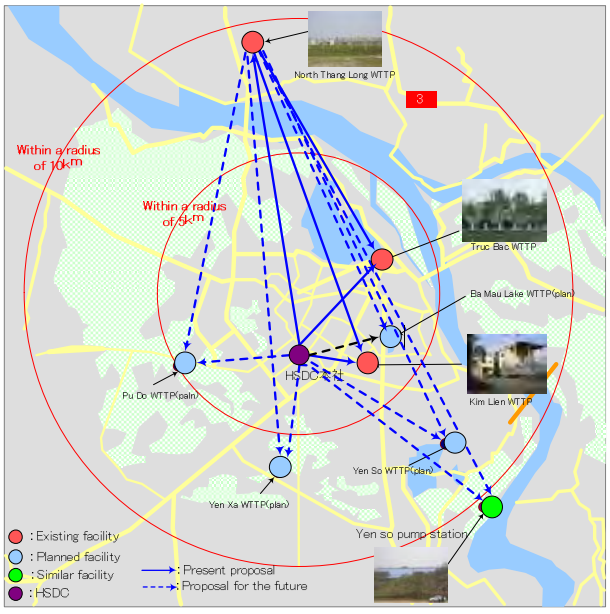
As for sewerage, tariff rate of household is significantly at low level with 500 IDR/month (0.05 USD/moth). Thus, Yogyakarta Provincial Government has to subsidize part of the operational costs (84% of O&M cost in 2008). The salary of staffs employed in WWTP is paid by respective municipality governments. It is thus noted that since revenue of sewerage charge only accounts for 4.5% of the total expenditure, sewerage services can not be managed without government subsidies.

Tariff system amended in 2009 will raise tariff rate to 3,000 or 6,000 IDR/month in the case of household (consisting of 1-5 family members). Although the amended tariff system will increase annual revenue to about 8 times, this is still insufficient to cover the full O&M costs. Tariff rate of household (3,000 or 6,000 IDR/month) is set up taking into account of affordability for low income households, which is equivalent to 0.3-0.6 % of the monthly household expenditure. However, the amended tariff system does not employ cross subsidy from commercial/high income to low income households. Thus, for sustainable financing, the deficit shall be covered by hotel/commercial groups like tariff systems of Jakarta or Denpasar, Bali.

Meanwhile, Hanoi and Ho Chi Minh are constructing activated sludge treatment plant and interceptor sewerage system, which effectively contributes to water environment improvement. As for sewerage operation, tariff of sewerage is 10% to 12 % of water supply charged with a flat rate, which covers O&M expenditures of only 15-18% in Hanoi and 6-19 % in Ho Chi Minh respectively. Therefore, the present tariff system will seriously affect the general budget of governments because the service coverage area might be expanded through customer connection increase or new WWTP development.

Financing mitigation is indispensable through comprehensive approach, from providing proper O&M plan consistent with stipulated performance and reduced costs, to collaboration with private projects, financial simulation and public education.

Three WWTPs are already operational in Hanoi, while seven more is proposed. Existing WWTPs are not equipped with control center and apply on-site O&M structures. Staffs are designated to perform on-site O&M during day time including weekends and holidays. Personnel expenses are less costly at present, and do not affect finances seriously. Comprehensive monitoring and control system with simplified SCADA system is proposed to prevent personnel cost escalation in line with economic growth in the future. This system requires support center for monitoring and remote controls, patrolling, inspection and water quality examination, and large scale inspection and repairs. Staffs on-site are



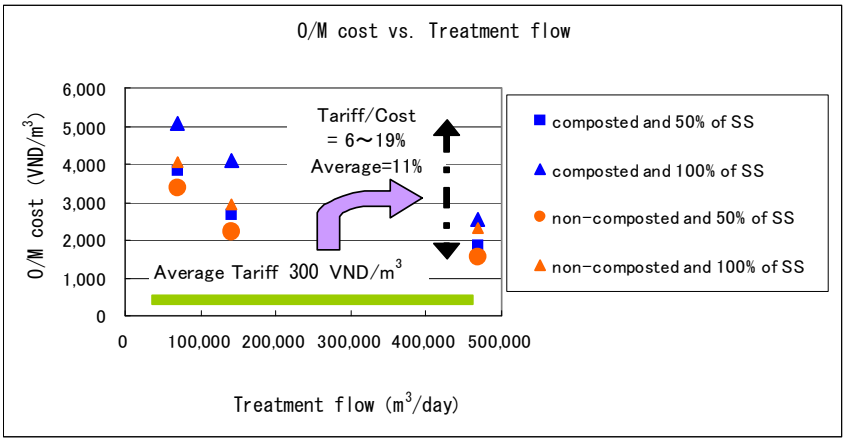
Integrated WWTP Monitoring System for Hanoi

engaged in routine inspections during day time. This system will consequently minimize staffs and personnel cost. Furthermore, data acquired continuously are processed and used as reference for O&M plans and utility purchases. Hence, professional expertise is vital for every facility. In case of machinery failures or storm water events occur, support center dispatches staffs to perform prompt counter measures.

For planning of O&M for the Ho Chi Minh sewerage, low concentration wastewater and future increase of inflow, and possibility of sludge recycling are focused.

Inflow rate increase affects the number of equipment operated and procedure of inspection and maintenance. Appropriate O&M organization corresponding inflow rate and equipments on-duty contributes to O&M cost reduction. The inflow water quality affects BOD removal process, number of reactor tanks, sludge production and disposal cost. The cost for sludge composting is estimated under the condition that the sludge production is 109 tons/day (141,000 m^3/day of inflow rate and 82% of water content), taking consideration of procurement route and cost of rice husk, possibility of on-farm utilization and risks of fertilizer use.

The result of cost simulation shows that it will be possible to improve the O&M cost to be 2,500 VND/m^3 in the mid and long-term (0.15 USD/m^3). The present sewerage tariff rate meanwhile is only 6-19% (average 11%). A comprehensive sewerage administration plan including the plans for cost reduction, proper tariff setting to be affordable rate for low-income households, conducting of public awareness, and collaboration with the urban development projects is indispensable.



Case Studied Treatment Cost vs. Tariff Rate

Comprehensive monitoring and control system also contributes to personnel cost reduction, prompt trouble shooting and precise communication for emergency. Bing Hung WWTP is recommended to be a supporting center for monitoring and controlling Bing Hung Pumping Station and Bing Hung Hwa WWTP (aerated lagoon process). In addition, it is preferable that Tan Quiy Dong WWTP is converted into a pumping station since: i) its small treatment capacity of 500m^3/day is insufficient to serve adjacent urban areas to be developed; ii) effluent water quality is not sound; and iii) it difficult to keep monitoring and maintaining because of closed facility.

Lessons learned related to O&M know-how and practicability obtained through investigation in Indonesia and Vietnam, and review of Japanese experiences, is summarized as shown in the following table. Individual technology and know-how suitable to Astana are to be selected and reviewed at each stage from designing to operation, from the viewpoints of work efficiency, economical efficiency, safety and environmental impacts.

Obtained Know-how/Practicability in Indonesia and Vietnam

Category	Detail	Efficiency	Life duration	Safety	Cost reduction	Environmental issues
Facility design	Simplified SCADA system ・data processing, data-base system	○		○		
	Simplified civil structure ・out-door power receiving ・proper facility arrangement to reduce accessories	○			○	
	Selection of automation & manual operation	○			○	
	Dual safe system for principal facilities		○	○		
	Instrumentation for operation indicator	○		○		
	Lagoon treatment (land acquisition, efficiency)	○			○	
	Sludge drying bed ・existing facility use, mechanical back-up	○			○	
Machinery design	Air-cooled engine ・air-cooled generator ・mechanical seal	○	○			
	Air conditioning of electric room ・air conditioning to IT devices		○			
First operation trouble	Small capacity equipment ・smooth on/off operation	○			○	
Flooding	Flooding pumping station ・Lay-out on ground of electric equipments ・Water proof door		○	○		
Offensive odor	Covering and deodorant facilities		○	○	○	○
Corrosion	Anti-corrosion material (plastic material) Corrosion prevention lining		○	○		
Environmental issues	Green space & gardening Environment issue mitigation					○
Easiness of O/M	Centralization (Remote monitoring, laboratory)	○			○	
	Light weight material (screening basket, cover)	○		○		

It is conceivable that introduction of the following measures is practicable for Astana sewerage works:

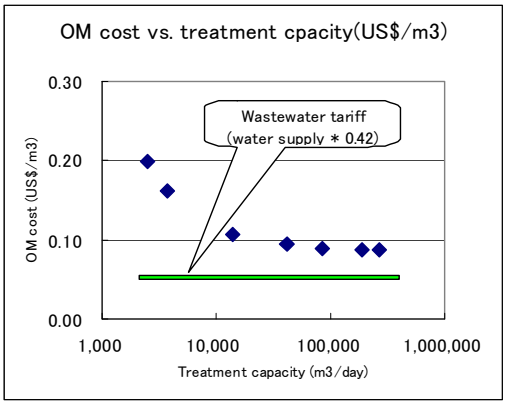
(Practicable to be considered for Astana)

- Simplified SCADA system
- Simplified civil structure such as out-door type power receiving panel
- Dual safe system for tanks and accessories
- Instrumentation for operation indicators
- Small capacity equipment against first operation trouble
- Measures against flooding underground facilities
- Defending against odor/corrosion

- Improving surrounding environment of facilities
- Centralization of monitoring system and laboratory

O&M plan should provide operation methods and water quality management procedures including manners for keeping O&M records. Such data to be recorded can make the future O&M activities and procurement procedures more effective through reviewing and analyzing them. It is recommendable to maintain an asset database to keep historical records on working conditions and performances of facility and equipment as well as records on maintenance activities in order to establish a proper asset management system.

The present tariff structure for the Astana sewerage services applies a flat rate method (which is not progressive), with a sole group of household/commercial consumers. The revenue from the tariff collection is approximately 60% of O&M expenditures estimated based on the case study in Vietnam. A comprehensive financial mitigation program is required, which should be comprised of: i) cost reduction program; ii) restructuring of tariff system, iii) planning for public awareness and public meetings on sewerage tariff system; and iv) planning for service expansions such as septage sludge collection and treatment system.



O&M Cost for Classified Treatment Flow Rate in Vietnam

A public private partner scheme (PPP) contributes to sewerage services both for retaining/upgrading service performance and cost reduction through the private company's skills and expertise in O&M experiences. As sewerage business lacks marketability, it is important to develop an institutional system in order to upgrade the public service quality. This shall be initiated through appropriate municipal intervention, and promotion of marketing and competition.

PPP for sewerage services have various risks which only can not be solved by private companies alone. These risks include natural disaster, barrier of public acceptance and unpredictability. It is also difficult for WWTP operators to solve issues such as storm water infiltrations and hazardous wastewater inflow. If all risks are committed to the private sector alone, the project may fail and cause the service suspension through declining of its marketability. Hence, efficient and sustainable public service shall be achieved through a proper risk demarcation system between public and private entities involved. The key factors for risk analysis are listed below:

(1) Financial availability for project progressing or retarding
(2) Project cost hike
(3) Suspension of project
(4) Value for money

(5) Efficiency of equipments and performance monitoring

(6) Performance of wastewater treatment, inflow related accidents and storm water infiltration

Since Japanese companies have limited experiences in PPP water related services, it is practicable to participate in the market through step-wise approach. Such related services are categorized into technical and know-how assistance, technology transfer and overall project implementation including facility constructions, O&M and public services. Information and human resources obtained through the technical and technology transfer to be carried out in the first step will contribute to PPP project findings.

Institutional systems from the both aid recipients and donors are should be redesigned in order to promote various PPP schemes such as unified schemes of water supply and wastewater management, concession services, bulk water supply services, considering incentive system for private sectors and implementation supporting system for public sectors. Properly developed PPP institution will aim to achieve an advanced public infrastructure management with high marketability and high service quality.

The study in Indonesia and Vietnam confirms that every city is developing a sewerage system as infrastructure for improving the urban environment. Sewerage-related sectors in Indonesia are exchanging information on technology, tariff system and financial issues through workshops. Joint ownership and transfer of practicability and failure are efficient to enhance the sewerage service level. In order to establish a proper O&M plan, it is very important to conduct a alternative study through financial analysis based on estimation of energy and chemical consumptions and equipment working times in various cases of wastewater inflow qualities and quantities. The alternative studies on introduction of remote monitoring system for Hanoi and modification of sludge treatment system for Ho Chi Minh conducted in the Study are sound examples for conducting such financial analysis.

The O&M plan as well as financial and administration plans should be provided with a systematic training program for all the staff from technical staff to administrative staff for all the skill levels.

Building-up a store of know-how obtained through the activities on O&M and administration for sewerage system can contributes to enhance its service level continuously, introducing a proper PDCA cycle system.

THE REPUBLIC OF KAZAKHSTAN

THE STUDY ON SEWERAGE OPERATION AND MAINTENANCE KNOW-HOW TRANSFER

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Abbreviations

ASA	Astana Su Arnacy
BOD	Biochemical Oxygen Demand
BORDA	Bremen Overseas Research and Development Association
BPS	Badan Pusat Statistik, Republik Indonesia (Statistics Indonesia of the Republic of Indonesia
CDM	Clean Development Mechanism
COD	Chemical Oxygen Demand
CSO	Combined Sewer Overflow
DO	Dissolved Oxygen
FCI	Financial Capacity Index
HSDC	Hanoi Sewerage and Drainage One-member State Company Limited
JBIC	Japan Bank of International Cooperation
Kabupaten	Prefectural Government
MBR	Membrane Bio Reactor
MCK	Mandi, Cuci and Kakus (Bathing, Laundry and Toilet)
O&M	Operation and Maintenance
PAC	Poly Aluminum Chloride
PD PAL JAYA	Perusahan Daerah Pengelolaan Air Limbah DKI Jakarta
PDAM	Perusahan Daerah Air Minum
PMB	Project Management Board
PPLi	Prasadha Pamunah Limbah Industri
PPP	Public and Private Partnership
PROKASIH	Proyek Kali Bersih(Clean River Program)
PROPER	Performance Level Evaluation Program
ROT	Rehabilitation, Operation and Transfer
SANIMAS	Sanitation for Public
SAWACO	Saigon Water Company
SEKBER KARTAMANTUL	Joint Secretariat Yogyakarta, Sleman and Bantul
SS	Suspended Solid
TKCM	Tirta Kencana Cahaya Mandiri
T-N	Total Nitrogen
UDC	Urban Drainage Company Hi Chi Minh City
WTP	Willingness to Pay

CHAPTER 1 GENERAL

1.1 Background and Objectives of the Study

The main objectives of the Study are as follows:

- To collect and organize practical know-how on management, operation and maintenance (O&M) of sewerage works in Southeast Asian countries, and
- To conclude recommendable solutions on management, and O&M for sewerage works in Astana City, the capital of Kazakhstan, based on the findings of the Study.

Sewerage works in Indonesia started during the colonial period. Although several pilot wastewater treatment projects have been put into operation until now, not any large-scale sewerage project has been developed. On the other hand, developments of such large-scale projects are being undertaken in Vietnam and Kazakhstan in the recent years, under the Japanese loan program. These two countries however have not earned sufficient experience to independently manage, operate and maintain sewerage facilities. Therefore, sustainable sewerage management system shall be urgently established in said countries.

Based on such background, the Study Team conducted field surveys to obtain both successful and unsuccessful experiences on sewerage works in Indonesia and Vietnam, organized collected information considering generality and particularity, studied sewerage management procedures and financial arrangements, and provided a draft sewerage O&M plan as well as wastewater tariff system. and public private partnership (PPP) scheme for Astana City. Main subjects of the Study are as follows:

1) Fact-finding survey on O&M condition of sewerage works

   For the fact-finding activities related to sewerage works in Indonesia and Vietnam, the Study Team collected and analyzed as much as possible available data such as O&M organization and procedure, resource consumption and procurement of materials, considering such basic data is one of the key factors to bring about an accurate study.

2) Evaluation of the current O&M status in Indonesia and Vietnam

   Based on the collected data, the current O&M status at model sewage treatment plants were evaluated from various viewpoints such as O&M procedure, condition of equipment, water quality in the treatment process, amount of resource consumption and financial status.

3) Investigation of draft financial plan and wastewater tariff system for Indonesia and Vietnam

   Based on the current O&M procedure in the model wastewater treatment plant, necessary annual O&M cost shall be estimated taking account of life cycle of the facilities. Willingness to pay (WTP) of local people was also surveyed. Eventually, annual cash-flow was analyzed in order to grasp the amount to be subsidized by the

government. Estimated WTP was evaluated and compared with the local people's capacity to pay.

4) Proposal for the Astana City sewerage system facilities O&M

On the basis of the available data in Astana, the draft O&M and financial plans are prepared taking consideration of the know-how obtained through the Study. Particular requirements of Astana have also been carefully considered.

5) Investigation of PPP scheme to Astana City

The possibility of the PPP scheme for sewerage works of Astana was studied as well as the possibility of involving Japanese private firms in said PPP.

1.2 Basic Strategy of the Study

1.2.1 Basic Concept of the Study

In general, sewerage works are intended for the following:

- To improve public sanitation environment by means of septage treatment and storm water drainage,
- To ensure public security and urban function through proper storm water drainage and flood control system, and
- To promote water resource conservation, public amenity and urban vitality through water environment improvement.

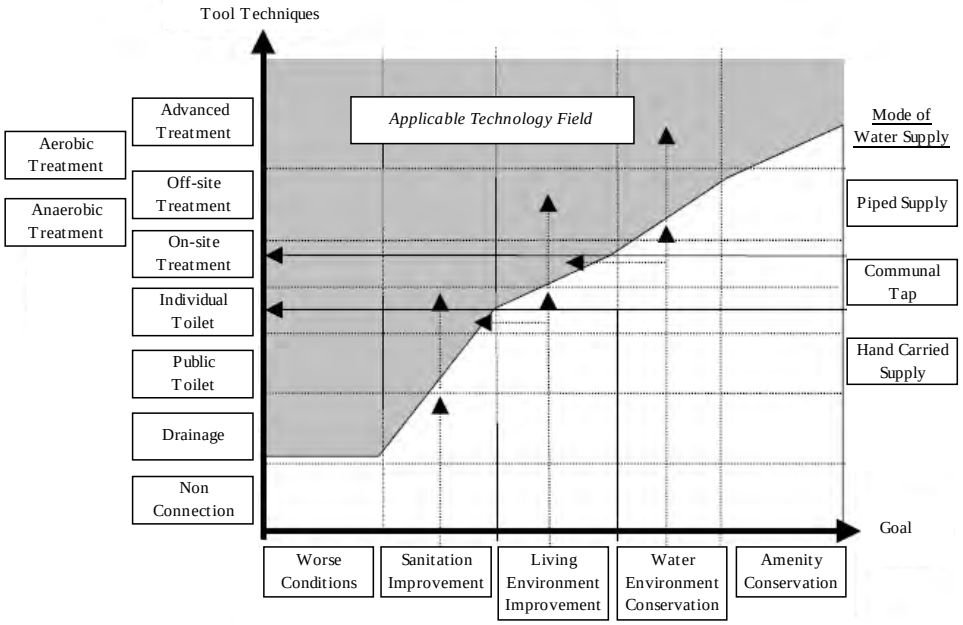
On the other hand, characteristics of the major cities in the developing countries vary in natural and social environment such as climate, geography, economy, culture and so on. Hence, it is not always applicable to introduce the procedures of developed countries to the sewerage works of developing countries. Financial capacity and procurement possibility also vary among developing countries. Thus, advanced technology is rarely demanded for sewerage works except for specific cases. Policy, goal and tools for the sewerage works are shown in the following figure. Applicable procedures shall be selected among various sewerage methods such as conventional sewerage, septic tank, on-site and offsite treatment, gray water treatment and advanced treatment taking account of the demand and cost burden.

From the said viewpoint, the following particular conditions have been considered for the sewerage management plan in a developing country:

- Wastewater treatment procedure is selected among various sewerage methods such as conventional sewerage, interceptor sewerage, simplified sewerage and septic tank taking account of the role of sewerage and demanded service level,
- For sustainable O&M, it is most important that specification of facilities and equipments is determined based on the capacity in procurement, maintenance and repair
- Cross subsidy principle was considered for the wastewater tariff system which is to

be integrated with the water supply tariff system.

Draft O&M plan for Astana City shall provide the sewerage service upgrading process in the medium- and long-terms.



Source: Guideline for Sewerage Works in Developing Country

Figure 1.2.1 Policy Goal and Tool

1.2.2 Study Areas and Organizations

(1) Study Areas

The target area of the Study is Astana City in the Republic of Kazakhstan. For the case studies, The following cities were selected in Indonesia and Vietnam, where two or more wastewater treatment plants are operated, with some private sector operating both water supply and sewage facilities.

Indonesia: Jakarta, Yogyakarta, Tangerang and Bekasi

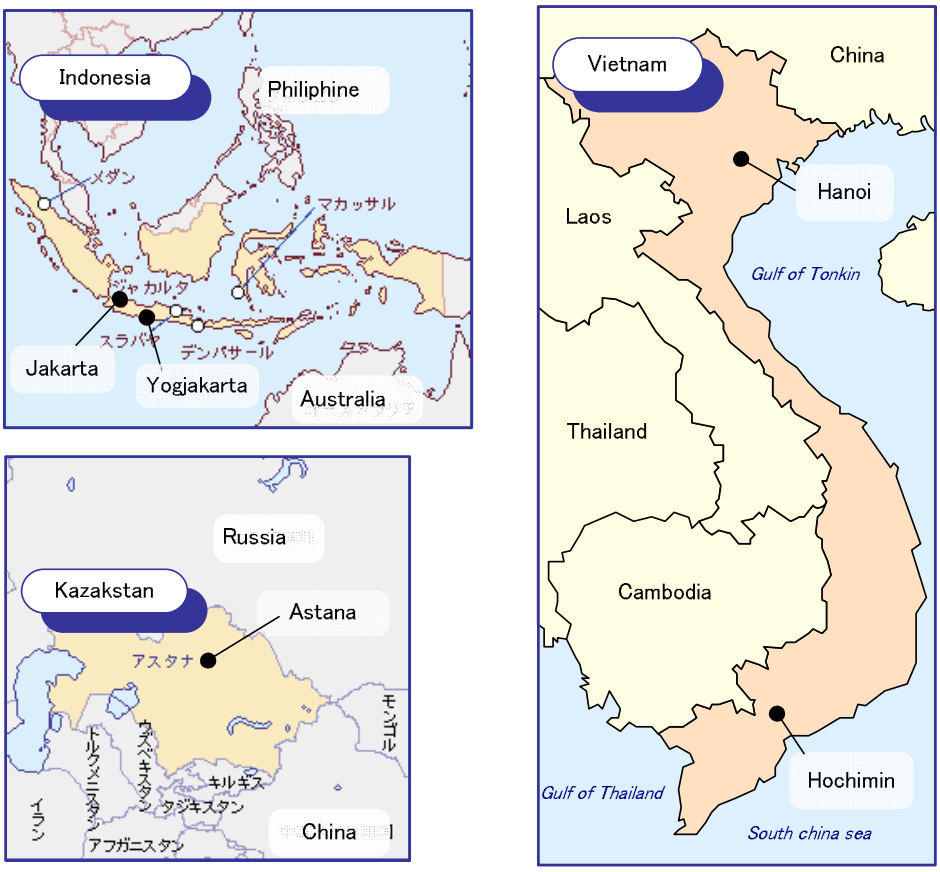
Vietnam: Hanoi and Ho Chi Minh

(2) Counterpart Organizations

The Astana City Council and Astana Water Authority (Astana Su Arnacy , ASA) is the counterparts of the Study.

(3) Location Map

The following figure shows the locations of target areas of the Study.



Source: JICA Study Team

Figure 1.2.2 Location Map of Study Area

1.2.3 Study Team

The members of the Study Team, consisting of a consortium between Nippon Koei Co., Ltd. and HELS Corporation, are as follows:

Table 1.2.1 Composition of the Study Team

Position	Name	Company
Tam Leader/Civil and Sewerage Planning Expert	INOUE Yakuro	Nippon Koei Co., Ltd.
Sewerage O&M Expert	TSUTA Hideo	Nippon Koei Co., Ltd.
Mechanical/Electrical O&M Expert	KAWATSU Toshiaki	HELS Corporation
Business Management (O&M Contract)	IKEDA Daisuke	HELS Corporation
Sewerage Works Financial Expert	KIM Hyeonyeoul	HELS Corporation

1.2.4 Study Schedule

The planned and actual schedule of the Study is shown in the following figure. The detailed schedules of activities and participants for the site surveys in Indonesia and Vietnam are tabulated as shown in Table 1.2.2 to 1.2.5.

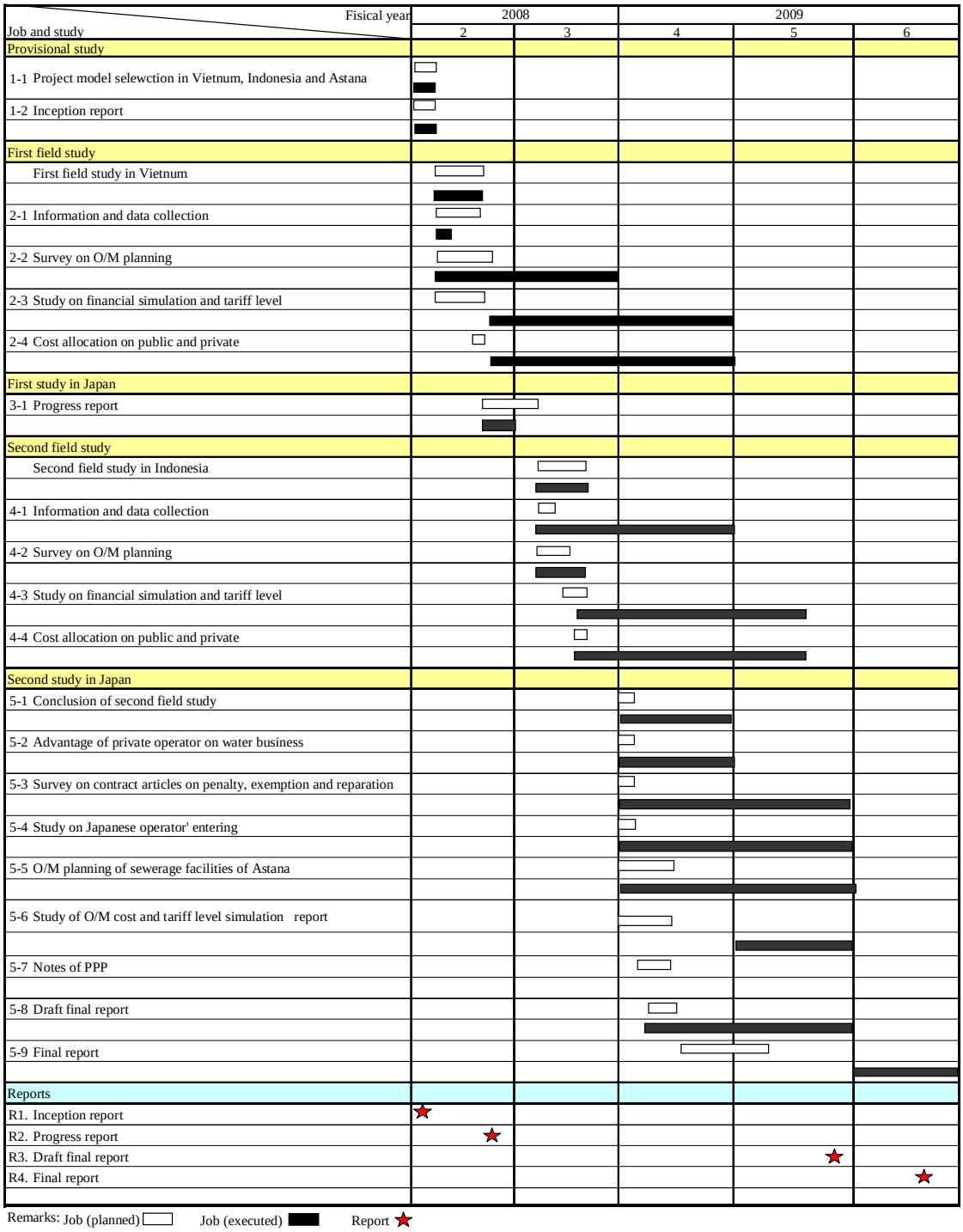


Figure 1.2.3 Study Schedule

Table 1.2.2 Activity Report of Field Survey in Indonesia

Study Schedule Executed
Indonesia (Jakarta / Yogyakarta)

Day	Date		Itinerary of Study Team	Participants from Indonesia Side	Accommodation Place
1	8-Mar	Sun	Travel from Narita to Jakrta via JL725		Jakarta
2	9-Mar.	Mon	AM/PM Field survey in Jakrta		Jakarta
3	10-Mar.	Tue	09:00 Courtesy call to Directorat of Human Settlement, Ministry of Public Works (CIPTAKARYA PU)	Mr. Handy B. Legowo / Vice Director of Sanitation Division Mr. Joko Mursito / Vice Director of Technical and Planning Division Ms. Asri Indiyani / Secretary of Mr. Handy	Jakarta
			17:00 Courtesy call to JICA Indonesia Office	Ms. Kitamura / Project Formulation Advisor	
4	11-Mar.	Wed	10:00 Courtesy call to PD PAL JAYA	Ms. Liliansari Loedin / Director General Ir. Erwin Marpiali / Head of Technical Department Ir. Hendry Sitohang / Program & Development Division	Jakarta
			13:00 Courtesy call to Dians PU, DKI Jakarta	Mr. Fakhrurrazi / Head of Water Resources Management Ms. Hemini / Water Resources Management Section	
			15:00 Courtesy call to Regional Environment Management Board	Mr. H. Djoni Tagor / Director Ir. Andono Warih / Head of Laboratory Mr. Eko Gumelar Susanto / Environmental Impact Control Specialist Mz. Dinar Savitri / Head of Environmental Planning and Order Division Mr. Rahmat Bayangkara / Chief of Environmental Education Sub-	
5	12-Mar.	Thu	09:00 Meeting on social survey in Jakarta and field survey for the Setiabudi Pond (aerated lagoon)	Ir. Setyo Dukhito / Program & Development Division Ir. Hendry Sitohang / Program & Development Division	Jakarta
			11:00 O&M site inspection of wastewater treatment facilities in Agro Building (Hotel Marriot)	Mr. Donny / Assistant Chief of Engineering Mr. Endang / Engineering Supervisor	
			14:00 O&M site inspection of the Setiabudi Pond (primary water quality test)	Ir. Hendry Sitohang / Program & Development Division Mr. Ekky Hariyatno / Program & Development Division Mr. Rudy Badrudin / Pump and Pump House O&M	
6	13-Mar.	Fri	09:00 Courtesy call to Japan Embassy in Indonesia	Mr. Muronaga / Second Secretary Economic Section (public Works)	Jakarta
			11:00 O&M site inspection of private water supply and wastewater treatment facilities in EJIP	Mr. Omata / President Director Mr. Nasu / Engineering Manager Mr. Gnawan / Water Treatment and Environment Control Manager	
7	14-Mar.	Sat	AM Mobilization to Yogyakarta PM Field investigation along Code River		Yogyakarta
8	15-Mar.	Sun	AM Field investigation and primary water quality test along Code River and Winongo River		Yogyakarta
9	16-Mar.	Mon	08:00 Courtesy call to Living Environemetal Service of Yogyakarta and field investigation of sewer facilities	Ir. Hadi Prabowo / Head Mr. Peter Lawasa / Chief of Environment Recovery Sub-Division Mr. Indro Sutopo / Chief of Recycling Sub-Division	Yogyakarta
			13:00 O&M site inspection of Sewon WWTP	Ir. Purwoko / General Manager of Sewon WWTP	
10	17-Mar.	Tue	08:30 Courtesy call to Dinas Pemukiman dan Prasarana Wilayah	Mr. Eko Suryo / Head Ir. Djoko Hardjono / Chief of Wastewater Canal Section Ir. Agus Sularso / Chief of Road and Bridge Section Mr. Nurul Huda / Road and Bridge Section Ms. Nunik / Wastewater Canal Section	Jakarta
			13:00 Technical meeting with Living Environemetal Service of Yogyakarta	Mr. Peter Lawasa / Chief of Environment Recovery Sub-Division Mr. Indro Sutopo / Chief of Recycling Sub-Division	
			14:00 Data collection at provincial PU (Sewon WWTP electrical consumption amoount in FY 2008)	None	
			16:30 Courtesy call to Joint Secretariat of KARTAMANTUL and return to Jakarta	Mr. R. Ferry Anggoro Surokusumo / Office Manager	
11	18-Mar.	Wed	09:00 Meeting with PD PAL JAYA	Ir. Setyo Dukhito / Program & Development Division Ir. Hendry Sitohang / Program & Development Division	Jakarta
			13:30 Pre-test of WTP survey in Jakarta	Ir. Hendry Sitohang / Program & Development Division Mr. Ahamad Fauzi Mr. Abdur Ahman	
			14:00 O&M site inspection Cicokol Water Treatment Plant in Tangerang	Mr. Jos Tupamahu / President Director	
12	19-Mar.	Thu	08:30 O&M site inspection Cicokol Water Treatment Plant in Tangerang	Mr. Jos Tupamahu / President Director	Jakarta
			PM Internal meeting on social survey and primary water quality test in Jakarta		
13	20-Mar.	Fri	09:00 Courtesy call to Mr. Yudi of PD PAL JAYA and meeting with PD PAL JAYA on social survey in Jakarta	Ir. E. Yudi Indardo / Director of Technical &Business Division Ir. Hendry Sitohang / Program & Development Division Mr. Ahamad Fauzi Mr. Abdur Ahman Mr. Jubaidin	Jakarta
			11:00 CIPTAKARYA PU	Ir. Emah Sudjimah / Engineer of Sanitation Division	
			17:00 Report to JICA	Ms. Kitamura / Project Formulation Advisor	
14	21-Mar.	Sat	AM Data organization PM Departure from Jakarta to Narita via JL726		
15	22-Mar.	Sun	Arrival at Narita		

Table 1.2.3 List of Participants in Indonesia

Directorate General of Human Settlements (CIPTAKARYA), Ministry of Public Works	
Mr. Handy B. Legowo	Vice Director of Sanitation Division
Ir. Emah Sudjimah	Engineer of Sanitation Division
Mr. Joko Mursito	Vice Director of Technical Planning and Development
Ms. Ansi Indiyani	Secretary of Mr. Handy
Perusahaan Daerah Pengelolaan Air Limbah (PD PAL) JAYA, DKI Jakarta	
Ms. Liliansari Loedin	Director General
Ir. E. Yudi Indardo	Director of Technical &Business Division
Ir. Erwin Marpiali	Head of Technical Division
Ir. Setyo Duhkito	Head of Program & Development Division
Ir. Hendry Sitohang	Engineer of Program & Development Division
Mr. Ekky Hariyatno	Program & Development Division
Mr. Rudy Badruin	Pump and Pump House O&M
Dinas Pekerjaan Umum (PU), DKI Jakarta	
Mr. Fakhrurrazi	Head of Water Resource Management
Ms. Hernini	Expert of Water Resource Management
Regional Environment management Board (BPLHD), DKI Jakarta	
Mr. H. Djoni Tagor	Director of BPLHD
Mr. Eko Gumelat Susanto	Environmental Impact Control Specialist)
Ms. Dinar Savitri	Head of Environmental Planning and Order Division
Mr. Rahamat Bayangkara	Chief of Environmental Education Sub-division
Ir. Andono Warih	Head of Laboratory
Joint Secretariat of KARTAMANTUL	
Mr. R. Ferry Anggoro Suryokusumo	Office Manager
Dinas Lingkungan Hidup (DLH), Pemeritah Kota Yogyakarta	
Ir. Hadi Prabowo	Head of DLH
Mr. Peter Lawasa	Chief of Environment Recovery Sub-division
Mr. Indro Sutopo	Chief of Recycling Sub-division
Dinas Pemukiman dan Prasarana Wilayah, Pemeritah Kota Yogyakarta	
Mr. Eko Suryo	Head
Ir. Djoko Hardjono	Chief of Wastewater Canal Section
Ir. Agus Sularso	Chief of Road and Bridge Section
Mr. Nurul Huda	Road and Bridge Section
Ms. Nunik	Wastewater Canal Section
Sewon Wastewater Treatment Plant (WWTP)	
Ir. Purwoko	General Manager of Sewon WWTP
Agro Building, JW Mariot Hotel	
Mr. Donny	Assistant chief of Engineering
Mr. Endang	Engineering Supervisor
Instalasi Pengolahan Air Minum Cikkokol	
Mr. Jos Tupamahu	President Director
Japan Embassy in Indonesia	
Mr. MURONAGA Takeshi	Second Secretary Economic Section (Public Works)

Japan International Cooperation Agency Indonesia Office	
Ms. KITAMURA Keiko	Project Formulation Advisor
P.T. East Jakarta Industrial Park	
Mr. OMATA Takeichi	President Director
Mr. NASU Yujiro	Engineering Manager
Mr. Gunawan	Water Treatment and Environment Control Manager

Table 1.2.4 Activity Report of Field Survey in Vietnam

Study Schedule Executed
Vietnam (Hanoi / Ho Chi Minh)

Day	Date		Itinerary of Study Team		Participants from Vietnam Side	Accommodation Place
			Group A	Group B		
1	8-Feb.	Sun	Travel from Narita to Hanoi via JL5135			Hanoi
2	9-Feb.	Mon	09:00 Courtesy call to Hanoi Sewerage & Drainage Project Management Board (HSDPMB)		Mr. Le Hong Quan/Vice Director Ms. Hoang Thi Mai Huong/Official of Planning Dept.	Hanoi
			10:30 Courtesy call to Hanoi Sewerage & Drainage Company (HSDC)		Mr. Nguyen Hong Phong/Vice Director of Wastewater Treatment Enterprise	
			PM Internal meeting with local assistants of study schedule and social survey			
3	10-Feb.	Tue	08:30 Field investigation of water environmental condition around Hanoi city			Hanoi
			14:00 Field investigation of O&M condition of North Thang Long WWTP		Mr. Son/Head of North Thang Long WWTP Mr. Trung/Chief of Technical Department of NTLWWTP	
4	11-Feb.	Wed	09:30 Field investigation of O&M condition of North Thang Long WWTP		Mr. Son/Head of North Thang Long WWTP	Hanoi
			PM Data collection of NTLWWTP	14:00 Meeting with Tan Mai Ward PC on social survey permission	(Social Survey) Mr. Vu Ngoc Cung/Vice Chairman of Tan Mai Ward	
5	12-Feb.	Thu	09:30 Field Investigation of O&M condition of Thang Long Industrial Park	9:00 Field investigation of O&M condition of Kim Lein WWTP	(TLIP) Mr. Okaji Toshio/Engineer of Thang Long Industrial Park Corporation (Kim Lien WWTP) Mr. Phan Hoai Minh/Director of Wastewater Treatment Enterprise Mr. Phong and Mr. Son	Hanoi
			14:00 Field investigation of O&M condition of Kim Lien WWTP			
6	13-Feb.	Fri	09:00 Technical Meeting with HSDC on Kim Lien WWTP		Ms. Nguyen Thi Thuy Nga/Head of Water Environment Engineering Dept. of HSDC Mr. Phong, Mr. Trung	Hanoi
			15:00 Courtesy call to JICA Vietnam		Mr. Katsutai Taro/Senior Project Formulation Advisor	
7	14-Feb.	Sat	Field investigation of water environmental condition around Hanoi including primary water quality test			Hanoi
8	15-Feb.	Sun	Travel from Hanoi to Ho Chi Minh via VN 217			Ho Chi Minh
9	16-Feb.	Mon	10:30 Courtesy call to East-West Highway & Water Environment Improvement Project Management Unit		Mr. Luong Minh Phuc/Vice Director Mr. Dang Ngoc Hoi/Chief of Division Water Environment Management Project I	Ho Chi Minh
			14:00 Courtesy call to Saigon Water Corporation (SAWACO)		Mr. Ly Chung Dan/Vice General Director Mr. Pham Ngoc Khoi/Deputy Office Manager	
10	17-Feb.	Tue	09:00 Courtesy call to Urban Drainage Company HCM City		Mr. Chu Quoc Huy/Director Mr. Nguyen Bao Khanh/Manager of Research & Development Division Mr. Phung Ngoc Chinh Ms. Nguyen Phuoc Minh Uyen	Ho Chi Minh
			10:30 Courtesy call to Anti-Flooding Management Center		Mr. Nguyen Phuoc Thao/Director Mr. Nguyen Ngoc Cong/Vice Director Mr. Viet/Head of Financial & Investment Division Mr. Long/Head of Wastewater Management Division Mr. Yung/Expert of Center	
11	18-Feb.	Wed	09:30 Field investigation of O&M condition of Binh Chanh WWTP	09:00 Courtesy call to Ha Tien 1 Cement Factory	(Binh Chanh WWTP) Mr. Suzuki Hiroshi/Project Manager Mr. Takata Naohiro/Resident Engineer (Ha Tien 1) Mr. Nguyen Luyen/Chief of Research & Deploy Department	Ho Chi Minh
				14:00 Meeting with Mr. Don Audet (Financial expert of SAPI)	Mr. Don Audet/Team Leader of HCMC Environmental Sanitation Project Institutional Strengthening	
12	19-Feb.	Thu	08:30 Field investigation of O&M condition of Binh Chanh WWTP	9:30 Meeting with Go Vap District People Committee on social survey	Ms. Le Thi Thanh Trang/Vice Chairman of Go Vap District Mr. Le Thanh Tuan/Economic Division of Go Vap District Mr. Than Huy/Construction & Environment Division of Go Vap District	Ho Chi Minh
				14:00 Courtesy call to Tan Mai Joint Stock Co.	Mr. Le Quang Huy/Deputy General Director of Technics Mr. Nguyen Phi Phung/Manager of Safety and Environment Department	
13	20-Feb.	Fri	09:00 Field investigation of O&M condition of Thu Duc Water Treatment Plant		(SAWACO) Mr. Tran Lim Thach/Environmental Engineer of production Engineering Team Mr. Tran Nhuan Hoat/Mechanical Engineer of Production Engineering Team Mr. Luong Quang Thuy/Expert of Technology Application Team (Thu Duc WTP) Mr. Vo Duy Quang/Deputy Director	Ho Chi Minh
			14:00 Field Investigation of O&M condition of Tan Qui Dong Wastewater Treatment Plant and Binh Hung Hoa Wastewater Treatment Plant		(Binh Hung Hoa) Mr. Trung/Chief Technical Management Division	
14	21-Feb.	Sat	Field investigation of construction condition of Water Environment Management Project I of HCMC			
15	22-Feb.	Sun	Arrival at Narita			

Table 1.2.5 List of Participants in Vietnam

Hanoi Sewerage & Drainage Project Management Board (HSDPMB)	
Mr. Le Hong Quan	Vice Director
Ms. Hoang Thi Mai Huong	Official of Planning Dept.
Hanoi Sewerage & Drainage Limited Company (HSDC)	
Ms. Nguyen Thi Thuy Nga	Head of Water Environment Engineering Dept
Hanoi Sewerage & Drainage Limited Company Wastewater Treatment Enterprise	
Mr. Phan Hoai Minh	Director of Wastewater Treatment Enterprise
Mr. Nguyen Hong Phong	Vice Director of Wastewater Treatment Enterprise
Mr. Son	Head of North Thang Long WWTP (NTLWWTP)
Mr. Trung	Technical Chief of Department of NTLWWTP
People's Committee of Tan Mai Ward in Hanoi City	
Mr. Vu Ngoc Cung	Vice Chairman of Tan Mai Ward
East-West Highway & Water Environment Improvement Project Management Unit (WEIPMU)	
Mr. Luong Minh Phuc	Vice Director
Mr. Dang Ngoc Hoi	Chief of Division of Water Environment Management Project I
Anti-Flooding Program Management Center of People's Committee of Ho Chi Minh City	
Mr. Nguyen Phuoc Thao	Director
Mr. Nguyen Ngoc Cong	Vice Director
Mr. Viet	Head of Financial &Investment Division
Mr. Long	Head of Wastewater Management Division
Mr. Yung	Expert of Center
Urban Drainage Company (UDC) of HCM City	
Mr. Chu Quoc Huy	Director
Mr. Nguyen Bao Khanh	Manager of Research & Development Division
Mr. Phung Ngoc Chinh	Expert
Ms. Nguyen Phuoc Minh Uyen	Expert
Saigon Water Corporation (SAWACO)	
Mr. Ly Chung Dan	Vice General Director
Mr. Pham Ngoc Khoi	Deputy Office Manager
Mr. Tran Lim Thach	Environmental Engineer of production Engineering Team
Mr. Tran Nhuan Hoat	Mechanical Engineer of Production Engineering Team
Mr. Luong Quang Thuy	Expert of Technology Application Team
Thu Duc Water Treatment Plant	
Mr. Vo Duy Quang	Deputy Director
Mr. Mai Luong Binh	Deputy Director
Binh Chanh Wastewater Treatment Plant	
Mr. Suzuki Hiroshi	Project Manager
Mr. Takata Naohiro	Resident Engineer
Binh Hung Hoa Wastewater Treatment Plant	
Mr. Trung	Expert of Binh Hung Hoa Wastewater Treatment Plant
People's Committee of Go Vap District in HCM City	
Ms. Le Thi Thanh Trang	Vice Chairman
Mr. Le Thanh Tuan	Expert of Economic Division

Mr. Than Huy	Expert of Construction & Environment Division
HCMC Environmental Sanitation Project Institutional Strengthening	
Mr. Don Audet	Team Leader
Ha Tien 1 Cement Factory	
Mr. Nguyen Luyen	Chief of Research & Deploy Department
Tan Mai Joint Stock Company.	
Mr. Le Quang Huy	Deputy General Director of Technics
Mr. Nguyen Phi Phung	Manager of Safety and Environment Department
Japan International Cooperation Agency Vietnam Office	
Mr. KATSURAI Taro	Senior Project Formulation Advisor
Thang Long Industrial Park Cooperation	
Mr. OKAJI Toshio	Engineer

CHAPTER 2 THE SYSTEMS OF WATER AND SEWERAGE WORKS OF FOUR CITIES IN INDONESIA

2.1 Field Survey

2.1.1 Sewerage Works in DKI Jakarta

(1) Overview of Sewerage Works

1) Outline

DKI Jakarta, the capital of Indonesia, is the most populous city in South East Asia, with a population of about 12 million. However, the rate of sewerage coverage population in DKI Jakarta is only approximately 2.8%, which is lower than most of other cities in Indonesia (Table 2.1.1 and Figure 2.1.1.)

Table 2.1.1 Sewerage Coverage Population of Each City in Indonesia

City	No. of Pipelines	Coverage Population (persons)	Coverage Population (%)
Kota Bandung	90,000	450,000	20
Kota Cirebon	18,800	90,000	32
DKI Jakarta	2,300	220,000	2.8
Kota Meden	7,400	49,000	2.3
Kota/Kab Tangeran	9,800	46,000	4
Greater Yogyakarta	10,100	85,000	10

Source: Finacing Affordable Water and Sanitation Systems, 2006, JBIC

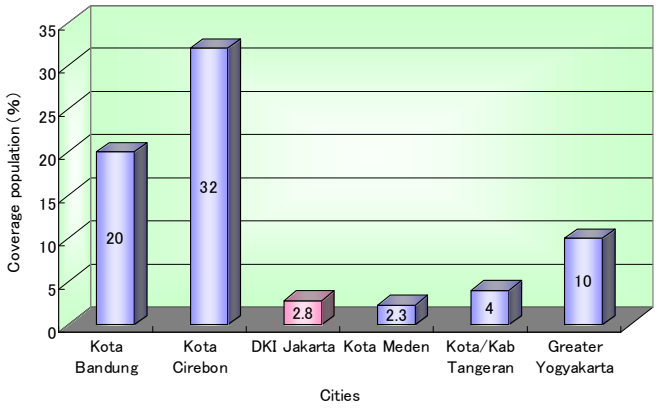


Figure 2.1.1 Sewerage Coverage Population of Each City in Indonesia

As for wastewater treatment plants, only one exists in DKI Jakarta, which is the Setiabuti pond. A new proposed plant has not been constructed yet due to economical reasons.

Setiabuti pond is situated in Jakarta City, which was developed for flood controlling. In 1991, Germany assisted in installing the surface aerators in the pond for

wastewater treatment. Eventually, it is used not only for flood control purposes but also for wastewater treatment process. Wastewater comes from households, shops and markets and flows into the plant either directly or via pumping stations such as the Krukut and Manggarai pump stations (Figure 2.1.2.). The treated water is then released into the Banjir Canal.

