People's Committee of Hanoi City
Socialist Republic of Viet Nam

Study for Introduction of PPP for Sewerage Facilities in Hanoi

FINAL REPORT

OCTOBER 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.
WATER AGENCY INC.
ORIX CORPORATION
PADECO CO., LTD.
YOKOHAMA WATER CO., LTD.

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SUMMARY

i. Objectives of the Study

Accompanying with rapid industrialization and urbanization in Hanoi City, domestic and non-domestic wastewater discharge is increasing significantly. Japanese Government has assisted the Hanoi City to protect the City's water environment from increasing wastewater discharge by constructing sewerage facilities in Kim Lien, Truc Bach, North Thang Long through the Hanoi City Water Environment Improvement Project Phase 1&2 implemented by Japanese ODA Loan Program. In near future, construction of additional two sewerage facilities for water environment improvement will be commenced by Japanese ODA Loan in Bai Mau and Yen Xa.

Hanoi Sewerage and Drainage Company (HSDC) has been assigned by the Hanoi People's Committee (HPC) as a public entity for Operation and Maintenance (O&M) of drainage and wastewater facilities owned by the City. In order to accommodate expanding the sewerage service area and increasing the sewerage facilities in near future, Japan International Cooperation Agency (JICA) conducted the Study for Introduction of PPP for Sewerage Facilities in Hanoi. The Study contains three scopes below;

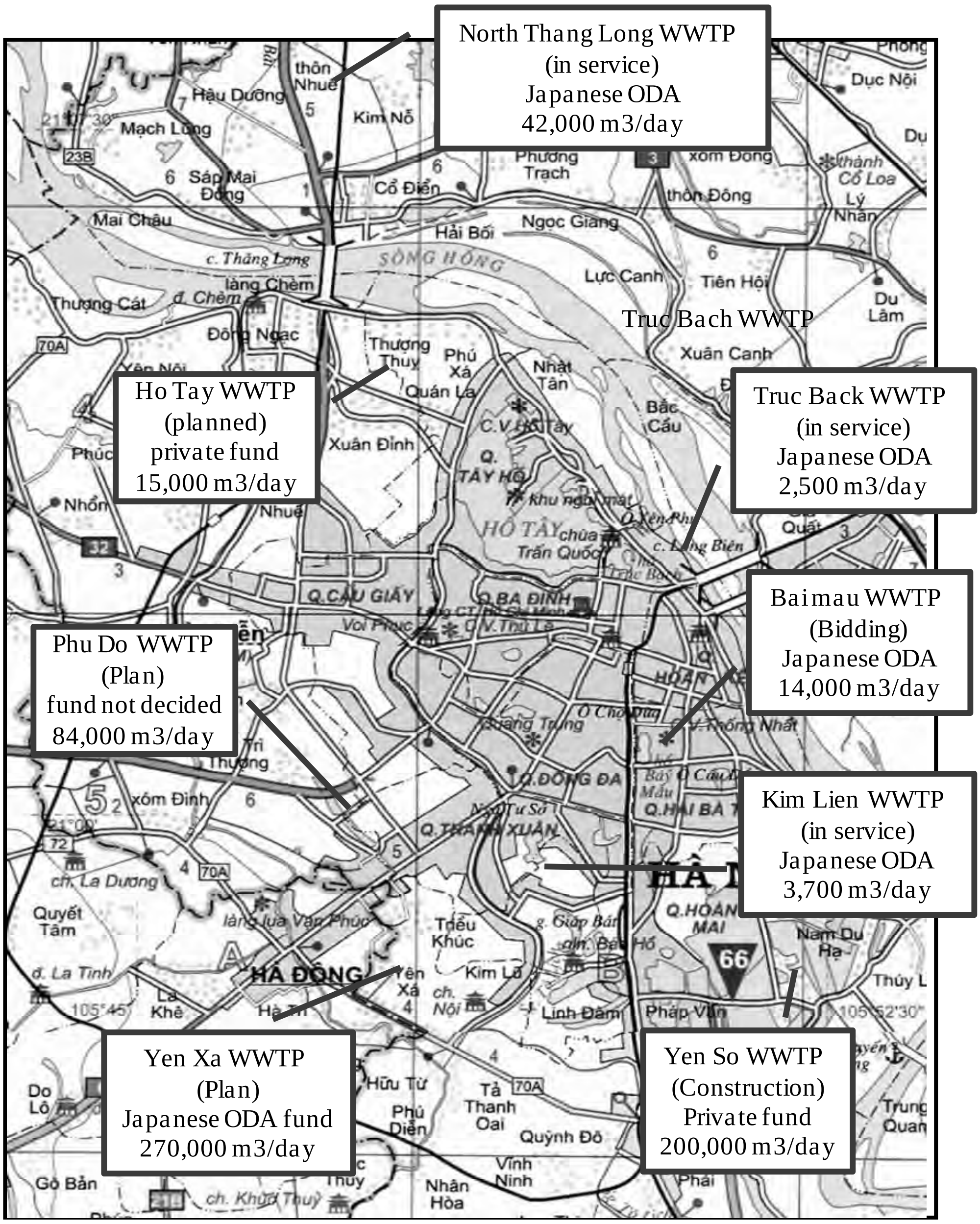
(1) Betterment of Operation and Maintenance in the existing wastewater treatment plants
(2) Development of a framework for the Integrated Operation and Maintenance Services (IOMS) to Bai Mau and Yen So WWTPs by using maximum benefits of PPP scheme
(3) Formulation of Sewerage Tariff Plan and Financial Plan related the sewerage service for ensuring sustainability of the sewerage services in Hanoi.

Table S1 Existing & Additional Wastewater Treatment Plants in Hanoi

Plants / Feature	Existing Plants		
	Kim Lien	**Truc Bach**	**North Thang Loang**
Capacity (m^3/d)	3,700	2,500	42,000
Service population	15,700	—	110,000
Start operation year	2005	2005	2009
Fund	Japanese ODA loan	Japanese ODA loan	Japanese ODA loan
O&M body	HSDC		

Plants / Feature	Additional Plants				
	Bai Mau	**Yen So**	**Yen Xa**	**Phu Do**	**Ho Tay**
Capacity (m^3/d)	14,000	200,000	270,000	84,000	15,000
Status	Bidding	Construction	Plan	Plan	Construction
Fund	ODA loan	Private	ODA loan		Private
O&M body	Not decided y	HSDC	Not decided	Not decided	HSDC

Source: HSDC and JICA Study Team



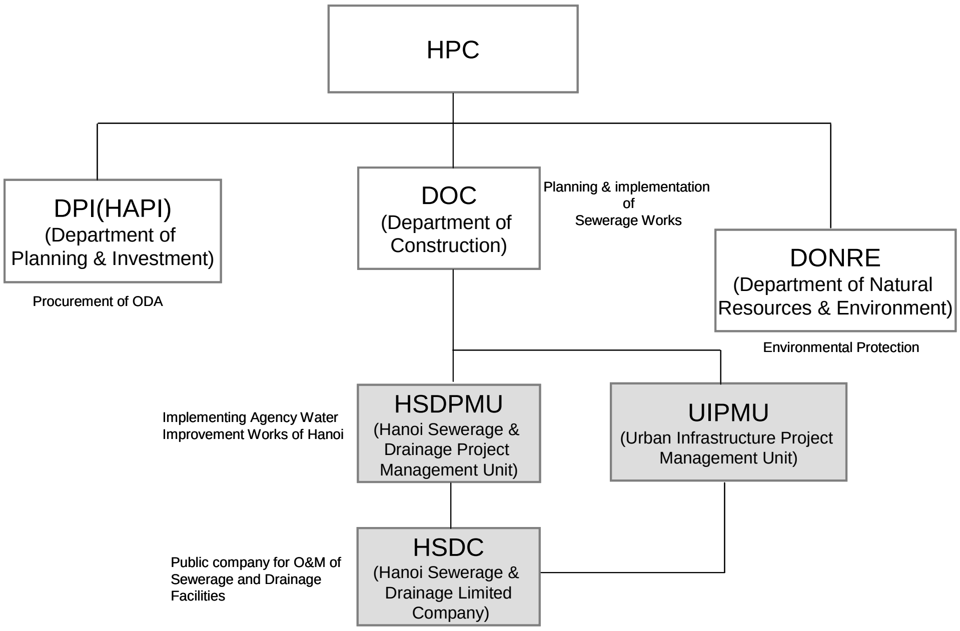
Source：Strengthening of Operation and Maintenance of Sewerage Facilities in Hanoi

Figure S1　Wastewater Treatment Plant in Hanoi

ii. Operation and Maintenance of Drainage and Sewerage Facilities in Hanoi

The administration agencies for drainage and sewerage in Hanoi People's Committee (HPC) are Hanoi Planning and Investment Authority for the planning aspect, the Department of Finance for the financial aspect and the Department of Construction (DOC) for the technical aspect. Under DOC, Hanoi Sewerage & Drainage Project Management Board (HSD-PMB) is assigned for the project management and HSDC is assigned for O&M of facilities.

HSDC's working field has expanded widely, hence HSDC is managing facilities through their subsidiary company called Wastewater Treatment Enterprise (WTE).

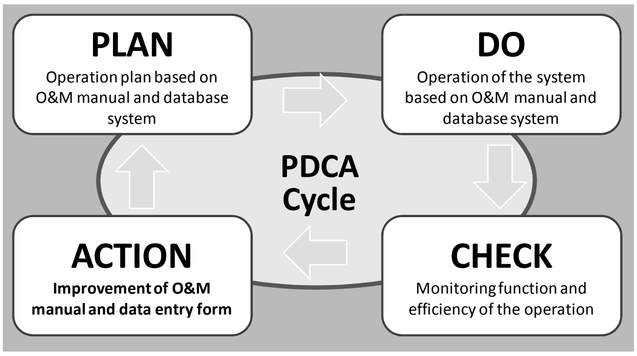


Source：Strengthening of Operation and Maintenance of Sewerage Facilities in Hanoi

Figure S2 Institutional Framework of Sewerage Service in Hanoi

iii. Betterment of Operation and Maintenance of existing Wastewater Treatment Plants

HSDC's O&M works in 3 existing WWTPs are implemented based on the O&M manual. The JICA study team intended to introduce Plan-Do-Check-Action (PDCA) cycle in their O&M works. PDCA cycle means P for decision making, D for working as per decision, C for monitoring & evaluation and A for rectification, that is essential for continuous improvement of organizational working efficiency.



Source: JICA Study Team

Figure S3　PDCA cycle

The JICA study team used the O&M manual as a medium for introduction of PDCA cycle. The existing O&M manual was authorized by HPC at completion of each WWTP construction that covers most things for O&M works, though HSDC found necessary improvement of the O&M manual during 5 year operation of WWTPs requested The JICA study team to improve the O&M manual relating to the points below;

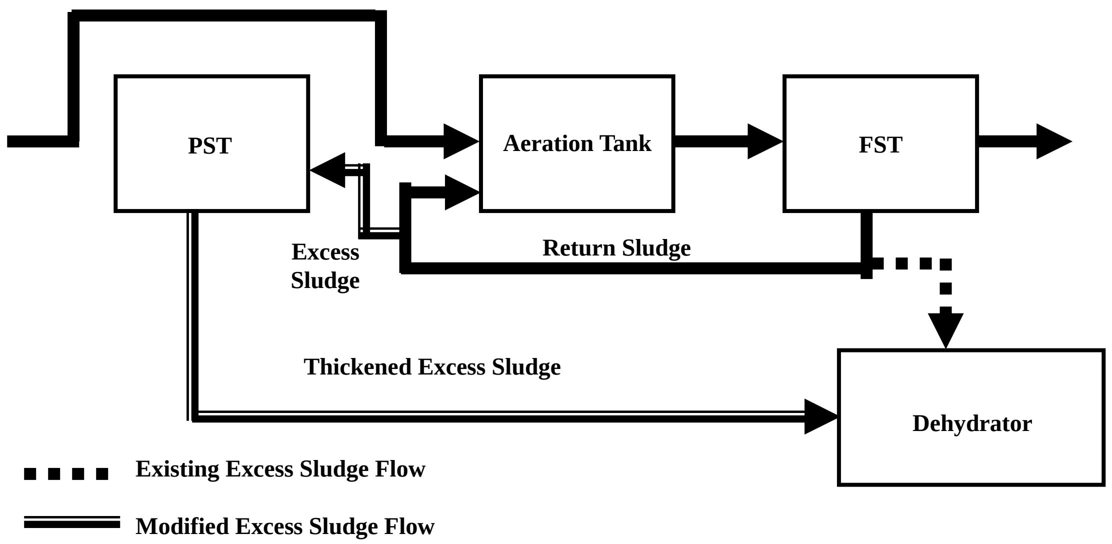
(a) Add the evaluation criteria of O&M data,
(b) Contingency plan of the sewage treatment process and safety measures
(c) Glossary of technical terms

In order to respond to HSDC's request, the JICA study team prepared the supplemental O&M manual with following information;

a) O&M data format by adding the further O&M data to be monitored in preparation for introduction of the computerized O&M database in near future,
b) Evaluation criteria of O&M data by showing the normal range of the data,
c) Contingency plan been relational with the evaluation criteria of O&M data for when O&M data becomes out of the normal range,
d) Safety plan of WWTP O&M works, and
e) Glossary of technical terms regarding the sewage treatment process and electric works for unskilled operator.

In order to practice the improved O&M manual and PDCA cycle, the JICA study team implemented the improvement trial of the sewage treatment process in the North Thang Long WWTP as the On-the-Job Training (OJT) to HSDC site staff. The OJT practice is to improve the dehydration efficiency of excess sludge by using the primary sedimentation tank as sludge thickener as shown in the figure below. The result of practice achieved the expected efficiency. Based on this practice, the JICA study team asked HSDC to apply this result as an example of PDCA cycle of O&M work.

Through the abovementioned technical transfer, HSDC got the suggestions for betterment of O&M works. In the wrap-up meeting, HSDC asked the JICA study team to provide further information of computerized O&M database system.



Source: JICA Study Team

Figure S4 Modification of the excess sludge flow as PDCA practice

Table S2 Introduction Step of Computerized O&M database

Step	Target	Description	Status
1	Accumulation of O&M data	Improvement of the existing O&M data sheet format	Short term
2	Upgrade of O&M data filing as database level	Assessment of O&M data by versatile software.	Mid term
	Standardization of O&M data formats in all WWTPs	Standardization of O&M data input format for looking forward introduction of computerized O&M database	
3	Networking of O&M database	Development of Inter-WWTP O&M data network applying Internet VNP or IP-VNP for the WWTP remote control system	Long term

Source: JICA Study Team

iv. Development of a framework for the Integrated Operation and Maintenance Services (IOMS) to Bai Mau and Yen So WWTPs by using maximum benefits of PPP scheme

At present, 3 WWTPs with a sum total capacity of 48,200m^3/day are in-service. After additional 2 WWPs including Yen So WWTP and Bai Mau WWTP start operation in the near future, total sewage treatment capacity in Hanoi will be 252,000m^3/day, which is about 5 times the present capacity. This study proposed the asset management of sewerage facilities in the near-future Hanoi applying the Integrated O&M Service (IOMS) concept.

IOMS is the multi-year performance base contract meanwhile the conventional O&M contract is the single-year cost-plus-fee contract. In 2010, 251 IOMS projects are on-going in Japan. Advantage of IOMS is to save O&M works. IOMS allows the wider range of contractor’s originality and creativity in the O&M work than the conventional contract. On the other hand, the contractor’s outcome accountability is bigger than the conventional contract. By using the wider allowance in the O&M works, the contractor is motivated to save the O&M costs for their profit. In fact, the Japanese IOMS cases are realizing 8 to 12 % reduction of sum of the employer’s administration costs plus the contractor’s O&M costs. Cost-cut measures in the Japanese cases are combination of the contractor’s saving effort of power consumption, chemical consumption and worker input, and the reduction of employer’s administration job. The Japanese IOMS are classified into 4 levels by sizes of repair & replacement work included in the contract. The most popular IOMS contract in Japan is the level 2 as shown in the table below;

Table S3 Comparison of Conventional O&M and IOMS

	Conventional O&M	IOMS
Basis of Contract	✓ Fixed Scope of Work ✓ Single-year & Unit price base contract	✓ Performance Indicators & Delivery conditions at the end of the contract. ✓ Multi-year & Lump-sum contract
Repair & Replacement	✓ Quantity and budget of repair and replacement is accounted as a Provisional-Sum.	✓ Repair and replacement budget is included in lump-sum amount as a provisional-sum.

Source: Japan Sewage Works Agency (JSWA)

Table S4 Japanese IOMS types

Contract Level	Period	Cost components
Conventional	Single year	Process cost (measurement base)
IOMS level-1	Short term multi year	Process + utility cost (Lump sum)
IOMS level-2		Process + utility cost (Lump sum) + Small repair
IOMS level-3		Process + utility cost (Lump sum) + Medium repair
IOMS full scale	Long term multi year	Process + utility cost (Lump sum) + Large repair and replacement

Source: Japan Sewage Works Agency (JSWA)

The reason why includes the repair and replacement in the contract is that the reduction of repair and replacement by appropriate O&M works can be their profit. As the result, IOMS can prolong the lifetime of equipment.

The JICA study team examined an appropriate body to undertake the IOMS through the alternative study. As HSDC has a 5-year O&M experience of new WWTPs, their ability to undertake the IOMS contract is supposed to be not sufficient at this moment. But if HPC orders the IOMS to the experienced company, HSDC cannot have skills for IOMS. Based on the alternative study shown in the table below, the JICA study team suggest that the Joint Company established with HPC and the skilled private firm is appropriate because the Joint Company can synergizes HSDC's locality and the private firm's technical ability as Option 2.

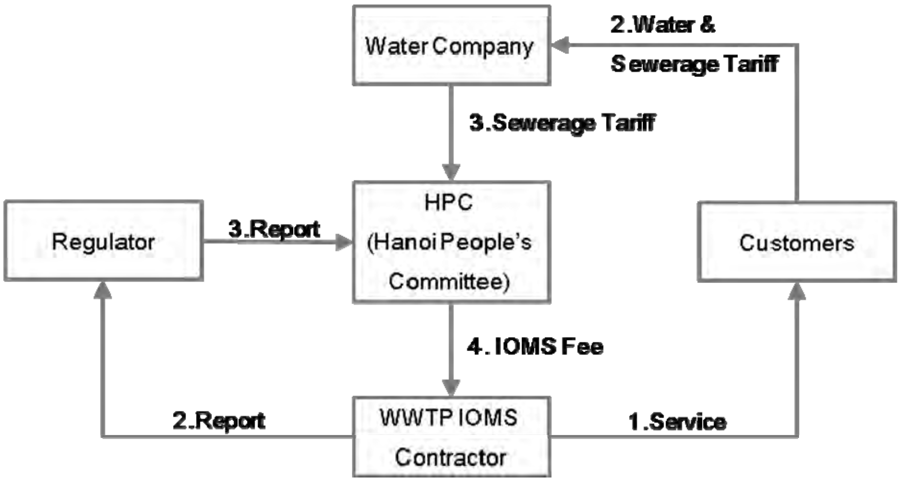
Table S5 Alternatives of IOMS Contractor

	Option 1	Option 2	Option 3
Capacity to undertake IOMS	Need time for new experience	Enough capacity	Enough capacity
Cost saving opportunity	Less because lack of experience	Promising	High cost due to Foreign company
Comfort for HPC	Comfort	Comfort	Uncomfortable to ignore HSDC
Compliance of laws and regulations	Complied	Complied	Complied
Evaluation	Need enough time for experience and support from outside	HSDC's locality and Private firm's skill produce synergy. **Recommendable**	HSDC's 5 year experience cannot contribute in this option.

Source: JICA Study Team

As mentioned above, the IOMS is potential alternative of the sewerage O&M work for Hanoi from technical and institutional points of view. Then the JICA study team checked a financial viability of the IOMS in Hanoi. The financial viability analysis is carried out in conditions of total 8 WWTPs in service (incl. existing 3 WWTPs plus Bai Mau, Yen So, Yen Xa, Phu Do and Ho Tay). According to discussion with the counterpart working group, HSDC undertakes the O&M works of the existing 3 WWTPs, and the Joint Company undertakes the O&M works of other 5 WWTPs. Based on the analysis, the cost-saving opportunity by the IOMS will be VND 17 billion/year (equiv. at JPY 63 million/year) assuming 10% reduction of the Direct O&M costs and the Joint Company Capital is VND 47 billion (equiv. at JPY 170 million) shared evenly by HPC and the Joint Company. Internal Rate of Return (IRR) of the Joint Company is 10 to 20% even if the cost reduction will be shared at 50:50 by HPC and the Joint Company. Hence it is found that the IOMS by the Joint Company is feasible.

Compiling the above study results, the JICA study team proposed to establish the Joint Company for IOMS, and got the basic consensus from the counterpart working group. The counterpart working group will carry over the JICA study team's proposal to discuss internally further together with the introduction of the sewerage tariff system.



Source: JICA Study Team

Figure S5 Operational Framework of the IOMS contract

The operational framework to implement the IOMS is shown in the Figure above. The IOMS contractor carries out the O&M works as per the IOMS contract, and reports the performance data to the Regulator. The Regulator verifies the performance data with the Performance Indicators (PIs), and submits the Statement of Performance to HPC. HPC will pay the O&M fee to the IOMS contractor based on the Regulator's report. Usually, the PIs are set to be more severe than the environmental control criteria. The spread between the PIs and the environmental control values is a safety allowance against unforeseeable malefaction of the treatment process. Proposed PIs for sewerage IOMS in Hanoi are shown in the Table below.

Table S6 Proposed Performance Indicators

Items	Legal Effluent Quality	Proposed Effluent Quality
BOD5 (mg/L)	50	40
COD (mg/L)	100	80
SS (mg/L)	100	80
Nitrogen (mg/L)	30	24
Phosphorus (mg/L)	6	5

Source: JICA Study Team

Table S7 Conventional vs. IOMS by Joint Company in 2022

Items	Conventional(A)		Joint Company(B)		Difference (B-A)	
	million VND	%	million VND	%	million VND	%
Direct Cost	461,239	89.7%	426,769	83.0%	-34,470	-7.5%
Utilities	183,653	35.7%	165,288	32.1%	-18,365	-10.0%
Chemicals	87,157	16.9%	78,441	15.3%	-8,716	-10.0%
Repairs	72,517	14.1%	65,265	12.7%	-7,252	-10.0%
Sludge disposal	52,773	10.3%	52,773	10.3%	0	0.0%
Small replace	20,944	4.1%	20,944	4.1%	0	0.0%
Labor	29,952	5.8%	29,952	5.8%	0	0.0%
Site establish	10,472	2.0%	10,472	2.0%	0	0.0%
Other Expenses	3,771	0.7%	3,633	0.7%	-137	-3.6%
Overhead	29,981	5.8%	27,740	5.4%	-2,241	-7.5%
Provisional sum	23,062	4.5%	21,338	4.1%	-1,724	-7.5%
Profit	**0**	**0.0%**	**21,338**	**4.1%**	**21,338**	**4.1%**
Total	**514,282**	**100.0%**	**497,186**	**96.7%**	**-17,096**	**-3.3%**

Source: JICA Study Team

v. Formulation of Sewerage Tariff Plan and Financial plan related the sewerage service for ensuring sustainability of the sewerage services in Hanoi

In 2010, the O&M costs for existing 3 WWTPs are estimated at VND 20 billion/year. When Yen So WWTP starts operation, total O&M costs becomes VND 143 billion/year that is 8 times of the current O&M costs. In order to sustain the sewerage services in Hanoi, new sewerage revenue mechanism is indispensable.

Table S8 Estimated O&M costs of new WWTPs (excl. replacement)

(unit : VND million/year)

	Yen So	Bai Mau	Yen Xa	Puu Do	Ho Tay
O&M costs	142,858	26,620	192,022	75,660	26,620

Source: JICA Study Team

Finance to the Sewerage development in Hanoi are combination of the Government grant for the initial capital and the Environmental Protection Fee (EPF) for the O&M. EPF has collected at 10% of water supply fee and contributed to infrastructure services such as drainage, sewerage, road sweeping and so on. Based on the water supply company data from HAWACO and VIWACO, the average household water supply fee in 2010 was about VND 80,000/month that is equivalent at 10% of household income. As the EPF is 10% of the water supply fee, VND 8,000/month is collected from household in average.

The JICA study team conducted the Willingness-To-Pay for the sewerage service. According to the survey results, the domestic responders answered VND 21,212/month and the non-domestic responders (commercial & industry) answered VND 2.8 million/entity.

In principal, the sewerage tariff revenue shall fulfill the operation expenditures including O&M costs, replacement and depreciation. However when the tariff revenue is lower than the required amount, the Government needs to subsidize the deficit. The JICA study team calculated 4 cases of the tariff revenue shown in the table below and compared with the operation expenditures. The JICA study team's tariff calculations were based on the water consumption volume because the sewerage tariff maybe collected by the water company together with the water supply fee. The wastewater generation is assumed to be 80% of water supply volume.

Table S9 Cases of the analysis

Case No.	Sewage Discharge	Tariff Collection Area
1	190L x 80%	Service Area
2	190L x 80%	Whole of Hanoi
3	153L x 80%	Service Area
4	153L x 80%	Whole of Hanoi

Source: JICA Study Team

Cases are set with the following conditions.

<u>Sewage Discharge</u>

190L: It is assumed that water consumption for domestic use is 190L/day/person. This amount is assumed in accordance with the Plant Design of WWTPs. Sewage discharge is estimated based on the forecast population in 2020.

153L: Water consumption for domestic use in the service area is 153L/day person, based on data provided by the water company. Sewage discharge is estimated based on current water consumption and population in Hanoi.

<u>Tariff Collection Area</u>

Service Area: Sewerage tariffs will be collected from the service area of the WWTPs.

Whole of Hanoi: The sewerage tariffs will be collected from the whole Hanoi region. This area is separated into the urban area and the rural area. It is assumed that tariffs in the rural area are half the amount of the tariffs in the urban area, because the average income in the rural area is approximately 50% of the average income in the urban area.

<u>Cost Recovery Level</u>

In setting up the tariff for domestic use, the following 5 levels are taken into consideration:

Table S10 Cost Recovery level in Tariff Calculation

Level	Description
a	Refer to the Willingness-To-Pay of domestic customers
b	Fulfill the O&M costs of WWTPs
c	Fulfill the O&M costs of WWTPs and sewers
d	Fulfill the O&M costs of WWTP and sewers, and replacement of equipment
e	Fulfill the O&M costs of WWTP and sewers, replacement of equipment and depreciation

Source: JICA Study Team

Calculation Results

Among 5 cases, Case 3 is practical and understandable for the citizen. Sewerage tariff per m^3-water consumption and average amount to be paid by household are shown in the tables below:

Table S11 Sewerage Tariff of Case 3

(unit: VND/m^3-water supply)

Level	Domestic tariff	Non-domestic tariff
Refer to the Willingness-To-Pay of domestic customers	1,111	2,221
Fulfill the O&M costs of WWTPs	3,577	7,153
Fulfill the O&M costs of WWTPs and sewers	4,371	8,742
Fulfill the O&M costs of WWTP and sewers, and replacement of equipment	5,939	11,878
Fulfill the O&M costs of WWTP and sewers, replacement of equipment and depreciation	15,207	30,414

Condition 1: Average water consumption per capita = 153 L/day
Condition 2: Tariff collection area is equal to the sewerage service area.
Condition 3: Object WWTPs are eight including Truc Bach, Kim Lien, North Thang Long, Bai Mau, Yen So, Yen Xa, Phu Do and Ho Tay

Source: JICA Study Team

Table S12 Average Household Payment for Sewerage (excl. VAT & collection fee)

Level	Average Monthly Payment(VND/Mon)	Sewerage Fee/Household Income
a	21,000	0.3%
b	64,400	0.9%
c	78,700	1.0%
d	106,900	1.3%
e	273,700	3.4%

Condition: Average water consumption per household is $18m^3$

Source: JICA Study Team

On August 30 2011, the JICA study team summed up the study activities and proposed the following matters to the counterpart working group.

1) After the Yen So WWTP will be in service since year 2012, annually VND 160 billion will be required for the O&M works of sewerage facilities in Hanoi that is about 8 times of the present O&M expenditure. In order to accommodate such huge growth of O&M costs, new revenue mechanism is indispensable for Hanoi City.

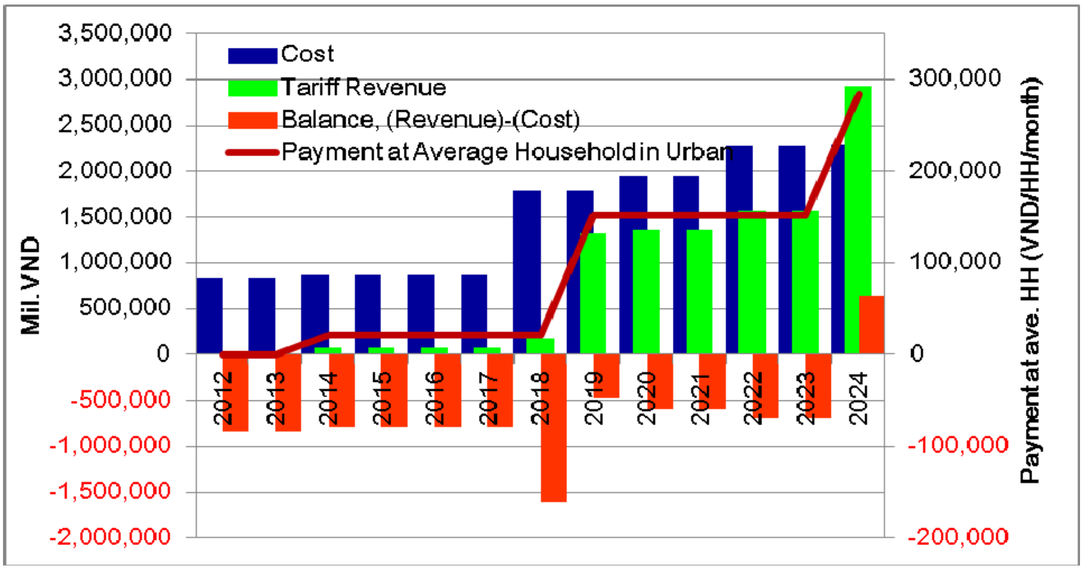
2) Charging area of the sewerage tariff are two choices, the first is collection from the sewerage service area as the service price and the other is collection from whole Hanoi as the public environmental fee. Taking into account easiness of consensus building to the payers, the first one is practical.

3) Since the legal and administrative procedure for setting new tariff system takes, at least, 2 years. It is recommended to start the further work for new tariff setting in HPC in order to effectuate the tariff system in 2014 until when Yen So WWTP will fully handed over from the investor to HPC.

4) The JICA study team recommends that the starting tariff is recommended to be the Willingness-To-Pay level in 2014, and afterword the tariff will be risen up to the O&M cost-recovery level within ten year. Hence the Government assistance to fill the gap between revenue and expenditures is required from 2014 till 2023. (refer to the Figure below)

5) O&M costs for WWTPs shall be reduced by introducing the Integrated O&M Service (IOMS) contract.

6) Inclusion of the return on initial capital investment for the construction and additional capital investment for the equipment investment shall be discussed further based on the customer’s affordability to pay and the environmental protection policy of the Government.



Source: JICA Study Team

Figure S6 Cost and Revenue Balance of Tariff Case staring in 2014 and catching-up to the O&M recovery level within 10 years.

The counterpart working group gave a basic consensus to the JICA study team's aforementioned proposal of introduction of the sewerage tariff in 2014. In order to materialize the proposal, the JICA study team suggested the counterpart working group to transfer further works for the tariff setting to the Joint Company for assisting HPC regarding the subjects below;

- Willingness-To-Pay survey for sewerage service in whole Hanoi
- Checking wastewater characteristics in non-domestic customers
- Reference survey of sewerage tariff in Japan and similar cities
- Additional financial simulation of sewerage revenue and expenditures
- Details of tariff collection system and budget allocation mechanism
- Subsidiary analysis of the sewerage services
- Draft and modification of legislation document relating to the sewerage tariff system

The counterpart working group accepted to bring the JICA study team's proposal to HPC for sake of the internal meeting of HPC.

Table of Contents

Appendices:

Abbreviations and Glossary

ATP	Affordability to Pay
BOD	Biochemical Oxygen Demand
C.A.S	Conventional Activated Sludge Process
CI	Commercial and Industrial Costomer
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DOC	Department of Construction
FST	Final Settling Tank
HAPI	Hanoi Authority for Planning and Investment
HAWACO	Hanoi Water Limited Company
HH	Household
HPC	Hanoi People's Committee
HSDC	Hanoi Sewerage and Drainage One-Member State Company Limited
HWBC	Hanoi Water Business Company
HWSC	Hanoi Water Supply Company
IOMS	Integrated Operation and Maintenance Services
IRR	Internal Rate of Return
JICA	Japan International Cooperation Agency
JICWELS	Japan International Corporation of Welfare Services
JPY	Japanese Yen
JSWA	Japan Sewage Works Agency
MLSS	Mixed Liquor Suspended Solid
NRW	Non-Revenue Water
O&M	Operation and Maintenance
O.D	Oxidation Ditch Process
ODA	Official Development Assistance
OJT	On-the-Job Training
ORP	Oxidation Reduction Potential
PDCA	Plan-Do-Check-Action
PIs	Performance Indicators
PP	Purification Plant
PPP	Public-Private Partnership
PST	Primary Settling Tank
S.A.S	Standard Activated Sludge Process
SCADA	Supervisory Control and Data Acquisition
SPC	Special Purpose Company

SS	Suspended Solid
T-N	Total Nitrogen
T-P	Total Phosphorus
TSA	Technical Support Assisst
TSE	Treated Sewage Effluent
USD	US Dollar
VINACONEX	Vietnam Construction and Import - Export Joint Stock Corporation
VIWACO	Vietnam Water Company
VND	Vietnamese Dong
WTP	Willingness to Pay
WWTP	Wastewater Treatment Plant

Chapter 1 Introduction

1.1 Background

Deterioration of the water environment has been a non-negligible issue in Hanoi, the Vietnamese Capital. The causes of the deterioration are insufficient wastewater treatment and an increase in water pollution due to urbanization and industrialization.

The Government of Japan has continuously supported water environment improvement in Hanoi through Official Development Assistance (ODA) since 1997. Presently, 3 wastewater treatment plants (WWTPs) constructed under Japanese ODA are in service including Truc Bach WWTP 3,700 m^3/day, Kim Lien WWTP 2,500 m^3/day and North Thang Long WWTP 42,000 m^3/day. In addition, another 2 WWTPs are under construction by Japanese ODA and private fund including Yen So WWTP 200,000 m^3/day and Bai Mau WWTP 14,000 m^3/day, and construction of more plants is planned in the future.

With the expansion of sewerage services over the years, appropriate management of sewerage services is becoming more important to sustain system performance, ensure customer satisfaction and secure the financial aspects of the business. In response to this, the Japan International Cooperation Agency (JICA) conducted a study called the "Assistance for Strengthening of the Operation and Maintenance of Sewerage Facilities in Hanoi" in 2010. The "Assistance for Strengthening of the Operation and Maintenance of Sewerage Facilities in Hanoi, 2010" provided (1) suggestions for plant Operation and Maintenance (O&M), (2) technical transfer to other cities and (3) road mapping for the introduction of Public Private Partnership (PPP). This "Study for Introduction of PPP for Sewerage Facilities in Hanoi" focuses on procedures for outcomes (1) and (3) as described in the box below;

Output of 2010 JICA Study (1) Suggestions for plant operation and maintenance

The study team conducted the survey on the existing facilities and made suggestions for improvement of operation and maintenance (O&M) to the counterpart (HSDC), for which the counterpart showed his understanding. However, concrete action plans were not discussed or decided in this stage. It is one of the major objectives in this study to discuss the suggested action plans with the counterpart and to practice those plans for encouraging him to continuous action.

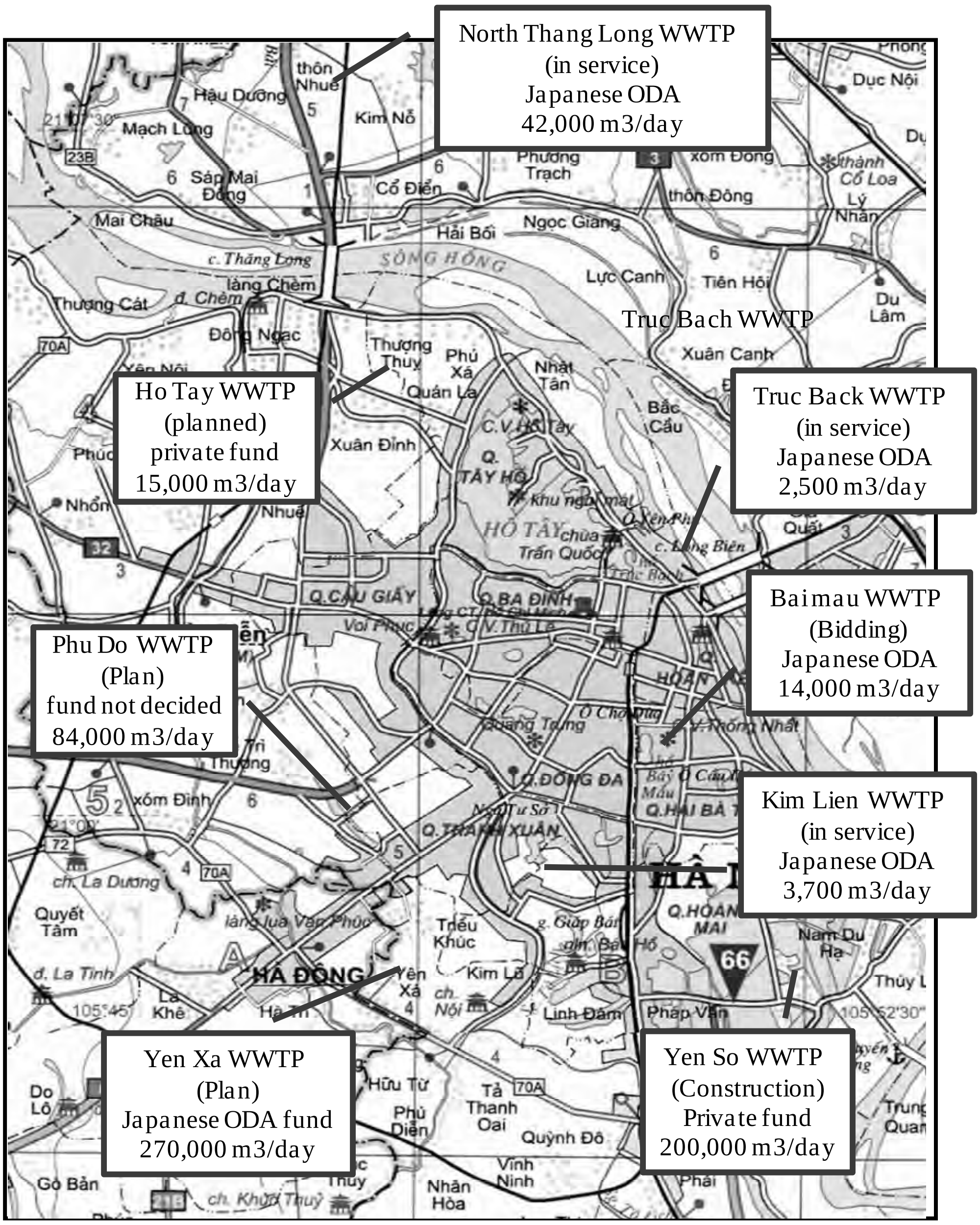
Output of 2010 JICA Study (3) Road mapping for the introduction of Public Private Partnership (PPP)

As a result of discussions with the relevant organizations in Hanoi City, the study team explained the advantages of conducting PPP in O&M of the existing facilities and construction and O&M of the planned facilities and obtained their understanding in principle. This study aims at coming to an agreement about introduction of PPP by preparing more detailed proposals for introducing PPP in O&M of Bai Mau WWTP and Yen So WWTP which are now under bidding and under construction respectively.

1.2 Objectives

The objectives of the Study for Introduction of PPP for Sewerage Facilities in Hanoi

a. Development of an approach for streamlined operation and maintenance in the existing sewage treatment plants
b. Creation of a framework for applying the Integrated O&M Services (IOMS) to Yen So WWTP (under-construction) and Bay Mau WWTP (bidding stage) by using maximum benefits of PPP scheme
c. Financial analysis and sewerage tariff plan for sustainability of the Hanoi sewerage services
d. Organization of an appropriate administrative structure for the sewerage system in Hanoi
e. Enhancement of advantageous effects of Japanese ODA loans.



Source: JICA Study Team

Figure 1.2.1 Locations of WWTPs

1.3 Study Area

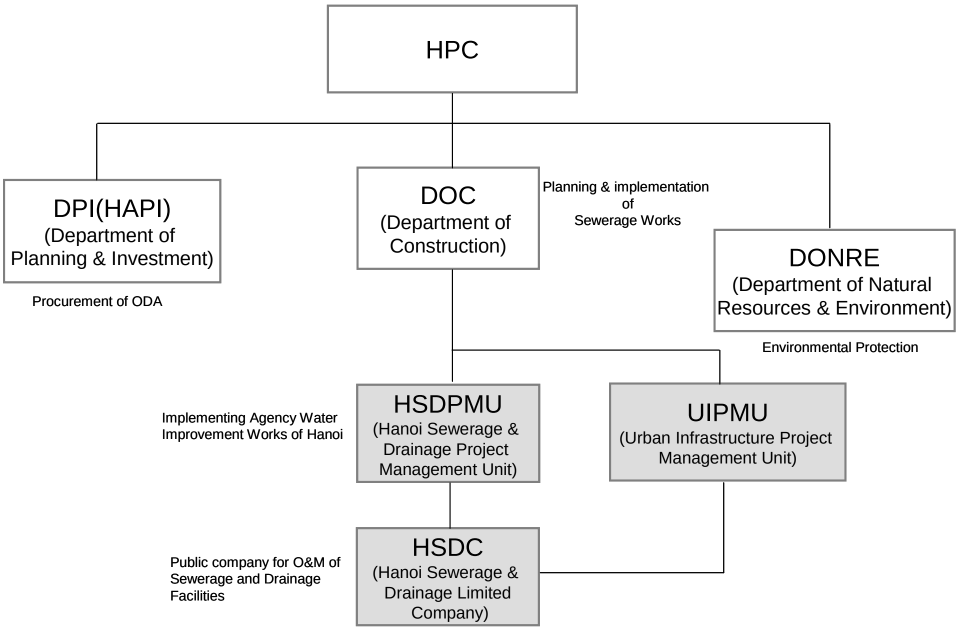
Hanoi City, Socialist Republic of Vietnam

1.4 Implementation Structure of the Study

In the planning stage of drainage and sewerage services, the Hanoi Planning and Investment Authority (HAPI) and the Department of Construction (DOC) lead the city planning aspect and the technical aspects respectively. In the Construction stage, the Hanoi Sewerage & Drainage

Project Management Board (HSD-PMB) under DOC is assigned for the project management and the Department of Finance (DOF) administers the financial matters. In O&M stage, HSDC is assigned for O&M of facilities by Hanoi People's Committee (HPC).

HPC organized the counterpart working group for this "Study for Introduction of PPP for sewerage facilities in Hanoi" by inviting DOC, HAPI, DOF and HSDC to cover the aspects throughout the sewerage development. The counterpart working group was chaired by the Deputy Director of DOC.



Source：Strengthening of Operation and Maintenance of Sewerage Facilities in Hanoi

Figure 1.4.1 Institutional Framework of Sewerage Service in Hanoi

1.5 Scope of Work

The scope of work and methodologies are as described below. The consultants will prepare proposals on each subject through examination and discussions with the counterparts and make a proposition to the working group to come to an agreement among relevant organizations.

(1) Approach to streamlined 0peration and maintenance of the existing WWTPs

Goal of (1)
The betterment of operation and maintenance of 3 existing WWTPs

(1)-1 The consultants shall assist Hanoi sewerage and drainage company (HSDC) to achieve the betterment methods of operation and maintenance for the 3 existing

WWTPs (Truc Bach, Kim Lien and North Thang Long) proposed in this study, "JICA Assistance for Strengthening of the Operation and Maintenance of Sewerage Facilities in Hanoi in 2010".

a. Improvement of Wastewater Treatment Process
b. Upgrading O&M Manual
c. Introduction of Equipment Resister

(1)-2 To realize the above, the consultants shall prepare concrete / practical approaches based on the findings from monitoring the one and a half month long trial on-the-job training and day-to-day guiding of the HSDC.

(2) Proposal of framework for applying the Integrated Operation and Maintenance Services (IOMS) to Yen So WWTP (under construction) and Bay Mau WWTP (bidding stage) by using maximum benefits of PPP scheme

Goal of (2)

The proposal on the integrated operation and maintenance framework taking into consideration the PPP for the Yen So and Bay Mau WWTPs will be formulated based on the consensus of the counterpart working group.

EXPLANATION OF THE INTEGRATED OPERATION AND MAINTENANCE SERVICES (IOMS)

- In contrast to the individual asset-based contracts as a conventional operation and maintenance ordering system, the IOMS is a system-based ordering system. One of the main advantages of this paradigm shift is that it enables the evaluation of the business value brought about by reaching solutions that balance or trade-off between technical necessity and overall system economical feasibility.
- The IOMS is premised on the IOMS contractor's experiential problem solving capacity including proactive measures and contingency measures. The contractor's holistic view of the asset management process is expected to save the life-cycle costs of the system with prolongation of equipment lifespan.

(2)-1 Framework of Integrative Operation and Maintenance Services (IOMS)

a. Study of alternative framework for the IOMS

The consultants shall carry out a comparative analysis of the following 3 options for the IOMS framework:

Option 1: HSDC to undertake the Integrated Operation and Maintenance Services (IOMS)

Option 2: Joint Company established by HPC, HSDC and Private firm to undertake the IOMS

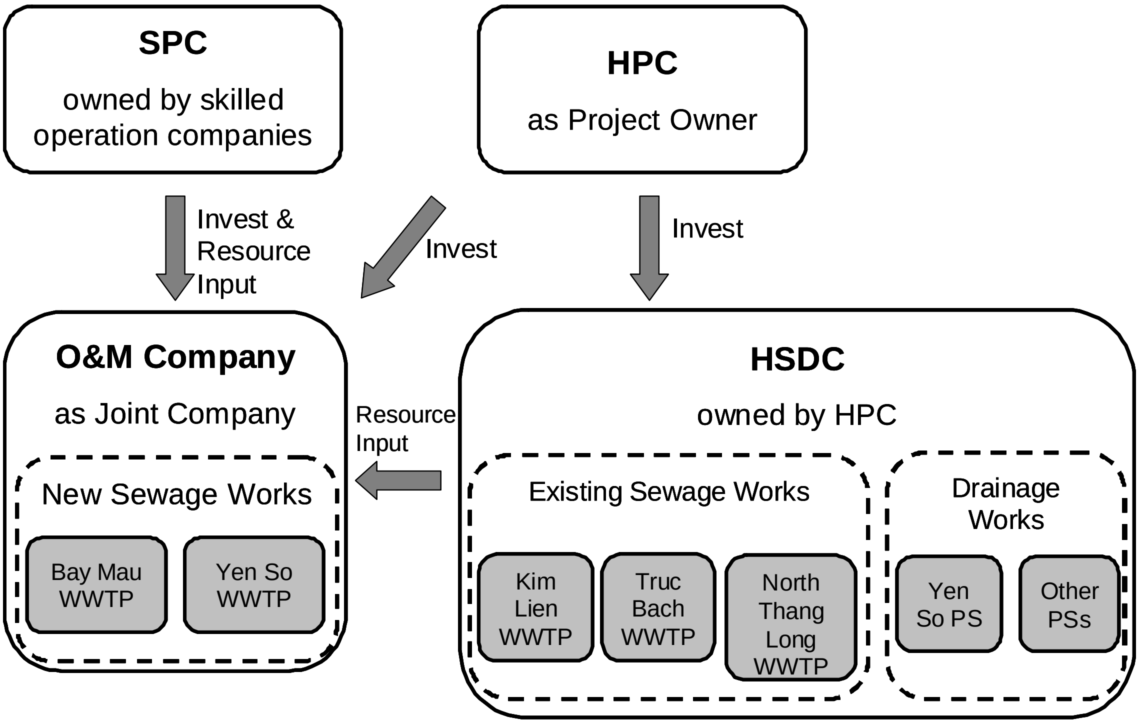
Option 3: A Private firm to undertake the IOMS

Major points in the comparative analysis are:

- Ease of transition of framework from a current operation to the IOMS
- Effects of cost saving in regular operation and maintenance, replacement of equipment
- Potential of operational efficiency improvement
- Compliance of laws and regulations

b. Feasibility analysis of establishment of a Joint Company by HPC, HSDC and a private firm and Concession Agreement

The consultants shall analyze the feasibility of (1) establishment of a Joint Company with HSDC and a private firm, and (2) applicability of the Concession Agreement into the IOMS.



Source: JICA Study Team

Figure 1.2 Image of Option 2

c. Proposal of the IOMS in Yen So WWTP and Bay Mau WWTP

The consultants shall propose the most practical and effective IOMS framework for Yen So WWTP and Bay Mau WWTP. The proposed framework shall mention the institutional structure, size, sharing of roles and responsibilities between the ordering party (Government) and contractor (Private), the contract form and the ordering system.

REFERENCE: STATUS OF YEN SO WWTP AND BAY MAU WWTP AS OF DECEMBER 2010

i. Yen So WWTP - Design Treatment Capacity is 270,000 m³/d - Under construction funded by the investor - Commissioning test is scheduled in 3rd quarter of 2011 - After the defect liability period of 1 year, the facilities are to be transferred to the Hanoi People's Committee
ii. Bay Mau WWTP - Design Treatment Capacity is 14,000 m³/d - Bidding stage of the construction package - Planned construction period is 2 years - Construction work is funded by the Japanese ODA loan

(2)-2 Needs analysis for modification of legal system for the proposed IOMS

a. Legal consistency of the proposed IOMS

The consultants shall review the consistency between the existing laws and regulations and the proposed IOMS, and identify necessary revisions of the legal system for the proposed IOMS.

b. Costs of operation and maintenance of Yen So WWTP and Bay Mau WWTP, cost sharing plan between stakeholders, and Hanoi City financial program for the entire sewerage services

The consultants shall estimate the costs for operation and maintenance of Yen So WWTP and Bay Mau WWTP, and propose a cost-sharing plan between the customers, Hanoi People's Committee and the Central Government. In line with this, the consultants shall simulate the financial program of Hanoi People's Committee to incorporate the costs for all the sewerage services in the city. This work shall coordinate with the "Financial Plan with Sewerage Rate Structure for Sustainability of the Hanoi Sewerage Services".

c. Suggestions on other subjects

The consultants shall provide suggestions on subjects other than a. and b. above for materialization of the proposed IOMS.

d. Action plan for materialization of the proposed IOMS

The consultants shall formulate an action plan for materialization of the proposed IOMS. When formulating this action plan, the consultants shall confirm the consensus of the counterpart working group for all essential matters such as IOMS framework, tariff system, cost sharing plan, etc.

(3) Financial plan with a sewerage rate system for sustainability of Hanoi sewerage services

Goal of (3)

Proposal of the financial plan for Hanoi sewerage services and sewerage rate system will be formulated taking into account the affordability for customers including low-income households.

(3)-1 Estimates of operation and maintenance cost of each sewerage system

a. Interannual operation and maintenance costs

The consultants shall estimate the interannual operation and maintenance cost of each sewerage system, including collection, treatment and disposal.

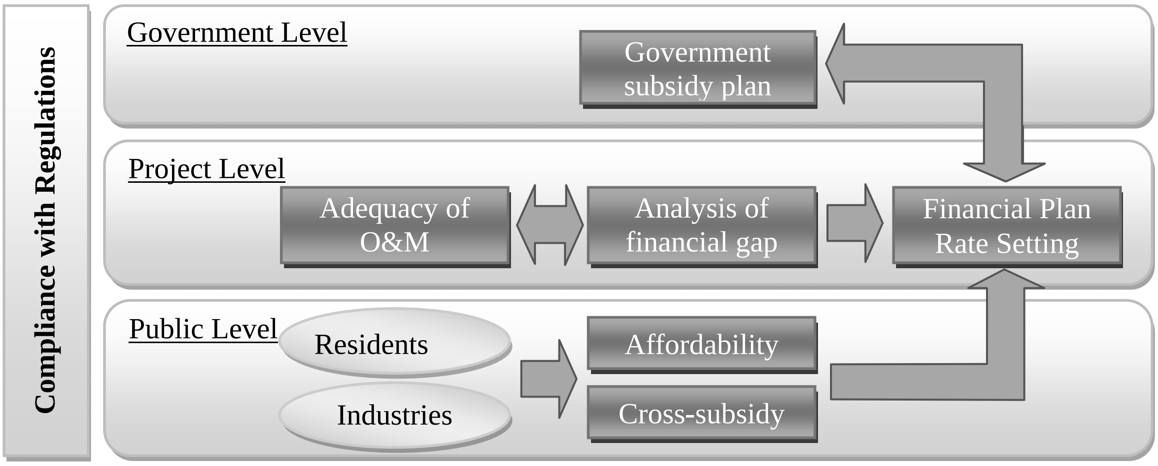
b. Interannual overhead costs for sewerage services

The consultants shall estimate the interannual overhead cost of each sewerage system to be borne by the stakeholders including customers, the operator, Hanoi People's Committee and the Central Government.

c. Interannual financial gap for sewerage services

The consultants shall analyze the interannual financial gap between income and expenditure for each sewerage system in Hanoi.

(3)-2 Review of water and sewerage rates



Source: JICA Study Team

Figure 1.5.2 Flow of rate setting

a. Rate setting based on reasonable cost sharing to the customers

The consultants shall carry out a questionnaire survey regarding household expenditure structure and willingness to pay for sewerage service (with samples targeting 100 households). If the census or any other statistic reference can be used, the consultants shall propose an alternative approach regarding this subject to JICA. The consultants shall analyze the customers' reasonable share for the sewerage service costs and determine an appropriate sewerage rate based on the questionnaire survey results.

b. Rate setting for low income households

With reference to the questionnaire survey results and the poverty alleviation policy of Hanoi People's Committee, the consultants shall propose the sewerage rate setting for the low-income households.

c. Analysis of financial gap

Based on the above survey and analysis, the consultants shall analyze the interannual financial gap in the sewerage services in Hanoi for each sewerage system.

d. Cross-subsidy between rate categories

The consultants shall propose sewerage cost sharing through cross-subsidy methods between residents, businesses and industries.

e. Sewerage rate system

Based on the above survey and analysis, the consultants shall propose a sewerage rate system and a cost sharing policy for sustainable sewerage services in Hanoi.

(3)-3 Sewerage rate plan and financial plan

a. Interannual financial balance

Based on the analysis mentioned above, the consultants shall forecast the interannual financial balance for the sewerage services of Hanoi.

b. Government subsidy plan in case of negative financial balance

The consultants shall propose a government subsidy plan to compensate for negative balance years for the sewerage service operation in Hanoi.

c. Sewerage rate plan and financial plan

The consultants shall propose a sewerage rate plan and a financial plan for sustainability of the sewerage service operation in Hanoi.

(4) Interim meeting and wrap-up meeting

In order to present the progress of the study and build consensus between the counterpart working group and JICA about the consultants' outputs, the consultants shall organize an Interim meeting and Wrap-up meeting. The decision makers of the study in Hanoi People's Committee shall be invited to both meetings. In addition, the consultants shall report their outputs and the progress of the study to the decision makers of the study in Hanoi People's Committee based on instruction from JICA.

1.6 Activities (Year 2011)

Scope of Work	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Preparatory Work										
(1) Approach to Streamlined Operation and Maintenance in the Existing WWTPs										
(1)-1 Betterment methods of O&M of 3 existing WWTPs										
(1)-2 On-The-Job training of O&M to HSDC										
(1)-3 Upgrading Equipment register and O&M manuals										
(2) Proposal for Applying IOMS to Yen So WWTP and Bay Mau WWTP by Using Maximum Benefits of PPP Scheme										
(2)-1 Framework of Integrative Operation and Maintenance Services (IOMS)										
(2)-2 Needs analysis for modification of legal system for the proposed IOMS										
(3) Financial Plan with Sewerage Rate System for Sustainability of Hanoi Sewerage Services										
(3)-1 Estimates of operation and maintenance cost of each sewerage system										
(3)-2 Review water and sewerage rate										
			Questionnaire Survey							
(3)-3 Sewerage rate plan and financial plan										
(4) Interim Meeting and Wrap-up Meeting			Kick off meeting			Interim meeting		Wrap up meeting		
Reports			Inception report							Final report

1.7 Staffing

Task	Person in charge
Team Leader	Mr. Koichi SUZUKI (OC)
(1) Approach to Streamlined Operation and Maintenance in the Existing WWTPs (1)-1 Betterment methods of O&M for 3 existing WWTPs (1)-2 On-The-Job training of O&M for HSDC (1)-3 Upgrading equipment register and O&M manuals	Mr. Takehiro NAKANO (Water Agency) Mr. Kota KINOSHITA (Water Agency) Mr. Etsuo FUJIWARA (Water Agency)
(2) Proposal for Applying the IOMS to Yen So WWTP and Bay Mau WWTP by Using Maximum Benefits of PPP Scheme (2)-1 Framework of Integrative Operation and Maintenance Services (IOMS) (2)-2 Needs analysis for modification of legal system for the proposed IOMS	Mr. Koichi SUZUKI (OC) Mr. Yoichiro ONO (ORIX)
(3) Financial Plan with Sewerage Fare System for Sustainability of Hanoi Sewerage Services (3)-1 Estimates of operation and maintenance cost of each sewerage system (3)-2 Review water and sewerage rate (3)-3 Sewerage rate plan and financial plan	Mr. Kenji SUZUKI (PADECO) Ms. Nami TANAKA (PADECO) Mr. Takeo TANAKA (Yokohama Water) Mr. Susumu SHIBUYA (Yokohama Water)

Chapter 2 Approach to Streamlined Operation and Maintenance of the Existing WWTPs

2.1 Aim of Task

This task is aiming at upgrading O&M skills of HSDC.

For achieving the aim, the JICA study team implemented On-the-Job Training to develop Plan-Do-Check-Action (PDCA) cycle in cooperation with HSDC for upgrading O&M manuals and improvement of the O&M database.

2.2 Improvement of O&M Manuals

2.2.1 Necessity for Improvement

HSDC's daily operation in its existing 3 Wastewater Treatment Plants (WWTPs) is based on the original O&M manuals submitted by the contractor at the handing-over of the plants and authorized by Hanoi People's Committee (HPC). The original O&M manuals cover most of the requirements however HSDC has been aware of the necessity for improving a part of the O&M manual. The JICA study team responded to HSDC's demand for improving the O&M manuals by supplementing with the following information;;

a. More control parameters for evaluating status of treatment processes and equipment conditions

HSDC is periodically monitoring five very fundamental items for checking the sewage treatment process and for controlling aeration ratio, return sludge ratio and excess sludge volume. In order to improve the skill for the operation control for HSDC, the JICA study team proposed additional monitoring items and the allowable range of each monitoring value for evaluation of the treatment process as shown in Table 2.2.1 and 2.2.2.

Table 2.2.1 Original Monitoring Items (Monitoring at Reactor)

Control parameter	unit	Allowable Range (added by JICA study team)			Countermeasures for deviation of data
		Kim Lien	Truc Bach	North Thang Long	
DO	mg/L	2.5-3.5	2.5-3.5	2.0-3.0	Control aeration rate Maintenance of blower and diffuser
MLSS	mg/L	2000-3000	1500-2000	2000-3000	Control excess sludge volume
Anaerobic tank ORP	mV	< -50	< -150	< -50	Control return sludge ratio Control aeration rate
Anoxic tank ORP	mV	< -50	< -150	none	Control recirculation ratio Control aeration rate
Aerobic tank ORP	mV	> 100	> 50	> 50	Control aeration rate

Source: JICA Study Team

Table 2.2.2 Monitoring Items added by the JICA study team

Place	Control parameter	unit	Target Min.	Target Max.	Countermeasures for deviation of data
Receiving well	pH	–	6.5	8.0	(abnormal influent flow) Check waste water quality
Reactor	pH	–	6.0	7.4	Control aeration rate
Final settling tank	Sludge-liquid interface	m	---	0.5	Control excess sludge volume
Dehydrator	Water content	%	---	85 (TB) 83 (KL) 82 (NTL)	Control sludge volume of supply Control polymer injection Control $FeCl_3$injection rate Maintenance of dehydrator

Source: JICA Study Team

b. Contingency plan

HSDC requested the JICA study team to provide a contingency plan to accommodate fluctuation of influent water quality of the WWTP. Because the influent water quality has fluctuated due to the inflow of rain.

In responce to HSDC's request, the JICA study team provided a series of items to be checked and potential countermeasures relating to fluctuation of influent water quality as shown in Table 2.2.3 to 2.2.5.

Table 2.2.3 Contingency plan: Total phosphorus value of effluent increase

Condition	Occasions	Countermeasures
More than -50mv ORP	DO interfusion by rainfall	Increase coagulant ($FeCl_3$) injection rate (Be careful of excess injection)
	DO interfusion by return sludge	Reduce return sludge ratio Reduce aeration rate
Under -50mv ORP	BOD/P ratio of influent to the reactor is under 20.	Bypass Primary settling tank Supply methanol etc. to increase BOD
	Shortage of coagulant dosage	Increase coagulant ($FeCl_3$) injection rate (Be careful of excess injection)

Source: JICA Study Team

Table 2.2.4 Contingency Plan: Floating sludge from bottom of final settling tank

Condition	Occasions	Countermeasures
Bubbling surface of brown colored sludge	NO_3-N is denitrified in bottom of FST	Reduce the aeration rate Reduce the sludge retention time with high return sludge volume.
Surfacing of gray–black colored sludge	Sludge retention occurs for long time.	Increase the return sludge ratio Increase the excess sludge volume Cleaning of FST

Source: JICA Study Team

Table 2.2.5 Contingency Plan: Abnormal activated sludge

Condition	Occasions	Countermeasures
Black colored sludge (Accumulation of sulfide)	Factory wastewater (Industrial wastewater) Over-retention of Sludge	Governmental instruction
Many filamentous microorganisms occur	Deposition of sludge in a pipe (It is easy to increase the filamentous microorganisms.)	Removal of deposition of sludge in the pipe

Source: JICA Study Team

c. Definitions of technical terms

Responding to HSDC's request, the JICA study team made a glossary of technical terms regarding the treatment process and electric works.

2.2.2 Development of Supplemental O&M Manual

Compiling all additional inputs mentioned above, the JICA study team developed and submitted the supplemental O&M manual, which is attached in Appendix 2.

Table 2.2.6 Table of Contents combining the Original Manual & Supplemental Manual developed by the JICA Study Team

Original	**1. Explanation of Wastewater Treatment Plant**
Original	**2. Equipment List**
Original	**3. Operation and Maintenance** 3.1 Operation Method • Grit chamber facility • Lift pump facility • Wastewater treatment facility • Disinfection facility • Water supply facility • Sludge treatment facility • Deodorization facility • General room facility
Supplemental	**3.1.S Operation Method - Supplemental** • Control parameters • Frequency of water analysis
Supplemental	**3.1.S Safety, Health, Contingency Plan - Supplemental** • Measures for safety and health • Contingency plan

Original	**3.2 Maintenance** • Grit chamber facility • Lift pump facility • Wastewater treatment facility • Disinfection facility • Water supply facility • Sludge treatment facility • Deodorization facility • General room facility
Original	**3.3 Maintenance for non-operation period** 1. Grit chamber facility 2. Lift pump facility 3. Wastewater treatment facility 4. Disinfection facility 5. Water supply facility 6. Sludge treatment facility 7. Deodorization facility 8. General room facility
Supplemental	**3.4 Supplemental Manual - Electric & Instrumentation Equipment Inspection / Maintenance** 1. Cautions 2. Monthly Inspection Items 3. Annual Inspection Items 4. Device List
Original	**4. Trouble Shooting and Fault Finding** • Process • Control panel
Original	**5. Reference Documents** • Design calculation • Calculation of capacities • Motor and control list
Supplemental	**5.S Glossary of Technical terms** • Operation • Electric equipment • Instrumentation equipment

Source: JICA Study Team

2.3 Suggestion for O&M Database System

2.3.1 Purpose of O&M Database System

The purpose of the O&M Database is to ensure that the treated sewage quality satisfies the environmental control values or the Performance Indicators and proactively recognizing signs of trouble. In order to develop the PDCA cycle in O&M of WWTPs, O&M data shall be utilized more dynamically for self-rectifying of working results.

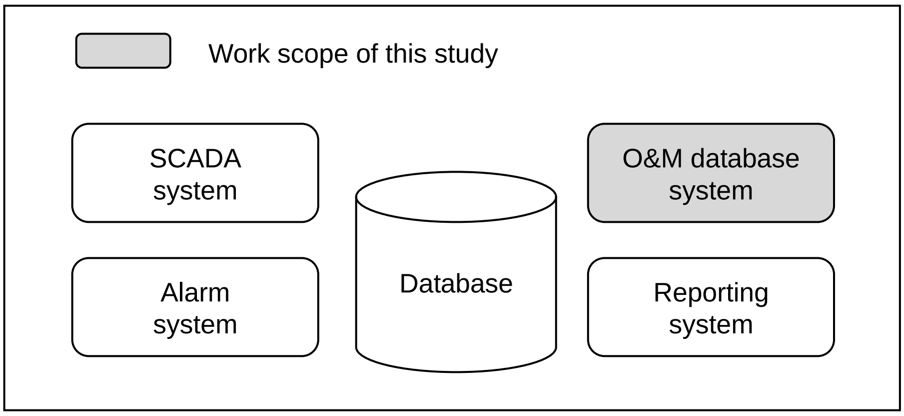
Table 2.3.1 Advantage of O&M Database

For Operation	For Maintenance
• Evaluation of settings for the treatment process • **Cause analysis of unacceptable treated quality** for determination of countermeasures • Determine the impact on influent due to weather and temperature and how it affects the treatment process • Determine **the relationship between the characteristics of the treatment process and the resultant quality of the treated water** • Check and optimize the control parameters of the treatment process	• Evaluation of condition of the system and equipment • Recognizing **signs of trouble** from the trend of monitoring data and take countermeasures. • Optimize the monitoring program • **Scheduling the replacement** of equipment based on fault data and repair record. • Review of the specifications of the equipment.

Source: JICA Study Team

2.3.2 Integrated Control System

The O&M database system is a sub-system of the integrated control system. The integrated control system is a centralized monitoring and operation system linking with several facilities for not only remote operation of the equipment but also stock logistic control, statistical analysis of data, maintenance and repair schedule control, etc. The JICA study for the “Preparatory study on the project for Yen Xa Wastewater Treatment Plant in Hanoi, Vietnam” examines the Integrated Control System Design. Figure 2.3.1 shows the sub-systems of the Integrated control system with the work scope of this study. Hardware, software, and networks for an O&M database system will be considered in the above-mentioned study. It is desirable that the Integrated control system includes an upgraded sewer management system.



Source: JICA Study Team

Figure 2.3.1 Sub-systems of the Integrated control system

2.3.3 Recording Items and Format

In the past the existing O&M data have been recorded and filed on a paper-base which is simple but it is just records. Items currently recorded are:

- Operation data
- Maintenance logs
- Water quality

The JICA study team proposed additional items and new format as follows:
Further details of the O&M data base format are attached in Appendix2.

Table 2.3.2 Contents of O&M Database

Sheet Name	Item List
Equipment	installation location, year, manufacturer, builder, expected lifetime, specification
Construction	Construction year, name, description, equipment, location, contract date, completion date, contractor
Books	Year, title, contractor, description, equipment, storage location, electronic file name
Stock List	Item name, category, equipment, manufacturer, specification, location
Operation	Weather, temperature, flow rate, sludge volume, operating hours of machine, water quality
Maintenance	voltage, current value, insulation resistance, repair year, overview of repair, contractor

Source: JICA Study Team

Table 2.3.3 Data entry form - Equipment

Equipment name	Facility name	Classification	Style	Year Installed	Contractor

Source: JICA Study Team

Table 2.3.4 Data entry form - Stock

Item Name	Specification	Storage	Unit	Present stock quantity	Minimum stock quantity

Source: JICA Study Team

Table 2.3.5 Data entry form - Operation

Day		Weather	Rain (mm)	Inflow rate		Raw Sewage							
				IPS m^3/d	PSD m^3/d	Temp	Appearance	pH	SS mg/L	COD mg/L	BOD mg/L	T-N mg/L	T-P mg/L
1	Su												
2	Mo												

Source: JICA Study Team

2.3.4 Introduction Procedure of O&M Database

We proposed 3 steps to introduce this system. Table 2.3.6 shows the procedure for introduction.

Table 2.3.6 Introduction procedure

Step	Objectives	Procedures	Status
1	Data collection	HSDC can collect data using new data entry sheets recorded on paper daily at each WWTP. These basic data are expected to be computerized at Step 2.	Method presently used (Carried out in this Study)
2	Data computerization	HSDC computerizes the data using Microsoft excel software on personal computers.	Mid-term goal (JICA study for Yen Xa is studying this Step 2)
	Data standardization	HSDC should revise and standardize items on the data entry sheets. It is important to standardize items of data among WWTPs being operated by HSDC in Hanoi. Data standardization will be helpful to design a better database at Step 3.	
3	Data sharing	In this step, the existing WWTPs and other places are networked via the Internet VPN or IP-VPN. Each site has its own Web server for its O&M database system. Authorized users can access this system with Web browsers, and utilize the data with the advantages listed in 2.3.1.	Final goal

Source: JICA Study Team

2.3.5 Introduction Cost of O&M Database

Table 2.3.7 Cost per each site

No	Item	Price (Mil. VND)	Qty	Unit	Sum (Mil. VND)
1	Package software	1,008	1	set	1,008
2	Software customization (localization)	403	2	M/M	806
3	Adjustment cost (on site)	605	1	M/M	605
Total					2,419

Source: JICA Study Team

2.4 PDCA Cycle Activities

Due to change of influent quality and quantity, and deterioration of equipment for treatment, there is a need for the operation methods of the WWTPs to be changed accordingly.

The PDCA cycle is helpful to guide appropriate treatment processes if there are any problems or if changes are required.

PDCA cycle activities for improving the O&M manuals are as follows:

“PLAN” means modifying an operation method based on existing O&M manuals using the database.

“DO” means implementing the modified method.

“CHECK” means judging works that were implemented according to the modified method based on data accumulated in the database, and comparing the results with the desirable range of parameters described in current O&M manuals.

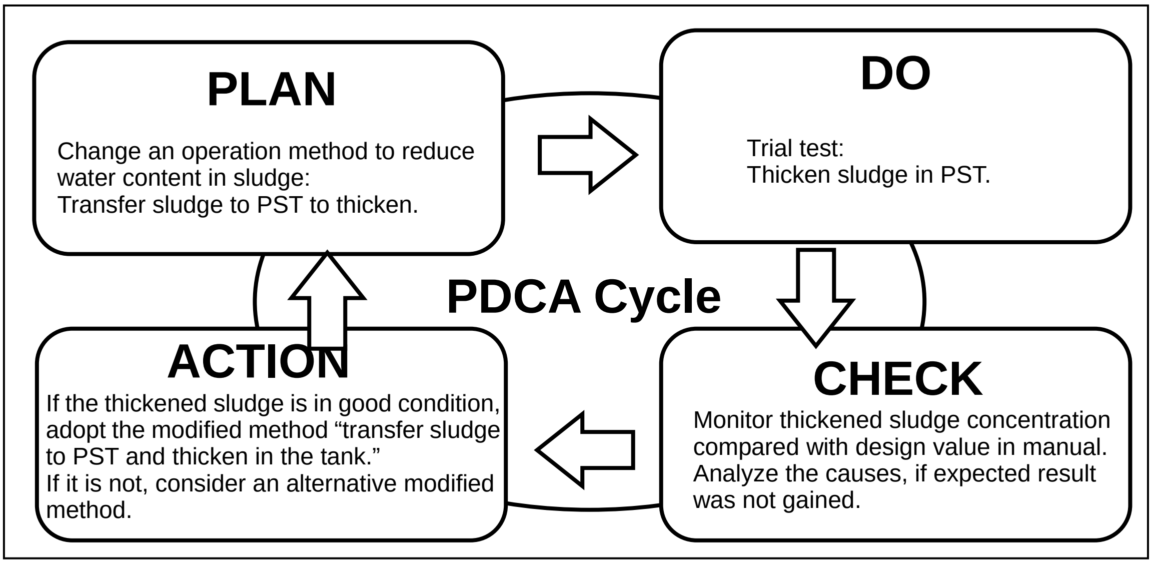
“ACTION” means operation within the desirable range of parameters studied in “CHECK” generally. If we have no problems with the operation and it is within the desirable range of parameters studied in “CHECK”, we can review (rewrite) the existing manual. But, if we have any unexpected problems, we have to consider the process again.

By repeating this PDCA cycle, the manual will be continuously improved.

One example is shown in Figure 2.4.1. That is for North Thang Long - Van Tri WWTP. In the study of JICA in 2010, low efficiency of dehydration in the sludge treatment process was reported. It was caused by excess sludge with too high a water content going to the dehydrator. As the countermeasure, the JICA study team made a plan using a PDCA cycle to thicken the excess sludge of FST using the PST as shown in Figure 2.4.2.

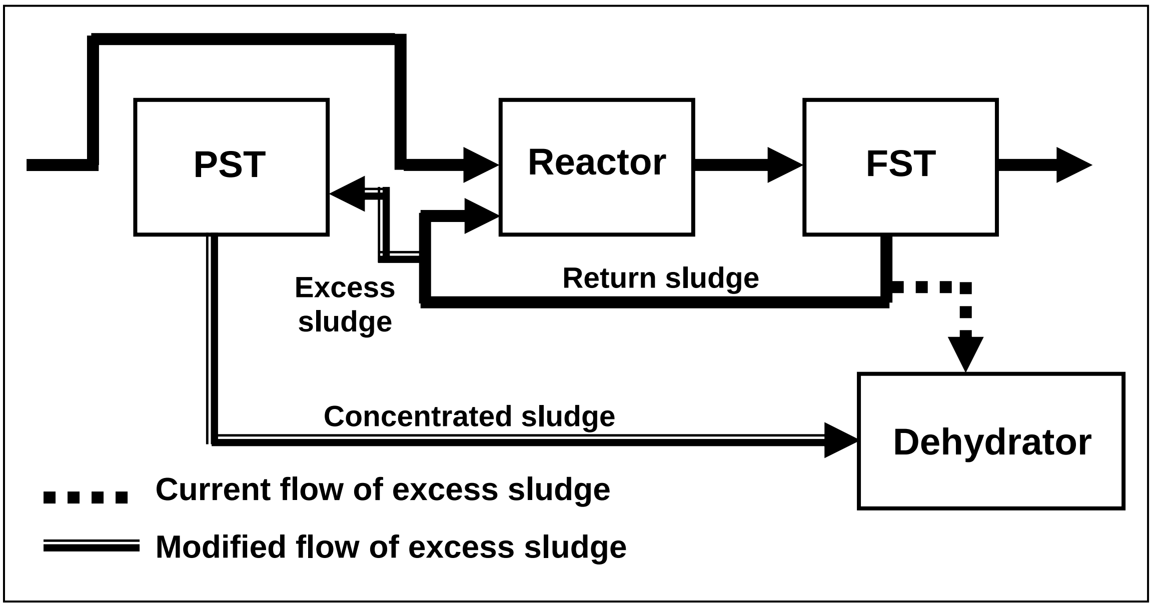
As expected, we were able to obtain a good result. The details are presented in 2.5.

Based on this result, the JICA study team suggested adding the method of thickening excess sludge using the PST.



Source: JICA Study Team

Figure 2.4.1 Example of PDCA cycle for the quality betterment of dehydrated sludge



Source: JICA Study Team

Figure 2.4.2 Modified excess sludge flow for sludge concentration in North Thang Long WWTP

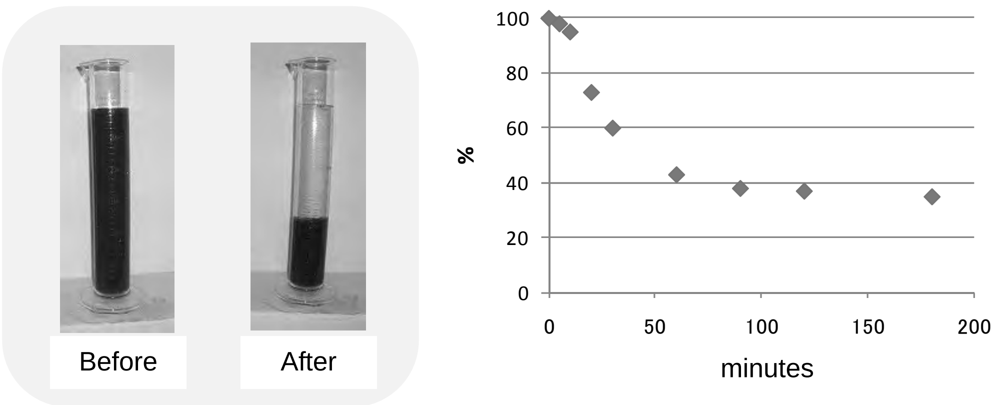
2.5 Review for Ability to Thicken Excess Sludge and Improving Effluent Water Quality (North Thang Long WWTP)

In the study of "Strengthening of the Operation and Maintenance of Sewerage Facilities in Hanoi in 2010", the study team found dehydrated sludge with high water content and the study team pointed out the reason for the poor dehydration was due to the poor sludge concentration and proposed to utilize the PST, which was not being used, to thicken the excess sludge.

In this study, through the following test, the JICA study team confirmed the efficiency of using the PST as the thickener.

1) The thickening test using a cylinder

An excess sludge thickening test using a cylinder was implemented before a trial test at the site. Figure 2.5.1 shows the relationship between time and sludge volume. Sludge volume was reduced to less than 40 % of original volume in 3 hours. Based on the result, the JICA study team chose the thickening time for the trial test as 3 hours.



Source: JICA Study Team

Figure 2.5.1 The thickening test in a cylinder

2) Trial test on site

Before the test, HSDC cleaned the PST and set the temporary pump for transfer of the excess sludge from the FST. The temporary pump was set to pump from the return sludge canal and 100 m^3 of excess sludge was pumped to the PST. After 3 hours, the JICA study team took a sample of the thickened sludge from the drainage pipe of the PST.

Table 2.5.1 shows the results of the analysis as measured by HSDC. Even though the concentration rates of the sludge measured were very high compared to general concentration rates, the results showed that excess sludge was thickened by a factor of more than 3.

Table 2.5.1 Analysis result by HSDC

Status	Concentration of sludge (%)
Before (Excess Sludge)	2.0
After (Thickened Sludge)	6.3

Source: HSDC

3) Result consideration

The JICA study team considered that the concentration of thickened sludge was very high in this analysis by HSDC. Nevertheless, judging from the appearance, the JICA study team guessed that excess sludge concentration was not more than 1 %, and thickened sludge concentration in the PST was about 2 to 3 %.

Anyway, the effectiveness of sludge thickening using the PST was confirmed, and this method will be helpful to concentrate excess sludge. Based on the good results, the JICA study team suggested continuous measuring and determination by HSDC of the appropriate allowable range for sludge concentration.

Chapter 3 Proposal for the Integrated Operation and Maintenance Services (IOMS) by using Maximum Benefits of PPP Scheme

3.1 Introduction of IOMS

3.1.1 What is IOMS

The Integrated Operation and Maintenance Service (IOMS) is the system-base ordering system in contrast to the individual asset-based contracts as a conventional operation and maintenance ordering system. One of the main advantages of this paradigm shift is that it enables the evaluation of the business value brought about by reaching solutions that balance or trade-off between technical necessity and overall system economic feasibility.

The IOMS is premised on the IOMS contractor's experiential problem solving capacity including proactive measures and contingency measures. The contractor's holistic view of the asset management process is expected to save the life-cycle costs of the system with prolongation of equipment lifetime.

Table 3.1.1 Comparison of conventional O&M and IOMS

	Conventional O&M	IOMS
Basis of Contract	✓ Fixed Scope of Work ✓ Single-year & Unit price base contract	✓ Performance Indicators (mainly treatment quality) & Delivery conditions at the end of the contract. ✓ Multi-year & Lump-sum contract
Criteria of contractor's performance	✓ The contractor shall comply with Performance Indicators and methods bound in the contract.	✓ The contractor shall comply with Performance Indicators bound in the contract.
Repair & Replacement	✓ Budget of repair and replacement of equipment is accounted as a Provisional-Sum.	✓ Repair budget is either included in lump-sum amount or accounted as a provisional-sum. ✓ Replacement budget is usually accounted as a provisional-sum.

Source: Japan Sewage Works Agency (JSWA)

3.1.2 On-going IOMS in Japan

1) General

In Japan, IOMS is called "Hokatsu Itaku" in Japanese, and has been implemented for over ten years. IOMS is classified in three levels generally. The levels are determined by the scale of the replacement. Each scale is limited by the actual price for the replacement within a single or multi year.

According to the statistic data as of 2009, 251 IOMS projects have been implemented. A Level-2, 3-year contract is the most popular so far. The Japanese government encourages the long term, full scale IOMS contract since the new PFI law was effectuated in 2011.

Table 3.1.2 Levels of IOMS

Contract Level	Period	Cost components
Conventional	Single year	Process cost (measurement base)
IOMS level-1	Short term multi year	Process + utility cost (Lump sum)
IOMS level-2		Process + utility cost (Lump sum) + Small replacement
IOMS level-3		Process + utility cost (Lump sum) + Medium replacement
IOMS full scale	Long term multi year	Process + utility cost (Lump sum) + Large replacement

Source: JSWA

Table 3.1.3 Number of IOMS projects

Number of IOMS project in 2009	
Level-1	29 projects
Level-2	201 projects
Level-3	21 projects
Total	251 projects

Source: Kokyo Toshi Journal Inc.

Table 3.1.4 Contract period

Statistic, Contract Period (as of 2009)	
1 year	32 projects
3 years	182 projects
4 years	14 projects
5 years	14 projects
Over 5 years	1 project
Total	243 projects

Source: Kokyo Toshi Journal Inc.

2) Hanamigawa no.2 WWTP - Case 1

Hanamigawa no.2 WWTP is one of the representative examples of IOMS, which is located in Chiba prefecture, next to Tokyo. It was implemented in 2007, with a level-2, 3-year contract.

(1) Plant features

- ✓ Capacity: 576,000m^3/day
- ✓ Conventional activated sludge treatment
- ✓ Sludge incinerator: 150 ton/day
- ✓ Treated Sewage Effluent (TSE) Tertiary Treatment
- ✓ Photovoltaic power generation (1828 KWh)

(2) Scope of work

- ✓ O&M of sewage treatment, sludge treatment, TSE transmission

- ✓ Environmental monitoring & protection
- ✓ Ancillary facility maintenance
- ✓ Replacement of equipment (less than JPY 2,500,000 per item)
- ✓ Procurement of consumables

(3) Outcome of IOMS (2007-2009)

The post-project evaluation presents three notable merits; one is 14% reduction of total O&M costs. Second is 7% saving of electricity consumption, and last is a 12% reduction in equipment mal-functions and system failures.

Table 3.1.5 Hanamigawa cost comparison before & after project in 3 years

(Unit: million JPY)

Item	Before project (2006)	After project (2009)	Improvements
Public Remuneration	231	138	▼93 or -40%
Direct costs incl. Utilities	3,548	2,886	▼662 or -19%
Small replacement (<JPY250K)	72	52	▼20 or -28%
Large replacement (>JPY250K)	954	1,049	△95 or +10%
Others	114	118	△4 or +4%
Total	4,919	4,243	▼676 or -14%

Source: Chiba prefecture

3) Amagasaki East WWTP - Case 2

Another IOMS example is Amagasaki East WWTP, which is located in Hyogo prefecture, next to Osaka. It was first introduced in 2003, with a level-2, 5-year contract.

(1) Plant features

- ✓ Capacity: 134,000m^3/day for sewage
- ✓ Conventional activated sludge treatment
- ✓ Relay Pumping S-1: 139m^3/min(S) + 1971m^3/min(R)
- ✓ Relay Pumping S-2: 1745m^3/min(R)
- ✓ Sludge transmission pumping station

(2) Scope of work

- ✓ O&M of Sewage treatment
- ✓ Environmental monitoring
- ✓ O&M of relay pumping stations
- ✓ Inspection and maintenance of plant utilities
- ✓ Procurement of consumables and utilities

- ✓ Equipment replacement (> JPY 1M)
- ✓ O&M of rooftop plaza, planting zone

(3) Outcome of IOMS

Although detail figures are not available, it seems that total costs have been reduced by 20% over the five years.

Table 3.1.6 Amagasaki cost comparison before & after project

Item	Before project (2002)	After project (2007)	Improvements
Public Remuneration	28%	7%	-21%
Direct costs incl. Utilities, and Others	72%	73%	+1%
Total	100%	80%	-20%

Source: Kankyoshimbunsha, Co., Ltd.

4) Other IOMS cases in Japan

Other typical IOMS cases are listed in Table 3.1.7. The 3-year, level-2 contract is most popular. The Performance Indicators are different due to the conditions of areas and capacity.

Table 3.1.7 Other Japanese IOMS Cases

Item	Shiwa (Iwate)	Hamakurosaki (Toyama)	Arakawa (Saitama)	Nagata (Shizuoka)	Takehara (Hiroshima)	Matsuyama (Ehime)
Period	3 year	3 year	3 year	3 year	3 year	3 year
Type	Combined	Separated	Separated	Separated	Separated	Combined
Contract level	2	2	2	2	1	2
Replacement Max at one time	USD 10,000	N/A	USD 5,000	USD 5,000	N/A	USD 5,000
Process	C.A.S	C.A.S	O.D	C.A.S	S.A.S	C.A.S
Design capacity (m^3/d)	9,200	178,500	38,700	17,000	N/A	151,000
PI - BOD	13 mg/L	5.6 mg/L	N/A	N/A	5 mg/L	4.3 mg/L
COD		8.9 mg/L	N/A	N/A	10 mg/L	7.2 mg/L
SS	20 mg/L	5.3 mg/L	N/A	N/A	5 mg/L	2 mg/L
T-N	None	None	N/A	N/A	10 mg/L	13 mg/L
T-P	None	None	N/A	N/A	1 mg/L	0.48 mg/L
Coliform G	80 MPU/mL	7 MPU/mL	N/A	N/A	Nil	Nil

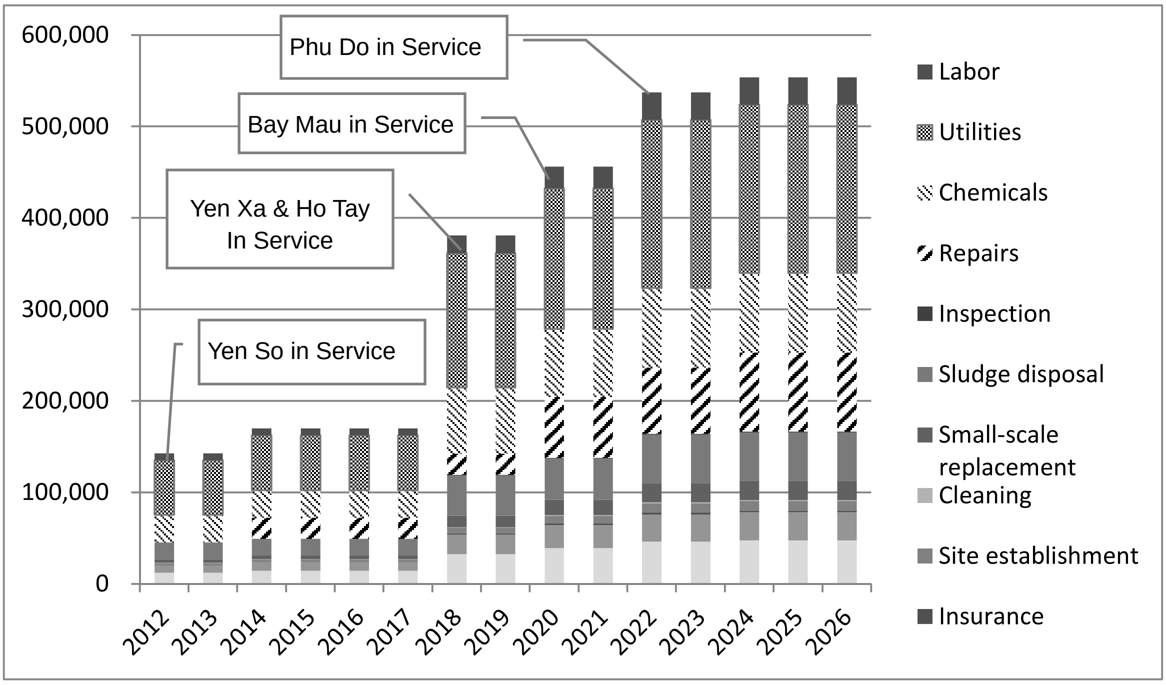
Source: Ministry of Land, Infrastructure, Transport and Tourism

3.1.3 Cost Merit Analysis

1) Total O&M cost

Hanoi will develop at least 5 WWTPs in ten years. When Yen So WWTP starts in service in 2012, the O&M cost would be approximately 150,000 million VND. In 2022, when 5 WWTPs are in service, the O&M cost will be about 550,000 million VND. Taking into consideration such substantial costs, it will be necessary to adopt efficient O&M in the near future.

(Unit: million VND)

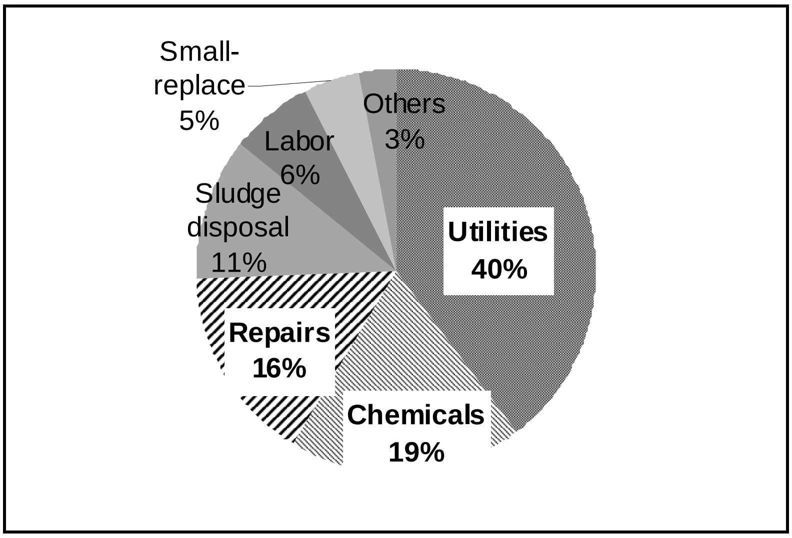


Source: JICA Study Team

Figure 3.1.1 Total O&M cost of newly developed WWTPs

2) Breakdown of direct cost

Figure 3.1.2 shows the breakdown of direct O&M cost in 2022. A total of 75% of the direct cost is occupied by Utilities, Chemicals, and Repairs. These items are variable costs and tend to be less expensive under IOMS because of the contractor’s optimization effort for the O&M works. According to the IOMS statistics, the Ministry of Land Infrastructure and Transportation of Japan 2010, the IOMS reduces these costs by 8 to 12%.