The pond is separated into two, the east and west ponds. The total area of the ponds is 4.35 ha, and its volume capacity is 84,200 m^3. As for surface aerators, three aerators are set in the east pond while four aerators are in the west pond.

There are six influent gates in the ponds, two in the east pond and four in the west pond. However, in the west, the inlets are two, to which the influent is coming from two of those gates respectively.

Figure 2.1.2 Location of Setiabuti Pond

Table 2.1.2 Overview of Setiabuti Pond

Item		East Pond	West Pond	Total
Surface Area (ha)		1.74	2.61	4.35
Storage Capacity (m3)		33,300	50,900	84,200
Average Depth (m)		Approx. 2m		
Estimated Average Sludge Layer (m)		1.5m via hearing survey		
Average Retention Time[2)]	Estimation[3)]	4.1days		
	Actual[4)]	2.3days		
No. of Surface Aerator (unit)		3	4	7
Sewer Inlet (no)		2	4	6
Storm Water Drain Inlet (no)		2	2	4
Screen		2	0	2

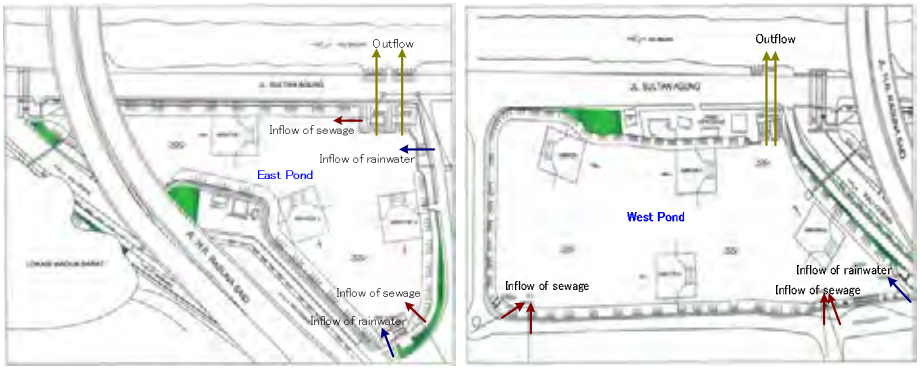
Source
1) Surface area and storage capacity of ponds are referred to PENGELOLAAN AIR LIMBAH SISTEM PERPIPAAN.PD PAL JAYA.
2) Estimation was done by use of the average treatment amount at 20,750m3/day in the report because of lack of the inflow data for the ponds.
3) Retention time was estimated on the basis of full storage capacity.
4) Retention time was estimates actual storage capacity deducting accumulated sludge layer.

Table 2.1.3 Overview of Pump Stations

Pump stations	Capacity	Type	Head
Krukut pump station	1,314m^3/hour	Vertical spiral pump	16.7m
Manggarri pump station	140m^3/hour	Aquatic pump	11.7m

According to PD PAL JAYA's (Perusahaan Daerah Pengelolaan Air Limbah DKI Jakarta) annual report in 2008, it is estimated that the average volume of influent into Setiabuti Plant is 20,753 $m^{3/}$day, or 240 L/sec. However, this seems unreliable since no flow meter is available for measuring the influent volume, and that said estimates are only based on the amount of clean water usage.

In 2008, the plant received wastewater from 1,147 households and 179 commercial buildings. The total floor space area of those customers is 4,193,684m^2 (Tab.2.1.4 and Figure 2.1.4).



East Pond **West Pond**

Figure 2.1.3 Layout Plan of Setiabuti Pond

Table 2.1.4 Customers of PD PAL JAYA

Customer Category	Number	Ratio (%)	Floor Space (m^2)	Ratio(%)
Common Household	1,147	86.5	125,597	3.0
Small scale commercial building	10	0.8	22,700	0.5
Large scale commercial building	140	10.6	3,815,146	91.0
Public sector building	28	2.1	229,841	5.5
Industry	1	0.1	400	0.0
Total	1,326	100	4,193,684	100.0

Source: PD PAL JAYA annual report 2008

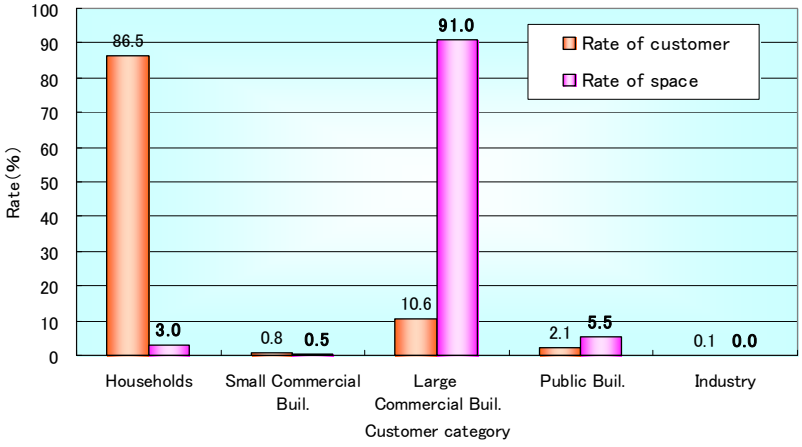


Figure 2.1.4 Customers of PD PAL JAYA

2) Governing Organization

PD PAL JAYA was established in 1991 by the government of DKI Jakarta to install and maintain sewerage facilities such as sewer collection pipes and treatment plants. Its services include installation of new sewer pipes, perform contract operation of small-scale treatment plants owned by private sectors, perform operation and maintenance of Setiabuti Pond, and collect wastewater charges.

The organization of PD PAL JAYA is classified into two departments, the Technical and Business Department, and the Administration and Finance Department (Figure 2.1.5).

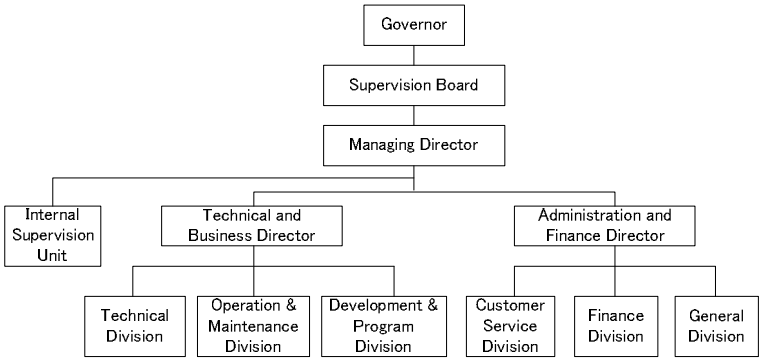


Figure 2.1.5 Organization of PD PAL JAYA

The personnel organization of PD PAL JAYA is shown in Table 2.1.5. There are about 22 persons designated to operate and maintain sewer pipes and treatment plant. Their works include water quality analyses, operation and maintenance of treatment plant, pumping station and pipes. PD PAL JAYA meanwhile outsources works related to collecting garbage floating in the ponds.

Table2.1.5 Number of Staff in PD PAL JAYA

Department		Person	Remarks
Management Div.	Supervision Board	3	
	Supervision Board Secretariat	1	
	Management	3	
	Internal Supervision	9	
	Subtotal	16	
Operation Div.	Technical Div.	9	
	Operation & Maintenance Div.	22	O&M for sewage treatment: 7 O&M for pump station and sewer: 7
	Development & Program Div.	9	
	Subtotal	40	
Administration and Financial Div.	Finance Div.	12	
	General Div.	23	
	Customer Service Div.	11	
	Others	4	Secretary and contract basis worker
	Subtotal	50	
Total		106	

Source: PD PAL Jaya Managing Director Decree No.12 of 2009

3) Sewerage tariff

The sewerage tariff is shown in Table 2.1.7. It is classified into households and commercial buildings, etc. Said tariff is calculated based on floor space area rather than the amount of wastewater water. Although the quantity of sewage from households is 86.5% of the total influent, the related floor space is very small at about 3% of the covered area (Table 2.1.4). Thus, in this charging system, the amount of receipts from households is only 0.7% of the total receipts while most of the receipts are collected from commercial facilities (Table 2.1.6, Figure 2.1.6).

PD PAL JAYA does not receive subsidy from DKI Jakarta. Instead, it gives financial aids to households based on benefits gained from commercial facilities.

Commercial facilities and others pay sewage fees through bank transfer while households pay directly to the designated collectors. PD PAL JAYA commissions the local communities, the smallest administrative organization, to collect sewerage fees from households.

Table 2.1.6 Details of Revenue from Sewerage Fees to PD PAL JAYA

(Unit: Million Rp)

Fiscal Year / Item	2006		2007	
	Amount	Ratio (%)	Amount	Ratio (%)
Large scale commercial buildir	16,312.5	90.4	20,447.6	90.0
Small scale commercial buildir	41.3	0.2	54.6	0.2
Public sector building	391.3	2.2	470.1	2.1
Industry	0.7	0.0	0.8	0.0
Common household	***126.3***	***0.7***	***149.8***	***0.7***
Connection fee	1,169.0	16.4	1,600.1	7.0
Total	18,041.1	100.0	22,723.0	100.0

Source: PD PAL JAYA Annual Report

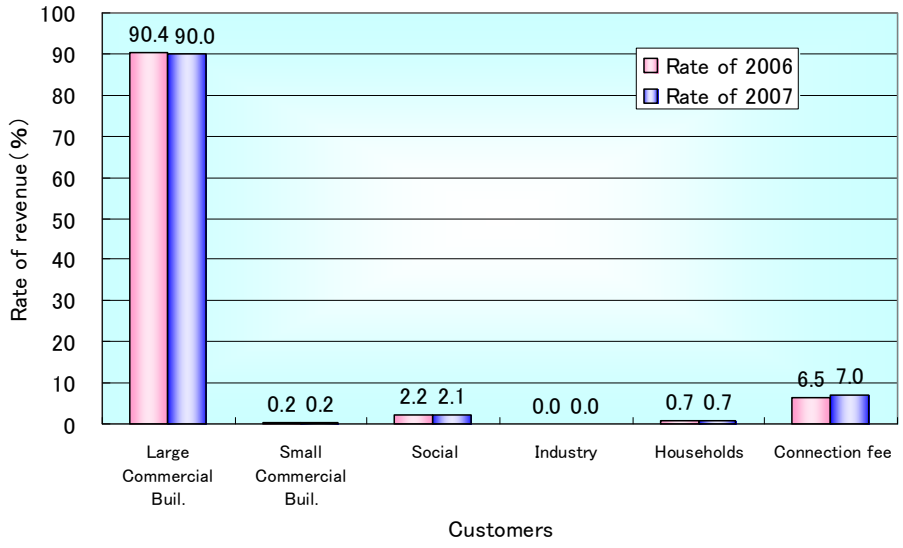


Figure 2.1.6 Revenue from Sewerage Fees by Customer Types (2006 and 2007)

The rate of fees collected is about 80% in average. Almost 100% is collected from commercial facilities while about 60% from households. If a customer fails payment of the sewerage fee for a long time, he will be prohibited from utilizing the sewerage system according to the regulation, but in the actual operation, such customer is receive only the notice without any service cut. It is noted that the rate of fee collection in Jakarta City is similar to other cities in Indonesia (Table 2.1.8).

Table 2.1.7 Sewerage Tariff in DKI Jakarta

NO	CUSTOMER CATEGORY	TARIFF (Rp/m^2)	CONNECTION FEE	
			Unit	Rp
I	***HOUSEHOLDS***			
1	HOUSEHOLDS TYPE A(Electricity 450-900VA)	90	unit	10,000
2	HOUSEHOLDS TYPE B(Electricity 900-1,300VA)	113	unit	10,000
3	HOUSEHOLDS TYPE C(Electricity 1,300-2,200VA)	135	unit	10,000
4	HOUSEHOLDS TYPE D(Electricity 2,200- VA)	158	unit	110,000
II	***SMALL COMMERCIAL***			
1	SHOPS	135	per m^2	1,000
2	OFFICE(Up to 3 Floors)	135	per m^2	1,000
3	HAIR DRESSER	158	per m^2	1,000
4	CATERING	180	per m^2	1,400
5	RESTAURANT	225	per m^2	1,500
6	SMALL HOTEL	225	per m^2	1,500
7	OTHER	225	per m^2	1,500
III	***LARGE COMMERCIAL***			
1	HIGH OFFICE BULDINGS	450	per m^2	1,750
2	HIGH OFFICE BULDINGS INCL.. RESTRAUNT AND/OR FITNESS	495	per m^2	1,925
3	SHOPPING CENTERS/MALLS/SUPERMARKETS/SHOWROOM	495	per m^2	1,925
4	Ⅰ,Ⅱ,Ⅲ-STARS HOTEL	495	per m^2	1,925
5	APARTMENT/CONDOMINIUM	675	per m^2	2,625
6	Ⅳ-STARS HOTEL	675	per m^2	2,625
7	ENTERTAINMENT CENTERS/BIG RESTRAUNTS/CAFE	720	per m^2	2,800
8	PRIVATE HOSPITALS	720	per m^2	2,800
9	Ⅴ-STARS HOTEL	720	per m^2	2,800
10	OTHER	720	per m^2	2,800
IV	***SOCIAL***			
1	RELIGEOUS PLACES	50	per m^2	550
2	SCHOOLS	135	per m^2	850
3	COMMUNITY HEALTH CENTERS	180	per m^2	1,100
4	GOVERNMENT INSTITUTIONS	180	per m^2	1,100
5	OTHER INSTITUTIONS	180	per m^2	1,100
6	SCHOOLS INCL.. DORMITORY	180	per m^2	1,100
7	SWIMMING POOLS	225	per m^2	1,100
8	GOVERNMENT HOSPITALS	270	per m^2	1,500
9	CLINIC	270	per m^2	1,500
V	***INDUSTRY***			
1	SMALL INDUSTRY	475	per m^2	1,000
2	MEDIUM INDUSTRY	675	per m^2	4,200
3	LARGE INDUSTRY	720	per m^2	4,300

Table 2.1.8 Collection Rate of Each City in Indonesia

City	Collection Rate (%)	City	Collection Rate (%)
DKI Jakarta	80	Banjarmasin	86
Bandung	80	Kota Modan	97
Yogyakarta	80	Kota Prapat	85

Source: PD PAL JAYA for DKI Jarta and USAID Report (2006) for the others

(2) Present Situation of Operation and Maintenance

1) Operation of Surface Aerator

Figure 2.1.7 Surface Aerator

Surface aerators are manually operated three times per day, and two hours at a time. Thus, they function for a total of six to seven hours per day. According to a staff from PD PAL JAYA who is in charge of operations, although he wanted to operate continuously, operating time was cut short since residents living near the plant complained about the bubbles found during the operation of the aerators. Three aerators are out of order currently. These were not repaired due to expensive costs. Moreover, said aerators need to be updated.

It is found that gases are produced in many places of the pond surface. These are due to lack of dissolved oxygen (DO) caused by the short operating period and low efficiency of surface aerators. This is also caused by the decomposition of accumulated thick sludge layer.

Currently, the treatment process by the aerators is inefficient. It is therefore necessary to select a better aeration system based on an integrated survey, once these equipment are updated. The bubbles appear to be caused by phosphate as surface-active agent included in the sewage. To improve the efficiency of aeration, it needs to be kept operating for a long time while simultaneously controlling the bubbles as much as possible.

2) Quality of Treated Water

Considering the operating condition and thick sludge layer described above (according to PD PAL JAYA, average sludge accumulated is 1.5m), influent sewage is not treated properly. Based on the interview survey with a staff of PD PAL JAYA who is in charge of water quality analysis, the effluent BOD exceeds the standard value on a frequency of about once every two weeks. Moreover, based on the PD PAL JAYA's annual report 2008, the average BOD of treated water exceeded the acceptable standards (Table2.1.9).

Environmental Agency of Indonesia pointed out that the effluent water quality exceeded the legal standard. PD PAL JAYA has proposed to develop a new plant as a countermeasure to the government. Consequently, it is necessary to build a new treatment plant facility. This is however difficult due to budget issues.

Table 2.1.9 Water Quality of Inflow and Outflow in Setiabuti Pond

Item	BOD (mg/L)				SS (mg/L)				COD (mg/L)			
	Influent		Effluent[1)]		Influent		Effluent[1)]		Influent		Effluent[1)]	
	East	West	East	West	East	West	East	West	East	West	East	West
Standard	400		50		—		50		—		80	
Actual[3)]	80.9	77.0	52.6	51.2	69.3	71.3	50.9	47.9	—	—	75.9	74.1

Note:

1) Allowable limit was upgraded at 50mg/L under new regulation in 2006 against at 75mg/L in original design.

2) Allowable limit for effluent is not design value, but the legal standard value.

3) Actual value is referred to PD PAL JAYA annual report 2008.

4) Allowable limit for influent is design value, and concentration was obtained via hearing survey.

3) Operation and maintenance of pipes

In 2008, there are 1,326 buildings including households, commercial facilities and others which have been connected to the sewerage pipes. Maintenance of pipes is performed through visual checks of the manholes. Inspection of pipes is vital considering that the materials have already aged since these were installed.

In this inspection, the concentration of influent into Setiabuti Pond was measured. Results indicate that the concentration during sunny days is almost the same as that published by PD PAL JAYA. The influent COD during rainy days is low at 18-20 mg/L. This may be due to the influence of rain water and poor connection of storm drains.

If a large amount of sewage flows into the pipes, it will cause flooding from the manholes and consequent damage to the pipes. Hence, it is necessary that the pipes are inspected regularly.

4) Cost of operation and maintenance

Table 2.1.10 shows the cost necessary for the operation and maintenance of Setiabuti Plant and pipes. While the personnel cost has increased up to 2006 but reduced in 2007 due to staff number reduction and welfare expenses increase. Thus, average total personnel cost consequently increases every year.

Maintenance cost has not changed much because it has been kept low under the limited budget condition. PD PAL JAYA therefore can not initiate repairs to the surface aerators and other malfunctioning facilities. Hence, it has kept the surface aerators unusable.

Depreciation expense meanwhile increases yearly due to new constructions of pipes, etc.

Table 2.1.10 Annual Operation and Maintenance Cost of PD PAL JAYA

(Cost of operation and maintenance concerned treatment only)

(Unit : Mil.Rp)

Item \ Year	2001	2002	2003	2004	2005	2006	2007
Salary	1,716.8	1,769.9	2,273.7	2,300.6	2,602.8	2,720.9	2,506.6
(%)	34.6%	32.8%	36.9%	37.8%	40.2%	38.6%	33.3%
Employee benefits	969.9	1,037.8	1,224.4	1,130.1	1,232.0	1,346.0	1,412.7
(%)	19.6%	19.2%	19.9%	18.6%	19.0%	19.1%	18.8%
O&M fee	1,046.9	1,260.9	1,412.7	1,310.7	1,182.7	1,233.9	1,222.6
(%)	21.1%	23.4%	22.9%	21.5%	18.3%	17.5%	16.3%
Administration	262.5	380.3	433.4	444.8	365.3	498.7	742.0
(%)	5.3%	7.0%	7.0%	7.3%	5.6%	7.1%	9.9%
Depreciation	959.9	945.9	816.7	903.8	1,091.1	1,247.0	1,635.0
(%)	19.4%	17.5%	13.3%	14.8%	16.9%	17.7%	21.7%
Total	**4,956.8**	**5,395.6**	**6,161.8**	**6,090.9**	**6,474.7**	**7,047.3**	**7,519.7**

(3) Operation and Maintenance Issues

1) Sludge Withdrawal from the Ponds

The ponds used for treatment is also used for rainwater storage. These are basically managed by Dinas PU and not by PD PAL JAYA. Thus, there are various problems that occurred which influence the performance of treatment. The main problem is the removal of sludge accumulated in the ponds. Sludge is withdrawn about once every two years. According to PD PAL JAYA, sludge layer thickness is more than 1.5 m. This accumulated sludge could cause elution of organic matters which could affect the effluent water quality. Withdrawing the sludge more frequently is expected to improve the effluent water quality.

However, it is difficult to carry out due to extensive sludge flow into with rainwater. It is thus a burden to PD PAL JAYA to withdraw the sludge. Therefore, it is necessary to withdraw the sludge using an appropriate method (PD PAL JAYA could share the expense with Dinas PU).

2) Construction of New Treatment Plants

As discussed above, there are various problems observed concerning the poor quality of treated water. It is also difficult to operate and maintain treatment facilities attached to high-rise buildings in the city center because of technical or cost issues. For example, due to technical problems, the Marriot Hotel of Jakarta no longer pursued self-treatment system and decided to connect to the public sewer pipes. The treated water qualities of such treatment system of private sectors are also poor (Table 2.1.12). It is noted that related operations were entrusted to PD PAL JAYA. This means that it is more reasonable to construct a new single sewage treatment plant to serve all the buildings, instead of upgrading the existing plants

and constructing new ones attached to buildings. It is however necessary to consider the quantity of sewage already flowing into Setiabuti pond from an existing treatment area.

High-rise buildings which are not connected to existing treatment areas must build their own treatment facility, as per DKI Jakarta regulation enforced from 2005. If the initial cost for installing such facilities can be converted as share of expenses, then combined with the government subsidy for constructing a single new treatment plant, a more economical and efficient solution is achieved. This would also contribute to environmental conservation.

Table 2.1.11 Overview of Plants Contract Operated by PD PAL JAYA

Name of Bldg..	AGRO PLAZA	TIFA ARUM	GRAHA XL	MENARA DANAMON	MENERA DEA
Treatment type	Extended Aeration	Bio-Filter	Bio-Filter	Bio-Filter	Rotor Disk
Capacity (m^3/day)	300	170	170	261	120
Influent volume (m^3/day)	Not clear（Not measured）				
Influent BOD (mg/L)	79.58	78.52	84.08	80.75	82.08
Outflow BOD (mg/L)	**47.0**	**52.83**	**54.5**	**50.92**	**54.5**
BOD removal rate (%)	40.9	32.7	35.2	36.9	33.6

2.1.2 Sewerage Works in Yogyakarta City

(1) Overview of Water Environment and Sewerage

1) Overview

Yogyakarta City is the capital of Daerah Istimewa Yogyakarta (DI Yogyakarta) and the second largest city in Indonesia. Its population is 511,744 in 2004.

Being an ancient city in Indonesia with preserved culture, Yogyakarta City is famous for sightseeing and tourism. Popular attractions include the royal palace called Kraton inside the city area, the world heritage Borobudur Temple and the Prambanan Temple in its adjacent area.

In Yogyakarta City, about 110 km long

Figure 2.1.8 River of Yogyakarta City

sewage pipes were constructed in 1936, while it was colonized by the Netherlands. The sewage was discharged into Code River, Gajah Wong River, and Winongo River, which all flow through the city (Figure 2.1.8). Hence, environmental pollution due to sewage had been a problem.

Figure 2.1.9 Sewon STP

In order to improve the situation, a mid-term plan was initiated and implemented from 1993 to 1998, which included the construction of the Sewon Sewage Treatment Plant (STP) in 1996 with the support of the Japanese government. Sewage treatment commenced from Yogyakarta City, Sleman area (5 small treatment areas), and Bantul area. The current rate of covered population is around 10% while only 22% in the city/urban area is covered. By 2012, it is expected to increase to 59% in the city area, serving a population of 273,000. Presently, they are focusing on installing the main pipes.

According to the final report from the urban development plan in DI Yogyakarta made in 2002, 6.35 km main pipes and 6 km flushing pipes were planned to be installed in Yogyakarta City and Sleaman. Meanwhile, about 4km new flushing pipes were planned to be installed in Bantul. Total cost estimated was 17,233 million Rp. Yogyakarta City, Sleman, and Bantul will share the costs in addition to the subsidies from both the national and state governments.

The specification and process flowchart of Sewon STP is shown in Table 2.1.12 and Figure 2.1.10, respectively.

Table 2.1.12 Overview of Sewon STP

Name of Plant	SEWON BANTUL Sewage Treatment Plant
Commencement of Operation	1996
Sewer Collection Method	Separate Sewer System with Flushing Facilities
Planned Coverage Population	273,000 inhabitants
Design Treatment Capacity	15,500m^3/day
Current Inflow Rate	8,000m^3/day including flushing water

Source: DI Yogyakarta

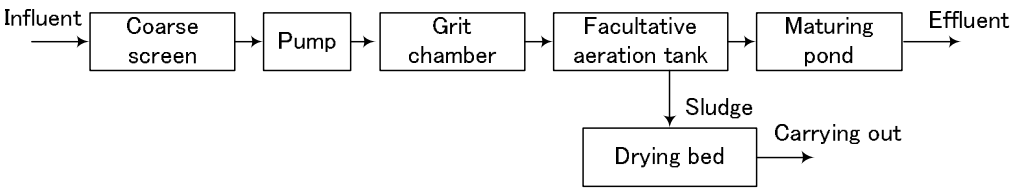


Figure 2.1.10 Flow Diagram of Sewon STP

The sewer pipes have been constructed mainly in the west part of the city, which are known to be populated areas, requiring a separate piping system. Flushing system, utilizing river water from high areas into sewer pipes, was adopted since these areas are geographically low. This is intended to achieve a smooth flow and clear sediments in the pipes. Because of this, pumping stations are not constructed. Although the concern in the flushing system is low sewage concentration, this is a good way in terms of costs, considering high expense in sewage maintenance cost for the O&M (such as electricity cost and construction of lifting pump station).

Figure 2.1.11 Pond of Flushing Water

Flushing pipes are constructed separately from sewerage pipes and the flushing is operated by opening and closing the gates in manholes. The recovered flushing water used for sewerage process is also utilized for agricultural purposes.

There are three rivers flowing in Yogyakarta City, namely, Winongo River and Code River flowing in populated areas, and Gajah Wong River flowing in the fields.

In the Study, the water quality in upper, middle, and lower parts of Winongo River and Code River was analyzed using simple test kits, in order to evaluate the pollution in said rivers. Sampling points are shown in Figure 2.1.12 while results of tests are shown in Table 2.1.13.

Figure 2.1.12 Sampling Points for Water Quality Analysis

Table 2.1.13 Analyzed Water Quality of Code River and Winongo River

Location	Code River			Winongo River		
	COD_{Mn}	NH_4-N	NO_3-N	COD_{Mn}	NH_4-N	NO_3-N
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Upper	8	0	3	7	0	3
Middle	18	0.2	3	6	0.2	3
Lower	7	0.4	4	7	0	5

Note: The water quality was tested by JICA Study Team through the pack-test method of Kyoritsu Chemical Check Lab. Corp.

According to the table above, COD_{Mn} is 8 mg/L or less except for the middle part of Code River, while Ammonium-nitrogen are 0.4 mg/L or less, and Nitrate-nitrogen are 3 to 5 mg/L. Although gray water flows into these rivers, it seems to have enough dissolved oxygen for nitrification. From these results, it appears that these rivers keep natural depuration ability. This is because sewer pipes have been connected to the STP since1996, minimizing flow of gray water into the rivers.

Some samples from drain pipes of the upper part of Code River and the middle part of Winongo River were also analyzed. Corresponding results are shown in Table 2.1.14. The drain water from the upper part of Code River is regarded as irrigation drain because there are fields and few houses in the area, and COD_{Mn} is low at 5mg/L. The drain water from the middle part of Winongo River is also regarded as gray water because COD and ammonium-nitrogen are high at 75 mg/L and 70 mg/L, respectively. Therefore, reasonable conclusions were made. In the middle part which is populated, gray water and sewage flow into the rivers. However, COD_{Mn} and ammonium-nitrogen are removed by natural depuration of the river. In the middle part of Code River, the water quality of effluent water, directly drained to the river from a septic tank of public toilet, was analyzed. It was found that COD_{Mn} and ammonium-nitrogen were very high at 450mg/L and 80 mg/L, respectively. Thus, it is necessary to expand the sewage system continuously.

Table 2.1.14 Quality of Drained Water from Drain Pipes

Sampling Point	COD_{Mn}	NH_4-N	NO_3-N
	(mg/L)	(mg/L)	(mg/L)
Upper Reach of Code River	5	0.6	1
Middle Reach of Winongo River	75	72	0.5
Effluent of septic tank in middle reach of Code River	450	80	3

Source: JICA Study Team

Figure 2.1.13 Analyzing Water Quality

Figure 2.1.14 Drain Pipe in the Upper Part of Code River

Figure 2.1.15 Sampling Point of Winongo River

Figure 2.1.16 Effluent of Septic Tank

2) Management of sewerage works

Sewon STP was operated until 2008 by the Cleaning Department of Yogyakarta City. Since 2009, operation was handed over to Kartmantul, which is a broad administration organization. Said organization was formed consisting of representatives from Yogyakarta City, Kabupanten Bantul, and Kabupanten Sleman in order to collectively perform social infrastructure business, including sewerage works.

There are 40 staffs employed to operate the Sewon STP. Personnel organization is shown in Table 2.1.15.

Table 2.1.15 Personnel Organization of Sewon STP

Classification	Person	Remarks
Manager	1	
Operation	15	Night works : 2 shifts with 3 Teams(2 persons per a team)
Maintenance		
Analysis	3	
Administration	2	
Others	18	Securities
Total	40	

DI Yogyakarta, Yogyakarta City, Kabupanten Bantul, and Kabupanten Sleman share

the O&M cost of said STP. Although most sewage water flowing into the plant comes from Yogyakarta City, Kabupanten Bantul and Kabupanten Sleman pay shared cost considering future sewerage system expansion in these areas.

The amount of shared cost for O&M is shown in Table 2.1.16. Meanwhile, Yogyakarta City, Kabupanten Bantul, and Kabupanten Sleman pay the salaries of their staffs under their jurisdiction.

Table 2.1.16 Detail of the Shared Cost

(Unit:Rp)

Region \ Year	2003[1)]	2004[1)]	2005[1)]	2008	2009[2)]
Yogjakarta city	100,000,000	125,000,000	125,000,000	145,000,000	145,000,000
Suleman	—	—	10,000,000	20,000,000	20,000,000
Bantul	—	—	10,000,000	20,000,000	20,000,000
DI Yogjakarta	450,000,000	500,000,000	650,000,000	1,000,000,000	1,327,451,520
合　計	550,000,000	625,000,000	795,000,000	1,185,000,000	1,512,451,520

Source: 1) USAID Report, 2006
2) Planning Report of KARTAMANTUL

While the Kartmantul has a task for planning the development of new plants and sewer pipes, maintenance works for existing facilities are carried out by Yogyakarta City, Kabupanten Bantul, and Kabupanten Sleman. For example, staff in Yogyakarta regularly dredged sediments inside the pipes as part of their maintenance works. However, their activity is limited due to cost issues. The detailed of O&M cost in 2008 is shown in Table 2.1.17.

Since operation staffs are dispatched from Daerah Istimewa (DI) Yogyakarta, Yogyakarta City, Kabupanten Bantul, and Kabupanten Sleman, as mentioned above, pay the salaries of the staffs under their jurisdiction. The cost of O&M includes only the benefit of staffs and the salary of contracted employees, and excludes labor cost of operating staffs. According to the field survey, the salary of staffs is 30,000,000 Rp. per year on average. Total annual salary therefore is: 30,000,000 Rp/year x 40 persons = 1,200,000,000 Rp./year (Shared cost of Yogyakarta City: 630,000,000 Rp./year for 21 persons, estimated based on survey). This total annual salary is added on the current cost of O&M. Consequently, the O&M cost excluding the salary of staffs is 1,185,000,000Rp while the O&M cost including the salary of staffs is 2,385,000,000Rp.

In the latter cost, repair and electric consumption are the major items, which are 22.5% and 25.8%, respectively. The total of these reaches about 50%. It is necessary to reduce the cost for O&M.

It was observed that the cost of O&M increased yearly from 582,559,000 Rp. in 2002 to 1,185,000,000 Rp. in 2008.

Table 2.1.17 O&M Cost of Sewon STP in 2008

(Unit: Rp.)

No.	Item	State Subsidy	Burden Charge for Municipalities[2)]	Total (Rp.)	Ratio
1	Labor Cost[1)]				
	1.1	*1,200,000,000*		*1,200,000,000*	
	1.2 Salary	9,120,000	14,040,000	23,160,000	2.0%
	1.3 Contract Employee	22,854,000	1,080,000	23,934,000	2.0%
	Subtotal	31,974,000	15,120,000	47,094,000	4.0%
2	Procurement of Goods and Labor				
	2.1 Consumables	3,565,200	—	3,565,200	0.3%
	2.2 Electrical parts	47,100,000	—	47,100,000	4.0%
	2.3 Cleaning tools	4,077,900	—	4,077,900	0.3%
	2.4 Fuel	76,884,000	—	76,884,000	6.5%
	2.5 Chemical	34,745,000	4,500,000	39,245,000	3.3%
	2.6 Electricity and communication cost	306,000,000	—	306,000,000	25.8%
	2.7 Insurance	—	26,460,000	26,460,000	2.2%
	2.8 Environmental monitoring	—	26,200,000	26,200,000	2.2%
	2.9 Vehicle running cost	22,500,000	—	22,500,000	1.9%
	2.10 Copy etc	5,010,000	—	5,010,000	0.4%
	2.11 Food and beverage	5,300,000	—	5,300,000	0.4%
	2.12 Work clothing	3,610,000	5,605,000	9,215,000	0.8%
	2.13 Allowance	1,900,000	—	1,900,000	0.2%
	2.14 repair	247,331,500	19,135,000	266,466,500	22.5%
	2.15 Fence repair	192,133,400	—	192,133,400	16.2%
	2.16 Other	—	80,948,000	80,948,000	6.8%
	Subtotal	950,157,000	162,848,000	1,113,005,000	93.9%
3	Purchase of equipments	17,869,000	—	17,869,000	1.5%
Surplus			7,032,000	7,032,000	0.6%
Total excluding salary for staffs		1,000,000,000	185,000,000	1,185,000,000	100%
Total including salary for staffs		2,385,000,000		*2,385,000,000*	

Source: PD PAL JAYA Financial Statement

Note: 1) Salary for staff shall be born by each municipality and excluded from budget and account of STP.
2) Burden charge shall be born by Yogyakarta, Banthul and Sleman.

The cause of this increasing cost could not be analyzed in detail since no related data, such as influent quantity and repair costs, are available. However, it appears that this is due to the increase in electricity consumption, inflow quantity, and repair costs of the aging facilities.

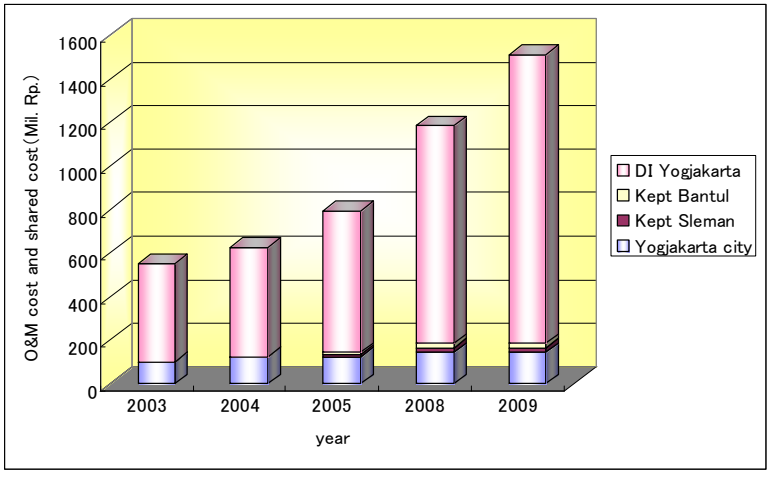


Figure 2.1.17 Alternation of O&M Cost from 2005 to 2009

3) Sewerage Tariff

In 2008, the sewerage system of Yogyakarta City covers 10,100 customers with a population of about 67,000 (rate of covered population is 13%). The sewerage tariff is shown in Table 2.1.18. Said tariff is divided into two main groups, households and industries. Household and industries are classified according to family size and revenue, respectively. The revenue of sewerage fee in 2008 is about 108,000,000 Rp. which is insufficient to compensate the O&M cost described above.

Table 2.1.18 Present Sewerage Tariff of Yogyakarta City

(Unit: Rp)

Household					
No.	Class	O&M fee(per month)	Administaration fee	Connection fee	Remarks *
1	K1	500	500	2,000	1～5 persons
2	K2	1,000	500	2,500	6～10 persons
3	K3	2,000	500	3,000	11～20 persons
4	K4	4,000	500	3,500	21～50 persons
5	K5	8,000	500	4,000	>50 persons
Enterprise					
1	P1	3,000	500	2,500	<25Mil.Rp
2	P2	6,000	500	5,000	>25Mil.Rp
3	P3	12,000	500	7,500	>50Mil.Rp

＊Enterprise is decided by annual revenue.
＊＊Perda No.9（1991）

(2) Current Situation of O&M

The amount of sewage water into the plant is 8,681-10,488.7m3/day on monthly average in January and February, 2009. The BOD, COD and SS levels are measured at the laboratory in the plant. The monthly average BOD concentration of influent was 100-120 mg/L and that of treated water was 13 mg/L during the same time. Meanwhile, the monthly average COD concentration of influent was 205.3-339.8mg/L and that of treated water was 44.0-54.7 mg/L. As for SS, the monthly average SS concentration of inflow sewage water was 112.1-124.0 mg/L and that of treated water was 7.6-9.7mg/L.

Based on the standard of effluent quality decided by DI Yogyakarta, the standard required is 50 mg/L of BOD, 100 mg/L of COD, and 200 mg/L of SS in accordance with LEVEL II (214/KPTS/1991, Governor Decision of Yogyakarta Special Region). Hence, the effluent satisfies the criteria defined in the standards. From these results, it seems that treatment process in these facilities is conducted properly.

Fundamental items were analyzed three times a week and the analysis of the legally-established 35 items is consigned to a nationally certified external institution every month. However, analyzing equipment in the laboratory is already obsolete, and a lot of equipment is unusable. Thus, there are some doubts on the accuracy of analysis. Since there are many concerns such as high DO concentration in the influent, it is necessary to repair, renew, and expand facilities as soon as possible.

The sludge accumulated in the pond is withdrawn and then dried by drying bed one or two times per year. After the drying bed, the sludge is distributed to nearby users such as farmers. Therefore, the cost of sludge disposal is not borne. However, there is a concern on soil pollution by heavy metals or others in the sludge. This could not be verified since analyses of the components were not done properly. It seems better to utilize these materials for agriculture only after proper analysis is performed.

In maintenance of the facilities which mainly consist of aerators and pumps, the staffs do not have difficulties because repairing works related works can be easily outsourced to a local manufacturer.

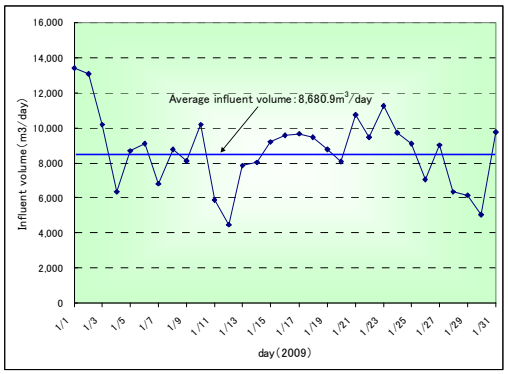


Figure 2.1.18 Influent Volume (Jan. 2009)

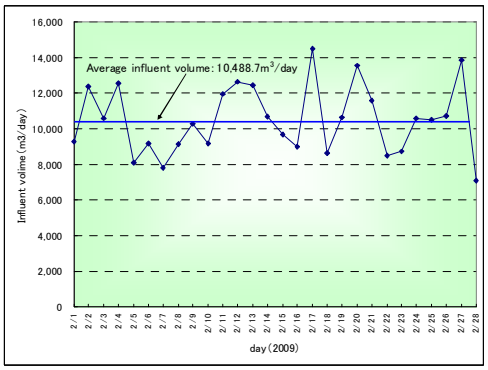


Figure 2.1. 19 Influent Volume（Feb. 2009）

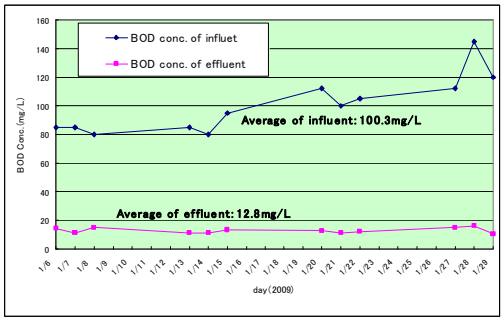


Figure 2.1.20 BOD in Influent and Effluent (Jan. 2009)

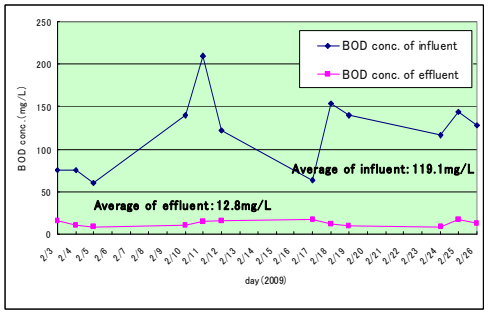


Figure 2.1.21 BOD in Influent and Effluent (Feb. 2009)

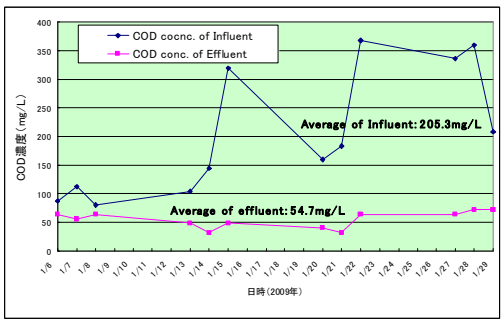


Figure 2.1.22 COD in Influent and Effluent (Jan. 2009)

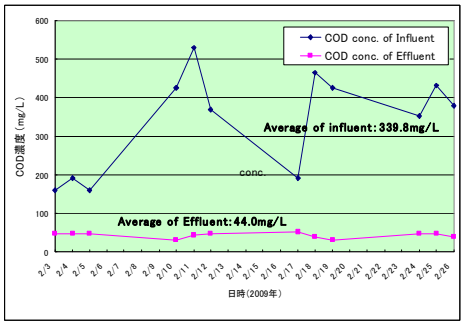


Figure 2.1.23 COD in Influent and Effluent (Feb. 2009)

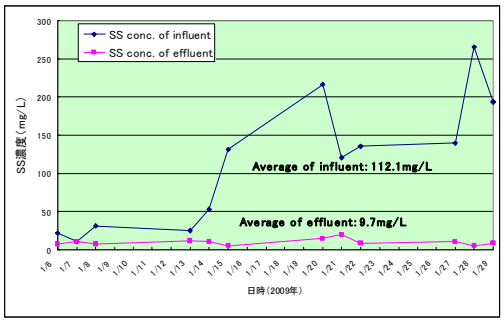


Figure 2.1.24 SS in Influent and Effluent. (Jan. 2009)

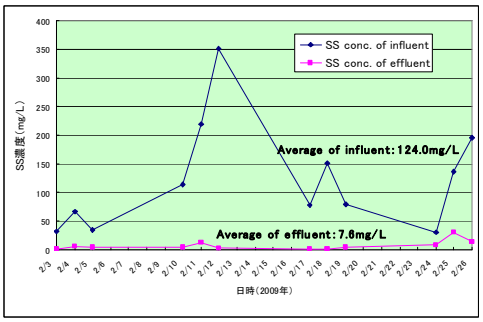


Figure 2.1.25 SS in Influent and Effluent (Feb. 2009)

(3) Wide Area Administration (Sekber Kartamantal)

1) Overview

The central city area of DI Yogyakarta is composed of Kota Yogyakarta, Kab.Bantul, and Kab.Sleman (Figure 2.1.26).

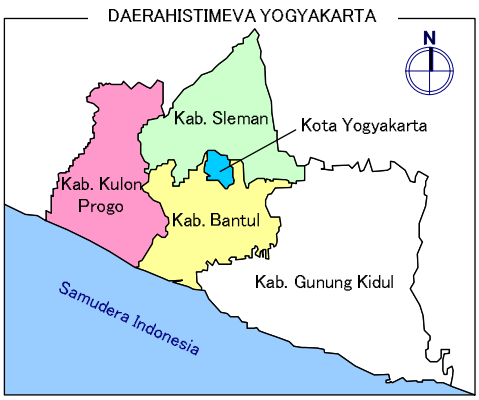


Figure 2.1.26 DI Yogyakarta (Yogyakarta Special State)

The government of DI Yogyakarta organized Sekber Kartamantal (Yogyakarta, Sleman , Mantul) in 1992. It is a joint secretariat formed among nearby cities for arbitration, to plan and implement infrastructure developments in cooperation with surrounding municipalities, such as traffic, road, water supply, sewerage, drainage and solid waste. It also executes planning, construction, and operation of those facilities through the support from private investors and other agencies.

Planning, construction, and operation of those facilities integrally as a system regardless of administrative jurisdiction, makes investment and management more efficient.

Sekber Kartamantal defined seven missions as follows:

i) Conference for fair conclusions
ii) Arbitration for solving problems
iii) Control of realization and management processes
iv) Encouragement of decision making processes
v) Establishment of a cooperation system
vi) Instructing the system designing
vii) Policy recommendation

2) Process for decision-making

The technical team is comprised of four task forces, i.e. i) Planning Board, ii) Public Works Department, iii) Environmental Department, and iv) Legal Division, of which members are dispatched from each specialized department or section. The members of technical team are the strategists of departments concerned.

The technical team institutionalizes and implements projects. They listen to comments from stakeholders, adjust according to the state government, and discuss with Head Secretary composed of Managers, Steering Committee composed of Directors, and Governing Board composed of heads of administrations.

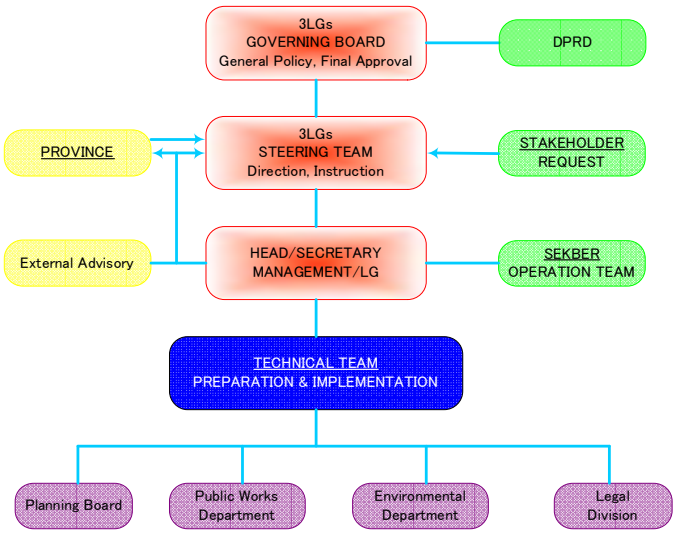


Figure 2.1.27 Process for Decision-making in SEKBER KARUTAMANTUL

(4) Problems in O&M

1) Improvement of laboratory equipment and training on water quality analysis

As discussed earlier, laboratory equipment has not been updated since the plant was established in 1996. Through reviewing the existing analysis data on raw water quality and treated water quality, the figures of results are ranged widely. This may be mainly caused by the two reasons, i.e. i) the plant accepts the sludge of septic tanks, and ii) accuracy of equipment for water quality analysis is very low.

It is necessary to devise conditions of analysis, such as the period, sampling method and analysis method, for performance evaluation and facility operation.

In the plant, raw water changes widely in quantity and quality, which may have an influence on treatment. Thus, it is necessary to analyze water quality accurately.

For such analysis, not only repairing and improvement of existing equipment but also training the staff on water quality analysis should be considered.

2) Reduction of staffs performing O&M

There are presently 40 staffs assigned for the plant operation. This seems extensive compared to other treatment plants of the same capacity.

Since there are few facilities and retention time of pond is significantly long, it is therefore sufficient to analyze water quality for just once a week. It seems that the current staff number is beyond the sufficient level. The personnel costs cause burden to each municipality's budget. Thus, issue on reduction of the staff number should be further discussed to ease the burden of them.

3) Load on treatment tanks

Presently, the plant is operated with two treatment lines. However, there is a difference on the inflow volumes between said lines. Although the loading of influent is not heavy, and sufficient treatment is done in each tank, it would be more advantageous to equalize the imbalance.

2.1.3 Water Supply System of Kota Tangerang（Cikokol Purification Plant）

(1) Historical Overview of Waterworks

The Cikokol purification plant is owned by the Waterworks Bureau (PDAM, Perusahaan Daerah Air Minum Kabupaten Daerah Tingkat Ⅱ Tangerang) of Kota Tangeran. The Dutch government established it in 1923 with a new water supply system of 6 L/sec.

In 1984, with the assistance of World Bank, it was designed as a modern purification plant by James M. Montgomery Consulting Engineers, Inc. USA. The treatment capacity was later updated to 500 L/sec by a joint local and British company.

Since a local company and a Singaporean company additionally constructed new facilities in 1998 through the support of Asian Development Bank (ADB), it has been able to supply a total of about 1,000 L/sec (86,400 m^3/day) of purified water.

Presently, Tangerang PDAM supplies 5,000 L/sec (about 432,000 m^3/day) of purified water through the Cikokol and Serpong purification plants, serving about 100,000 of households and business establishments in Tangerang area. It also supplies 2,800 L/sec of purified water to DKI Jakarta. The number of PDAM staff is about 500.

PDAM consigned operation of Serpong purification plant to Ondeo in France and entered into contract for supplying water for 25 years. PDAM also contracted a local company, PT. TIRKA KENCANA CAHAYA MADIRI (TKCM) to provide the 15-year water supply to Cikokol purification plant.

The Cikokol purification plant was not maintained until 2004 due to lack of budget of PDAM. Since then, treatment of water quality got worse. As a result, quality of supplied water became poor because of operation suspended frequently.

PDAM prepared the implementation program for improvement of water supply system,

identifying the priority projects listed below, which included a plan for procurement of a private sector for operation of Cikokol Purification Plant under the Rehabilitate-Operate-Transfer (ROT) scheme:

- Setting a facility which can remove suspended solid in the raw water from Cisadane River
- Installation of an emergency generator for using during power failure
- Installation of facilities for sludge disposal and conveying
- Establishment of appropriate monitoring, chemical feeding, and facility operating systems.

TKCM made a successful bid and was contracted to operate the plant for 15 years from 2004. According to the ROT contract, 72.5 billion Rp. is to be spent in the first three years for repairing and upgrading the facilities, i.e: i) 24.4 billion Rp. in the 1st year; ii) 27.3 billion Rp. in the 2nd year; and iii) 20.8 billion Rp. in the 3rd year. Scope and deliverables related to repair and improvement are as follows.

- Detailed design studies
- Preparation for ISO certification
- Environmental impact assessment
- Raw water pumps overhaul and rehabilitation of the existing water intake
- New raw water intake construction
- Chemical dosage equipment overhaul
- Installation of plate settlers
- Three existing filters and backwash system rehabilitation
- Transmission pumps overhaul and installation of a new flow meter
- New chlorine and alum injection systems
- Installation of new instruments (treated water reservoir and intake level indicator, online turbidity and pH meters)
- Upgrading of the electrical panels and equipment
- Civil works rehabilitation (warehouse, administration building, and reservoirs)
- Web site and database management system
- New laboratory equipment

(2) Current Situation of O&M

1) Cisadane River (Intake Source)

Cisadane River has 1,100 km^2 catchment area and runs into Java Sea through Banten province and West Java province. Its total length is 80 km. Its river flow is influenced by the rainfall of the catchment area, which increase during the rainy season and decrease during dry season. For example, the flow measured in the Serpong area from 1971 to 1997 was 2.93 m^3/sec in 1991 as the lowest, and 973.95 m^3/sec in 1997 as the highest. According to the monthly flow data from 1981 to

1997, the average flow was 25 m^3/sec, with the lowest yearly flow recorded in July, August, or September.

The water from said river is used for industrial, agricultural and domestic purposes. However, as industrial and urban activities pollute the river while inflow of illegal discharge makes water purification more difficult, costly purification process is realized.

Figure 2.1.28 Location of Cisadane River

2) Water purification plant

Rapid filtration system is adopted for the purification process. Figure 2.1.29 describes the flow of water purification system. Since TKCM installed high-rate plate settler module in sedimentation pond after TKCM was awarded ROT contract, the capacity of Cikokol purification plant is upgraded from 100,000 m^3/day to 136,000 m^3/day.

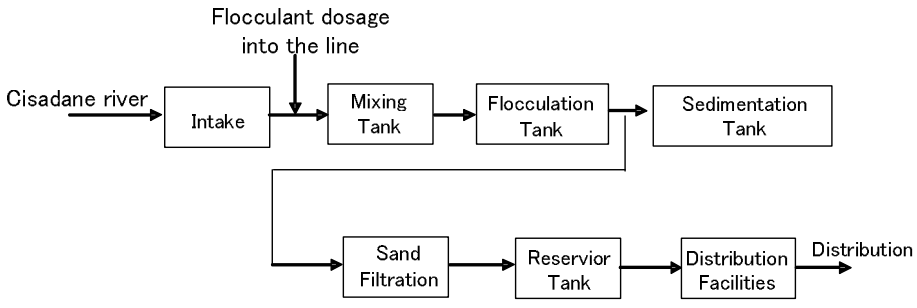


Figure 2.1.29 Flow of Purification

This seems to be the result of improving the productivity initiated by the private sector. Aside from prolonging the useful life of machines by installing necessary utilities such as air conditioner, improving management through privatization seems successful.

High-rate Plate Settler Module | Air Conditioner in the Electric Control Room | Cover to Prevent Accidental Contact

Figure 2.1.30 Example of Devices on O&M in Cikokol Purification Plant

The monitoring screen of the control system in Cikokol purification plant, which presents comprehensive 3-D graphic images, shows real-time data obtained from the measuring instruments.. It was observed that the other plants surveyed have not installed a similar control system in order to save construction cost. It should be realized that such control system similar to Cikokol purification plant is an efficient and accurate way in performing related activities.

Mixing Tanks and Settlement Tanks | Monitor of Turbidity | Monitor of Pumping Performance

Figure 2.1.31 Monitoring Conditions in Cikokol Purification Plant

3) Organization for Operation & Maintenance

TKCM has 57 staffs which consist of 37 in the plant and 20 in the office. The 37 staffs and outsourcing staffs perform O&M in Cikokol purification plant (see Figure 2.1.32). The works of security and cleaning was outsourced to ensure that management is efficiently executed.

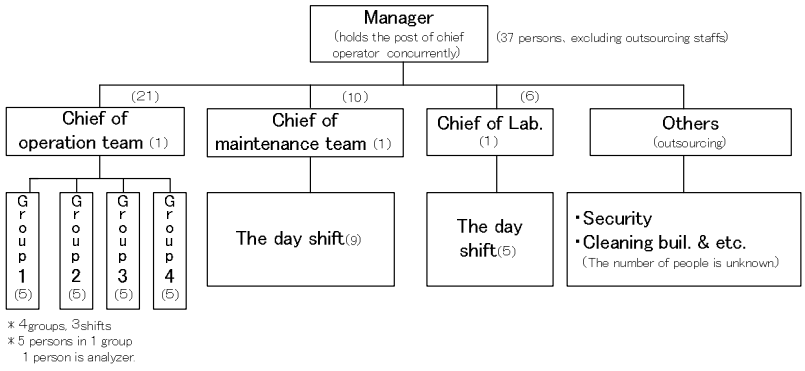


Figure 2.1.32 Organization for O&M in Cikokol Purification Plant

Operation team performs O&M in 8-hour shifts. The maintenance team perform checking and repairing of facilities during daytime.

As for the laboratory, they conduct daily examinations in order to record/show the data on water quality index. In accordance with the Contract with Kota Tangerang, the water quality analysis considering 42 parameters should be carried out by a certified laboratory according to the national standard for clean water in Indonesia, and the result of analysis should be reported to the city administration monthly. This directive exceeds the national standard which requires yearly examinations. As for the purification plant located in East Jakarta Industrial Park (EJIP), a private sector company managing the plant is also required to submit a monthly report on water quality.

The number of staffs in the plant was compared with the number of staffs in the plants of the same level of capacity in Japan, operated by Nihon HELS industry Co. It reveals that Cikokol is at the same level in terms of number of staff, as that of the other plants in Japan (see Table 2.1.19). This implies that Cikokol purification plant is operated and managed by appropriate number of staff.

Moreover, it was impressive that TKCM received ISO 9001 and 14001 certifications and focused on quality improvement. This means that the facilities inspected were maintained better than other direct management plants by administration.

Table 2.1.19 Comparison of O&M Staffs

Item	Cikokol Plant	Contract operationing plant by HELS Co.*		
		A Plant	B Plant	C Plant
Capacity (m^3/day)	136,000**	135,000	190,000	186,500
Employees (person)	**37**	**39**	**32**	**39**

＊include the employees for the analysis who belong to the administration.
include the employees for clearing out.
＊＊By using high-rate plates, exsiting capacity was increased from 100,000m3/day to 136,000m3/day.
＊＊＊Each process of A,B and C plant are the rapid filtration which is similar to Cikokol plant.

4) Quality of Raw and Purified Water

a) Raw Water

The result of water quality measurement of SUB (official facility for water quality measurement) on February 4th 2009 (see Table 2.1.20) is as follows:

- Suspended Solids (SS) is 106 mg/L, which is higher than the national standard of 50 mg/L.
- Dissolved Oxygen (DO) of 3.9 mg/L does not meet the standard of 6 mg/L.
- Iron dissolved is 0.54 mg/L, exceeding the standard of 0.3 mg/L.
- The number of fecal coliform of 4,900/100 ml is 49 times higher than the standard 100/100 ml. Meanwhile, the number of total coliform is 12,000/100 ml, i.e. 12 times bigger than the standard of 1,000/100 ml.

Based on these results, SS may not be a problem because most of it is clay.

However, the water with 3.9 mg/L DO makes it difficult for fish to survive, and causes pollution to the water source. Judging by the amount of fecal coliform, which seems to be the worst problem, the river appears significantly polluted due to human and domestic animal wastes.

Hence, SUB realized that the quality of raw water does not meet the standards. Therefore, if construction of a sewage system in the river basin is not implemented in the future, it should at least be considered to shift the intake source upstream in case of increase in treatment cost and by-products, such as THMs, due to significant amount of chemicals that exist.

Table 2.1.20 Water Quality and Raw Water Standard

Items	Unit	Raw water quality	Standards*				Remarks
			Ⅰ	Ⅱ	Ⅲ	Ⅳ	
Suspended solids	mg/L		50	50	400	400	must be below
Dissolved oxygen	mg/L	3.9	6	4	3	0	must be below
Iron	mg/L	0.54	0.3	—	—	—	must be below
E.. Coli	/100mL	4,900	100	1,000	2,000	2,000	must be below
Total E.. Coli	/100mL	12,000	1,000	5,000	10,000	10,000	must be below

＊The standards is based on the law No.82/2001.
Ⅰ: Water to use for drinking without treatment Ⅱ: Water to use for raw water
Ⅲ: Water to use for stockbreeding and fish farming
Ⅳ: Water to use for agriculture, industry and hydroelectric power generation

b) Purified water

The quality of purified water meets all the standard parameters, hence, no problem is foreseen. The main criteria of purified water quality is shown in Table 2.1.21.

Table 2.1.21 Water Quality and Purified Water Standard

Items	Unit	Result	Standard
Colour	TCU	0	0
TDS（Total Dissolved Solids）	mg/L	71	1000
Turbidity	NTU	0.88	5
Iron	mg/L	＜0.02	0.3
Total hardness(as CaCO3)	mg/L	27.1	500
Residual chlorine	mg/L	0.65	5
Total coliform	/100ｍL	0	0

5) Cost of O&M

Detailed data on the cost of O&M in Cikokol Purification Plant could not be obtained. Instead, the information is summarized as shown in Table 2.1.22 and Table 2.1.23, which was obtained through interview surveys.

Table 2.1.22 Amount of Utility Used（2009.3.18）

Items		Unit	Quantity	Remarks
Intake		m^3	105,476	
PAC		kg	3,236	Average dosage rate : 30.7 ppm
Chlorine		kg	212	Average dosage rate : 2.0 ppm
Electricity consumption	Intake	kwh	7,380	
	Treatment		17,040	

Table 2.1.23 Unit Price of Utility

Item	Unit	Unit Price (Rp)	Remarks
Electricity*	kwh	450	Approx. 600 Million Rp per year
Chlorine Gas	kg	6,500	Use of gas because of cost saving
PAC（Coagulant）	kg	2,000	
Sodium Carbonate	kg	5,000	
Heavy Fuel Oil	L	6,000	
Laboratory Running Cost	L.S.	200,000,000	Annual cost excluding labor cost

Source: JICA Study Team

* Average cost considering peak time charge, via hearing survey

6) Others

TKCM sells purified water to Kota Tangerang at 1,260 Rp./m^3 (about 0.1 US$/$m^3$). Kota Tangerang meanwhile supplies 2,300 Rp./m^3 purified water to DKI Jakarta.

(3) Problems on O&M

1) Obtaining safe raw water

Figure 2.1.33 Factory Located near the Purification Plant

Present intake gate is located near the purification plant at the middle section of Cisadane River. There are various types of factories scattered along the shores of said river. Several bridges crossing the river also exist. The concern is the effluence of toxic substances from factories and the oil pollution falling from tank lorries. No countermeasure is found at the moment. In case, the entire purification plant facilities might be suspended because of water quality problems. In Japan, water utilities generally have a manual for emergency cases to prevent from accidents to be caused by insufficient water quality.

In order to obtain safe raw water and protect facilities from pollution, it is necessary to set some countermeasures, such as installation of oil fence and emergency network.

2) Problem on drainage

There is no drainage system in the Cikokol purification plant, and drainage works are not included as part of O&M activities. Sludge production in the purification system is discharged back to the river. The other plants in Indonesia are subject to

the same condition. In the purification system, Poly Aluminum Chloride (PAC) is used for flocculation. Since PAC is a health hazard, the corresponding water quality standard related to it is established. It is very important to treat sludge because there is a possibility to contain unknown pollutants.

In Japan, in the case of settlement tank or filtration system which has a capacity exceeding 10,000 m^3/day, and a dewatering facility with capacity exceeding 10 m^3/day, these are classified as specific facilities. The law for prevention of water pollution has been applied in such case. Moreover, while the sludge carried out from the purification plants is classified as industrial waste, it is essential to treat it properly.

Drainage from the Cikokol purification plant is discharged back to the river after being stored. In order to prevent the pollution of river from the drainage, it is therefore necessary to initiate corresponding countermeasures.

2.1.4 Water and Sewerage Works in Bekasi Industrial Park (East Jakarta Industrial Park or EJIP)

(1) Overview of EJIP

EJIP is located in Kota Bekasi, which is about 40 km east of Jakarta. Its total developed area is 320 ha. This was developed in 1990 by PT. East Jakarta Industrial Park (PT. EJIP), a locally incorporated consortium, whose share of 60% is owned by 11 companies including Sumitomo Corporation. Presently, there are more than 30 factories in the Park including major Japanese electrical equipment manufacturers. PT. EJIP built a water purification plant and a wastewater treatment plant in the Park to provide the water supply and sewerage services for the factories.

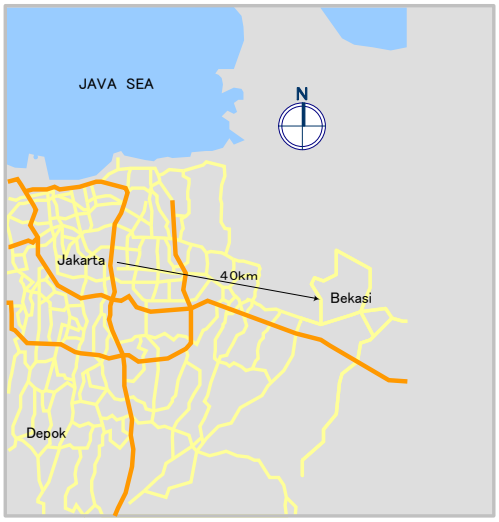


Figure 2.1.34 Location of Bekasi City

(2) Current Situation of O&M

1) Water purification plant

The purification plant can purify 9,000 m^3/day and has supplied that required amount of water until 2008. However, it supplied less this year since operation rate of the factories decreased due to the global economic recession.

Figure 2.1.35 Raw Water Intake

Surface stream water from the river near the Park is taken in as raw water. The quality is good except for its turbidity. Supplied water qualities are maintained by PT. EJIP. The water quality standard of EJIP is almost same as the one of Japan (see Table 2.1.24). They adopt rapid filtration to purify water, and have a reservoir for emergency cases such as insufficient raw water quantity or quality observed.

Similar to Cikokol purification plant in Kota Tangerang, there is no equipment for sludge treatment. Thus, sedimentation sludge is not treated and released directly into the river.

Table 2.1.24 Standard of Supply Water Qualities

Items	Standard of EJIP	Standard of Japan*
pH	5.8 ～8.6	6.5 ～8.0
Suspended Solids	5.0mg/L	20mg/L as Turbidity
Total Dissolved Solids	500mg/L	—
Total Hardness	150mg/L as $CaCO_3$	120mg/L as $CaCO_3$
Chloride ion (Cl^-)	100mg/L	80
Sulfide ion (SO_4^{2-})	100mg/L	—
Iron & Compound (Fe)	0.3mg/L	0.3
Manganese & Compound (Mn)	0.3mg/L	0.2

* established by Japan Water Association for Industry in 1981

When turbidity is seen to be a high level in the raw water, there is a countermeasure generally applied against increase of chemical materials dosing or decrease of the treatment capacity due to high turbidity, by means of introduction of a primal sedimentation before the purification plant.

Figure 2.1.36 Sedimentation Tank

The transmission and distribution pipes connected to the factories are observed to be corroded. Water become reddish through flowing in the iron pipes because of its rusts. The PT. EJIP tackles replacing the iron pipes into polyethylene pipes, which is one of high anti-corrosion materials.

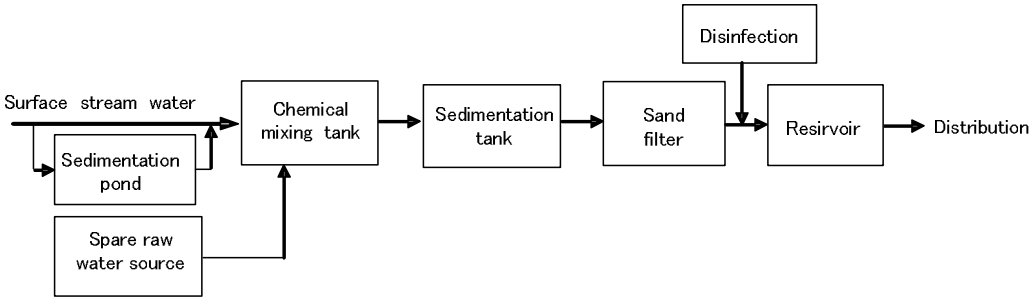


Figure 2.1.37 Flow Diagram of Purification System

2) Sewerage Treatment Plant

Aerated lagoon method (see Figure 2.1.38) is adopted, which removes solids through screens, and aerates using surface aerator with inclined screw shaft. The treatment capacity is 9,000 m^3/day. The current quantity of wastewater influent is estimated to be 4,900 - 5,600 m^3/day (approximately 70% of supplied water), treated with two out of the three aeration tanks.

Figure 2.1.38 Aerated Lagoon

As for sludge treatment, water content in the sludge is reduced by means of filter press instead of coagulants usage. Then, Sludge is dried on a drying bed. The sludge is then transported to an adjacent cement factory and used for fuel and material production. It costs 10 US$/ton for transport, but it is reasonable compared with the disposal cost estimated to be 100 US$/ton. This is therefore a good treatment method as it utilizes recycling process.

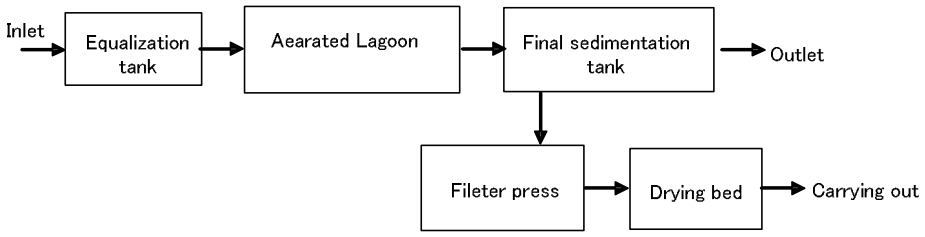


Figure 2.1.39 Flow Diagram of Sewerage Treatment System

3) Organization for O&M

The staffs are working for the both water supply and sewerage systems as shown in Figure 2.1.40. As the purification plant is for only the industrial uses, which is not required to have a high quality especially in the items related to health influences, their O&M organization can be simplified in comparison with the one for domestic

uses.

The operations team is comprised of three groups. Each group has three staffs who work in 8-hour shifts, 7:00 to 15:00 hrs, 15:00 to 23:00 hrs, and 23:00 to 7:00 hours. However, it is recommendable to change the current working shift into four groups shift in order to have the appropriate number of staff performing in operation. This will provide enough rest period in accordance with the labor law. They conduct daily inspections of equipment as planned. Partial repairing works are done by themselves, but overhauls of equipment are done through subletting to manufactures.

Although they are facing five times of power failure in a year, it is seen to be no problem because the government-managed and private sector's power supplies are available in addition to their owned standby generators.

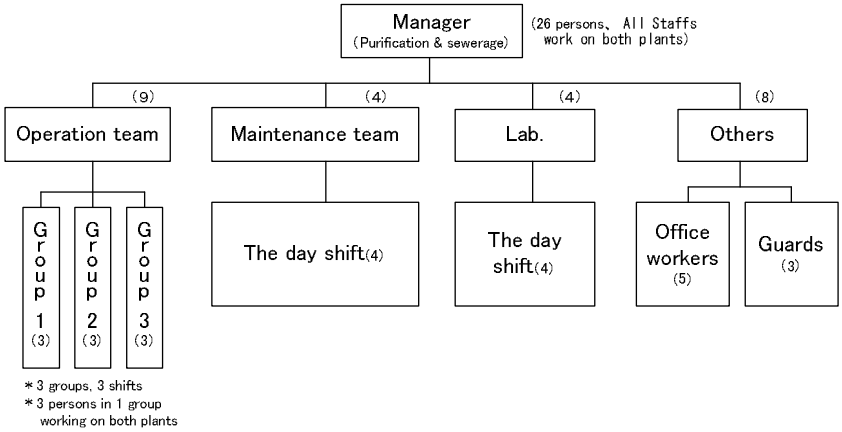


Figure 2.1.40 Organization for O&M

In the process of water quality analysis for industrial uses, the laboratory is available inside the plant, carrying out the analysis according to the schedule as shown in Table 2.1.25. Tests appear to be performed appropriately.

Table 2.1.25 Items and Frequency of Analysis for Supply

Items	Raw water		Treated water	
	Everyday	Every month	Everyday	Every month
pH	○		○	
Turbidity	○		○	
Suspended Solids	○		○	
Total Dissolved Solids		○		○
Total Hardness	○		○	
Conductivity	○		○	
Chloride ion(Cl^-)		○		○
Sulfide ion(SO_4^{2-})		○		○
iron & the Compound(Fe)		○		○
Manganese & the Compound(Mn)		○		○
Residual Chlorine			○	

(3) Problems on O&M

1) Problems on sewerage treatment

In the laboratory, SS, BOD, and COD levels of raw water and treated water are tested everyday. In addition, sewerage is legally examined every month by PT. Prasadha Pamunah Limbah Industri (PPLi) which is the national institution designated to perform tests. The result of measurement passed the legal standard as shown in Table 2.1.26. However, effluent BOD is observed with fluctuated figures. In order to constantly maintain the BOD level, it is necessary to review the operation of the whole facilities.

In 2009, the law will be changed to regulate NH_4-N level. They will therefore overhaul equipment, including upgrading of the aerator to meet the criteria under the new law.

Table 2.1.26 Legal Standard of Sewerage

Item	BOD (mg/L)		SS (mg/L)	
	Influent	Effluent	Influent	Effluent
Criteria	500	50	500	200
Actual Level	100-250	16-47	100	2-50

Note: Criteria for effluent water is subject to the Level II in the national regulation

2) Sludge treatment in purification plant

Like in the Cikokol purification plant, sludge treatment should be conducted to correspond the future restriction to be established.

3) Improving operation method and facilities of sewerage treatment plant

As the capacity of equalization tanks is bigger than the current inflow, sewerage influent accumulates with insufficient aeration in equalization tanks. As a result, decays are expected in the equalization tanks. It will be better to use only 1 of the 2 equalization tanks and to control the water level. The current aerator does not supply sufficient air for BOD removal and nitrification. Thus, fundamental improvement on the aerating system is needed. Since each treatment system has different hydraulic loading, operating condition is different in each treatment system, which influences treated water quality. It will be advantageous to equalize hydraulic loading in each system in order to improve treated water quality.

Although there are knowledgeable engineers in the plant, they have limited experience in various operation techniques. Hence, it is necessary to conduct training to the engineers to improve their capacity.

Figure 2.1.41 Equivalent Tanks

Figure 2.1.42 Surface Aerator with Inclined Screw Shaft

2.1.5 Water Quality Standard for Effluent

The water quality standard for effluent was established in 1995 through the Decree of Minister of Environment. The Decree has been adapted to industries (Keputusan Menteri Negara Lingkungan Hidup No. 51 Tahun 1995), hotels of 3 star class or more (Keputusan Menteri Negara Lingkungan Hidup No. 52 Tahun 1995) and hospitals (Keputusan Menteri Negara Lingkungan Hidup No. 58 Tahun 1995). Subsequently, the Decree of Minister of Environment on sewerage systems was established in 2003 (Keputusan Menteri Negara Lingkungan Hidup No.112 Tahun 2003). The facilities restricted by the Decree are the sewerage systems for housing development areas, governmental offices, commercial buildings, apartments, restaurants up to 1,000 m^2 area, and accommodations for 100 persons or above.

The major standards established by the Said Decree are tabulated as shown in the following table.

Table 2.1.27 Standard of Discharge (Minister of Environment Decree)

Item	No. Kep 52/MENLH/ I/1995 (Hotel)	No. KEP-51/MENLH/ 10/1995 (Industrial wastewater)	No. Kep 112/2003 (Domestic wastewater)
	Max. (mg/L)	Max. (mg/L)	Max. (mg/L)
BOD_5	30（75）	50	100
COD	50（100）	100	－
TSS	50（100）	200	100
pH	6.0 – 9.0	6.0 – 9.0	6.0 – 9.0
Oil and Grease	－		10

Note: The figures between brackets are temporarily set up until January, 2000.
Source: Decree of Minister of Environment on Effluents and Sewerage Systems

2.1.6 Financial Plan on Sewerage Works

(1) Surveys on Willingness to Pay and Household Expenditures

As for the affordability in Indonesia, the report of the Study on Financing Affordable Water and Sanitation System (November 2006), which was conducted in Indonesia by JBIC, was

used as reference. This JBIC Study reviewed the results of the household interview survey conducted by the Central Statistics Bureau of Indonesia (BPS) in 2004 in terms of 27 expenditure items of households in 143 local government areas (districts). The JBIC Study categorized 143 surveyed areas into 4 income-level groups according to the Financial Condition Index (FCI), selected 2 or 3 districts ranked at the medium level in each group and then, picked up the 9 representative districts for analyzing their expenditures. According to the analysis through such process, the trends of household expenditures in each represented districts are summarized as shown in the following table.

Table 2.1.28 Estimated Household Expenditure Distribution in Each District (JBIC Survey)

ID	District Government	Average monthly household expenditure(IDR 1,000)		
		<500	500-1,000	1,000<
1a.	Kota Manado	3%	43%	54%
1b.	Kb. Klungkung	4%	35%	61%
2a.	Kota Bogor	3%	43%	54%
2b.	Kota Surakarta	20%	44%	36%
3a.	Kab. Tasikmalaya	42%	52%	6%
3b.	Kab. Mojokerto	34%	53%	13%
4a.	Kab. Purbalingga	43%	45%	13%
4b.	Kab. Banjarnegara	50%	42%	8%
4c.	Kab. Cilacap	47%	46%	8%
	Total	30%	45%	25%

Source: Financing Affordable Water and Sanitation System, Final Report, 2006, JBIC

Furthermore, the JBIC Study conducted analysis on detailed characteristics of household expenditures through categorizing the expenditure items into 10 items as listed below:

i) Basic foodstuffs (BFT)
ii) Alcohol and tobacco (A&T)
iii) Housing and household operations (H&O)
iv) Non-consumables (N-C)
v) Education (EDU)
vi) Apparel and footwear (A&F)
vii) Medical care (MED)
viii) Recreation (REC)
ix) Fuel, transport and public services (FTP)
x) Others

The structures of household expenditures in the 9 districts were found as shown in Table 2.1.29.

Table 2.1.29 Household Expenditure Estimated in Typical Districts

District Government	Average monthly household expenditures by category (IDR '000)										
	BFD	A&T	H&O	N-C	EDU	A&F	MED	REC	FTP	OTH	Total
1a. Kota Manado	516	82	200	91	36	54	18	29	93	7	1126
1b. Kab. Klungkung	610	60	158	106	23	32	25	122	92	12	1240
2a. Kota Bogor	580	120	213	80	51	50	19	9	122	15	1258
2b. Kota Surakarta	397	53	204	118	69	32	31	6	105	13	1028
3a. Kab. Tasikmalaya	306	68	63	28	14	27	10	4	57	3	580
3b. Kab. Mojokerto	362	65	65	64	20	28	27	6	72	7	715
4a. Kab. Purbalingga	328	82	59	55	20	27	13	3	62	4	653
4b. Kab. Banjarnegara	314	52	46	48	14	28	13	2	61	4	582
4c. Kab. Cilacap	298	48	62	59	22	25	13	2	59	4	592
Average share*	**49%**	**9%**	**13%**	**8%**	**3%**	**4%**	**2%**	**2%**	**9%**	**1%**	**100%**

Source: Financing Affordable Water and Sanitation System, Final Report, 2006, JBIC

The result shows that the structure of household expenditure and affordability varies among districts. The upper limit of sewerage charges could be however estimated from the result above. According to survey, it was suggested to consider the following items when districts set up the sewerage charges:

i) Should not exceed the cost for health and medical treatment
ii) Should not exceed the charges of electricity, gas and water supply
iii) Should not exceed 25% of fuel, traffic and public services cost, and the 1% of household expenditure for low income groups

Taking the result of JBIC Study mentioned above, the Study Team conducted WTP surveys in DKI Jakarta and Kota Yogyakarta. Some survey results on WTP were already available, which were conducted by the City, university and NGO in Kota Yogyakarta because the City has aplan to change the sewerage tariff in 2009. Therefore, those survey results were studied in parallel with carrying out the interview survey. The outline of interview survey is summarized as shown in the following table.

Table 2.1.30 Overview of the Survey

City	DKI Jakarta	Kota Yogyakarta
Period	Mar.30.2009～Apr.8.2009（8 days）	Apr.13.2009～Apr.16.2009（4 days）
Organization	Local expert : 1 person Local employee : 3 persons Interview survey each household with 2 groups	Local expert : 1 person Local employee : 1 person Interview survey each household
No. of sample	114 samples	20 samples
No. of effective answer	110 answers（96.5% of response rate）	20 answers（100% of response rate）

Source: JICA Study Team

1) Result of Survey in DKI Jakarta

Random sampling of households of each customer hierarchy was executed. This was taken from a list of household customers of PD PAL JAYA, which classifies customers into four classes (Types A-D) depending on the monthly electrical

consumption. Results of the sampling are shown in Table 2.1.31.

Table 2.1.31 Outline of Interview Survey in DKI Jakarta

Classification	Type A	Type B	Type C	Type D	Total
Definition	450-900VA	900-1,300VA	1,300-2,200VA	2,200VA-	
Position	Low-income	Middle-income	High-income		
No. of customer	896	196	20	25	1,137
No. of sample	90	20	2	2	114
Reference(sewerage works)					
i) Connection fee[1)]	10,000Rp				
ii) Basic charge[1)]	90Rp/m2	113Rp/m2	135Rp/m2	158Rp/m2	
iii) Avg. floor space[2)]	101.11m2	121.18m2	136.65m2	307.08m2	
iv) Avg. charge[2)]	10,153Rp	15,234Rp	20,293Rp	52,610Rp	
v) Tobacco 1 box (malboro)	10,000Rp（the market price）				

Source: - DKI Jakarta Governor Decree No.1470, 2006
- Customer data of PD Pal JAYA in Aug. of 2008, Charge includes the VAT.

Questionnaires for the interview survey are enclosed as Appendix. The question items are comprised of mainly two parts: one is about WTP while the other is about water pollution due to gray water. The outcome of the construction of sewerage system was also included in the questionnaire. Double-bounded dichotomous choice contingent valuation was used to determine the WTP in each class.

The main feature of above technique is to determine feedbacks on WTP in relation to the price suggested. Answers were limited to be “Yes” or “No”. Since it does not cause strategic bias and is efficient to limit WTP of examinee as compared with step, it is said to be accurate considering statistical efficiency. Moreover it is said that estimation can be done with few samples. For example, the Contingent Valuation Method (CVM) estimation technique was used for non-market outcome such as the effect of water environment improvement. This technique is applicable considering the changing advantage of non-market outcome as compared to the monetary value of WTP. It was adopted double-bounded dichotomous choice as a method of interview. The result of the interview survey was classified based on answer patterns as shown in Table 2.1.32.

Table 2.1.32 Sampling of WTP Based on Double-bounded Dichotomous Choice Method

Classification	Type A		Type B		Type C	Type D
No. of sample	90		20		2	2
No. of interview	86		20		2	2
Response rate	95.6%		100%		100%	100%
WTP at 1 step	20,000Rp/ household/month		30,000Rp/ household/month		50,000Rp/ household/month	
Ans. at 1 step	No	Yes	No	Yes	No	Yes
WTP at 2 step	15,000Rp	25,000Rp	25,000Rp	40,000Rp	40,000Rp	70,000Rp

Classification	Type A				Type B				Type C		Type D	
Ans. at 2 step	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No. of response	29	29	15	13	8	8	2	2	0	2	1	1

Source: JICA Study Team

For the purpose of understanding the limit of increase, the 1st step of WTP shall be considered as twice the existing payment. As for the survey on types C and D, considering of few number of samples, the contents of interview was set up to be the same. The questionnaire sheets are enclosed in the Appendix as reference.

With the result, after the acceptance curve concerning WTP is calculated using the logarithmic Logit Model and the Weibull regression analysis, the median and average WTP is determined. The result of analysis is shown in Table 2.1.33 while the acceptance curve of the each model is shown Figure 2.1.43.

The analysis on WTP is carried out using the logarithmic Logit Model and the Weibull regression analysis model. These models can simulate the distribution of the answer "Yes". In general, the logarithmic Logit Model has a tendency to result with wide range of distribution and high average. The Weibull regression analysis model meanwhile is a flexible function, producing reliable results. In this survey, both methods were undertaken for comparison purposes

Table 2.1.33 Result of Analysis on WTP

Analysis Model	Logarithmic Logit Model		Weibull Regression Analysis	
No. of Sample	110		110	
Parameter	Coefficient	t-value	Coefficient	t-value
1) Constant	34.8327	9.568	10.0552	149.124
2) Sigma	-3.5407	-9.774	0.5664	12.222
Logarithmic Likelihood Value	-163.670		-171.434	
WTP(Median Value)	18,726IDR		18,913IDR	
WTP(Average Value)				
1) without restriction	21,429IDR		20,720IDR	
2) with restriction at maximum value	21,172IDR		20,715IDR	

Source: JICA Study Team (using free program by Mr. Kuriyama, Prof, Waseda Univ.)

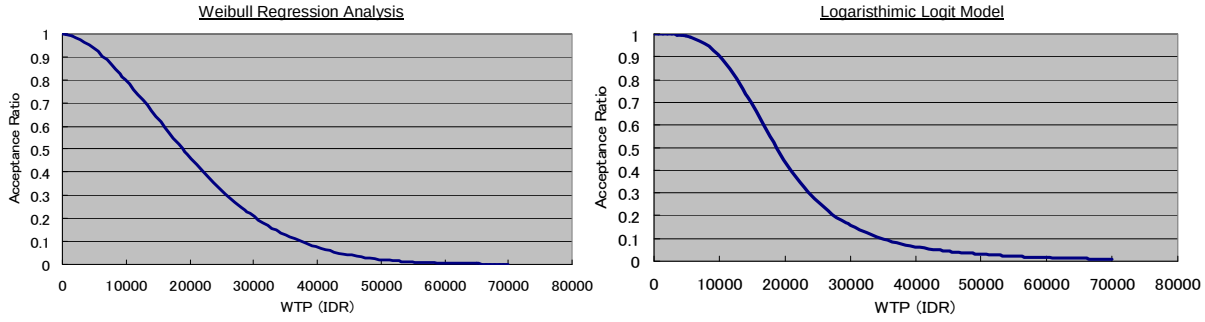


Figure 2.1.43 Result of Analysis on WTP

Results of both analysis methods are nearly the same. In general, the median, which is not influenced by the difference of the function model, is used largely. Since the average changes among the same function model by the integration range, it has a tendency to be higher than the median. The median value therefore is safe to adopt. However, in this survey, significant differences could not be recognized. Hence, the WTP of residents was determined to be about 20,000 IDR.

2) Result of surveys in Yogyakarta

As sewage works was transferred from the Environmental Agency (DLH) to Dinas Public Works Agency (PU) in 2009, the activity has not been completed. Dinas PU has not collected charges for sewerage. Due to this, an interview survey about household expenditure was conducted with DLH supporting, using the list of customers given by Dinas PU.

Considering the tight schedule for executing interviews, only the households from Bausasran in Kecamatan were sampled, where residents are from low-income groups. The result of sampling is as follows.

Table 2.1.34 Sampling Condition in Yogyakarta

Category	K1	K2	Remarks
Tariff	500Rp/month	1,000Rp/month	Tariff under previous tariff system
No. of Household	578 (73.3%)	165 (21.0%)	K3: 20 (2.6%), P1: 16 (2.0%), P3: 3 (0.4%)
No. of Sampling	16	4	Total 20

Source: JICA Study Team

Door-to-door interview surveys were conducted with the aid of questionnaires. The sampling was carried out classifying the family size into K1 (1-5 persons per family) and K2 (6-10 persons per family). Some of original data on the sampling list was wrong comparing with the actual data on family sizes as shown in the following table.

Table 2.1.35 Sampling Ratio Based on Survey Result

Classification	K1	K2
No. of original sample	16	4
Result of survey	12	8

Source: JICA Study Team

The result of surveys to obtain the structures of household expenditures are summarized as shown in the following table.

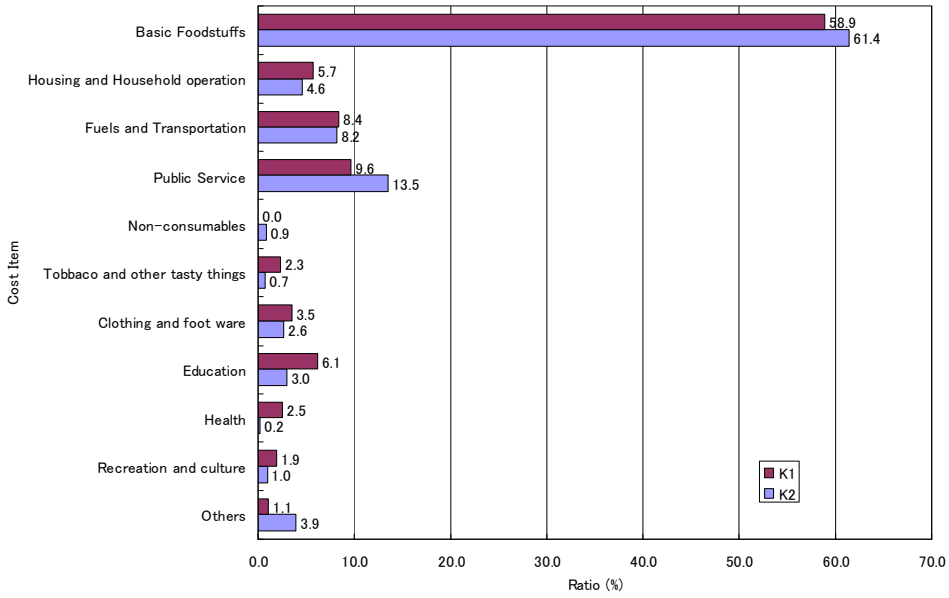
Table 2.1.36 Overview of Interview Survey Result

Unit: IDR

Grooup		Result of Hearing Survey											
		Basic Foodstuffs	Housing and Household operation	Fuels and Transportation	Public Service	Non-consumables	Tobbaco and other tasty things	Clothing and foot ware	Education	Health	Recreation and culture	Others	Total Monthly Expenditure
K1	Min	150,000	4,000	9,000	3,000	0	0	0	0	0	0	0	392,500
	Max	1,500,000	100,000	288,000	300,000	0	210,000	100,000	260,000	200,000	100,000	120,000	2,243,833
	Ave	675,000	58,417	108,917	99,417	0	25,833	36,389	77,361	23,208	17,925	10,000	1,132,467
K2	Min	240,000	10,000	0	60,000	0	0	0	0	0	0	0	473,000
	Max	1,500,000	100,000	150,000	200,000	41,667	60,000	50,000	100,000	5,000	160,000	90,000	1,955,833
	Ave	568,750	40,063	48,500	101,250	5,208	11,250	18,229	32,917	1,542	25,729	22,500	875,938

Source: JICA Study Team

Household expenditure widely ranged in each class. The result represented by bar chart is shown in Figure 2.1.44.



Source: JICA Study Team

Figure 2.1.44 Affordability in Yogyakarta

According to said figure, basic foodstuff is about 60% of expenditure followed by public service which is about 10% for each class. Since the old sewerage tariff is 500 IDR/month, this is considered to be less than 0.1% of household expenditure. In Yogyakarta, sewerage tariff was changed since 2009. In the previous K1 class, tariff of two stages was set up based on house floor area, in addition to the number of household (less than 100 m^2: 3,000 IRD/month; more than 100 m^2: 6,000 IRD/month). This is considered to be 0.3-0.6% of household expenditure.

The tariff became 9,000 IRD/month for K2 class. The proportion of this new tariff in the household expenditure is considered to be about 1%. The old and new tariffs are set up based on the number of household member. However, in this survey, it seems that classification is based on income flexibility. As the DKI Jakarta case, it seems preferable to set the tariff on the basis of power consumptions, which is rather related to the household incomes than the others.

Considering household expenditure and WTP in sewerage, the survey was conducted in two stages. During the interview related to household expenditure, the question on WTP was raised on the 1st stage. The effect of sewerage system was explained simultaneously with the view on water environment and sanitary improvement. Subsequently, the question on WTP was raised on the 2nd stage. As a result, WTP of sewerage tariff was determined as shown in the following figure. The questionnaire used in the survey is enclosed in Appendix.

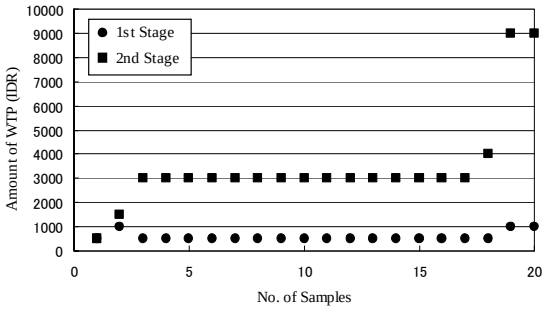


Figure 2.1.45 Survey Result of WTP

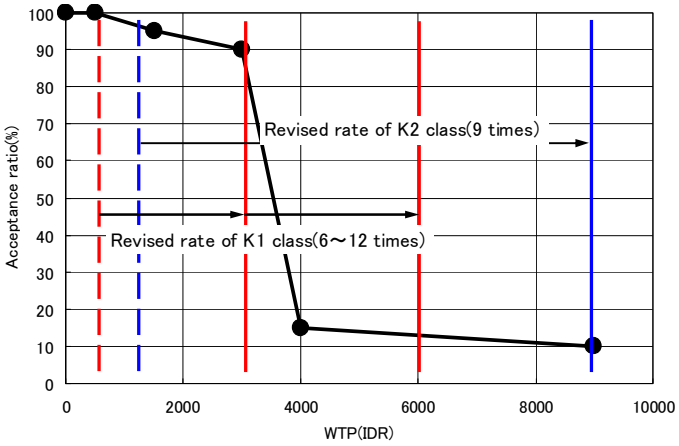


Figure 2.1.46 Acceptance Ratio of WTP

Based on the survey, WTP of customers plunged from 90% to 10%, considering a tariff rate of 3,000 IDR/month. The new tariff set in 2009 increased significantly. However, the fairness of expense sharing between the two divisions of K1 class using the floor area should be considered. Old tariff for K1 class was changed from 500 IDR/month to 6,000 IDR/month. Said revision is generally in accordance with WTP. The revision to 6,000 IDR/month and 9,000 IDR/month of K2 class are difficult based on the acceptance ratio. However, since the tariff ratio against income is 1% or less, it is realized to be the same as the cost level of maintaining health. Regardless of the tariff being different for each household, it is still at low level as compared with the cost of luxury products. Therefore, it could be concluded that the customer can endure the new tariff rates. It is however necessary to continuously educate the residents regarding the issue.

(2) Financial Condition of Sewerage Works

1) Financial condition of sewerage works in DKI Jakarata

a) Revenue and expenditure

Table 2.1.33 and Figure 2.1.46 show the revenue, expenditure, and pre-tax profit of PD PAL JAYA in the sewerage management for DKI Jakarta from 2006 to 2008.

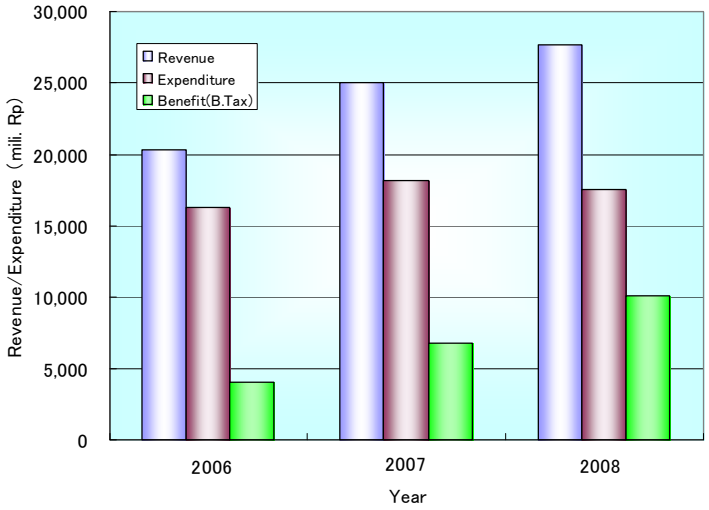
The pre-tax profit has increased every year because of the increase in connection ratio and the tariff revision. According to the revenue and expenditure from each annual report, PD PAL JAYA finances seem to be managed appropriately.

Table 2.1.37 Revenues and Expenditures of PD PAL JAYA

(Unit:Mil.Rp)

Items \ Year	2006	2007	2008
Revenue	20,343.4	24,996.0	27,641.8
Expenditure	16,238.8	18,197.7	17,526.6
Benefit(Pre-tax)	4,109.6	6,798.3	10,115.2

Source: PD PAL JAYA Annual Report



Source: PD PAL JAYA Annual Report

Figure 2.1.47 Revenues and Expenditures of PD PAL JAYA

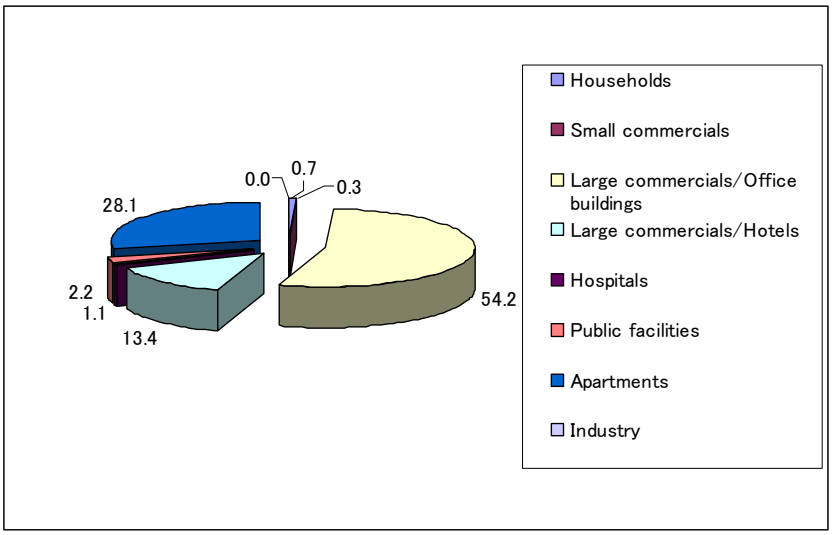
b) Examination of sewerage tariff

Customers of PD PAL JAYA include large office buildings, commercial facilities and households located in the Setiabuti, Kuningan area, and the business center in DKI Jakarta. The sewerage tariff is not imposed based on water supply use but on floor area of occupancy. Therefore, although the connection ratio of high-rise buildings such as those for offices, hotels and apartments is only about 10%, the revenue on tariff is about 98% of the total tariff revenue.