Source: JICA Study Team

Figure 3.1.2 Breakdown of direct cost in 2022

3) Cost comparison

Suppose IOMS could reduce the costs of Utilities (mainly Electricity and Water), Chemicals, and Repairs by 10% compared with Conventional O&M, total direct cost will be reduced by 7.5%. Table 3.1.8 presents the result of the trial calculation. This shows that IOMS is worth introducing.

Table 3.1.8 Direct cost comparison; conventional vs. IOMS in 2022

Items	Conventional	IOMS	Reduction rate (%)
	million VND	million VND	
Utilities	183,653	165,288	10.0%
Chemicals	87,157	78,441	10.0%
Repairs	72,517	65,265	10.0%
Sludge disposal	52,773	52,773	0.0%
Small-scale replacement	20,944	20,944	0.0%
Labor	29,952	29,952	0.0%
Others	14,243	14,105	1.0%
Total Direct Cost	461,239	426,769	7.5%

Source: JICA Study Team

3.1.4 Terms of IOMS Contract

As mentioned in section 3.1.2, the Japanese IOMS level-2 is the most popular form for IOMS contract in Japan. Referring to the Japanese IOMS level-2, the JICA study team proposes the Terms of IOMS Contract as follows;

1) Project owner & contractor

The project owner is HPC, and the contractor is the Joint Company, which is referred to later.

2) Contractor's obligation

The contractor shall provide the IOMS stipulated by the IOMS contract.

3) Payment

The owner shall confirm conformity of the contractor's performance compared with the performance indicators.

Nonconforming work by the contractor will cause the reduction of the payment to the contractor.

4) Contractor's possession of site and duty to reserve function

The owner shall grant the right to use the sewerage facility to the contractor for the purpose of fulfilling the contractor's obligation.

The contractor shall maintain the function of the facility and compensate for any damage or losses caused by the contractor.

5) Scope of Work in IOMS Contract

The scope of work is composed of general, technical, and optional parts. The major points of each part are described below.

1) General
- ✓ Staff management and Material Control for O&M
- ✓ Reporting of results of O&M work to the regulator
- ✓ Customer technical service

2) Technical
- ✓ O&M in wastewater treatment and sludge treatment/disposal in compliance with Performance Indicators (PIs)
- ✓ Repair work of facilities
- ✓ Small scale replacement of equipment

3) Option
- ✓ Promotion of sewerage service
- ✓ Engineering service to other cities
- ✓ Staff Training to other cities

3.1.5 Performance Indicators

The IOMS contractor carries out all necessary work for conforming with the Performance Indicators (PIs). Usually the PIs are set to be more severe than the environmental control criteria. The difference between the PIs and the environmental control values is a safety allowance against unforeseeable malefaction of the treatment process. Proposed PIs for sewerage IOMS in Hanoi are shown in the Table below.

These items should be checked and reported to the regulator weekly, and then the regulator verifies and reports the conformity of the contractor's performance to HPC. If the performance does not conform to the PIs, HPC reduces the payment to the contractor.

Table 3.1.9 Performance indicators

Items	Legal Effluent Quality QCVN24:2009 column B	Proposed Effluent Quality
BOD5 (mg/L)	50	40
COD (mg/L)	100	80
SS (mg/L)	100	80
Nitrogen (mg/L)	30	24
Phosphorus (mg/L)	6	5

Source: JICA Study Team

3.1.6 Contractor's Risk

1) Major risk

In the performance based lump-sum contracts such as IOMS, it is essential to share the risk and clarify the responsibilities between the owner and the contractor. Table 3.1.10 shows the major risks in the contract that the contractor should mitigate. Among those risks, price escalation and tariff collection are critical issues for the IOMS contractor.

Table 3.1.10 Contractor's major risks

➢ Third-party Liability
➢ Complaints from Residents
➢ Changes of Regulations
➢ Fluctuation of Influent Volume
➢ Increase of repair expense due to sudden failure
➢ Price Escalation
➢ Tariff Collection

Source: JSWA

2) Price escalation

Price escalation impacts on Utilities, Chemicals, Repairs, Overhead, and Labor cost. A 10% price escalation causes an 8-9% O&M cost increase. O&M cost in the contract is usually a lump-sum.

As an assurance, a price adjustment clause against unexpected price escalation is needed in the contract. Also, the contract period of IOMS shall be set within a predictable range of price escalation.

3) Tariff collection

Non-revenue sewage would be encountered due to the lack of user's appreciation for sewerage services and to the additional burden on the households' economy.

It is difficult for the contactor to directly request households to pay for non-revenue sewage. The contractor will not incur financial loss due to non-revenue sewage risk.

To collect the sewage tariff steadily, one bill for water supply and sewerage is recommendable.

3.1.7 Service Fee

The service fee, which the contractor receives from the owner, is composed of variable and fixed expenses. Variable expenses are in proportion to actual inflow volume. Usually, Chemicals, Fuel, and Electricity are set as variable expenses. By including variable expenses, the service fee becomes a performance based payment.

Monthly Service Fee = α ×(Actual inflow volume) + β

α = Variable expenses basic unit = Total variable expenses / Design flow
β = Monthly fixed expenses

Table 3.1.11 Fixed and variable expenses

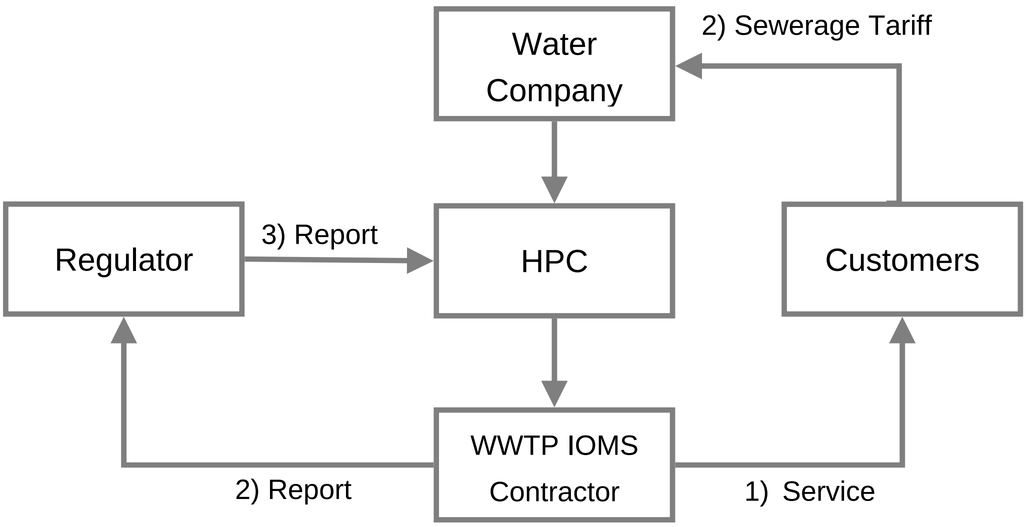
Items	Type
Labor	Fixed
Chemicals	Variable
Fuel	Variable
Electricity	Variable
Consumables	Fixed
Repair	Fixed
Other expenses	Fixed
Overhead	Fixed

Source: JSWA

3.2 Implementation of IOMS

3.2.1 Implementation Framework of IOMS

The relationship of concerned parties is described in Figure 3.2.1. The WWTP IOMS contractor provides IOMS to customers, i.e. the contractor treats the wastewater for the domestic and non-domestic users. The contractor has to report the result of their service to the regulator routinely. The customers pay the sewerage tariff along with water tariff to the water company of each area. The water company pays the collected sewerage tariff to HPC. Judging from the regulators reports, HPC pays the service fees to the IOMS contractor in accordance with the IOMS contract.



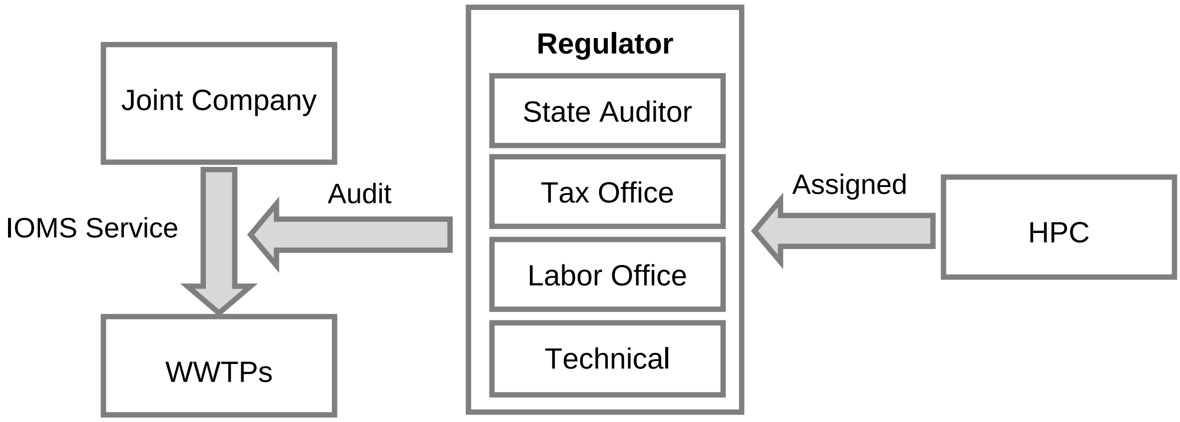
Source: JICA Study Team

Figure 3.2.1 Implementation framework of IOMS

3.2.2 Framework of Regulator

The objective of the regulator is to audit the IOMS quality according to the Performance Indicators. The regulator audits and reports to HPC the result of the contractor's performance. If the performance does not satisfy the PIs in the IOMS contract, HPC could reduce the payment of the service fee to the contractor.

The regulator consists of the State Auditor, Tax Office, Labor Office, and Technical Office, and so on. In Hanoi, DOC and HSDC might play a key role to develop it.



Source：JICA Study Team

Figure 3.2.2 Framework of regulator

3.2.3 Contractor of IOMS

The study team carried out a comparative analysis of the following 3 options for the IOMS framework;

- ✓ Option 1: HSDC to undertake the IOMS
- ✓ Option 2: Joint Company established by HPC, HSDC and a private firm to undertake the IOMS
- ✓ Option 3: A Private firm to undertake the IOMS

Table 3.2.1 shows the result of the comparative analysis. As a conclusion, option 2 would be the best option for the contractor due to the advantage of synergy created by HSDC's locality and the private firm's skill and experience.

Table 3.2.1 Comparison of contractor's options

	Option 1	**Option 2**	**Option 3**
Capacity to undertake IOMS	Need time for new experience	Enough capacity	Enough capacity
Cost saving opportunity	Less because lack of experience	Promising	High cost due to Foreign company
Comfort for HPC	Comfort	Comfort	Uncomfortable to ignore HSDC
Compliance of laws and regulations	Complied	Complied	Complied
Evaluation	Need enough time for experience and support from outside	HSDC's locality and Private firm's skill produce synergy. **Recommendable**	HSDC's 5 year experience cannot contribute in this option.

Source: JICA Study Team

3.2.4 Analysis for Modification of Legal System for IOMS by Joint Company

1) Related Laws and Regulations for IOMS

The futures of IOMS contracts are lump-sum, multi-year, and performance based payment. The study team examined whether IOMS can be implemented under existing related laws or regulations. The following decree and circular are the related ones.

- ✓ Decree No. 88/2007/ND-CP, on Urban and industrial-park water drainage
- ✓ Circular No. 09/2009/TT-BXD, Defining detailed guidelines to implement some contents of Decree 88/2007/ND-CP

(1) Assignment of O&M contract

HPC can assign O&M to the contractor in accordance with the contracts on the agreement of the HPC and the contractor.

In article 29 of decree 88/2007, it is stated “Water drainage units may assign part or the whole of their obligations and rights in the management and operation contracts to a third party upon the agreement of the water drainage work owners.”

Also in article 4 of the circular 09/2009, it is provided “they (the Municipal People’s Committee) will assign contracts to specialized agencies with the relevant capacity to carry out those O&M performance contracts.

(2) Contract type

Lump-sum contract is possible to implement. Article 10 of circular 09/2009 stipulates “contract type shall be defined approximately, such as lump-sum contract, unit price contract, or combined.”

(3) Duration

Although it seems a multi-year contract has not been adopted in Vietnam yet, legally it is possible.

In article 33 of decree 88/2007, it is provided that “A management and operation contract has a minimum term of 5 years and a maximum term of 10 years.”

(4) Payment to contractor

Performance based payment will be possible to include in the contract although it is not clearly stipulated in the decree or the circular.

According to article 11 of circular 09/2009, the contract price is the total value for carrying out O&M, and it shall be agreed by both parties (the owner and the contractor). This context enables performance based payment as long as both parties reach an agreement.

2) Related Laws and Regulations for Joint Company

Regarding the establishment of the Joint Company between HPC and the foreign private companies, the issues to be discussed are the proportion of contributed equity, the amount of subsidy, and organization form. The related laws are as follows;

- ✓ Decision No. 71/2010/QD-TTg, Promulgating the regulation on pilot investment in the public-private partnership form (Pilot PPP Law)
- ✓ Law No. 59/2005/QH11, On Investment (Investment Law)
- ✓ Decree No.108/2006/ND-CP, Providing Detailed Provisions and Guidelines for Implementation of a Numbers of Articles of Law on Investment
- ✓ Law No. 60/2005/QH11 on Enterprise (Enterprise Law)

Although the study team has discussed with working group members whether or not decision 71/Pilot PPP Law is applied in this case, no conclusion has been reached. This is because decision 71 has just taken effect in January in 2011, and has much to be considered.

(1) Proportion of Joint Company's contributed equity

The proportion of the contributed equity can be set at the demand of HPC and the Private Firm whether decision 71 is applied or not. Article 9, clause 2 of decision 71 stipulates "The total state participation portion must not exceed 30% of the total investment level of a project, except in other cases decided by the Prime Minister". However, article 2 clause 4 stipulates "the state participation portion is neither the contributed equity capital in the project enterprise nor associated with the right to receive the profits from the project's revenues." Judging from this clause, 30% is not the limit of the contributed equity from HPC

(2) The amount of subsidy

Decision 71 stipulates the ceiling of the state participation portion at 30% of the total investment. It will take time to establish and raise the sewerage tariff to the level of full cost recovery for O&M. A subsidy has to be injected until the tariff is raised high enough to recover the full cost of O&M. If the subsidy portion is limited to 30% of total O&M cost, it may cause a shortage of O&M budget.

(3) Organization form

The organization form of the Joint Company shall comply with Law 60/Enterprise Law regardless of whether decision 71 is applied. The possible form will be a "Limited Liability Company with More Than One Member" capitalized by HPC and a private firm or a "Shareholding Company". Taking into consideration the operational procedures, a "Limited Liability Company with More Than One Member" is suitable in this case. Legal capital is not regulated in this case.

3.3 Business Plan of Joint Company for IOMS

Through the working group meeting between the counterpart working group and the JICA study team, the whole concept of the Joint Company was discussed many times and we came to a basic consensus to establish the Joint Company for the IOMS implementation in the near future based on the following points.

3.3.1 Objective, Mission, and Operating Plan of the Joint Company

1) Objectives

- ✓ To implement IOMS in Hanoi
- ✓ To develop the standard IOMS model in Vietnam
- ✓ To promote the standard IOMS model throughout Vietnam with HSDC

2) Mission

- ✓ To provide users the a sanitary environment
- ✓ To provide an efficient O&M of WWTPs
- ✓ To upgrade the skills of WWTP operators

3) Operating Plan

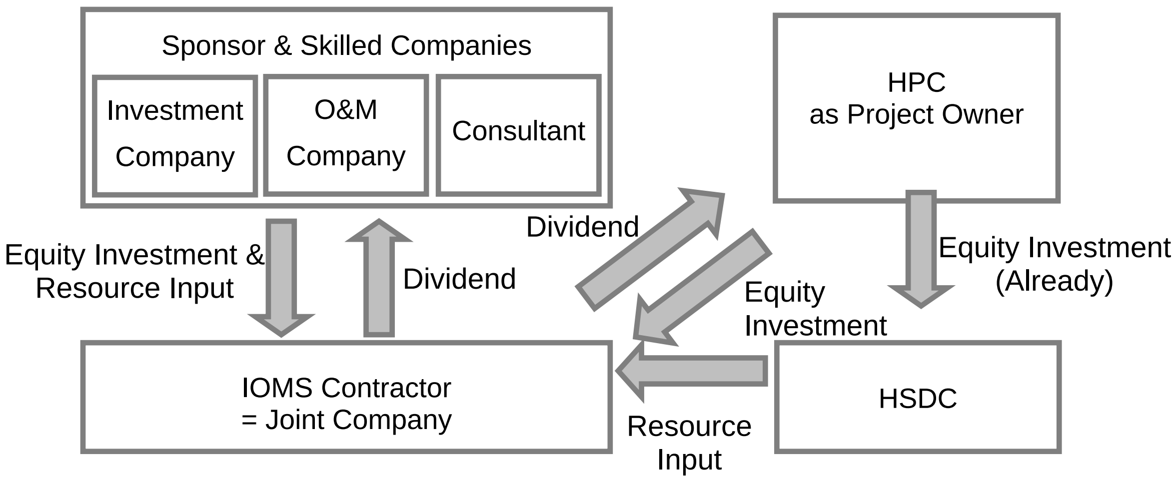
- ✓ Starts to operate IOMS at Yen So WWTP in 2014
- ✓ Starts to operate IOMS at Yen Xa and Ho Tay WWTP in 2018
- ✓ Starts to operate IOMS at Bay Mau in 2020
- ✓ Starts to operate IOMS at Phu Do in 2022

3.3.2 Company Structure

1) Company ownership

- ✓ Hanoi People’s Committee (HPC): Japanese Consortium (*1) = 50: 50

  *1 Japanese Consortium will consist of ORIX Corp, Water Agency Inc., and others.



Source: JICA Study Team

Figure 3.3.1 Participation image

2) Company locations and facilities

- ✓ Headquarters: One room in HSDC (Rental base)
- ✓ Branches: Each WWTP's site office (Provided by HPC)

3.3.3 Management Plan

1) Management board members

(1) President

a. Qualification

Vietnamese, who shall be appointed by HPC subject to acceptance of the Japanese Consortium having enough experience in the management of similar works.

b. Task

He/she has the right of representation of the company that shall be responsible for all aspects of the company including internal and external matters. He/she will have the lead role in making decisions that concern the well-being of the Joint Company.

(2) Vice president

a. Qualification

Japanese, who shall be appointed by the Japanese consortium subject to acceptance of HPC having enough management experience in similar works.

b. Task

He/she shall be responsible for the financial aspects of the company including accounts payable, accounts receivable, and bookkeeping.

2) O&M staff

(1) Senior advisor

a. Qualification

Japanese, who has enough experience in the IOMS of wastewater treatment plants. JICA's technical assistance might be utilized in this position.

b. Task

He/she shall be knowledgeable of, and capable of communicating regarding the entire O&M works in which he/she advises;

- Monitoring O&M staff's progress.
- Providing guidance for developing and achieving meaningful educational, professional, and personal goals for O&M staff.
- Proactively involving O&M staff in their career planning process, self-reflection.

(2) Director

a. Qualification

Vietnamese who has a bachelor decree or higher in engineering and has enough experience in the O&M works of wastewater treatment plants.

b. Task

He/she shall represent the site office being responsible for all aspects in the O&M works and administration of the wastewater treatment plant.

(3) Vice director

a. Qualification

Vietnamese who has a bachelor degree or higher in engineering and has enough experience in similar works.

b. Task

He/she shall be responsible for the technical aspects in the operation and maintenance of each plant.

(4) Engineer

a. Qualification

Vietnamese who has a bachelor degree or higher in engineering, science or equivalent.

b. Task

He/she shall be a superintendent of a part of the O&M work.

(5) Worker

a. Qualification

Vietnamese who has a junior high school diploma or higher.

b. Task

He/she shall carry out a part of the O&M work under the engineer.

3) General staff

(1) Secretary

a. Qualification

Vietnamese who has a bachelor degree or higher having experience in a similar job.

b. Task

Bilingual secretary to support the management board member.

(2) Procurement

a. Qualification

Vietnamese who has a bachelor degree or higher having experience in a similar job.

b. Task

Control the procurement and stock of consumables and spare parts.

(3) Accountant

a. Qualification

Vietnamese who has a high school diploma or higher and has enough experience in accounting.

b. Task

Accounting and financial affairs.

(4) General Staff

a. Qualification

Vietnamese who have a junior high school diploma or higher.

b. Task

General affairs.

4) Recruit plan

The initial recruit plan is on the basis of operation for Yen So WWTP in 2014. Total number of Staff is 84 including 3 management board members, 1 senior adviser. Resources will be recruited from DOC, HSDC, member companies of the Japanese Consortium.

Table 3.3.1 Initial recruit plan

Labor Type	Numbers (Persons)	Grade	Labor unit cost		Subtotal (year)	
			VND(month)	VND(year)	VND	USD
Unit price	-	-	2,000,000	24,000,000	-	-
Headquarters Labor Cost (A)						
President	1	10	20,000,000	240,000,000	240,000,000	11,459
Vice president	1	8	16,000,000	192,000,000	192,000,000	9,167
Secretary	1	5	10,000,000	120,000,000	120,000,000	5,730
Accountant	1	5	10,000,000	120,000,000	120,000,000	5,730
Procurement	1	4	8,000,000	96,000,000	96,000,000	4,584
General Staff	2	4	8,000,000	96,000,000	192,000,000	9,167
Senior Advisor	1	-	314,160,000	3,769,920,000	3,769,920,000	180,000
Sub-Total	8	-	-	-	4,729,920,000	225,837
Direct Labor Cost (B)						
Director	1	7	14,000,000	168,000,000	168,000,000	8,021
Vice Director	2	6	12,000,000	144,000,000	288,000,000	13,751
Manager	5	5	10,000,000	120,000,000	600,000,000	28,648
Engineer & Worker	70	4	8,000,000	96,000,000	6,720,000,000	320,856
Sub-Total	78	-	-	-	7,776,000,000	371,276
Total (A+B)	86	-	-	-	12,505,920,000	597,112

Source: JICA Study Team

3.3.4 Financial Plan

1) Contributed equity

The contributed equity will consist of the preparatory costs and operating funds to cover the preparatory period and a three-month operating fund for Yen So WWTP.

(1) Preparatory costs

Our preparatory costs will be approximately 11,000 million VND which will be arranged by the contributed equity of each shareholder. The components of the preparatory cost are listed below:

The preparatory costs are the costs for the twelve-month preparation time prior to commencement of O&M service in Yen So WWTP.

Table 3.3.2 Preparatory costs

A) Preparatory Expenses	USD	VND	Remarks
Legal	12,000	251,328,000	1,000USD*12 months
Phone/utilities deposits	500	10,472,000	
Licenses/tax deposit	5,000	104,720,000	
Brochures/sales literature	500	10,472,000	
Employee salaries (12 months)	225,837	4,729,920,000	Headquarters labor
Office Rental (12 months)	12,000	251,328,000	1,000USD*12 months
Car Rental (12 months)	6,000	125,664,000	500USD*12 months
Furniture and supplies	5,000	104,720,000	
Website development	1,500	31,416,000	
Miscellaneous	20,000	418,880,000	
Sub Total	**288,337**	**6,038,920,000**	
B) Preparatory Assets			
Cash Required	200,000	4,188,800,000	
Personal Computers	10,000	209,440,000	
Initial Inventory	10,000	209,440,000	
Sub Total	**220,000**	**4,607,680,000**	
Provisional Sum for Contingency	25,417	532,330,000	(A+B)*5%
Total Preparatory Costs	**533,753**	**11,178,930,000**	

Source: JICA Study Team

(2) Operating fund

The operating fund is to cover 3-month direct cost and overhead of O&M service in Yen So WWTP. The amount will be approximately 35,000 million VND.

(3) Total amount of contributed equity for the Joint Company

The amount of contributed equity will be 47,000 million VND. Total contributed equity will be paid by HPC and the Japanese Consortium in proportion to the equity contribution.

Table 3.3.3 Total amount of Contributed Equity for the Joint Company

	USD	VND	Remark
Initial Expenses	533,753	11,178,930,000	
3-month JC Cost of Yen So	1,687,463	35,342,215,345	Direct Cost + Overhead
Total Equity	**2,221,216**	**46,521,145,345**	**JPY 184,360,918**
Total Equity (Round Up)	**2,244,079**	**47,000,000,000**	**JPY 186,258,594**

Source: JICA Study Team

2) Projected profit and loss

The table shown below summarizes the anticipated profit and loss of the Joint Company for the first ten years. Year 2013 is the preparatory period. The commencement of O&M service in Yen So WWTP is in 2014 (Year 1). Yen Xa WWTP and Ho Tay WWTP will be operated in 2018 (Year 5), and Bay Mau WWTP in 2020 (Year 7), Phu Do WWTP in 2022 (Year 9).

The sales of the company is the amount equal to the total costs required for O&M service in Yen So WWTP estimated by the JICA study team. Tariff revenue is not linked with the sales because the sewerage tariff will be short for the O&M service in the first ten years. It is anticipated that there will be a Government subsidy to compensate the deficit of the tariff revenue.

Cost cuts by IOMS are considered in the direct cost. Utilities, Chemicals, and Repairs are reduced by 10% compared with conventional O&M.

It is assumed that the company benefits from corporate tax exemption and reduction. According to Law No.14/2008/QH12 on Corporate Income Tax, the tax rate of ten per cent shall apply for fifteen years to an environmental entity. In addition, the environmental entity is entitled to tax exemption for four years and a 50% reduction of payable tax amounts for no more than nine subsequent years. That is, the corporation tax is exempted for the first four years, 5% for the next nine years, and 10% for next two years.

The duration of the preferential tax rates stipulated in this article shall be calculated from the first year in which the enterprise has turnover.

Table 3.3.4 Projected profit and loss

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	0	1	2	3	4	5	6	7	8	9	10
Sales *1	0	156,852	156,852	156,852	156,852	352,856	352,856	421,725	421,725	497,186	497,186
Direct Cost	0	134,637	134,637	134,637	134,637	302,881	302,881	361,996	361,996	426,769	426,769
Utilities	0	53,706	53,706	53,706	53,706	131,995	131,995	138,265	138,265	165,288	165,288
Chemicals	0	26,934	26,934	26,934	26,934	65,210	65,210	67,105	67,105	78,441	78,441
Repairs	0	20,847	20,847	20,847	20,847	20,847	20,847	59,667	59,667	65,265	65,265
Sludge disposal	0	18,135	18,135	18,135	18,135	43,887	43,887	45,157	45,157	52,773	52,773
Small replacement	0	4,189	4,189	4,189	4,189	12,566	12,566	16,755	16,755	20,944	20,944
Labor	0	7,776	7,776	7,776	7,776	19,632	19,632	23,712	23,712	29,952	29,952
Site establishment	0	2,094	2,094	2,094	2,094	6,283	6,283	8,378	8,378	10,472	10,472
Other Expenses	0	954	954	954	954	2,460	2,460	2,957	2,957	3,633	3,633
Overhead *2	-11,179	8,751	8,751	8,751	8,751	19,687	19,687	23,530	23,530	27,740	27,740
Provisional sum *3	0	6,732	6,732	6,732	6,732	15,144	15,144	18,100	18,100	21,338	21,338
Profit before Tax *4	**-11,179**	**6,732**	**6,732**	**6,732**	**6,732**	**15,144**	**15,144**	**18,100**	**18,100**	**21,338**	**21,338**
Profit after Tax *5	**-11,179**	**6,732**	**6,732**	**6,732**	**6,732**	**13,630**	**13,630**	**16,290**	**16,290**	**19,205**	**19,205**

Source: JICA Study Team

*1 The sales is total JC's cost, not linked with sewerage tariff revenue.
*2 6.5% of Direct Cost
*3 5% of Direct Cost
*4 5% of Direct Cost
*5 Tax rate: Exempted in Year 1-4, 5% in Year 5-10

3) Comparison of conventional O&M and IOMS by Joint Company

As mentioned in 3.1.3, IOMS delivers a 7.5% reduction in direct cost compared with conventional O&M. When considering the establishment of the Joint Company, the Joint Company should achieve the total cost reduction even including the profit from it. Table 3.3.5 presents the Total cost comparison between conventional O&M and IOMS by the Joint Company as of 2022. If the profit, which is 5% of direct cost, is added, the Joint Company is able to realize a 3.3% cost reduction. This means cost savings by IOMS can be shared with both HPC and the Joint Company.

Table 3.3.5 Conventional vs. IOMS by Joint Company in 2022

Items	Conventional(A)		Joint Company(B)		Difference (B-A)	
	million VND	%	million VND	%	million VND	%
Direct Cost	**461,239**	**89.7%**	**426,769**	**83.0%**	**-34,470**	**-7.5%**
Utilities	183,653	35.7%	165,288	32.1%	-18,365	-10.0%
Chemicals	87,157	16.9%	78,441	15.3%	-8,716	-10.0%
Repairs	72,517	14.1%	65,265	12.7%	-7,252	-10.0%
Sludge disposal	52,773	10.3%	52,773	10.3%	0	0.0%
Small replace	20,944	4.1%	20,944	4.1%	0	0.0%
Labor	29,952	5.8%	29,952	5.8%	0	0.0%
Site establish	10,472	2.0%	10,472	2.0%	0	0.0%
Other Expenses	3,771	0.7%	3,633	0.7%	-137	-3.6%
Overhead	**29,981**	**5.8%**	**27,740**	**5.4%**	**-2,241**	**-7.5%**
Provisional sum	**23,062**	**4.5%**	**21,338**	**4.1%**	**-1,724**	**-7.5%**
Profit	**0**	**0.0%**	**21,338**	**4.1%**	**21,338**	**4.1%**
Total	**514,282**	**100.0%**	**497,186**	**96.7%**	**-17,096**	**-3.3%**

Source: JICA Study Team

4) Projected cash flow

Tables 3.3.6 and 3.3.7 show the projected cash flow in the one-year preparatory period and the first ten years of the IOMS service by the Joint Company.

The base case is assumed not to be a loan from a bank. The operation fund is covered by only equity and service fees. On the other hand, the bottom case is based on short term borrowing from a bank for the operational fund. The amount of the short term borrowing is the three-month cost of the Joint Company. The interest rate is set at 12.5% by reference to the latest financial market of Vietnam.

As a result of the calculation, 10-year IRR (free cash flow base) of the base case is 19.7%, and of the bottom case is 10.1%. The difference is the interest payment for the short term borrowing.

Table 3.3.6 Projected cash flow (Base Case)

Base Case	Total	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
		0	1	2	3	4	5	6	7	8	9	10
Sources of Funds												
Pre-Operation												
Equity	47,000	47,000										
Debt	0	0										
Operation												
Service Fees Received	3,170,943	0	156,852	156,852	156,852	156,852	352,856	352,856	421,725	421,725	497,186	497,186
Total Sources of Funds (A)	3,217,943	47,000	156,852	156,852	156,852	156,852	352,856	352,856	421,725	421,725	497,186	497,186
Uses of Funds												
Operation												
O&M Costs	-2,721,840	0	-134,637	-134,637	-134,637	-134,637	-302,881	-302,881	-361,996	-361,996	-426,769	-426,769
Initial Expenses	-11,179	-11,179	0	0	0	0	0	0	0	0	0	0
Provisional Sum	-136,092	0	-6,732	-6,732	-6,732	-6,732	-15,144	-15,144	-18,100	-18,100	-21,338	-21,338
Overhead	-176,920	0	-8,751	-8,751	-8,751	-8,751	-19,687	-19,687	-23,530	-23,530	-27,740	-27,740
Total Uses of Funds (B)	-3,046,030	-11,179	-150,120	-150,120	-150,120	-150,120	-337,712	-337,712	-403,625	-403,625	-475,848	-475,848
Cash Surplus (A+B)	171,913	35,821	6,732	6,732	6,732	6,732	15,144	15,144	18,100	18,100	21,338	21,338
Equity IRR (Cash Surplus)												
Equity Subscribed (C)	47,000	47,000										
Free Cash Flow (D)	136,092	0	6,732	6,732	6,732	6,732	15,144	15,144	18,100	18,100	21,338	21,338
Equity Cash Flow (D-C)	89,092	-47,000	6,732	6,732	6,732	6,732	15,144	15,144	18,100	18,100	21,338	21,338
Project IRR	**19.24%**											

Source: JICA Study Team

Table 3.3.7 Projected cash flow (Bottom Case)

Bottom Case	million VND	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
		0	1	2	3	4	5	6	7	8	9	10
Sources of Funds												
Pre-Operation												
Equity	47,000	47,000										
Debt	353,422	0	35,342	35,342	35,342	35,342	35,342	35,342	35,342	35,342	35,342	35,342
Operation												
Service Fees	3,170,943	0	156,852	156,852	156,852	156,852	352,856	352,856	421,725	421,725	497,186	497,186
Total Sources of Funds (A)	3,571,365	47,000	192,194	192,194	192,194	192,194	388,198	388,198	457,067	457,067	532,528	532,528
Uses of Funds												
Operation												
O&M Costs	-2,721,840	0	-134,637	-134,637	-134,637	-134,637	-302,881	-302,881	-361,996	-361,996	-426,769	-426,769
Initial Expenses	-11,179	-11,179	0	0	0	0	0	0	0	0	0	0
Provisional Sum	-136,092	0	-6,732	-6,732	-6,732	-6,732	-15,144	-15,144	-18,100	-18,100	-21,338	-21,338
Overhead	-176,920	0	-8,751	-8,751	-8,751	-8,751	-19,687	-19,687	-23,530	-23,530	-27,740	-27,740
Interest Payment	-44,178	0	-4,418	-4,418	-4,418	-4,418	-4,418	-4,418	-4,418	-4,418	-4,418	-4,418
Principal Payment	-353,422	0	-35,342	-35,342	-35,342	-35,342	-35,342	-35,342	-35,342	-35,342	-35,342	-35,342
Total Uses of Funds (B)	-3,443,630	-11,179	-189,880	-189,880	-189,880	-189,880	-377,472	-377,472	-443,385	-443,385	-515,608	-515,608
Cash Surplus (A+B)	127,735	35,821	2,314	2,314	2,314	2,314	10,726	10,726	13,682	13,682	16,921	16,921
Equity IRR (Cash Surplus)												
Equity Subscribed (C)	47,000	47,000										
Free Cash Flow (D)	91,914	0	2,314	2,314	2,314	2,314	10,726	10,726	13,682	13,682	16,921	16,921
Equity Cash Flow (D-C)	44,914	-47,000	2,314	2,314	2,314	2,314	10,726	10,726	13,682	13,682	16,921	16,921
Project IRR	**10.05%**											

Source: JICA Study Team

3.4 Conclusions

1) Features and advantages of IOMS

IOMS is a system-base ordering system, which includes multi-year, lump-sum, and performance based payment contracts.

Compared with conventional O&M, IOMS could realize a 7.5% reduction of direct cost. In addition, it enables the contractor to enhance its ability for asset management and efficient O&M.

2) Implementation of IOMS

In order to implement IOMS, a Joint Company between HPC and private firms (Japan Consortium) would be the best option due to the synergy of HSDC's locality and private firms' skills and experiences.

Although there is still much room to discuss the application of Decision 71, it is possible to implement IOMS under current laws and other regulations.

3) Profit performance of the Joint Company

Even adding the profit, the Joint Company could achieve a 3.3% reduction in total cost. A win-win relationship would be built between HPC and the Joint Company by implementing IOMS.

The JICA study team proposes 50:50 equity proportions between HPC and the Japanese Consortium, and the amount of total contributed equity is 47,000 million VND.

The project IRR (10year, cash flow base) is 19.7% in the base case, 10.1% in the bottom case.

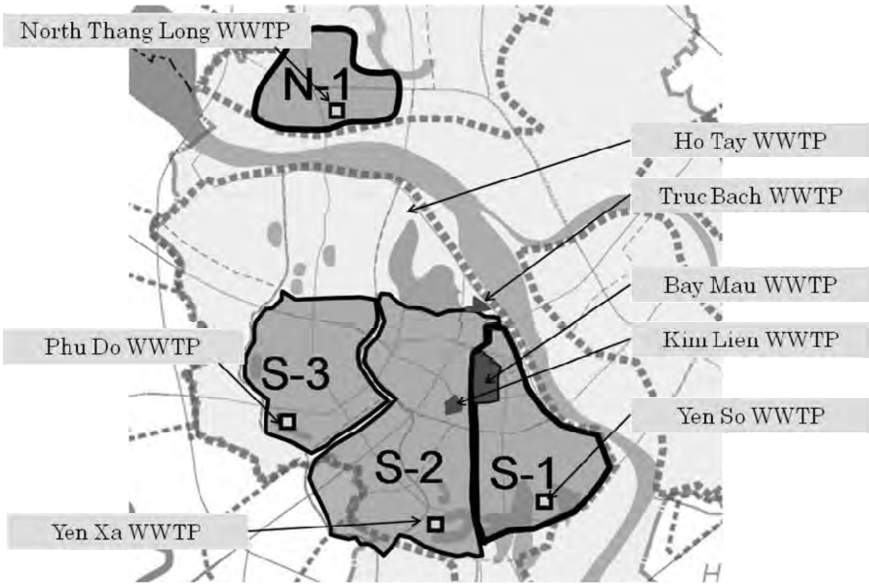
Taking into consideration the results of the research, it is recommendable to establish the Joint Company to introduce IOMS.

Chapter 4 Proposal for Tariff and Financial Plan for Sustainable Sewerage Operation in Hanoi

4.1 Current Situation of Sewerage Operation in Hanoi

4.1.1 Sewerage Operation Status in Hanoi

In Hanoi, 3 WWTPs (Truc Bach, Kim Lien, and North Thang Long) are operating now. In addition 5 WWTPs are planned. The locations of the WWTPs are shown in Figure 4.1.1 and summary of the WWTPs are shown in Table 4.1.1.



Source: JICA Study Team

Figure 4.1.1 Location of WWTPs in Hanoi

Table 4.1.1 Summary of WWTPs

WWTP		Capacity (m^3/day)	Basin	Expected Operation Start Year
1	Truc Bach	2,300	-	In operation
2	Yen So	200,000	S-1	2012
3	Bay Mau	14,000		2020
4	Kim Lien	3,700	S-2	In operation
5	Yen Xa	270,000		2018
6	Phu Do	84,000	S-3	2022
7	North Thang Long	42,000	-	In operation
8	Ho Tay	15,000	-	2018
	Total	**574,000**		

Note: The basins are defined in "Partial Adjustment to Hanoi Drainage Master Plan (Wastewater Drainage Plan) Oct, 2010"

Source: JICA Study Team

4.1.2 Related Legal Documents

In Decree No. 88/2007/ND-CP, sewerage tariff in Vietnam is identified. The methodology to determine sewerage tariff is set for domestic use and for non-domestic use separately. In Hanoi, sewerage tariff is not collected, but an environmental protection fee is collected. The environmental protection fee is mentioned in Decree No. 67/2003/ND-CP. In the decree, the objectives of the environmental protection fee are defined as follows; "In order to limit the environmental pollution caused by waste water; to economically use clean water and create the funding source for the Environmental Protection Fund in protecting the environment and addressing the environmental pollution". Currently, the environmental protection fee has been collected at the rate of 10% of the water supply fee and contributed to infrastructure services such as drainage, sewerage, road sweeping and so on. The current rate of the environmental protection fee for domestic use is defined in Decision No. 119/2009/QD-UBND, and the rate for non-domestic use is defined in Decision No. 120/2009/QD-UBND. In the following, the main legal documents related to sewerage tariff, including documents mentioned above and their supporting legal documents, are summarized.

1) Decree No.88/2007/ND-CP

This decree establishes drainage and sewerage for urban areas and industrial zones. "Chapter VI WATER DRAINAGE CHARGES" establish the basic concepts of sewerage tariff. Items of this chapter are as follows.

Article 48 - Subjects liable to collection of water drainage charges
Article 49- Principles for determination of water drainage charges
Article 50- Methods of determining water drainage charge rates
Article 51- Determination of charged wastewater volumes
Article 52- Determination of contents of charged pollutants
Article 53- Determination of water drainage charge levels
Article 54- Grounds for formulation of water drainage charge schemes
Article 55- Responsibility to formulate, competence to appraise and decide on water drainage charges
Article 56- Adjustment of water drainage charges
Article 57- Modes of water drainage charge collection and payment
Article 58- Management and use of water drainage charges

2) Circular No. 09/2009/TT-BXD

This circular defines detailed guidelines to implement some contents of Decree No.88/2007/ND-CP. The following 2 articles mention sewerage tariff.

Article 8: Differentiation and application of wastewater fees in accordance with the stipulations of Decree No.88/2007/ND-CP and environmental protection fees applicable to wastewater as stipulated in Decree No.67/2003/ND-CP and Decree No.04/2007/ND-CP amending and supplementing a number of articles of the Government's Decree No. 67/2003/ND

Article 9: Development and submission of wastewater fee options to authorized agencies for approval as stipulated in clause 1, Article 55 of Decree 88/2007/ND-CP

3) Decree No. 67/2003/ND-CP

This decree prescribes the environmental protection charges for waste water; the regime of collection, remittance, management and use of the environmental protection charges for waste water.

4) Joint Circular No. 125/2003/TTLT-BTC-BTNMT

This decree guides implementation of Decree No. 67/2003/ND-CP.

5) Decree No. 04/2007/ND-CP

This decree amends and supplements a number of clauses in Decree No. 67/2003/ND-CP.

6) Decision No. 119/2009/QD-UBND

This decision defines water tariff and environmental protection fees for domestic use in Hanoi.

7) Decision No. 120/2009/QD-UBND

This decision defines water tariff and environmental protection fees for non-domestic use in Hanoi.

4.2 Expenditure Forecast for Sewerage Operation in Hanoi

4.2.1 Estimation of Operation and Maintenance Cost of WWTPs

1) Operation and maintenance cost of operating 3 WWTPs

Currently, 3 WWTPs (Truc Bach WWTP, Kim Lien WWWTP and North Thang Long WWTP) are operating. Their operating and maintenance costs in 2010 are indicated by HSDC. The amounts are summarized in Table 4.2.1.

Table 4.2.1 Operating and maintenance costs of 3 WWTPs in 2010

WWTP	Annual Operation and maintenance Cost
Truc Bach	VND 4,581 million
Kim Lien	VND 5,732 million
North Thang Long	VND 7,321 million

Source: HSDC

2) Operation and maintenance cost of 5 WWTPs

The JICA study team estimated operation and maintenance cost of 5 WWTPs. They are Yen So WWTP, Bay Mau WWTP, Yen Xa WWTP, Phu Do WWTP, and Ho Tay WWTP. First, the JICA study team estimated direct cost, based on data from HSDC and calculations. Direct cost consists of 10 items. The estimated amounts by item are shown in Table 4.2.2. These numbers are averages over 15 years.

Table 4.2.2 Annual direct cost of 5 WWTPs

(million VND/year)

WWTP	Yen So	Bay Mau	Yen Xa	Phu Do	Ho Tay
Labor Cost	7,776	4,080	7,776	6,240	4,080
Utilities	59,674	6,967	80,020	30,026	6,967
Chemicals	29,927	2,106	40,422	12,596	2,106
Legal Inspection Cost	240	240	105	240	240
Sludge Disposal Cost	18,135	1,269	24,482	7,616	1,269
Repairs	20,075	5,391	31,991	12,180	5,391
Small-scale Replacement	4,189	4,189	4,189	4,189	4,189
Cleaning and yard maintenance	178	178	178	178	178
Site Establishment	2,094	2,094	2,094	2,094	2,094
Insurance	569	106	765	301	106
Total	142,858	26,620	192,022	75,660	26,620

Source: JICA Study Team

Total operation and maintenance costs of 5 WWTPs are estimated by calculating the provisional sums for contingencies and overhead. The results are summarized in Table 4.2.3.

Table 4.2.3 Annual total operation and maintenance costs of 5 WWTPs

WWTP	Direct Cost (DC) (million VND/year)	Provisional Sum for Contingencies (million VND/year, 5% of DC)	Overhead (million VND/year, 6.5% of DC)	Total (million VND/year)
Yen So	142,858	7,143	9,286	159,286
Bay Mau	26,620	1,331	1,730	29,682
Yen Xa	192,022	9,601	12,481	214,105
Phu Do	75,660	3,783	4,918	84,361
Ho Tay	26,620	1,331	1,730	29,682

Source: JICA Study Team

4.2.2 Estimation of Replacement Cost of WWTPs

The JICA study team estimated replacement costs of 5 WWTPs in 20 years, and then divided by 20 years to gain average annual replacement cost. Replacement costs of 3 operating WWTPs are estimated based on the result of the 5 WWTPs, considering capacity of each WWTP. The results are summarized in Table 4.2.4.

Table 4.2.4 Replacement cost of 8 WWTPs

WWTP	Capacity (m^3/day)	Replacement Cost (million VND/year)
Truc Bach	2,300	9,726
Kim Lien	3,700	10,082
North Thang Long	42,000	19,806
Yen So	200,000	52,119
Bay Mau	14,000	13,996
Yen Xa	270,000	83,053
Phu Do	84,000	31,620
Ho Tay	15,000	13,996

Source: JICA Study Team

4.2.3 Other Costs

1) Operation and maintenance cost of sewer networks

Unit rate of operation and maintenance cost of sewer networks in 2007 is VND 5.94 million/ha/year[1]. Unit rate of operation and maintenance costs of sewer networks in 2010 is estimated by utilizing the price escalation rate from 2007 to 2010. The rate is 1.43[2]. As a result, the unit rate of operation and maintenance cost of sewer networks in 2010 is VND 8.49 million/ha/year. The estimated operation and maintenance costs of the sewer systems for each WWTP are estimated as shown in Table 4.2.5.