Table 2.1.38 Number and Floor Area of Each Customer

Customer category	Number of customer	Floor space of customer(m^2)
Households	1,147	125,597
Small Commercials	10	22,700
Large Commercial/ Office buildings	100	2,313,721
Large Commercial/ Hotels	12	362,738
Hospitals	5	37,736
Public facilities.	28	229,841
Apartments	23	1,100,951
Industry	1	400
Total	1,326	4,193,683

Source: PD PAL JAYA



Source: PD PAL JAYA

Figure 2.1.48 Tariff Revenue Ratio of Each Customer in PD PAL JAYA (2007)

Sewerage tariff revenue per 1 m^3 of treated water in 2008 is shown in Table 2.1.39. The unit tariff revenue per treated water is 3,295 Rp/m^3 (about 0.33 USD/m^3). It includes the connection fee and revenue from other sources which is 3,600 Rp/m^3 (about 0.36US$/$m^3$). Therefore, it reveals a high level of revenue.

Table 2.1.39 2008 Revenue and Unit Rate per Water Treatment

Items	Revenue of 2008 (Rp)	Unit Revenue per Treated Water (Rp/m^3)
Main Business Revenue (Tariff Revenue)	24,960,685,664	3,295
Side Business Revenue (Connection Works)	995,764,082	131
Others	1,685,414,869	223
Total	27,642,864,615	3,649

Note: The volume of treated water is 20,753m^3/day (4.95L/m^2 floor/day)

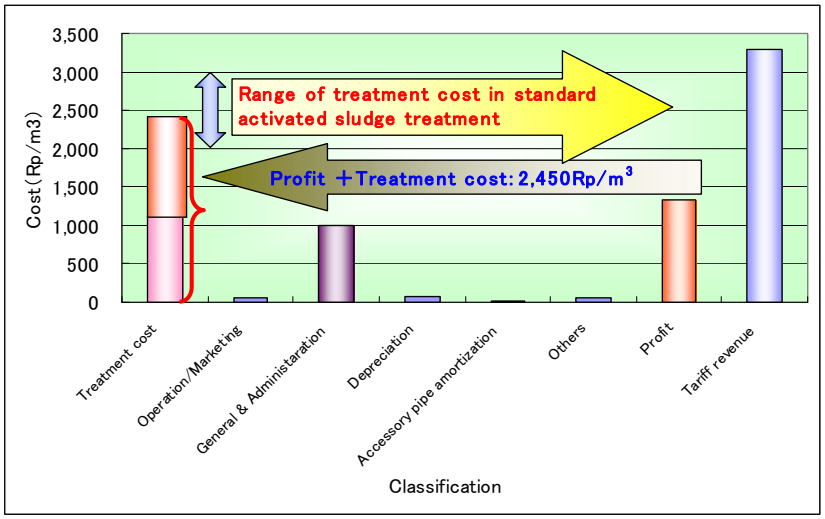
Source: Annual report of PD PAL JAYA in 2008.

Expenditure of PD PAL JAYA consisted of the treatment cost of 1,115 Rp/m^3 (about 0.11 USD/m^3), management cost of 992 Rp/m^3 (about 0.1USD/m^3) and the administration and depreciation cost of 207 Rp/m^3 (about 0.02US$/m^3). The profit is 1,335 Rp/m^3 (0.13US$/m^3) before taxation.

Table 2.1.40 Expenditure and Unit Expenditure per Water Treatment in 2008

Items	Expenditure of 2008 (Rp)	Unit expenditure per treatment water (Rp/m^3)
Sewerage treatment cost	8,449,589,604	1,115
Management cost	7,512,134,720	992
Administration cost, depreciation cost and etc.	1,685,414,869	207
Total	17,647,139,193	2,314

2,450Rp/m^3 (about 0.25 USD/m^3) or the sum of treatment cost and profit can offsets the treatment cost of standard activated sludge method (0.2～0.3 USD/m^3, based on results from Vietnam). Therefore, it is possible to introduce a new plant of activated sludge method with the 2,450 Rp/m^3 cost. Considering that sewerage system has high public interests with the effect of the water environment improvement, and has the characteristic of independent financial management for O&M, it is possible to manage the sewerage works with the current tariff in the city area urbanized (see Figure 2.1.49).



Source: JICA Study Team

Figure 2.1.49 Comparison of Treatment Cost and Profit

In the viewpoint of preservation of water utilized for the public, effluent should be managed strictly to be discharged. However, effluent from the private sewerage systems operated in the non-service coverage area of public sewerage systems is insufficient with the standard level.

Because individual facilities have not been operated and maintained appropriately, it is necessary to set the regulation on effluent restrictions and prepare a sewerage development plan.

The construction of new treatment plant contributes to the reduction of treatment cost and water quality improvement of sewerage system.

2) Financial condition of sewerage works in Kota Yogyakarta

a) Revenue and expenditure

In 2007, sewerage works of Kota Yogyakarta is 180 million Rp (see Table 2.1.41). As discussed earlier, the deficit in O&M for Sewon STP was estimated to be 810 million Rp.

Table 2.1.41 2007 Budget of Sewerage Works in Kota Yogyakarta in

Revenue		Expenditure	
Revenue[1)]	115,000,000	Salary for tariff collection	40,000,000
		O&M cost[2)]	130,000,000
		Share of the expenses for KARTBANTUL	125,000,000
Total	115,000,000	Total	295,000,000
		Salary of operators dispatched in Sewon STP	630,000,000
Budget (Revenue－Expenditure, excludes salay of operators dispatched)			-180,000,000
Budget (Revenue－Expenditure, includes salay of operators dispatched)			-810,000,000

1) calculated by Kota Yogyakarta
2) O&M cost means the cost of O&M for pipes without Sewon STP.

However, if the tariff will be revised in 2010 (see Table 2.1.44), the revenue will increase to 868,758,000 Rp (calculated by Kota Yogyakarta). Therefore, the financial condition of sewerage works in Kota Yogyakarta can be improved as shown in the following table.

Table 2.1.42 Expected Budget of Sewerage Works in Kota Yogyakarta in 2010

Revenue		Expenditure	
Revenue[1)]	868,758,000	Salary for tariff collection	40,000,000
		O&M cost[2)]	130,000,000
		Share of the expenses for KARTBANTUL	145,000,000
Total	868,758,000	Total	315,000,000
		Salary of operators dispatched in Sewon STP	630,000,000
Budget (Revenue－Expenditure, excludes salay of operators dispatched)			553,758,000
Budget (Revenue－Expenditure, includes salay of operators dispatched)			-76,242,000

1) calculated by Kota Yogyakarta
2) O&M cost means the cost of O&M for pipes without Sewon STP.

b) Sewerage tariff

In 2008, the sewer pipe connection serves 10,100 households and buildings, covering a population of 67,000. Since the tariff revenue of 2008 was about 108 million Rp, it could not satisfy the cost for O&M. Therefore, Kota Yogyakarta will introduce new tariff rates (see Table 2.1.44). The current tariff system has customer

types of household users and commercial users only, but the new tariff system consists of three types: i.e. household, commercial, and public users.

The new tariff for households (K1) will be increased by 6-12 times. However, the new tariff system concerns about low-income households, applying a progressive rate categorizing into two classes in the tariff K1 according to customers' house floor areas. Based on the result of household expenditure previously discussed, the new tariff will be about 0.3% of the average household expenditure and about 0.75% of the minimum household expenditure. Therefore, it is expected that the financial conditions of sewerage management might be improved, and sewerage coverage ratio be increased.

Table 2.1.43 Present Sewerage Tariff of Kota Yogyakarta

(Unit : Rp)

Households					
No.	Class	Maintenance cost(/month)	Administration cost	Connection fee	Remarks*
1	K1	500	500	2,000	1～5 persons
2	K2	1,000	500	2,500	6～10 persons
3	K3	2,000	500	3,000	11～20 persons
4	K4	4,000	500	3,500	21～50 persons
5	K5	8,000	500	4,000	> 50 persons
Enteprise					
1	P1	3,000	500	2,500	< 25 Mil. Rp
2	P2	6,000	500	5,000	> 25 Mil. Rp
3	P3	12,000	500	7,500	> 50 mil. Rp

＊Enteprise is seperated with income.
** Perda No.9(1991)

Table 2.1.44 New Sewerage Tariff of Kota Yogyakarta (2010)

(Unit:Rp)

Households				
No.	Class	Maintenance cost(/month)	Connection fee	Remarks
1	RT1	3,000	10,000	1～5 persons, below 100m^2 of floor area
2	RT2	6,000	10,000	1～5 persons, above 100m^2 of floor area
3	RT3	9,000	10,000	6～10 persons
4	RT4	30,000	10,000	> 10 persons
Public facilities				
1	S1	6,000	10,000	Temples, Community facilities, Museum
2	S2	9,000	10,000	Government offices with 24 staffs below Schools with 179 staffs and students below
3	S3	21,000	10,000	Government offices with 25～50 staffs Schools with 180～240 staffs and students
4	S4	37,000	10,000	Government offices with 51 staffs above Schools with 241 staffs and students above
Commercial facilities				
1	P1	9,000	10,000	below 10 employees, below 50 Mil. Rp. Income
2	P2	28,000	10,000	11～50 employees, 50～100 Mil. Rp. Income
3	P3	60,000	10,000	50～100 employees, 100～500 Mil. Rp. Income
4	P4	100,000	10,000	100～150 employees, 500 Mil.～1 Bil. Rp. Income
5	P5	125,000	10,000	above 150 employees, above 1 Bil. Income

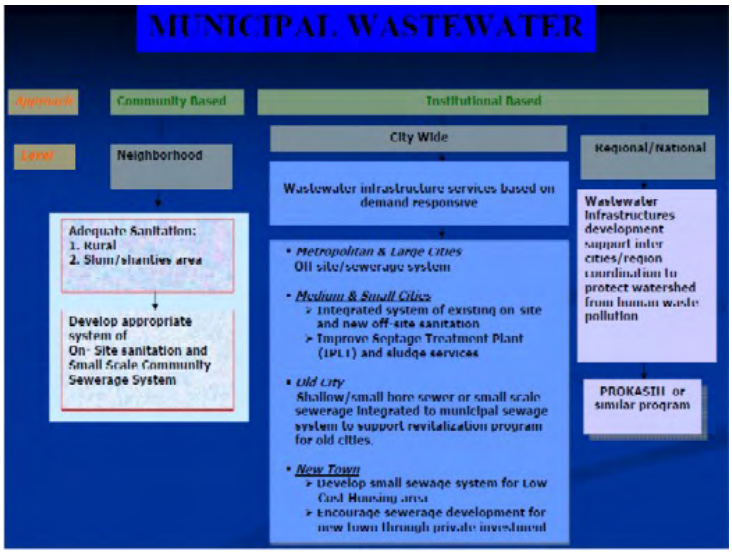
2.2 Proposal for O&M Planning in Indonesia

2.2.1 Knowledge in Indonesia

(1) Policy/Countermeasures for Sludge Treatment (SANIMAS Sewerage Works)

The government of Indonesia sets the policy to develop sewerage systems according to the local characteristics such as land use and population density: i.e. large-scale sewerage systems for urbanized areas; combination of small-scale systems and septic tanks for suburban areas; and small-scale sewerage system for housing development areas. Following the policy, the Jakarta administration classifies sewerage works into large-scale (over 300 persons/ha), small-scale (100-300 persons/ha), and individual treatment (less than 100 persons/ha). The administration also instructs the construction of the related facilities subject to securing building permits.

The national government and state governments have the responsibility to carry out: i) Construction of sewerage work facilities, preventing pollution of river basin due to garbage; and ii) Promoting PROKASIH Program (Clean River Program) or other similar programs.

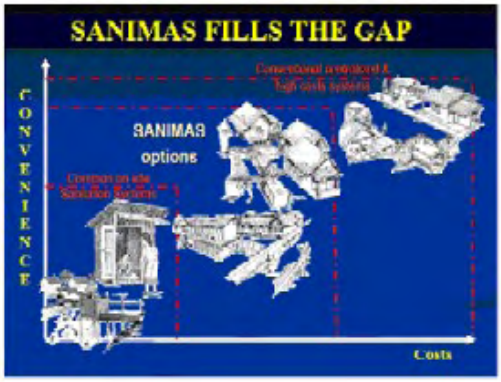


Source: Community based sanitation (SANIMAS) in Indonesia

Figure 2.2.1 SANIMAS Project

SANIMAS involves a small-scale sewerage works or simplified sewerage. It aims to improve the sanitation of communities and promotes a program for educating residents which is called “MCK+1”. This program consists of improvement of Mandi (Bathing), Cuci (Washing), Kalus (Toilet), and biomass use. Most facilities are constructed at low lands along rivers with sewerage pipes buried at deep level. Thus, this system does not need lifting pumps and generators and saves energy. Bremen Overseas Research and Development Association (BORDA) South East Asia located in Jakarta City, and the national government promotes development of community-based small-scale sewerage systems. SANIMAS has been initially implemented in DKI Yogyakarta and Bali. Consequently, it was commenced out in all the states in 2006.

Figure 2.2.2 Facility Allocation of SANIMAS (left) and the Structure of Treatment



No.	Year	CHOSEN TECHNOLOGY		
		Public Toilet	Shallow Sewer	TOTAL
1	2003	3	3	6
2	2004	6	2	8
3	2005	8	3	11
4	2006	57	12	69
5	2007	104	24	128
TOTAL		178	44	222

Source: Community-based Sanitation (SANIMAS) in Indonesia

Figure 2.2.3 Recognition of SANIMAS (left) and Record of Conducting (right)

Figure 2.2.4 Area of SANIMAS Project (Yogyakarta)

(2) Sewage Countermeasures of Office Building (the Case of Marriott Hotel)

When high-rise buildings are constructed in areas outside sewerage-covered areas, Jakarta City requires construction and operation of sewage treatment facilities in high-rise buildings.

In the case of Marriott hotel which is in the central part of Jakarta City, treatment facilities of activated sludge method in the hotel was first constructed. After two years they connected the hotel to the public sewerage system due to lack of techniques and high cost

in O&M.

As previously indicated, the water quality of treated water from building where treatment facilities are installed, is not good. Hence, it is better to that these buildings are covered by the public sewerage services like Marriott hotel. Although new buildings are constructed in sewerage-covered areas, they still need to install treatment facilities. In this case however, it is also better to treat sewage at a newly constructed waste water treatment plant, considering O&M technique, care for sludge, and operating costs.

(3) Revision of Water Law

The new Water Law (No.7/2004) describes the current problems/issues and strategic policies as shown in the followings. Moreover, this revision is recognized as a good action because it focuses on watershed management. In the sector of sewerage and water environment, the new law is also expected to play various roles such as water resources conservation, community participation, drought management, flood management and use of rainwater usages.

1) Problems on water resources management
   - Deterioration of the quantity and quality of water resources
   - Sediment accumulation
   - Inadequate operation and maintenance of water resource facilities
   - Effect of flood and drought causing related damages
   - Lack of community participation and role of users
   - Inefficient government investment for water resource management, currently which does not benefit water users.
2) Goals of water resources management
   - To implement comprehensive and sustainable methods for water resources management
   - To assess the stakeholders and users relationships
   - To expand water supply systems to meet the domestic, commercial, agricultural and industrial demands, but taking traditional irrigation manners and local community activities into account
   - To mitigate the effect of flood and drought and reduce consequent damage
   - To prevent isolation of islands, seashores in border regions from conflicts on water use
   - To encourage the community participation
   - To improve the relationship among stakeholders
   - To develop a database system for water resources management
   - To stimulate water resources and water infrastructure
   - To reduce the damage of flood especially in urban areas

3) Clean River Program

In order to promote countermeasures against water pollution, Environmental Management Agency and local governments carry out the Clean River Program (PROKASHI). This program includes establishment of grading system of private companies, which are evaluated and graded from the view point of contribution to anti-pollution on environment, called Performance Level Evaluation Program (PROPER).

In PROPER, Ministry of Environment in Indonesia classifies companies into five grades: i.e. gold, green, blue, red and black and then, publishes the results. Moreover, the companies are restricted in terms of discharge volume control and pollution penalties. The evaluation items for such grading are shown as follows.

- Duty to report on environmental measures
- Compliance with the standards of water outflow
- Compliance with the rules on air pollution
- Compliance with the rules on the disposal of toxic chemical compounds

(4) Wide Area Administration

Indonesian government promoted decentralization, giving the authorities for development and management of urban infrastructures to the local municipalities. As a result, while urban infrastructure has been improved in urbanized areas and areas with sound financial conditions, it has been hardly improved in areas with small population and poor financial conditions.

Although decentralization has a point considering that each municipal government can promote projects under their own responsibility, it also has its disadvantage as it widens the gap among municipal governments, especially in the sectors such as road, traffic, water supply and sewerage, solid waste and storm drainage. In order to reduce the gap and systematically improve infrastructure, it is better to execute related works in cooperation with several cities. Because urban infrastructures are similar to other cities, it could reduce the cost by simultaneously executing construction with several cities.

The central city area of DI Yogyakarta consists of Yogyakarta City, Bantul, and Sleman. The government of DI Yogyakarta organized SECBER KARTAMANTAL (SECBER: Joint Secretariat). This is a joint secretariat with neighbor cities intended to perform planning and implementation for development of transport, road, sewerage, water supply, drainage and solid waste management.

(5) Charging System

In Jakarta City, water supply-coverage is low at 50%. Many water users, such as households, buildings, and stores, use well water. Workers involved in water supply are

different from those of sewerage works. As for sewerage works, charge is based on floor size. For houses, sewerage charge is classified based on electricity consumption, which identifies distinction according to income of households. For businesses, sewerage charges are classified according to the size of company, building size (high-rise or low-rise), and grading (as for hotels). With these classifications, subsidy from high-income group to low-income group can be initiated.

Yogyakarta and Bali take charging system regardless of water supply. Bandung City promotes the coverage of water supply and sewerage works, and charges 30% of water charge as sewerage charge. Houses without water meter is charged with a flat rate.

For raising awareness on sewerage works management, Indonesia government holds symposiums for administrators of water supply and sewerage works, and discusses charging system.

2.2.2 Proposals to Sewerage Works of Jakarta City

(1) Operation and Maintenance

1) Measures for sewage and rainwater

Sewerage works of Jakarta City has problems on water pollution and stormwater drainage. They are improved through the development of sewerage works. The development also has effects: i) collecting and treating sewage; ii) reusing treated water; iii) preventing flood damage, iv); utilizing rainwater (storage and infiltration), and v); conserving the quality and quantity of underground water.

Jakarta City takes cost-reduction interceptor sewerage which is an effective approach to improve water environment of big cities. It can reduce the project cost and start sewerage services early. While it does sewage treatment and stormwater drainage with the same system, their management agencies are different: stormwater drainage belongs to the Public Work Bureau while sewage treatment is under the Environment Bureau. It is necessary for these agencies to manage business planning, charging system, and regenerate urban river.

2) Improving the quality of treated water at Setiabudi waste water treatment plant

The water quality of outflow does not meet the legal standards at present. This is because storm water reservoir is used for both storm water reserves and sewage treatment.

To improve the quality, the following shall be performed:

- Bottom-sludge treatment: regular sludge withdrawal prevents worsening of water quality.
- Fixing or using aerators: Intermittent operation for reducing bubbles is being performed. It is better to supply sufficient air and remove organics by

continuous low-speed operation. Hence, fault aerators should be repaired urgently.

Setiabudi plant does not have sufficient facilities for treatment. It is necessary to construct such facilities especially for sewage treatment.

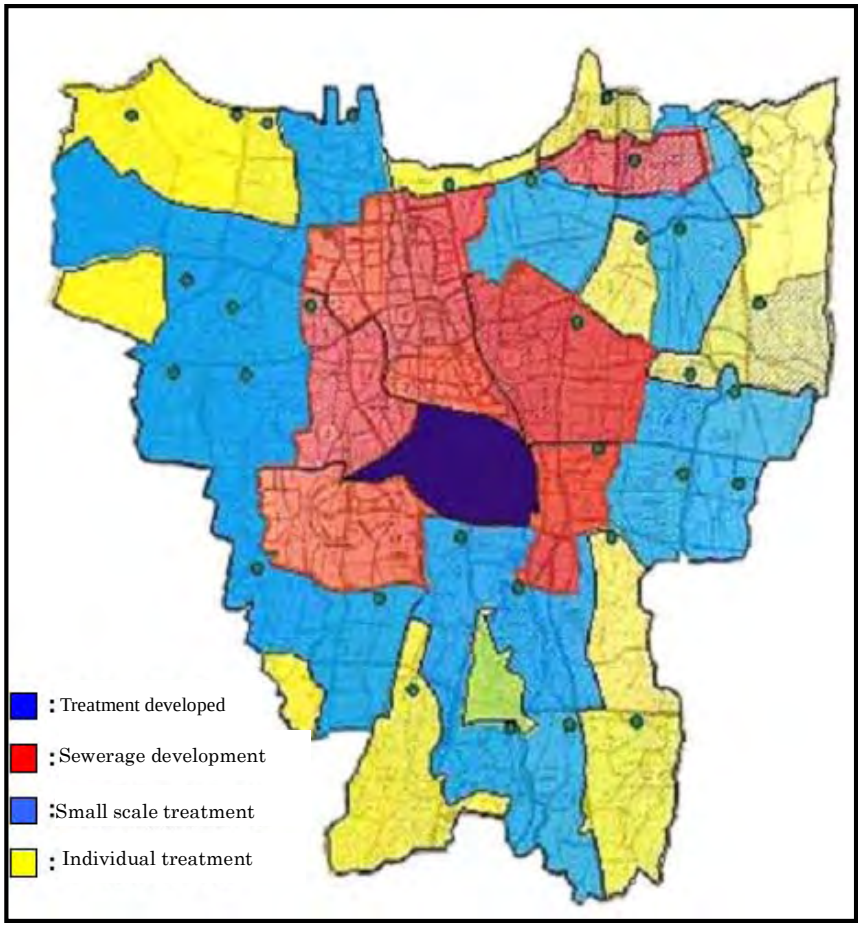
(2) New Sewerage Works Project

1) Construction of a new wastewater treatment plant

a) Sewerage planning of Jakarta City

Jakarta City (government) includes planning on treatment plan in their sewage master plan. It classifies the area of sewage treatment according to population density: sewerage works is developed to serve over 300 people/ha, small-scale sewerage works for 100-300 people/ha, and individual treatment for less than 100 people/ha. The city central area from Setiabudi-Kuningan to Kota, until the Thamrin-Menteng area, is densely populated. Shopping centers and office buildings are located in said areas.

Wastewater treatment plants require huge land area and should be constructed near the sea. Jakarta City plans to develop sewerage works in the areas from south to north through the central area, which are regarded as priority (Figure 2.2.5). In these areas, there a lot of high-rise buildings exist and redevelopment plan is being promoted. In said plan, improvement of the old facilities in existing high-rise buildings is not required to be executed. It is preferable that the planned public sewerage system cover those buildings making the sewer connections. The development also should consider the relation with redevelopment plan. The plan also consider about earlier realization of improvement through local area planning and implementation, i.e. sectioning sub-areas in the target area, and partially developing the sewerage services in terms of construction of small- or middle-scale treatment plants in phasing because it will take time to clear the land acquisition problems for a large-scale sewerage facilities. The Jakarta City has a plan not only for expansion of sewerage services but also for securing urban water introducing water recycling system.



Source: Concept and Strategy For Wastewater Management Of Jakarta City (PD PAL JAYA Jakarta)

Figure 2.2.5 Sewerage Plan for Jakarta City

b) Cost of sewerage works and its effects

Effects of sewerage works vary according to its size. The larger capacity is developed, the unit cost for construction and O&M becomes cheaper (Figure 2.2.6). This means that it is better for buildings such as offices, to connect to sewerage works rather than their independent treatment facilities. For example, Marriot Hotel no longer relies on their individual treatment facilities. Instead, they connected to sewerage works two years after they constructed that. This was due to high cost and techniques required in O&M.

It is expected there will be further disconnection of individual treatment facilities to connect to the public sewers. The building owner will have advantages in maximized usage of their land for their business and being relieved from annoyance of foul smell, screenings, and withdrawal of individual treatment facilities.

Public sewerage systems generally have the following advantages in comparison with individual treatment systems:

- The effect of sewerage works depends on the cost of construction and O&M. Thus, this is suitable for wastewater treatment in densely population areas.

Considering the lifecycle from construction to renewing, it is irrational for buildings to have individual treatments facilities.

- Sewerage works is highly effective on improving water quality. On the other hand, individual treatment facilities depend on individual capability in O&M skills and then, it is not expected to maintain the sufficient effluent water qualities.
- Sewerage works contributes to city redevelopment. In various related projects in areas with high dense population, sewerage works contribute to maintaining drainage, effective land use, and recycled water use.

PD PAL JAYA with the urban planning agency obligates the building owners to either to install and operate proper sewage treatment facilities or to connect to sewerage works. The development of sewerage system and expansion of services might be realized in terms of that the buildings which are connected to sewerage are charged by PD PAL JAYA with the cost which is the same level as that for individual facilities.

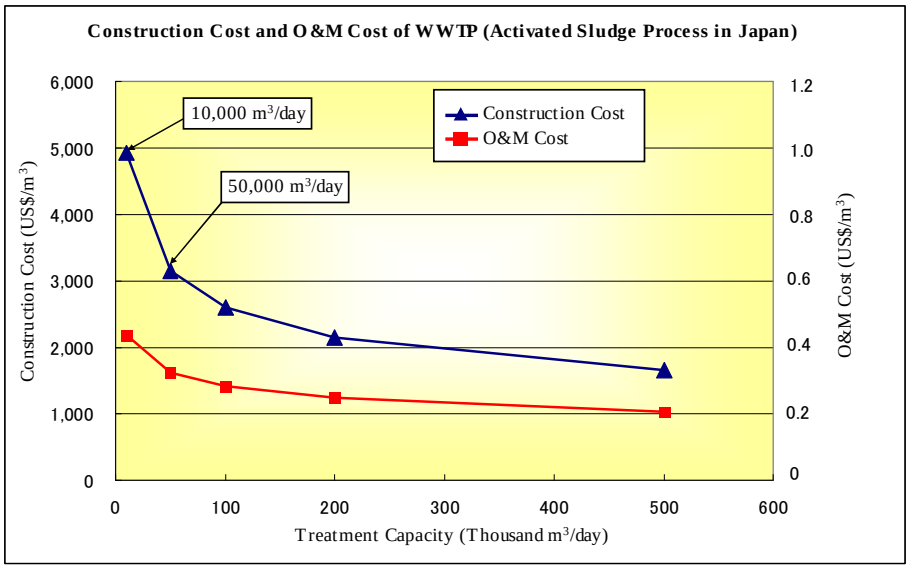


Figure 2.2.6 Cost by Size of Plant (Japan)

c) Priority area in sewerage works

Based on the master plan, Jakarta City government intends to develop sewerage works in the central city as its priority. It is proposed to include Setiabudi, Thamrin, and Kota areas. In these areas, mid- and high-rise buildings exist while reconstruction and redevelopment is promoted. As for drainage measures, it is rational to consider sewerage works prior to construction and reconstruction of buildings and updating of facilities. It is important to develop the sewerage systems in connection with related governmental agencies dealing with environment, building permissions and development restrictions.

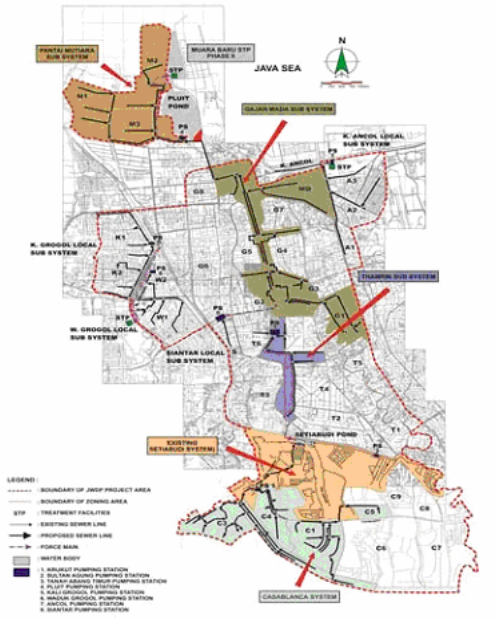


Figure 2.2.7 Priority Area for Sewerage Development

With establishment of sewerage laws and city development laws setting up a development obligation for urban infrastructures development, public sewerage systems will be realized to be expanded with more advantages than individual sewerage systems.

Development of sewer pipelines to cover larger areas will improve living and water environment, and hence, the effect of sewerage will expand widely.

Figure 2.2.8 Cooperation between Public and Private

d) New treatment plant

Developing large-scale sewerage works needs a lot of time and cost for land acquisition and construction. The Jakarta City considers the sewerage development for the priority areas as a long-term program with step-wise implementation. The program includes upgrading of the treatment capacity of Setiabudi pond and

development of middle- and small-scale sewerage works in the city center prioritized. Treated water is one of precious urban water resources, and its use has been promoted as recycle water in the central area. In Jakarta, there is a clear distinction between rainy and dry seasons and the City faces water shortage in every dry seasons. Excessive extraction of groundwater is causing land subsidence. As discussed earlier, due to raising the needs of residents to secure water for urban activities and amenities, sustainable sewerage management can be expected in Setiabudi, Kuningan and other similar urban areas.

Source: Sewerage and Wastewater Management Dept., Ministry of Land, Infrastructure, Transport and Tourism

Figure 2.2.9 Satellite Plant

There are lots of high-rise buildings in Jakarta City (Figure 2.2.10), and the redevelopment projects are ongoing in the City. In the central area of Jakarta, there are a lot of areas with high-class land uses. Besed on the cases of Setiabudi, the trial estimation for sewerage development plan for Jakarta was carried out under assumption to set the target area to be around 1,000ha.

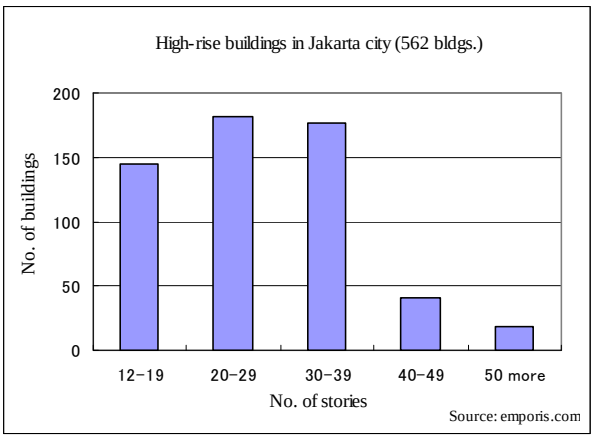


Figure 2.2.10 High-rise Buildings in Jakarta

In the plan, sewer lines with the intercepting method and wastewater treatment plant will be constructed as Phase-1 project. Subsequently, branch sewer pipes will be constructed as Phase-2 project through coordination with the urban

redevelopment project. The financial balance shall be estimated based on: i) total floor areas of the target customers; ii) tariff level of Setiabudi; and iii) the sample O&M cost for the activated sludge method (ASM) plant obtained in Vietnam. As the result, on the condition that fare receipt is allocated to O&M cost, the sewerage project is deemed manageable.

Measures for cost reduction are also studied. The cost reduction in the government budget can be realized through setting a charging system sharing the cost for sewer pipes installation works.

Through the project, utilization of recycled water will be expanded as well as rain water, as the alternative water resources for treated water and groundwater, which will be used as reclaimed water and ambient water.

Table 2.2.1 Priority Development Projects

Project Phase	Design	Cost (mili IDR)	Remarks
Coverage area	1000 ha		
Phase 1			
Treatment facilities	Capacity 30,000 m^3/日 Method:ASM Site area 1.5 ha	500,000	17,000,000 IDR/m^3
Pipeline facilities	12km	360,000	30,000,000 IDR/m interceptor（12m/ha）
Others		140,000	
subtotal		1,000,000	
Phase 2			
Pipeline facilities	100 km	500,000	5,000,000 IDR/m branch pipes (100 m/ha)
Mid-term plan Large-scale sewerage in Sudirman, Thamrin and Kota			

Table 2.2.2 Potential Income and Outgo of Priority Project

Items	Design and Price	Remarks
Coverage area(ha)	1,000 ha	
Treatment capacity	30,000 m^3/day	（20,753 m^3/day）
Total floor area	4,200,000 m^2	（4,193,684 m^2） floor-space ratio about 0.4 m^2/m^2
Fare income (①)	25,200 mili. IDR/yr	（24,960 mili IDR）
		（500 IDR/m^2/month）
OM cost (②)	21,900 mili. IDR/yr	Vietnam：2,000 VND/m^3
Deduction（①－②）	＋3,300 mili. IDR/yr	For construction of pipelines

Note: Total floor area and fare standard of Setiabudi are indicated the “Remarks” column

Figure 2.2.11 Development of Water Environment and Town Scenery

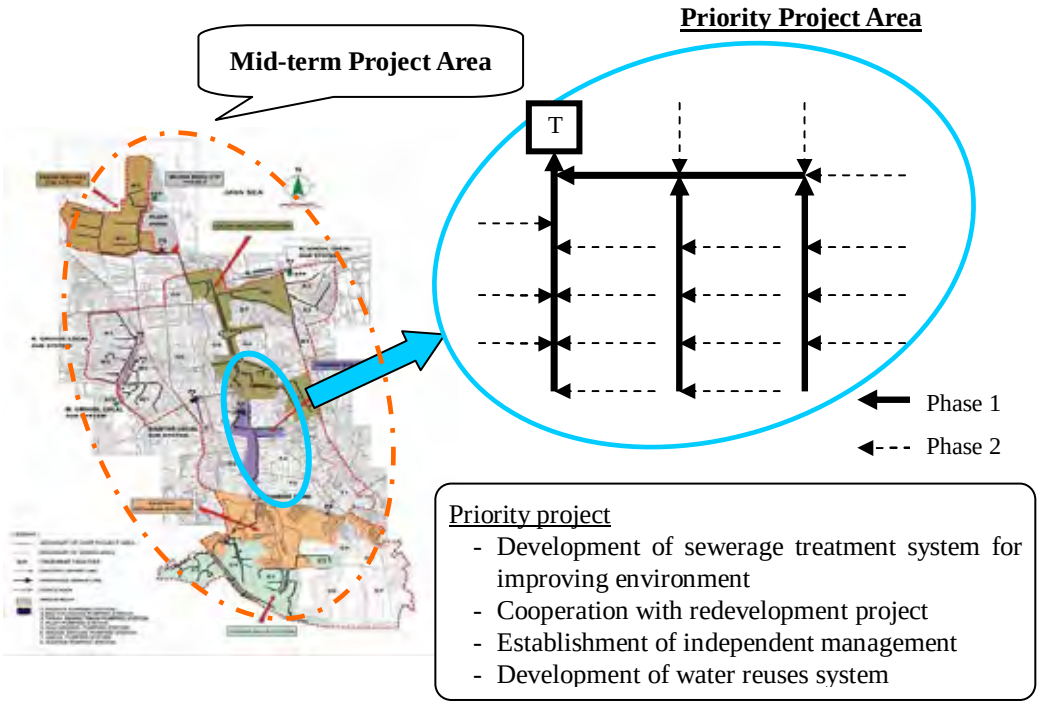


Figure 2.2.12 Stepwise-development

2) Wide area administration considering neighboring cities

Jakarta City forms the greater urban city with its surroundings such as Tangerang, Depo, and Bekasi. It is essential to focus on the river basin management taking consideration of river water pollution caused by river water utilization and wastewater effluent at the several points of river from upper to lower. As Kartamantul develops the infrastructure of Jakarta City, it is essential for cities included in the Jabodetabek urban area to cooperate with each other concerning sewage treatment and water use from the view point of mid and long-term water environment conservation.

2.2.3 The Proposal on Waste Water Treatment Plant in Yogyakarta City

(1) O&M

1) Reduction of O&M staff at Sewon wastewater treatment plant

Tasks of 40 staffs at Sewon wastewater treatment plant are shown in Table 2.2.3. In this plant, lagoon method is used for water treatment while sludge drying bed is used for sludge treatment, requiring simple operations. Hence, reduction of more than half of labor force is possible. Although workers are paid with low salary, it seems that many of them are assigned to perform similar duties. Hence, reduction of workers could improve the financial situation of the treatment plant. As the sharp rise of unit cost of workers is predicted, saving the personnel cost by assigning only enough numbers of workers is important to save expenses for the treatment operations.

Table 2.2.3 Workers of Sewon Wastewater Treatment Plant

works	number	remarks
manager	1	
operating maintaining	15	2perssons-3groups-2lotations in night-time
analizing	3	
deskwork	2	
others	18	guradman etc.
total	40	

2) Improvement of laboratory equipment

The results of water quality test at Sewon wastewater treatment plant are doubtful. During the visit to the laboratory, many equipment including mobile measuring devices appear obsolete and unusable. As the results of water quality test at the plant are one of the most important data for efficient O&M, it is necessary to urgently procure new equipment

3) Proposal on providing farers with sludge from Sewon wastewater treatment plant

The sludge generated from the Sewon wastewater treatment plant is treated by sun drying bed. After the treatment, this is provided to farmers. However, its components were not analyzed and unknown. If any heavy metals are included in the sludge, that will be harmful for the people through contaminating vegetables. It is therefore necessary to analyze the sludge and understand the harmful effects in the sludge before providing farmers.

(2) Awareness Program on Water Environment

For Yogyakarta City, as one of most popular tourism cities, securing sound water environment is as important as securing the cultures and historical heritages. Yogyakarta City is required to promote awareness activities on water environment to the communities through Prokasih Program.

According to the affordability survey, resident's awareness of paying for drainage measures is not effective. In the second survey is conducted related to the effect of sewerage works, the willingness to pay (WTP) increased to 3,000 Rp/month/house. It is therefore important to raise awareness of the water environment securing to conduct the sewerage development smoothly.

(3) Cooperation with Mid-term Project

For areas where sewerage works are planned to be developed, it is effective to define the coverage area clearly and to oblige implementation of large-scale sewerage development projects. In Japan, there is a restriction to connect public sewerage systems under municipal bylaws. For certain scale or larger projects, urban development should include a sewerage development by the developer under the urban development bylaws and its governmental instructions.

Figure 2.2.13 Shopping Center

(4) Plan on Connecting Pipes and Multi-treatment Area

Installing connecting pipes enables effective access for the utilization of Sewon wastewater treatment plant. In the long term, planning and developing another trunk sewer and treatment plant are necessary to increase the capability of the plant and trunk mains. This approach enables efficient development of sewerage works and will meet the developmental process of the city. If the treatment facilities are set near each other, the effect of scale and synthesis of operation system can be obtained.

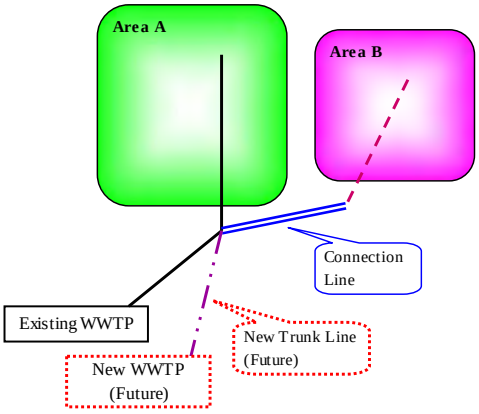


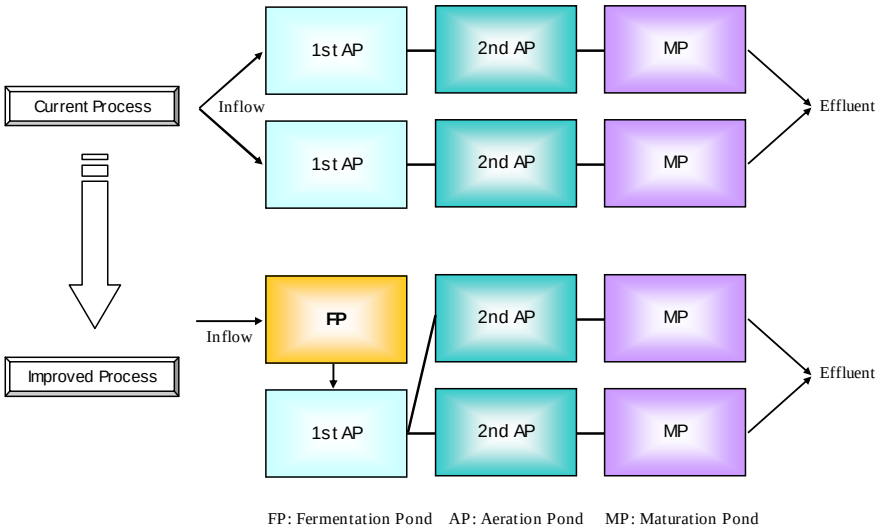
Figure 2.2.14 Typical Planning of Trunk Line Development

Thus, in the early stage of development, investment cost can be reduced by connecting the pipes to the trunk sewer and starting sewerage services as early as possible. In the long term, when two plants are expanded or reconstructed, their capacity will be considerable and investment effects on the operations will be realized.

(5) Improving the Capability of Treatment

Sewon wastewater treatment plant is operated with two parallel lines (Figure 2.2.15). As

sewerage works is developed, the volume of inflow will increase in the future. When this is implemented, it is recommended that the works for rearrangement of the two 1st lagoons currently separated with serial connection to let the one have a function as a fermentation pond like Vinh Hung wastewater treatment plant explained latter, prior to implementation of the entire sewerage system expansion, which will contribute to increase the treatment capacity.



2.2.15 Improvement Method of Lagoon

(6) Proposal on Management Planning and Charging System

The overview of financial balance in sewerage O&M of Yogyakarta City is shown in Table 2.2.2. Sewon wastewater treatment plant is managed using the fund resources such as subsidies from DI Yogyakarta, Yogyakarta City, Sleman, Bantul, and compensation of staff salaries from said cities. Sum of O&M cost and labor cost is estimated to be 2,385 million IDR.

Out of the expenditure of treatment plant O&M, there are two major expenditure items such as pipeline O&M and tariff collection expenses. The total of these two is estimated to be 170 million IDR. However, income from the tariff was 115 million IDR in 2007, which is less than the subsidy from Yogyakarta City, the cost for pipeline O&M and tariff collection expenses. The deficit is covered by the general account of the city.

Yogyakarta City intends to improve such financial status in terms of legislation revising to establish a new tariff system to be introduced in 2010. However, the estimated income generated from the new tariff system is around 800 million IDR. Hence, It is necessary to continue the subsidies and compensation for personnel cost as well as fund supplementation from the general account.

Table.2.2.4 Sewerage Management of Yogyakarta, 2008

Income（IDR）		Outgo（IDR）	
Subsidy of DI Yogyakarta	1,000,000,000	Sewon WWTP	1,185,000,000
Contribution		Worker's salary	1,200,000,000
Sleman	20,000,000	subtotal	2,385,000,000
Bantul	20,000,000	Yogyakarta (pipeline)	130,000,000
Yogyakarta	145,000,000	Yogyakarta(charging）	40,000,000
Worker's salary	1,200,000,000	subtotal	170,000,000
From general account	170,000,000		
Total	2,555,000,000	Total	2,555,000,000

The appropriate sewerage tariff level is estimated in the Study. The simulation of financial balances is assessed under the following fixed pre-conditions:

Pre-conditions for financial simulation

i) The tariff for households are fixed to be subject to the new tariff system as shown in Table 2.1.44, which is 6-12 times (family size: 1-5 persons) of the current figure, without cross subsidy between households and commerce facilities.
ii) Progressive tariff is applied in the tariff for household taking low-income customers into consideration.
iii) The maximum affordable tariff for households is set to be around 4,000 IDR/month, which is estimated based on a finding of the survey conducted by JBIC in 2006, that the maximum tariff was estimated to be 1% of household incomes.

Table 2.2.5 Fare of Households

New Charging System	Rare	Remarks
Households (1-5 persons)	3,000 IDR/month	Less than 100m^2 floor
Households (1-5 persons)	6,000 IDR/month	More than 100m^2 floor
Low-income Class	Approx. 4,000 IDR/month	1% outcome (JBIC, 2006)
WPT (Affordability Survey)	Approx. 3,000 IDR/month	Figure 2.1.45 and 46

In the new tariff system, the proportion of tariff income will be: 44% from households; 2% from public customers; 14% from commercial customers; and 40% from hotels. Yogyakarta City is one of the most popular tourism cities. Therefore, the simulation was tried for the following tree cases, referring the Denpasar tariff system for setting the tariffs for commercial facilities and hotels which high-income persons are to use.

i) Case-1: The tariff for commercial facilities including hotels is set to be three times of the 2010 new tariff
ii) Case-2: In addition to Case-1, luxury accommodations would be charged at five times of the 2010 tariff.
iii) Case-3: In addition to Case-2, 4 or 5 star-class hotels would be charged at seven times of the 2010 tariff, estimated based on the tariff for households (Type A: 15,000 IDR/month), accommodation rate (100,000 IDR/month for high-class hotels), and progressive rate in the tariff system in Denpasar.

As a result, it was found that they could earn enough revenue to cover the personnel cost in the Cases-2 and 3. While hotels occupy about 60% of the total revenue, household is cut more than half to be at around 20% (Figure 2.2.17).

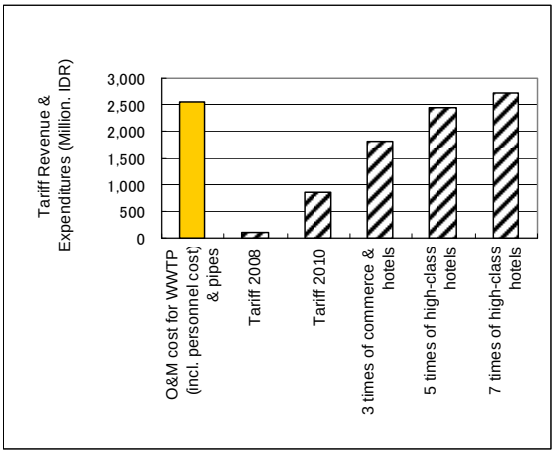


Figure 2.2.16 Estimated Income and Expenditure

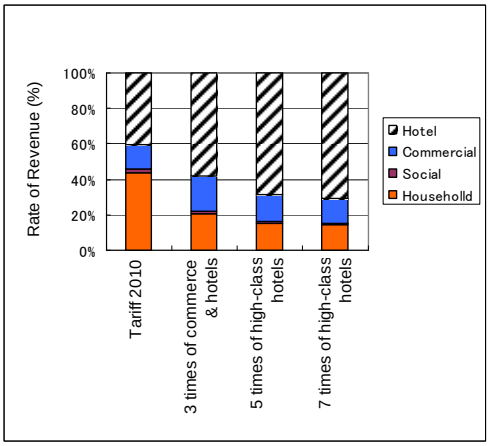


Figure 2.2.17 Proportion of Revenue by Customer Type

CHAPTER 3 SEWERAGE IN TWO CITIES OF VIETNAM

3.1 Field Study

3.1.1 Sewerage in Hanoi

(1) Outline

A sewerage system consisting of 23.9 km sewer line, Kim Lien wastewater treatment plant (WWTP) with capacity of 3,700 m3/day and Truc Bac WWTP with capacity 2,300 m3/day has been implemented through Hanoi Drainage Project for Environmental Improvement under Japanese ODA which commenced in March 1997. Prior to the introduction of modern wastewater treatment in 2005, municipal wastewater and sewage was discharged into the river without any treatment. Subsequently, North Than Long WWTP with a capacity 42,000 m^3/day was constructed in 2005. Additional four WWTP construction projects namely, Ba Mau Lake WWTP, Yen So WWTP, Yen Xa WWTP and Pu Do WWTP are planned to be implemented. The sewerage system is expected to be developed as shown in the following figure (Figure 3.1.1)

Figure 3.1.1 Distribution of WWTPs in Hanoi

Table 3.1.1 Outline of WWTPs in Hanoi

Item \ WWTP	Existing Plant		
	Kim Lien	Truc Bach	North Thanh Long
Capacity（m3/day)	3,700	2,500	42,000
Treatment Method	A2O	A2O	Conventional Actibated Sludge
Sewered Population (persons)	15,700	—	110,000
Operational Year	2005	2005	2009
Fiancial Source	Yen Loan	Yen Loan	Yen Loan
O/M body	Hanoi Sewerage and Drainage Company（HSDC）		

Table 3.1.2 Outline of Planned WWTP

Item \ WWTP	Planned Treatment Plant			
	Bai Mau	Yen So	Yen Xa	Phu Do
Capacity（m3/day)	14,000	190,000	270,000	84,000
Treatment Method	Conventional Activated Sludge	Nitrification Activated Sludge	Nitrification Activated Sludge	Nitrification Activated Sludge
Progress	Tender Preparation	under Construction	Plan	Plan
Financial Source	Yen Loan	BOT	Yen Loan	
O/M body[1)]	Hanoi Sewerage and Drainage Company（HSDC）			

1）O/M for the Yen So WWTP will be transferred to HSDC after one year operation by the contractor.