Table 4.2.5 Operation and maintenance costs of sewer systems

WWTP	Service Area (ha)	Operation and Maintenance Costs of Sewer Systems (million VND/year)
Truc Bach	39	331
Kim Lien	55	467
North Thang Long	3,282	27,864
Yen So	2,951	25,054
Bay Mau	240	2,038
Yen Xa	4,634	39,343
Phu Do	2,547	21,624
Ho Tay	240	2,038

Source: JICA Study Team

1 Source: Feasibility Study for the Construction Project of Central Large-Scaled Wastewater Treatment Plants for Hanoi Environmental Improvement, p8-7

2 Source: World Economic Outlook Database, Inflation in 2008 x Inflation in 2009 x Inflation in 2010 = 1.23115 x 1.06717 x 1.09207 = 1.43

2) Depreciation of WWTPs

The JICA study team estimated initial cost for machinery and equipment and initial cost for civil works of 5 WWTPs. They are Yen So WWTP, Bay Mau WWTP, Yen Xa WWTP, Phu Do WWTP, and Ho Tay WWTP. Initial costs of the 3 operating WWTPs are estimated based on the result of the 5 WWTPs, considering the capacity of each WWTP.

Duration of use of fixed assets is defined in Circular No. 203-2009-TT-BTC. In appendix 1 of the circular, minimal duration and maximal duration of use are defined. In this analysis, the average of minimal duration and maximal duration are utilized to estimate the depreciation of the WWTPs. The durations are summarized in Table 4.2.6.

Table 4.2.6 Durations of use for depreciation

Item	Minimal Duration (year)	Maximal Duration (year)	Average Duration (year)	Item Referred to in Circular No. 203-2009-TT-BTC Appendix 1
Machinery and Equipment	5	12	8.5	B-18 Other working machinery and equipment
Civil Works	5	20	12.5	F-4Storehouses, tanks/reservoirs; bridges, roads; air runways; parking lots, drying yards and so forth

Source: JICA Study Team

The results of the estimation are summarized in Table 4.2.7.

Table 4.2.7 Depreciation of WWTPs

WWTP	Initial Cost		Depreciation	
	Machinery and Equipment (million VND)	Civil Works (million VND)	Machinery and Equipment (million VND/year)	Civil Works (million VND/year)
Truc Bach	144,938	12,823	17,052	1,026
Kim Lien	164,616	13,642	19,367	1,091
North Thang Long	702,961	36,028	82,701	2,882
Yen So	2,084,745	2,178,993	245,264	174,319
Bay Mau	55,833	35,982	65,863	2,879
Yen Xa	3,322,137	1,471,316	390,840	117,705
Phu Do	1,264,808	586,432	148,801	46,915
Ho Tay	55,833	35,982	65,863	2,879

Source: JICA Study Team

4.3 Questionnaire Survey

4.3.1 Questionnaire Survey for Households

1) Objectives of the survey

The objectives of the household (HH) survey are to provide baseline data and information for the following aspects;

- To determine the rate setting based on reasonable cost sharing to the customers
- To analyze the financial gap of sewerage services and systems

In order to fulfill the above objectives, the JICA study team carried out a HH questionnaire survey of 105 HHs in seven districts, where either existing or planed sewerage plants service. Five different levels of income groups were included in the sample HHs to take into account the economically valuable households.

The general descriptions of the surveyed districts are as follows (Table 4.3.1).

Table 4.3.1 Surveyed districts

	WWTP	District Name	Categories	Area (km^2)	Total No. of HH	No. of Poor HH*	Rate of Poor HH (%)*
1	Truc Bach	Ba Dinh	Urban	9.25	58,431	814	1.69
2	Kim Lien	Dong Da	Urban	9.96	96,669	790	1.09
3	Bay Mau	Hai Ba Trung	Urban	10.01	77,188	793	1.06
4	Yen So	Hoang Mai	Urban	39.81	91,783	885	1.12
5	Yen Xa	Thanh Tri	Rural	62.93	54,455	1,761	3.68
6	Phu Do	Tu Liem	Rural	75.33	112,228	1,906	3.04
7	North Thang Long	Dong Anh	Rural	182.14	87,002	3,136	3.95
	Whole city			3,344.6	1,667,331		

Source: Hanoi Statistical Yearbook 2009, *Labor Department, Hanoi (2010)

2) Methodology of the survey

The survey applied direct interviews with fixed questionnaires by a team that consisted of four surveyors and one supervisor. The questionnaire design was closely consulted with local authorities and the experienced survey supervisor (refer to Appendix 5). Prior to the survey implementation, the surveyors were instructed by the supervisor and pre-testing of the questionnaire was done. The survey team acknowledged their gratitude to the responsible leaders and staff from all relevant agencies for their cooperation during the survey.

In each district, 15 households from 3 or 4 wards or communes were selected for interviews. The surveyors interviewed households from five income groups. In total, 105 households were interviewed.

3) Results of the survey

(1) Profiles of surveyed households

Table 4.3.2 Profiles of surveyed households

Respondents	Male:21%, Female:79%
Age (average)	45 years old
Occupation	Trade and Service:47%, Public:7%, Production& Manufacturing:7%
HH size (average)	4.1 person
HH Income	Monthly Average: VND 8,560,962 Upper:11,936,667 (11%) (More than VND 4,000,000 /person/month) Middle: 9,349,683 (34%) (More than VND 2,000,000-4,000,000) Low:6,161,338 (40%) (More than VND 1,000,000-2,000,000) Almost Poor:4,116,667(10%) (More than VND 750,000-1,000,000) Poor: 2,833,333(5%) (Less than VND 750,000)
HH Expenditure	Monthly Average: VND 7,015,320 (81.9% of Income)

Source: JICA Study Team

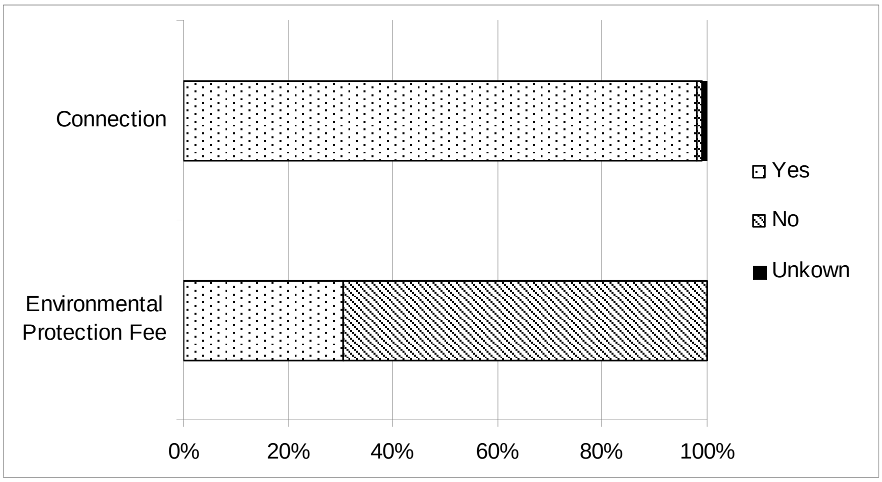
The majority of the respondents were female (79%) and the average age was 45 years old. The HH size was 4.1 persons and this is close to the 3.9 of the targeted district average in the official statistics[3]. The average monthly HH income was VND 8,560,962 and when divided by the average HH size it indicated an income per capita of VND 2,088,040. This is higher than the VND 1,719,600 of the Old Hanoi average statistics[4] (Table 4.3.2).

(2) Awareness of sewerage facilities

Awareness of the sewerage facilities was investigated for different aspects. One is awareness of sewerage connection and the environmental protection tariff. The other was awareness of positive impacts from the sewerage facilities (Figure 4.3.1).

3 Source: Hanoi Statistical Yearbook 2009

4 Source: STATISTICAL PUBLISHING HOUSE, Government of Vietnam, Result of the survey on household living standards 2008



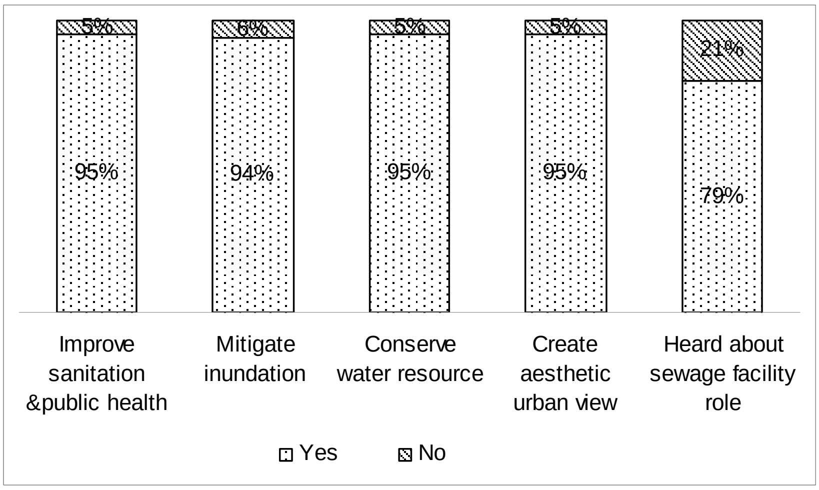
Source: JICA Study Team

Figure 4.3.1 Awareness of sewerage facilities and environmental protection fee

More than 98% answered that their house was connected to the sewerage facility. Contrarily, the environmental Protection fee which is utilized for sewerage service provision and collected through their water tariff is not well recognized (Figure 4.3.2).

As for the positive impacts from the sewerage facilities, most of the indicated items were recognized as “known”. The source of their information was mainly through the media, which indicates that the media has a strong potential as an awareness campaign tool.

The interview extended a question as to whether or not they discussed the role of sewerage facilitation. The answers included that the discussion is mainly about conserving the sewerage system, avoiding empting rubbish into the sewerage system, avoid obstructing the sewerage system, conserving sanitation, and conserving water resources.



Source: JICA Study Team

Figure 4.3.2 Awareness of positive impacts from the sewerage facilities

(3) Household expenditures

a. Overall household expenditures

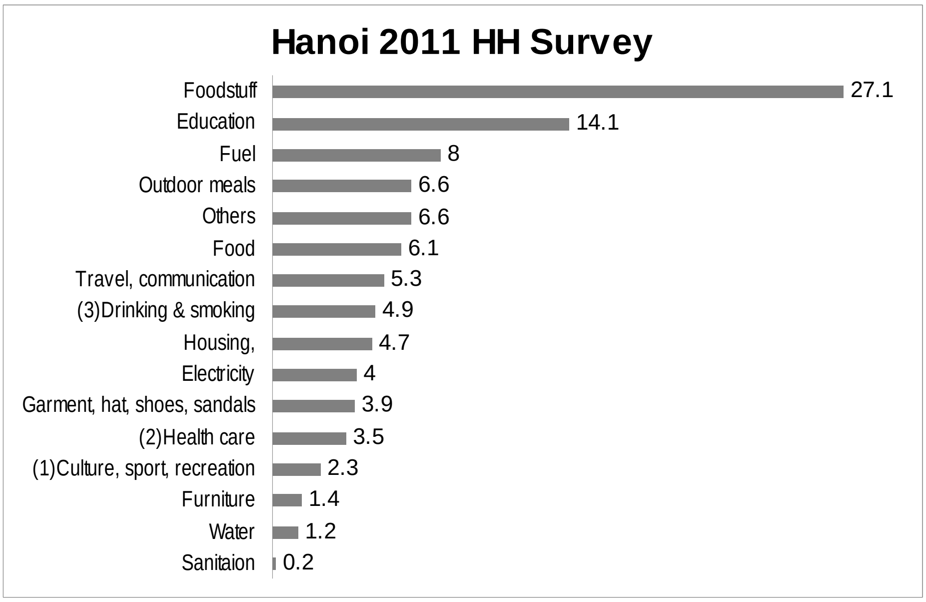
Household expenditures were queried item by item applying the same items used for the official data of the 2008 Living Standard Survey[5]. However, the national survey combined the housing items (rent and repair), water, electricity and sanitation together but the HH survey asked for a breakdown of the respective amounts.

The results showed food stuffs (staple foods) and food items represented more than 30% of the expenditures. This is still lower than the whole nation average (41.1%)[6]. Education (14.1% VS 6.2%) and fuel (8.0% VS 2.9%) are relatively higher than national averages (Figure 4.3.3).

When housing, water, electricity and sanitation are combined, it totals on average VND 708,810 per month (10.1% of income), which is higher than the national average of 3.9%.

[5] Source: STATISTICAL PUBLISHING HOUSE, Government of Vietnam, Result of the survey on household living standards 2008

[6] Note: the national data is per capita percentage



Unit: %

Source: JICA Study Team

Figure 4.3.3 Household expenditures (%)

b. Water expenditure and income groups

An average expenditure for water was VND 85,972 per month and this is 1.2% of total expenditures and 1.0% of income. Only four HH in Dong Anh district use well water and they pay for the costs of operation and maintenance of the well. An average expenditure was VND 33,000 per month.

Although the amount is low, the percentage to income indicates Middle Low and Lower Low HHs bear a higher percentage than other income groups. The high income HHs only pay 0.7% of income for water and this is less than half the percentage of Lower Low HHs (1.6%). This implies that the current water tariff is more favorable to the higher income HHs rather than poor HHs (Table 4.3.3).

Table 4.3.3 Water expenditure by income level

	Poor	Almost Poor	Low	Middle	High
Water Expenditure (average VND per month)	45,917	88,167	88,978	77,981	107,000
% of Income	1.6%	2.1%	1.4%	0.8%	0.7%

Source: JICA Study Team

c. The public measures for poor households

The poor HHs in Hanoi mostly live in the districts of old Ha Tay province. In Hanoi, there were no special public measures/ supports for water or sewerage but the following supports exist for poor HHs. The financial support may mitigate the gaps between the wealthier and poor HHs.

There is “Social welfare systems benefits, financial support for low income HHs in Hanoi 2010”, which is based on Plan No13/ KH-UBND dated 19 January 2010 of the Hanoi People’s Community (HPC) and the Hanoi Poverty Reduction Program in 2010, the welfare benefits and financial supports for the poor HHs are as follows:

- Monthly financial support for the poorest (11,250 persons) in the amount of VND 200,000 per person per month;
- Financial support in professional skill training for 2,300 poor persons;
- Financial support in training for Hanoi poverty reduction staffs;
- Financial support in house building in the amount of VND 15,000 thousand per house;
- Financial support in buying health insurance certificates for 400,000 poor persons;
- Financial support in buying cows in the amount of VND 7,000 thousand per cow;
- Financial support in buying small production tools, machines and equipment for the poor HHs;
- Financial support in buying seeds for cultivation and husbandry in poor communes (more than 25% of poor HH) in the amount of VND 200, 000 per HH;
- Small preferable financial credit for the poor for trade business, production development, and education;

d. Willingness to pay (WTP) for the sewerage tariff

<u>WTP and amount</u>

The Willingness to Pay (WTP) for the sewerage tariff was queried regarding both their intention and the amount per month in VND.

Most of respondents answered “Yes” for the WTP. Only six HHs (6%) answered “No”. The “No” answering HHs were all from Dong Da district and income levels are Middle (2), Low (3), and Almost Poor (1). The reasons are; they do not have enough money to pay for the sewerage tariff, their household is in the low-income group, they do not create pollution so they do not intend to pay the sewerage tariff, and the Government should pay this sewerage tariff.

Among the “Yes” HHs, an average indicated amount was VND 21,212 per month, which is 0.25% of Income. The amount is higher than the current environmental protection fee for an average household (VND 6,460/month) which is 10% of the water tariff (Table 4.3.4).

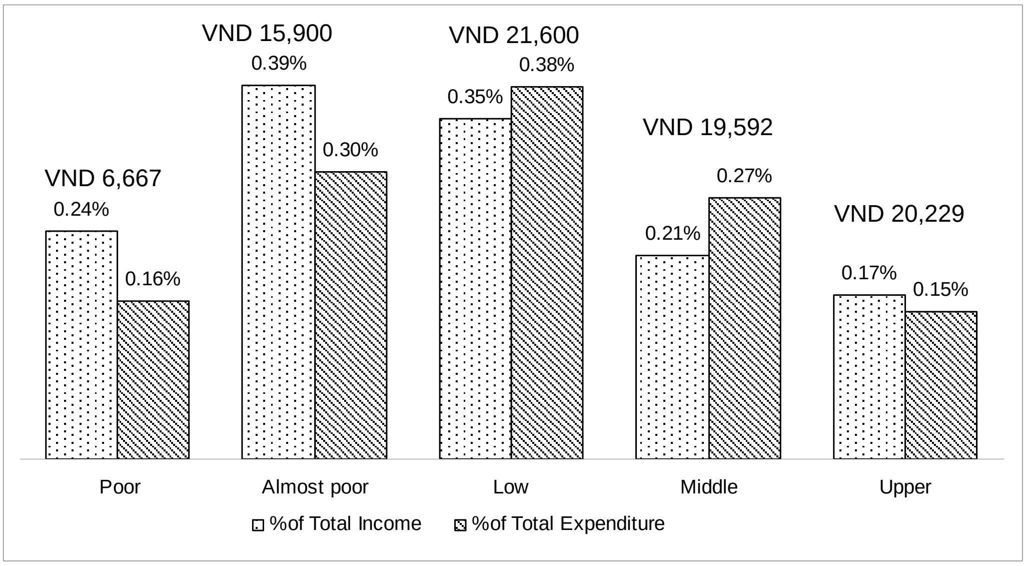
Table 4.3.4 Willingness to pay and amount

WTP	Yes 94%, No:6%
Average WTP Amount	VND 21,212 per month（0.25％of Income）

Source: JICA Study Team

WTP and income groups

WTP amount differs by income group. The highest amount mentioned among the Low HHs as VND 21,600 per month and the lowest amount was VND 6,667 per month among the Poor HHs. This is a huge variation, but the share of their income and expenditures shows the different trends. The highest percentage of 0.39% is among the Almost Poor HHs and the lowest percentage of 0.17% is among the Upper HHs. This implied, if the same sewerage rate was applied for all income groups, the economically vulnerable HHs (Poor, Almost Poor and Low HHs) will bear a higher percentage than the others (Figure 4.3.4).



Source: JICA Study Team

Figure 4.3.4 WTP and income group

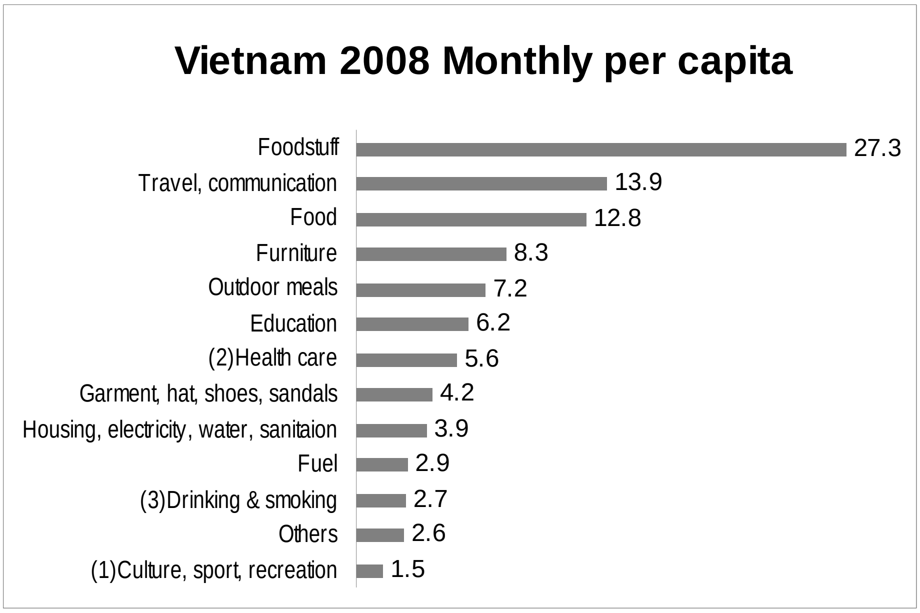
e. Affordability to pay (ATP)

Method of ATP survey

In order to determine the ATP, the HH survey applied the anchoring method. This survey asks whether the respondents feel comfortable to pay an amount (percentage) equal to that which they are currently spending on another item for the water tariff, sewerage tariff, and water and sewerage combined tariff. The average current HH expenditures are shown in Figure 4.3.5, which was prepared based on the Household Living Standards Survey 2008[7]. If respondents were not comfortable to pay an amount equivalent to what they were spending on the item chosen by the survey, they were asked to indicate which alternative item they would be comfortable with..

The three separate questions were presented as follows.

- Are you comfortable to pay a sewerage tariff equivalent to your current expenditure on "culture, sports, and recreation"? If "No" please select an alternative item from the figure.
- Are you comfortable to pay a combined tariff for water and sewage equivalent to your current expenditure on "health care"? If "No" please select an alternative item from the figure.
- Are you comfortable to pay a water tariff equivalent to your current expenditure on "drinking and smoking"? If "No" please select an alternative item from the figure.



Unit: %

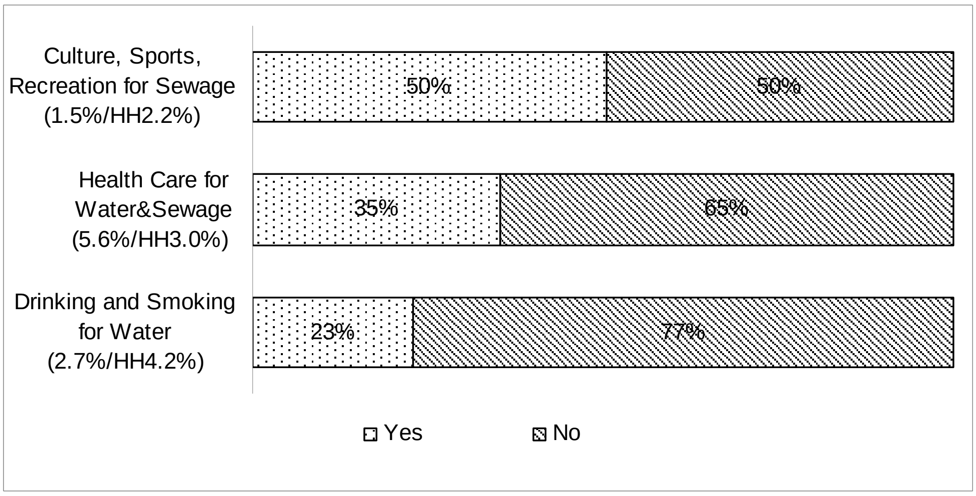
Source: JICA Study Team

Figure 4.3.5 Expenditure figure used for ATP questions

7 Source: STATISTICAL PUBLISHING HOUSE, Government of Vietnam, Result of the survey on household living standards 2008

<ins>The results of the questionnaires</ins>

- For the sewerage tariff, 50% of the respondents answered “Yes” to pay the equivalent amount of “culture, sports, and recreation”. This is 1.5% of total HH expenditure as reported in the National data and 2.2% of the surveyed HH expenditures. The figure below indicates both ratios accordingly.
- Both water and sewerage combined tariff and water tariff received fewer positive replies than sewerage tariff. A total of 35% answered “Yes” for the water and sewerage combined tariff being the same amount as for “health care”. Only 23% answered “Yes” for the water tariff being the same amount as for “drinking and smoking (Figure 4.3.6)



Source: JICA Study Team

Figure 4.3.6 Results of ATP questions

When the respondents answered “No”, they were asked to select an alternative item from the figure. Nevertheless, they said it was difficult to choose from the figure since the other items were of higher import than the indicated items. Therefore, the survey asked for an alternative amount in VND.

Regarding the sewerage tariff, the alternative amount (VND 22,053 per month) was close to the WTP amount of VND 21,212 per month. Meanwhile, water tariff VND 91,923 per month is about 7 percent higher the current average expenditure of VND 85,972 per month (Table 4.3.5).

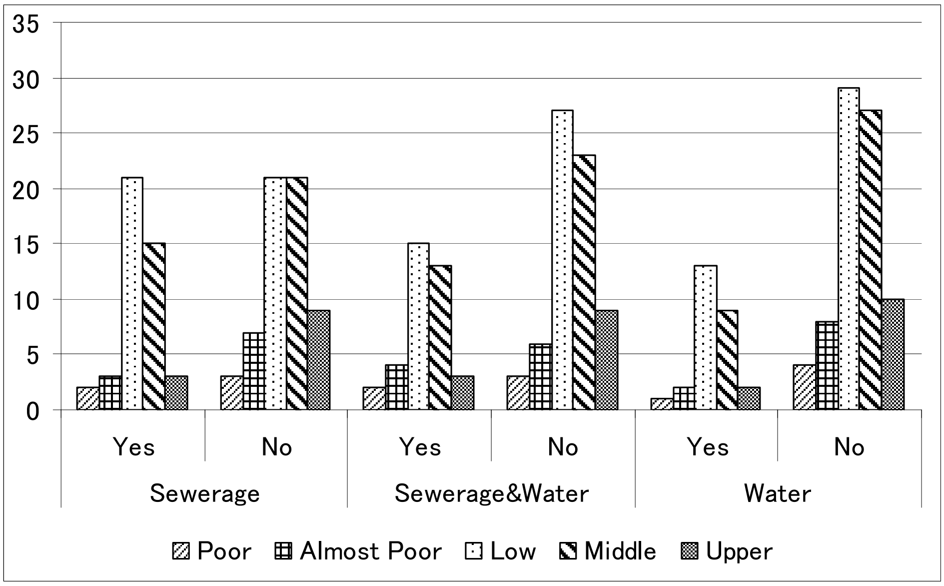
Table 4.3.5 Alternative amount given by "No" respondents

Tariff	Indicated Items (National/HH)	Results	Average Alternative Amount (Income%/Expenditure%)
Sewerage	Culture, Sports, Recreation (1.5%/2.2%)	Yes 50% No:50%	VND 22,053/month (0.26%/0.44%)
Water& Sewerage	Health Care (5.6%/3.0%)	Yes 35% No:65%	VND 106,074/month (1.24%/1.61%)
Water	Drinking and Smoking (2.7%/4.2%)	Yes 23% No:77%	VND 91,923/month (1.07%/1.50%)

Source: JICA Study Team

(4) Difference among income groups

In the following, answers for ATP questions, shown in Figure 4.3.6, are broken down by income category. As for the sewerage tariff, a half of Low income HHs answered "Yes". The "No" answer was dominant in the other groups and the trend was the same among the Middle and Upper income HHs. The combined tariff for water and sewerage and water tariff also showed a similar trend dominated by "No" answers in all income groups (Figure 4.3.7).



Source: JICA Study Team

Figure 4.3.7 Composition of answers by income groups

When compared with the alternative amount indicated by the "No" answering HHs, there are significant gap by groups. Especially for the sewerage tariff, while the Poor HHs indicated VND 5,000, the Upper HHs indicated VND 33,000. The Upper HH amount comprises 2.2 % of their income, therefore, their ATP can be considered as higher than the other income groups. The same trend was observed for the combined tariff for water and sewerage and water as well (Table 4.3.6).

During the interview survey, the low income HH (Low, Almost Poor and Poor HHs) mentioned that they could afford the same amount for the sanitation fee as for the sewerage tariff, which was on an average VND 15,219 per month and (0.2%-0.5% of Income).

Table 4.3.6 Alternative amount and income group (VND per month/% of Income)

Tariff	HH No.	Average	Poor	Almost Poor	Low	Middle	Upper
Sewerage	52	22,053 (0.26%)	5,000 (0.2%)	10,833 (0.3%)	19,650 (0.3%)	23,667 (0.3%)	33,000 (2.2%)
Water & Sewerage	68	106,074 (1.24%)	86,667 (3.1%)	90,833 (2.2%)	87,111 (1.4%)	119,913 (1.1%)	144,222 (9.7)
Water	82	91,923 (1.07%)	47,500 (1.7%)	91,250 (2.2%)	77,310 (1.3%)	106,407 (1.1%)	113,500 (7.6%)

Source: JICA Study Team

4.3.2 Questionnaire Survey for Commercial and Industrial Organizations

1) Objectives of the survey

The objectives of the Commercial and Industrial (CI) survey are to provide baseline data and information for CI's awareness, willingness to pay, affordability to pay and cross-subsidy capacity. In order to fulfill the above objectives, the JICA Team carried out a CI questionnaire survey of 35 CIs in 7 districts, where there were either existing or planned sewerage plants.

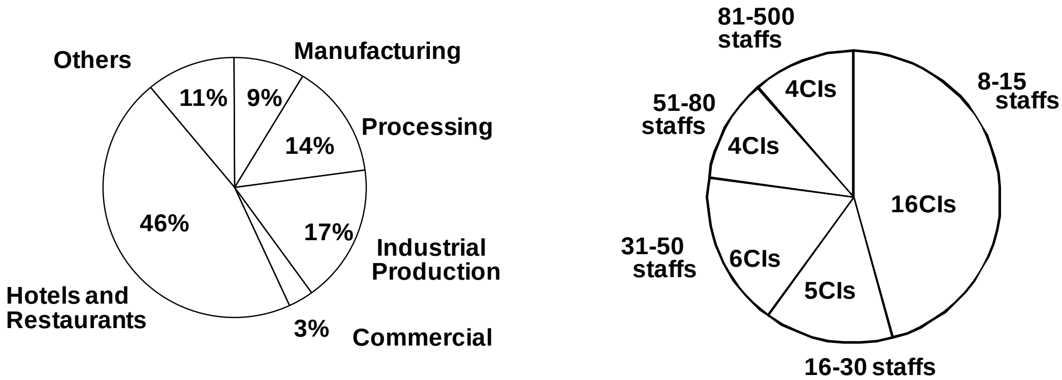
2) Methodology of the survey

The CI questionnaires were designed and prepared before the survey implementation. The questionnaire design was closely consulted with local authorities and the experienced survey supervisor (refer to Appendix 5). The CI survey team consisted of 3 surveyors and 1 supervisor. Prior to the survey implementation, the surveyors were trained by the supervisor and completed a pretest. The survey team acknowledged their gratitude to the responsible leaders and staffs from all relevant agencies for their help and active cooperation during the survey. In each survey district, 5 CI organizations from 3 or 4 wards or communes are selected for interviews. The surveyors tried to select CI organizations from both state and private sectors for interviews

3) Results of the survey

(1) Profile of interviewed CI organizations

Figure 4.3.8 shows the profiles of the surveyed CI organizations. The largest business category was hotels and restaurants and next was industrial production. From 8 to 15 in number of staff is the largest category. These samples were selected as typical CI organizations in each district by the survey supervisor in cooperation with local authorities.



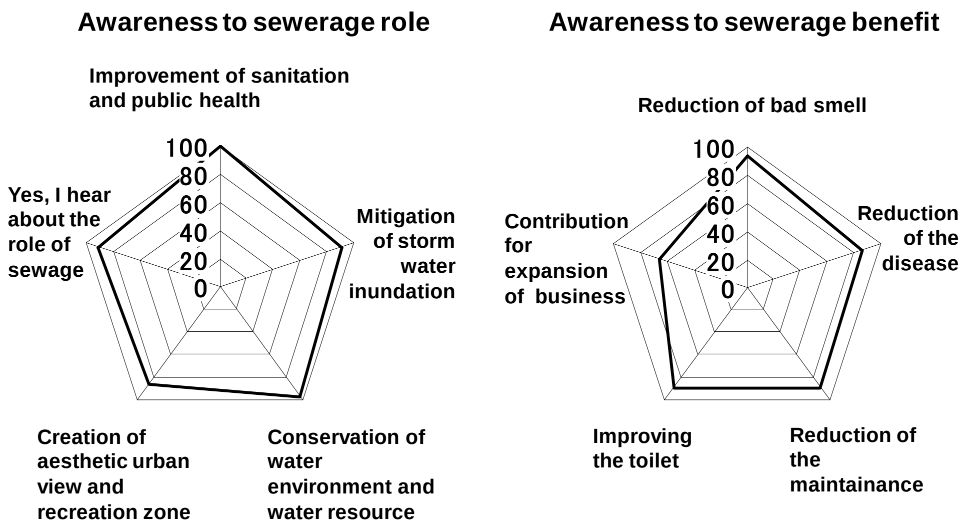
Source: JICA Study Team

Figure 4.3.8 Business category and number of staff

(2) Awareness of sewerage system

The left side of Figure 4.3.9 shows awareness of the sewerage system role. The questionnaire offered five roles as shown below and all of these items are recognized as a role of sewerage services by more than 90% of the CI organizations.

The right side of Figure 4.3.9 shows the awareness of sewerage system benefits. Overall, numbers on the right are lower than the numbers on the left. In particular, "contribution for expansion of business" is the lowest item. Awareness of sewerage benefit for their business is a critical factor for a CI organizations' willingness to pay, hence further promotion is necessary to improve their willingness to pay for sewerage.



Source: JICA Study Team

Figure 4.3.9 Awareness of sewage facility

(3) Expenditure for water supply

Table 4.3.7 shows the average of monthly water tariff payment per district. In the 7 districts interviewed, Hai Ba Trung district is the highest water consumption area. Average consumption of 35 CI organizations is 683 m^3, and payment is 2,659,571 VND. Eight organizations interviewed, 23% of this survey sample, use wells. This number includes organizations not only in rural areas but also in urban areas, such as Hai Ba Trung district.

Table 4.3.7 Monthly average water payment per district

District	Average Water Payment (VND)	Water Payment per Average Monthly Sales	Water Payment per Average Monthly Expense
Ba Dinh	5,040,000	1.04%	0.89%
Dong Da	1,202,000	1.25%	0.70%
Hai Ba Trung	6,112,000	0.63%	0.31%
Hoang Mai	2,150,000	0.12%	0.03%
Thanh Tri	644,000	0.05%	0.04%
Tu Liem	1,309,000	0.09%	0.08%
Dong Anh	2,160,000	1.15%	1.02%
Total average	2,659,571	0.291%	0.129%

Source: JICA Study Team

Table 4.3.8 shows water payment per business category. The largest category that pays water tariff is the "hotels and restaurants" industry segment and the second is the processing industry.

Table 4.3.8 Monthly water payment average per business category

Business Category	Average Water Payment (VND)	Water Payment per Average Monthly Sales	Water Payment per Average Monthly Expense
Manufacturing Industry	783,333	0.08%	0.06%
Processing Industry	3,242,000	0.31%	0.25%
Production Industry	2,120,000	0.12%	0.09%
Trade	800,000	0.50%	0.42%
Hotels, restaurants	3,610,333	1.34%	1.05%
Other services	1,371,000	0.08%	0.02%
Total average	2,659,571	0.29%	0.13%

Source: JICA Study Team

(4) Willingness to pay considering the benefit of sewerage system

CI organizations were asked around what percent of water tariff payment they were willing to pay considering the benefit of sewerage. Table 4.3.9 shows the result. A total of 94% of CIs are willing to pay 100% or more for sewerage. A total of 6% of CIs will pay less than 100% but most of the CI organizations are willing to pay for sewerage when the sewerage system brings them some kind of benefit for their business. However, it is uncertain whether or not it might be beneficial for them as of now (refer to Figure 4.3.9), and the answer range between 100% and 120%.

Table 4.3.9 Willingness to pay for sewerage considering its benefit

<table>
<tr><th>Percentage of water tariff</th><th colspan="2">Number of CI</th><th colspan="2">Rate</th></tr>
<tr><td>Same as now (100% of water tariff)</td><td>22</td><td rowspan="3">33</td><td>63%</td><td rowspan="3">94%</td></tr>
<tr><td>10% More (110% of water tariff)</td><td>7</td><td>20%</td></tr>
<tr><td>20% More (120% of water tariff)</td><td>4</td><td>11%</td></tr>
<tr><td>30% More (130% of water tariff)</td><td colspan="2">0</td><td colspan="2">-</td></tr>
<tr><td>40% More (140% of water tariff)</td><td colspan="2">0</td><td colspan="2">-</td></tr>
<tr><td>Less than now</td><td colspan="2">2</td><td colspan="2">6%</td></tr>
</table>

Source: JICA Study Team

The average of CI organizations' percentage was 105% of water tariff which is 0.13% of their monthly sales. 0.13% of the monthly sales of 33 CI organizations which will pay more than 100% of water tariff is equivalent to VND 2,823,668/month.

(5) Question regarding cross-subsidy

Interviewees were told that their unit rate for sewerage was around 20% or more than that for households to support the poor citizens, and then asked how much higher was acceptable. Table 4.3.10 shows the result. A total of 77% of CI organizations want the same level as the current cross-subsidy rate.

Table 4.3.10 Acceptable unit rate for cross-subsidy

Acceptable percentage	Number of CI	Rate
Same as now (120% of households).	27	77%
No more than 150% of unit rate for households	8	23%
No more than 170% of unit rate for households	0	-
No more than 180% of unit rate for households	0	-
No more than 200% of unit rate for households	0	-
No more than 300% of unit rate for households	0	-
More than 300% of unit rate for households	0	-

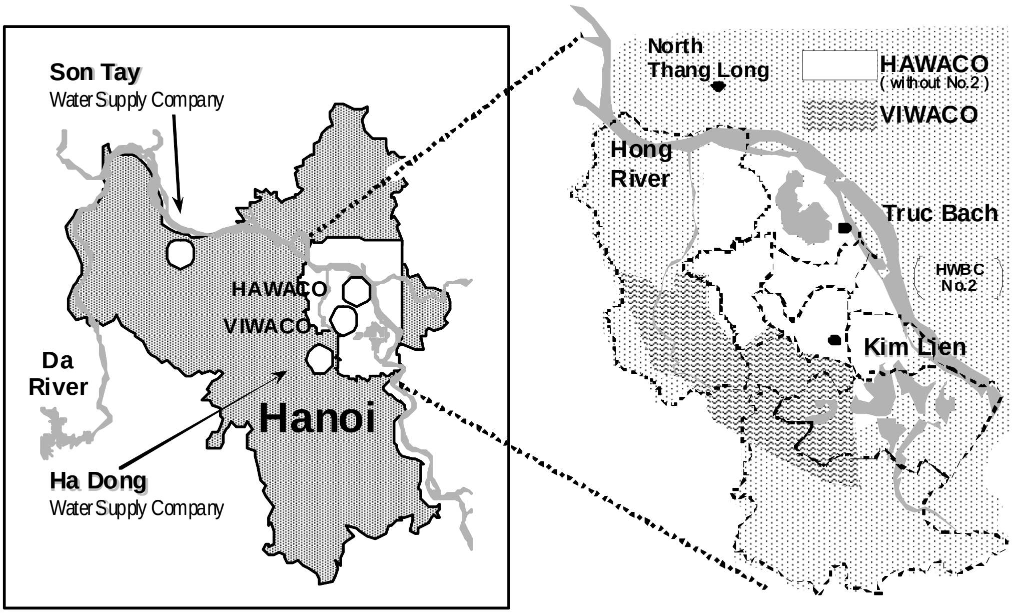
Source: JICA Study Team

4.4 Analysis of Water Supply Operation

4.4.1 Summary of Current Water Supply Operation

1) Operating organization

Four water supply companies, HAWACO, VIWACO, Ha Dong Water Supply Company and Son Tay Water Supply Company, are supplying water in Hanoi City now (Figure 4.4.1). In this report only HAWACO and VIWACO are mainly mentioned, because the 2 companies are supplying the central area of Hanoi.



Source: JICA Study Team

Figure 4.4.1 Water supply in Hanoi City

(1) HAWACO

The water supply in central Hanoi was handed over from the national government to HWSC (Hanoi Water Supply Company) in 1991 and HWSC was reorganized into an autonomous organization and renamed HWBC (Hanoi Water Business Company) in 1994. Since 1996, the newly established HWBC No.2 had begun to supply water to the left bank of the Hong River (existing HWBC's supply area was the right bank). These companies were combined into one and named HAWACO (Hanoi Water Company Limited) in 2008. HAWACO's water source is the Hong River and the average volume of daily water supply was around 556,000m^3 in 2010. In this report, hereinafter, HAWACO's water supply information to the right bank of Hong River will be mentioned mainly without former HWBC No.2's area, because the central area of Hanoi is located on the right bank of the Hong River. Figure 4.4.1 shows the water supply area of the right bank. Main data for HAWACO is summarized in Table 4.4.1.

Table 4.4.1 Main data for HAWACO

Population	3,009,975 persons
Supplied Water Population	2,031,200 persons
Supplied Water Customers	507,800 customers
Number of Installed Meters	507,605 meters
Public Taps	0 taps
Water Supply Capacity per Day	556,214 m^3/day
Daily Average of Water Supply	556,214 m^3/day
Rate of Non-revenue Water	31.7%
Total Length of Distribution Pipes	4,363 km
Number of staff	2,316 persons
Number of the Meter Reader	490 persons

Note: as of 2010

Source: HAWACO

(2) VIWACO

VIWACO is a joint stock company established in 2009 and its supply area was broken off from HAWACO's southwest network system (Figure 4.4.1). The share holders are VINACONEX (51%), HAWACO (30%), ACUATICO (15%) and others. VIWACO's water source is the surface water of the Da River and the distance between intake point and supplied area is around 47.5km. Average of daily water supply volume was around 71,000m^3 in 2010. VIWACO gets purified water through VINACONEX's purification plant in Hoa Binh Province. Diameters of the transmission pipes are from 1500mm to 1800mm.

2) Water tariff income

Figure 4.4.2 shows the last five years' water tariff income for HAWACO and VIWACO. In step with the recent growth of the city, water consumption is increasing year by year, and the incomes of HAWACO and VIWACO are growing steadily except for the year 2009 (HAWACO and VIWACO were split in 2009).

Table 4.4.2 Annual water tariff income

	year	Number of user	Consumption(m^3)	Annual revenue (VND)
HAWACO	2006	362,439	93,987,830	360,383,815,500
	2007	386,183	105,700,806	407,822,339,800
	2008	418,695	112,546,209	437,593,007,300
	2009	392,032	111,015,719	161,452,562,179
	2010	428,123	118,132,305	658,981,698,318
VIWACO	2009	58,769	15,883,416	59,486,246,606
	2010	66,931	25,933,698	131,949,733,168

Sources: HAWACO, VIWACO

4.4.2 Technical Issues and Water Supply Operation

1) Facility operation

(1) Purification

In HAWACO's service area, 9 major purification plants (PP) and 5 minor plants have been supplying water to the right bank of the Hong River. All plants share the same water source, which is the Hong River. The sizes and the method of purification of the plants are similar throughout. The main data regarding Yen Phu PP as a representative sample is as follows

Table 4.4.3 Main data of Yen Phu PP

Intake Facilities	33 wells (Capacity: 100,000m^3/day, Daily average pumping volume is 92,000m^3/day)
Purification Process	Sprinkling aeration with 13 rapid sand filtration basins
Disinfection	Chlorination (with liquefied chlorine)
Reservoir	1,000m^3 (semi subterranean reinforced concrete structure)
Water Distribution Pumps	7 pumps

Source: JICA Study Team

This plant is operated by one director, one vice director and 70 workers in shifts. Shift work is performed by 10 teams which consist of 6 or 7 workers each. The contact oxidation process with rapid sand filtration is applied, because raw groundwater contains highly-concentrated manganese and iron. Backwash frequency is setup according to the water head loss at the sand filtration basin and was every 48 hours. The disinfection process is controlled to keep the chlorine concentration at 0.3 mg/L at the terminal of all distribution pipes. To achieve this number, the operation maintains chlorine concentration at 0.5mg/L at the exit of the reservoir, but their chlorination management along the distribution pipes is unknown.

Source: JICA Study Team

Figure 4.4.2 Aeration in Yen Phu PP

Source: JICA Study Team

Figure 4.4.3 Pumps in Yen Phu PP

This plant has 7 pumps in total and operates some of them according to the water demand. Daily peak demand period is from 4am to 10 am and from 5pm to 10 pm. During these periods, 5 pumps (water pressure is 0.5MPa) are operated. The other 2 pumps (water pressure is 0.2MPa) are operated alternately. The 7 pumps are alternated sequentially.

(2) Distribution

In HAWACO's service area, 5 subsidiary enterprises are maintaining distribution and service the pipe line network systems. The service area is flat and linked to the reservoirs through the pumping system. The water service pressure, however, is unstable because of the alternating of running pumps. Water users tend to install their own booster pumps or elevated tanks to deal with the low water pressure. HAWACO maintains linkage with VIWACO's water supply network to tackle over capacity water demand, but they have not been supported through this network so far.

In VIWACO's service area, 6 subsidiary enterprises are maintaining distribution and the service pipe line network systems by observing water pressure with a remote supervisory control system. The water pressure is stable because of gravity flow from Hoa Binh province.

Table 4.4.4 Breakdown of distribution pipes as of 2010

(Unit: km)

Distribution pipe	HAWACO	VIWACO	Distribution pipe	HAWACO	VIWACO
Ductile iron pipe	596.47	50.0	HDPE	416.82	-
Cast iron pipe	389.88	174.1	PEH	1,730.75	-
PVC pipe	259.56	3.0	Steel pipe	11.70	1.5
PE pipe	6.18	35.0	Fiber glass	-	4.4
Galvanized steel pipe	8.64	1.0	TOTAL	3420	269

Source: JICA Study Team

2) Non-revenue water

(1) HAWACO

HAWACO's non-revenue water (NRW) rate was 31.7% in 2010. Referring to the JICWELS report[8], HAWACO's NRW rate in 2001 was 52%. This number was reduced to 48% in 2003[9]. Considering these data, the NRW rate of HAWACO had been reducing annually by around 2% over these 10 years. This rate of improvement can make it possible that their next year's NRW rate target will be less than 30%.