(2) Water Environment in Rivers

Rivers in the urban area are seriously polluted, exhibiting blackish color. Gas fumes are released by the sediments since sewerage system is not constructed completely. Water in the rivers sometimes produces offensive odor due to sewage contamination.

Water quality examination, simple pack-test method, is conducted in To Lich River, Kim Ngnu River, Set River and Lu River which flow across Hanoi City Center (Figure 3.1.2)

(Examination results are only used as reference since only simple pack-test method, by Kyoritsu Chemical Check Lab. Corp., is conducted.)

COD_{Mn} and $N\text{-}NH_3$ levels in the upper To Lich River are 45mg/L and 30mg/L respectively. These are also 70mg/L and 55mg/L in its middle stream, respectively. This means that river water is contaminated as water flows from upstream to downstream. Upper Lu River has 100mg/L of COD_{Mn} and 55mg/L of $N\text{-}NH_3$. This implies that municipal wastewater and human waste affects the water contamination. River water in the middle and lower streams are also contaminated.

Figure 3.1.2 Water Sampling Points

In other rivers, COD_{Mn} and $N\text{-}NH_3$ are 45.60 mg/L and 30.45 mg/L respectively, with serious water contamination detected. Furthermore NO3-N is not detected in all the rivers, implying that no dissolved oxygen exists. Stream flowing into Nhue River is also observed to be subject to same condition.

Water quality in Bay Mau Lake has COD_{Mn} of 15 mg/L, which is lower than those found in rivers. Contaminants such as $N\text{-}NH_3$ of 4 mg/L, NO3-N of 5 mg/L and plankton are also observed. This reveals that pollution exists due to municipal wastewater and human wastes.

Table 3.1.3 Water Quality in Urban Rivers in Hanoi

Location \ Item		Temperature (℃)	pH —	COD_{Mn} (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)
To-Lic River	Upper	29.9	7.7	45	35	0
	Middle	29.1	7.4	70	55	0
Kim-Ngnu River	Upper	28.2	7.4	60	30	0
Set River	Middle	28.0	7.4	45	45	0
Lu River	Upper	29.0	7.4	100	55	0
Canal to Nhue River	Western Part of the City	29.9	7.8	45	30	0
Bay Mau Lake	Northern Part of the City	30.4	8.5	15	4	5

* Sampling Date : 14 Feb. 2009

(3) Operation and Management of Sewerage System

Operation and management of sewer and treatment facilities are executed by Sewerage Treatment Enterprise which is a subsidiary of Hanoi Sewerage and Drainage One-Member State Company Limited (HSDC).

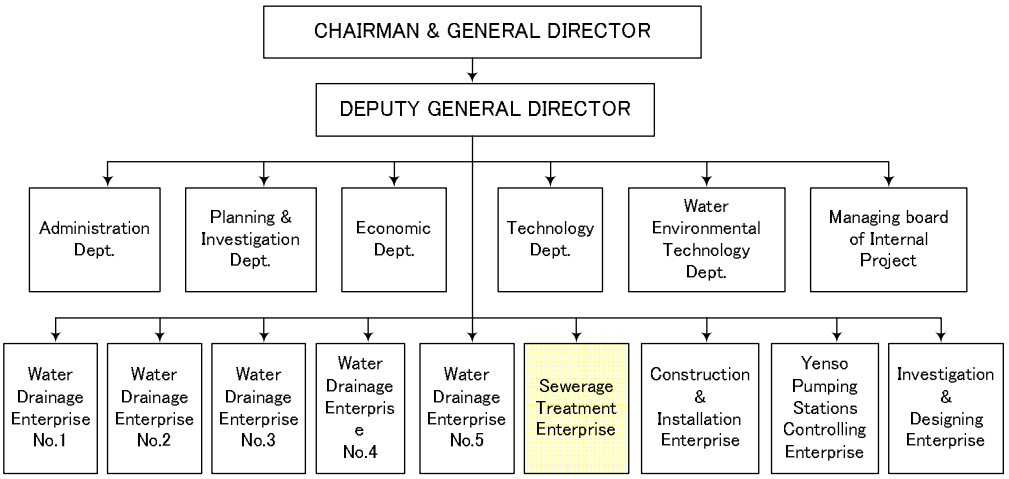


Figure 3.1.3 HSDC Organization Structure

(4) Sewerage Tariff Structure and Charge Collection

Hanoi People' Committee (HPC) regulates sewerage charge of 10% of water supply charge. Customers consist of household, social, industry and commercial customers. Customers outside the sewerage service and factories are exempted, but levied with environmental protection fee for industrial waste water.

Water supply company levies wastewater charge based on water supply charge. Collected wastewater charge is paid to HPC.

Table 3.1.4 Water Supply Charge for Urban Areas in Vietnam

Group	Rate	
House hold	Un-metered	30,000 VND/month
	less than 16m3	2,800 VND/m^3
	17－20m3	3,500
	21－35m3	5,000
	more than 36m3	7,500
Industry	4,500 VND/m^3	
Commercial	7,500 VND/m^3	
Public	4,000 VND/m^3	

(5) North Thang Long WWTP

1) Outline of facility

North Thang Long WWTP was constructed in August 2005. Its operation was delayed to September 2008 due to lack of sewer connection. It treats 3,700 m^3/day of wastewater produced in adjacent Thang Long Industrial Park Treatment process and applies activated sludge process with surface mechanical aerator. Said WWTP serves the treatment area at the north side of Red River. Full facilities is planned to operate in 2020. However, it may be delayed due to lagging urban development project and sewer construction. Two relay pumping stations are constructed, including control facility of WWTP monitors. No control facility for pumping stations was however installed.

Figure 3.1.4 Aerator of North Thang Long WWTP

Figure 3.1.5 Relay Pumping Station

Since it was more than three years past the construction completion, maintenance was not executed and degradation of machinery in the whole facilities is taking place. O&M plan in accordance with amount of inflow should be provided. Sequencing operation of whole facilities will contribute to the efficient operation and extended durability life of the facilities.

Table 3.1.5 Features of North Thang Long WWTP

Item	Specification	Remarks
Construction Completion	2005.8	
Operation Start	2009.2	
Design Sewered Population (person)	110,000	
Treatment Capacity (m3/day)	42,000	Sewage: 38,000m^3/day, Infiltrated water : 4,000m^3/day
Current Inflow Rate (m3/day)	3,700	All sewage is discharged from TLIP without households.

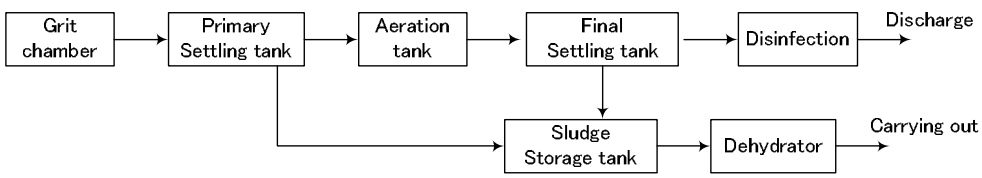


Figure 3.1.6 Treatment Flow of North Thang Long WWTP

2) O&M Organization Structure

O&M organization structure is divided into routine job on-site and supporting job of HSDC headquarters shown in Table 3.1.6. The headquarters team works with Kim Lien or Truc Bac teams and, executes sequencing jobs excluding routine and other unexpected tasks. This joint O&M team shown in Figure 3.1.7 is efficient.

To evaluate water quality, examination for daily operation is executed on-site while periodic examination of two WWTPs is executed in the laboratory of HSDC headquarters. Examination is legally required to be outsourced to authorized institutions.

On-site operators (7 members x 4 crew for 3 shifts) are assigned to monitor and operate facilities, perform routine inspection and repairs.

Table 3.1.6 O&M Organisation of North Thang Long WWTP

Position	No. (person)	Remarks
1.Permanent Staff		
Manager	1	
Operator	28	4 groups, 7 persons per group, 3 work sift, including monitoring service
Water Quality	1	Simple testing at sitte for WWTP operation
Total	30	
2.Supporting Staff at Head Office		
Water Quality	5	Laboratory at HSDC Head Quarter
O/M	5	Peridical testing and large scale repair
Other	15	Administrative role for all WWTPs
Total	25	

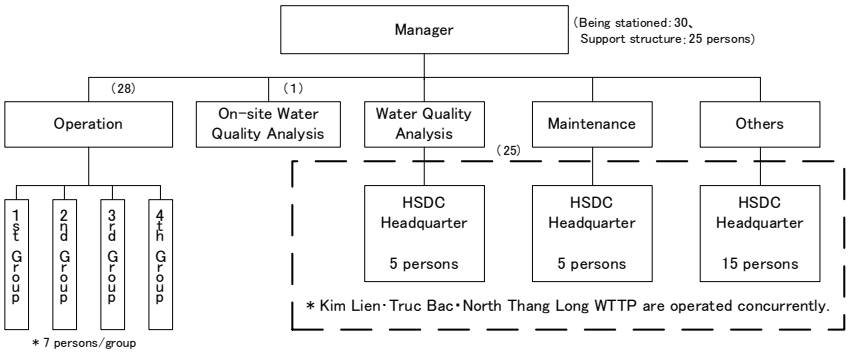


Figure 3.1.7 O&M Organization Structure of North Thang Long WWTP

Number of staff, which Nihon Hels Industry Co. assigns to operate the WWTP of equivalent treatment capacity, is described in Table 3.1.7. Based on said table staffing of North Thang Long WWTP appears excessive considering the wastewater inflow rate. Since present wastewater inflow rate is minimal, O&M staffing should be just sufficient in accordance with the present number of operating facilities and tasks involved.

Table 3.1.7 Number of Operators for WWTP with Equivalent Capacity as North Thang Long

WWTP / Inflow Rate	A WWTP	B WWTP	C WWTP	D WWTP
4,000～ 6,000m^3/day	4persons	2persons	4persons	4persons
	E WWTP	F WWTP	G WWTP	
43,000～48,000m^3/day	17persons	20persons	15persons	

1) Operation and working conditions are unified on the basis of North Thank Long WWTP.

3) O&M Condition

Although treatment capacity of Thang Long Industrial Park is 42,000 m^3/day, its present wastewater inflow rate is only 3,700 m^3/day.

BOD and SS concentration of inflow is 100 mg/L each. Both are lower than 220 mg/L and 190mg/L of design inflow, respectively. BOD loading rate of 400 kg-BOD/day is equivalent to only 4.3 % of 9,240 kg-BOD/day design load. O&M task force operates well one out of the six trains while aeration is also controlled on/off sequentially. DO meter is not sufficient to the whole aeration tank. Therefore one DO meter should be replaced for the duty tank.

Water effluent quality is mandated to Class B (TCVN 4945-2005) with 50 mg/L BOD and 100 mg/L SS, which is suitable for agricultural irrigation use. Present effluent quality complies with water effluent standard.

Said standard mandates 37 indicators. From these, 20 indicators are examined in HSDC laboratory while the remaining 17 indicators are outsourced to authorized corporation.

Table 3.1.8 Influent and Effluent Water Quality of North Thang Long WWTP

Category		BOD (mg/L)	SS (mg/L)	Remarks
Influent	Design	220	190	
	Actual	100	100	Same value as TLIP WWTP
Effluent	Design	50	100	TCVN 5945-2005 Class B
	Actual	<50	<100	Result of hearing survey

Maintenance plan is provided in accordance with the O&M manual submitted by the contractor. Inspection and maintenance is executed daily by on-site staffs, and monthly/yearly by supporting staffs. Periodic repairs including replacement of expendable supplies are executed during the scheduled inspection. Periodic inspection of electric equipment is outsourced once per month as mandated by municipal government decree. This supersedes the frequency required by the national government, which is every six months. Although power fails approximately 10 times a year, emergency generator seems to be functioning well.

Power consumption is estimated to be 2,400 to 3,000 kwh/day, considering that wastewater inflow is only minimal and energy saving operation is executed through on/off aeration. Effluent is discharged after sodium hypochlorite disinfection. Sludge dewatering is dosed with ferric chloride ($FeCl_3$) and polymer, and thickening is not produced. At present, there is no excess sludge and dewatering is not being carried out. Polymer is imported from Japan while other chemicals are available locally. Supplying duration is within three days.

Locally available expendable supplies for O&M are obtained within one week from purchase date while those imported are expected to be delivered three months from the order date. Meanwhile, chemicals for water examination are obtained within 2-3 weeks from purchase.

Table 3.1.9 Utilities Consumption and Purchasing

Item	Use	Consumprtion	Procurement	Remarks
Electricity	Operation	2,400～3,000 k Wh/day		estimation based on current inflow rate
Sodium Hyrochlorite	Disinfection	N/A 1)	3days	via local market
$FeCl_3$	Coagulation	N/A 1)	3days	via local market
Polymer	Coagulation	N/A 1)	3days	via local market (import goods)
Consumable (domestic)	O/M	N/A 2)	1week	via local market
Consumable (import)	O/M	N/A2)	3months	via local agent

1) The operation has not been commenced.
2) Currently the cost is covered by the contingency.

(6) Kim Lien WWTP

1) Outline of facility

Figure 3.1.8 Kim Lien WWTP

Wastewater treatment process involves carrier-added activated sludge process with anaerobic-anoxic-oxic. This eliminates nitrogen and phosphorus biologically. WWTP construction was implemented as a pilot project under the Hanoi Drainage Project for Environmental Improvement (Phase-1). The treatment area occupies 33.9 ha within Kim Lien District. WWTP is located adjacent to houses and commercial facilities near the city center. Wastewater is conveyed through a relay pumping station.

Effluent is discharged into Lu River. During dry season, effluent is reclaimed into Kim Lien Lake and contributes to lake water improvement.

Since the WWTP is located in the city center, area of site is limited and its facilities are easily accessible. All equipments/facilities are operated on-site. Its electric room

is not equipped with monitoring and control system. Therefore, treatment performance is relied on the operator's skills. If treatment area is not eventually integrated with adjacent large WWTP, sequencing control and data acquisition (SCADA) can only be effective through replacement of principal electrical and control facilities.

Table 3.1.10 O&M Condition of Kim Lien WWTP

Item	Specification	Remarks
Construction Completion	2005	Pump facilities in Kim Lien PS was upgraded.
Operation Start	2005.9	
Design Sewered Population (person)	15,000	
Treatment Capacity (m3/day)	3,700	
Current Inflow Rate (m3/day)	3,700	

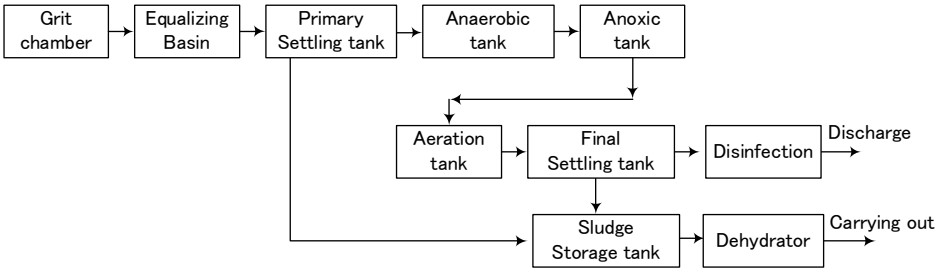


Figure 3.1.9 Treatment Flow of Kim Lien WWTP

WWTP is designed to serve adjacent residential environment and its offensive odor control is equipped adequately. Facilities, which produce offensive odor, are sealed, and gases are collected and deodorized by carbon adsorption. Hence, there is no offensive odor inside and within the adjacent vicinity of WWTP. (Figure 3.1.10 and 11).

Figure 3.1.10 Odor Plumbing of Screen Facility

Figure 3.1.11 Carbon Adsorption

2) O&M organization

O&M organization consists of five members with four crews operating in three shifts. Water treatment and dewatering are subject to 24-hour operation. They also execute water examination. However, periodic water examination is executed in

HSDC laboratory (Table 3.1.11).

Table 3.1.12, which describes O&M force of Nihon Hels Indusry Corp. equivalent to Kim Lien WWTP, shows four members. Periodic inspection, maintenance and water examination in Japan is also executed by regional support center, similar to HSDC.

Table 3.1.11 O&M Force of Kim Lien WWTP

Position	No. (person)	Remarks
1.Permanent Staff		
Water Quality	1	
O/M	20	4 groups, 5 persons per group, 3 work sift, including monitoring service
Other	0	Simple testing at sitte for WWTP operation
Total	21	
2.Supporting Staff at Head Office		
Water Quality	5	Laboratory at HSDC Head Quarter
O/M	5	Peridical testing and large scale repair
Other	15	Administrative role for all WWTPs
Total	25	

Table 3.1.12 O&M Force of Kim Lien WWTP Compared with Same Facility in Japan

Item	Kim Lien	Experiences of HELS for WWTP Operation (4,000~6,000m^3/day) 2)			
		A WWTP	B WWTP	CWWTP	D WWTP
Staffs (person)	21	4	2	4	4

1)24hours operation
2)Automatic operation for night time and week end

Kim Lien WWTP employs more operators since monitoring and controlling facilities involve 24 hour on-site operation. During the 24 hour on-site operation, SCADA system can be shifted to automatic control at night time while monitoring the adjacent WWTP. And sludge dewatering can also be renovated to day time operation through efficient operation of dewatering machine. These renovation and automation will reduce O&M staffing.

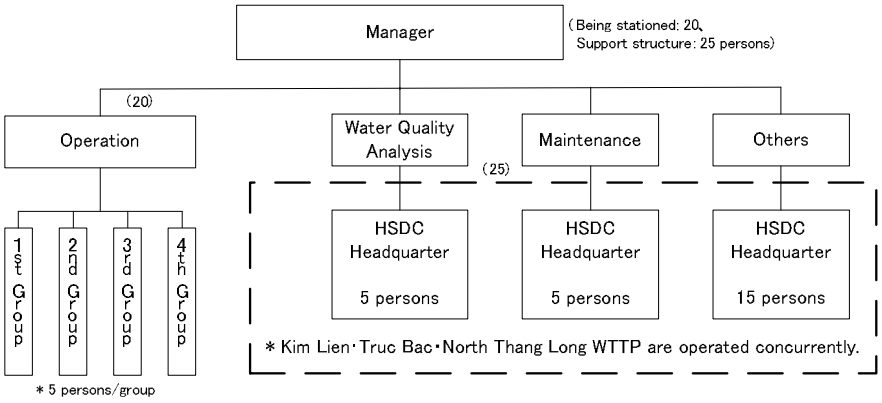


Figure 3.1.12 O&M Organization Structure of Kim Lien WWTP

3) O&M condition

Water quality of inflow is 150 mg/L of BOD (lower than 250 mg/L of design value) and 200 mg/L of SS (same as design value). Effluent quality is sufficiently below than the effluent standard and complies with Class B standard.

Water examination result detects BOD and SS removal and nitrification, but not nitrogen removal. Nitrification and denitrification is not to carried out, because of temporary load increase, as it was scheduled during the Teto (Vietnamese New Year Day). O&M organization should consider emergency events by developing a manual for load/flow fluctuation.

Table 3.1.13 Water Quality of Kim Lien WWTP

Category		BOD (mg/L)	SS (mg/L)	Remarks
Influent	Design	250	200	
	Actual	150	200	
Effluent	Design	30 (50)	60 (100)	( ): TCVN 5945-2005 Class B
	Actual	<30	<60	Result of hearing survey

Reactor is operated well through the operation indicator of DO (2-3 mg/L), using a sensor in the reactor. Phosphorus removal is processed biologically together with chemical precipitation. Disinfection is dosed with chlorine tablet although chlorination chamber is already installed. Residual chlorine and perfect chlorine-contact are detected.

Figure 3.1.13 Disinfection of Chlorine Tablet

Sewer in Kim Lien District is designed and constructed as a separate sewer system. Considerable storm water inflow increases during storm events due to cross connection, and excess flow is discharged from equalization tank by bypassing the sedimentation-reaction tank. Storm water inflow (SSO) cause serious damage to water treatment performance and cost, therefore, existing collection system should be installed with storm water pipe and modified to be a separate system.

Sludge is dewatered by belt press filter. Filter cloth lasts only one year. Its durability however could be improved through acid cleansing. Maintenance plan is provided in accordance with the O&M manual submitted by the contractor. Inspection and maintenance executed periodically by supporting staffs. Related activities include checking oil and grease, and repairing/replacing expendables.

Periodic inspection of electric equipment is outsourced once per month as mandated by the Municipal Government Decree, superseding the six-month frequency

regulated by the National Government.

Table 3.1.14 shows the amount and purchasing procedure and duration of principal utilities. Principal expendables include activated carbon for deodorization and carrier of reactor. Activated carbon is purchased locally every six months while carrier is imported periodically.

Table 3.1.14 Consumption Rate and Purchasing of Principle Utilities in Kim Lien WWTP

Item	Use	Consumprtion	Procurement	Remarks
Electricity	Operation	3,700 k Wh/day		
Chlorine (solid)	Disinfection	N/A	3days	via local market
Sodium Hyrochlorite	Disinfection pH control	600L/day	3days	via local market
FeCl3	Phosphorus removal	200kg/day	3days	via local market
Polymer	Sludge treatment	9kg/day	3days	via local market (import goods)
Consumable (domestic)	O/M	-	1week	via local market
Consumable (import)	O/M	-	3months	via local agent

3.1.2 O&M Issues

(1) Number of Manpower

North Than Long WWTP and Kim Lien WWTP engage more manpower than Nihon Hels Industry Corp. Personnel costs do not affect O&M expenses since it is less costly at present. As prices and personnel costs increase, this is expected to eventually affect O&M expenses seriously. It is important that proper arrangement of manpower is considered at the initial stage to contribute to efficient utilization of future personnel cost.

Causes of large manpower are as follows:

- Kim Lien WWTP is not equipped with central monitoring system and control facilities, and is operated using on-site manual control.
- North Thang Long WWTP engages number of operators based on planned treatment capacity, in spite that present inflow rate is only 10% of the treatment capacity.
- Automatic control is not activated at night time, weekends and holidays. Automation through monitoring and control system is not studied sufficiently.

Simplifying O&M organization requires installation of central monitoring control facility at Kim Lien WWTP and Truc Bac WWTP. Integrated control center monitors and controls all WWTPs including North Thang Long WWTP (Refer Section3.2.1 Introducing integrated monitoring and control system).

(2) Inflow Related Issues

1) Low flow rate of North Thang Long WWTP

Flow rate of North Thang Long WWTP is low due to delayed sewer construction. Projects such as housing construction and urban development may affect wastewater flow rate. If sewerage construction will not progress, sewerage planning shall be reviewed effectively including activities such as collecting wastewater of out of present service area. Low flow rate involves difficult treatment operation and causes equipments to degrade.

Standby equipments must be maintained until design inflow rate is produced and all facilities are operational. O&M plan should be in accordance with sewerage development program. HSDC understands this issue and requested the contractor to submit revised O&M manual. HSDC then amended the O&M procedures based on the revised manual. Said manual should be provided based on equipment specifications to prevent degradation of equipment.

2) Storm water inflow of Kim Lien WWTP

Although Kim Lien treatment area is constructed as a separate sewer system, flow rate during storm events increases significantly. Storm water infiltration not only affects water treatment performance such as flow rate and quality of effluent, but discharges SSO that exceeds treatment capacity and pollutes receiving river water. Inspection and fixing of existing sewer are necessary. It is important to provide mapping/ledger system for O&M of sewer network, as this will facilitate sewer inspection contributes to efficient O&M in the future.

(3) General-purpose Equipment

Almost all equipments are imported and some of its specifications are not locally available. Delivery date and price of parts affect O&M performance. When equipment needs to be replaced, it is recommended to select a general-purpose equipment locally available, for sustainable operation.

(4) Degradation Counter Measure

Since Kim Lien WWTP has been operational for four years, many of its facilities and equipments have degraded. In view points of stock (asset) management, appropriate counter measure for degradation is important through overhaul inspection which will detect facilities that need to be fixed or corrected. Overhaul will prevent equipment from possible failure and reduce life-cycle-cost of the facility.

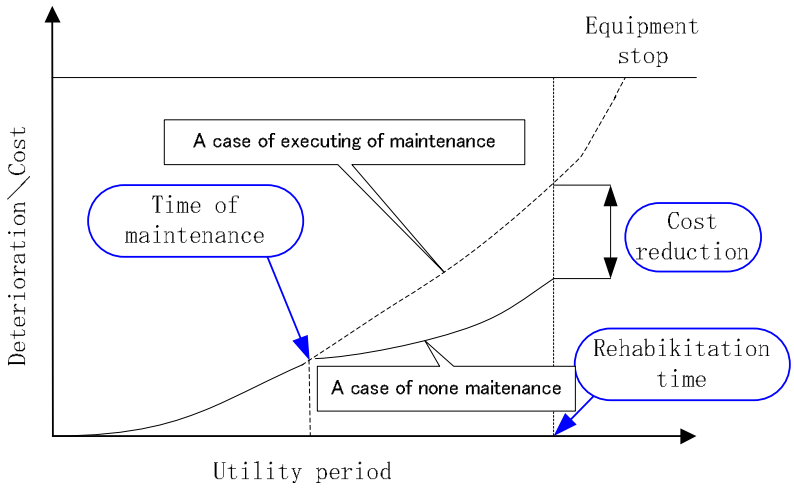


Figure 3.1.14 Cost Reduction through Preventive Maintenance

(5) Training on O&M

O&M staffs seem to execute inspection and maintenance based on O&M manual procedure.

Experience of Nihon Hels Industry Inc. reveals that skills of O&M staff not only contributes to cost reduction but also maintains proper functions of facilities. Hence, continuous training of O&M staffs is important.

Professional training and enhancement of motivation contribute to sustainable and effective O&M by providing training program related to rigorous tasks in wastewater management.

Example of O&M training program is described as follows:

Table 3.1.15 Example of O&M Training Program

Group	Role	Subject and O&M training program
Administrator	Administration	- Sewerage development program - Providing O&M organization - Risk management for personnel & facility - Personnel management, Financial administration - Comprehensive O&M management plan - Inspection on relevant industry
Manager	Professional engineers providing direction to staff	- Operation program & process management - Providing O&M manual - O&M manner - Technical training - Routine job manner, safety management, health management - Routine management, risk management - Report, record, data processing - OJT program, OJT training

Group	Role	Subject and O&M training program
Staff	Routine work	- Routine job manner, safety management, health management - Routine management, risk management - Report, record, data processing
Common	―	- Facility information(treatment process, control system, information system) - Performance of facility & equipment - Safety & health related - Design criteria(Facility capacity, structural information, water level, equipment performance) - Laws relevant to water business - Information on relevant industry

3.1.3 Sewerage in Ho Chi Minh

(1) Outline

Sewer system in Ho Chi Minh was constructed in 1870s for storm water drainage, and covers 50% of the urban area. Wastewater is discharged from 95 outlets. Interceptor and Binh Hung WWTP (with treatment capacity of 141,000 m3/day) have been constructed in February 2009 through the Environment Sanitation Improvement Project. Ben Nge Canal and Ta Phu Canal will be improved since wastewater is intercepted and treated where canals flow through districts of 1, 2, 4, 6 and 8 wards. Binh Hung WWTP is implementing an expansion project, to increase treatment capacity to 512,000 m^3/day, which is 3.6 times the present capacity 141,000m3/day.

Figure 3.1.15 Binh Hung WWTP

Figure 3. 1.16 Den Canal

Figure 3.1.17 Binh Hung Hwa WWTP

Binh Hung Hwa WWTP which adopts lagoon process to produce a treatment capacity of 30,000 m^3/day, is financed by Belgium and started its operation in 2006. This WWTP intercepts and treats wastewater from Den Canal. Domestic wastewater from the surrounding housing area where the population is estimated to be around 120,000 and industrial wastewater from about 40 factories are discharged into the canal. Den Canal produces offensive odor, and thus sewer construction project will be necessary for public service of water environment, ground water conservation and human waste treatment. Treatment capacity of two WWTPs in Ho Chi Minh City amounts to 171,000 m^3/day and serve a population of 485,000. Sewerage service ratio is equivalent to 7.7% considering

6,240,000 total population. Sewerage project including Binh Hung WWTP expansion project aims to serve more than 80% of the population by 2020.

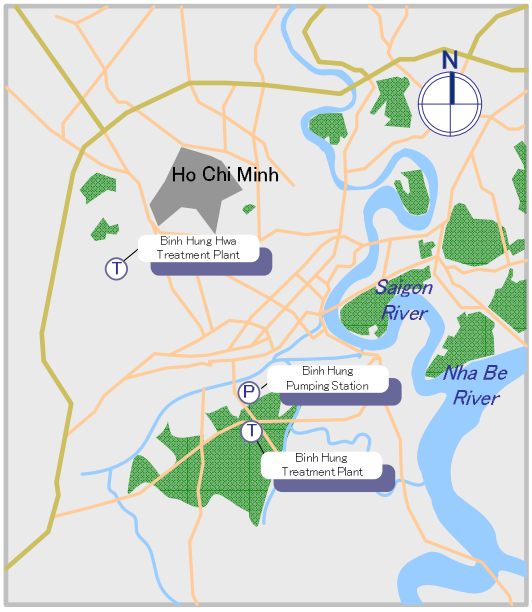


Figure 3.1.18 WWTP in Ho Chi Minh City

(2) Sewerage Tariff Structure and Collection

Saigon Water Company (SAWACO) bills and collects wastewater charges as part of the water supply charge. The collected wastewater charges are paid to the People's Committee of Ho Chi Minh City. Said charge is levied around 12% of the water supply charge. In case of household (4 m^3/member/month), wastewater charge is 300 VND/m^3. Water supply tariff of Ho Chi Minh City is shown Table 3.1.15.

Urban Drainage Company Ho Chi Minh City (UDC), which is responsible for sewerage facilities, acknowledges that present tariff rate is lower than the living standard of the public, and is thus too low to efficiently operate and expand the facilities. UDC initially intends to implement tariff system and simultaneously review financial plan including tariff increase.

Table 3.1.16 Tariff Structure of Water Supply, Ho Chi Minh City

Category	Old (1999)	Current (2004)
	(VND/m^3)	
Domestic		
less than 4m^3/inhabitant/month	1,300	2,700
4 ~ 6m^3/inhabitant/month	2,100	5,400
more than 6m^3/inhabitant/month	—	8,000
Industry	3,100	4,500
Public Sector	—	6,000
Commercial		
less than 8m^3/month	5,200	8,000
more than 8m^3/month	8,700	

(3) O&M Condition

1) Bin Hung WWTP

a) Outline of facility

Binh Hung WWTP has a treatment capacity of 141,000 m^3/day as shown in Table 3.1.16. It adopts modified aeration process, which will be upgraded to conventional activated sludge process during the phase-3 project. Treatment flow rate and expansion program are described in Figure 3.1.19 and Table 3.1.17, respectively. Treatment capacity will increase to 512,000 m^3/day by 2020.

One relay pumping station equipped with grid chamber is installed. Treatment process consists of lift pump, primary sedimentation, reactor, secondary sedimentation and disinfection. Sludge treatment process involves thickening (gravity and centrifugal thickener), mechanical dewatering and composting, in which rice husk is dosed as bulking agent.

As composting is disadvantageous considering related purchase costs, amount of rice husk and O&M cost of composting facilities, alternative study on sludge treatment is being considered (refer to Section 3.2.2 O&M Proposal on WWTP of Ho Chi Minh City).

WWTP which was planned to be operational in February 2009, is still undergoing commissioning tests. O&M will be committed to a private company.

Table 3.1.17 Outline of Bin Hung WWTP

Item	Value	Remarks
Operation start	February 2009	Committed to private company
Treatment capacity	141,000m^3/day	Raise to 512,000m^3/day in future
Present inflow rate	30,000m^3/day (February 2009)	70,000m^3/day (Expected in July 2009)

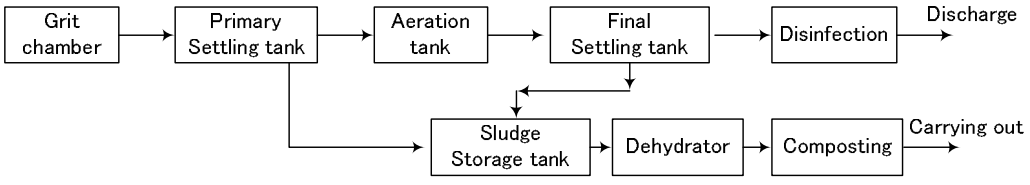


Figure 3.1.19 Binh Hung WWTP Treatment Flow

Table 3.1.18 Binh Hung WWTP Construction Program

Phase	Target Year[1)]	Treatment capacity	Design quality
Phase-1	2005	141,000m3/day	BOD：50mg/L、SS：100 mg/L
Phase-2	2010	469,000m3/day	BOD：50mg/L、SS：100 mg/L
Phase-3	2020	512,000m3/day	BOD：20mg/L、SS：50 mg/L

[1)] Target year is implementation program of M/P.

b) O&M organization

O&M organization is being studied further during ongoing commissioning tests. Study team proposes the O&M organization shown in Figure 3.1.20. Relevant details are described in clause 3.2.2

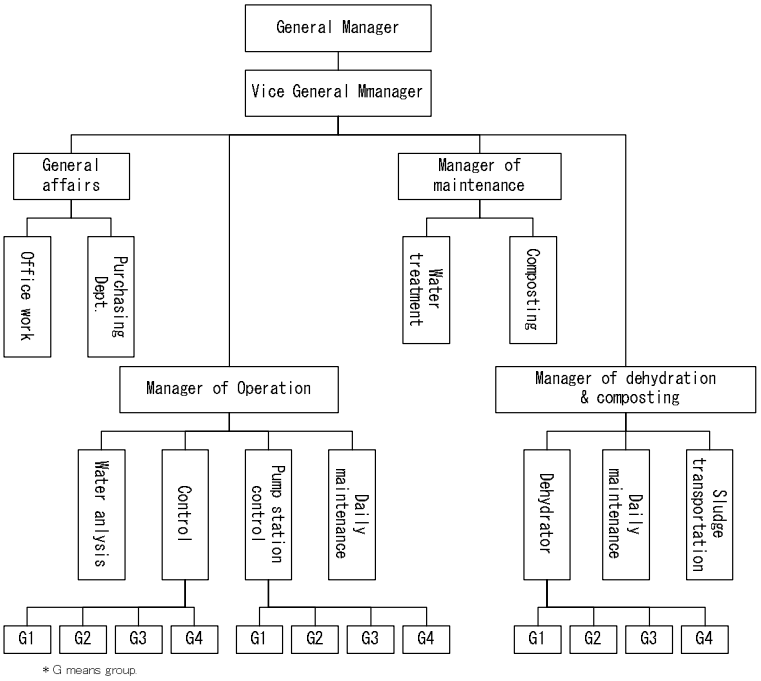


Figure 3.1.20 Proposed O&M Organization

c) Outline of O&M

Wastewater inflow rate on February 2009 is 30,000 m^3/day and is expected to gradually increase to 70,000 m^3 by July 2009. BOD concentration is 50 mg/L and lower than 163 mg/L of design value. This is equivalent to 1,500 kg-BOD/day or 6.4% of 23,265 kg-BOD/day design load. Low rate load operation is executed because commissioning test is being done to the whole ten trains. Operation is recommended for facilities and trains in accordance with the actual flow rate and load even during commissioning, since the provided O&M plan is intended to detect original performance.

If low inflow load continues, it is important to provide proper O&M plan in accordance with actual flow rate and load. Treatment performance only of primary sedimentation and disinfection can attain effluent standard as far present inflow rate continues. O&M plan is to be scrutinized comprehensively in view points of actual flow rate and load.

Table 3.1.19 Inflow Load of Binh Hung WWTP

Category		BOD	SS	Remarks
		(mg/L)		
Influent	Design	163	163	
	Actual	< 50	-	
Effluent	Design	50	100	( ): TCVN 5945-2005 class B
	Actual	12	45	Result of hearing survey

Desludging and sludge treatment are not executed properly, therefore, putrefaction leads to sludge thickening. Influent flow concentration on distribution tank of primary sedimentation is 270 mg/L of COD_{Mn} (analyzed by Pack Test), which is extensively high and affected by the return flow of sludge treatment. When inflow rate is low at the start of the operation, putrefaction due to intermittent dewatering operation is prevented, resulting in corrosion and low dewatering performance. These low performance and facility degradation will be recovered according to flow rate increase, proper sludge thickening and, dewatering operation.

Commissioning test is executed in accordance with the O&M manual submitted by contractor. Lift pump, blower and centrifugal dewatering machine will be transported to Japan for overhaul operations of 5 to 10 years interval. Inspection and maintenance will take around six months. Since facility database is not introduced, information is limited to determine the machinery condition. Through the facility information data-base, it is important to provide inspection and maintenance plan in order to propely operate and maintain the facilities. Overhaul of principal equipment in Japan require transport costs. Therefore, it is important to provide elaborated preventative maintenance plan which can prolong overhaul intervals.

Table 3.1.20 shows utility consumption rates for the present inflow rate. Each vale is estimated since there are no data that excludes electricity consumption. Rice husks with specific gravity of 0.1 as bulking agent for composting is notable since 20 to 40 trucks (20 tons) are needed to provide 30,000 m^3/day inflow rate. Meanwhile, inflow rate of 141,000 m^3/day requires around 140 trucks of rice husks. Collection and transportation of rice husks is a burden, hence, proper purchasing plan is indispensable.

Table 3.1.20 Utility Consumption Rate of Binh Hung WWTP (for 30,000m^3/day of inflow rate)

Utility	Consumption rate	Remarks
Electricity	13,000kWh/day	Actual flow rate for 30,000m^3/day
Sodium hypochlorite	500L/day	Estimated for 30,000m^3/day
Polymer (Sludge dewatering)	45-90kg/day	Estimated for 30,000m^3/day Fluctuated by SS inflow load rate
Rice husks（Composting）	40～80 m^3/day	Estimated for 30,000m^3/day Fluctuated by SS inflow load rate

Relay pumping station is located at 3.5 km from WWTP. As remote monitoring and control is not executed from WWTP, on-site O&M organization is provided for emergency. O&M information is conveyed via telecommunication. However, continuous monitoring and control such as SCADA is more desirable for emergency situations.

2) Binh Hung Hwa WWTP

Binh Hung Hwa WWTP applies aerated lagoon process, which treats wastewater flow in Den Canal. This WWTP was financed by Belgium and started operation on March 2006. Its treatment capacity is 30,000 m^3/day and presently treats 26,000 m^3/day. Treated effluent is reclaimed to Den Canal and prevents pollution in the canal.

Figure 3.1.21 Outline of WWTP

Figure 3.1.22 Inlet and Screenings

Treatment flow is shown in Figure 3.1.22. Effluent quality of BOD is around 8 mg/L stably.

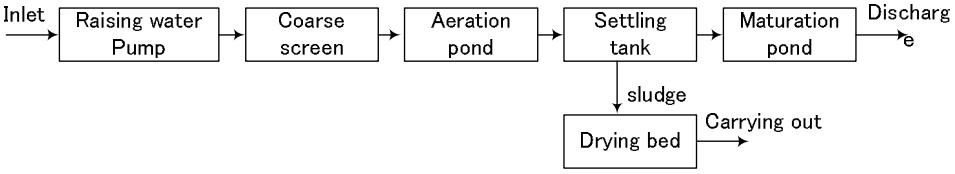


Figure 3.1.23 Treatment Flow of Binh Hung Hwa WWTP

Figure 3.1.24 Surface Aerator

Figure 3.1.25 Grit Chamber and Inspection

O&M force consists of 25 staffs including eight staff performing patrols. The coverage area of served residents adjacent to WWTP site is broad. Therefore, patrol staffing ensures that accidents due to illegal invaders are avoided during the 24-hour operation.

Regarding laboratory, five staffs seem excessive considering that water quality is analyzed only for the water treatment facility operation. This number could therefore be reduced.

Table 3.1.21 O&M Staffing of Binh Hung Hwa WWTP

Category	Staff (person)	Remark	
		Present	Proosal
Manager	1		
O/M	8	4 group, 2 staffs per group, 3shift	4 group, 1 staff per group, 3shift, 2staffs for daytimeoperation (-2)
Water quality	5		3 staffs (-2)
Administration	3		2 staffs (-1)
Security	8	4 group, 2 staffs per group, 3shift	
Total	25		-5 staffs

Electricity consumption is 7,800 kWh/day at present. This is equivalent to 0.3 kWh/m^3 of energy saving treatment process. Disinfection utilizes sunlight (ultra violet rays) which does not require chemical agents. Drying bed process is adopted for sludge treatment. Dewatered sludge is then distributed to farmers. This process consumes no chemical and low O&M cost.

Mechanical aerator is frequently out of order and corresponding repair is executed on-site. All parts are imported and delivery of purchased items takes more than 20 days from order date.

3) Tan Quiy Dong Pilot Plant

Treatment capacity is suitable for 4,000 households at a rate of 500 m^3/day. This WWTP applies contact aeration process as small scale treatment, financed by Taiwan. Actual inflow rate is around 500 m^3/day. Shifts of tow staffs of operator and guardsman are utilized for operation.

Figure 3.1.26 Reactor

Blower operates for 24 hrs and air is deduced in the front chamber of reactor for

nitrogen removal. Sludge is removed once every 18 months.

Closed type facility is difficult to inspect and maintain. Treatment performance for this is not considerable. During proposed sewerage development, it is recommended to abandon the plant and replace the pumping station of Binh Hung WWTP.

(4) Issues on O&M

1) Binh Hung WWTP

a) Wastewater inflow

Actual wastewater inflow rate is around 21% of design inflow rate or 30,000 m^3/day. The combined wastewater is 50% of the design BOD value. It is expected to increase to 70,000 m^3/day by July and 140,000 m^3/day by October 2009. BOD concentration will be lower than the design value. It means that since activated sludge control is difficult, it is recommended that the manner of O&M should be intended to reduce the number of operating aeration tank.

Inflow rate and BOD and SS concentration will be low. Thus, phase 2 project with treatment plant expansion should consider the difference between actual pollution load and the design facility load. In case low BOD value continues, alternative solution should be initiated to reduce the number of aeration tank on operation. It is also recommended to construct only sedimentation tanks which operate on surface loading rate.

b) O&M of relay pumping station

Relay pumping station located around 3.5 km from WWTP, involves 24 hour on-site O&M activities. Night time operation excluding at storm events is possible by remote-control of WWTP. In case pump malfunctions, WWTP dispatches O&M staff. Remote monitoring items are shown in Table 3.1.21. Such remote monitoring and control system contributes to O&M cost reduction through automatic operation at night time and on-site operator at day-time, engaged in routine works for adjusting and maintaining equipments.

Table 3.1.22 Remote Monitoring Items of Binh Hung Pumping Station (Draft)

Item	Monitoring job
Water level sensor of inlet	Monitoring water level
Emergency gate	Closing gate
Pump	Monitoring of on/off and failure
Water level sensor of pump pit	Monitoring water level
Electricity failure	Monitoring failure

c) Operation of composting facility

Rice husk is used as bulking agent for the composting facility. This method is disadvantageous as it requires purchasing of husk which is an additional cost, and the difficulty in marketing of composted product. WWTPs in Japan have abandoned such composting facility because of poor demand of composted product. Marketing of product and purchasing bulking agent affect the performance of the composting facility. It is important to provide an O&M plan related to appraising the marketing and operation cost affordability. Relevant details are presented in clause 3.2.2）.

2) Binh Hung Hwa WWTP

There is no issue on water quality control and O&M of facilities in Binh Hung Hwa WWTP. Its staffing can be reduced since routine work is limited to ensuring security, cleaning and mowing. O&M of facilities and water quality examination can be committed to Binh Hung WWTP as control center. Integrated O&M system with Binh Hung, which is starting its operation, contributes to O&M cost reduction.

3.1.4 Thang Long Industrial Park WWTP

(1) Outline of Facility

North Thang Long-Van Tri District is proposed to be the new city center based on comprehensive amendment of Master Plan of Hanoi City for year 2020. This was approved by the National Government in 1996. This district has been developing its infrastructures such as highways, water supply and sewerage, and power supply through Japanese ODA project of Hanoi Urban Infrastructure Development.

Thang Long Industrial Park was developed as principal infrastructure for urban development on February 1997. Its area is 274 ha and accommodates around 85 companies. Number of workers is 40,000 as of January 2009, and its export products reached 2.85 billion USD, which shares 4.6% of the whole Vietnam.

Figure 3.1.27 Thang Long Industrial Park

Figure 3.1.28 MBR Reactor Tank

Industrial water supply plant and wastewater treatment plant are operating in the industrial park. Extended aeration process was applied at beginning. Membrane Bio

Reactor (MBR) was installed when T-N effluent standard was regulated in 2008 as shown in Figure 3.1.28.

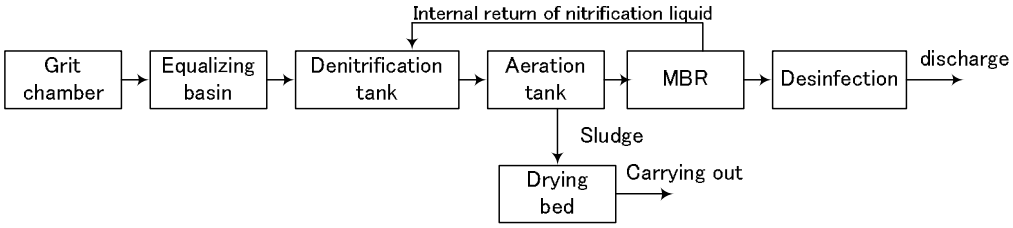


Figure 3.1.29 Treatment Flow of Thang Long Industrial Park WWTP

Table 3.1.23 Outline of Thang Long Industrial Park WWTP

Item	Specification	Remarks
Operation Start	1997 Feb	MBR was installed in Oct 2008
Treatment Method	MBR	Conventional Activated Sludge in original was decomissioned.
Treatment Capacity	3,000m^3/day	7,000m3/day in original, 4,000m3/day conveyed to North Thanh Long WWTP at present
Current Inflow Rate	2,500m^3/day	Decrease due to lowered factory operation rate
O/M body	TLIP	O/M including WTP for industry water supply

(2) O&M Organization

Industrial water supply and WWTP are operated by a single organization, which seems efficient. Three shifts of four groups of staff execute routine works. Only one staff is designated in the laboratory to ensure water quality of facility operation. Legally required examination is outsourced to authorized institution.

O&M section of the industrial park infrastructure facilities executes periodic inspection and minor repairs. This initiates efficient operation performance.

Table 3.1.24 Staffing of Thang Long Industrial Park WWTP

Position	No. (person)	Remarks
1.Permanent Staff		
Water Quality	1	
O/M	4	4 groups, 1 person per group, 3 work sift, including WTP
Other	1	Legal test is outsoourced.
Total	6	
2.Supporting Staff at Head Office		
General Affair	2	including WTP
O/M	—	

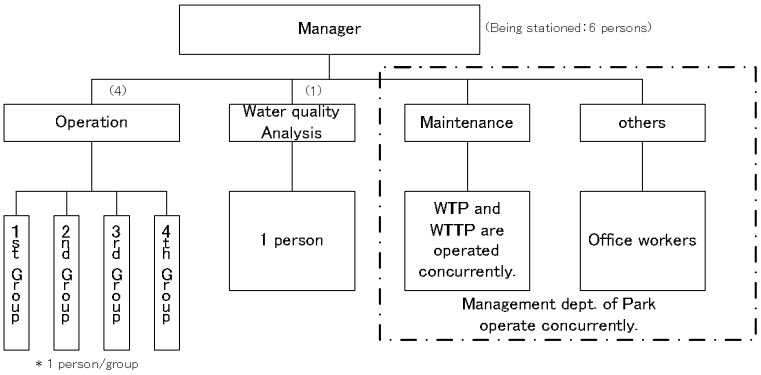


Figure 3.1.30 O&M Organization of Thang Long Industrial Park WWTP

(3) O&M Situation

Inflow water qualities shown in Table 3.1.24 indicate 100 mg/L of BOD and SS concentration. These levels are lower than design value of 300 mg/L and 200 mg/L, respectively. The industrial park regulates discharge standard to sewerage, which is stipulated in tenants' contracts. Quality of inflow sometimes varies.

Effluent quality complies with the standard 30 mg/L BOD and 50 mg/L SS. Regarding T-N standard of 15 mg/L, O&M staffs lack experience in performing nitrogen removal treatment process.

Table 3.1.25 Water Quality of Thang Long Industrial Park WWTP

Category		BOD	SS	T-N	Remarks
		(mg/L)			
Influent	Design	300	200	—	
	Actual	100	100	—	
Effluent	Design	30	50	15	TCV 5945-2005 Class A
	Actual	< 10	< 20	< 15	Result of hearing survey

MBR process is advantageous in compact foot print and well treatment performance, although it requires experience and know-how in operation. Three months experience since the start of operation is insufficient as there has been an incident of failure during the first stage. Anaerobic tank is not properly controlled, consequently producing scum. Detailed O&M manual provided by the contractor is being improved based on practical issues.

Utility consumption is described as follows.

Table 3.1.26 Utility Consumption

Category	Use	Consumption	Unit Prise	Procurement	Remarks
Electricity	Operation	1,000 kWh/day	0.27 US$/kwh		Average cost including base cost
Sodium Hypochlorite	Disinfection	134 L/day	3,000 VND/L	3days	10%, via local market
Consumable (domestic	O/M	N/A	-	1 week	via local market
Consumable (import)	O/M	N/A	-	1 month	via local agent

3.1.5 Effluent Water Quality Standard

Effluent water quality standard is described as follows. Applied quality standard is determined by the formula considering effluent flow rate and receiving water capacity.

$C_{max} = C \times K_q \times K_f$

Where:

C_{max}: Applied quality standard
C: Stipulated standard of TCVN 5945:2005
K_q: Coefficient value of receiving water capacity
K_f: Coefficient value of effluent flow rate

Table 3.1.27 Effluent Water Quality Standard (TCVN 5945-2005)

Effluent water quality standard C value (Table 1)

	Parameter	Unit	Limitation		
			A	B	C
1	Temperature	°C	40	40	45
2	pH	-	6 - 9	5.5 - 9	5 – 9
3	Odor	-			
4	Color	-	20	50	-
5	BOD_5	mg/L	30	50	100
6	COD	mg/L	50	80	400
7	Suspended solids	mg/L	50	100	200
8	Arsenic	mg/L	0.05	0.1	0.5
9	Mercury	mg/L	0.005	0.01	0.5
10	Lead	mg/L	0.1	0.5	1.0
11	Cadmium	mg/L	0.005	0.01	0.5
12	Chromium (VI)	mg/L	0.05	0.1	0.5
13	Chromium (III)	mg/L	0.2	1	2
14	Copper	mg/L	2	2	5
15	Zinc	mg/L	3	3	5
16	Nickel	mg/L	0.2	0.5	2
17	Manganese	mg/L	0.5	1	5
18	Iron	mg/L	1	5	10
19	Tin	mg/L	0.2	1	5
20	Cyanide	mg/L	0.07	0.10	0.20
21	Phenol	mg/L	0.1	0.5	1
22	Mineral oil and grease	mg/L	5	5	10
23	Animal-vegetable fat and oil	mg/L	10	20	30
24	Residual chlorine	mg/L	1	2	-
25	PCBs	mg/L	0.003	0.01	-
26	Organic phosphorous	mg/L	0.3	1	-
27	Organic Chloride	mg/L	0.1	0.1	-
28	Sulfide	mg/L	0.2	0.5	1
29	Fluoride	mg/L	5	10	15
30	Chlorine	mg/L	500	600	1000
31	Ammonia (as N)	mg/L	5	10	15
32	Total nitrogen	mg/L	15	30	60
33	Total phosphorous	mg/L	4	6	8
34	Coliform	MPN/100m	3000	5000	-
35	Bioassay	-	90 % fish can stay alive in water for 96 hours		
36	Gross α activity	Bq/l	0.1	0.1	-
37	Gross β activity	Bq/l	1.0	1.0	-

Class A: Receiving water for water supply use
Class B: Receiving water for navigation, irrigation, bathing and aqua culture
Class C: Specific receiving water approved by authority agency

K_q coefficient value of river water (Table 1B)

Stream flow of river receiving waste water Unit: m^3/s	K_q coefficient value
Q=<50	0.9
50<Q=<200	1
Q>200	1.1

K_q coefficient value of lake water (Table 2B)

Lake capacity receiving waste water Unit: 10^6m^3	K_f coefficient's value
V=<10	0.6
10<V=<100	0.8
V>100	1.0

K_q coefficient vale of effluent flow rate (Table 3B)

Waste water flow Unit: $m^3/24h$	K_f coefficient value
F=<50	1.2
50<F=<500	1.1
500<F=<5000	1.0
F>5000	0.9

3.1.6 Monthly Household Expenditure Survey

Monthly household expenditure survey was conducted to grasp the affordability of wastewater charges in the both Hanoi and Ho Chi Minh. Said survey is conducted through face to face interviews with each sample household. Prior to the survey, the Study Team had a meeting with related organizations such as Hanoi Sewerage and Drainage Project Management Board (HSDPMB) and Ho Chi Minh Urban Drainage Company (HCMUDC) to obtain approval, identify selected survey area and request for support. Outline of the survey is summarized in the table below.

Table 3.1.28 Outline of Monthly Household Expenditure Survey

City Name	Hanoi	Ho Chi Min
Survey Period	2 March ~ 6 March, 2009 (5 days)	23 February ~ 27 February, 2009 (5 days)
Survey Area	Tan Mai Ward, Hoang Mai District	Ward No. 5, Go Vap District
Survey Method	Social Survey Expert: 1 Assistant Surveyor: 1 Interview to each sample household	Social Survey Expert: 1 Assistant Surveyor: 1 Interview to each sample household
No. of Sample	15	15
Effective Answer	15 (100%)	15 (100%)

According to the survey plan, 15 sample house holds were selected and divided into three income groups, namely, low, middle and high, in each city. Finally the number of samples determined is 30. Categorization of each group was decided with reference to the previous social survey in Hanoi, 2008, as shown in the following table.

Table 3.1.29 Categorization of Income Group

Income Level	Monthly Household Income	Ratio (Survey in Hanoi, 2008)
Low (L)	2millionVND or less	28%
Middle (M)	2million VND ~ 5million VND	38%
High (H)	5million VND or more	34%

The willingness to pay for the sewerage works was also asked to each sample households. The result of the survey is summarized in the following table.

Table 3.1.30 Result of the Survey

(Unit: VND)

Income Level		Result of Hearing Survey												
		Monthly HH Income	1 Basic Foodstuffs	2 Housing and Household	3 Fuels and Transportatio	4 Public Service (Ele	5 Non-consumables	6 Alchol, Tobbaco, etc	7 Clothing and Foot Ware	8 Education	9 Health	10 Recreation and Culture	11 Others	Wilingness to Pay
Low	Max	2,300,000	1,500,000	0	300,000	540,000	0	100,000	40,000	800,000	300,000	0	320,000	6,000
	Min	600,000	300,000	0	0	40,000	0	0	0	0	0	0	0	0
	Average	1,540,000	955,000	0	66,000	167,500	0	12,000	10,500	150,000	78,000	0	134,000	1,900
Middle	Max	4,900,000	2,500,000	0	760,000	700,000	100,000	450,000	150,000	1,200,000	300,000	150,000	1,270,000	30,000
	Min	3,000,000	1,200,000	0	100,000	90,000	0	0	0	0	0	0	0	0
	Average	3,570,000	1,790,000	0	416,000	369,000	10,000	110,000	41,000	404,000	86,000	15,000	244,500	7,800
High	Max	10,000,000	4,000,000	500,000	1,000,000	2,500,000	100,000	1,000,000	500,000	2,000,000	2,000,000	500,000	3,040,000	60,000
	Min	5,800,000	2,000,000	0	120,000	190,000	0	0	0	0	0	0	90,000	4,000
	Average	7,480,000	3,250,000	85,000	507,000	633,000	12,000	330,000	180,000	645,000	336,000	150,000	1,141,500	13,800

Monthly household expenditure in each category is shown in the following figure.

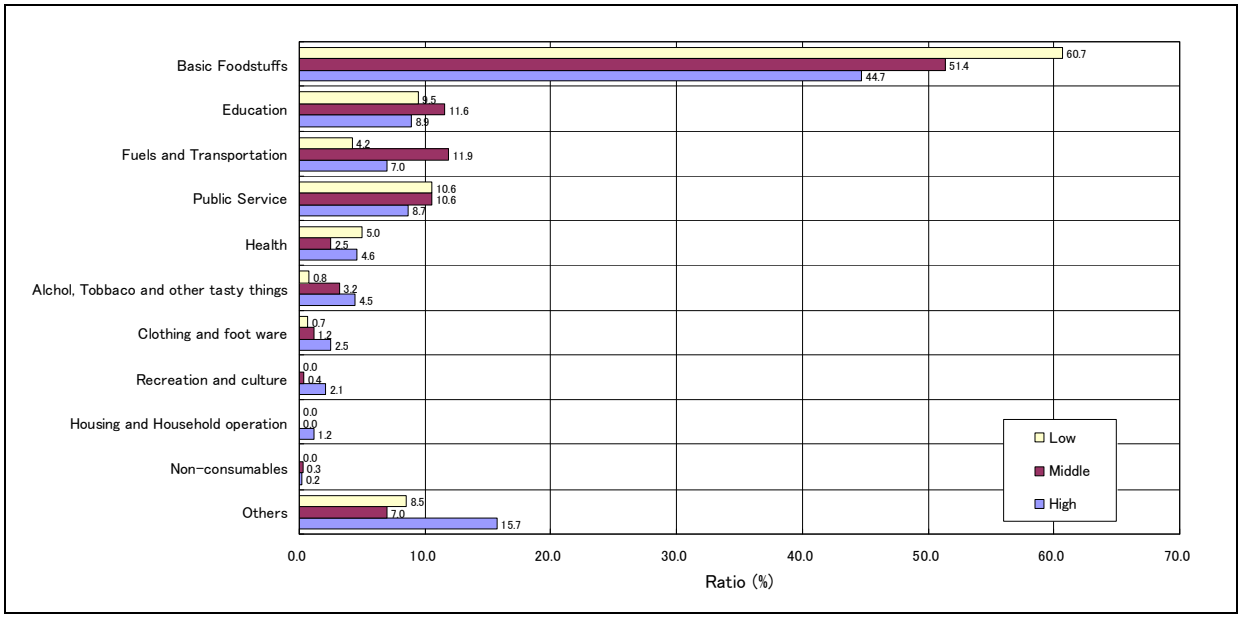


Figure 3.1.31 Monthly Household Expenditure Structure

The findings through the survey are as follows:

i) Expenses for basic food stuffs shares more than 50% in each group. The low income group shares 60% of the monthly expense.

ii) Expenses for public service shares 10% in each group. It was found that 70% of public service expense is normally for the electricity charge and the remaining 30% is for the water charge. Hence, about 3% of the monthly expense is normally spent

for water charge.

iii) Expenses for luxury items and consumable goods are less than 5%.

iv) Expense for education is one of the major items in Vietnam, which shares about 10% of the monthly expenditures.

v) Shares for others items are at 10%. (This lead to the confusion of the interviewees)

vi) Replies regarding willingness to pay are very low, suggesting 0.1-0.2% of monthly expense. It is especially noted that households using their own wells for domestic water use expressed unwillingness to pay for the wastewater tariff, as shown in the following figure.

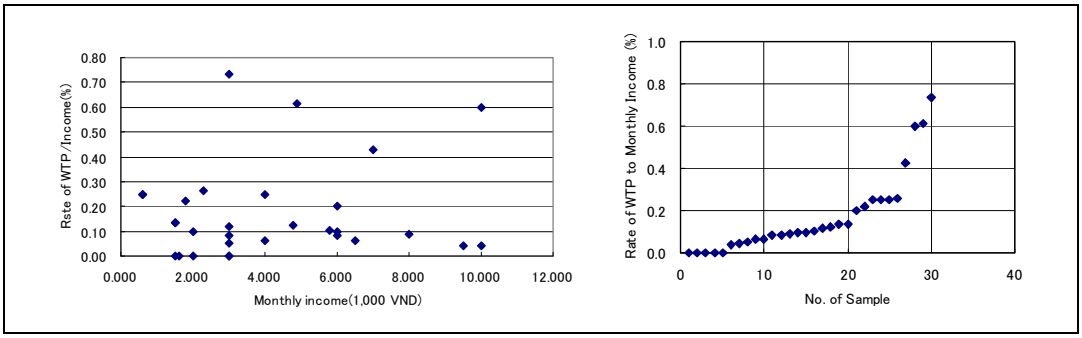


Figure 3.1.32 Willingness to Pay to Wastewater Tariff

According to the survey results, affordability of household is subsequently assumed. At present, wastewater tariff is basically collected at 10% of water charge as the environmental tax is added to the water charges. Hence, the environmental tax is deemed at 0.3% of the monthly expenses. The draft project appraisal manual of the World Bank states that the benchmark to public sanitation sector is at 1% of the consumable household income. In line with this, if additional expense of 0.7% of monthly expense is allocated to the wastewater tariff, benchmark of World Bank is satisfied.

Present public awareness to the sewerage works is quite low. However, some of the sample households expressed higher willingness to pay at 0.6-0.8% of the monthly expenses. Hence, the public sector shall promote public awareness activities for sustainable sewerage works.

3.2 Proposed O&M and Financial Plan

3.2.1 Integrated Remote Monitoring and Control System

(1) Outline of the System

Three WWTPs (Kim Lien, Rruc Bac and North Thang Long) are operating in Hanoi at present and four additional WWTPs are planned to be operated. The O&M staffing of the present WWTPs are excessive as shown in Table 3.2.1. Distribution of staffing is in accordance with the design treatment capacity.

Monitoring staff at night time can be replaced to remote monitoring from the control

center. Remote monitoring and control system requires supporting staff during emergency, and the HSDC has already organized one. It means the smooth introduction of control and monitoring system.

Present O&M methods of Kim Lien and Truc Bac are on-site manual operation and North Thang Long is also operate accessories on-site manual excluding principal equipment. Kim Lien and Truc Bac do not facilitate control center and every facility is manually adjusted because constructed as pilot project.

As each WWTP started operation since 2005, an integrated monitoring system collecting the signals of the main equipment is recommended instead of a total renovation of the plants.

Table 3.2.1 Staffing of WWTP in Hanoi

Category	North TL	Kim Lien	Truc Bach1)	Supporting2)	Total
Manager	1	1	1		3
Operator	28	20	20		68
Maintenance				5	5
Water quality	1	0	0	5	6
Other				15	15
Total	30	21	21	25	97

1) same number as Kim Lien
2) HSDC Headquarter

For sludge treatment, a personnel restructuring to daytime operation only from the present 24-hr shift is also proposed to enable sludge extraction and dewatering to be efficient.

Elements of integrating the existing facilities to the remote monitoring and control system are as follows;

- Control: Pump and influent gate of North Thang Long WWTP
- Monitoring: Signals of on/off and failure of main equipment of each WWTP
- Effluent quality monitoring: To install ultra violet (UV) sensors at the outlet and monitor suspended solids (SS) of effluent flow

Monitoring center will be appropriate to facilitate in North Thang Long WWTP in order to integrate the three existing WWTPs. The operational situation can be monitored everywhere through the internet (refer to Figure 3.2.6). One option for the monitoring station in the HSDC Head Office and North Thang Long WWTP is studied. Additional four WWTPs integrated to remote monitoring/control system will contribute to refine staffing. Storm water pumping and water supply purification plant can also be integrated into the system.

Detailed monitoring and control activities are as follows;

i) Kim Lien and Truc Bac WWTP (refer to Appendix 3)
   - Remote monitoring WWTP and relay pumping station

- Monitoring machinery failure and data acquisition of existing instrumentation facilities
- Monitoring on/off situation and emergency alarm for principal facilities

ii) North Thang Long WWTP

- Existing monitoring items and data acquisition of existing instrumentation facilities
- Monitoring on/off situation and emergency alarm for dewatering facilities
- Controlling inlet gate and lift pump

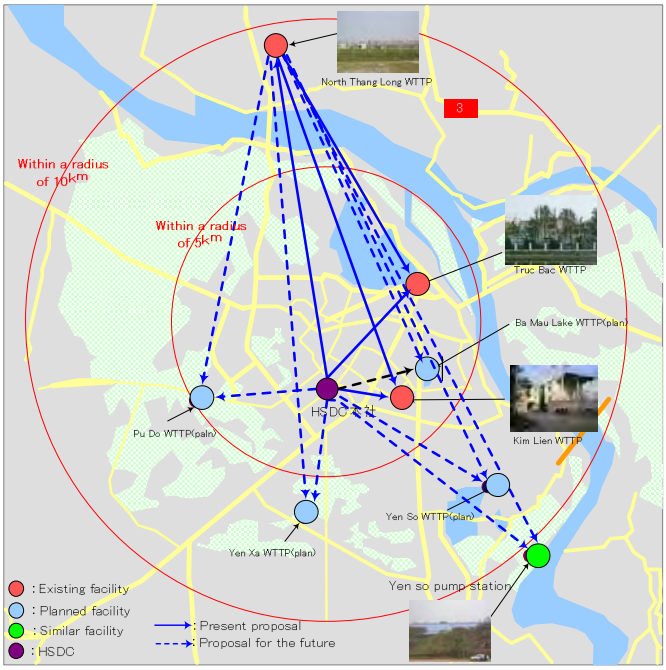


Figure 3.2.1 Concept of the Integrated Monitoring System for the Hanoi Sewerage System

A diagram of the integrated remote monitoring system is shown as follows;

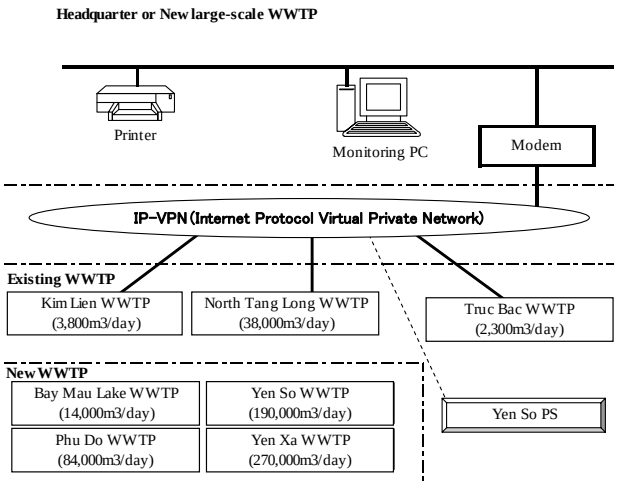


Figure 3.2.2 Diagram of Integrated Remote Monitoring System

The installation cost for the system is around JPY165 million（US$1.65 million), the breakdown of which is presented in Table 3.2.2.

Table 3.2.2 Installation Cost of the Integrated Monitoring System for the Three WWTPs

Item	Cost (JPY)
Central Remote Monitoring System	4,000,000
Monitoring Software	20,000,000
Equipment for Kim Lien WWTP	22,500,000
Equipment for Kim Lien PS	9,000,000
Equipment for Truc Bach WWTP[1)]	22,500,000
Equipment for North Tanh Long WWTP	32,500,000
Installation Cost	27,300,000
General Administration Cost	27,500,000
Total	165,300,000

Note: Allowances for operators are not included.

(2) Advantages of Integrated Remote Monitoring/Control System

O&M staffing of HSDC will be modified through the remote monitoring system as shown in Figure 3.2.3.

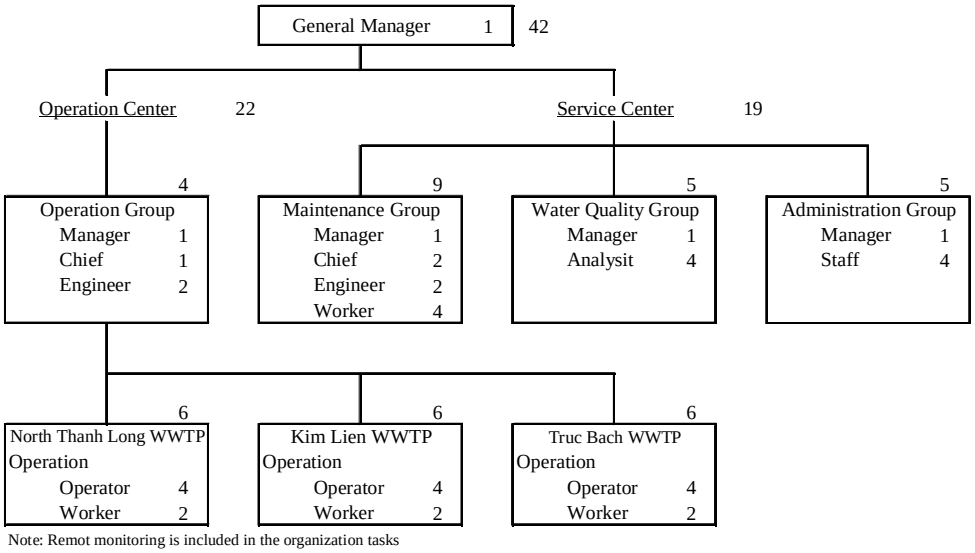


Figure 3.2.3 Draft O&M Organization of Hanoi Sewerage

The General Manager for operation & administration and managers for O&M, water quality management and administration are working in the HSDC Head Office, and service center staffs patrol each WWTP. The Operation Manager supervises the facility operation of the three WWTPs.

Operator of each WWTP is one staff for every 24-hr shift (one staff in four shifts). Therefore, there are four staffs assigned to each WWTP and two workers are assigned for dewatering and patrol, respectively. Staffs of service center are engaged for inspection,

repair, and water quality examination.

Table 3.2.3 shows the advantage of personnel cost reduction through use of an integrated monitoring and control system. As for the ten years life duration, O&M cost reduction is estimated to be 131.47 billion VND（0.8 million USD）. Through the machinery database or information system, a clear maintenance and utility consumption history is created. The information system contributes to undertake preventive repair and planned purchasing. As a result, cost reduction due to the system becomes very significant.

Table 3.2.3 Personnel Cost Reduction Using Integrated Remote Monitoring System

Cost Item	1st yr	2nd yr	3rd yr	4th yr	5th yr	6th yr	7th yr	8th yr	9th yr	10th yr	Total
1 Installation Cost1) （Million VND）	28,928										28,928
2 Reduction amount of Labor Cost （Million VND/year）	2,640	2,904	3,194	3,514	3,865	4,252	4,677	5,145	5,659	6,225	42,075
Economic Impact (2-1)											13,147

3.2.2 O&M Plan (Binh Hung WWTP)

(1) O&M Plan for the Binh Hung WWTP

1) Condition of O&M plan

Although Binh Hung WWTP has a treatment capacity of 141,000 m3/day, the actual inflow rate is 30,000 m3/day and will increase to 70,000 m3/day in July 2009.

As described in Table 3.2.4, nine case conditions were selected for the simulation of the O&M plan. Three cases of wastewater inflow rates, i.e., 70,000 m3/day, 141,000 m3/day and 469,000 m3/day were selected. Water quality parameters of BOD &SS were also selected in three cases of 50% (present value), 75% and 100% of the design value.

For wastewater treatment, five aeration tanks of one train for 70,000 m3/day, 10 aeration tanks of two trains for 141,000 m3/day and 30 aeration tanks for 469,000 m3/day.

As for sludge treatment, the whole sludge processes to composting up to 141,000 m3/day. Composting facility is assumed not to expand and remaining excess sludge is dewatered and disposed without composting. Moreover, cases of composting and sludge dumping without composting are also simulated.

Table 3.2.4 Cases of O&M Plan Simulation

Case	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ	Ⅵ	Ⅶ	Ⅷ	Ⅸ
Inflow rate (m^3/day)	70,000	70,000	70,000	141,000	141,000	141,000	469,000	469,000	469,000
SS/BOD [1)] (Actual/design)	0.5	0.75	1	0.5	0.75	1	0.5	0.75	1
Treatment process	Modified aeration process								
No. of train/tanks	1 train(5 Tanks)			2 trains(10 Tanks)			6 trains(30 Tanks)		
Sludge disposal	Whole composted						Composted + dewatered sludge		

1) Design valueis 163mg/L of BOD and SS.

The O&M organization is described in Table 3.2.5 and Figure 3.2.4.

Table 3.2.5 Major Roles of Staff

Position	Major Role
General Manager	Total management
Deputy General Manager	Support to General Manager
General Affairs	Procurement and general affairs
Operation	Operation and monitoring of treatment plant and pump station
Maintenance	Maintenance of treatment plant and pump station
Dewatering and Compost Operation	Operation of dewatering and compost facilities
Security and Environment	(To be outsourced)

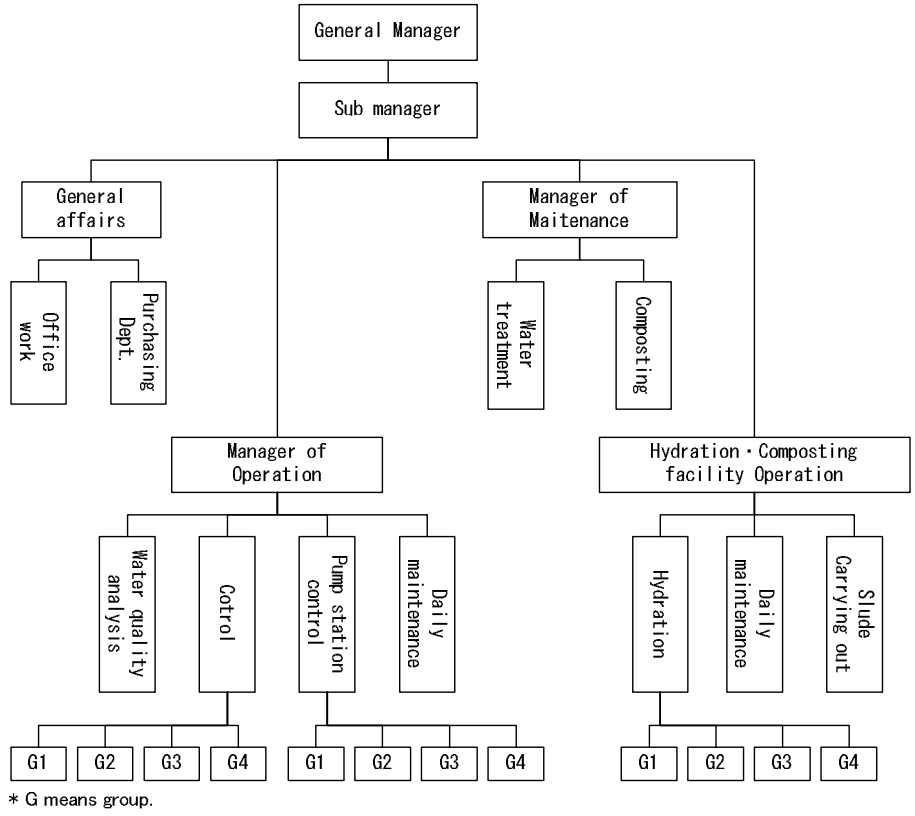


Figure 3.2.4 Proposed O&M Organization Chart

2) Personnel allocation

As shown in Figure 3.2.3 and described in Table 3.2.6, personnel allocation takes into consideration the following conditions:

- Staff in pumping station is replaced to remote monitoring system in WWTP (Additional installation costs of 10 million JPY or 0.1 million US$)
- Inspection and repair is executed by only one group.
- Cleaning and mowing are outsourced because of light duty.
- Water quality examination for operation is executed in-house, but legally required examination is outsourced to authorized institution.
- Whole facility is monitored by the control center.

Table 3.2.6 does not include outsourced personnel, which is calculated in utility or cleaning/mowing cost. The number of O&M staff is estimated to be 40 to 67, although in case of a specified request, O&M force will be increased.

Table 3.2.6 Case Studied O&M Staff Force

No	Position	Job	Case I, II, III		Case IV, V, VI		Case VII, VIII, IX	
			Person	Sub total	Person	Sub total	Person	Sub total
1	General Manager (GM)	Wastewater treatment	1	1	1	1	1	1
2	Deputy GM	Mechanical	1	1	1	1	1	1
3	General Affair	General	1	2	1	2	2	4
		Procurement	1		1		2	
4	Operation	Manager	1	16	1	17	1	21
		Water quality	2		2		4	
		Monitoring and Control	8		8		8	
		Control for PS	4		4		4	
		Daily Inspection	1		2		4	
5	Maintenance	manager	1	5	1	7	1	14
		Wastewater treatment	4		6		13	
		Dewatering and Composting						
6	Operation for dewatering and composting	Manager	1	13	1	20	1	21
		Operation of dewatering	5		8		8	
		Daily Inspection	1		1		2	
		Sludge transportation	6		10		10	
7	Security	Manager	1	5	1	5	1	5
		Guard man	4		4		4	
Total			-	**43**	-	**53**	-	**67**

(2) O&M Cost Estimation for the Binh Hung WWTP

1) O&M Cost Estimation

a) Utility Consumption

Utility consumption rate for each case is presented in Table 3.2.7.

Table 3.2.7 Utility Consumption Rate of Case Study

Category			Case I	Case II	Case III	Case IV	Case V
1	Annual Electricity Consumption	Pump Station (kWh)	1,280,000	1,280,000	1,280,000	2,460,000	2,460,000
		Treatment Plant (kWh)	7,010,000	7,440,000	7,770,000	9,400,000	9,830,000
2	Annual Chemical Consumption	10% Sodium Chlorite (L)[1]	425,900	425,900	425,900	857,800	857,800
		Coagulant (kg)[2]	54,900	89,700	124,600	110,500	180,700
		Rice Husk (m^3)[3]	8,400	13,800	19,200	16,800	27,700
		Fuel (L)	18,200	29,900	41,700	36,500	60,200
Category			Case VI	Case VII	Case VIII	Case IX	
1	Annual Electricity Consumption	Pump Station (kWh)	2,460,000	8,540,000	8,540,000	8,540,000	
		Treatment Plant (kWh)	10,750,000	24,730,000	28,540,000	32,310,000	
2	Annual Chemical Consumption	10% Sodium Chlorite (L)[1]	857,800	2,853,100	2,853,100	2,853,100	
		Coagulant (kg)[2]	251,000	367,300	601,000	834,700	
		Rice Husk (m3)[3]	38,600	38,600	38,600	38,600	
		Fuel (L)	83,900	83,900	83,900	83,900	

1) Conversion ratio of NaOCl: 2.0mg/L
2) Conversion rate of coagulant: 1%
3) Mixture ration of Rice Husk: 22% of sludge weight

Subsequently, the utility cost is estimated as presented in the following table.

Table 3.2.8 Estimated Utility Cost

Category			Case I	Case II	Case III	Case IV	Case V
1	Annual Electricity Cost (Million VND/year)[1]		7,848	7,848	8,145	10,674	11,061
2	Annual Chemical Cost (MVND/year)	10% Sodium Chlorite (L)[2]	1,508	1,508	1,508	3,037	3,037
		Coagulant (kg)[3]	5,929	9,688	13,457	11,934	19,516
		Rice Husk (m^3)[4]	3,917	6,435	8,953	7,834	12,917
		Fuel (L)[5]	200	329	459	402	662
	Sub total		11,554	17,959	24,377	23,206	36,132
Total			19,402	25,807	32,522	33,880	47,193
Category			Case VI	Case VII	Case VIII	Case IX	
1	Annual Electricity Cost (Million VND/year)[1]		11,889	29,943	33,372	36,765	
2	Annual Chemical Cost (MVND/year)	10% Sodium Chlorite (L)[2]	3,037	10,100	10,100	10,100	
		Coagulant (kg)[3]	27,108	39,668	64,908	90,148	
		Rice Husk (m^3)[4]	18,000	18,000	18,000	18,000	
		Fuel (L)[5]	923	923	923	923	
	Sub total		49,068	68,691	93,931	119,170	
Total			60,957	98,634	127,303	155,935	

1) Unit price of electrcity: 900VND/kWh (JETRO, Jan. 2008)
2) Local price: 3,540VND/L
3) Empirical data of HELS: 108,000VND/kg
4) Hearing survey: 466,321VND/m3
5) Local price: 11,000VND/L

b) Treated Sludge and Disposal Cost

Composted product and dewatered sludge is described in Table3.2.9.

Table 3.2.9 Annual Production of Compost and Dewatered Sludge

Category		Case I	Case II	Case III	Case IV	Case V
Sludge generation amoount (Composting + Sludge cake)	Conpost (m^3/day)	45	75	104	91	150
	Sludge cake (t/day)	0	0	0	0	0
	Discharge amount (m^3/year)	16,600	27,300	38,000	33,300	55,000
Category		Case VI	Case VII	Case VIII	Case IX	
Sludge generation amount (Composting + Sludge cake)	Conpost (m3/day)	210	210	210	210	
	Sludge cake (t/day)	1	34	124	214	
	Discharge amount (m3/year)	76,600	88,900	121,900	154,800	

In the worst case for composted sludge disposed in dumping site, the sludge disposal cost is given in Table 3.2.10.

Table 3.2.10 Sludge Disposal Cost

Category	Case I	Case II	Case III	Case IV	Case V
Sludge Disposal Cost (Million VND/year) 1)	8,300	13,650	19,000	16,650	27,500
Category	Case VI	Case VII	Case VIII	Case IX	
Sludge Disposal Cost (Million VND/year) 1)	38,300	44,450	60,950	77,400	

1) Local unit price in Hanoi: 500,000VND/m^3

Sludge disposal cost of composting and non-composting is described in Table 3.2.11. Amount of sludge of non-composting is approximately half of composted case except for cases VIII and IX. Therefore composting affects the sludge disposal cost.

Table 3.2.11 Produced Sludge Amount and Disposal Cost of Composting/Non-composting

Category		Sludge Generation (1000 m^3/year)			Disposal Cost 1)	Category		Sludge Generation (1000 m^3/year)			Disposal Cost 1)
		Bio Sludge	Compost	Sub total	(Million VND/year)			Bio Sludge	Compost	Sub total	(Million VND/year)
Case I	A	0.0	16.6	16.6	8,300	Case VI	A	0.0	76.6	76.6	38,300
	B	8.4	0.0	8.4	4,200		B	38.6	0.0	38.6	19,300
Case II	A	0.0	27.3	27.3	13,650	Case VII	A	12.4	76.6	89.0	44,476
	B	13.8	0.0	13.8	6,900		B	55.8	0.0	55.8	27,900
Case III	A	0.0	38.0	38.0	19,000	Case VIII	A	45.3	76.6	121.9	60,947
	B	19.2	0.0	19.2	9,600		B	92.1	0.0	92.1	46,050
Case IV	A	0.0	33.3	33.3	16,650	Case IX	A	78.2	76.6	154.8	77,417
	B	16.8	0.0	16.8	8,400		B	128.3	0.0	128.3	64,150
Case V	A	0.0	55.0	55.0	27,500						
	B	27.7	0.0	27.7	13,850						

1) Land fill : 500,000VND/m3

2) A: with composting, B: without composting

c) Consumables and Repair Cost

Average expendable cost in 20 years is described in Table 3.2.12.

Table 3.2.12 Annual Expendable Cost

Category	Case I	Case II	Case III	Case IV	Case V
Consumable Cost (Million VND/year)	2,310	2,310	2,310	3,300	3,300
Category	Case VI	Case VII	Case VIII	Case IX	
Consumable Cost (Million VND/year)	3,300	9,900	9,900	9,900	

1) Life time of Equipment: 20 years

Average annual repair cost in 20 years is presented in Table 3.2.13.

Table 3.2.13 Annual Repair Cost

Category	Case I	Case II	Case III	Case IV	Case V
Repair Cost (million VND/year)	9,660	9,660	9,660	13,800	13,800
Category	Case VI	Case VII	Case VIII	Case IX	
Repair Cost (million VND/year)	13,800	41,400	41,400	41,400	

1) The repair cost estimated as the annual average cost in duration of equipment's ife time (20years).

d) Technology Transfer and O&M Personnel Cost

The modified aeration process applied to Binh Hung WWTP is rather difficult than conventional activated sludge process. Since centrifugal dewatering and composting are applied to sludge treatment, technology transfer for professional engineers will be necessary in due course. Personnel cost for technology transfer is presented in Table 3.2.14. Similar cost will also be required if committed to a private company.

Table 3.2.14 Personnel Cost of Technology Transfer

Position	Staff (Person)	Unit Price (Million VND/year)	Total Cost (Million VND/year)
Expert	5	5,400	27,000
Interpreter	3	540	1,620
Total			28,620

Personnel cost is estimated under the condition that: i) Professional engineers are assigned for the General Manager (GM), Deputy GM and managers for operation, monitoring, inspection, maintenance, and sludge treatment; and ii) Local engineers are assigned for the other positions and workers. The unit costs of personnel including both direct and indirect costs are estimated based on the result of interview surveys. The estimated personnel cost for each case is presented in Table 3.2.15.

Table 3.2.15 Case Study of Personnel Cost

No.	Position	Job	Case I, II, III			Case IV, V, VI			Case VII, VIII, IX		
			Staff	Labor cost (million VND/yr)		Staff	Labor cost (million VND/yr)		Staff	Labor cost (million VND/yr)	
			(person)	Unit Rate	Sub total	(person)	Unit Rate	Sub total	(person)	Unit Rate	Sub total
1	General Manager (GM)	Wastewater treatment	1	5,400	5,400	1	5,400	5,400	1	5,400	5,400
2	Deputy GM	Mechanical	1	5,400	5,400	1	5,400	5,400	1	5,400	5,400
3	General Affair	General	1	108	108	1	108	108	2	108	216
		Procurement	1	54	54	1	54	54	2	54	108
4	Operation	Manager	1	5,400	5,400	1	5,400	5,400	1	5,400	5,400
		Water quality	2	54	108	2	54	108	4	54	216
		Monitoring and Control	8	54	432	8	54	432	8	54	432
		Control for PS	4	54	216	4	54	216	4	54	216
		Daily Inspection	1	54	54	2	54	108	4	54	216
5	Maintenance	manager	1	5,400	5,400	1	5,400	5,400	1	5,400	5,400
		Wastewater treatment	2	54	108	4	54	216	8	54	432
		Dewatering and Composting	2	54	108	2	54	108	5	54	270
6	Operation for dewatering and composting	Manager	1	5,400	5,400	1	5,400	5,400	1	5,400	5,400
		Operation of dewatering	5	54	270	8	54	432	8	54	432
		Daily Inspection	1	54	54	1	54	54	2	54	108
		Sludge transportation	6	54	324	10	54	540	10	54	540
7	Security	Manager	1	54	54	1	54	54	1	54	54
		Guard man	4	36	144	4	36	144	4	36	144
8	Interpreter	Interpreter	3	540	1,620	3	540	1,620	3	540	1,620
Total			46	-	30,654	56		31,194	70		32,004

e) Environmental Management

The task of environmental management is principally cleaning of buildings and mowing the grounds. Cleaning and mowing will be outsourced, with the estimated

cost described in Table 3.2.16 below.

Table 3.2.16 Cleaning and Mowing Cost

No.	Position	Job	Case I, II, III			Case IV, V, VI			Case VII, VIII, IX		
			Staff	Cost (Million VND/year)		Staff	Cost (Million VND/year)		Staff	Cost (Million VND/year)	
			(person)	Unit rate	Sub total	(person)	Unit rate	Sub total	(person)	Unit rate	Sub total
1	Manager	Supervision	1	54.0	54.0	1	54.0	54.0	1	54.0	54.0
2	Cleaner	Cleaning	6	27.0	162.0	10	27.0	270.0	15	27.0	405.0
3	Landscaper	Gardening	6	27.0	162.0	10	27.0	270.0	15	27.0	405.0
Total			13	-	378.0	21	-	594.0	31	-	864.0

2) Case Study Result for O&M cost

Annual O&M cost estimated in each case study is described in Table 3.2.17. This estimation is calculated to be outsourced to a professional company. Particularly, case IV through IX, which are for expanded facilities in the future, are calculated on present price bases. For sludge treatment, two cases of composted and non-composted conditions are described.

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Table 3.2.17 Annual Operation and Maintenance Cost

(Unit : Million VND/year)

Item		Laybor Cost	Sludge Disposal	Electricity	Chemical	Consumable	Repair	Cleaning	Direct Operation Cost	Common Temporary Works	Site Work Expence	Site Management Cost	Total Site Expence	General Management Cost	Total O/M Cost
		a	b	c	d	e	f	g	(a～g) h	(h×0.1) i	(h＋i) j	(j×0.1) k	(j+k) l	(l×0.1) m	(l+m)
Case I	A	30,654.0	8,300.0	7,848.0	11,554.2	2,772.0	11,592.0	378.0	73,098.2	7,309.8	80,408.0	8,040.8	88,448.8	8,844.9	97,293.7
	B	*30,654.0*	*4,200.0*	*7,289.8*	*7,637.1*	*2,772.0*	*11,592.0*	*378.0*	*64,522.9*	*6,452.3*	*70,975.2*	*7,097.5*	*78,072.7*	*7,807.3*	*85,880.0*
Case II	A	30,654.0	13,650.0	7,848.0	17,959.4	2,772.0	11,592.0	378.0	84,853.4	8,485.3	93,338.8	9,333.9	102,672.6	10,267.3	112,939.9
	B	*30,654.0*	*6,900.0*	*7,195.2*	*11,524.2*	*2,772.0*	*11,592.0*	*378.0*	*71,015.4*	*7,101.5*	*78,116.9*	*7,811.7*	*85,928.6*	*8,592.9*	*94,521.5*
Case III	A	30,654.0	19,000.0	8,145.0	24,376.6	2,772.0	11,592.0	378.0	96,917.6	9,691.8	106,609.3	10,660.9	117,270.2	11,727.0	128,997.3
	B	*30,654.0*	*9,600.0*	*7,492.2*	*15,423.2*	*2,772.0*	*11,592.0*	*378.0*	*77,911.4*	*7,791.1*	*85,702.5*	*8,570.3*	*94,272.8*	*9,427.3*	*103,700.1*
Case IV	A	31,194.0	16,650.0	10,674.0	23,206.3	3,960.0	16,560.0	594.0	102,838.3	10,283.8	113,122.1	11,312.2	124,434.4	12,443.4	136,877.8
	B	*31,194.0*	*8,400.0*	*9,926.6*	*15,372.1*	*3,960.0*	*16,560.0*	*594.0*	*86,006.7*	*8,600.7*	*94,607.4*	*9,460.7*	*104,068.1*	*10,406.8*	*114,474.9*
Case V	A	31,194.0	27,500.0	11,061.0	36,131.5	3,960.0	16,560.0	594.0	127,000.5	12,700.1	139,700.6	13,970.1	153,670.6	15,367.1	169,037.7
	B	*31,194.0*	*13,850.0*	*10,219.0*	*23,214.4*	*3,960.0*	*16,560.0*	*594.0*	*99,591.4*	*9,959.1*	*109,550.5*	*10,955.1*	*120,505.6*	*12,050.6*	*132,556.2*
Case VI	A	31,194.0	38,300.0	11,889.0	49,067.5	3,960.0	16,560.0	594.0	151,564.5	15,156.5	166,721.0	16,672.1	183,393.1	18,339.3	201,732.4
	B	*31,194.0*	*19,300.0*	*10,857.8*	*31,067.5*	*3,960.0*	*16,560.0*	*594.0*	*113,533.3*	*11,353.3*	*124,886.6*	*12,488.7*	*137,375.3*	*13,737.5*	*151,112.8*
Case VII	A	32,004.0	44,476.2	29,943.0	68,691.3	11,880.0	49,680.0	864.0	237,538.5	23,753.8	261,292.3	26,129.2	287,421.6	28,742.2	316,163.7
	B	*32,004.0*	*27,900.0*	*28,911.8*	*50,691.3*	*11,880.0*	*49,680.0*	*864.0*	*201,931.0*	*20,193.1*	*222,124.2*	*22,212.4*	*244,336.6*	*24,433.7*	*268,770.2*
Case VIII	A	32,004.0	60,946.8	33,372.0	93,930.9	11,880.0	49,680.0	864.0	282,677.7	28,267.8	310,945.5	31,094.5	342,040.0	34,204.0	376,244.0
	B	*32,004.0*	*46,050.0*	*32,340.8*	*75,930.9*	*11,880.0*	*49,680.0*	*864.0*	*248,749.6*	*24,875.0*	*273,624.6*	*27,362.5*	*300,987.1*	*30,098.7*	*331,085.8*
Case IX	A	32,004.0	77,417.4	36,765.0	119,170.5	11,880.0	49,680.0	864.0	327,780.9	32,778.1	360,559.0	36,055.9	396,614.9	39,661.5	436,276.4
	B	*32,004.0*	*64,150.0*	*35,733.8*	*101,170.5*	*11,880.0*	*49,680.0*	*864.0*	*295,482.2*	*29,548.2*	*325,030.5*	*32,503.0*	*357,533.5*	*35,753.4*	*393,286.9*

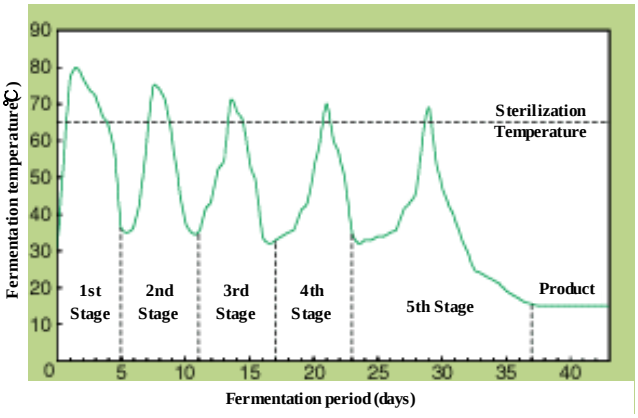
1) A: with composting, B: without composting

3.2.3 Sludge Reuse and Fuelization

Sewage sludge increases in accordance with sewerage system development and is easily putrefied. Since low cost and sustainable sludge treatment and reuse is to be provided, existing composting system and other sludge reuse methods have been studied and are described hereafter.

(1) Sewage Sludge Composting

Binh Hung WWTP applies the thickening–composting method for sludge treatment. Composted sludge becomes a safe product for human reuse through a two-day and 60℃ fermentation, which inactivates pathogenic bacteria. The composting facility in Binh Hung WWTP is equipped with two-stage fermentation and water content (W/C) is expected to decrease (design W/C is 50%). Produced sludge is a huge volume at 210 m^3/day (for treatment capacity case of 141,000 m^3/day) and contains heavy metals. Thus, use of the sludge as fertilizer for farm lands should be carefully made. Through the interview survey for the Binh Hung WWTP staff, It is found that they are planning of sludge management under consumption that the composted sludge would be dumped in a landfill in due time because it can not be expected to be used as fertilizer so far.



Source: Report on Efficient Utilization of Compost from high-polymer sludge (Toho LEO Co., Ltd.

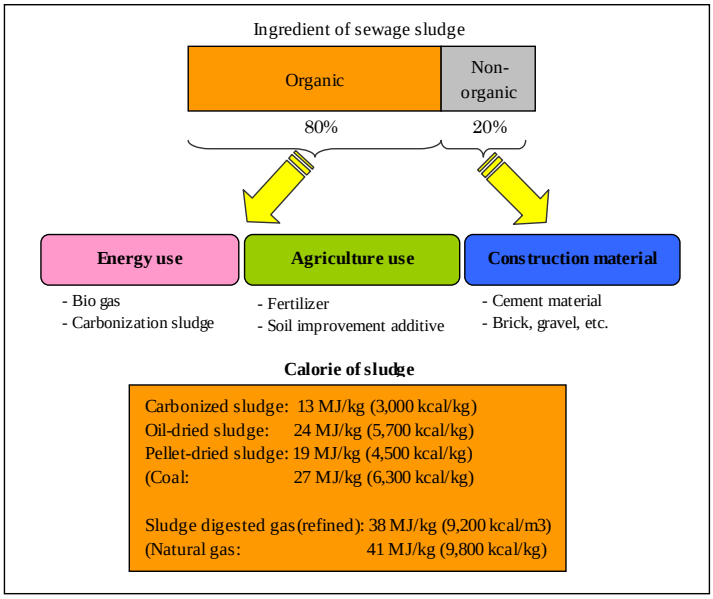
Figure 3.2.5 Composting Process (Example)

Composting is a process to stabilize sludge characteristic through fermentation in aerobic atmosphere. Bulking agent of husk, saw dust or bark is mixed to adjust W/C of 50-60%, in which composting proceeds. Composted product is suitable as fuel because 50% of W/C.