Table 4.4.5 HAWACO's NRW as of 2010

Category		Quantity	Rate
Revenue (Paid water)		138,016,139 m^3	68.07%
Non-revenue water	Unpaid water	469,486 m^3	0.23%
	Commercial and Physical Loss	64,242,810 m^3	31.68%
	Waterworks usage	31,090 m^3	0.02%

Source: JICA Study Team

In 2010, there were 10,074 leakage problems. Among these leaks, 2,941 were reported by general citizens. These visible ground surface leakages are repaired by the staff, but there is no information about underground water leakage. A total of 172 network workers are maintaining the pipeline systems, but there is no specific leakage detection team. Actually, they keep leakage detectors made in Israel or other countries and some staff member have taken intensive leakage detection

8 Source: Japan International Corporation of Welfare Services "Survey Report on Hanoi urban water supply improvement plan in the Socialist Republic of Vietnam" March.2002

9 Source: Yokohama Waterworks Bureau "Study Report of water supply in Hanoi" March.2003

training. Leakage detection activity, however, is not applied in the routine of the organization so far. According to the executive staff, HAWACO does not intend to adopt leakage detection because of lack of skilled human resources. Within the 32% NRW rate, water leakage, meter loss and stolen water (illegal connections) are not distinguished.

(2) VIWACO

VIWACO's NRW rate is 33% and they defined the breakdowns of NRW as 8% for meter loss, 7% for stolen water and 18 % for water leakage with other unknown water losses. Executive staff said that they estimated these contents by their experience. VIWACO assigns 3 technicians at their headquarters, 2 or 3 workers to every 6 service stations and totally 20 staff are dealing with water leakage trouble. No leakage detection team, however, has been organized so far. There were 72 cases of leakage trouble in 2010 and all of them were reported by general citizens.

Table 4.4.6 VIWACO's NRW as of 2010

Category		Quantity	Rate
Revenue water	Water Tariff	25,939,670 m^3	66.92%
	Others	469,486 m^3	0.05%
Non revenue water	Meter loss	3,200,000 m^3	8.25%
	Stolen water	2,800,000 m^3	7.22%
	Unpaid water	9,000 m^3	0.02%
	Leakage water	6,200,000 m^3	15.99%
	Waterworks usage	0 m^3	0.00%
	Unknown water	603,094 m^3	1.55%

Source: JICA Study Team

A Technical Support Assistant program (hereinafter TSA program) will start within 2011 at VIWACO. The target of this 5 year-long program is reducing NRW with ACUATICO's support. ACUATICO is an investor, developer and operator of water infrastructure established in Singapore in 2006. VIWACO have recently focused on replacement of water meters, their main countermeasure for deducing NRW, and they have been replacing from 2,000 to 3,000 water meters annually. From this year the main countermeasure shifts to the TSA program. Executive staff is expecting good results through this program, because ACUATICO reduced the NRW rate from 46% to 10% in Jakarta.

3) Tariff collection

Meter readers read meters monthly in HAWACO and VIWACO. They report daily to their service stations and operators process the data with a customer administration system at their stations. Money collectors visit water users with the processed bills. The unpaid water rate is 0.23% at HAWACO and 0.02% at VIWACO. These comparatively low rates mean that unpaid water charge is not a serious issue in Hanoi. A matter for concern is stolen and leaked water. It is important to check the condition of the water meters and to analyze changes in consumption to reduce stolen water and find terminal leakage. Meter readers and money collectors are not expected to deal with these tasks. The processing contents of customer administration systems are not focused on analyzing data to reduce the NRW rate.

4.4.3 Suggestions for Water Supply Operation

1) Suggestions for water leakage reduction

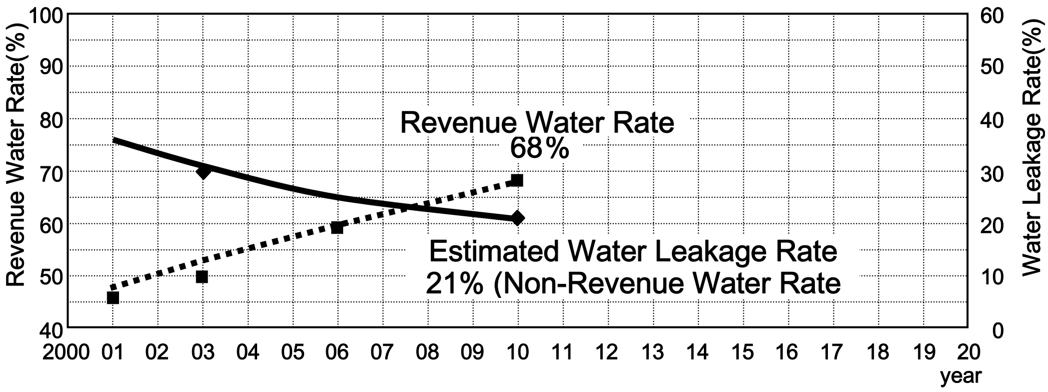
(1) Estimation of water leakage in Hanoi

Table 4.4.7 is an estimation of HAWACO's NRW contents. In this table, meter loss rate of HAWACO is estimated as 4%. This number was applied referring to the Yokohama Waterworks report in 2003. They were supposed to maintain almost the same rate since 2003, because they have been continuously checking water meters every 5 years after their organization reorganized from HWBC to HAWACO. Stolen water rate is estimated at 7% which is almost same as VIWACO's in 2010 and HWBC's in 2003. Hence we get the number of 21% as the water leakage rate. Figure 4.4.4 is an estimation of water leakage in Hanoi in these 10 years.

Table 4.4.7 Estimation of HAWACO's NRW contents

<table>
<tr><th colspan="2">Category</th><th colspan="2">VIWACO in 2010</th><th colspan="2">HWBC in 2003</th><th colspan="2">HAWACO in 2010</th></tr>
<tr><td rowspan="2">Revenue water</td><td>Water Tariff</td><td colspan="2">66.92%</td><td colspan="2" rowspan="2">52%</td><td colspan="2">68.07%</td></tr>
<tr><td>Others</td><td colspan="2">0.05%</td><td colspan="2">(0%)</td></tr>
<tr><td rowspan="6">Non revenue water</td><td>Unpaid water</td><td colspan="2">0.02%</td><td colspan="2">8%</td><td colspan="2">0.23%</td></tr>
<tr><td>Stolen water</td><td rowspan="4">33.01%</td><td>7.22%</td><td rowspan="4">40%</td><td>6%</td><td rowspan="4">31.68%</td><td>(7%)</td></tr>
<tr><td>Meter loss</td><td>8.25%</td><td>4%</td><td>(4%)</td></tr>
<tr><td>Leakage water</td><td>15.99%</td><td rowspan="2">30%</td><td rowspan="2">(21%)</td></tr>
<tr><td>Unknown water</td><td>1.55%</td></tr>
<tr><td>Waterworks usage</td><td colspan="2">0.00%</td><td colspan="2">-</td><td colspan="2">0.02%</td></tr>
</table>

Source: JICA Study Team

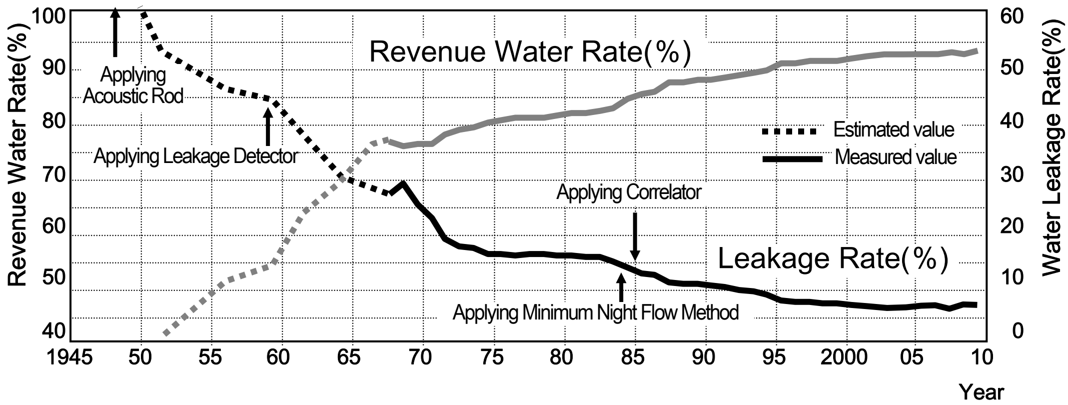


Source: JICA Study Team

Figure 4.4.4 Estimated water leakage rate in Hanoi

(2) Leakage reduction case in Yokohama

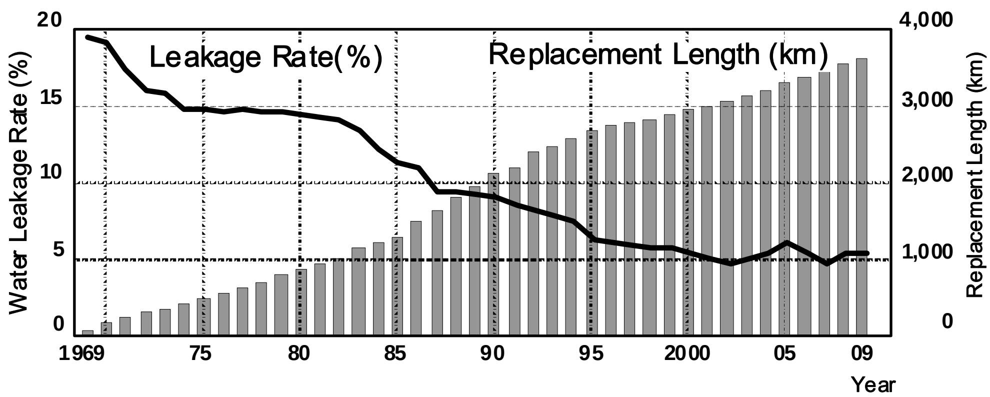
Figure 4.4.5 shows the leakage reduction in Yokohama. After World War II, leakage rate in Yokohama was estimated to be from 70% to 80% and Yokohama Waterworks Bureau established a leakage detection team in 1948. The team basically detected leakage with acoustic rods. The curve seems to go down sharply in the '50s, but this did not reflect the reduction of leakage trouble but the expansion of the distribution pipe line system. With the surge of population in Yokohama which was brought on by the big economic growth after the world war, total water consumption also surged. This growth of distribution quantity was supported by newly installed pipelines. Leakage troubles were rare in these new pipes, thus the growing total distribution and the almost same number of leakage troubles made the leakage rate smaller at that time. Leakage rate in Yokohama had decreased to lower than 20 % by the 1970's. However, this leakage rate reduction slowed down in the early 70's and the percentage was stagnant at around 15%. Yokohama Waterworks divided their supply area into blocks in 1975 and started to detect all blocks every 2 years with acoustic rods and leakage detectors. From the middle of the 1980's a minimum night flow method and correlator were applied to leakage detection activity and the leakage rate began to reduce again. Present leakage rate in Yokohama is stable at around 5% for the most recent 10 years.



Source: JICA Study Team

Figure 4.4.5 Water leakage in Yokohama

According to JICWELS's report in 2001, daily water supply of HWBC was 150 m^3 and that of HAWACO plus VIWACO in 2010 was more than 220 million m^3. The water supply in central Hanoi has grown 1.5 times in these 10 years. This rapid rise resembles that of Yokohama in its high-growth period. Along with this growth, the leakage rate in Hanoi has been steadily decreasing these 10 years. Intensive distribution pipe line installation reduced the leakage rate, and such case also can be seen in Phnom Penh in Cambodia. However, after the period of expansion, the leakage rate reduction activity must proceed to the next phase like Yokohama. Key factors are highly skilled leakage detection personnel and precisely planned distribution pipe line replacement. Intensive replacement will reduce water leakage and illegal connections along the replaced area. This ripple effect was proved in Manila in the Philippines. Figure 4.4.6 shows the correlation of leakage rate and replaced distribution pipe line length in Yokohama after the period of its expansion.



Source: JICA Study Team

Figure 4.4.6 Leakage rate and pipe line replacement in Yokohama

The leakage rate in Hanoi is estimated at 21%, but the reduction will slow down in the near future, because the maintenance skill for expanded long distribution pipe lines is not adequate now in Hanoi. Figure 4.4.7 shows the prospection of water leakage rate and revenue water rate in Hanoi. To realize this curve, intensive leakage prevention and detection are necessary. They are summarized in the following. Without them, reduction in leakage rate may slow down in the near future.

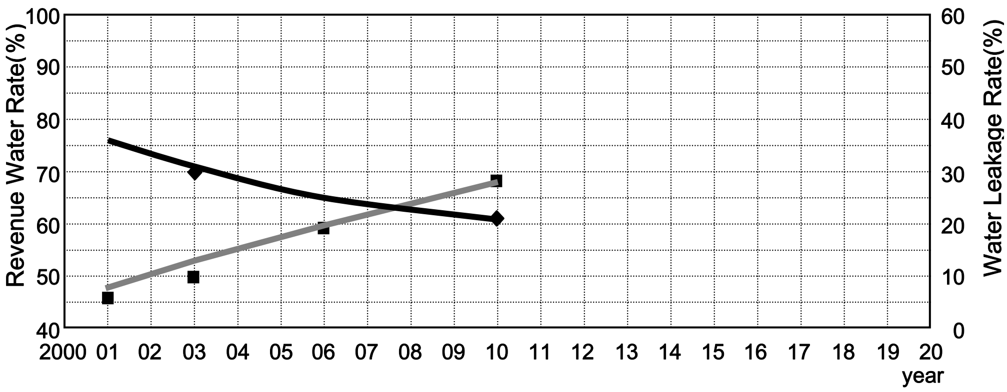
Organizing leakage detection teams and intensive training for the team members is necessary. HAWACO has already obtained leakage detectors, but they are not utilized at all. As of now, they depend on citizens' reports to find leakage points. However, to reduce leakage rate to less than 20%, it is necessary to tackle underground leakage which is difficult to find for general citizens and can be found only with special apparatus like leakage detectors.

A precise distribution pipe line replacement plan is necessary. In this plan, the following data has to be included.

- Past leakage points and treatment history
- Organized pipe line data of material, position, set term years, etc.
- Transportation condition
- Soil properties

With these data, priority of replacement can be determined and efficient replacement can be implemented.

A long term investment plan is necessary to maintain stable distribution pipe line replacement. It is difficult to execute continuous replacement without keeping a balance between investment for leakage countermeasures and expected revenue yielded by the countermeasures.



Source: JICA Study Team

Figure 4.4.7 Water leakage rate prospection in Hanoi

2) Suggestions for tariff collection methodology

(1) Water supply tariff

Table 4.4.8 Water tariff for domestic use

(unit: VND/m^3)

No.	Water usage level of household (m^3/month/HH)	Tariff before tax & fee	VAT (5%)	Environmental protection fee (10%)	Payment tariff
1	First 16m^3	3,478.26	173.91	347.83	4,000
2	Above 16m^3 to 20m^3	4,086.96	204.35	408.70	4,700
3	Above 20m^3 to 35m^3	4,956.52	247.83	495.65	5,700
4	Above 35m^3	8,173.91	408.70	817.39	9,400

Source: Decision No. 119/2009/QD-UBND

Table 4.4.9 Water tariff for non-domestic use

(Unit VND/m^3)

No.	Usage purpose	Tariff before tax & fee	VAT (5%)	Environmental protection fee (10%)	Payment tariff
1	Water usage for Administrative organizations	4,956.52	247.83	495.65	5,700
2	Water usage for Implementation organizations	4,956.52	247.83	495.65	5,700
3	Water usage for public purpose	4,086.96	204.35	408.70	4,700
4	Water usage for Manufacturing units	6,086.96	304.35	608.70	7,000
5	Water usage for Business and Service units	10,434.78	521.74	1,043.48	12,000

Source: Decision No. 120/2009/QD-UBND

(2) Observation of user information

The current tasks of meter readers and money collectors are focused on their daily routines to read the meters or to collect the payments. The scope of their tasks, however, should be enlarged to include observing the users total condition. When a meter reader or money collector visits a user, they can observe the way of daily life of the user including meter condition. A sudden surge in consumption means the possibility of terminal water leakage, and a sudden reduction can be an illegal connection. The water tariff, however, must be determined not only reflecting these facts but also considering other trivial matters like sudden change in the number of occupants, long term absence or other change of users' daily lives. Meter readers and money collectors are available to get such kind of information, because they keep in touch with each user's ordinary lives. Assigning them to observe and report these items can contribute to find terminal water leakage and illegal connections.

At the same time the customer administration system must be modified to analyze users' data for dealing with these matters. Automatic water consumption checks comparing with annual averages, last month's consumption or same month of last year's consumption is helpful for meter readers or money collectors to become aware an unusual situation. These analysis data are useful for not only for finding the troubles but also settling and solving the troubles.

(3) Improvement of willingness to pay

The authority of meter readers or money collectors is limited and the tasks concerning the tariff are fragmented. But they are the most familiar staff for ordinary water users and their performance affects customer satisfaction directly. Customer satisfaction is one of the key factors for willingness to pay. The economy and society of Vietnam is maturing year by year. Importance of customer satisfaction is becoming larger nowadays. In particular, money collectors are key players to ask for cooperation by all users when the water or sewerage rate is raised. Training has to be held more often for these staff members as representatives of their organization and their awareness should be improved.

At the same time the public relations activities of the water supply organization should be improved. Recent activity tends to be one way notification. In order to get more positive understanding of users and to progress the willingness to pay, interactive communication is important. Not only meter readers or money collectors but also other organization-wide staff should be involved in such a public relations activity. Solving these challenges is effective not only to gain users' willingness to pay but also to promote staffs' motivation.

4.5 Tariff Level Analysis

4.5.1 Introduction of Cross-subsidy

1) Determination of sewerage tariff in Vietnam

In Vietnam, Decree No.88/2007/ND-CP Article 53 defines sewerage tariff. The definition is as follows;

<u>Article 53. Determination of wastewater tariff</u>

Wastewater tariff is determined by the following formula:

F = f x V x k

Where:

f is wastewater tariff determined on percentage (%), and no less than 10% of water supply fee applied for various water supply customers.

V is charged wastewater volume which is determined.

K is coefficient of adjustment which depends on pollutant loading. K = 1 applies for domestic wastewater.

K is determined as follows:

STT	COD (mg/L)	Adjustment coefficient (K)
1	<= 100	1
2	101-200	1.5
3	201-300	2
4	301-400	2.5
5	401-600	3.5
6	>600	4.5

Therefore, sewerage tariff for non-domestic users is set higher than sewerage tariff for domestic users in accordance with COD level.

2) Application of cross-subsidy

Cross-subsidy means charging higher sewerage tariff to one group of sewerage users in order to subsidize another group by applying lower sewerage tariff to the latter group.

There are 2 kinds of cross-subsidy.

(1) Cross-subsidy according to the scale of discharged amount

A progressive rate system is a typical cross-subsidy through scale of discharged amount. In this case, those who discharge larger amounts pay higher unit rates of tariff than the unit rate of sewerage tariff for those who discharge smaller amounts.

(2) Cross-subsidy according to the usage of water

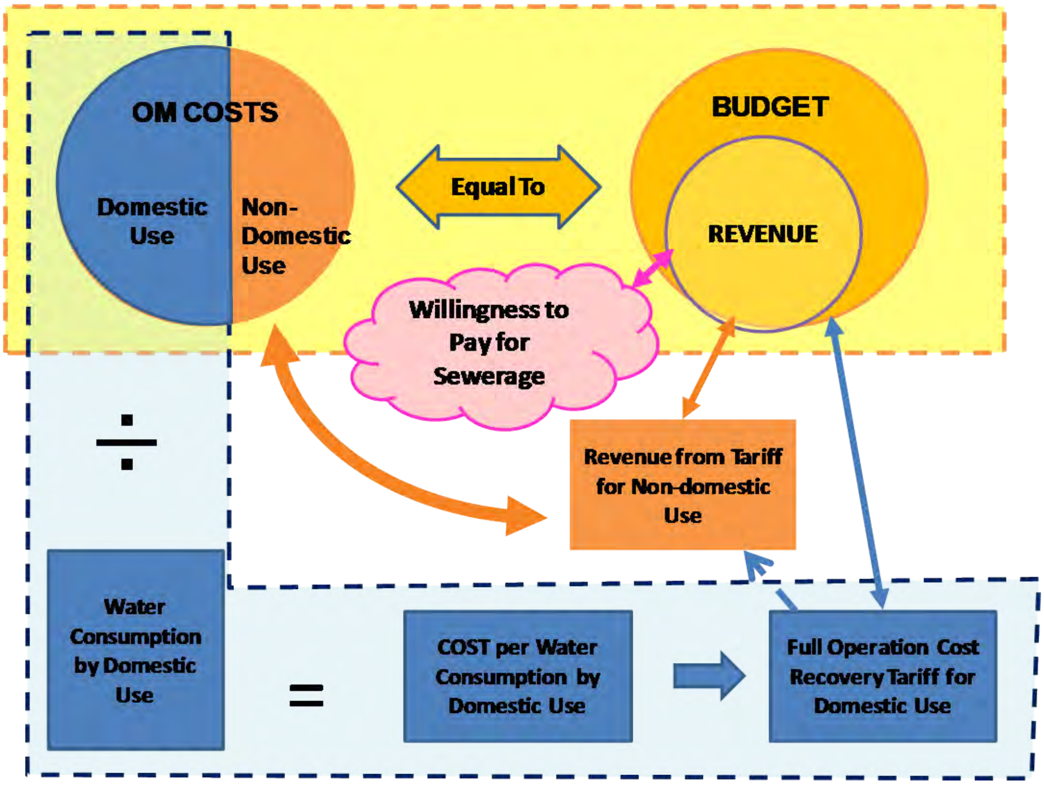
This is the cross-subsidy among different types of users. By setting higher unit rates of sewerage tariff for non-domestic users, domestic users, especially poor households, are subsidized.

In Decree No.88/2007/ND-CP, cross-subsidy according to the usage of water is applied, considering the level of COD of the discharged wastewater.

4.5.2 Methodology of the Analysis

1) Concept of tariff calculation

The following figure shows the basic concept for the methodology of the analysis.



Source: JICA Study Team

Figure 4.5.1 Basic concept for the methodology of the analysis

Main points of the methodology are as follows.

The sewerage tariff for domestic use is set to cover the necessary costs of sewerage operation for domestic use in Hanoi.

The cost of sewerage operation is estimated by cost combinations for WWTP O&M, replacement, and depreciation, as well as the O&M cost of the associated sewer system. The necessary cost for domestic service is established by the proportion of domestic sewage to non-domestic sewage.

In the analysis, tariffs are collected from (i) the service area of the WWTPs, or (ii) the whole Hanoi region.

In the analysis, sewage will be discharged in accordance with (i) design of WWTPs, or (ii) actual water consumption in Hanoi.

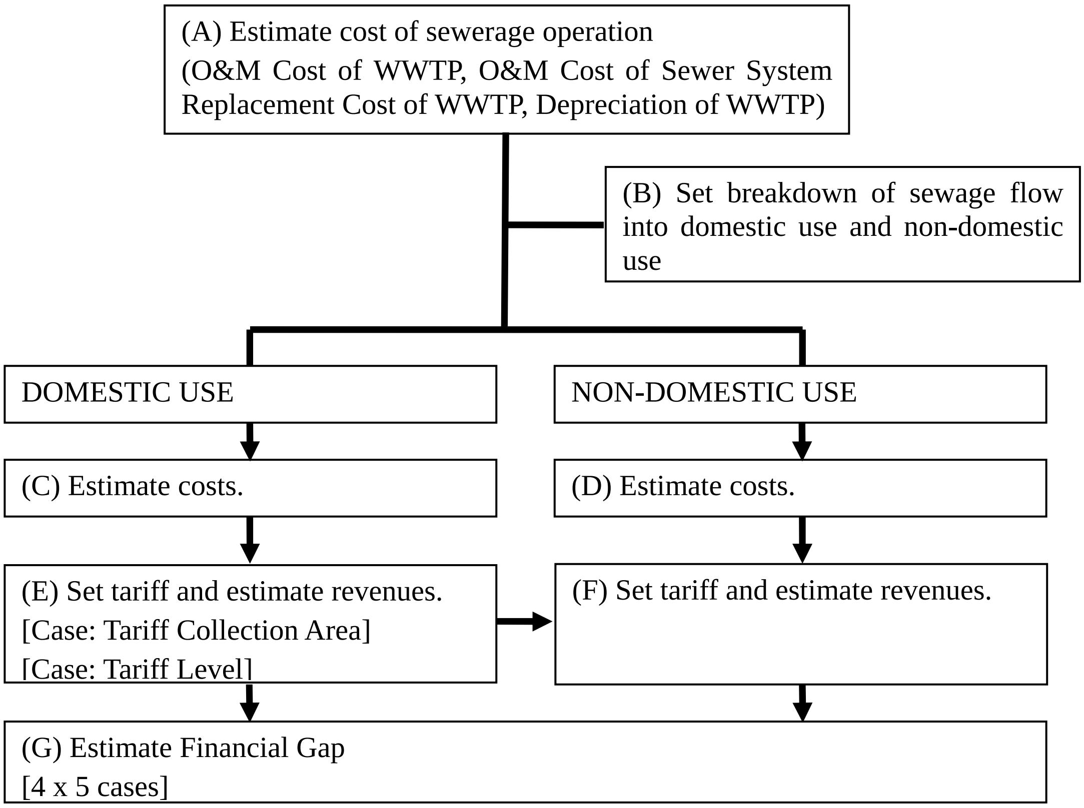
The sewerage tariff for non-domestic use is set in accordance with Decree No. 88/2007/ND-CP.

The sewerage tariff for non-domestic use is set as indicated in Decree 88/2007/ND-CP Article 53. Waste water from non-domestic use is assumed to be STT3 (COD 201-300 mg/L), and their adjustment coefficient (K) is 2.0. This indicates that the tariff for non-domestic use is twice as much as that for domestic use.

Based on these concepts, the tariff setup and financial gap in each case are estimated.

2) Calculation flow

Along the concept mentioned above, calculation flow is summarized in the following figure.



Source: JICA Study Team

Figure 4.5.2 Calculation flow

3) Cases of the analysis

The studied cases for tariff setup and financial gap estimation are summarized in the following table.

Table 4.5.1 Cases of the analysis

Case No.	Sewage Discharge	Tariff Collection Area
1	190L x 80%	Service Area
2	190L x 80%	Whole of Hanoi
3	153L x 80%	Service Area
4	153L x 80%	Whole of Hanoi

Source: JICA Study Team

Cases are set with the following conditions.

Sewage Discharge

190L: It is assumed that water consumption for domestic use is 190L/day/person. This amount is assumed in accordance with the Plant Design of WWTPs. Sewage discharge is estimated based on the forecast population in 2020.

153L: Water consumption for domestic use in the service area is 153L/day person, based on data provided by the water company. Sewage discharge is estimated based on current water consumption and population in Hanoi.

Tariff Collection Area

Service Area: Sewerage tariffs will be collected from the service area of the WWTPs.

Whole of Hanoi: The sewerage tariffs will be collected from the whole Hanoi region. This area is separated into the urban area and the rural area. It is assumed that tariffs in the rural area are half the amount of the tariffs in the urban area, because the average income in the rural area is approximately 50% of the average income in the urban area.

In setting up the tariff for domestic use, the following 5 levels are taken into consideration:

a. Willingness to Pay Level
b. O&M Cost of WWTPs Full Recovery Level
c. b + O&M Cost of Sewer System Full Recovery Level
d. c + Replacement Cost Full Recovery Level
e. d + Depreciation of WWTPs Full Recovery Level

4.5.3 Result of the Analysis

Details and processes of the calculation for the analysis are shown in Appendix 6. The results of the analysis are shown in the following tables.

Case No.1 <u>Sewage Discharge</u> **190L**: Sewage is discharged in accordance with the Plant Design of WWTPs.

<u>Tariff Collection Area</u> **Service Area**: Sewerage tariff is collected from the service area of the WWTPs.

No.	Tariff Level of Domestic Service	Tariff for Domestic Use in Urban Area	Tariff for Non-domestic Use in Urban Area	Necessary Cost	Revenue	Financial Gap (Revenue) - (Necessary Cost)	Financial Gap (Revenue) - (O&M Cost of WWTP)
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,111	2,221	44,555	21,713	-22,842	-22,842
b	O&M Cost of WWTP Full Recovery Level	2,871	5,743	44,555	56,137	11,582	11,582
c	b + O&M Cost of Sewer System Recovery Level	3,509	7,081	54,452	68,607	14,155	24,052
d	c+ Replacement Cost Recovery Level	4,768	9,536	73,985	93,218	19,233	48,663
e	d+ Depreciation of WWTPs Recovery Level	12,208	24,417	189,439	238,685	49,246	194,130

Case No.2 <u>Sewage Discharge</u> **190L**: Sewage is discharged in accordance with the Plant Design of WWTPs.

<u>Tariff Collection Area</u> **Whole of Hanoi**: Sewerage tariff is collected from the whole of Hanoi.

No.	Tariff Level of Domestic Service	Tariff for Domestic Use in Urban Area	Tariff for Non-domestic Use in Urban Area	Necessary Cost	Revenue	Financial Gap (Revenue) - (Necessary Cost)	Financial Gap (Revenue) - (O&M Cost of WWTP)
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,135	2,270	44,555	42,461	-2,094	-2,094
b	O&M Cost of WWTP Full Recovery Level	1,475	2,951	44,555	55,194	10,639	10,639
c	b + O&M Cost of Sewer System Recovery Level	1,803	3,606	54,452	67,454	13,002	22,899
d	c+ Replacement Cost Recovery Level	2,450	4,900	73,985	91,651	17,667	47,096
e	d+ Depreciation of WWTPs Recovery Level	6,273	12,545	189,439	234,674	45,235	190,119

Case No.3 Sewage Discharge **153L:** Sewage is discharged in accordance with current water consumption and population in Hanoi.

Tariff Collection Area **Service Area**: Sewerage tariff is collected from the service area of the WWTPs.

No.	Tariff Level of Domestic Service	Tariff for Domestic Use in Urban Area	Tariff for Non-domestic Use in Urban Area	Necessary Cost	Revenue	Financial Gap (Revenue) - (Necessary Cost)	Financial Gap (Revenue) - (O&M Cost of WWTP)
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,111	2,221	44,555	17,807	-26,748	-26,748
b	O&M Cost of WWTP Full Recovery Level	3,577	7,153	44,555	57,345	12,790	12,790
c	b + O&M Cost of Sewer System Recovery Level	4,371	8,742	54,452	70,083	15,631	25,528
d	c+ Replacement Cost Recovery Level	5,939	11,878	73,985	95,224	21,239	50,669
e	d+ Depreciation of WWTPs Recovery Level	15,207	30,414	189,439	243,821	54,382	199,266

Case No.4 Sewage Discharge **153L**: Sewage is discharged in accordance with current water consumption and population in Hanoi.

Tariff Collection Area **Whole of Hanoi**: Sewerage tariff is collected from the whole of Hanoi.

No.	Tariff Level of Domestic Service	Tariff for Domestic Use in Urban Area	Tariff for Non-domestic Use in Urban Area	Necessary Cost	Revenue	Financial Gap (Revenue) - (Necessary Cost)	Financial Gap (Revenue) - (O&M Cost of WWTP)
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month	Mil. VND/ month	mil. VND/month
a	Willingness to Pay Level	1,135	2,270	44,555	35,125	-9,430	-9,430
b	O&M Cost of WWTP Full Recovery Level	1,737	3,474	44,555	53,759	9,204	9,204
c	b + O&M Cost of Sewer System Recovery Level	2,123	4,246	54,452	65,700	11,248	21,145
d	c+ Replacement Cost Recovery Level	2,884	5,769	73,985	89,268	15,283	44,713
e	d+ Depreciation of WWTPs Recovery Level	7,385	14,771	189,439	228,571	39,132	184,016

In Case No. 3, the sewerage payment for the average household in each case becomes as follows:

No.	Tariff Level of Domestic Service	Tariff for Domestic Use in Urban Area	VAT	Water Consumption at Average Household in Urban Area	Monthly Sewerage Payment at Average Household in Urban Area
		A	B = A x 5%	C	D = (A+B) x C
		VND/m^3	VND/m^3	m^3/household/month	VND/household/month
a	Willingness to Pay Level	1,111	57	18.19	21,221
b	O&M Cost of WWTP Full Recovery Level	3,577	179	18.19	68,314
c	b + O&M Cost of Sewer System Recovery Level	4,371	219	18.19	83,492
d	c+ Replacement Cost Recovery Level	5,939	297	18.19	113,433
e	d+ Depreciation of WWTPs Recovery Level	15,207	760	18.19	290,436

Until the sewerage tariff catches up with the full sewerage operation cost recovery level, there will be a financial gap between revenue and cost. When the sewerage tariff is at the willingness to pay level, the gap will become VND 269,215/household/month (=290,436 – 21,221).

4.5.4 Sensitivity Analysis

Collection rate of the sewerage tariff will influence the tariff revenue. If the tariff collection rate becomes lower, the revenue will decrease. In the urban area of Hanoi, sewerage tariff can be collected with the water supply tariff by the water companies. But, tariff collection in rural areas may be a difficult task, because the Peoples Committee of each district has to issue the sewerage bills and collects only sewerage tariff. In the following, a sensitivity analysis by collection rate is conducted. In the analysis, tariff collection rate in rural areas changes from 0% to 100%, and tariff collection rate in urban areas changes from 70% to 100%.

The following table shows the result of the sensitivity analysis. The table shows how necessary sewerage tariff changes as collection rates in urban and rural areas changes. The indicated tariff is sewerage tariff for domestic use in the urban areas of Case No. 4, e (O&M cost of WWTP, O&M cost of sewer system, replacement cost, and depreciation of WWTPs recovery level). The result of the analysis indicates that tariff for domestic use in urban areas becomes VND 7,385/m^3, if tariff collection rate is 100%.

Table 4.5.2 Results of sensitivity analysis for domestic use in urban areas (Case No.4 e)

(Unit: VND/m^3)

		Collection Rate in Rural Areas					
		100%	80%	60%	40%	20%	0%
Collection rate in Urban Areas	100%	7,385	8,000	8,727	9,598	10,664	11,995
	90%	7,870	8,572	9,412	10,433	11,704	13,327
	80%	8,423	9,232	10,213	11,427	12,970	14,993
	70%	9,059	10,002	11,163	12,631	14,542	17,135

Source: JICA Study Team

4.6 Financial Plan for Sewerage Operation

4.6.1 Tariff Plan

Considering the results of the tariff level analysis, the JICA Team recommends that a tariff is introduced and increased via the following scenarios:

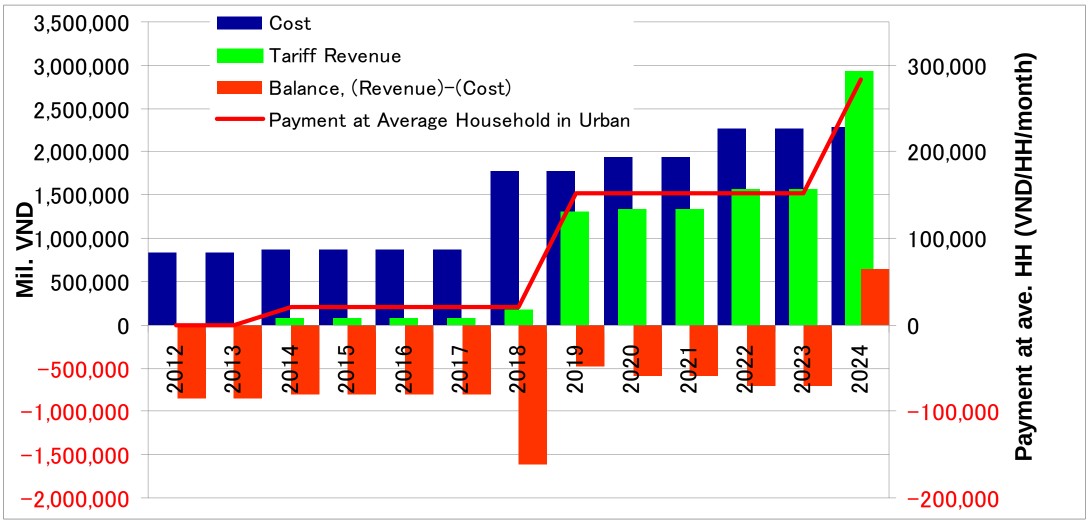
A sewerage tariff is to be introduced in 2014 and at Willingness to Pay Level across the whole of Hanoi. Hence, the tariff for domestic use in the urban area is 1,111 VND/m^3. The tariff for non-domestic use in the urban area should cost 2,221 VND/m^3. (Case No.3 a)

The sewerage tariff should be increased every 5 years until it reaches the necessary cost for sewerage operation recovery level in 2024. The tariff for domestic use in the urban area would then be 15,207 VND/m^3. The tariff for non-domestic use in the urban area would then be 30,414 VND/m^3. (Case No.3 e)

4.6.2 Cash Flow Analysis of Sewerage Operation

Along with the tariff plan mentioned in 4.5.1, a cash flow analysis was conducted. Cost includes O&M cost of WWTP, O&M cost of sewer system, replacement cost, and depreciation of WWTPs. As for revenue, it is assumed that the tariff is collected from the area served by WWTPs. Therefore, the collection area expands as new WWTPs start their operation.

The result is shown in the following figure.



Source: JICA Study Team

Figure 4.6.1Cash flow analysis for sewerage operation in Hanoi

The result indicates that total financial gap to be covered in 13 years (2012 to 2024) becomes VND 8,893 billion.

4.6.3 Recommendations for Sewerage Tariff

1) Potential case of sewerage tariff

(1) Tariff collection area

There are 2 choices of tariff collection areas, those are i. sewerage service area and ii. whole of Hanoi.

Collecting tariff in the sewerage service area is an understandable option. In the same manner as electric power and water supply, the end user pays the money corresponding to the value of the service. This option could adapt the existing water supply tariff collection mechanism to the sewerage tariff collection.

Collecting tariff in the whole of Hanoi is an autonomous idea based on the idea that the polluter should pay for the service, since every citizen is discharging sewage to the environment and the government is treating it. The advantage of this choice is to avoid the citizen's feeling of injustice in payment of sewerage tariff between the service area and non-service area. Needless to say, the individual sewerage tariff for the whole of Hanoi will be less than the individual tariff that is collected only in the service area. It may be suitable to utilize a tax payment mechanism for sewerage tariff collection.

Our recommendation is the tariff collection in the service area. This idea could be applied as an extension of the current tariff collection system operated by the water company, and does not require new legislation for tariff collection.

(2) Tariff for domestic & non-domestic sewage

Characteristics of influent to the sewage treatment plant are limited by the design condition of the plant.

Domestic sewage can meet the design condition of the plant because the design conditions of the plant were fixed based on the characteristics of domestic sewage.

Non-domestic sewerage tariff, presently, shall comply with Decree 88/2007/ND-CP. This decree requests that the non-domestic tariff be determined based on COD influent. The Characteristics of non-domestic sewage are widely varied by the discharger's activities. However the characteristic data of non-domestic sewage are adequate to use as baseline data for the tariff.

It is recommended that the Hanoi People's Committee survey the characteristics of non-domestic sewage in order to set the non-domestic sewerage tariff. The non-domestic sewage discharger shall be obligated to pre-treat their sewage to meet the design conditions of the sewage treatment plant.

(3) Coverage of tariff revenue

Coverage levels of tariff revenue are five;

a. Revenue to be in accordance with Willingness to Pay
b. Revenue to fulfill O&M costs of Sewage Treatment Plants
c. Revenue to fulfill O&M costs of Sewage Treatment Plants and Sewer
d. Revenue to fulfill O&M costs of Sewage Treatment Plants, Sewer and Replacement of Equipment
e. Revenue to fulfill O&M costs of Sewage Treatment Plants, Sewer, Replacement of Equipment and Depreciation

It is recommended that the sewerage tariff is started from the willingness to pay level in order to introduce the sewerage tariff as soon as possible without heavy objections from the citizens. Then, the sewerage tariff is to be raised to the level covering O&M costs within 10 years. Taking into consideration the required time for administrative processes, raising of the tariff may be once every five years.

As a long term target, the tariff should catch up with the full costs including O&M, equipment replacement and depreciation in accordance with the growth of the household economy.

2) Introduction schedule for sewerage tariff

The legal decision made by the Hanoi People's Committee is required, and this will take at least two years. Assuming that the official process for the sewerage tariff establishment will be started in the beginning of Year 2012, the sewerage tariff system will be implemented in year 2014.

3) Assistance of Joint Company for establishment of sewerage tariff system

Prior to the implementation of the sewerage tariff system, there needs to be a great deal of surveys and research such as;

- willingness to pay survey in the whole of Hanoi,
- survey of non-domestic sewage characteristics,
- comparison study of sewerage tariff in other cities and countries,
- design and establishment of tariff collection and accounting system and
- financial calculation relating to sewerage tariff.

It is recommended that the Joint Company for IOMS proposed in this report assist Hanoi People's Committee regarding establishment of the sewerage tariff. Because the DOC & HSDC will be core members of the Joint Company and they shall drive this matter to the goal with the assistance of experienced people.

APPENDICES

Appendix 1 Meeting Materials

1) Kick-Off Meeting, 20-21 April 2011
2) Working Group Meeting, 26 May 2011
3) Working Group Meeting, 20 June 2011
4) Interim Meeting, 23 June 2011
5) Working Group Meeting, 12 August 2011
6) Wrap-Up Meeting, 30 August 2011

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

INTRODUCTION OF PPP FOR SEWERAGE FACILITIES IN HANOI STUDY A

KICK-OFF MEETING

20 April 2011, Hanoi

Study Team A

JAPAN

Conventional O&M

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

HPC

Fixed Scope of Work
Annually updated Cost-plus-profits-contract

HSDC

O&M

Truc Bach WWTP
Kim Lien WWTP
North Thang Long WWTP
Yen So Storm Water PS
Others

I. Sewage treatment quality shall comply with the Environmental Standards

II. Repair and replacement of equipment is carried out within the budget.

Integrated O&M

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

HPC

Performance Benchmarks (mainly treatment quality)
Delivery conditions at the end of contract period
Multi-year Lump-sum contract

O&M contractor

O&M

Yen So WWTP
Bai Mau WWTP

I. Sewage treatment quality shall comply with the Environmental Standards

II. Repair and replacement of equipment is carried out in order to satisfy the delivery conditions by the contractor's discretion.

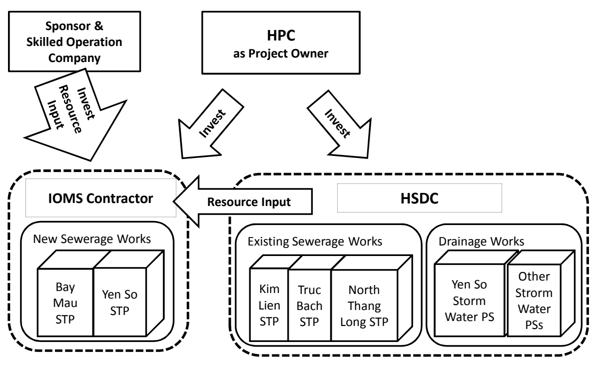
Integrated O&M

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Conventional O&M	Integrated O&M
Basis of Contract	**a. Fixed Scope of Work** **b. Annually updated** Cost-plus-profits-contract	**a. Performance Benchmarks** (mainly treatment quality) & **Delivery conditions** at the end contract. **b. Multi-year** Lump-sum contract
Employer's Requirement	I. Sewage treatment quality shall comply with the environmental standards **II. Repair and replacement** of equipment is carried out **as per the Scope of Work**.	I. Sewage treatment quality shall comply with the environmental standards **II. Repair & replacement** of equipment is carried out by the contractor's discretion, in order to **comply with the delivery conditions**.

IMAGE of IOMS CONTRACTOR

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



PLACE TO GO

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-1: Streamlined **O&M** in the existing WWTPs
TOR-2: Integrated **O&M** Services to Yen So and Bay Mau WWTP applying **PPP**
TOR-3: **Financial plan** with new sewerage **Tariff** structure

TOR-1: HSDC's O&M capacity up in asset management

JOIN

TOR-2
A) Design of the Integrated O&M Hanoi model
B) Feasibility check and Legal check of the proposed O&M model
C) IOMS Implementation Action Plan

SUPPORT

TOR-3: New Tariff for funding to the IOMS contract

Points to be concerned

Oriental Consultants **(OC)** , ORIX Corporation **(ORIX)** , Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

- **improving environment** → improve health, wealth & lifestyle
- **financially viable** → not exposed to budgetary trauma
- **socially acceptable** → create benefits – not a grudge purchase
- **administratively understandable** by community
- **'pay for use'** → no subsidies?! Encourage economic efficiencies

7

REVENUE, MOST CONCERN

Oriental Consultants **(OC)** , ORIX Corporation **(ORIX)** , Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

Drivers – factors that most affect revenue from tariffs collection:
- Willingness to Pay;
- Affordability;
- Tariff level;
- Service Coverage;
- **Level of cost recovery**;
- Community Service Obligations

The income structure shall be made within local situation.

History of low tariffs and fees
- Difficult to get decisions on a 'cost recovery' basis
- Often perceived as easier
  - to subsidize and/or
  - Provide a low quality service

WORK PLAN (TOR-1)

Oriental Consultants **(OC)** , ORIX Corporation **(ORIX)** , Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

TOR-1: Streamlined O&M in the existing WWTPs

A. Improvement of Treatment Process | **B. Upgrading O&M Manual** | **C. Introduction of Equipment Register**

APRIL MAY
- Planning
- Proposal of O&M Manual

JUNE JULY
- **OJT in 3 WWTPs**
  - Improvement of Treatment Process
  - Improvement of O&M Manual
  - Improvement of Equipment Register

AUGUST
- **OJT in 3 WWTPs**
  - Supplemental OJT
- Conclusion of an Effect
- Proposal

Work Plan (TOR-2 & TOR-3)

Oriental Consultants **(OC)** , ORIX Corporation **(ORIX)** , Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

	TOR-2 IOMS & PPP	**TOR-3 Tariff & Financial Plan**
APRIL MAY	Institutional Design of Integrated O&M service (IOMS) Legal check of IDMS	Interview Survey for Willingness to Pay and Affordability
JUNE JULY	Cost estimates of IOMS Feasibility check of IDMS for the company to undertake	New Tariff Case Study Financial Plan for viability check of IOMS for HPC
AUGUST	IOMS Implementation Action Plan	New Tariff Plan Financial Plan

FAQ (frequently-asked question)

Oriental Consultants **(OC)** , ORIX Corporation **(ORIX)** , Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

Frequent Questions	**Our Answers**
B) This PPP is just for money to Japanese?	No it isn't. Japan invest to this PPP with you.
D) Suppose, PPP uses his money not my money, right?	We share costs , so you save money.
E) What is advantage of this PPP for us?	You can have more employment opportunities in this PPP. Most staff in new company is Vietnamese who can learn and earn in the job. New company gives opportunity to wider business into staff training services and even planning & engineering in sewerage field.

Study Team

Oriental Consultants **(OC)** , ORIX Corporation **(ORIX)** , Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

Phase 2	**Introduction of PPP for Sewerage Facilities in Hanoi, 2011**			
TOR-1: Streamlined **O&M** in the existing WWTPs	 Takehiro NAKANO (HELS)	 Kota KINOSHITA (HELS)	 Etsuo FUJIWARA (HELS)	
TOR-2: **Integrated O&M Services** to Yen So & Bay Mau WWTPs applying **PPP**	 Koichi SUZUKI (OC)	 Yoichiro ONO (ORIX)		 Masami SHIRAI Assistant (OC)
TOR-3: **Financial plan** with new sewerage **Tariff** structure	 Kenji SUZUKI (PADECO)	 Nami TANAKA (PADECO)	 Susumu SHIBUYA (Yokohama Water)	 Takeo TANAKA (Yokohama Water)

ASSIGNMENT SCHEDULE

	APRIL					MAY				JUNE				JULY					AUGUST				
Sun	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27
Mon	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28
Tue	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29
Wed	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30
Thu	30	6	13	20	27	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31
Fri	31	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	1
Sat	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2
Koichi Suzuki (Leader)	■	■	■	■					■			■	■	■					■	■	■	■	■
Takehiro Nakano (O&M)			■	■								■	■	■							■	■	■
Kota Kinoshita (O&M)												■	■	■							■	■	■
Etsuo Fujiwara (O&M)												■	■	■							■	■	■
Yoichiro Ono (PPP)			■	■									■	■								■	■
Kenji Suzuki (Financial)													■	■							■	■	■
Nami Tanaka (Financial)			■	■			■	■	■														
Takeo Tanaka (Tariff)			■	■									■	■								■	■
Susumu Shibuya (Tariff)													■	■									

Work Plan (TOR-2 & TOR-3)

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

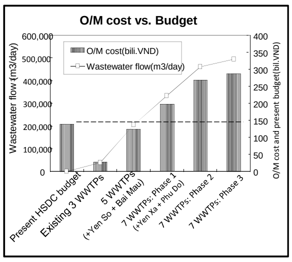
	TOR2 Integrated O&M + PPP	TOR3 Tariff & Financial Plan
APR	1. PPP model and proposal of Joint Company Option 2. Design of Joint Company	A. Approach to New Tariff and Financial Plan B. Implementation Plan of Interview Survey
MAY		Interview Survey
JUN	1. Cost estimates of JC incl. O&M, office running costs 2. SPC business expansion plan 3. Preliminary FS of JC 4. Review of Regulations concerned	A. Analysis of Interview survey result B. Case study for New Tariff C. Conditions for Financial Planning D. Review of Regulations concerned E. Current status of Water works in Hanoi
JUL		
AUG	1. FS for establishing Joint Company 2. Road Map for establishing Joint Company	A. Proposed amendment of Tariff system B. Financial plan for HPC (incl. Subsidy plan)

PREDICTION

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Current Status of Sewage Works in Hanoi

Waste Water Treatment Plant	Capacity (m^3/day)	Operation Year
Kim Lien	3,700	2005
Truc Bac	2,500	2005
North Thang Long	42,000	2009
Bay Mau Lake	14,000	2013(Planned)
Yen So	190,000	2011(Planned)
Yen Xa	270,000	2016(Planned)
Phu Do	84,000	2016(Planned)
Total	606,200	



Many WWTPs to be operated in the near future ⇨ The more WWTPs, the more cost of Construction and O&M…

2

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

INTRODUCTION OF PPP FOR SEWERAGE FACILITIES IN HANOI, STUDY A

TOR-2 Integrated O&M service by PPP

A. Approach to TOR 2
B. Required Data & Information
C. Selection of PPP model

21 April 2011, Hanoi

JAPAN

SOLUTION

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

ISSUES		SOLUTION
With increasing WWTPs		
a. **Operation costs** increase.	→	**Direct costs** (power, chemical) are increasing as per treatment volume. **Overheads** (management, administration) shall be minimized.
b. **More O&M staff** are required.	→	Recruitment of additional O&M staff is needed but to be **minimized by rationalizing work- procedure**.
c. **Stock management** becomes cumbersome.	→	Stock (chemical, spare parts, consumables) shall **be managed transparently by computerized database**.
With aging equipment		
d. **Replacement costs** are required.	→	Proper maintenance with proactive care can **prolong the life-time of equipment**.

Conventional O&M

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

HPC

Fixed Scope of Work
Annually updated Cost-plus-profits-contract

HSDC

O&M

Truc Bach WWTP
Kim Lien WWTP
North Thang Long WWTP
Yen So Storm Water PS
Others

I. Sewage treatment quality shall comply with the Environmental Standards
II. Repair and replacement of equipment is carried out within the budget.

Integrated O&M

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

HPC

Performance Benchmarks (mainly treatment quality)
Delivery conditions at the end of contract period
Multi-year Lump-sum contract

O&M contractor

O&M

Yen So WWTP
Bai Mau WWTP

I. Sewage treatment quality shall comply with the Environmental Standards
II. Repair and replacement of equipment is carried out in order to satisfy the delivery conditions by the contractor's discretion.

Integrated O&M

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Conventional O&M	Integrated O&M
Basis of Contract	a. **Fixed Scope of Work** b. **Annually updated** Cost-plus-profits-contract	a. **Performance Benchmarks** (mainly treatment quality) & **Delivery conditions** at the end contract. b. **Multi-year** Lump-sum contract
Employer's Requirement	I. Sewage treatment quality shall comply with the environmental standards II. **Repair and replacement** of equipment is carried out **as per the Scope of Work**.	I. Sewage treatment quality shall comply with the environmental standards II. **Repair & replacement** of equipment is carried out by the contractor's discretion, in order to **comply with the delivery conditions**.

Who will undertake IOMS?

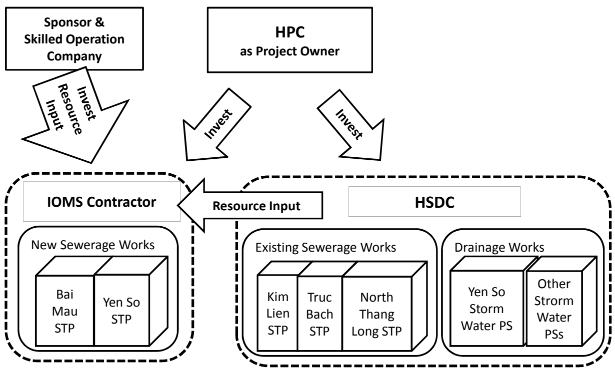
Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Option 1:	HSDC to undertake the IOMS
Option 2:	Joint Company established by HPC, HSDC and Private firm to undertake the IOMS
Option 3:	A Private firm to undertake the IOMS

	Option 1	Option 2	Option 3
Capacity to undertake IOMS	Lack of capacity to undertake	Enough capacity	Enough capacity
Cost saving opportunity	Less because lack of experience	Promising	High cost due to Foreign company
Comfort for HPC	Comfort	Comfort	Uncomfortable to ignore HSDC
Compliance of laws and regulations	Complied	Need to study	Complied
Evaluation	Need more capacity development of HSDC.	HSDC's locality and Private firm's skill make synergy. **Recommendable**	HSDC's 5 year experience cannot contribute in this option.

IMAGE of IOMS CONTRACTOR

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



Scope of Work of Joint Company

OC, ORIX, HELS, PADECO, YW

Integrated O&M service

A) Sewage treatment & disposal
B) Sludge treatment & disposal
C) Repair and Replacement of equipment
D) Water quality check and report to DONRE
E) Management of spare parts and consumables

Staff Training Service (OPTION)

A) Capacity building course for sewerage operators (Junior, Senior)
B) Capacity building course for administrators of sewerage

Technical Service (OPTION)

A) Sewerage development planning
B) Engineering of sewerage facilities
C) Construction management, Project management

Finance of Joint Company

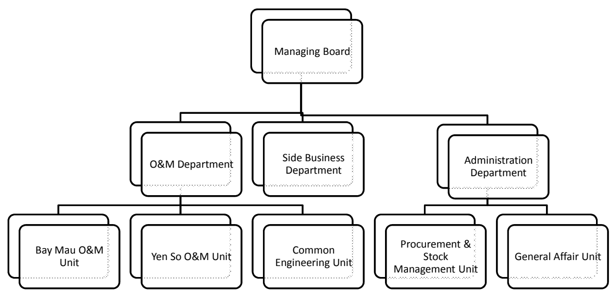
OC, ORIX, HELS, PADECO, YW

Income	**WWTP O&M fee from HPC** **In addition (as option),** **Sewerage operator training fee from other cities** **Engineering service fee from other cities**

Expenses	**WWTP O&M costs** **WWTP repair/replacement costs** **(optional) Sewerage operator training costs** **(optional) Engineering service costs** **Overheads (administration & management)** **Taxes**

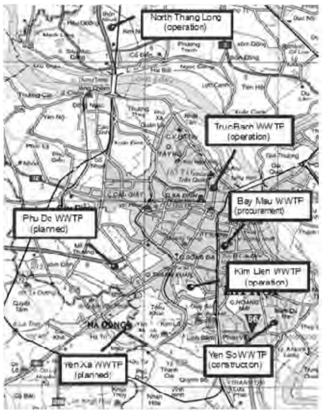
Structure of Joint Company

OC, ORIX, HELS, PADECO, YW



Location, Assets of Joint Company

OC, ORIX, HELS, PADECO, YW



Location	Either Bay Mau WWTP site or Yen So WWTP site
Assets	Administration office Side business office
Facilities provided at no cost	Bay Mau WWTP Yen So WWTP

NEXT STEP

OC, ORIX, HELS, PADECO, YW

I. Cost Estimates of O&M costs, Running costs of JC, Overhead of JC

II. Feasibility Study of JC

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

INTRODUCTION OF PPP FOR SEWERAGE FACILITIES IN HANOI, STUDY A

TOR-3 Tariff Plan & Financial Plan

A. Approach to TOR 3
B. Required Data & Information
C. Interview Survey

21 April 2011, Hanoi

JAPAN

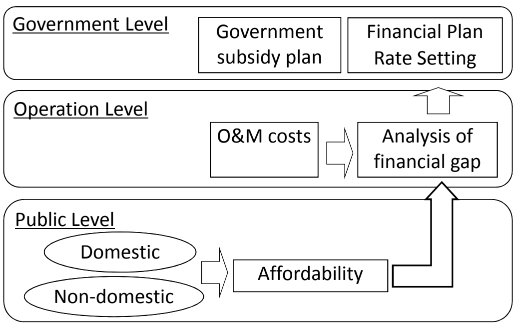
Content of the Study

Goal:

Proposal of financially sustainable mechanism for Hanoi sewerage services

1. Review of Water and Sewerage Rates
2. Estimates of WWTP O&M Costs
3. Sewerage Rate Plan and Financial Plan

Flow of Sewerage Charge Rate Setting



Cases of Tariff Setting

Case 1: Current rate setting

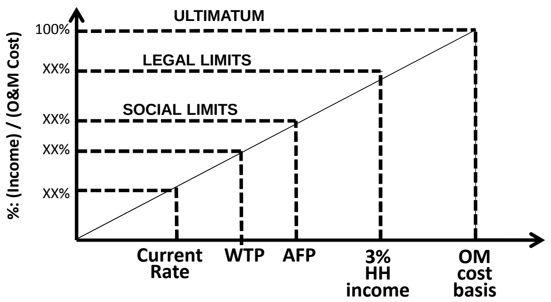
Case 2: Based on current Willingness-to-Pay

Case 3: Based on current Affordability-to-Pay

Case 4: 3% of average household income (referring No. 09/2009/TT-BXD)

Case 5: Based on all O&M costs

Output image of Tariff Setting



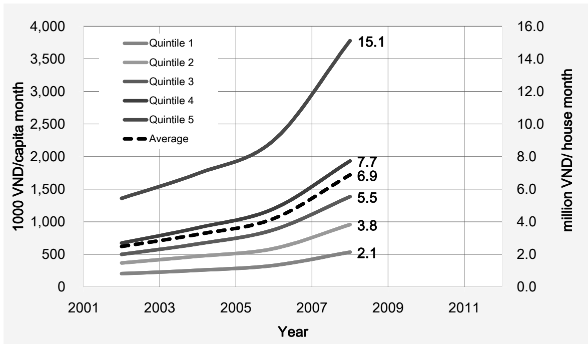
Charges in Vietnamese Cities

- Hanoi: 10% (≈VND300)
- Haiphong: VND300
- Cantho: VND300
- Nhatrang: VND250
- Danang: VND300

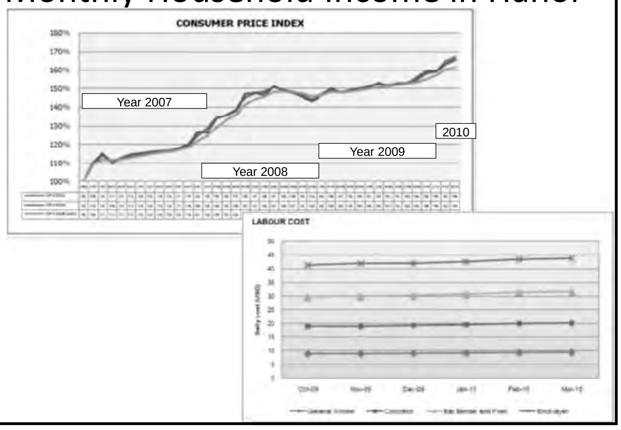
Charges in Other Cities (USD/m3)

- HCMC 0.32
- Manila East 3.19
- Manila West 5.36
- Tokyo 14.97
- Sydney 36.16
- London 19.84

Monthly Household Income in Hanoi



Monthly Household Income in Hanoi



Very Preliminary Calculation

(no confident)

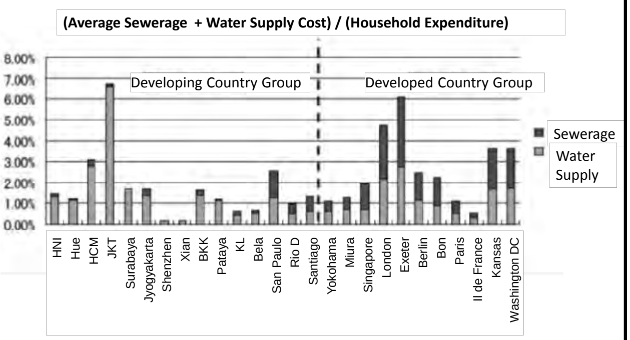
Monthly sewage discharge (Preliminary)
= 120Lpcd x 4 peroson/HH = 0.48m3/day HH = **14.4 m3/month HH**

Current expenses for Water & Sanitary
(World Bank 2009)

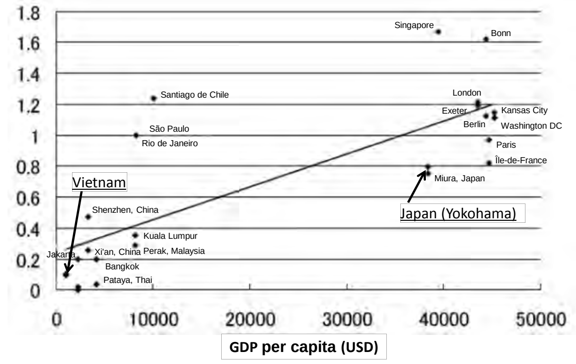
	VND / month HH	VND / m3
Water max	100,000	
Water min	20,000	
Sanitary max	10,000	694
Sanitary min	2,000	139

Census 2009	Average	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
3% of household income VND	206,400	64,200	114,840	166,320	231,960	453,360
per Water+Sanitation Max	188%	58%	104%	151%	211%	412%
per Water+Sanitation Min	938%	292%	522%	756%	1054%	2061%

Ratio of Average (Sewerage + Water) Charge to Household Expenditure



Sewerage tariff/ Water tariff



Immediate Action after this Meeting

a. Check Willingness-To-Pay	Interview survey
b. Check Social Limits	Per% of Household Income
c. Check Legal Limits	3% of Household Income
d. Check Financial Gap	Affordability - Willingness

Water Supply Data

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Water supply data as follows is necessary for analyzing sewage income.

Classification of water user	Number of the user	Unit price (VND/m³)	Consumption (m³)	Annual turn over
General household				
Commercial user				
Industrial user				
…				
Total				

Study at Public Level

Questionnaire Survey

Target:

Households (100 samples)

Commercial and Industrial Organization (30 samples)

Item:

Willingness to Pay (WTP): the maximum amount a person would be willing to pay, sacrifice or exchange in order to receive a good or to avoid something undesired

Schedule:

Preparation: Mid. April – Early May

Implementation: Mid. May

Data Processing: Late May – Early June

Survey Schedule

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Survey Area: **7 Districts (Ba Dihn, Dong Da, Hai BaTrung, Hoang Mai, Thanh Tri, TuLie, Dong Anh)**

Household Survey: **105 samples (15 household/Districts)**

Commercial & Industry Survey: **35 Samples (5 CI/Districts)**

APRIL	Preparation -Questionnaire Forms -Local survey team arrangements -Endorsement letter by HAPI -Identification of CI by DOC (request letter dispatched)
MAY	Interview Surveys Implementation(planned schedule) -25 April- 5 May Household Survey -27 April - 12 May Commercial & Industry Survey
	Results analysis and Reporting -6 May-25 May: Analysis, preparation of materials for the 26th meeting -26 May: Survey Results Reporting at the Meeting

ASSIGNMENT SCHEDULE

	APRIL					MAY				JUNE				JULY					AUGUST				
Sun	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27
Mon	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28
Tue	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29
Wed	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30
Thu	30	6	13	20	27	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31
Fri	31	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	1
Sat	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2
Koichi Suzuki (Leader)	■	■	■	■					■			■	■	■					■	■	■	■	■
Takehiro Nakano (O&M)			■	■								■	■	■							■	■	■
Kota Kinoshita (O&M)												■	■	■							■	■	■
Etsuo Fujiwara (O&M)												■	■	■							■	■	■
Yoichiro Ono (PPP)			■	■									■	■								■	■
Kenji Suzuki (Financial)													■	■							■	■	■
Nami Tanaka (Financial)			■	■			■	■	■														
Takeo Tanaka (Tariff)			■	■									■	■								■	■
Susumu Shibuya (Tariff)													■	■									

Work Plan (Detail)

Oriental Consultants (OC) , ORIX Corporation (ORIX) ,
Nihon HELS Industry (HELS), PADECO,
YOKOHAMA Water (YW)

	TOR2 Integrated O&M + PPP	TOR3 Tariff & Financial Plan
April	1. Approach to TOR2 2. Design of Joint Company (SPC) A) Scope of Work (O&M, Training Services, Planning & Engineering) B) Profit Structure C) Staffing (HSDC + Private firms) D) Location, Assets, Equipment	A. Approach to TOR3 B. Approach to New Tariff and Financial Plan C. Implementation plan and utilization of Interview survey (Willingness to Pay) D. Analysis of current sewerage income E. Linkage between Tariff and Financial Plan F. Necessary data for Financial Plan
May		
June	1. O&M costs of Bay Mau & Yen So STP 2. SPC Running Costs 3. SPC Training service business plan 4. SPC Engineering service business plan 5. Preliminary FS for establishing SPC 6. Regulations for establishing SPC	A. Analysis of Interview survey result B. Case study for Amendment of Tariff C. Conditions for Financial Planning D. Regulations for New Tariff & Financial Plan E. Current status of Water works in Hanoi
July		
August	1. FS for establishing SPC under New Tariff System proposed 2. Road Map for establishing SPC in compliance with current regulations	A. Proposed amendment of Tariff system B. Income forecast under New Tariff System C. Financial plan under New Tariff System for HPC (incl. Subsidy plan)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC) , ORIX Corporation (ORIX) ,
Nihon HELS Industry (HELS), PADECO,
YOKOHAMA Water (YW)

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Team Leader
Framework of Integrated O&M Services

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(Treatment Process)

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Etsuo FUJIWARA
(HELS)
Sewerage & Drainage
Expert
(O&M System)

Yoichiro ONO
(ORIX)
PPP Expert
PPP Framework

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

INTRODUCTION OF PPP FOR SEWERAGE FACILITIES IN HANOI

Working Group Meeting – Study A
26 May 2011, Hanoi
TOR-3 Tariff Plan & Financial Plan

AGENDA

A. Household Interview Survey

B. Commercial & Industry Survey

C. Next action

TOR-3:HH Survey Result

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

PURPOSE OF THE HOUSEHOLD SURVEY

- To grasp the citizen's awareness of sewerage services
- To get the citizen's willingness to pay for the sewerage services

Contents
1. Outline of the Survey
2. Household Income & Expenditure
3. Awareness of Sewerage Services
4. Willingness to Pay
5. Recommendation

TOR-3:HH Survey-Outline

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

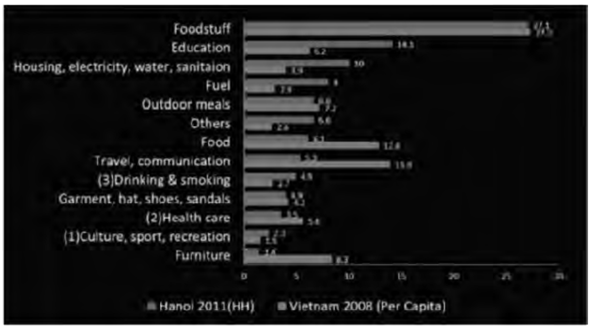
Outlines of Survey	
Surveyed Area 7 Districts in Hanoi	Ba Dinh, Dong Da, Hai BaTrung, Hoang Mai, Thanh Tri, Tu Liem, Dong Anh
Sampled Number	105 House Hold (15HH from each district)
Method	Interview by trained surveyors
Duration of Survey	6th to 9th May 2011

Profiles of HH	
SEX	Male:21%, Female:79%
Age	45 year old (average)
Occupation	Commercial:47%, Public:7%, Manufacturing:7%, Others (incl. agriculture, temporary workers, unemployed) 39%
Income	8,560,962 VND /month per HH in average
Expenditure	7,024,368VND/month per HH in average (82.1% of Income)

TOR-3:HH Survey-Expenditure

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

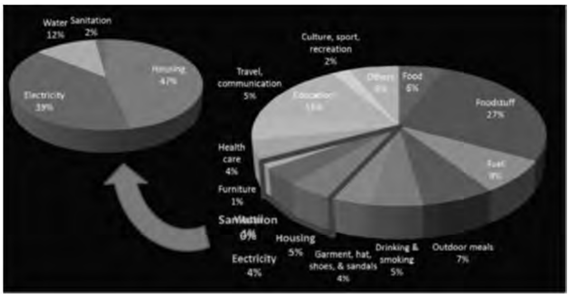
Average HH Expenditure
7,024,368 VND/month (82.1% of HH Income)



TOR-3:HH Survey-Current Fee

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

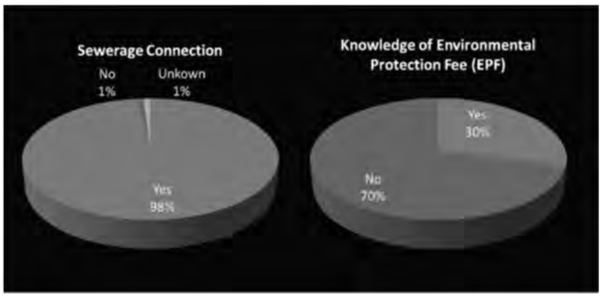
HH Expenditure for Housing, Electricity, Water, and Sanitation
Average Water Expenditure: 85,971 VND/month
(1.0% of Income)



TOR-3:HH Survey-Awareness

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

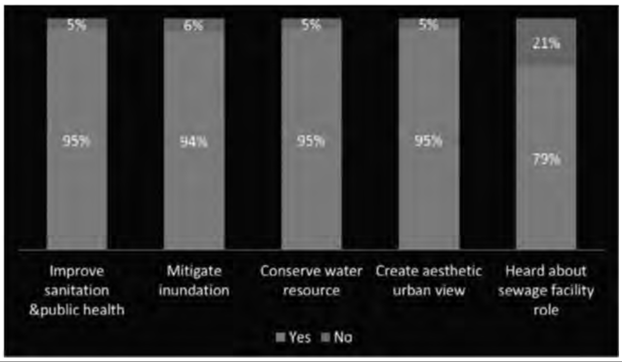
Awareness of Sewerage Facility
Average payment of Environmental Charge



TOR-3:HH Survey-Awareness

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

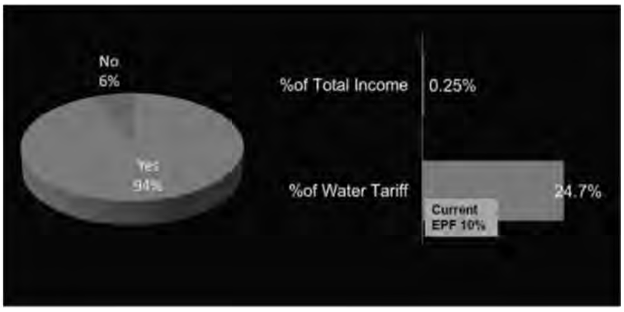
Awareness of Sewerage Facility Effectiveness



TOR-3:HH Survey-WTP

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Willingness to Pay (WTP) for Sewerage Tariff
Average Amount: 21,212 VND/month

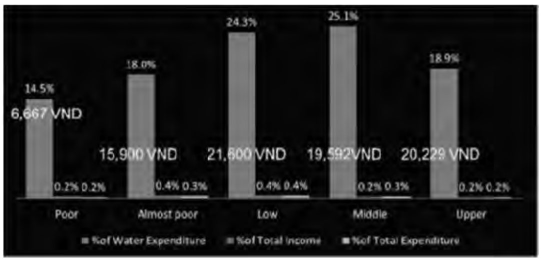


TOR-3:HH Survey-WTP

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

WTP for Sewerage Tariff by Income Level

Upper	(11%) :	> VND 4M person/mon	VND 11.9M in Ave.
Middle	(34%) :	VND 2M-4M person/mon	VND 9.3M in Ave.
Low	(40%) :	VND 1M-2M person/mon	VND 6.2M in Ave.
Almost Poor	(10%) :	VND 0.75M-1M person/mon	VND 4.1M in Ave.
Poor	(5%) :	VND 0.55M-0.75M person/mon	VND 2.8M in Ave.



TOR-3:HH Survey Result

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Our HH Survey Results & Other Factors

1) **Citizen are recognizing to be served by the sewerage service conducted by HPC.**
2) **Willingness to Pay was VND 21,212 per month in average that is equivalent to 0.25% of average HH income.**

Recommendations

1) **Remarks to determine the sewerage charge are (1) Willingness-to-Pay (WTP), (2) Legal Max 3% and (3) Revenue for full coverage of O&M costs.**
2) **Reasonable Affordability-to-Pay (ATP) is subject to the required budget for O&M of sewerage services.**

TOR-3:CI Survey Result

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

PURPOSE OF THE Commercial & Industry (CI) SURVEY

- To grasp the CI's awareness of sewerage services
- To get the CI's willingness to pay for the sewerage services

Contents
1. Outline of the Survey
2. Sales
3. Awareness of Sewerage Services
4. Willingness to Pay
5. Recommendation

TOR-3:CI Survey-Outline

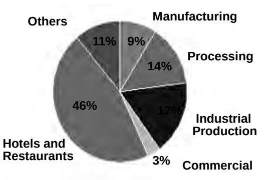
Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

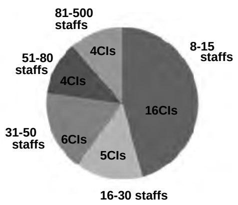
Survey Area: 7 Districts
Ba Dinh, Dong Da, Hai Ba Trung, Hoang Mai, Thanh Tri, TuLiem, Dong Anh

Interviewed CIs: 35 CI
Every 5 CIs per district

Sampling:
Interviewed ICs selected by District People's Committees

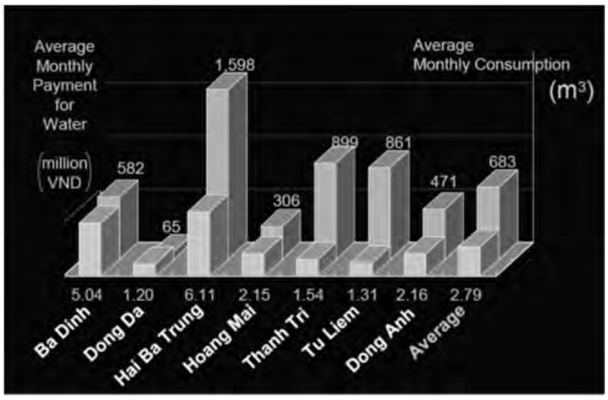
Duration:
from May 5th to May 13th 2011





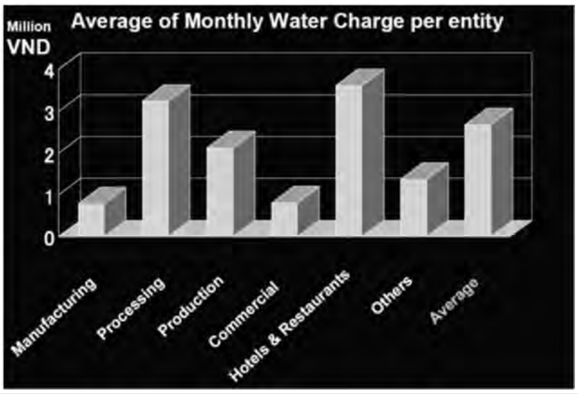
TOR-3:CI Survey Result Water Consumption

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



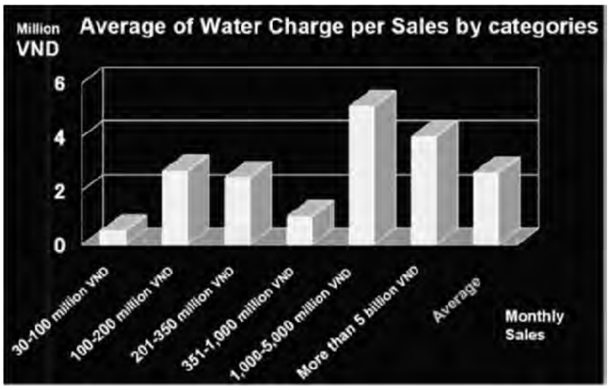
TOR-3:CI Survey-Water Charge

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



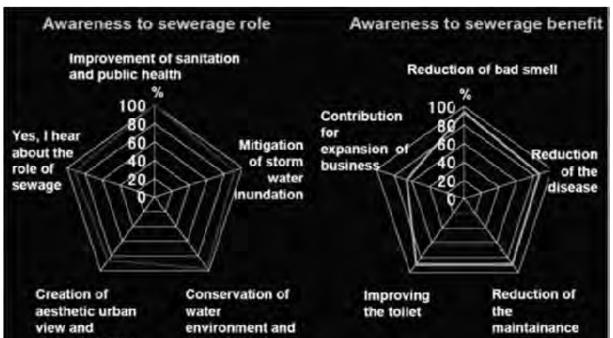
TOR-3:CI Survey Result

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-3:CI Survey Result Awareness to Sewerage

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-3:CI Survey Result

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Willingness to pay

CI's Willingness-to-Pay (WTP) is 0.13% per month sales that is equivalent to monthly VND 2.8 million per entity.

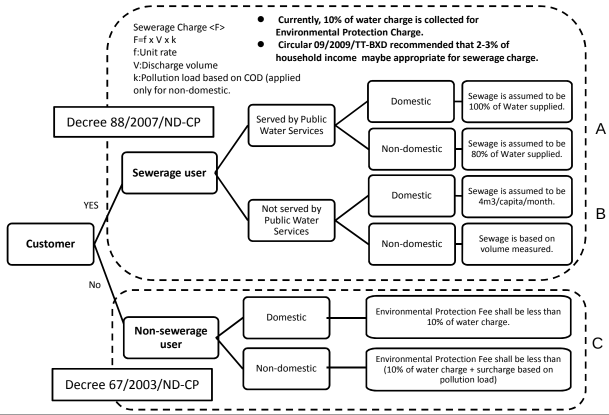
Recommendations

a. **Awareness of the sewerage benefit is low in interviewed CI, hence further promotion is required.**
b. **It shall be noted that WTP of CI per entity (VND 2.8M) is 132 times of WTP per HH (VND 21K). CI customer shall be reserved for Cross-Subsidy Financial Source.**
c. **Reasonable Affordability-to-Pay (ATP) is subject to the required budget for O&M of sewerage services and cross-subsidy plan.**

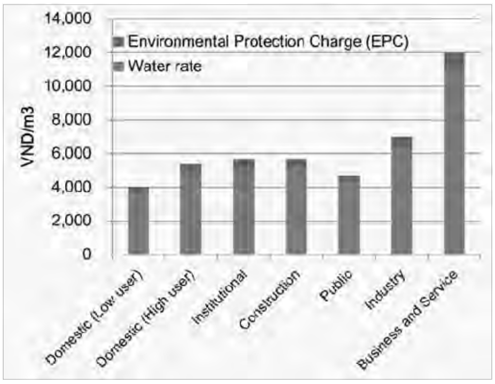
C. Sewerage Charge Financial Analysis

Purpose: Provide framework and action plan of the financial aspects for sustainable sewerage operation in Hanoi

C. Sewerage Charge-Legal Basis



C. Sewerage Charge-EPF Hanoi 2010



C. Sewerage Charge-EPF Hanoi 2010

EPF Hanoi, Domestic

	Water usage level of household (m^3/month/HH)	EPF (VND/m^3)
1	First $16m^3$	347.83
2	Above $16m^3$ to $20m^3$	408.70
3	Above $20m^3$ to $35m^3$	495.65
4	Above $35m^3$	817.39

(From 119/2009/QD-UBND)

EPF: Environmental Protection Fee

C. Sewerage Charge Financial Analysis

Scenario for Analysis to be done

- Scenario Set 1: 4WWTPs (Truc Bach, Kim Lien, Bay Mau and Yen So) in service

- Scenario Set 2: 6 WWTPs (Truc Bach, Kim Lien, Bay Mau, Yen So, Yen Xa and PhuDo) in service

C. Sewerage Charge Financial Analysis

Analysis of Set A: 4 WWTPs in service

Case	(EPF at HH) per (Average HH Income)	(EPF at HH) per (O&M Cost)
1: Current rate setting	0.09%	Under analysis
2: Based on current WTP	0.30% based on Census 0.25% based on the Survey	Under analysis
3: To cover all O&M Costs	O&M costs is under-calculation	Under analysis
4: Based on ATP	will be determined subject to required budget for O&M.	Under analysis
5: 3% of average HH Income	3.00%	Under analysis

EPF: Environmental Protection Fee

C. Sewerage Charge Financial Analysis

Result of the Analysis (Set B: 6 WWTPs operate)

Case	(EPF at HH) per (Average HH Income)	(EPF at HH) per (O&M Cost)
1: Current rate setting	0.09%	Under analysis
2: Based on current WTP	0.30% based on Census 0.25% based on the Survey	Under analysis
3: To cover all O&M Costs	O&M costs is under-calculation	Under analysis
4: Based on current ATP	will be determined subject to required budget for O&M.	Under analysis
5: 3% of average HH Income	3.00%	Under analysis
6: To Cover Initial Investment Costs	Total investment is under-calculation.	Under analysis

EPF: Environmental Protection Fee

Following Works

1. Estimates of O&M costs
2. Check Legal Limits (3% of Household Income)
3. Determination of ATP per household Income
4. Estimates of Operator's running costs & overheads
5. Project cash flow
6. Check Financial Gap in Full cost recovery, Affordability, and Willingness
7. Proposal for Cross Subsidy Plan

Thank You

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

INTRODUCTION OF PPP FOR SEWERAGE FACILITIES IN HANOI

Study-A Working Group Meeting no.5
20 June 2011, Hanoi

TOR-2 Integrated OM services
TOR-3 Tariff Plan & Financial Plan

AGENDA

1. PPP law & IOMS
2. Tariff plan
3. Sewerage promotion

Previous Meeting

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Date	Agenda	Participants
Kick-off M	April 20	Purpose and Scope of Work Study schedule	DOC, HAPI, DOF, HSDC
WGM no.1	April 21	Required Data & Information for Study Selection of PPP model for Integrated O&M Implementation plan of Interview survey	DOC, HAPI, DOF, HSDC
WGM no.3	May 26	Analysis of Interview survey result Willingness to pay for Sewerage service Average Household Income	DOC, HAPI, DOF, HSDC
Interim M	June 23	Status report of TOR 1,2 & 3	DOC, HAPI, DOF, HSDC
WGM no.4	June 28	Project Cost Estimates JC Business Plan New Tariff Plan Pre FS	DOC, HAPI, DOF, HSDC

TOR-2

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-2

Integrated O&M service (IOMS) applying Public Private Partnership

IOMS, Regulator, Pilot PPP Law

TOR-2: What IOMS brings

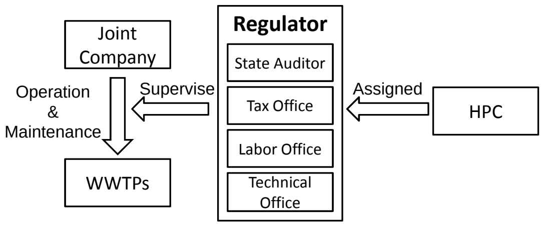
Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- **Cost Reduction**
  - ✓ Generally in Japan, 10-15% cost reduction is achieving.
  - ✓ Cost merit is significant when the duration is longer and the level is higher.
- **Prolongation of Equipment and Facility Lifetime**
  - ✓ Appropriate equipment inspection can act as a proactive measure against failure.
  - ✓ Regulate equipment running time.
- **After the contract period, what will happen? (Japan's case)**
  - ✓ Most contractors are re-contructing same job.
  - ✓ Tends to keep or raise the level.
  - ✓ Never return to Single-year, measurement base payment.

TOR-2: Regulator For IOMS

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- **Framework of Regulator**



- ✓ **Object: Supervision of O&M quality in accordance with Performance Indicators.**
- ✓ **Position: Inside or Outside of HPC?**
- ✓ **Members: State auditor, tax office, DOC, HSDC, and Independent Party, etc?**

TOR-2: Issues of PPP Pilot Law

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

<Applied or not>

●Article 2: Interpretation

✓Clause 2: Project means pilot project for infrastructure development or public provision implemented in the form of public –private partnership investment

●Article 4: Areas

✓8: Environment (waste treatment plants)
✓9: Other infrastructure development & public services

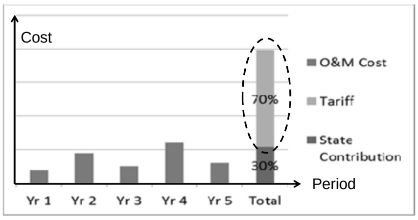
●Article 5: Criteria

✓Clause 3: A project which is capable of exploiting advantages in regards of technological and management and operation experiences, …

TOR-2: Issues of PPP Pilot Law

- **Article 9 clause 2**
  - ✓ State Contribution shall not exceed 30% of the total project investment

→ In this case, 30% of project cost (IOMS Cost) will be subsidies, but…



TOR-2: Subsequent Work

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

1. “Scope of Work” and “Contract terms” of IOMS
2. Estimates of operator’s running costs & overheads
3. Project cash flow & Sensitivity Analysis
4. Feasibility Check
5. Road map to materialize IOMS
6. Draft MOU between HPC and Partners for establishment of Joint Company

TOR-3

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-3

New Tariff Plan
Financial Plan

Estimates of O&M costs
New Tariff Plan

TOR-3:OM & Replacement Costs

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

		Inflow	O&M Cost		O&M + Replacement Cost	
	WWTP	m^3/day	mil VND/year	VND/m^3	mil VND/year	VND/m^3
1	Truc Bach WWTP	2,300	**3.672** (HSDC) 4,294 (JICA)	**4,374** (HSDC) 5,057 (JICA)	6,435 (JICA)	7,052 (JICA)
2	Kim Lien WWTP	3,700	**4,798** (HSDC) 5,465 (JICA)	**3,552** (HSDC) 4,047 (JICA)	8,047 (JICA)	5,959 (JICA)
3	Bay Mau WWTP	14,000	18,485 (JICA)	3,617 (JICA)	28,372 (JICA)	5,552 (JICA)
4	Yen So WWTP	200,000	140,674 (JICA)	1,927 (JICA)	219,771 (JICA)	3,011 (JICA)
5	Yen Xa WWTP	270,000	167,634 (JICA)	1,701 (JICA)	246,731 (JICA)	2,504 (JICA)
6	Phu Do WWTP	84,000	70,789 (JICA)	2,309 (JICA)	90,563 (JICA)	2,954 (JICA)
7	North Thang Long	6,000 ??	**7,231** (HSDC) 9,800 (JICA)	**3,301** (HSDC) 5,962 (JICA)	35,676 (JICA)	2,327 (JICA)

Note: North Thang Long Data is only reference because Inflow rate is not confirmed.

TOR-3: Assumptions of Analysis

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

<u>Assumptions for Financial Analysis</u>

•This analysis focuses on central area of Hanoi, without North Thang Long WWTP.

•Commercial Operation Schedule

-2011: Truc Bach, Kim Lien

2012-2013: Truc Bach, Kim Lien, Yen So

2014-2016: Truc Bach, Kim Lien, Yen So, Bay Mau

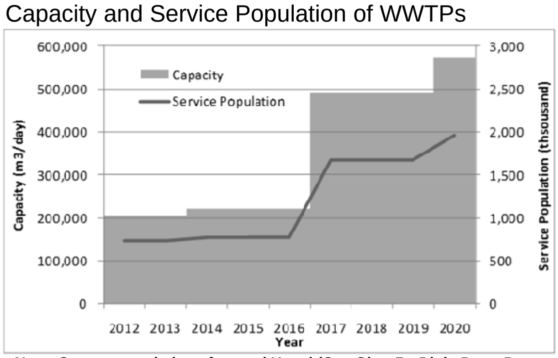
2017-2019: Truc Bach, Kim Lien, Yen So, Bay Mau, Yen Xa

2020- : Truc Bach, Kim Lien, Yen So, Bay Mau, Yen Xa, Phu Do

TOR-3: WWTP Operation

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Capacity and Service Population of WWTPs



Note: Current population of central Hanoi (Cau Giay, Ba Dinh, Dong Da, Hoan Kiem, Hai Ba Trung , Thanh Xuan, Hoan Mai) is 1,842 thousand.

TOR-3: Assumptions of Analysis

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

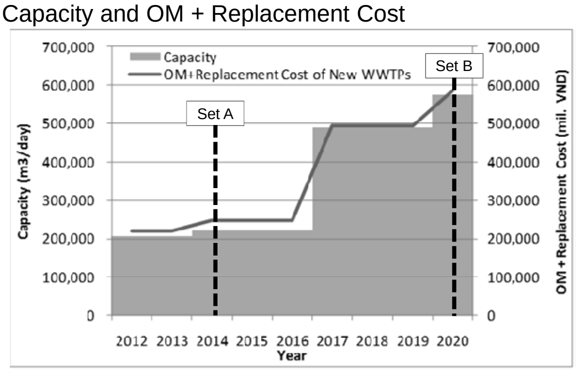
Concept of Income for WWTP Operation

- Existing 2 WWTPs are operated by local budget.
- New WWTPs are operated by sewerage tariff. Sewerage tariff is collected in service areas.
- Both sewerage tariff is collected from domestic and non-domestic.
- It is assumed that 58% of total tariff income is collected from domestic. Remaining 42% is collected from non-domestic.

TOR-3:WWTP Operation

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Capacity and OM + Replacement Cost



TOR-3:Cost Analysis

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

OM + Replacement Cost of New WWTPs

Operating New WWTPs	Year	OM + Replacement Cost per Capacity (VND/m³/day)	OM + Replacement Cost per Service Population (VND/person)
Yen So	2012-2013	1,065,812	299,458
Yen So, Bay Mau	2014-2016	1,126,896	320,145
Yen So, Bay Mau, Yen Xa	2017-2019	1,009,534	295,430
Yen So, Bay Mau, Yen Xa, Phu Do	2020-	1,019,569	299,442

TOR-3:Results of Analysis

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Set-A: 5 WWTPs in service

(Kim Lien, Truc Bach, North Thang Long, Bay Mau, Yen So)

	Sewerage tariff and EPF per Household Income	Revenue per O&M + Replacement Costs
Case 1 (Current, EPF)	0.085% (6,461 VND/HH/m)	0%
Case2 (Willingness to Pay)	0.278% (21,212 VND/HH/m)	24%
Case3 (Full recovery of O&M costs)	0.880% (67,246 VND/HH/m)	100%
Case4 (Legal Max)	3.000% (229,233 VND/HH/m)	366%

Note: All collected EPF from households is taken into consideration in this analysis.