(2) Potential of Sewage Sludge Fuelization

Large amounts of sewage sludge are continuously produced in the urban districts, Dried sludge or carbonized sludge has around 60% of coal calorie. Hence, sludge has been reused as fuel for coal boiler or biomass boiler. A recent study of sludge reuse was conducted for Tan Mai Pulp and Paper JSC (Joint Stock Company), adjacent Ho Chi Minh City.

Pulp & paper factory located in Bien Hoa City and new factory is under construction in Long Thai. Demand for pulp and paper in Vietnam is increasing by up to 24% in 2008, and many companies are constructing new factories.



Source: Sewerage and Wastewater Management Dept., Ministry of Land, Infrastructure, Transport and Tourism of Japan

Figure 3.2.6 Values of Sludge from Sewerage as Energy Resources

Tan Mai JSC was established in 1958 and was privatized in 2006. JSC is also the largest news paper producer and second largest paper & pulp company, since it merged with Binh An JSC. Production will be 1,380,000 tons of paper and 600,000 tons of pulp in 2010 and new factory construction projects of 100,000 - 200,000 tons are going in Quang Ngai, Lam Dong and Long Thai, and JSC is planning to produce 3,600,000 tons of paper and 1,800,000 tons of pulp.

The WWTP in factory in Bien Hoa City applies settling tank, with sediments dewatered and pressed to board paper. Chip is used for farm. Bark is nuisance. Steam boiler uses coal and oil, but the new plant is planning to use waste as fuel through Swedish technology.

Tan Mai JSC is located about 40 km adjacent to Ho Chi Minh City, and is interested in waste reuse of saw dust, bark, black liquid and paper sludge. Sewage sludge has the potential for use as fuel for the steam boiler in JSC factory.

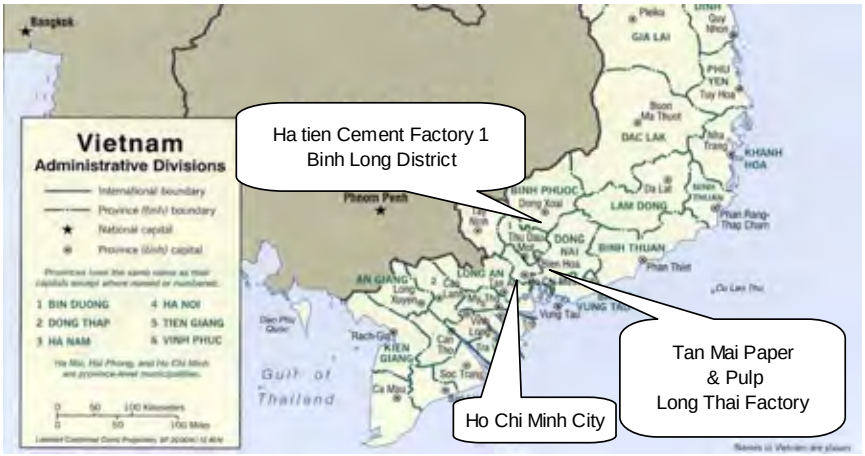


Figure 3.2.7 Potential Site of Sewage Sludge Reuse

Figure 3.2.8 Tan Mai Paper Factory

Figure 3.2.9 Paper Sludge Recycling

(3) Cement Material Use of Sewage Sludge

Cement materials are calcium, silica, alumina and ferric. These materials are milled and grilled in rotary kiln, and materials are processed to cement through hydration reaction. Waste containing such mineral can be used to cement material. Dried sewage sludge is to replace coal as fuel and residuals are processed to cement products.

Figure 3.2.10 Ha Tien Cement 1

Potential of sludge reuse for biomass fuel has been studied in the Ha Tien Cement 1 Factory adjacent to Ho Chi Minh City, which uses large amounts of coal. Factories of Ha Tien Cement are located in Ho Chi Minh City and Binh Long District, Binh Phuoc Province. The factory in Ho Chi Minh City is a milling clinker, which ships transport, and is not equipped with rotary kiln. The factory does not consume large amount of fuel nor have a plan to use fuel.

The factory in Binh Phuoc Province, which starts operation in 2008 and produces 1,760,000 tons of cement in a year, is using wastes as fuel. It is located 100 km from Ho Chi Minh City, however, which means that there is no advantage to use the sludge of Ho Chi Minh WWTPs.

The factory is now procuring wastes as follows;

- Waste Oil : free of charge
- Tires : charged
- Sawdust : charged
- Bio-fuel : charged
- Paper and Cartoon : charged

(4) Proposed CDM Project

Paper & pulp factories consume large amounts of steam and electricity. These have the potential to replace fossil fuel of coal & oil to renewable fuel, which contributes to mitigation of green house gas effects. Along with fuel cost reduction, bark for composting bulking agent will create a win-win situation for the paper factory and sewerage system.

Sewerage in Ho Chi Minh City has also some advantages in sustainability of sludge disposal, dumping cost reduction, and benefit of carbon finance.

To be applied for a CDM project, there is a need to study in detail the calorie of the composted fuel, CO2 base-line, process operation of composting, combustion test of biomass boiler, and corrosion of biomass boiler.

CO_2 Reduction Efficiency Estimated Based on Case VI-B in Table 3.2.17

Wastewater flow rate	:	141,000 m^3/day (Phase 1)
Produced sewage sludge	:	19 DS-ton/day
Sludge amount (W/C82%)	:	106 ton/day
Coal equivalent	:	11.4 ton/day＝4,161 ton/year (calorie base 60%)
CO_2 reduction	:	15,200 ton/year

3.2.4 Financial Mitigation and Tariff Structure

(1) Financial Estimation in Hanoi Sewerage

The O&M cost of the existing and planned WWTP is shown in Table 3.2.18. Wastewater inflow rate is estimated by construction phasing.

The estimated O&M cost excludes governmental administration of related regulation, asset management, depreciation and repayment of loan. Furthermore, price escalation and salary increases are also excluded. The O&M cost for only the wastewater treatment is likewise estimated.

Shown in Table 3.2.18, the annual O&M cost is estimated to 197,376, 268,833 and 287,303 million VND/year in each phase. Unit treatment cost is therefore around 1,600 VND/m3. Breakdowns of the cost are described in Tables 3.2.19 – 3.2.23.

Table 3.2.18 O&M Cost of WWTP in Hanoi

WWTP	Capacity	Estimated Daily Treatment Ampunt[1]			O/M COst[2]		
		Phase-1	Phase-2	Phase-3	Phase-1	Phase-2	Phase-3
	m^3/day	m^3/day			Million VND/year		
Kim Lien[3]	3,700	3,700	3,700	3,700	3,863	3,863	3,863
Truc Bach	2,500	2,041	2,041	2,041	2,642	2,642	2,642
North Thanh Long	42,000	34,286	34,286	34,286	21,098	21,098	21,098
Bai Mau	14,000	11,429	11,429	11,429	7,874	7,874	7,874
Yen So	190,000	155,102	155,102	155,102	87,922	87,922	87,922
Yen Xa	270,000	110,204	220,408	220,408	62,838	124,335	124,335
Phu Do	84,000	17,143	34,286	68,571	11,139	21,098	39,568
Total	606,200	333,904	461,251	495,537	197,376	268,833	287,302
Unit Treatment Cost （VND/m^3）					**1,619**	**1,597**	**1,588**

1) Capacity /1.225 (daily maximum)
2) Labor cost for administration excluding depreciation cost and debt interest charge
3) Actual inflow rate for Kim Lien WWTP
4) Excluding price escalation and labor cost escalation

Table 3.2.19 Estimated Personnel Cost of WWTP in Hanoi

Plant Name	Staff (person)			Average Labor Cost （VND/year）	Labor Cost （VND/year）			Remarks
	Phase-1	Phase-2	Phase-3		Phase-1	Phase-2	Phase-3	
Kim Lien[1]	21	21	21		840,000,000	840,000,000	840,000,000	Present employee number
Truc Bach[2]	21	21	21		840,000,000	840,000,000	840,000,000	Same number as Kim Lien WWTP
North Thanh long[1]	30	30	30		1,200,000,000	1,200,000,000	1,200,000,000	Present employee number
Bai Mau[3]	26	26	26		1,040,000,000	1,040,000,000	1,040,000,000	Manager 1, Administration 1, 24 operator in 4 groups with 3 sifts
Yen So[3]	38	38	38	40,000,000	1,520,000,000	1,520,000,000	1,520,000,000	Manager 1, Administration 1, 36 operator in 4 groups with 3 sifts
Yen Xa[3]	34	42	42		1,360,000,000	1,680,000,000	1,680,000,000	Manager 1, Administration 1, 32 (40) operator in 4 groups with 3 sifts
Phu Do[3]	26	30	30		1,040,000,000	1,200,000,000	1,200,000,000	Manager 1, Administration 1, 24 (28) operator in 4 groups with 3 sifts
Supporting Section[3]	50	50	50		2,000,000,000	2,000,000,000	2,000,000,000	Water quality analysis 10, Maintenance 20, Other 20
Total	246	258	258	40,000,000	9,840,000,000	###########	###########	

1) Kim Lien and North Thanh Long: Present O/M organization
2) Same organization for Truc BacWWTP
3) Empirical estimation

Table 3.2.20 Estimated Electricity Cost of WWTP in Hanoi

WWTP	Electricity Consumption (kwh/year)			Unit Price[2]	Electricity Cost (VND/year)		
	Phase-1	Phase-2	Phase-3	（VND/kwh）	Phase-1	Phase-2	Phase-3
Kim Lien	1,350,500	1,350,500	1,350,500		1,215,450,000	1,215,450,000	1,215,450,000
Truc Bach	744,965	744,965	744,965		670,468,500	670,468,500	670,468,500
North Thanh Long	6,257,143	6,257,143	6,257,143		5,631,428,571	5,631,428,571	5,631,428,571
Bai Mau	2,085,714	2,085,714	2,085,714	900	1,877,142,857	1,877,142,857	1,877,142,857
Yen So	25,475,510	25,475,510	25,475,510		22,927,959,184	22,927,959,184	22,927,959,184
Yen Xa	18,101,020	36,202,041	36,202,041		16,290,918,367	32,581,836,735	32,581,836,735
Phu Do	3,128,571	6,257,143	11,262,857		2,815,714,286	5,631,428,571	10,136,571,429
Total	57,143,424	78,373,016	83,378,730		51,429,081,765	70,535,714,418	75,040,857,276

1) Actual basis for the Kim Lien WWTP
2) Price information of JETRO

Table 3.2.21 Estimated Chemical Cost of WWTP in Hanoi

WWTP	Coagulant [1]			Sodium Chlorite [2]			Total Chemical Cost		
	Phase-1	Phase-2	Phase-3	Phase-1	Phase-2	Phase-3	Phase-1	Phase-2	Phase-3
	(Million VND/year)			(Million VND/year)			(Million VND/year)		
Kim Lien	438	438	438	115	115	115	552	552	552
Truc Bach	241	241	241	63	63	63	305	305	305
North Thanh Long	4,055	4,055	4,055	1,063	1,063	1,063	5,118	5,118	5,118
Bai Mau	1,352	1,352	1,352	354	354	354	1,706	1,706	1,706
Yen So	18,342	18,342	18,342	4,810	4,810	4,810	23,152	23,152	23,152
Yen Xa	13,033	26,065	26,065	3,417	6,835	6,835	16,450	32,900	32,900
Phu Do	2,027	4,055	8,109	532	1,063	2,126	2,559	5,118	10,236
Total	39,487	54,548	58,602	10,354	14,304	15,367	49,842	68,851	73,969

1) SS of influent: 150mg/L (ex. Kim Lien), dosing ratio: 2%, unit proce: 108,000VND/kg
2) Dosing ratio: 2mg/L, unit price: 3,540VND/L (10%)

Table 3.2.22 Estimated Sludge Production and Disposal Cost of WWTP in Hanoi

WWTP	Sludge Generation			Sludge Disposal		
	(m^3/year)			(Million VND/year)		
Kim Lien	833	833	833	333	333	333
Truc Bach	461	461	461	184	184	184
North Thanh Long	7,722	7,722	7,722	3,089	3,089	3,089
Bai Mau	2,578	2,578	2,578	1,031	1,031	1,031
Yen So	34,911	34,911	34,911	13,964	13,964	13,964
Yen Xa	24,806	49,611	49,611	9,922	19,844	19,844
Phu Do	3,861	7,722	15,439	1,544	3,089	6,176
Total	75,172	103,839	111,556	30,069	41,536	44,622

1) SS removal in 1st Clarifier: 35%, Conversion rate of primary sludge: 1, Conversion ratio of bio sludge: 0.9
2) SS in influent: 150mg/L、SS in effluent: 50mg/L
3) Water content of sludge cake: 82%
4) Gravity ratio of sludge cake: 1
5) Sludge disposal cost: 400,000VND/m3

Table 3.2.23 Estimated Consumables and Repair Cost of WWTP in Hanoi

WWTP	Consumable Cost			Repair Cost		
	Phase-1	Phase-2	Phase-3	Phase-1	Phase-2	Phase-3
	(Million VND/Year)			(Million VND/Year)		
Kim Lien	111	111	111	511	511	511
Truc Bach	61	61	61	282	282	282
North Thanh Long	1,029	1,029	1,029	4,731	4,731	4,731
Bai Mau	343	343	343	1,577	1,577	1,577
Yen So	4,653	4,653	4,653	21,404	21,404	21,404
Yen Xa	3,306	6,612	6,612	15,208	30,416	30,416
Phu Do	514	1,029	2,057	2,366	4,731	9,463
Total	10,017	13,838	14,866	46,079	63,653	68,384

1) Unit rate of consumable cost: 30,000VND per daily treatment amount (m3)
2) Unit cost of the repair cost: 138,000VND per daily treatment amount (m3), average cost for 20 years

(2) O&M Cost of Hanoi Sewerage

Three WWTPs in Hanoi, namely Kim Lien, Truc Bac and North Thang Long, are in operation, two WWTPs under design and construction, and two additional WWTPs in the planning stage. Yen Xa and Pu Do WWTPs will be operated step-wised in one-half and one-fourth capacities, respectively, in accordance with increase in population of the treatment area.

Treatment capacity of the seven WWTPs is increased step-wise as shown in Table 3.2.24. The O&M cost of personnel, electricity and chemicals, sludge disposal and repair is estimated. Figures 3.2.11 and 3.2.12 show the relation between the O&M cost and treatment flow rate.

The O&M cost studied in Section3.2.4(1) is equivalent to HSDC annual budget as follows:

- Cost of existing three WWTPs is equivalent to 20% of HSDC budget
- Cost of five WWTPs is equivalent to 90% of HSDC budget
- Cost of seven WWTPs is equivalent to 1.5 - 2 times of HSDC budget

Therefore, financial sustainability of HSDC is vulnerable because of the low tariff rate of 10% of water supply and subsidy by the Hanoi City Government.

For financial sustainability, levy of O&M cost to service user is indispensable. Present sewerage charge (environmental protection charge of Circular No.67 (2003) is too much lower than the cost of conventional activated sludge treatment, and is enacted for only drainage. Therefore, financial regulation is an urgent issue to enhance the sewerage tariff system, with the tariff structure and rate, along with low household income and financial mitigation plan（cross subsidizing from commercial/high income to low income）to be taken into consideration.

Table 3.2.24 WWTP Development Plan in Hanoi

WWTP	Treatment capacity(m3/day)					
	Plan	Existing	5 WWTP	7 WWTP (Phase-1)	7 WWTP (Phase-2)	7 WWTP (Phase-3)
Kim Lien	3,700	3,700	3,700	3,700	3,700	3,700
Truc Bac	2,500	2,500	2,500	2,500	2,500	2,500
North Thang Long	42,000	42,000	42,000	42,000	42,000	42,000
Ba Mau Lake	14,000	－	14,000	14,000	14,000	14,000
Yen So	190,000	－	190,000	190,000	190,000	190,000
Yen Xa	270,000	－	－	135000	270,000	270,000
Pu Do	84,000	－	－	21000	42000	84,000
Total	**606,200**	**48,200**	**252,200**	**408,200**	**564,200**	**606,200**

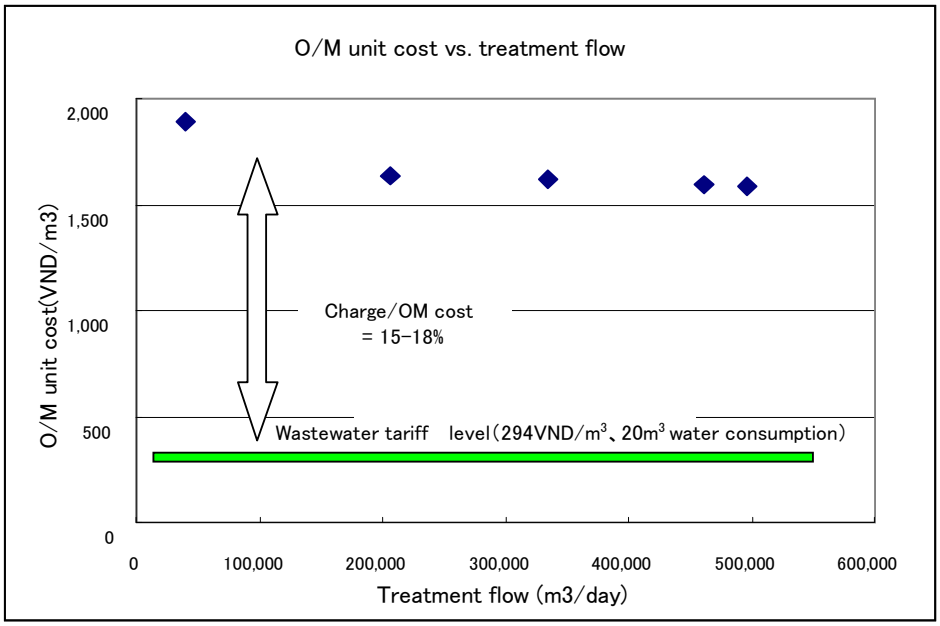


Figure 3.2.11 O&M Cost & Wastewater Flow Rate vs. Budget

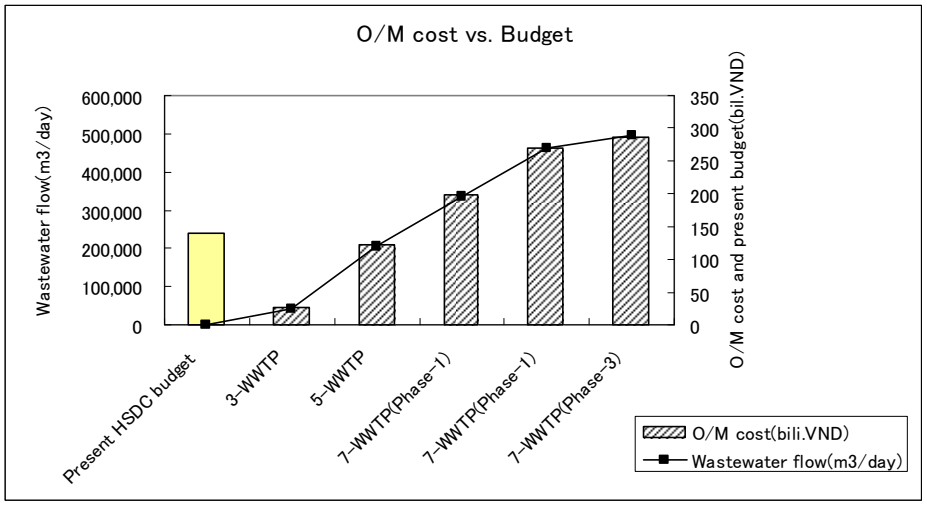


Figure 3.2.12 WWTP Development vs. O&M Cost and Tariff Rate （Hanoi）

(3) O&M Cost of WWTPs of Ho Chi Minh City

Figure 3.2.13 shows the O&M cost, which is studied in Section 3.2.2, wastewater inflow rate and tariff rate of WWTPs in Ho Chi Minh City.

Unit O&M cost declines in accordance with wastewater inflow increase. Water quality of SS & sludge production, and O&M staffing affect O&M cost by about 50% to 200 %.

Sewerage tariff rate is much lower than the 6-19% (average 11%) of O&M cost. Sustainable O&M operation, therefore, requires a comprehensive approach of cost

reduction, increase of costumer/levied customers, amendment of the tariff rate and subsidy of government account (refer to Appendix 7 "Role of Private and Public for Wastewater Management" and Appendix 11 "Sewerage Tariff Structure").

O&M cost can be reduced through execution of the O&M plan properly in the facility operation, utility dosing adjustment, and staffing, in accordance with wastewater inflow rate and sludge production. An appropriate O&M plan will reduce cost up to 2,500VND/m^3 (0.15USD/m3) in the medium-term.

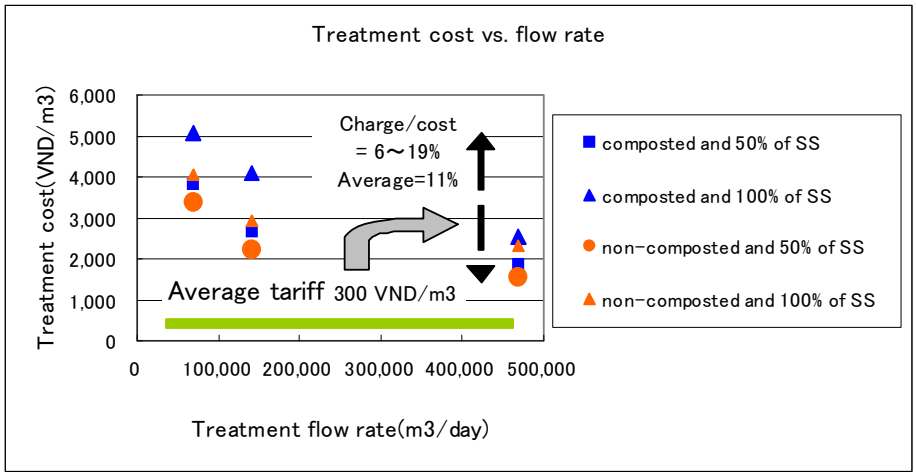


Figure 3.2.13 Treatment Cost by Treatment Capacity and Estimated Appropriate Sewerage Tariff

(4) Sewerage Tariff System

The tariff structure of sewerage in Hanoi and Ho Chi Minh is described in Table 3.2.25.

Table 3.2.25 Water Supply Tariff and Wastewater Charge（Hanoi & Ho Chi Minh）

Group	Hanoi	Ho Chi Minh（amended in 2004）
Household	non-metered 30,000 VND/month	VND/m^3
	<16m3 2,800 VND/m^3	<4m3/member/month 2,700
	17-20m3 3,500	4－6 m3/member/month 5,400
	21-35m3 5,000	6m3/member/month > 8,000
	36m3> 7,500	
Industry	4,500 VND/m^3	4,500 VND/m^3
Commercial	7,500 VND/m^3	8,000 VND/m^3
Public	4,000 VND/m^3	6,000 VND/m^3
Wastewater	10% of waster supply	Approximate 12% of water supply

Tariff rate of households is progressive and the commercial rate is equivalent to a large user household. Wastewater charge is either 10% or 12% of the water supply charge (detailed in Section 3.1.1 (4), 3.1.3 (2)).

Water utility bodies apply the wastewater tariff system combining metered/non-metered, progressive and subsidy rate (from high-income/commercial to low-income).

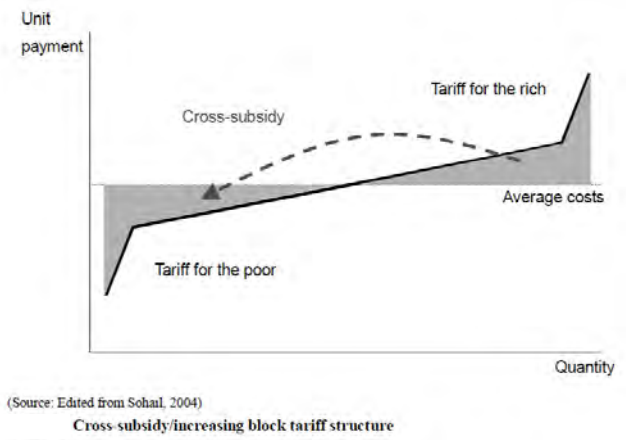


Figure 3.2.14 Cross Subsidy Concept

Table 3.2.26 Studied Wastewater Tariff System

City	Metered water	Non-metered water	Domestic			Commercial			Remarks
			Flat rate	Progress	Progress Max/Min	Flat rate	Progress	Progress Max/Min	
Jakarta		○		○	1.76		○	1.6	HH : electricity class Commc : business type&star Comm/HH = 5 ~ 8
Yogyakarta		○	○	○	2	(○)	(×)	−	Employee&revenue
Bandung	○	○		○	Flow 3.1-3.5 Income 2.0		○	Flow 2.75/3.33 Income 1.1-1.3	flow rate & income
Denpasar, Bali		○		○	1.67	Commerc. (○)	Hotel (○)	Hotel -2	HH : access road Hotel: star
Surakarta (Solo)		○	○		1.5	○		1.5	HH&Comm: class&type
Banjarmasin		○	○		−	○		−	
Hanoi	○	○	○		−	○		−	
Ho Chi Minh	○			○	2.96	○		−	
Astana	○		○		−	○		−	HH equal to commercial
Manila	○	○		○	4.2		○	1.1-1.2	Comm/HH:4.5
Maynilad	○	○		○	4.2		○	1.1-1.2	Comm/HH:4.5

(5) Tariff Rate of Asian Cities

Wastewater tariff rate of Hanoi and Ho Chi Minh is around 0.34 US $ /20 m^3 (1 US$ = 17,500 VND) and are lower than in Indonesia or the Philippines (Refer to Figure 3.2.15). Rate of wastewater to water supply is also low at 10%.

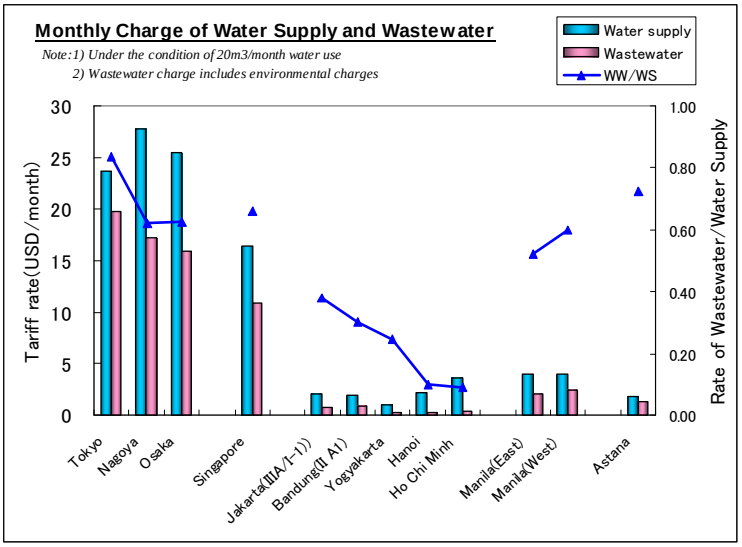


Figure 3.2.15 Water and Wastewater Tariff in Asian Cities

(6) Study on Tariff Rate

The tariff rate of Hanoi and Ho Chi Minh, whether financially sustainable or not, is simulated based on water supply tariff system. Target O&M costs are as follows:

- Hanoi City : 1,500－2,000 VND/m^3
- Ho Chi Minh City : 1,600－3,000 VND/m^3

Applied parameters for the financial simulation include the tariff rate, rate of sewerage charge to water supply, and factor to household expenditure (low-income expenditure of two million VND/month) and tariff system of adjacent countries.

Since water supply tariff is at a progressive rate of 2.6−3 times of the basic tariff, gross average rate in commercial districts is higher than the rate in residence areas, and revenue per wastewater flow is also advantageous. In this simulation, the water utilization in the whole city and commercial areas are assumed as listed below.

- Whole city: actual value to rate of domestic and commercial uses
- Commercial area : commercial use shares 70% of supplied water (referred large cities in Japan)

In Hanoi, the sewerage charge in the whole city requires 30 to 50% of the water supply charge and the factor to household expenditures is 1% as estimated, while in Ho Chi Minh, the sewerage charge in the whole city requires 30 to 50% of the water supply charge and factor to household expenditures is 1% to 1.5 % as estimated.

Sewerage tariff of both cities requires to be increased three to five times in order to be at same level of Manila. Therefore, public awareness is important for the revision of the tariff structure.

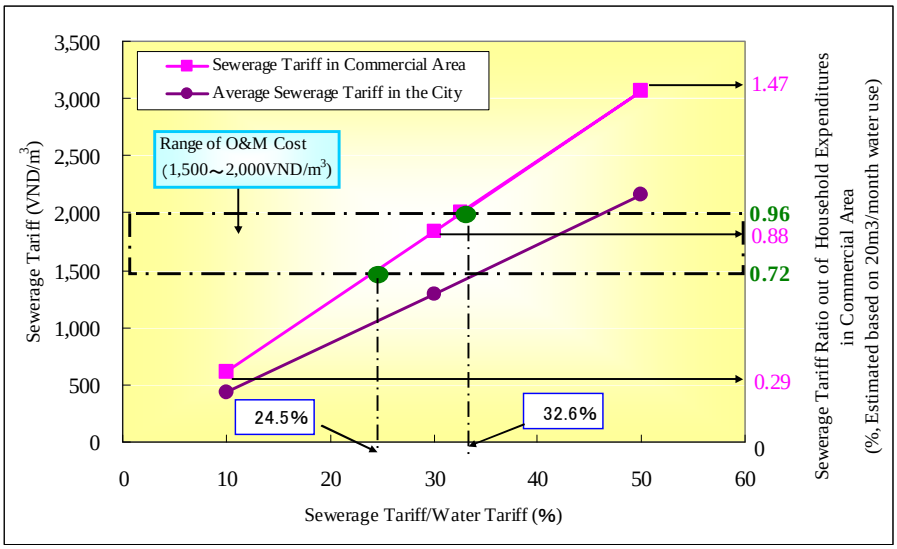


Figure 3.2.16 Appropriate Sewerage Tariff and Impact on Household Expenditures (Hanoi City)

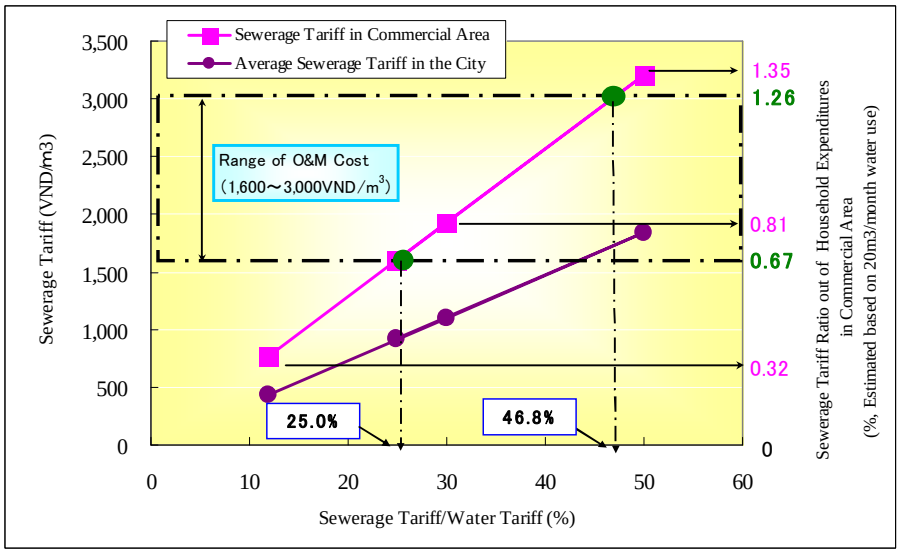


Figure 3.2.17 Appropriate Sewerage Tariff and Impact on Household Expenditures (Ho Chi MinhCity)

3.2.5 Public Awareness and Upgrading Public Services

(1) Interceptor Sewerage

Hanoi and Ho Chi Minh apply the interceptor sewerage system mainly to environmental sanitation and water environment improvement. Interceptor sewerage catches the wastewater from existing drainage systems and streams, therefore this sewerage system does not require lateral sewers and is a low-cost system. The negative issue is storm water infiltration. Increased wastewater flow during a storm causes the overflow in manholes,

flooding the pumping station, and spilling out of activated sludge from the aeration tank. Moreover, excess flow of sewerage system in a storm can cause combined sewer overflow (CSO), which then constrains the project result on the water environment.

Interceptor sewerage is a transitional state of upgrading to eventual conventional sewerage in developed countries.

(2) Upgrading Sewerage System and Human Waste Treatment

Interceptor sewerage improves polluted water environment rapidly because drainage wastewater is collected. Existing drainage in the living environment, however, is not improved and the service to households does not change. This may lead to households being unsatisfied since on-site household treatments still remain.

Septage disposal and septic tank operation is a nuisance to the public. From the view point of public service, a step-wise upgrading of the sewerage system through review of the functions of the drainage system, providing sewer maintenance, and re-evaluating septic tank installation in the building code (refer to Appendix 5 ”Step-wise Sewerage System Development”).

The city centers of Hanoi and Ho Chi Minh are habitually affected by inundation. Small-scale pumping stations and retention tanks are useful for drainage in a limited area, but CSO becomes tangible due to the improved water environment. The multi-purpose use of storm water retention tank to reservoir of pollution control is a usual practice for CSO mitigation.

Interceptor sewerage is low-cost and effective to improve sanitation and the water environment in a short period, but human waste disposal and CSO issues remain. Step-wise upgrading to conventional sewerage system as the medium-/long-term project is indispensable, in collaboration with storm water management and urban development projects.

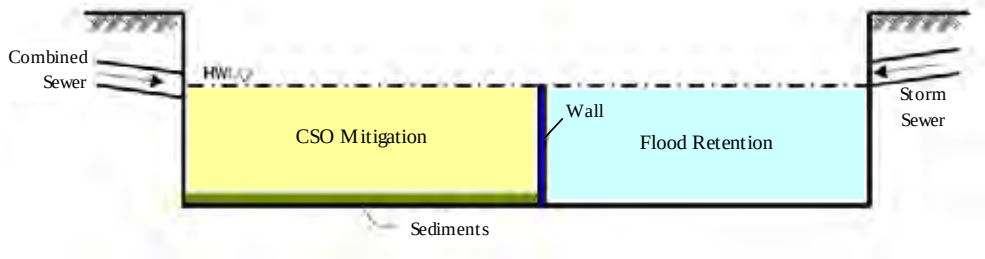


Figure 3.2.18 Multi Purpose Use of Storm Water Reservoir for Flood and Pollution Control

(3) Public Awareness & Education

Result of the social survey shows that public awareness of sewerage & water environment is weak and affordability is only around 0.3 % of the household monthly expenditure. As shown in Figure 3.1.32, willingness to pay (WTP) is at a very low 0.1-0.2%. Some residents show positive awareness of 0.5-0.8% of household monthly expenditure. Public awareness affects all aspects of sewerage, from construction to connection to financing & tariff.

It is important to have comprehensive social education programs on sewerage role. Some programs are efficient in household awareness. Education in kindergarden and primary school bring water-related topics back home. Education of housewives is advantageous because sanitation issues affect them most seriously. An open school in bio-diversity of rivers also makes clear pollution mechanism of the water environment.

Figure 3.2.19 Cartoon for Kindergarten (Japan)

Figure 3.2.20 Community Education (Indonesia)

3.2.6 Collaboration of Relevant Organizations

(1) Private and Public Relationships

Hanoi City approved the urban development concession to project provider in exchange for the Yen So WWTP construction. Hanoi City or Ho Chi Minh City requires big amounts of project cost for sewerage development and the exchanged concession is an appropriate move. In addition, private finance of BOT (build-operate-transfer) projects can be considered. Regarding existing facilities, private know-how is efficient in accordance with the public service principle. Various private partnerships are applied from several years of comprehensive operation to concession contract and privatization (refer to Section 4.2 and 5.3).

(2) Cost Reduction of Sewerage Development and Relation with Urban Development

Large-scale urban development projects are being promoted in Hanoi. In order to develop a well-planned sewerage system, it is appropriate to levy sewerage construction cost on projects by the beneficiary pay principle. Project provider can also save construction cost of on-site treatment.

Figure 3.2.21 Urban Development

(3) Collaboration of Organizations

Operation of a sewerage system is the responsibility of the People's Committee, Department of Construction, PMB, and HSDC. HSDC establishes enterprises of drainage system management and wastewater treatment, respectively.

Sewerage management is sustained by specifying clients through a sewerage ordinance. Wastewater substances such as pH, oil/grease, heavy metal/toxics and extensive organic load, causes serious damage on concrete material, wastewater treatment or sewage sludge reuse. Guidelines and ordinances are required.

Levying wastewater quality charge on exceeding discharge of SS/BOD which can be treated biologically contributes to both sewerage administrator and service user. Factories can save pre-treatment facility cost. Since HSDC can not manage the entire sewerage-related administration, collaboration with the People's Committee, Department of Construction, PMB and HSDC is indispensable.

CHEPTER 4 OPERATION AND MAINTENANCE (O&M), AND FINANCIAL PLAN FOR SEWERAGE SYSTEM OF ASTANA

4.1 Present Situation of Water Supply and Sewerage Facilities

The present situation of water supply and sewerage facilities in Astana City are studied based on available existing JICA study reports, design documents, reports provided by other institutions, interviews with project contractor and information from web sites.

(1) Outline of Water Environment and Water Supply and Sewerage

Since Astana became the capital city of Kazakhstan in 1997, JICA initiated preparation of an urban development master plan leading to the rapid progress of urbanization. Population in Astana is 610,679 in April 2008. The three main rivers in the city and its adjacent districts include Ishim River in the city center flowing from east to west, Seleti River in the north, and Nura River in south. The Vyacheslavsky artificial reservoir is located 50 km east from the city. It stores raw water from Ishim River as a principal water supply resource. Tardecol Lake, meanwhile, located 6 km south of the city center, receives effluent of existing wastewater treatment.

Nura - Ishim Canal, which was developed for diverting river water from Nura to Ishim, does not function well due to mercury pollution in the Nura River. Water of the Ishim River is periodically examined by the National Meteorological Agency. Examination results are shown in the following table:

Table 4.1.1 Water Environment Quality in Astana Region

Sampling Point	BOD(mg/L)	COD(mg/L)	SS(mg/L)
Water quality standard of surface water for water supply	3.0	15	—
Vyacheslavsky Reservoir	0.8	23	0.7
Ishim River (Telman Village)	1.6	22	0.5
Ishim River (in Astana City)	2.7	24	1.1
Ishim River (Kyelov Village)	2.0	23	1.3

Source: JICA F/S Report (2000)

Water supply and sewerage works is endorsed to Astana Su Arnacy (ASA), which is owned by Astana City (AKIMAT: Astana City Government). ASA is an autonomous organization having the tasks for collection of water supply charges as well. While ASA is responsible for the routine O&M, AKIMAT acts as an administrative organization for the investment plan, tariff system, personnel assignment and salary system.

Water supply and sewerage in Astana started operation in 1937. Water supply purification plant was constructed in 1969 and has expanded its capacity to 200,000 m^3/day. However, it only produces 120,000-140,000 m^3/day at present. Facilities have already been degraded, with rehabilitation projects financed by Japan ODA presently on-going. Water supply network has also deteriorated, with non revenue water (NRW) rate of

approximately 26%. The public seems less conscious in conserving water. Moreover, there may be an additional 20% of water losses due to leakages.

Water supply demand in Astana is described as follows:

Table 4.1.2 Water Demand in Astana（Water Resources Bases）

Year	2000	2010	2020	2030
Population (Cap.)	331,000	490,000	690,000	800,000
Total water demand(m^3/day)		175,100	243,700	295,300
Water supply(m^3/day)		151,700	217,100	264,600
Industrial water(m^3/day)		23,400	26,600	30,700

Source: JICA Master Plan (M/P) Report（2000）

According to the JICA Master Plan (M/P) Report (2000), the existing water supply system in Astana consists of 489.3 km of iron/cast-iron pipes, with some polyethylene (PE) pipes installed in some districts. Facility planning of the on-going rehabilitation project aims to achieve the followings:

Table 4.1.3 Outline of Water Supply Facility Rehabilitation Project

Category	Facility and equipment
1. Intake	Intake flow rate：210,000m^3/day Intake pump：36.5m^3/mini. 6units（including stand-by 2 units）
2. Water purification plant	Treatment capacity :105,000 m^3/day（Expanded） Treatment process：Rapid filtration SCADA centralizing monitoring
3. Distribution facility	Machinery equipment of booster pumping station New water supply pipe：φ1,000 mm, 5.6 km Rehabilitation pipe：φ100～1,000 mm,100 km
4. O&M facility	Water meter for residence：152,000 units Water meter for flat house：1,900 units

Source: JICA Detailed Design (D/D) Report (2003)

For sewerage system, the served population rate is 72% in 2000. It is being planned to serve the anticipated growth of 97% in 2030.

Table 4.1.4 Sewerage System Development Project

Year	1999	2010	2020	2030
Served population (cap.)	331,000	490,000	690,000	800,000
Population served area (cap.)	306,249	474,537	666,933	780,525
Connected population (cap.)	220,100	421,400	641,700	760,000
Served rate (%)	72	88	96	97

Source: JICA Master Plan (M/P) Report (2000)

Wastewater in Astana is conveyed to Kos WWTP, located beside Tardecol Lake. Effluent water is consequently discharged into said lake. Resort development project in the district near the lake, and lake water improvement project (Moscow project) are proceeding. Scope of rehabilitation project of Japanese ODA includes improvement of the existing WWTP facility, and expansion of sedimentation tank and dewatering facilities as shown in the following table.

Table 4.1.5 Outline of Sewerage Facility Rehabilitation Project

Category	Facility & equipment
1. Wastewater Treatment Plant	Facility rehabilitation（Capacity:136,000m3/day） Lift pump replacement：0.9m3/sec x 2, 0.45m3/sec x 2 Sedimentation tank (1st・2nd) 2tanks Sedimentation tank, Aeration tank: Machinery equipment Effluent pump：0.45m3/sec x 2,0.9m3/sec×2,1.33m3/sec x 2 Piping：φ200～2,000mm x 3,000m
2. Sludge Treatment Plant	Gravity thickener: Machinery equipment Mechanical thickener:75m3/hr x 3 Sludge digestion tank：Machinery equipment, Boiler Sludge dewatering
3. Collection System	Relay pumping equipment：17 stations Sewer：φ100～800mm x 21km Man-hole cover：5,300 units

Source: JICA Detailed Design (D/D) Report (2003)

(2) Outline of O&M

O&M outline of ASA, which is the responsible organization for water supply and sewerage management in Astana, is described hereinafter:

ASA, subsidized by Astana City, operates water supply and sewerage services. It is an autonomous organization and is committed to operate sewerage work of routine works, although all its assets belong to Astana City. Therefore, its financial needs are subsidized by Astana City, and hence, the governing capacity of ASA is restricted. Number of personnel of ASA is presented in Table 4.1.6.

(3) O&M Issues

O&M issues of sewerage in Astana are described as follows;

- Average wastewater inflow rate is 100,000 m^3/day, while the one in spring increases to 120,000 m^3/day due to snow melting during spring (max flow rate 150,000 m^3/day)
- Electricity consumption rate is 0.5 kWh/m^3 which higher than 0.3-0.4kWhr/m^3 of ordinary WWTP. This is due to effluent pump station, 100% of sludge return rate and inefficient blower.
- Since Astana City is located on a flat plain, 30 relay pumping stations are functioning not to make the sewer lines deeper installed. Consequently, electricity consumption rate increases.
- Coal boiler is being replaced. It is realized that although coal is cheap, coal boiler requires exhaust gas purifier.
- Offensive odor from sludge drying bed affects nearby residents which are living about 1.5 km far from the WWTP. It thus becomes an environmental issue.

Table 4.1.6 Personnel of ASA（2000）

Job description	Staff No.	Remarks
ASA Head office	416	
Pipe network-1	15	
Pipe network-2	15	
Sewer	108	
Emergent affair	24	water supply & sewerage
Work shop	10	ditto
Machinery	150	ditto
Electricity	60	ditto
Repair/construction	34	ditto
Water purification	84	
Administration	5	
Manager	1	Engineer
Engineer	4	
Operation	29	4 team
Engineer	4	
Operator	25	
Laboratory	21	
Chief	1	
Engineer	3	
Analyst	8	
Light job for Shift	9	
Repair/inspection	20	
Others	9	

Job description	Staff No.	Remarks
Water intake	15	
Administration	2	
Manager	1	
Engineer	1	
Operation	8	
Operator	8	
Repair/inspection	3	
Others	2	
Sewerage treatment	90	
Administration	4	
Manager	1	
Engineer	3	
Operation	44	
Engineer	4	
Operator	40	
Laboratory	11	
Chief	1	
Engineer	2	
Analyst	8	
Repair/inspection	21	
Others	10	
Total	605	

4.2 O&M Plan

(1) Lessons Learned in Indonesia and Vietnam

Operation of sewerage facility will be successful if O&M is executed properly with appropriate future planning. Facility design for risk management is also important. Lessons learned related to know-how/practicability in Indonesia and Vietnam is described in Table 4.2.1.

Table 4.2.1 Lessons Learned Related to Know-how/Practicability in Indonesia and Vietnam

Category	Detail	Efficiency	Life duaration	Safety	Cost reduction	Environmental issues
Facility design	Simplified SCADA system ・data processing, data-base system	○		○		
	Simplified civil structure ・out-door power receiving ・proper facility arrangement to reduce accessories	○			○	
	Selection of automation & manual operation	○			○	
	Dual safe system for principal facilities		○	○		
	Instrumentation for operation indicator	○		○		
	Lagoon treatment (land acquisition, efficiency)	○			○	
	Sludge drying bed ・existing facility use, mechanical back-up	○			○	
Machinery design	Air-cooled engine ・air-cooled generator ・mechanical seal	○	○			
	Air conditioning of electric room ・air conditioning to IT devices		○			
First operation trouble	Small capacity equipment ・smooth on/off operation	○			○	
Flooding	Flooding pumping station ・Lay-out on ground of electric equipments ・Water proof door		○	○		
Offensive odor	Covering and deodorant facilities		○	○	○	○
Corrosion	Anti-corrosion material (plastic material) Corrosion prevention lining		○	○		
Environmental issues	Green space & gardening Environment issue mitigation					○
Easiness of O/M	Centralization (Remote monitoring, laboratory)	○			○	
	Light weight material (screening basket, cover)	○		○		

Source: JICA Study Team

(2) Proposed O&M Plan for WWTP in Astana

1) Outline of WWTP

Astana City is located on a plain with 37 relay pumping stations working to mitigate sewer depth in 2003. WWTP involves a conventional activated sludge process and treatment design capacity of 136,000 m^3/day, with existing sewer of 227 km. Treated wastewater effluent is reclaimed to Tardecol Lake which is an enclosed water reservoir without any outfall. Therefore, excess water is discharged to wetland through emergency siphon, and flows into the Ishim River. Sludge produced is reclaimed in the WWTP site.

The quality of influent is similar to domestic wastewater. The wastewater inflow rate is 100,000 m^3/day on a daily average. As for the treatment capacity of 136,000 m^3/day, inflow rate increases in spring due to melting snow, which is recorded to be 158,000 m^3/day in 2000-2001. Effluent water quality of BOD and SS are less than 20 mg/L. Performance of the activated sludge process as treatment seems sufficient. Disinfection is not applied since there are no stipulations against discharging into

Tardecol Lake. Therefore, coliform reaches at a relatively high level. The lake water quality is better than WWTP effluent water quality because effluent wastewater is treated by natural means.

The most pumping stations are constructed using caisson foundation technology. Underground structures meanwhile are made up of reinforced concrete circular walls. Buildings on ground are of single layer brick wall intended for small and old pumping stations. Newly constructed medium height pumping stations are rectangular in shape. Pump facilities consist of horizontal shaft volute type pump. Large scale pumps meanwhile are of vertical shaft volute type with mixed flow. All pumping stations do not facilitate grid chamber, and sand is conveyed to WWTP.

Design features of Astana WWTP Astana are described in Table 4.2.2 and Figure 4.2.1.