TOR-3:Results of Analysis

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Set-B: 7 WWTPs in service

(Kim Lien, Truc Bach, , North Thang Long Bay Mau, Yen So, Yen Xa, Phu Do)

	Sewerage tariff and EPF per Household Income	Revenue per O&M + Replacement Costs
Case 1 (Current, EPF)	0.085% (6,461 VND/HH/m)	0%
Case2 (Willingness to Pay)	0.278% (21,212 VND/HH/m)	28%
Case3 (Full recovery of O&M costs)	0.829% (63,315 VND/HH/m)	100%
Case4 (Legal Max)	3.000% (229,233 VND/HH/m)	392%
Case5 (Full recovery of WWTP Investment)	1.261% (96,369 VND/HH/m)	158%

TOR-3: Tariff Scenario

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- Example: Set A, Case 3 (Full recovery of O&M costs)

Sum of Sewerage tariff and EPF per Household Income: 0.880%

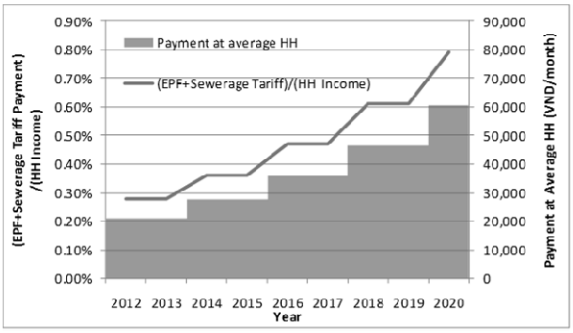
[For Domestic]

Supplied Water Use	Water Tariff	Sewerage Tariff
-16m³	4,000 VND/m³	3,273 VND/m³
16-20m³	4,700 VND/m³	3,845 VND/m³
20-35m³	5,700 VND/m³	4,663 VND/m³
35m³-	9,400 VND/m³	7,690 VND/m³

TOR-3:Example of Tariff Plan

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

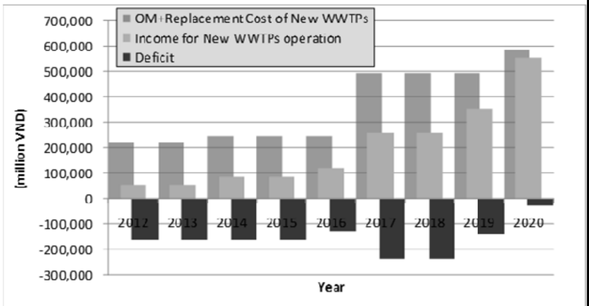
(Sample) Sewerage tariff increases to WTP level in 2012. Then, increases 30% every 2 years.



TOR-3:Example of Tariff Plan

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Income and Cost of New WWTP Operation



Total Deficit: 1,417,639 million VND

Subsequent Works

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

1. Determination of Affordable Tariff per Household Income
2. Operation Cash Flow
3. Check Financial Gap in Full Cost Recovery, Affordability, and Willingness
4. Proposal for Cross Subsidy Plan

Strategy of Public Awareness Development for Sewerage

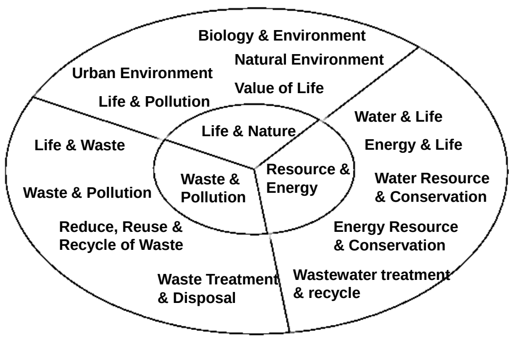
OC
ORIX
HELS/PADECO
Yokohama Water

Strategy

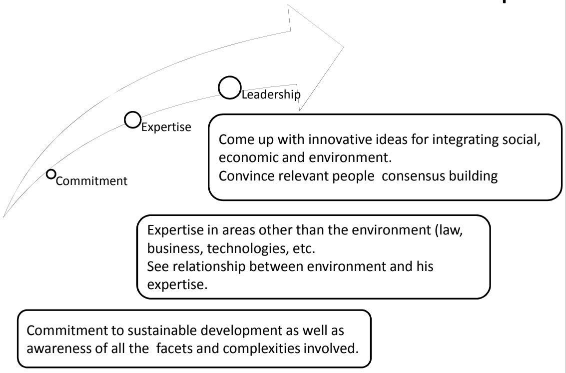
Sewerage service is a silent force behind the scene of living. Hence the people are not aware of value of sewerage.
Lack of awareness makes introduction of sewerage tariff and PPP promotion been slow down. To avoid it, Strategies of public awareness development are;

A)Environmental education to School children for teaching importance of sewerage as a part of discipline.
B)Sewerage service promotion through the media such as TV, radio and internet.
C)HPC's Public consensus meeting to make residents' understanding of sewerage tariff.
D)Sewerage customer service counter is established in HPC website for inquiry and complain.

Environmental Education Program



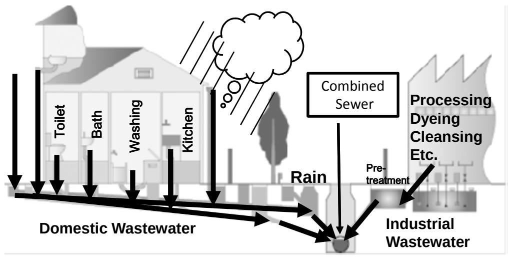
Environmental Protection Leadership



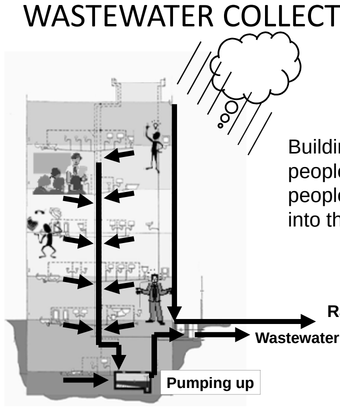
Awareness of Sewerage

WASTEWATER COLLECTION

Rain is flowing into sewers. Water discharged from kitchen, toilet, washing and bath is combined with rain water in the sewer. Industrial water also come into sewer after pretreatment. This system is called the <u>Combined Sewer System</u>.



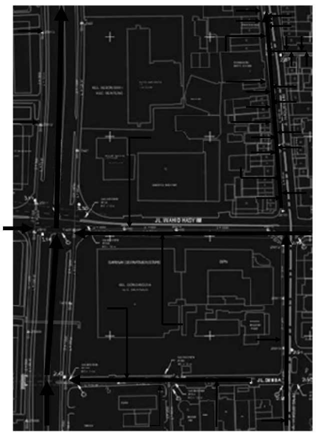
WASTEWATER COLLECTION

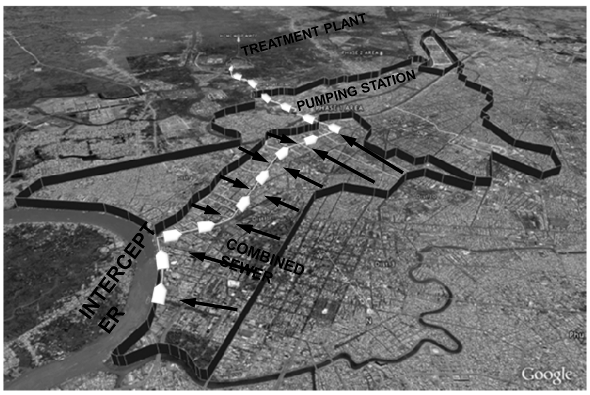


Building contains a lot of people. Water used in people's activity is flowing into the sewer.

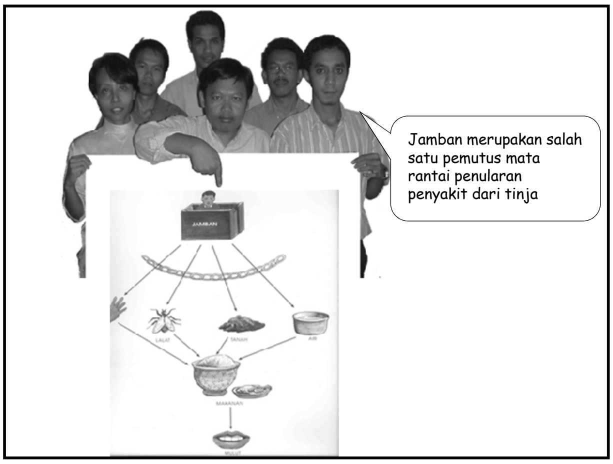
WASTEWATER TRANSFER SEQUENCE

- House connection sewers
- Service sewers (COMBINED SEWER)
- Main sewers (INTERCEPTER)





Environmental education - Promotion Video for Kids



Pengelolaan lingkungan adalah tanggung jawab masyarakat dan pemerintah. Salah satu bentuk bantuan pemerintah berupa rehabilitasi MCK yang telah rusak.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

INTRODUCTION OF PPP FOR SEWERAGE FACILITIES IN HANOI

Study-A Interim Meeting, 23 June 2011

AGENDA

1. **Status report-TOR1** OJT with improvement of O&M manual
2. **Status report-TOR2** IOMS cases in Japan & Thai
   Implementation framework for Integrated OM Service
3. **Status report-TOR3** Sewerage Tariff plan and sewerage O&M costs

Previous Meeting

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Date	Agenda	Participants
Kick-off M	April 20	Purpose and Scope of Work Study schedule	DOC, HAPI, DOF, HSDC
WGM no.1	April 21	Required Data & Information for Study Selection of PPP model for Integrated O&M Implementation plan of Interview survey	DOC, HAPI, DOF, HSDC
WGM no.2	May 26	Analysis of Interview survey result Willingness to pay for Sewerage service Average Household Income	DOC, HAPI, DOF, HSDC
Interim M	June 23	Status report of TOR 1,2 & 3	DOC, HAPI, DOF, HSDC
WGM no.3	June 28	Project Cost Estimates JC Business Plan New Tariff Plan Pre FS	DOC, HAPI, DOF, HSDC

Proposal in the Study

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Single Year Cost+ base O&M contract

to be converted to

Multi-year Performance base O&M contract

Why?

Because expecting the **Saving Project Life-cycle costs**

A) Conventional O&M ordering system is the Cost plus contract in which the contractor is paid his cost plus a stated percentage of profit for achieving fixed scope of work.

B) IOMS is the Performance-based ordering system in which the contractor is paid his cost and create his profit in achieving performance benchmarks.

Key Factor & TOR

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

❶ **TOR-1: Selection of capable contractor with**
- experiential problem solving capacity
- holistic view of the asset management process with prolongation of equipment lifespan.

❷ **TOR-2: Terms of reference clarifying**
- performance indicator & project delivery method
- liabilities of government & contractor

❸ **TOR-3 : Political support for**
- financially viable revenue stream
- fair allocation of profits and losses

TOR-1

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-1

Betterment of O&M in 3 WWTPs

OJT with upgrading O&M manual

5

TOR-1:Purpose & Goal

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Purpose

- Upgrading O&M manual with HSDC
- Upgrading O&M data management system with HSDC

Goal

- Upgrading HSDC's O&M skills

6

TOR-1: Work done

- JICA team provided supplemental O&M manual that HSDC have checked.
- Exchange of opinions between HSDC and JICA team about up-gradation of O&M manual and O&M data management system
- Exchange of opinions between HSDC and JICA team about treatment process testing

TOR-1: Findings

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Current status

- HSDC is using the O&M manuals authorized by HPC at taking-over the WWTP.
- HSDC is recording O&M data by simple data management system.

Alternative treatment process was scheduled in 3 WWTPs however cancelled due to technical issues.

TOR-1: Common understanding

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

O&M manual

O&M manual will be supplement for existing one.

O&M data management system

HSDC is using equipment resister.

O&M data management system is proposed to make up…
- Historical failure record
- Repair / restore record
- Water quality analysis record

TOR-1: Common understanding

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

HSDC's expectation

HSDC asks JICA team to add more information in O&M manual.

- Further control parameters
- Contingency plan for unexpected case
- Definitions of technical term

TOR-1: Actions in July

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- JICA team reviews existing O&M manual and data recording sheet.
- JICA team feeds back into the upgraded O&M manual and O&M data management system
- JICA team provides more information for O&M in the upgraded O&M manual
- HSDC checks particular water quality items for stabilization of effluent quality

TOR-1:Actions in August

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

To upgrade the O&M manual and O&M data management system

Existing O&M manual

Existing O&M data management system

\+

Supplemental O&M manual and O&M data management system

JICA team asks HSDC will upgrade supplemental O&M manual and O&M data management system continuously

TOR-2

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-2

Integrated O&M service (IOMS) applying Public Private Partnership

IOMS cases in Japan & Thai
Proposed IOMS framework

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Contract Level	Period	Cost components
Conventional	Single year	Process cost (measurement base)
IOMS level-1	Short term multi year	Process + utility cost (Lump sum)
IOMS level-2		Process + utility cost (Lump sum) + Small replacement
IOMS level-3		Process + utility cost (Lump sum) + Medium replacement
IOMS full scale	Long term multi year	Process + utility cost (Lump sum) + Large replacement

Number of IOMS project in 2011	
Level-1	29 projects
Level-2	201 projects
Level-3	21 projects
Total	251 projects

Statistic, Contract Period (as of 2011)	
1 year	32 projects
3 years	182 projects
4 years	14 projects
5 years	14 projects
Over 5 years	1 project
Total	243 projects

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service **Hanamigawa WWTP no.2**, Chiba, Japan, **3-year contract**

Project started in **2007**

Plant feature	Capacity 576,000m3/day Conventional activated sludge treatment Sludge incinerator 150 ton/day Treated Sewage Effluent (TSE) Tertiary Treatment Photovoltaic power generation (1828 KWh)
Scope of work	1) O&M of sewage treatment, sludge treatment, TSE transmission 2) Environmental monitoring & protection 3) Ancillary facility maintenance 4) Replacement of equipment (less than JPY 2,500,000 per item) 5) Procurement of consumables

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service, **Hanamigawa WWTP no.2**, Chiba, Japan

Employer's Requirements, **Performance Indicator (PI)**				
	Item	Unit	Legal limits	Contract target
Effluent Standard	pH		5.8~8.6	5.8~8.6
	Transparency	cm	-	>80
	BOD	mg/L	15	3
	COD	mg/L	-	12
	SS	mg/L	40	3
	T-N	mg/L	30	13
	T-P	mg/L	4.0	1.5
	F.Coli	MPU/mL	<3000	<500
incinerator Emission	NOx	ppm	250	20
	SOx	ppm	-	20
Odor	H2S	ppm	-	1.0
Energy saving	Year-on-year decrease 1%			

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service, **Hanamigawa WWTP no.2**, Chiba, Japan

3-year operation outcome (2007-2009)

i.Total O&M costs decreased 14% .
ii.Electricity consumption had been saved 7%.
iii.Equipment malfunction and system failure decreased 12% (52 to 46 per year)

Costs Comparison before & after project in 3 years, unit million JPY

Item	3-year costs before project	3-year costs during project	Improvements
Remuneration	231	138	▼93 or -14%
Direct costs incl. Utilities	3,548	2,886	▼662 or -19%
Small replacement (<JPY250K)	72	52	▼20 or -28%
Large replacement (>JPY250K)	954	1,049	△95 or +10%
Others	114	118	△4 or +4%
total	4,919	4,243	▼676 or -14%

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service **Amagasaki East WWTP**, Hyogo, Japan **5-year contract**

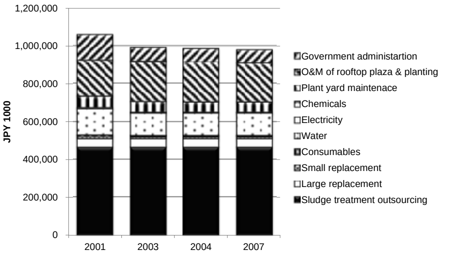
Project started in **2003**

Plant feature	Capacity 134,000m3/day for sewage Conventional activated sludge treatment Relay Pumping S-1 139m3/min(S) + 1971m3/min(R) Relay Pumping S-2 1745m3/min(R) Sludge transmission pumping station
Scope of work	(1) O&M of Sewage treatment (2) Environmental monitoring (3) O&M of relay pumping stations (4) Inspection and maintenance of plant utilities (5) Procurement of consumables and utilities (6) Equipment replacement (> JPY 1M) (7) O&M of rooftop plaza, planting zone

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service, **Amagasaki East WWTP**, Hyogo, Japan



Costs Comparison before & after project, unit million JPY

	2001	2003	2004	2007
Sludge treatment outsourcing	465.6	465.6	465.6	465.6
Large replacement	42.1	42.1	42.1	42.1
Government administration	132.4	70.1	70.1	70.1
IOMS fee	417.8	411.9	406.5	400.4
Total	**1,057.9**	**989.7**	**984.2**	**978.1**
Improvement	**100%**	**94%**	**93%**	**92%**

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Item	Shiwa (Iwate)	Hamakurosaki (Toyama)	Arakawa (Saitama)	Nagata (Shizuoka)	Takehara (Hiroshima)	Matsuyama (Ehime)
Period	3 year	3 year	3 year	3 year	3 year	3 year
Type	Combined	Separated	Separated	Separated	Separated	Combined
Contract level	2	2	2	2	1	2
Replacement Max	USD 10,000	Not available	USD 5,000	USD 5,000	0	USD 5,000
Process	C.A.S	C.A.S	O.D	C.A.S	S.A.S	C.A.S
Design capacity (m3/d)	9,200	178,500	38,700	17,000	Not available	151,000
PI - BOD	13 mg/L	5.6 mg/L	Not available	Not available	5 mg/L	4.3 mg/L
COD		8.9 mg/L	Not available	Not available	10 mg/L	7.2 mg/L
SS	20 mg/L	5.3 mg/L	Not available	Not available	5 mg/L	2 mg/L
T-N	None	None	Not available	Not available	10 mg/L	13 mg/L
T-P	None	None	Not available	Not available	1 mg/L	0.48 mg/L
Coliform G	80 MPU/mL	7 MPU/mL	Not available	Not available	Nil	Nil

TOR-2: Thailand IOMS case

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service
Nong Khaem WWTP ,
Bangkok, Thailand
5-year contract

Project started in **2003**

Plant feature	Capacity 157,000m3/day in Nong Khaem WWTP Vertical loop reactor activated sludge Sludge transmission pumping station
Scope of work	(1) O&M of Sewage treatment (2) O&M of Sludge treatment (dehydrate) (3) Environmental monitoring (4) Inspection and maintenance of plant utilities (5) Procurement of consumables and utilities
P.I	SS, BOD, COD, T-N, T-P, Coliform group, F.Coli & E.Coli
Payment	Payment = K_{fix} + Kq(Q) + KB + Ksludge where, fix = fixed rate, Q = inflow rate , B = storm water bypass flow and Sludge = sludge volume

TOR-2: Integrated OM Service

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Circular 09/2009/TT-BXD ANNEX1	Hanoi Model (This Study)	Compliance
Duration	5 to 10 years	3-5 Years?	To be Discussed
Scope	Drainage Sewerage Disposal of Sludge Asset Management, etc	Yen So STP Bay Mau STP (Other STPs) (Other PSs)	Complied
Contract Type	Lump-Sum, or Unit price	Lump-Sum	Complied
Repair & Replacement cost	Partly included	Japanese Level 2 is recommended	Under Consideration
Regulating Body	Drainage/Sewerage system owner	Not Appointed	To be Discussed

TOR-2: Regulation to be Applied

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- **Decision 71/2010/QD-TTg: Pilot PPP Law is not applied in this case**

✓ Article 1. This regulation provisionally provides the conditions, procedures, and principles applied for investment projects for infrastructure development … under the PPP model.

→ **Article 1 is not applied for the IOMS because the work dose not include a infrastructure development.**

✓ Article 4: Areas of pilot investment under PPP

Road, Bridges, Railway, Airport, Seaports, Power Plant, Fresh Water Supply System, Waste Treatment Plant, etc.

→**Wastewater is not included.**

TOR-2: Regulation to be Applied

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- **Regulations to be applied are as below**

▪59/2005/QH11: Law on Investment

▪60/2005/QH11: Law on Enterprises

and other related decrees and circulars

- **Joint Company's Proportion of Capital Contribution**

Vietnam: Japan = 50:50 (To be considered)

Vietnam: HPC

Japan: ORIX, and other skilled companies

TOR-2: JC's Legal Framework

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- **According to Law on Enterprise, possible legal framework**

	Shareholding Company	Single member Limited Liability Company	Limited Liability Company with 2 or more Members
Investor's Responsibility	Limited	Limited	Limited
Power of Operation	Board Meeting	Company Owner	Members (Capital Contributor)
Decision Making	Shareholder Meeting	Board meeting	Board Meeting
Number of Membership	At least 1	At least 1	2 or more

- **Generally in Vietnam, limited liability company with 2 or more members is preferred.**

TOR-2: Business Menu of JC

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

▪ **Business Menu**

A) O&M:
- ✓ Utilization of HSDC's Engineers and Staff at a maximum

B) Training:
- ✓ Capacity building course for operators in Hanoi and other neighboring cities
- ✓ Establishment of Training facilities by ODA fund (Possibility)

C) Planning & Engineering:
- ✓ Sending Japanese skilled engineers by ODA Technical Assistance

TOR-2: Subsequent Work

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

1. "Scope of Work" and "Contract terms" of IOMS
2. Estimates of operator's running costs & overheads
3. Project cash flow & Sensitivity Analysis
4. Feasibility Check
5. Road map to materialize IOMS
6. Draft MOU between HPC and Partners for establishment of Joint Company

TOR-3

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

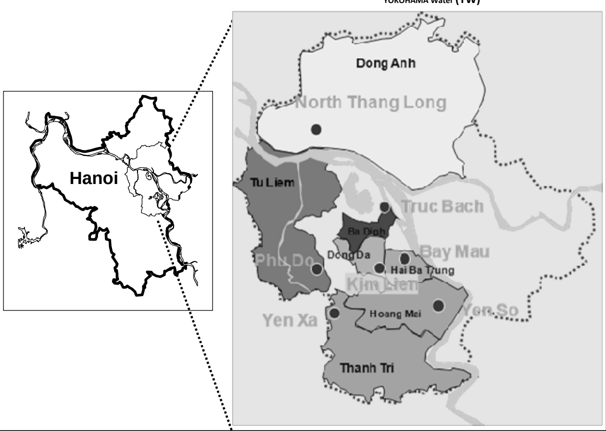
TOR-3

New Tariff Plan
Financial Plan

Estimates of O&M costs
New Tariff Plan

TOR-3: Survey Area

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-3:HH Survey-Outline

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

PURPOSE OF THE HOUSEHOLD SURVEY

- To grasp the citizen's awareness of sewerage services
- To get the citizen's willingness to pay for the sewerage services

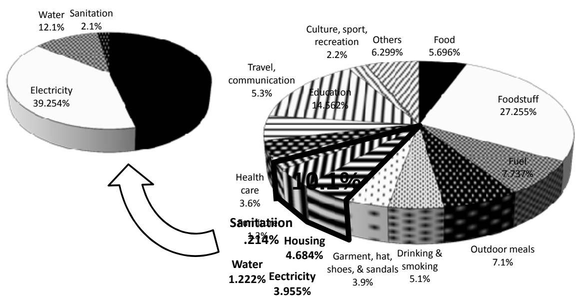
Outlines of Survey	
Surveyed Area 7 Districts in Hanoi	Ba Dinh, Dong Da, Hai BaTrung, Hoang Mai, Thanh Tri, Tu Liem, Dong Anh
Sampled Number	105 Household (15HH from each district)
Method	Interview by trained surveyors
Duration of Survey	6th to 9th May 2011

Income	**8,560,962 VND /month per HH in average**
Expenditure	7,024,368VND/month per HH in average (82.1% of Income)

TOR-3:HH Survey-Current Fee

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

HH Expenditure for Housing, Electricity, Water, and Sanitation
Average Expenditure for Sanitation: 8,600 VND/month

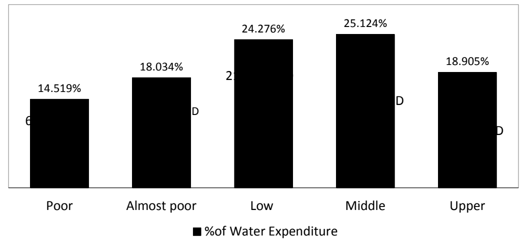


TOR-3:HH Survey-WTP

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Willingness to Pay for Sewerage Tariff by Income Level

Upper	(11%) :	> VND 4M person/mon	VND 11.9M in Ave.
Middle	(34%) :	VND 2M-4M person/mon	VND 9.3M in Ave.
Low	(40%) :	VND 1M-2M person/mon	VND 6.2M in Ave.
Almost Poor	(10%) :	VND 0.75M-1M person/mon	VND 4.1M in Ave.
Poor	(5%) :	VND 0.55M-0.75M person/mon	VND 2.8M in Ave.



TOR-3:HH Survey-WTP

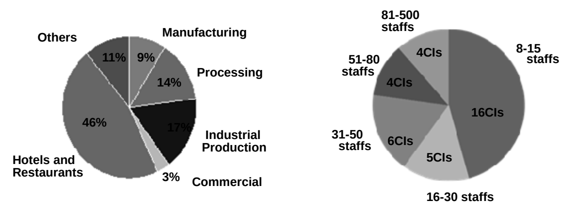
Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

1. Average monthly household income in survey area is VND 8,561,000 / month.
2. Average monthly household income of whole Hanoi (estimated based on GSO) is VND 7,641,100 / month (89.3 % of the survey).
3. Willingness to Pay (WTP) in survey area is VND 21,210/month.
4. WTP / Income is 0.25%.
5. Average Water Charge is VND 85,000/month.
6. (WTP : Ave. Water Charge) is (1 : 4).

TOR-3:CI Survey-Outline

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

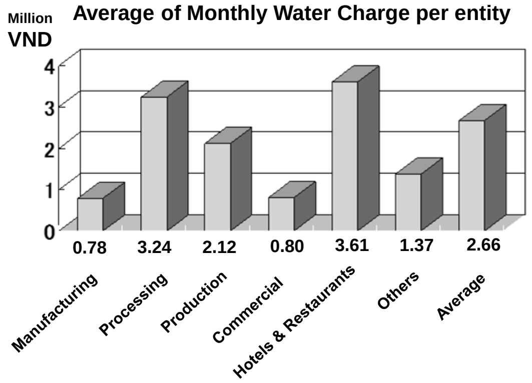
Survey Area	7 Districts including Ba Dinh, Dong Da, Hai Ba Trung, Hoang Mai, Thanh Tri, TuLiem, Dong Anh
Interviewed CIs	35 CI, Every 5 CIs per district
Sampling	Interviewed ICs selected by District People's Committees
Duration	from May 5th to May 13th 2011



TOR-3:CI Survey-Water Charge

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Average of Monthly Water Charge per entity



TOR-3:CI Survey Result

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Willingness to pay

CI's Willingness-to-Pay (WTP) is 0.13% per month sales that is equivalent to monthly **VND 2.8 million per entity**.

Recommendations

a. Awareness of the sewerage benefit is low in interviewed CI, hence further promotion is required.

b. It shall be noted that WTP of CI per entity (VND 2.8M) is 132 times of WTP per HH (VND 21K). CI customer shall be reserved for Cross-Subsidy Financial Source.

TOR-3:OM & Replacement Costs

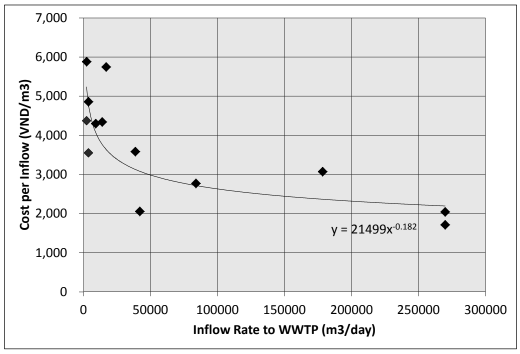
Oriental Consultants **(OC)**, ORIX Corporation **(ORIX)**, Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

		Inflow	O&M Cost		O&M + Replacement Cost	
	WWTP	m^3/day	mil VND/year	VND/m^3	mil VND/year	VND/m^3
1	Truc Bach WWTP	2,300	**3.672** (HSDC) 4,294 (JICA)	**4,374** (HSDC) 5,057 (JICA)	6,435 (JICA)	7,052 (JICA)
2	Kim Lien WWTP	3,700	**4,798** (HSDC) 5,465 (JICA)	**3,552** (HSDC) 4,047 (JICA)	8,047 (JICA)	5,959 (JICA)
3	Bay Mau WWTP	14,000	18,485 (JICA)	3,617 (JICA)	28,372 (JICA)	5,552 (JICA)
4	Yen So WWTP	200,000	140,674 (JICA)	1,927 (JICA)	219,771 (JICA)	3,011 (JICA)
5	Yen Xa WWTP	270,000	167,634 (JICA)	1,701 (JICA)	246,731 (JICA)	2,504 (JICA)
6	Phu Do WWTP	84,000	70,789 (JICA)	2,309 (JICA)	90,563 (JICA)	2,954 (JICA)
7	North Thang Long	6,000 ??	**7,231** (HSDC) 9,800 (JICA)	**3,301** (HSDC) 5,962 (JICA)	35,676 (JICA)	2,327 (JICA)

Note: North Thang Long Data is only reference because Inflow rate is not confirmed.

TOR-3:OM & Replacement Costs

Oriental Consultants **(OC)**, ORIX Corporation **(ORIX)**, Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

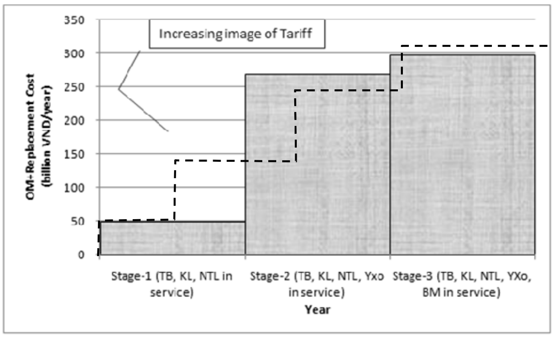


Note: This graphic is based on JICA team's O&M cost estimates.

TOR-3:OM & Replacement Costs

Oriental Consultants **(OC)**, ORIX Corporation **(ORIX)**, Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

Image of Income and Cost of Sewerage Operation



TOR-3:OM and Replacement Costs

Oriental Consultants **(OC)**, ORIX Corporation **(ORIX)**, Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

Set-A: 5 WWTPs in service

(Kim Lien, Truc Bach, North Thang Long, Bay Mau, Yen So)

	Sewerage tariff and EPF per Household Income	Revenue per O&M + Replacement Costs
Case 1 (Current, EPF)	0.080% (6,143 VND/HH/m)	0%
Case2 (Willingness to Pay)	0.278% (21,347 VND/HH/m)	26%
Case3 (Full recovery of O&M costs)	0.857% (65,807 VND/HH/m)	100%
Case4 (Legal Max)	3.000% (230,363 VND/HH/m)	381%

Note: All collected EPF from households is taken into consideration in this analysis.

TOR-3:OM and Replacement Costs

Oriental Consultants **(OC)**, ORIX Corporation **(ORIX)**, Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

Set-B: 7 WWTPs in service

(Kim Lien, Truc Bach, , North Thang Long Bay Mau, Yen So, Yen Xa, Phu Do)

	Sewerage tariff and EPF per Household Income	Revenue per O&M + Replacement Costs
Case 1 (Current, per EPF)	0.080% (6,143 VND/HH/m)	0%
Case2 (Willingness to Pay)	0.278% (21,347 VND/HH/m)	26%
Case3 (Full recovery of O&M costs)	0.847% (65,039 VND/HH/m)	100%
Case4 (Legal Max)	3.000% (230,363 VND/HH/m)	385%
Case5 (Full recovery of WWTP Investment)	1.284% (98,595 VND/HH/m)	158%

Subsequent Works

Oriental Consultants **(OC)**, ORIX Corporation **(ORIX)**, Nihon HELS Industry **(HELS)**, **PADECO**, YOKOHAMA Water **(YW)**

1. Determination of Affordable Tariff per Household Income
2. Operation Cash Flow
3. Check Financial Gap in Full Cost Recovery, Affordability, and Willingness
4. Proposal for Cross Subsidy Plan

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Thank You For Attention

JICA Study Team - A

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

INTRODUCTION OF PPP FOR SEWERAGE FACILITIES IN HANOI

Study-A Working Group Meeting #4
12 August 2011

AGENDA	
TOR-3 Tariff & Financial Plan	1. Determination of Affordable Tariff per Household Income 2. Operation Cash Flow 3. Check Financial Gap in Full Cost Recovery 4. Proposal for Cross Subsidy Plan
TOR-2 IOMS	1. IOMS "Contract terms" and "Scope of work" 2. Running costs & overheads 3. Sensitivity factors for project cash flow 4. Pay item for feasibility check 5. Road map to materialize IOMS 6. Draft MOU for establishment of Joint Company

Previous Meeting

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Date	Agenda	Participants
Kick-off M	April 20	Purpose and Scope of Work Study schedule	DOC, HAPI, DOF, HSDC
WGM no.1	April 21	Required Data & Information for Study Selection of PPP model for Integrated O&M Implementation plan of Interview survey	DOC, HAPI, DOF, HSDC
WGM no.2	May 26	Analysis of Interview survey result Willingness to pay for Sewerage service Average Household Income	DOC, HAPI, DOF, HSDC
Interim M	June 23	Status report of TOR 1,2 & 3	DOC, HAPI, DOF, HSDC
WGM no.3	June 28	Project Cost Estimates New Tariff Plan	DOC, HAPI, DOF, HSDC
WGM no.4	August 12	IOMS Road Map Tariff Case Study & Cash Flow Simulation	DOC, HAPI, DOF, HSDC
Wrap-up Meeting	August 30	Study Results Conclusion	DOC, HAPI, DOF, HSDC

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-3

New Tariff Plan
Financial Plan

Determination of Affordable Tariff per Household Income
Operation Cash Flow
Check Financial Gap in Full Cost Recovery
Proposal for Cross Subsidy Plan

TOR-3: OM + Replacement Cost

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

O&M Cost

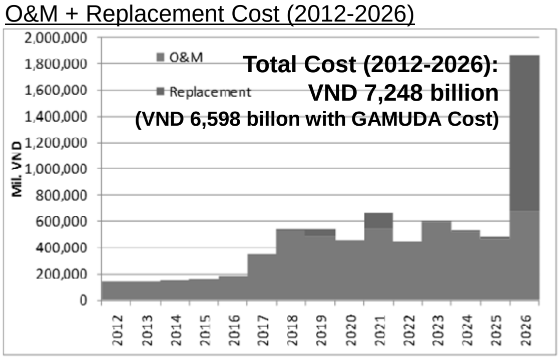
	Total Capacity (m^3/day)	Annual O&M Cost (mil. VND/year)	O&M Cost per Capacity (VND/m^3)
Existing 3WWTPs	48,200	17,544	997
Existing 3WWTPs +Yen So	248,200	190,891 (147,544 based on existing 3 WWTPs and GAMUDA)	2,107 (1,629)
Existing 3WWTPs +Yen So, Yen Xa, Bay Mau	532,200	445,739 (402,392 based on existing 3 WWTPs and GAMUDA)	2,295 (2,071)

Note: without replacement costs

TOR-3: OM + Replacement Cost

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

O&M + Replacement Cost (2012-2026)



↑Yen So Starts ↑Yen Xa and Bay Mau Starts
↑Phu Do Starts

TOR-3:Tariff Level Analysis

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

4 WWTPs in service

(Kim Lien, Truc Bach, North Thang Long, Yen So)

	Sewerage Tariff plus EPF per Household Income	Financial Gap (mil. VND/year)
A : Current, EPF	0.08% (VND 6,461/HH/m)	A-C= -173, 347 A-D= -252, 444
B: Acceptable Tariff based on Willingness to Pay	0.28% (VND 21,212/HH/m)	B-C= -117,842 B-D= -196,983
C: Tariff for Full O&M Cost Recovery	0.69% (VND 52,532/HH/m)	C-D= -79,091
D: Tariff for Full O&M and Replacement Cost Recovery	0.96% (VND 73,551/HH/m)	

Note: Include collection fee

TOR-3:Tariff Level Analysis

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

7 WWTPs in service

(Kim Lien, Truc Bach, North Thang Long, Bay Mau, Yen So, Yen Xa, Phu Do)

	Sewerage tariff plus EPF per Household Income	Financial Gap (mil. VND/year)
A : Current, EPF	0.08% (VND 6,461/HH/m)	A-C= -512,273 A-D= -702,222
B: Acceptable Tariff based on Willingness to Pay	0.28% (VND 21,212/HH/m)	B-C= -369,454 B-D= -559,403
C: Tariff for Full O&M Cost Recovery	0.78% (VND 59,372/HH/m)	C-D= -189,951
D: Tariff for Full O&M and Replacement Cost Recovery	1.03% (VND 78,991/HH/m)	

Note: Include collection fee

TOR-3: Tariff Issue

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Yen So WWTP Operation Case

- O&M + Replacement Cost: VND 252 bil.
- Income from tariff at Willingness to Pay Level: VND 56 bil.
- It is political issue whether sewerage tariff starts at full cost recovery level or at willingness to pay level.

7 WWTPs Operation Case

- O&M + Replacement Cost: VND 702 bil.
- Income from tariff at Willingness to Pay Level: VND 143 bil.

TOR-3: Cash Flow Analysis

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Case Study for Sewage Tariff Introduction in Hanoi

Premise

a.Tariff collection will be started in 2014

b.Tariff will be started at Willingness to Pay level.

c.Tariff will catch up the full cost recovery level within 10 years

Parameter

✓Duration of Tariff Raising-up

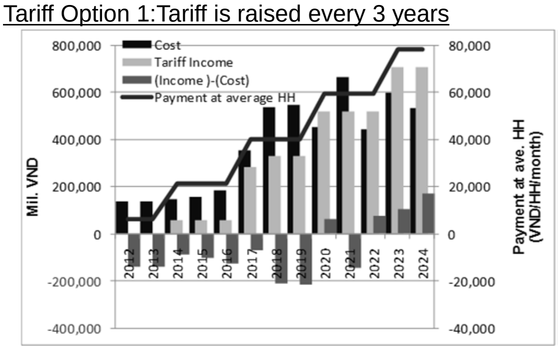
Tariff Option 1: every 3 years

Tariff Option 2: every 5 years

TOR-3: Cash Flow Analysis

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Tariff Option 1:Tariff is raised every 3 years

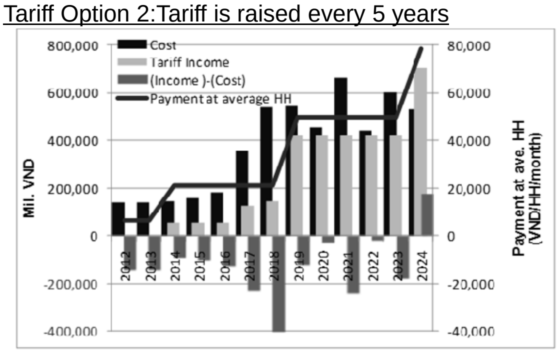


Total Amount (13 years, 2012-2024): -822 billion VND

TOR-3: Cash Flow Analysis

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Tariff Option 2:Tariff is raised every 5 years



Total Amount (13 years, 2012-2024): -1,637 billion VND

TOR-3: Weighting of Tariff Category

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Unit Rate of Water Supply in Hanoi as of 2010

Category	Weighting
Domestic	1.00
Manufactures	1.71
Administrative offices, and Implementation organization	1.40
Service business purposes	2.94
Public purposes	1.15

Water Supply Tariff Income Share in Hanoi as of 2010

Category	Share
Domestic	60%
Manufactures	6%
Administrative offices, and Implementation organization	10%
Service business purposes	24%

TOR-3: Conclusion

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

1. Hanoi needs the sewerage tariff to cover increasing O&M cost of sewerage facilities due to construction of new WWTPs.
2. As the result of willingness to pay survey does not meet O&M cost, it is required to make up the budgetary shortage somehow. (i.e. governmental subsidy)
3. In order to accommodate the operation of Yen So WWTP, preparation of tariff introduction should be conducted in 2012 and 2013.

TOR-3: Conclusion

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

4. Considering current social opinion, it is recommended that the tariff starts from willingness to pay level, and then catches up full O&M cost recovery level within 10 years.
5. Government shall support the O&M cost for Yen So WWTP with amount of VND 120 bil. per year in the early stage.
6. Large scale equipment replacement (relating to equipment life time) shall be discussed.
7. Weak point of this scenario is that the tariff level is not enough for Yen Xa operation when it will start.

TOR-2

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-2 Integrated Operation & Maintenance Service (IOMS)

1. IOMS "Contract terms" and "Scope of work"
2. Running costs & overheads
3. Sensitivity factors for project cash flow
4. Pay item for feasibility check
5. Road map to materialize IOMS
6. Draft MOU for establishment of Joint Company

TOR-2: Objective of IOMS

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Please remember the reasons why we suggest IOMS (multi-year performance-base contract) those are;

1.To reduce the life cycle O&M costs, and

2.To level up the O&M skills taking certain level of the risks.

TOR-2: IOMS Contract Terms

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Key Clause	Description
Project Owner & Contractor	Owner: HPC Contractor: Joint Company
Contractor's Obligation	The Contractor shall provide the IOMS stipulated by the IOMS contract. (refer to the next slide)
Payment	• The owner shall confirm a conformity of the contractor's performance in collation with the performance indicators. • Unconformable work of the contractor will cause the reduction of the payment to the contractor.
Contractor's possession of site and duty to reserve function	• The owner shall grant the right to use the sewerage facility to the contractor for the purpose of contractor's obligation. • The contractor shall reserve the function of facility and compensate the damage or losses caused by the contractor.

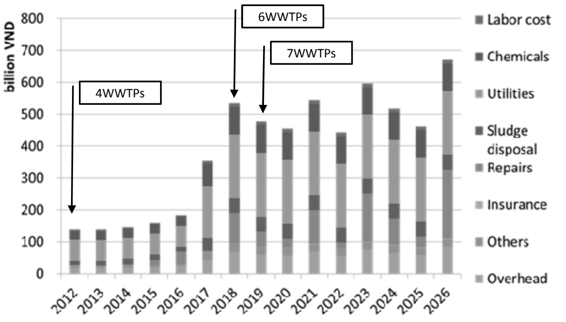
TOR-2: IOMS Scope of Work

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

General	a. Staff management and Material Control for O&M b. Reporting of results of O&M work to the regulator c. Customer technical service
Technical	a. O&M in wastewater treatment and sludge treatment/disposal in compliance with Performance Indicator (PI) b. Repair work of facilities c. Small scale replacement of equipment (refer to Japanese case) d. Technical transfer through O&M PDCA cycle
Option	a. Promotion of sewerage service b. Engineering service to other cities c. Staff Training to other cities

TOR-2: O&M Cost for 15 years (Yen So, Bay Mau, Yen Xa, Phu Do)

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

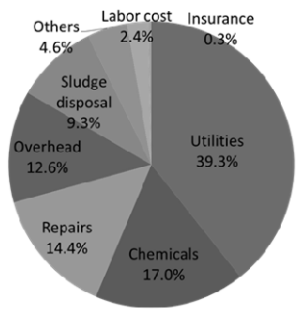


2012: Yen So, 2017: Bay Mau, Yen So, 2018: Phu Do

TOR-2: Hanoi's O&M cost for 15 years (Yen So, Bay Mau, Yen Xa, Phu Do)

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ 15-year Average Proportion



◆ Possibility of Cost Reduction

- Utilities
- Chemicals
- Repairs

According to Japan's experienced rule, approximately 10% of the O&M cost might be reduced by introducing IOMS.

TOR-2: Sensitivity factors for project cash flow 1

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- Price Escalation Risk

Issues	Rescues
Price escalation impacts on Utilities, Chemicals, Repairs, Overhead, Labor Cost.	Price adjustment clause against unprojected price escalation is needed to stipulate in the IOMS contract.
10% price escalation causes 8-9% of O&M cost increase.	The IOMS contract period shall be set at the period within a predictable range of price escalation.
O&M cost in the contract is used to be a lump-sum.	

TOR-2: Sensitivity factors for project cash flow 2

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- Tariff Collecting Risk

Issues	Rescues
Non-revenue sewage would be occurred 1) due to the lack of user's appreciation for sewerage . 2) due to the additional burden of households' economy.	Contractor will not be incurred financial loss due to non-revenue sewage risk. One water bill for water supply and sewerage is recommendable
It is difficult for contactor to directly request households to pay for non-revenue sewage.	

TOR-2: Pay Item for feasibility check

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Services fees payable by the Owner to the Contractor shall be calculated according to the following formula:

Services fees= Variable Expenses(A) + Fixed Expenses(B)

(A) Variable Expenses	= Basic unit x Volume of treated water (Electricity and chemical consumptions relating to treatment process are the majority of variable expenses.)
(B) Fixed Expenses	= Costs other than A

Detail of the simulation will be presented in the Wrap-Up meeting.

TOR-2: Road map to materialize IOMS

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Events	HPC's Actions	IOMS
2012	Yen So in service		
2012-2014		Setup of tariff system	Establishing JC
2014		Collection of sewerage tariff	Implementing IOMS at Yen So
2015-2016		Preparatory period of rising tariff (tariff option 1)	
2017	Bay Mau & Yen Xa in service	Rising Up tariff (tariff option 1)	Implementing IOMS at Bay Mau & Yen Xa
2018	Phu Do in service		Implementing IOMS at Phu Do
2017-2018		Preparatory period of rising tariff (tariff option 2)	
2019		Rising Up tariff (tariff option 2)	

TOR-2: Draft MOU between HPC and Partners for Joint Company

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Whereas:

HPC and JSC has been interest in establishing a joint venture company (JC) with HPC for the IOMS of sewerage facilities in Hanoi, based on their investment experiences to the infrastructure business. Both parties hereby confirm mutual understandings to commence further preparation for the actions listed below.