Table 4.2.2 Design Features of Astana WWTP

Category	Feature
Area site	Approximately 43 ha
Wastewater collection	Separated system
Treatment process	Wastewater treatment：Conventional activated sludge Sludge process: Thickening＋anaerobic digestion＋machinery dewatering
Receiving water	Tardecol Lake
Served population（plan）	490,000 cap.(in 2010), 800,000 cap.(in 2030)

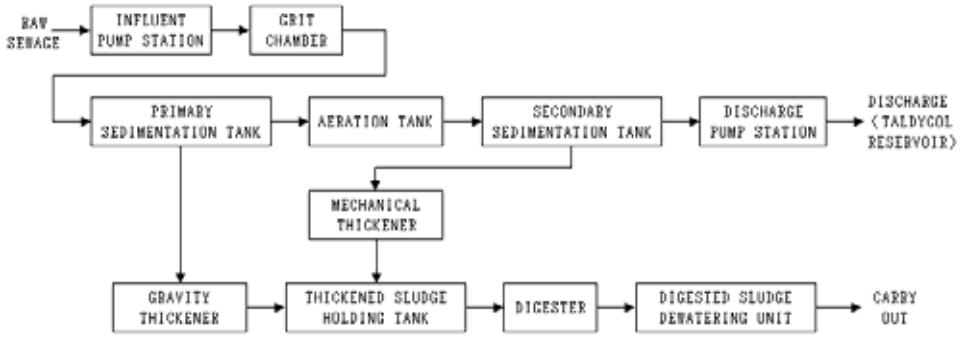


Figure 4.2.1 Treatment Flow of Astana WWTP

Design wastewater flow, wastewater quality and sludge production are described in the following tables:

Table 4.2.3 Design Wastewater Flow Rate

Category	Wastewater flow rate	
	m3/day	m3/hour
Daily average	114,000	4,750.0
Daily maximum	136,000	5,666.7
Hourly maximum	200,000	8,333.3

Table 4.2.4 Design Wastewater Quality

Item	Inflow (mg/L)	Primary treatment		Secondary treatment		Removal ratio
		Removal ratio	Effluent (mg/L)	Removal ratio	Effluent (mg/L)	
BOD	170	30%	119	83.2%	20	88%
SS	210	40%	126	84.1%	20	90%

Table 4.2.5 Design Sludge Production

Item	Sludge production		
	(m^3/day)	(DS-ton/day)	WC (%)
Thickened Sludge	546	27.3	95
Digested Sludge	546	16.4	97
Sludge Cake	74	14.7	80

2) O&M organization

O&M organization and job descriptions are presented in Table 4.2.6 and Figure 4.2.2.

Table 4.2.6 O&M Organization and Job Description of Staff

Organization/staff	Job description
General manager	Administration
Deputy manager	Assistance to administrator
Administration/financing	Purchasing and general affairs
Operation	Wastewater facility operation, monitoring & patrolling sludge facility operation, monitoring & patrolling Water quality examination
Maintenance/inspection	Inspection, repair
Guard and light job	Guard, cleansing & mowing

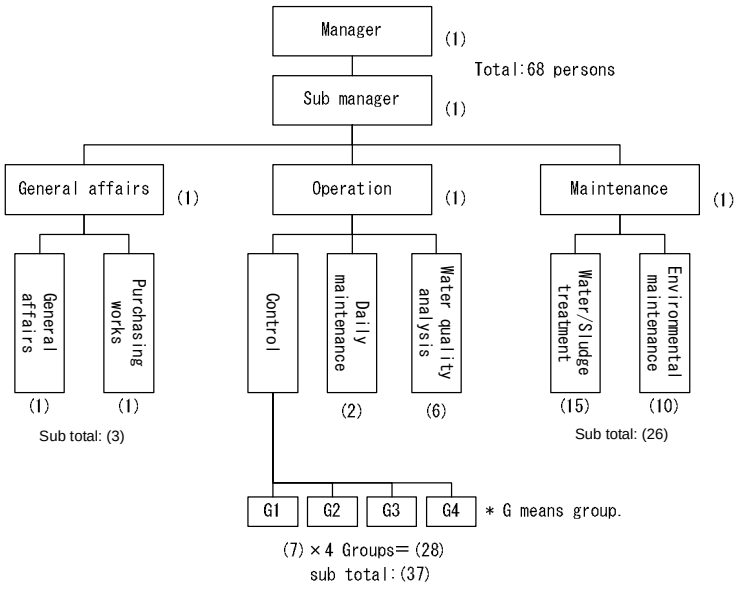


Figure 4.2.2 O&M Organization of WWTP in Astana

Table 4.2.7 Staff for Astana WWTP

Job	Occupation		No.	Remarks
Administrator	General		1	
	Deputy		1	
Administration/ Financial	Manager		1	
	Secretary		1	
	Financing		1	
Operation/ laboratory	Operation	Manager	1	
		Deputy	1	
		Cheaf	4	1 staff-4shift
		Operator	8	2 staff-4shift
		Worker	16	4 staff-4shift
	Patrol, inspection	Engineer	2	
	Laboratory	Manager	1	
		Analyst	3	
		Worker	2	
Inspection/ maintenace	Water treatment Sludge treatment	Manager	1	
		Chief	2	
		Engineer	2	
		Worker	10	
Light work	Cleansing, mowing	Manager	1	
		Worker	5	
	Guard	Guardman	4	1 staff-4shift
Total			68	

3) O&M Procedure for Sewerage Facility

a) O&M Plan and Execution

Sewerage O&M activities aim to improve environmental sanitation and to conserve water environment through sufficient treatment performance. WWTP in Astana intends to reduce pollution load on Tardecol Lake to comply with wastewater effluent discharge standards.

The O&M plan involves provision of operation manual for the facilities and equipment in accordance with wastewater effluent quality standard, based on information from design and construction documents.

Operation manual is supposed to provide operation range for stipulated water quality standard to ensure that every equipment fulfill its function. Routine inspection and patrolling, water quality examination and monitoring of control center determines the most practical operation range performance. In case operation is out-of-range, the cause will be detected and operation procedure consequently amended to meet the appropriate range. Regarding utility consumption of electricity and chemicals, most efficient ranges are detected through analyzing the relation between design target and actual performance.

b) Wastewater Quality Management

Since inflow rate and wastewater quality change in accordance with sewerage area expansion, number of tanks in operation, and operation range shall be reviewed in accordance with pollution load, sludge concentration and supplied air amount.

The points of concern for the sewerage facility in Astana WWTP are listed below:

- Wastewater inflow rate fluctuates seasonally. Reviewing the influence of flow increase and water temperature decline due to melting snow shall be performed as part of operation.
- Sludge putrefaction in primary sedimentation affects wastewater treatment and sludge processing through deposition during summer. Sludge shall be extracted within proper sludge retention time.
- In the case of biological nitrification/denitrification, difference of water temperature between summer and winter shall be carefully considered.
- Water temperature, which declines due to melting snow during spring, affects how long activated sludge settles in the final sedimentation. Activated sludge retention time (SRT) is to be controlled by adjusting the air supply and preventing sludge spill out.
- Sludge putrefaction proceeds with sludge flotation in gravity thickening tank. Sludge-liquid interface be reduced in order to prevent sludge putrefaction.
- Sludge concentration dose to digestion tank shall remain in high concentration in order to as much as possible retain digestion temperature. Gas production rate and digested sludge characteristics shall be monitored for stable digestion.
- In case of insufficient digestion, digestion period is controlled through dewatering of thickened sludge in order to reduce sludge dosing rate in the digestion tank.
- Sludge dewatering will be fixed in the most appropriate range through appropriate selection of coagulant and dosing rate.
- In case of wastewater and sludge putrefied, corrosive gas made up of sulfide hydrate is produced, eventually corroding metal and concrete. It is rational to retain sludge and wastewater in anaerobic condition in the shortest possible time.
- Ventilation efficiently prevents dew which easily captures corrosive gas.
- Water quality examination is executed for determining the operation manner of efficient treatment performance. Compliance with stipulations and results are recorded.

c) Recording and information management

Operation condition and inspection results are to be recorded. Monthly and annual records will be utilized to regularly verify fluctuation and its causes. This shall be considered in the preparation of the O&M plan for sequential annual plans. Data and information shown as follows are to be extracted for review:

i) Record on operation

Operation data of supplied air, wastewater flow rate and concentration automatically processed by SCADA system, shall be analyzed and considered

for daily and weekly operation to achieve stable/efficient performance.

ii) Information on water quality management

Information on water quality management is efficiently obtained through integrating water quality analyses and operation performance. Information and data items/frequency are to be selected from minimum but most reliable sources in order to properly update operation methods. Credibility is to be secured through routine sampling manner and examination procedures.

iii) Record of maintenance and inspection

Facility information system aims to accumulate record of maintenance and inspection, which is utilized for rehabilitation project as fundamental facts.

iv) Records of accident

Accidents and incidents are to be detected through analyzing alarm and routine operation. On-site inspection is indispensable to accurately determine causes of accidents and malfunctions. It also involves recording of failure process. Such procedure will anticipate causes and consequently determine corresponding counter measures.

4) Procedure for Facility Maintenance

a) Introduction of Condition-based Management

Since the life cycle cost of facility is considerable, cost reduction for maintaining the facility is vital. Facility role, inspection and examination in accordance with the degrading level shall be prioritized to ensure efficient facility management and reduce costs. This shall be executed as part of all O&M methods for the whole facilities.

Maintenance management system is categorized as shown Figure 4.2.3, which presents a comprehensive management procedure. Routine maintenance scrutinizes the individual method appropriately, while condition-based maintenance is most efficient for achieving cost reduction. Details of maintenance management system is described in Table 4.2.8.

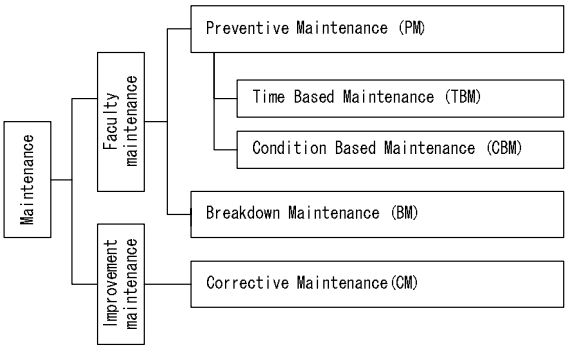


Figure 4.2.3 Structure of Maintenance Management System

Table 4.2.8 Detail of Maintenance Management System

Maintenance of Function	Preventive Maintenance (PM)	Time-based Maintenance (TBM)	Applied to facility after its failure to prevent future damage. Routine repair or replacing expendables is executed. This shall be with due consideration of the following: ・Cyclic degradation characteristics, less fluctuation failure ・Periodic replacement is more efficient than inspection.
			Maintenance procedure : Characteristic parameter (treatment performance, operation duration) of individual equipment detects maintenance cycle (design and empirical), and unconditional repairs. Applied equipment : life cycle easily detectable and those that fluctuates less Advantage : less inspection required consequently reducing man-power demand and equipment failures Disadvantage : may lead to over-maintenance and higher costs
		Condition-based Maintenance (CBS)	Inspect degraded condition and repair detected-base ・Advantageous equipment such as fluctuated life cycle ・Deterioration tendency which are difficult to detect ・Long and fluctuated life cycle
			Maintenance procedure : to repair based on detected sign and numerically analyzed life of degradation Applied equipment : fluctuated and accurately detected life cycle Advantage : Over-maintenance to be prevented Disadvantage: Higher costs for detecting system and demands of manpower for inspection
	Break down Maintenance (BM)	To repair based on break-down Equipment with less risk to the whole process break-down Equipment of fluctuated degradation tendency and which are difficult to inspect	
		Maintenance procedure : To repair after break-down without periodic inspection and replacement Applied equipment: Less risk for the whole system break-down with maintenance costs being less than the inspection cost Advantage: Less cost if there are no damage to adjacent facilities Disadvantage: Potential risk to the whole system and less efficient energy consumed	
Corrective Maintenance	Corrective Maintenance (CM)	Corrective maintenance shall be performed to expand life duration, reduce repair time and save operation cost. This takes into account the following: ・Equipment with short life cycle, frequently failing or requires high cost repairs ・Short time and high cost of maintenance, which significantly affects the whole system ・Fluctuated degradation tendency, which is difficult to inspect	

Lubricant inspection is applied to condition-based maintenance. Concentration of iron dust detects corrosion of rotating shaft shoe, gear and cylinder. Lubricant iron dust detecting technology is described as follows:

- Low-speed rotating machine, which does not produce vibration can be detected.
- Lubricant is degraded with grinding heat or moisture infiltration. Proper lubricity contributes to longer life duration.
- Irregular grind cause corrosion. Consequently, iron dust in lubricant increases due to the disorder.
- Position and condition of metal material and dust shape shall be detected.

b) Introducing Facility Information System

Database of facility information will provide record of periodic inspection, repair, failure, correction, various defective methods and maintenance. Facility information, in general, is described in Table 4.2.9.

Table 4.2.9 Facility Information

Data base	Facility	Information
Machinery information	Principal equipment	Name of equipment, equipment category, job description, location, installed date, spec, type, produced date, company name, constructor, maintenance history, other relevant information
	Accessories	Name, specifications and number of accessories, company name, other relevant information
	Expendables, provisions	Name, specifications and number of accessories, warehouse, replacement frequency, other relevant information
	Record of inspection, history of failure	Category of O&M works, job outline, date and cost
		Job description (venue, date, cost, counter measures)
Construction record	—	Annual record of construction and project cost

Facility information system (through processing statistical analysis) contributes to punctual inspection and repair cycle, leading to comprehensive O&M cost reduction and efficient management performance.

5) Utility purchasing and estimation of consumption rates

Rate of polymer dosing and electricity consumption of sludge dewatering process is described in Table 4.2.10 established based on 136,000 m^3/day of inflow rate, BOD of 170 mg/L and inflow quality, SS of 210 mg/L.

Table 4.2.10 Chemical Consumption

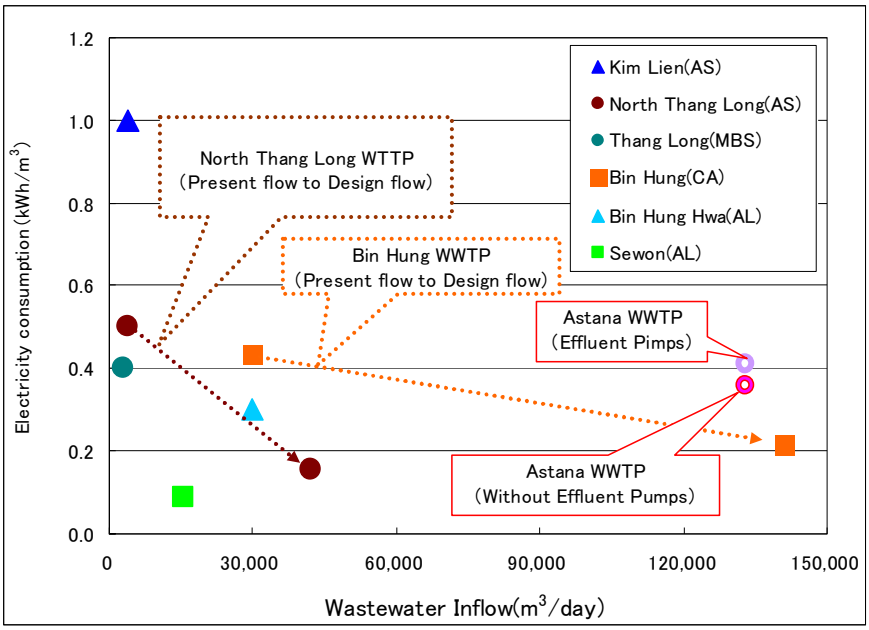
Chemical	Consumption rate	Remarks
Polymer	450 kg/day	Dosing rate：1.5 ppm

Table 4.2.11 Electricity Consumption

Facility	Equipment	Consumption rate [kWh/day]
WWTP	Lift pump	9,300
	Wastewater treatment	26,000
	Effluent pump	9,200
	Sludge treatment	5,200
	Boiler, others	6,800
WWTP Total		56,500
Unit electricity consumption（including effluent pump）		0.42 kWh/m^3
Unit electricity consumption（excluding effluent pump）		0.35 kWh/m^3

Since Astana WWTP facilitates effluent pumping station, the electricity

consumption rate of 0.42 kWh/m^3 is relatively high. In case effluent pumping is excluded, consumption is estimated to be 0.35 kWh/m^3, which is the same as the ordinary activated sludge process. Consumption rates obtained in Indonesia and Vietnam are described in the following figure for reference.



Source: JICA Study Team

Figure 4.2.4 Electricity Consumption Rate of WWTP in Astana

6) O&M plan

The O&M plan (Draft TOR of O&M contract) proposed for Astana is attached in Appendix-5.

4.3 Proposal to Sewerage Works

(1) Tariff Structure and Charging Level

Tariff structure for cold water (water supply and wastewater) of Astana is distinguished from hot water. Tariff structure is at flat rate and one group, in which household and commercial industries are not categorized due to fair charge rates (refer to Table 4.3.1).

Since O&M cost of conventional activated sludge process (excluding capital cost) is around 0.1 USD/m^3 (based on electricity price rate of 0.05 USD/kWh), revenue of tariff rate 0.06 USD/m^3 will be insufficient to meet O&M cost for treatment and pumping station (refer to Figure 4.3.1).

Table 4.3.1 Water Supply and Wastewater Tariff

Category	Tariff rate		Remarks
	(KZT/m^3)	(USD/m^3) *	
Cold water	23.15	0.15	Tariff structure for domestic/commercial consumption is based on flat rates
Water supply（58%）	13.43	0.09	
Wastewater（42%）	9.72	0.06	

Exchange rate: 1 USD＝150KZT

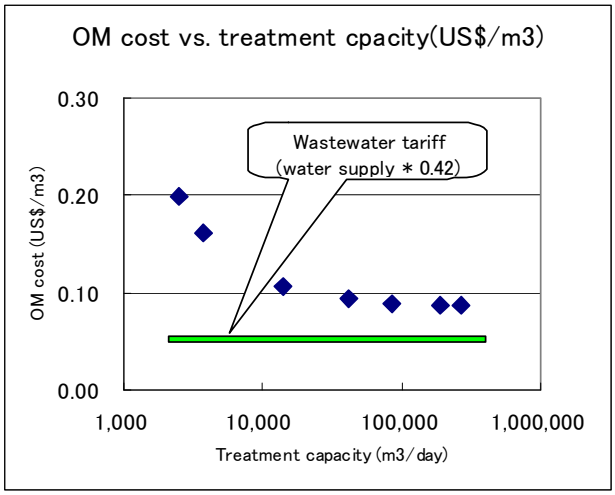


Figure 4.3.1 O&M Cost for Classified Treatment Flow Rate in Vietnam

Financial mitigation requires reviewing of O&M plan in detail, amending tariff structure and rates, and persuading levy on the public (Table 4.3.2).

Table4.3.2 Key Issues of Financial Mitigation

Issues	Details of financial mitigation	
Deficit of revenue - Low tariff rate - Sole tariff group	Financial plan: Tariff rate: Tariff structure:	Medium/long term financial mitigation (Financial simulation） Proper tariff rate Cross subsidy (From high income and commercial industries to low income groups), hierarchical tariff group for subsidizing effect
O/M plan	Retain performance and O&M cost reduction	
Lack of public awareness	Public education for water environment and sewerage tariff system	

(2) Guideline on Industrial Wastewater and Collaboration with Urban Development Projects

Sulfide (H_2S) and water temperature-related issues are reported, considering wastewater inflow. To prevent damages to sewer pipes and treatment plant facility, stipulation related to efficient wastewater quality is vital (refer Sewerage Ordinance of Appendix 6).

Population growth is remarkable in Astana since it became a capital city. In the city center, large scale urban development projects are on-going. It is preferable to let the developer

install sewer collection systems connecting to the public sewerage system. This will be advantageous in cost-saving not only for the government side but also for the developer side because it would not be necessary to install any on-site treatment systems.

(3) Septage Treatment

The housing areas are located adjacent the urban areas, where on-site treatment system are installed. To conduct septage treatment by on-site treatment plant is not efficient due to consequent anaerobic digestion, and household customer burdens. It is preferable to upgrade the public sewerage service receiving septage as well.

4.4 Study of Public Private Partnership (PPP) Scheme

(1) Outline of PPP Scheme

Water supply and sewerage are administrative services since these infrastructures are for public purposes and require long period and costs for facility implementation. In other developed countries, PPP methodology is applied to infrastructure development for rehabilitating aged facilities, upgrading the facility functions to mitigate environmental impact or disaster, due to financial and technical reasons as well as issues on decreasing the number of knowledgeable engineers. Developing countries also applies PPP for financing investment and for utilizing technology and know-how. PPP is applied to many sectors of public works in UK since 1990s, and related projects shares 10-13 % of public works at present.

OECD defines PPP projects as private company providing facilities and services such as hospitals, schools, correctional institutions, roads, bridges, tunnels, railways, water supplies, solid waste management, and others. Private entities may consist of private firms, NGOs, religious organizations, institutions or universities.

PPP also enhances public service efficiency, employment and new services through marketing and competition. PPP has characteristics of sharing risk and cost, and collaboration with public and private sectors. As an example, the public side has the tasks for establishment of related regulations or development of basic infrastructure.

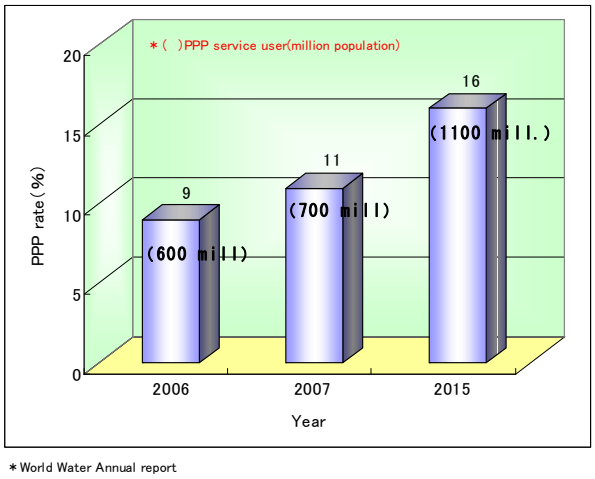
The difference between PPP and private finance initiative (PFI) is practicability of privatization. A PFI project is usually adopted, considering that the private company involved invests and operates on the basis of marketability, as they earn full profit without any governmental investment. On the other hand, PPP project is applied to non-marketable public services. The private company involved can get profit through proper government interventions. Hence, for the projects to be profitable, public service need to be more efficient through acceleration of marketability options.

International society has insisted the importance of PPP because motivation, finance and

technology and expertise of private companies contribute to the efficiency of the ODA. Millennium Development Goals (MDGs) in 2000 defines PPP as the 8th goal. In 2002, United Nations International Conference on Financing for Development emphasized governmental reconstruction for initiatives to private investments.

Water supply services and sewerage works have been operated by municipal governments in many countries. About 91% of people around the world purchased water supplied by governments until 2006. However, many countries have initiated privatization of water related services due to lack of government finances and serious drought.

Various types of PPP schemes are applied to projects. World Bank categorizes PPP projects as shown in Table 4.4.1. Private company which is implementing new infrastructure development (Greenfield project), rehabilitating existing facilities (Concession) and committed to operating projects are categorized. However, these are not related to business types.



＊World Water Annual report

Figure 4.4.1 PPP Service Rate (Water Supply)

United Kingdom (UK) differentiates BOT (operator collects charges from consumers) and PFI (operator obtains charges from the government) based on business types. In the BOT business type, ownership is transferred to a private company which collects capital cost and profit. In the PFI business type, private company invests in public works and obtains revenue from governments.

Table 4.4.1 Category of PPP Business Type

Category	Definition
Greenfield project	Private company constructs and operates facilities in due coarse of time. ＊ BOT（Build-Operate-Transfer） BOOT（Build-Own-Operate-Transfer） BOO（Build-Own-Operate） BTL (Build-Transfer-Lease), and others
Concession	Existing facility is transferred, and private company rehabilitates and operates facility in due coarse of time. ＊ ROT(Rehabilitate-Operate-Transfer), etc.
Divestiture	Private company purchases municipal asset or stocks.
Management & Lease Contracts	Private company manages and operates facility in due coarse of time. ＊ Excluding O&M outsourcing

(2) Present PPP in Asia, Indonesia and Vietnam

1) PPP in Asia

PPP projects in Asian developing countries declined since 1997 due to the currency crisis. This situation seems to be improving recently.

Water supply and sewerage projects under PPP scheme in Asia include 148 projects. This accounts for 13.3% of whole PPP projects, which is around 25.7 billion USD. This also involves 7.9% of investment cost. The number of projects and the amount of investment costs are less than the other sectors (Figure 4.4.2).

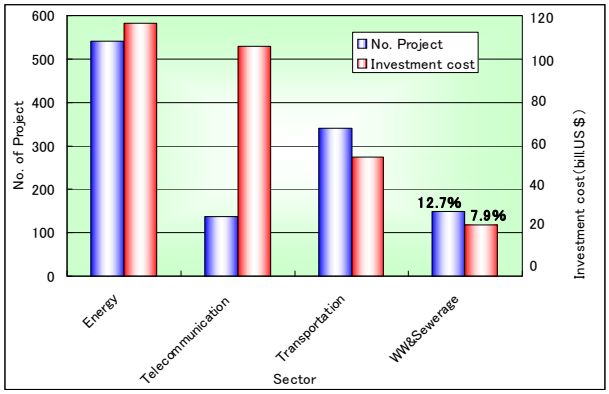


Figure 4.4.2 PPP projects in Asia (1999-2005)

As for regional and sector bases, a significant number of projects are seen in East Asia (mainly in China) during the period 1990-2005. Meanwhile, the projects with larger investment scale are seen in Southeast Asia (Indonesia, Philippines, Malaysia, Vietnam and Thailand). Investment for energy and transportation sectors is the largest scale, and telecommunication sector project scales are also relatively high in Southeast Asia (Figure 4.4.3). Sewerage sector accounts 8.6% of the total number of projects, and 13.0% (equivalent to 19.4 billion USD) of the total investment costs.

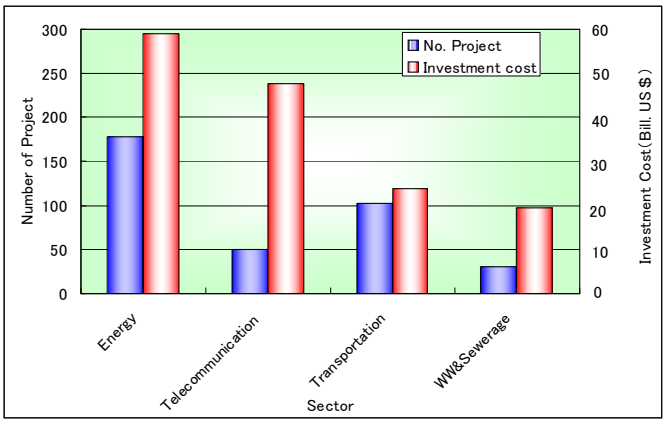


Figure 4.4.3 PPP Projects in Number in Southeast Asia (1999-2005)

2) PPP in Indonesia

The National Committee for the Acceleration of Infrastructure Provision was established for infrastructure development strategy, coordination and implementation program in Indonesia. The Committee consists of Departments of Economic Coordination (chairman), Development and Planning, Internal Affairs, Finance, Energy, Public Works, Transportation, Information and Communication, and the Government Administration Cabinet. The target sectors are sea ports, airports, highways, bridges, irrigation systems, water supply and sewerage facilities, telecommunication systems, power supply and oil/gas.

Investment project cost in Greenfield Projects (34 projects) is 17.5 billion USD in 1990-2005. This shares about 8.8% of the whole Greenfield Project PPP in Asia (199.1 billion USD for 732 projects). Energy and telecommunication sectors occupy the majority sector (Table 4.4.2 and 4.4.3). As for the whole projects in 1990-2005, Indonesia undertakes 68 projects equivalent to 32.6 billion USD, while Asia initiates 1,166 projects for 300.8 billion USD.

In the water supply and sewerage sectors, there are four Greenfield Projects undertaken. Meanwhile, there are three concession projects with investment of 160 million USD, 830 million USD and 990 million USD respectively.

Ticokol Water Purification Plant is a concession type (ROT) project operated by TKCM. Water supply in Jakarta, operated by Ondeo group, has raised issues on water price escalation of more than 30% every year.

Table 4.4.2 Number of PPP Projects in Indonesia (1990-2005)

Category	Greenfield Project	Concession	Divestiture	Management & Lease	Total
Energy	19	―	2	1	22
Communication	8	6	3	―	17
Transportation	3	19	―	―	22
Water supply/Sewerage	4	3	―	―	7
Total	34	28	5	1	68

Source: PPP Database, World Bank

Table 4.4.3 PPP Projects in Cost in Indonesia (1990-2005)

(Unit: Million USD)

Category	Greenfield Project	Concession	Divestiture	Management & Lease	Total
Energy	12,063	―	487	―	12,549
Communication	5,126	4,830	6,891	―	16,846
Transportation	164	2,073	―	―	2,237
Water supply/Sewerage	160	832	―	―	992
Total	17,512	7,735	7,377	―	32,624

Source: PPP Database, World Bank

3) PPP in Vietnam

Vietnam is rapidly promoting its market economy through renovation of its development policy (Doi Moi Policy). Demand for infrastructure development is increasing. However, PPP project implementations are facing some obstacles such as: the municipalities are negative; the tariff rate is low; and awareness on PPP is insufficient. PPP investment shares 16% of its whole infrastructure investment in 2003 (Vietnam Infrastructure Development Report 2003, World Bank). PPP project investment of the entire sectors in 1990-2003 are 3.2 billion USD in 1990-2005, which is the lowest among ASEAN and less than 2% of the total investment for Asian countries. The energy sector shares 81% while water supply and sewerage is at a low level of around only 2% (refer to Figure 4.4.4). Since the Vietnamese Government is positive towards PPP investment scheme in infrastructure, information on stipulations, the existing tariff systems and restrictions should be studied carefully prior to implementation of PPP projects.

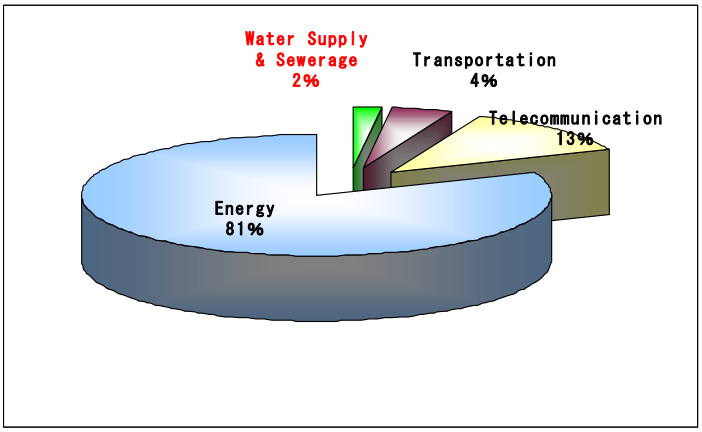


Figure 4.4.4 PPP Projects in Vietnam (1990−2003)

(3) Barrier on Participation of Japanese Companies in PPP Schemes

1) Barrier on regulations and stipulations

Although the Vietnam government is positive towards PPP investment on infrastructure, there are still various restrictions imposed on such scheme. The report on Vietnam Private Sector Assessment (ADB, 2005) indicates that there are the following issues in the water supply and sewerage sector in Vietnam:

- In large cites, private companies are restricted from operating WWTPs. The service provider should be established as a joint stock company with the 50 % shares of the government.
- No success cases of BOT and O&M contracting are seen.
- Only the wholesale services are permitted to the private sector.

Although the country is positive towards the scheme, there are still barriers on

regulation and stipulations related to PPP participation. In order to promote private investment, it is vital to review institutions and regulations related to preventing PPP participation. Moreover, private companies should build their capacity in the operation and executing business plan, including financing.

Project scheme with uncertain estimates of future demand, such as the Jakarta water supply, will levy tariff raise due to deficit of revenue, leading to serious public concerns that could affect PPP prevalence. Private companies should secure cost management though careful project programming and financial estimation. Furthermore, poor service levels provided, instead of finding means to reduce O&M, are issues of public complaints. Private company must achieve value for money (VFM) through applied knowledge and motivation.

2) Support of the government

PPP in developing countries is different from that in developed countries in terms of complicated issues between concerned recipient and donor countries. PPP in developed countries involves collaboration between the government and private company. In developing countries, meanwhile, PPP necessitates good relationship between the private companies from both the recipient and donor countries.

Global water business operator may succeed through government support. Japanese company also requires collaboration with and support of the national government.

Asia PPP study report (Ministry of Economy, Trade and Industry, 2005) reports the issue of PPP participation in Asia as follows:

- Political reforms initiated by the Japanese Government
- Administrative reforms of Japanese private companies
- Collaboration with Japanese Government and private companies

3) Issues on PPP contracts

PPP contributes to sewerage services in terms of retaining/upgrading service performance and cost reduction through O&M expertise, procurement network and skills in professional service providers. As sewerage business lacks marketability, it is important to develop an institutional system in order to upgrade public service quality through appropriate municipal intervention and “market” & “competition”.

Water supply and sewerage service is achieved through proper risk demarcation between public and private as follows:

a) Financial availability concerning project progress:

One of risks in construction phases of PPP is land site acquisition for intake and securing of water resources in water supply sector, and approval on effluent discharging in sewerage sector. In PPP contracts, responsibilities or penalties in case of progress delaying should be clearly mentioned.

Considering project progress, On the other hand, fund arrangement from the government side should be carefully managed if the projects perform good progresses.

b) Project cost hike:

Since project cost is easily affected by unpredictable price escalation and site-related conditions, penalty/responsibility of both parties shall make the followings clear:

- Price escalation: Price escalation is stipulated as payment of both parties based on general project contract. Excess risks levied to the contractor affects public service prices in PPP projects. Escalation procedure based on accomplishments needs to be defined
- Unpredictable conditions: Lack for on-site survey related to house-connections, for example, affects unpredictable delays or costs.

Since above mentioned risks may be attributed to both parties, risk sharing shall be stipulated.

c) Suspension of Project:

Suspension of the project could be caused due to either natural disaster or defects of the private sector side. The risks should be defined in terms of demarcation and exemption in accordance with risk background. Hence, said operator should scrutinize whether risk insurance is applicable or not.

d) VFM (Value for Money):

The contract should define condition of profit to the operator when VFM is estimated.

e) Efficiency of equipment and performance monitoring:

Responsibility related to deteriorated functions should be focused in the case of rehabilitation project (ROT) in the risk analysis. It is the operator's task to execute survey and analysis of functions the existing equipment and facilities to determine required repairs to be done by the public sector in the pre-construction stage. The public sector should also carry out inspections on those functions to ensure that O&M is executed properly by the designated operator.

f) Accidents on water quality and quantity:

The public side stipulates a penalty in case of poor performance of treatment works in the regulations or contracts. Operator scrutinizes whether insurance is applicable or not. Normally in the sewerage sector, there are accidents related to effluent water qualities and storm water inflow affecting the pipeline facilities. Against such accidents happenings, the tasks and responsibilities of the both sides should be stipulated.

(4) PPP Participation of Japanese Companies

PPP is defined as collaboration between governments and private companies through technical assistance, O&M, construction/rehabilitation, finance and operation of infrastructure.

PPP for water supply and sewerage in Asia is not common since it does not seem "commercially viable". Therefore, a Japanese company shall participate in the step-wise approach in order for such scheme to prevail.

Step-wise participation in PPP is applied to three phases, such as technical and know-how support, technology transfer during facility construction, and operation, including public service. Such phases are further discussed as follows:

1) Technical and know-how support

Acknowledgment for Japanese experienced technology is the first step in supporting the planning of various environmental infrastructures, design and construction. Facility inspection and rehabilitation programming contribute to the project implementation and construction. ODA from Japanese Government for such technical and know-how support is one form of assistance to PPP participation.

2) Technology transfer during facility construction

Transfer of construction and O&M technology enhances technology/capacity of developing countries. Human resources from concerned developing countries will be expected to improve during project implementation. This means that it is important for PPP participation to coordinate with expert engineers and companies in the concerned country.

Technology transfer is effective through government support to private company. For example, the private firms employ an affiliated company and participate in O&M outsource of PPP prototype. The private company therefore will learn from experiences related to various issues, and gain expertise in trouble shooting and reducing costs.

3) Operation including public service (Overall PPP participation)

As for the phase of facility construction and operation including public service, information and human resources obtained from technical and know-how support and technology transfer are focused as part of the proposal for the PPP project. The Study realized that some facilities are poorly functioning due to inappropriate market procurement or technology. Proposed feasibility projects will lead to sustainable operation (marketability).

Through these phasing, the private company minimizes risks and enhances public service quality.

(5) PPP Proposed in Astana City

Urbanization in Astana City is growing rapidly since becoming a capital city. Its population is 610,679 in April 2008 which is equivalent to the population in 2020 estimated based on the master plan of urban development (Table 4.1.2 and 4.1.4). Population is expected to further increase. It is therefore necessary to expand water supply facility and sewerage system to meet the increasing service demands.

Present water supply and sewerage tariff rates (0.09 USD/m^3 and 0.06 USD/m^3, respectively) are lower than O&M costs. Moreover, subsidy from municipal government is indispensable to initiate facility expansion and replacement. Investment for water supply and sewerage is insufficient due to costly project implementation and other infrastructure demands.

PPP may be effective for water supply and sewerage system services. While PPP invests in water supply due to marketability, PPP for sewerage system remains restricted.

The followings schemes are therefore proposed for PPP projects in Astana City:

- Affiliated operation of water supply and sewerage can be subsidized from water supply profits.
- Water supply introduces bulk water production in order to prevent price escalation in case of water retail.
- PPP operator should invest for stipulated service level in terms of VFM.
- Water supply and sewerage tariff should be amended to impose appropriate rates under implemented PPP project in order to mitigate municipal subsidy and minimize project deficit.

PPP is effective in mitigating financial issues for expansion and construction of water supply and sewerage system. It is noted that private company invests on water supply due to marketability. Sewerage system meanwhile requires subsidy from national/municipal government due to significant tariff escalation. Therefore, it is vital to carefully study financial sustainability.

CHAPTER 5 CONCLUSION

5.1 Issues on Sewerage Works in Developing Countries

(1) Sewerage in Developing Countries

Issues of sewerage in cities of developing countries normally affect not only human living conditions but also socio-economic activities, i.e. deterioration of natural environment, urban sanitation, surface water resources, and underground water resources, are caused by untreated wastewater discharges, and urban inundation and subsequent traffic hindrances are caused by lack of drainage systems. Particularly, urban inundation often seriously affects not only human activity and property, but also national or regional security control. Wastewater is also discharged to public water bodies through drainage facilities. Therefore, the drainage system should be prioritized and developed in accordance with measures to prevent the possibility of water environment pollution. These issues are examined through the environmental impact assessment of each target area.

For a long time, sewerage has been overlooked and neglected unlike the development of other infrastructures due to the limited capacity among municipalities and local people to bear the costs. In recent years, sewerage has been developed and operated in some places in Hanoi, Ho Chi Minh, Jakarta and Yogyakarta, where the study team surveyed. Affordability and willingness-to-pay for wastewater tariff among the local people, however, are basically much lower than the required cost for practical operation and maintenance of sewerage systems. Hence, policy goals and tools for sewerage development shall be adopted appropriately in order to establish a plan taking account of the demand and affordability of local people. In addition, wastewater tariff shall be carefully studied and set properly in consideration of the living status and income level in the target area.

Efficiency of the water environment improvement through sewerage normally influences not only individual living conditions but also the basin-wise environment, which goes beyond administrative boundaries. Therefore, it is important that the development and O&M costs be properly allocated among stakeholders on the basis of the sewerage level, i.e. development cost of trunk sewers and wastewater treatment plants shall be borne by the government, the development cost of collector sewers and O&M costs of sewerage by the municipality, and the sewerage connection costs by users.

(2) Stepwise Sewerage Development

In Hanoi, Ho Chi Minh and Yogyakarta, interceptor sewerage has been adopted to the sewerage development because almost existing sewerage can be used. The interceptor sewerage generally effects to the commencement of sewerage service in the immediate

term so that the interceptor sewerage is suitable to the said cities where the sewerage system shall be urgently developed for water environment improvement. On the other hand, Jakarta has introduced small-scale sewerage systems to communities or housing development areas. In the city center of Jakarta, the centralized sewerage system has been adopted as a basic sewerage development procedure. According to the sewerage policy of Jakarta, small-scale sewerage is promoted for basin-wise water environment improvement at the beginning of the sewerage development term. After partial development of the small-scale sewerage in the basin, Jakarta recognizes that a centralized wastewater treatment plant should be constructed and connected to the surrounding small-scale sewerage for collective wastewater treatment. Jakarta defined this system as the "modular system".

In other cities of developed countries like Singapore or Gaoxiong, interceptor sewerage system was constructed first from the standpoint that improvement of the river water environment and urban sanitation is indispensable to sustainable urban development. After the interceptor sewerage construction, sewerage have been upgraded into the conventional sewerage adopted in the developed countries through step-wise development process i.e. tertiary sewer development and house connection was promoted in accordance with public demand rising to sanitation improvement, water environment improvement and sewerage service expansion.

There are various kinds of low cost sewerage technologies in practical use i.e. simplified sewerage, condominial sewerage, interceptor sewerage, etc. It is important that medium- and long-term sewerage development plan be provided, taking account the integration of small-scale sewerage to the centralized sewerage. As applied in Yogyakarta and Denpasar, septage is collected and treated at the wastewater treatment plant. From the viewpoint that the sewerage functions as a basic process for water environment and sanitation improvement, the sewerage executing body shall be organized on the basis of a comprehensive management policy to ensure technical strengthening and efficient resource use.

5.2 Issues on Operation and Maintenance of Sewerage

In general, an O&M organization, regulation and institution related to the users shall be established in advance when the sewerage system is newly put into operation. As for the practical O&M of sewerage, various attentions to sewerage service ratio, inflow rate, inflow load, public comments, etc. shall be strictly required, unlike during the planning and construction stages. Particular conditions of the project area shall be considered in O&M planning and institutional arrangement, since demand and socio-economic status effects to sewerage normally varies in each area.

(1) Operation and Maintenance Plan

For operation and maintenance planning, it is important that daily observation records of the facilities be fed back to the O&M plan by means of the establishment of daily, weekly, monthly, annual and medium-term O&M plans for the purpose of costs savings and quality control. This should be undertaken in addition to the O&M procedures for the fluctuation of inflow rate, quality and mechanical trouble.

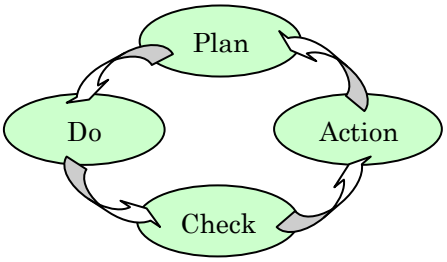


Figure 5.2.1 PDCA Cycle

Many kinds of materials and chemicals are imported from other countries because of their limited availability in the local market. Various kinds of industrial products are produced and distributed globally from the factories of international commercial companies in Indonesia and Vietnam. Common chemicals like chlorine used for disinfection and spare parts of general equipment are available in the local market. For important equipment and facilities, it is suggested that use of stand-by equipment, stocks of spare parts, and converted use of materials for similar works, shall be considered in the medium-term O&M plan to achieve savings in costs and for emergency use.

Hanoi City has been expanding sewerage services on the basis of a sewerage development plan, which include seven wastewater treatment plants. In this line, introduction of an integrated remote management system for the main facilities of the wastewater treatment plants and pumping stations seems to be efficient for O&M cost saving through minimization of operators. In the future, shakeout of O&M organizations may be indispensable after the efficient sewerage business operation is realized by means of promotion of the data feedback system to the O&M procedure. Particularly, the present operation procedure involving operators for 24 hours at the site shall be improved by means of the remote management system. Moreover, the said matters shall be considered in the medium- and long-term sewerage O&M plan.

It is important that the sewerage executing body to consider that daily O&M activity be fed back to the renovation and expansion plan of the facilities, and the medium- and long-term sewerage management plan, including strict control of discharge quality and quantity.

(2) Wastewater Tariff Level and System

Although a large budget is required for the development, operation and maintenance of sewerage, public awareness on the role of sewerage, such as water environment improvement and conservation, is not promoted enough. Domestic water use and public

sanitation environment are seriously affected by the interruption of sewage collection and treatment due to inappropriate O&M of the facilities. In addition, current wastewater tariff levels are set at quite low levels such that proper O&M for sewerage is not possible. Hence, the risk of financial implosion in some sewerage works will probably arise in the future.

It is strongly recommended that the wastewater tariff system be reformed to appropriate levels, taking into account the cross subsidy principle. This principle entrusts affordable tariff to the low income group, and levies higher tariff to the high income and commercial business groups in order to supplement revenue shortages from the low income group. In developed countries, the municipality introduces public involvement (PI) in their sewerage works in order to promote public awareness on water environment conservation, amenity creation, and so on. Accordingly, concise and sustainable public education shall be indispensable by means of public awareness promotion.

(3) Coordination among Concerned Organizations

Sewerage is one of the principal urban infrastructures to sustain public sanitation environment, socio-economic activities, and water resources conservation. As for public works of the water environment conservation, wastewater treatment and storm water drainage, it is quite difficult for a single organization to perform all of these tasks effectively. For enhancement of public awareness promotion on sewerage works, acceleration of urban development, control of wastewater pre-treatment for industries, flood control and sanitation improvement, coordination among public sectors and stakeholders, shall be indispensable.

On the other hand, it was found that a joint secretariat has been conducted among related municipalities where the sewerage works is highly demanded, area-wise. For instance, KARTAMANTUL in Yogyakarta has a joint secretariat for sewerage management for three municipalities, which is the same system as the Japanese regional sewerage system. Such administrative arrangement is also popular in western countries. The said institutional arrangement is efficient for regional development, consensus-building among stakeholders, and area-wide public works, including sewerage works.

5.3 Issues of PPP in the Sewerage Sector

With regard to Public-Private Partnership (PPP) for the public service sector, its objectives are to increase job opportunities and create new service field, as well as to promote the market competition mechanism for efficient public services. It is essential that PPP allocates risk and cost for public services between the public sector and the private sector i.e. development of the fundamental infrastructures and the related

regulations by the public sector normally enhances the market competitiveness of the country, including the private sector.

The environmental public works sector, including water supply and sewerage, in Asian countries has not been opened to the private sector. It is supposed that sewerage works may not be deemed commercially viable because the wastewater tariff is set at a low level to the practical O&M of the facilities, causing difficult business operation. Accordingly, PPP for sewerage works is not aggressively promoted as compared with other public works. Market participation to the sewerage sector should therefore be accelerated by steps to gradually penetrate the PPP market of the target country. Capacity development program on sewerage works for the private sector has been proposed in order to encourage technical knowledge and know-how support, technical transfer and comprehensive business participation, including O&M and management. In line with this, implementation of the proposal-based PPP will be highly expected through the efficient use of information and developed human resources obtained through the said training program.

In addition, the broader institutional design for PPP shall be required from both the donor country and a recipient country, in consideration of integrated PPP of water supply and sewerage works, the mode of the service contract like concession or wholesale, incentives for profit, and promotion of the PPP participation. It is concluded that high marketability and efficiency of the public service will be realized eventually by means of the proper application of PPP.

5.4 Recommendations to Issues

(1) Intelligence Sharing

Through the field survey and the literature examination, it was found that sewerage works is generally regarded and developed as an effective infrastructure for urban environment improvement in both countries of Indonesia and Vietnam. These two countries have also been tackling improvement of the sewerage works. For sustainable sewerage works, intelligence sharing on successful and unsuccessful experiences, and O&M know-how is most important issues among related organizations. In Indonesia, workshops on water supply and sewerage works are often conducted in a year in order to increase opportunities for intelligence sharing on wastewater treatment technology, tariff system, management procedure, etc.

(2) Feedback of Know-how to Sewerage Works

Regarding the sewerage O&M plan, the utility consumption and sludge generation normally fluctuate in accordance with the inflow rate and load. Consequently, alternative

measures to practical issues for efficient O&M can be established, through the analysis of the expenditure structure and work scopes of O&M. For instance, the study on introduction of the remote management system for the wastewater treatment plants of Hanoi and the study on sludge treatment process improvement for Ho Chi Minh are very useful to O&M cost saving.

In the medium-term, it is supposed that highly efficient and low-cost O&M procedures can be ensured through the introduction of the knowledge feedback system for sewerage works.