1. JSC desires to establish the JC with HPC for IOMS in the Yen So WWTP, Bai Mau WWTP and new sewerage facilities to be constructed in future.
2. The JC will operates the planning, engineering, construction management, operation and maintenance, operator's skill-up coaching and any other type of business related to sewerage.
3. JSC's share ratio in the JC with HPC will be determined later during the course of the establishment of the JC.
4. Both parties agree that the JC will be a licensed user of Bay Mau WWTP and Yen So WWTP.
5. HPC and JSC will assign members of the Coordination Committee to establish the JC.

It is further understood by the parties hereto that

a. JSC shall have the right to access and review all documents for the purpose of establishment of the JC.
b. Both party shall treat this M.O.U strictly confidential. Either party shall not disclose any information contained in this M.O.U to any third party without prior written consent of the other party.

The term of this M.O.U shall remain valid for an initial period of two (2) years starting from the date first set above, unless earlier terminated pursuant hereto or modified.

Thank you very much for your attention!

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

INTRODUCTION OF PPP FOR SEWERAGE FACILITIES IN HANOI

Study-A WRAP-UP MEETING
30 August 2011

AGENDA

TOR-1 Improvement of O&M	**Betterment of O&M in 3 WWTPs** OJT by interactive approach with HSDC and JICA team
TOR-3 Tariff & Financial Plan	**New Tariff Plan & Financial Plan** a. Comparison of Cost & Revenue b. Tariff System c. Financial Gap
TOR-2 IOMS	**1. Introduction of IOMS** **2. Implementation of IOMS**

Previous Meeting

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Date	Agenda	Participants
Kick-off M	April 20	Purpose and Scope of Work Study schedule	DOC, HAPI, DOF, HSDC
WGM no.1	April 21	Required Data & Information for Study Selection of PPP model for Integrated O&M Implementation plan of Interview survey	DOC, HAPI, DOF, HSDC
WGM no.2	May 26	Analysis of Interview survey result Willingness to pay for Sewerage service Average Household Income	DOC, HAPI, DOF, HSDC
Interim M	June 23	Status report of TOR 1,2 & 3	DOC, HAPI, DOF, HSDC
WGM no.3	June 28	Project Cost Estimates New Tariff Plan	DOC, HAPI, DOF, HSDC
WGM no.4	August 12	IOMS Road Map Tariff Case Study & Cash Flow Simulation	DOC, HAPI, DOF, HSDC
Wrap-up Meeting	August 30	Study Results Conclusion	DOC, HAPI, DOF, HSDC

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-1

Betterment of O&M in 3 WWTPs

OJT by interactive approach with HSDC and JICA team

TOR-1 Goal & Approach

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Goal
- Upgrading HSDC's O&M skills

Approach
- Interactive approach in Upgrading O&M manual and Upgrading O&M database system at the sites
- On-The-Job Training

TOR-1 Upgrading O&M Manual

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Original O&M manual
- HSDC is using the O&M manuals authorized by HPC at taking-over the 3WWTPs.
- HSDC's O&M work shall be comply with the original O&M manual because it was authorized by HPC.
- HSDC asked JICA team to add the information of (a) more control parameters for the operation, (b) Contingency plan for unexpected case and (c) Definitions of technical term in O&M manual.

Work done
- JICA team submitted the supplemental O&M manual covering of (a) more control parameters for the operation, (b) Contingency plan for unexpected case and (c) Definitions of technical term.

TOR-1 Upgrading O&M Manual

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Original	**1. Explanation of Wastewater Treatment Plant**
Original	**2. Equipment List**
Original	**3. Operation and Maintenance** 3.1 Operation Method • Grit chamber facility • Lift pump facility • Wastewater treatment facility • Disinfection facility • Water supply facility • Sludge treatment facility • Deodorization facility • General room facility
Supplemental	**3.1.S Operation Method - Supplemental** • Introduction • Control parameters • Frequency of water analysis
Supplemental	**3.1.S Safety, Health, Contingency Plan - Supplemental** • Measures for safety and health • Contingency plan

TOR-1 Upgrading O&M Manual

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Original	3.2 Maintenance • Grit chamber facility • Lift pump facility • Wastewater treatment facility • Disinfection facility • Water supply facility • Sludge treatment facility • Deodorization facility • General room facility
Original	3.3 Maintenance for non-operation period 1. Grit chamber facility 2. Lift pump facility 3. Wastewater treatment facility 4. Disinfection facility 5. Water supply facility 6. Sludge treatment facility 7. Deodorization facility 8. General room facility
Supplemental	**3.4 Supplemental Manual - Electric & Instrumentation Equipment Inspection / Maintenance** 1. Introduction 2. Cautions 3. Monthly Inspection Items 4. Annual Inspection Items 5. Device List

TOR-1 Upgrading O&M Manual

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Original	**4. Trouble Shooting and Fault Finding** • Process • Control panel
Original	**5. Reference Documents** • Design calculation • Calculation of capacities • Motor and control list
Supplemental	**5.S Definitions of Technical terms** • Introduction • Operation • Electric equipment • Instrumentation equipment

TOR-1 Upgrading O&M Manual

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Evaluation of Monitoring Data currently recorded by HSDC

Place	Control parameter	unit	Allowable Range			Countermeasures
			Kim Lien	**Truc Bach**	**North Thang Long**	
Reactor	DO	mg/L	2.5-3.5	2.5-3.5	2.0-3.0	Control aeration rate Maintenance of blower and diffuser
	MLSS	mg/L	2000-3000	1500-2000	2000-3000	Control excess sludge volume
	Anaerobic tank ORP	mV	< -50	< -150	< -50	Control return sludge ratio Control aeration rate
	Anoxic tank ORP	mV	< -50	< -150		Control recirculation ratio Control aeration rate
	Aerobic tank ORP	mV	> 100	> 50	> 50	Control aeration rate

TOR-1 Upgrading O&M Manual

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Evaluation of Monitoring Data to be recorded additionally by HSDC

Equipment	Control parameter	unit	Target minimum	Target maximum	Countermeasures
Influent	pH	–	6.5	8.0	(abnormal influent flow) Check waste water quality
Reactor	pH	–	6.0	7.4	Control aeration rate
Final settling tank	Sludge-liquid interface	m	---	0.5	Control excess sludge volume
Dehydrator	Water content	%	---	85 (TB) 83 (KL) 82 (NTL)	Control sludge volume of supply Control sludge conc. of supply Control polymer injection rate Control $FeCl_3$ injection rate Maintenance of dehydrator

TOR-1 Upgrading O&M Manual

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Problem-solving: Total phosphorus value of effluent increase

Condition		
More than -50mv ORP	• DO interfusion by rainfall	• Increase coagulant ($FeCl_3$) injection rate (Be careful of excess injection)
	• DO interfusion by return sludge	・Reduce return sludge ratio ・Reduce aeration rate
Under -50mv ORP	• BOD/P ratio of influent to the reactor is under 20.	・Bypass Primary settling tank ・Supply methanol etc. to increase BOD
	• Shortage of coagulant dosage	• Increase coagulant ($FeCl_3$) injection rate (Be careful of excess injection)

TOR-1 Upgrading O&M Manual

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Problem-solving: Floating sludge from bottom of final settling tank

Condition	Occasions	Countermeasures
Bubbling surface of brown colored sludge	• NO_3-N is denitrified in bottom of FST	・Reduce the aeration rate ・Reduce the sludge retention time with high return sludge volume.
Surfacing of gray–black colored sludge	• Sludge retention occurs for long time.	・Increase the return sludge ratio ・Increase the excess sludge volume ・Cleaning of FST

Problem-solving: Abnormal activated sludge

Condition	Occasions	Countermeasures
Black colored sludge (Accumulation of sulfide)	・Factory wastewater (Industrial wastewater) ・Over-retention of Sludge	• Governmental instruction
Many filamentous microorganism occur	• Deposition of sludge in a pipe (It is easy to increase the filamentous microorganism.)	• Removal of deposition of sludge in a pipe

TOR-1:O&M database system

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Present recording items (on daily bases)

a.Operation data,

b.Maintenance log, and

c.Water quality data.

Proposed additional recording items

d.Building and structural information,

e.Material and parts information, and

f.Technical document list (including design, drawings, manuals, instructions, warranties and correspondences)

O&M database System

JICA team proposes to consolidate the above data records and utilize for proactive trouble shooting and betterment of O&M work.

13

TOR-1: O&M database system

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Advantage of O&M database system

Operation	Maintenance
• Evaluation of settings of treatment process • **Cause analysis of unacceptable treated quality** for determination of countermeasure • Know about influent by weather and temperature to the treatment process • Know about **the relationship between setting of treatment process and quality of treated water** • Check and optimize the control parameters of treatment process	• Evaluation of condition of the system and equipment • Know about **sign of trouble** from trend of monitoring data and take countermeasure. • Optimize monitoring program • **Scheduling the replacement** of equipment based on fault data and repair record. • Review of specification of equipment.

14

TOR-1:O&M database system

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Installation Procedure

Step	Procedure	Status
1	Paper-based recording	• Method presently used. • JICA study is proposing improvement of the present method with new formats (refer to next sheets)
2	Upgrading the paper-based recording with computerized recording as data-base.	• Mid-term Goal • JICA study will provide the concept for step-2 in the report.
3	Applying internet-base data recording system aiming at the centralized control for plural facilities.	• Final Goal • JICA study will provide the concept for step-2 in the report.

15

TOR-1:O&M database system

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Get Started by collecting O&M data

Sheet Name	Item List
Equipment	installation location, year, manufacturer, builder, expected lifetime, specification
Construction	Construction year, name, description, equipment, location, contract date, completion date, contractor
Book	Year, title, contractor, description, equipment, storage location, electronic file name
Stock List	Item name, category, equipment, manufacturer, specification, location
Operation	Weather, temperature, flow rate, sludge volume, operating hours of machine, water quality
Maintenance	voltage, current value, insulation resistance, repair year, overview of repair, contractor

16

TOR-1:O&M database system

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Example of Data Entry Sheet

Equipment List

Equipment name	Facility name	Classification	Style	Installed year	Contractor

Stock List

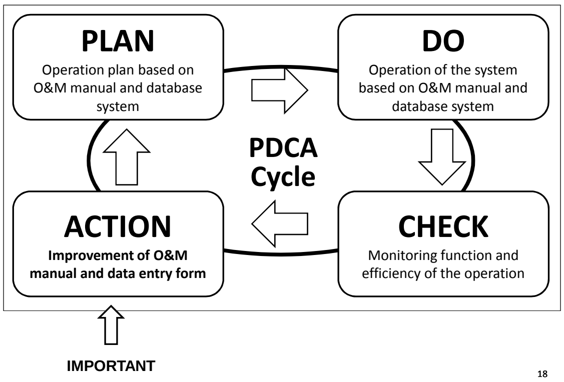
Item Name	Specification	Storage	Unit	Present stock quantity	Minimum stock quantity

Operation data

Day		Wea-ther	Rain mm	Inflow rate		Raw Sewage								
				IPS m3/d	PSD m3/d	Temp deg-C	Appea rance	pH	SS mg/L	COD mg/L	BOD mg/L	T-N mg/L	T-P mg/L
1	Su												
2	Mo												

TOR-1: PDCA Cycle

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

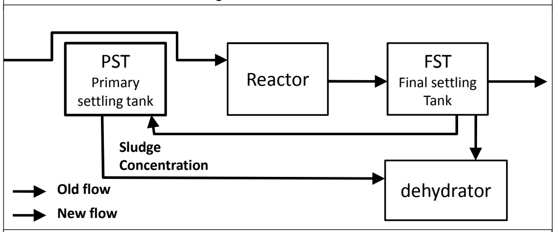


18

TOR-1: Example of PDCA Cycle in Van Tri WWTP

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Check: Low efficiency of dehydration due to High loading in FST
Action: Divert FST sludge to PST for concentration



Plan: Revision of O&M manual
Do: Change process flow based on revised O&M manual

19

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-3

New Tariff Plan Financial Plan

Comparison of Cost & Revenue
Tariff System
Financial Gap

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

O&M Cost Projection –Direct Cost (M VND/year)

	Yen So	Bay Mau	Yen Xa	Phu Do
Labor Cost	7,776	4,080	7,776	6,240
Utilities	59,674	6,967	80,020	30,026
Chemicals	29,927	2,106	40,422	12,596
Legal Inspection Cost	240	240	105	240
Sludge Disposal Cost	18,135	1,269	24,482	7,616
Repairs	20,075	932	31,991	12,180
Small-scale Replacement	4,189	4,189	4,189	4,189
Cleaning and yard maintenance	178	178	178	178
Site Establishment	2,094	2,094	2,094	2,094
Insurance	569	88	765	301
Total	142,858	22,143	192,022	75,660

◆ Major Items of Direct Cost (% in Yen So)
- Utilities 41.8%
- Chemicals 20.9%
- Repairs 14.1%
- Sludge Disposal Cost 12.7%
- Labor Cost 5.4%

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

O&M Cost Projection - Total

- O&M Cost consists of "Direct Cost", " Provisional Sum for Contingency" and "Overhead".

WWTP	Direct Cost (DC) (M VND/year)	Provisional Sum for Contingency (M VND/year, 5% of DC)	Overhead (M VND/year, 6.5% of DC)	Total (M VND/year)
Yen So	142,858	7,143	9,286	159,286
Bay Mau	22,143	1,107	1,439	24,690
Yen Xa	192,022	9,601	12,481	214,105
Phu Do	75,660	3,783	4,918	84,361

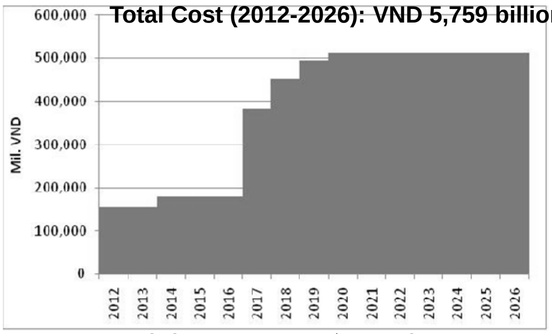
Note : All amounts are average in 15 years.

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

O&M Cost of WWTPs (2012-2026)

Total Cost (2012-2026): VND 5,759 billion



↑Yen So Starts ↑Yen Xa and Bay Mau Starts
↑Phu Do Starts

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Estimation of Average Household Income in Hanoi

(Monthly Income per Capita in 2008)
X (Average Number of Household)
X (Price Index Labor 2010 /Price Index Labor 2008)
= Average Household Income 2010= **VND 7.64 M/HH/month**

where

- Monthly Income per Capita (Source: Household Living Standards 2008)
  Hanoi (Old Hanoi, 2008): VND 1,719.6 thousand
  Ha Tay (New Hanoi, 2008): VND 876.4 thousand
- Average Number of Household (Source: Hanoi Statistical Year Book 2009)
  3.92 person/HH
- Price Escalation
  1.443 (=Price Index Labor 2010 /Price Index Labor 2008)

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Interview Survey

- In order to find the willingness to pay, JICA Team carried out the interview survey in 7 districts concerned to sewerage service in May, 2011.
- Sample number is 105 for domestic and 35 for commercial and industry organization.

[Questions in the interview survey]
✓Profile of respondents
✓Awareness of Sewerage
✓Household monthly expenditure
✓Willingness to pay for the sewerage
✓Comfortable payment for sewerage

Please see Handout for reference of TOR and questionnaire sheet of interview survey

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Comparison of Statistical Household Income and Surveyed Household Income

- **Statistical Household Income for whole Hanoi = VND7.64 M/HH/month**
- **Surveyed Household Income in 7 Districts**

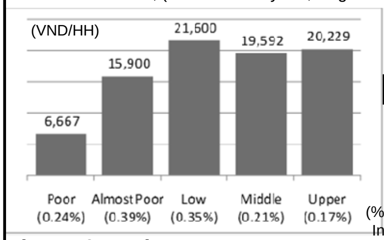
District	Average HH Income (M VND/month)
Ba Dinh	14.10
Dong Da	7.67
Hai Ba Trung	10.33
Hoang Mai	9.40
Thanh Tri	7.63
Tu Liem	5.97
Dong Anh	4.83
Total	8.56

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Willingness to Pay for Sewerage

Total answer: 105, (Positive to Pay: 99, Negative to Pay: 6)



Average: VND 21,212/HH/month (among positive answers)

(% of Total Income by Income Category)

[Income Category]			(Average Monthly HH Income)
Upper	(11%) :	> VND 4M person/month	VND 11.9M in Ave.
Middle	(34%) :	VND 2M-4M person/month	VND 9.3M in Ave.
Low	(40%) :	VND 1M-2M person/month	VND 6.2M in Ave.
Almost Poor	(10%) :	VND 0.75M-1M person/month	VND 4.1M in Ave.
Poor	(5%) :	VND 0.55M-0.75M person/month	VND 2.8M in Ave.

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

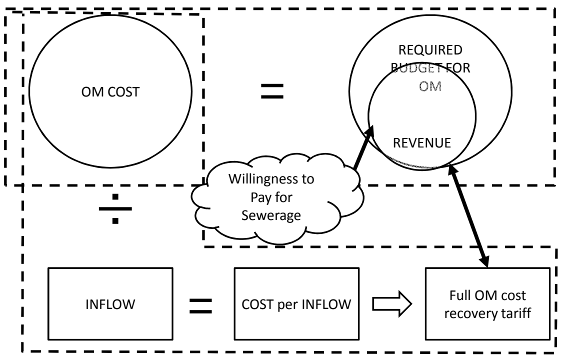
Water Consumption and Rate in 2010

(Source: HAWACO and VIWACO)

Category	Number of Connection	Unit Price (VND/m^3)	Consumption (m^3)		Annual Turnover (M VND)		Water Rate :F/D (VND/m^3)
A	B	C	D	E	F	G	H
Households	488,106	4,000-9,400	106,548,468	75%	472,694	60%	4,436
Commercial organizations	6,947	12,000	15,658,277	25%	187,899	40%	8,769
Industrial and manufacturing organizations		7,000	6,775,231		49,729		
Administrative organizations		5,700	13,329,814		75,980		

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

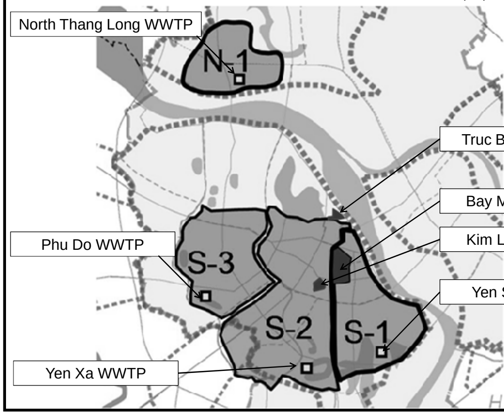
Treatment Plants & Service Area

	WWTP	Capacity (m^3/day)	Basin	Service Area (ha)	Service Pop. 2010	Service Pop. 2020	Sewage 2010 (m^3/d)	Sewage 2020 (m^3/d)	Operation Start
1	Truc Bach	2,300	-	39	9,697	9,541	1,953	2,333	
2	Yen So	200,000	S-1	3,006	697,870	711,635	140,779	174,016	2012
3	Bay Mau	14,000							2017
4	Kim Lien	3,700	S-2	4,874	967,418	900,000	195,153	220,077	
5	Yen Xa	270,000							2017
6	Phu Do	84,000	S-3	2,547	290,276	280,000	58,556	68,468	2018
	Total	574,000		10,465	1,965,261	1,955,093	396,445	464,895	

Note:
- Inflow of North Thang Long WWTP is set 6,500 m^3/day from manufacturing organizations, based on current operation.
- Service population in 2010 is estimated based on statistical data. Sewage is estimated based on water company data. (water consumption: 152L/day/person)
- Service area and service population in 2020 are estimated based on "Partial Adjustment of Hanoi Drainage Master Plan" (October, 2010). Water consumption is assume to be 190L/day/person.

TOR-3: WWTP Service Area

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Water Consumption Calculation

Based on Plant Design

- (Capacity of WWTP) = (Inflow) x (Daily Maximum Factor, 1.225)
- (Inflow) = (Water Consumption) x (Wastewater Generation Factor, 0.9) x (Infiltration Ratio, 1.1)
- (Water Consumption) = (Water Consumption by Domestic) + (Water Consumption by Nondomestic)
- (Water Consumption by Domestic) : (Water Consumption by Nondomestic)=75%: 25%

Based on Population

- (Population) x (Water Consumption per person) = (Water Consumption by Domestic)
- (Water Consumption by Domestic) : (Water Consumption by Nondomestic)=75%: 25%

Revenue Calculation

- (Revenue from Domestic) = (Water Consumption by Domestic) x (Unit Rate for Domestic)
- (Revenue from Nondomestic) = (Revenue from Domestic) x 39.9% / 60.1% + (Revenue in service area of North Thang Long)

  39.9% / 60.1% is estimated based on Annual Turnover of Water Company in 2010.
- (Revenue) = (Revenue from Domestic) + (Revenue from Nondomestic)

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Tariff Level Analysis (7 WWTPs in Service)

(Kim Lien, Truc Bach, North Thang Long, Yen So, Bay Mau, Yen Xa, Phu Do)

	Sewerage Tariff Payment, Fee, VAT and EPF at Average Household (% of Average Income)	Financial Gap (Average Cost)-(Revenue) (M VND/year)
A : Current, EPF	VND 6,460/HH/m (0.08%)	A-C= -499,986 A-D= -669,197
B: Acceptable Tariff based on Willingness to Pay	VND 21,212/HH/m (0.28%)	B-C= -344,026 B-D= -513,237
C: Tariff for Full O&M Cost Recovery	VND 53,753/HH/m (0.70%)	C-D= -169,205
D: Tariff for Full O&M and Replacement Cost Recovery	VND 69,758/HH/m (0.91%)	

Note: Revenue is estimated based on plant designs.
Water consumption is set 18.19 m^3/month at average household.

TOR-3: Tariff System

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Legal Tariff Management

- Establishment of Sewerage Tariff

  (Source: Decree No.88/2007/ND-CP, Article 55)

(1)Owner of Sewerage Works: Preparation of Tariff Alternatives ⇨ **(2) DOC & CMDOTP with DOF**: Appraise the Alternatives ⇨ **(3) People's Committee**: Determine Tariff flowing discussion with People's Councils

Note: CMDOTP: Central Municipal Departments of Transportation of & Public Works

- Establishment of Tariff Collection System

  (Source: Decree No. 88/2007/ND-CP, Article 57)

"Organizations that provide water supply services shall be responsible for sewerage tariff collection by including sewerage tariffs in water bills for customers consuming water supplied from a centralized water system."

TOR-3: Tariff System

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Tariff Collection System

Option	Collection Rate	Fee for Collection	HSDC Contribution
Option 1 (HSDC)	Low (due to lack of public appreciation to sewerage)	High (collect only sewerage tariff)	High (issue bills and collect tariff)
Option 2 (Water Company)	Middle	Middle (collect sewerage and water tariff)	Low
Option 3 (Public Charge Collection Office)	High	Low (collect several public tariffs)	Low

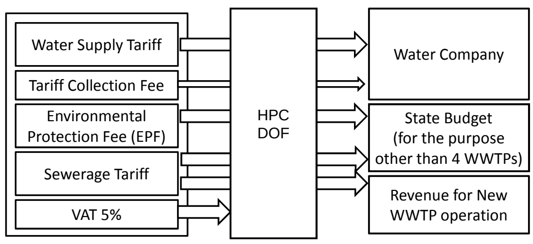
- Joint Circular No. 125/2003/TTLT-BTC-BTNMT V. Management, Use of the Revenue from EPF

  "Leave a portion of the total amount of the collected EPF for water supply units to cover the costs of fee collection. The retained percentage is not exceeded 10% of the total obtained EPF for the domestic water."
- Recommendation: Option 2 (Easy to introduce and consideration for legal manner)
- Assumption for Analysis: Water company gains 8% of total sewerage tariff as collection fee.

TOR-3: Comparison of Cost and Revenue

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Paid Amount of Customers



Circular No. 09/2009/TT-BXD Article 8

"3. Dischargers who already paid the wastewater fee as stipulated in the Decree No. 88/2007/ND-CP shall not have to pay the environmental protection fee applicable to wastewater as stipulated in the Decree No. 67/2003/ND-CP and Decree No. 04/2007/ND-CP"

TOR-3: Tariff System

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Tariff Table (2014, Acceptable Tariff based on Willingness to Pay)

[Domestic]

Water Use Level of Household(m^3/month/HH)	Sewerage Tariff before Tax (VND/m^3)	Water Supply Tariff before Tax and Fee (VND/m^3)
First 16m^3	756	3,478
Above 16m^3 to 20m^3	889	4,087
Above 20m^3 to 35m^3	1,078	4,957
Above 35m^3	1,778	8,174

[Nondomestic]

Usage purpose	Sewerage Tariff before Tax (VND/m^3)	Water Supply Tariff before Tax and Fee (VND/m^3)
Water use for administrative organizations	1,078	4,957
Water use for implementation organizations	1,078	4,957
Water use for public purpose	889	4,087
Water use for manufacture units	1,324	6,087
Water use for business and service units	2,269	10,435

Note: Include collection fee.

TOR-3: Tariff System

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Tariff Table (2024, Tariff for Full O&M Cost Recovery)

[Domestic]

Water Use Level of Household(m^3/month/HH)	Sewerage Tariff before Tax (VND/m^3)	Water Supply Tariff before Tax and Fee (VND/m^3)
First 16m^3	2,425	3,478
Above 16m^3 to 20m^3	2,849	4,087
Above 20m^3 to 35m^3	3,456	4,957
Above 35m^3	5,699	8,174

[Nondomestic]

Usage purpose	Sewerage Tariff before Tax (VND/m^3)	Water Supply Tariff before Tax and Fee (VND/m^3)
Water use for administrative organizations	3,456	4,957
Water use for implementation organizations	3,456	4,957
Water use for public purpose	2,849	4,087
Water use for manufacture units	4,244	6,087
Water use for business and service units	7,275	10,435

Note: Include collection fee.

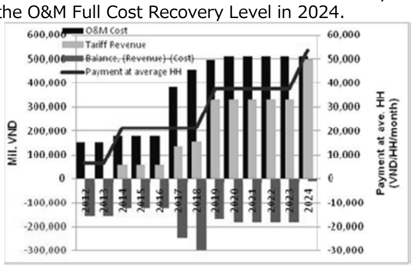
TOR-3: Financial Gap

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Tariff Scenario:

Stage 1: Sewerage tariff is introduce in 2014 by starting from the Willingness to Pay Level.

Stage 2: Thereafter the tariff will be raised in every 5 years and catch up the O&M Full Cost Recovery Level in 2024.



In this case, the government subsidy of VND -2,134 billion in total for 13 years (2012-2024) will be required.

TOR-3: Advertisement

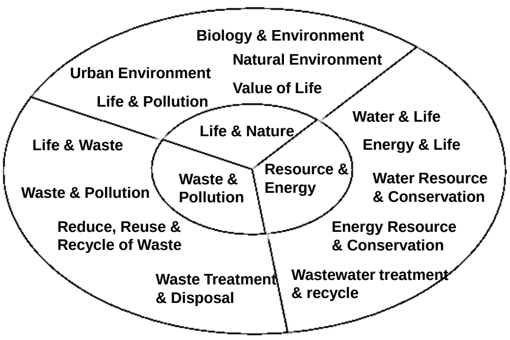
Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Sewerage service is a silent force behind the scene of living. Hence the people are not aware of value of sewerage.
Lack of awareness makes introduction of sewerage tariff and PPP promotion been slow down. To avoid it, strategies of public awareness development are;

A)Environmental education to school children for teaching importance of sewerage as a part of discipline.
B)Sewerage service promotion through the media such as TV, radio and internet.
C)HPC's public consensus meeting to make residents' understanding of sewerage tariff.
D)Sewerage customer service counter is established in HPC website for inquiry and complain.

TOR-3: Advertisement

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-3: Summary

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

1. Hanoi needs the sewerage tariff to cover increasing O&M cost of sewerage facilities due to construction of new WWTPs.
2. As the result of willingness to pay survey does not meet O&M cost, it is required to make up the budgetary shortage somehow. (i.e. governmental subsidy)
3. In order to accommodate the operation of Yen So WWTP, preparations of tariff introduction should be conducted in 2012 and 2013.
4. Public understanding for sewerage shall be improved by continuous advertisement activities.

TOR-3: Summary

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

5. Considering current social opinion, it is recommended that the tariff starts from willingness to pay level, and then catches up full O&M cost recovery level within 10 years.
6. Government shall support the O&M cost for Yen So WWTP with amount of VND 120 bil. per year in the early stage.
7. Financial source of large scale equipment replacement (relating to equipment life time) shall be discussed.
8. Weak point of this scenario is that the tariff level is not enough for Yen Xa operation when it will start.

TOR-2

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

TOR-2: IOMS

1. Introduction of IOMS
   a. Comparison of Conventional O&M vs. IOMS
   b. On-going IOMS in Japan & Thailand
   c. Cost merit analysis
   d. Terms of IOMS contract
   e. Scope of work in IOMS contract
   f. Performance Indicators
2. Implementation of IOMS
   a. Organizational plan
   b. Financial plan
   c. Analysis for modification of legal system for the proposed IOMS by JC

TOR-2: Comparison of Conventional O&M vs IOMS

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Conventional O&M	Integrated O&M
Basis of Contract	• **Fixed Scope of Work** • **Annually updated** Cost-plus-profits-contract (Unit price base)	• **Performance Benchmarks** (mainly treatment quality) & **Delivery conditions** at the end contract. • **Multi-year Lump-sum** contract
Criteria of contractor's performance	• The contractor shall comply with Performance Indicator bound in the contract.	• The contractor shall comply with Performance Indicator bound in the contract.
Repair & Replacement	• **Budget of repair and replacement** of equipment is accounted a **Provisional-Sum**.	• **Repair budget** is **either** included in **Lump-Sum amount** or accounted as a **Provisional-Sum.** • **Replacement budget** is accounted as a **Provisional-Sum**.

TOR-2: On-going IOMS in Japan

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Contract Level	Period	Cost components
Conventional	Single year	Process cost (measurement base)
IOMS level-1	Short term multi year	Process + utility cost (Lump sum)
IOMS level-2		Process + utility cost (Lump sum) + Small replacement
IOMS level-3		Process + utility cost (Lump sum) + Medium replacement
IOMS full scale	Long term multi year	Process + utility cost (Lump sum) + Large replacement

Number of IOMS project in 2011	
Level-1	29 projects
Level-2	**MAJORITY→ 201 projects**
Level-3	21 projects
Total	251 projects

Statistic, Contract Period (as of 2011)	
1 year	32 projects
3 years	**MAJORITY→ 182 projects**
4 years	14 projects
5 years	14 projects
Over 5 years	1 project
Total	243 projects

TOR-2: On-going IOMS in Japan

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service **Hanamigawa WWTP no.2**, Chiba, Japan,
3-year contract

Project started in **2007**

Plant feature	Capacity 576,000m3/day Conventional activated sludge treatment Sludge incinerator 150 ton/day Treated Sewage Effluent (TSE) Tertiary Treatment Photovoltaic power generation (1828 KWh)
Scope of work	1) O&M of sewage treatment, sludge treatment, TSE transmission 2) Environmental monitoring & protection 3) Ancillary facility maintenance 4) Replacement of equipment (less than JPY 2,500,000 per item) 5) Procurement of consumables

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service, **Hanamigawa WWTP no.2**, Chiba, Japan

3-year operation outcome (2007-2009)

i.Total O&M costs decreased 14% .
ii.Electricity consumption had been saved 7%.
iii.Equipment malfunction and system failure decreased 12% (52 to 46 per year)

Costs Comparison before & after project in 3 years, unit million JPY

Item	3-year costs before project	3-year costs during project	Improvements
Remuneration	231	138	▼93 or -14%
Direct costs incl. Utilities	3,548	2,886	▼662 or -19%
Small replacement (<JPY250K)	72	52	▼20 or -28%
Large replacement (>JPY250K)	954	1,049	△95 or +10%
Others	114	118	△4 or +4%
total	4,919	4,243	▼676 or -14%

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service **Amagasaki East WWTP**, Hyogo, Japan

5-year contract

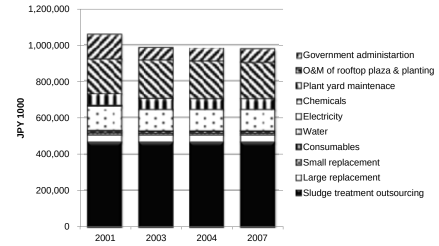
Project started in **2003**

Plant feature	Capacity 134,000m3/day for sewage Conventional activated sludge treatment Relay Pumping S-1 139m3/min(S) + 1971m3/min(R) Relay Pumping S-2 1745m3/min(R) Sludge transmission pumping station
Scope of work	(1) O&M of Sewage treatment (2) Environmental monitoring (3) O&M of relay pumping stations (4) Inspection and maintenance of plant utilities (5) Procurement of consumables and utilities (6) Equipment replacement (> JPY 1M) (7) O&M of rooftop plaza, planting zone

TOR-2: Japanese IOMS cases

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service, **Amagasaki East WWTP**, Hyogo, Japan



Costs Comparison before & after project, unit million JPY

	2001	2003	2004	2007
Sludge treatment outsourcing	465.6	465.6	465.6	465.6
Large replacement	42.1	42.1	42.1	42.1
Government administration	132.4	70.1	70.1	70.1
IOMS fee	417.8	411.9	406.5	400.4
Total	**1,057.9**	**989.7**	**984.2**	**978.1**
Improvement	**100%**	**94%**	**93%**	**92%**

TOR-2: On-going IOMS in Japan

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Item	Shiwa (Iwate)	Hamakurosaki (Toyama)	Arakawa (Saitama)	Nagata (Shizuoka)	Takehara (Hiroshima)	Matsuyama (Ehime)
Period	3 year	3 year	3 year	3 year	3 year	3 year
Type	Combined	Separated	Separated	Separated	Separated	Combined
Contract level	2	2	2	2	1	2
Replacement Max at one time	USD 10,000	Not available	USD 5,000	USD 5,000	0	USD 5,000
Process	C.A.S	C.A.S	O.D	C.A.S	S.A.S	C.A.S
Design capacity (m3/d)	9,200	178,500	38,700	17,000	Not available	151,000
PI - BOD	13 mg/L	5.6 mg/L	Not available	Not available	5 mg/L	4.3 mg/L
COD		8.9 mg/L	Not available	Not available	10 mg/L	7.2 mg/L
SS	20 mg/L	5.3 mg/L	Not available	Not available	5 mg/L	2 mg/L
T-N	None	None	Not available	Not available	10 mg/L	13 mg/L
T-P	None	None	Not available	Not available	1 mg/L	0.48 mg/L
Coliform G	80 MPU/mL	7 MPU/mL	Not available	Not available	Nil	Nil

TOR-2: On going IOMS in Thailand

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Integrated O&M service **Nong Khaem WWTP ,** Bangkok, Thailand

5-year contract

Project started in **2003**

Plant feature	Capacity 157,000m3/day in Nong Khaem WWTP Vertical loop reactor activated sludge Sludge transmission pumping station
Scope of work	(1) O&M of Sewage treatment (2) O&M of Sludge treatment (dehydrate) (3) Environmental monitoring (4) Inspection and maintenance of plant utilities (5) Procurement of consumables and utilities
P.I	SS, BOD, COD, T-N, T-P, Coliform group, F.Coli & E.Coli
Payment	Payment = $K_{fix} + K_q(Q) + K_B + K_{sludge}$ where, fix = fixed rate, Q = inflow rate , B = storm water bypass flow and Sludge = sludge volume

TOR-2: Features & Merits of IOMS

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Introduction of IOMS Summary

- Features of IOMS
  1.Multi-year contract
  2.Performance based payment (Lump-sum)

- Merits of IOMS
  1.Reduction of the life cycle O&M costs
  → 8-12% cost reduction is expected based the Japanese experience.
  2. Level up of the O&M skills taking certain level the risks

TOR-2: New PFI Law & IOMS

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ Acknowledgment for IOMS so far

IOMS has been enough verified to be worth for cost reduction in trial stage as shown in previous sheets.

◆ New PFI Law effectuated in 2011

New PFI Law is almost same as EU standard and encourages to have long term contract for operation.

⇩

Japan just started full scale IOMS under new PFI law.

TOR-2: IOMS for Hanoi

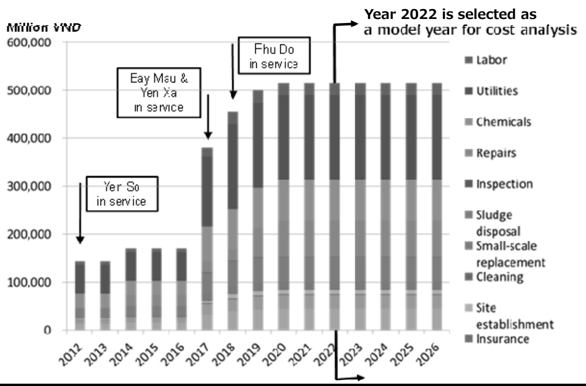
Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- Our Result will be carried over to Yen Xa
  JC is supposed to be established to implement full scale IOMS under the PPP contract b/w SPC and HPC.
- To maximize Benefit of IMOS for Hanoi
  Meantime, IOMS can be usually applied to operation itself after the construction.

The following calculation is the impact of IOMS for new 4 STPs.

TOR-2: O&M cost of Yen So, Bay Mau, Yen Xa, and Phu Do (2012-2026)

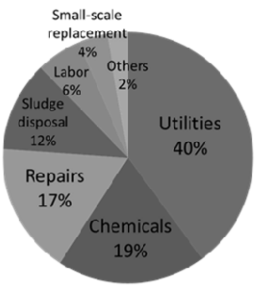
Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-2: Cost merit analysis

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- **Breakdown of Direct Costs in 2022**



- Potential Reduction of Direct costs, such as
  - Utilities
  - Chemicals
  - Repairs

According to Japan's experience, 8-12% of such direct costs might be reduced by introducing IOMS.

TOR-2: Cost merit analysis

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Comparison of Direct Costs between Conventional O&M contract vs. IOMS in Year 2022 under 4 new WWTPs in service.

Items	Conventional Contract	IOMS Contract	Reduction (%)
	million VND	million VND	
Utilities	176,687	159,018	10.0%
Chemicals	85,051	76,546	10.0%
Repairs	75,205	67,684	10.0%
Sludge disposal	51,504	51,504	0.0%
Small-scale replacement	16,755	16,755	0.0%
Labor	25,872	12,240	0.0%
Others	11,657	11,529	1.1%
Total Direct Cost	**442,730**	**408,908**	**7.6%**

TOR-2: Cost merit analysis

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

- Result of the analysis
  Based on the costs analysis referring to the Japanese experience, the IOMS can reduce 7.6% of the direct cost comparing with the conventional O&M contract.

It is, therefore, that IOMS is worth introducing.

TOR-2: IOMS Contract Terms

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Key Clause	Description
Project Owner & Contractor	Owner: HPC Contractor: Joint Company
Contractor's Obligation	The Contractor shall provide the IOMS stipulated by the IOMS contract. (refer to the next slide)
Payment	• The owner shall confirm a conformity of the contractor's performance in collation with the performance indicators. • Unconformable work of the contractor will cause the reduction of the payment to the contractor.
Contractor's possession of site and duty to reserve function	• The owner shall grant the right to use the sewerage facility to the contractor for the purpose of contractor's obligation. • The contractor shall reserve the function of facility and compensate the damage or losses caused by the contractor.

TOR-2: IOMS Scope of Work

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

General	a. Staff management and Material Control for O&M b. Reporting of results of O&M work to the regulator c. Customer technical service
Technical	a. O&M in wastewater treatment and sludge treatment/disposal in compliance with Performance Indicator (PI) b. Repair work of facilities c. Small scale replacement of equipment d. Technical transfer through O&M PDCA cycle
Option	a. Promotion of sewerage service b. Engineering service to other cities c. Staff Training to other cities

TOR-2: Performance Indicators

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

QCVN24:2009, column B

Item	Legal Effluent Quality	Proposed Effluent Quality
BOD5 (mg/L)	50	40
COD (mg/L)	100	80
SS (mg/L)	100	80
Nitrogen (mg/L)	30	24
Phosphorus (mg/L)	6	5

- 5 out of 36 items in QCVN24:2009 shall be used as Performance Indicators after the construction in 2009.
- These items shall be checked and reported to the regulator weekly.

TOR-2: Performance Indicators

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ How to use the Performance Indicators

The contractor reports the results of the wastewater treatment in accordance with PI.

⇩

The regulator verifies and reports the conformity of the contractor's performance to HPC

⇩

If the performance is not conformed with PI, HPC reduces the payment to the contractor.

TOR-2: Contractor's Risk

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ Contractor's Major Risk

- ➢ Third-party Liability
- ➢ Complaints from Residents
- ➢ Changes of Regulations
- ➢ Fluctuation of Influent Volume
- ➢ Increase of repair expense due to sudden failure
- ➢ Price Escalation
- ➢ Tariff Collection

⇦ Critical matters for the IOMS Contractor

TOR-2: Contractor's Risk

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ Price Escalation Risk

Issues	Rescues
Price escalation impacts on Utilities, Chemicals, Repairs, Overhead, Labor Cost. 10% price escalation causes 8-9% of O&M cost increase. O&M cost in the contract is used to be a lump-sum.	Price adjustment clause against unprojected price escalation is needed to stipulate in the IOMS contract. The IOMS contract period shall be set at the period within a predictable range of price escalation.

TOR-2: Contractor's Risk

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆Tariff Collecting Risk

Issues	Rescues
Non-revenue sewage would be occurred 1) due to the lack of user's appreciation for sewerage . 2) due to the additional burden of households' economy. It is difficult for contactor to directly request households to pay for non-revenue sewage.	Contractor will not be incurred financial loss due to non-revenue sewage risk. One water bill for water supply and sewerage is recommendable.

TOR-2: Service fees

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ Formula of Services fees (Payment form the Owner to the Contractor)

Services fees= Variable Expenses(A) + Fixed Expenses(B)

(A) Variable Expenses	= Basic unit x Volume of treated water (Electricity and chemical consumptions relating to treatment process are the majority of variable expenses.)
(B) Fixed Expenses	= Costs other than A

TOR-2: Service fees

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ Services Fee Calculation

Items	Type
Labor	Fixed
Chemicals	Variable
Fuel	Variable
Electricity	Variable
Consumables	Fixed
Repair	Fixed
Other expenses	Fixed
Overhead	Fixed

Calculation 1

α = Variable expenses basic unit = Total variable expenses / Design flow

Calculation 2

β = Monthly fixed expenses

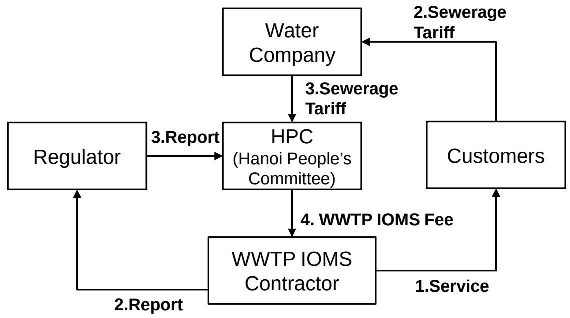
Calculation 3

Monthly Service Fee = α×(Actual inflow volume) + β

TOR-2: Organizational plan of IOMS

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

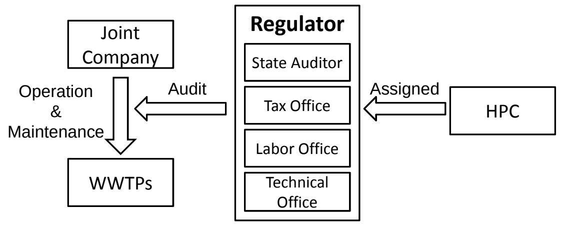
◆ Implementation framework of WWTP IOMS



TOR-2: Organizational plan of IOMS

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ Framework of Regulator



- ✓ **Objective: Supervision of O&M quality in accordance with Performance Indicators.**
- ✓ **Members: State auditor, tax office, DOC, and Independent Party, etc.**

TOR-2: Organizational Plan of JC

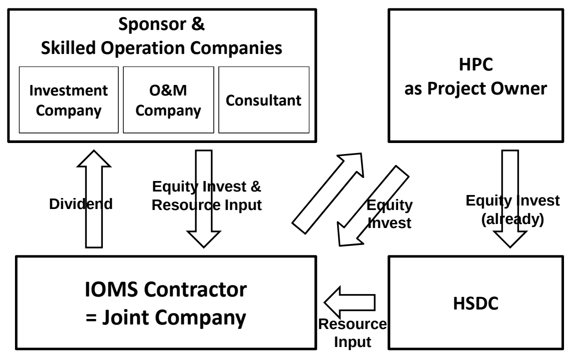
Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Option 1:	HSDC to undertake the IOMS
Option 2:	Joint Company established by HPC and Private firm to undertake the IOMS
Option 3:	A Private firm to undertake the IOMS

	Option 1	Option 2	Option 3
Capacity to undertake IOMS	Need time for new experience	Enough capacity	Enough capacity
Cost saving opportunity	Less because lack of experience	Promising	High cost due to Foreign company
Comfort for HPC	Comfort	Comfort	Uncomfortable to ignore HSDC
Compliance of laws and regulations	Complied	Need to study	Complied
Evaluation	Need enough time for experience and support from outside	HSDC's locality and Private firm's skill make synergy. **Recommendable**	HSDC's 5 year experience cannot contribute in this option.

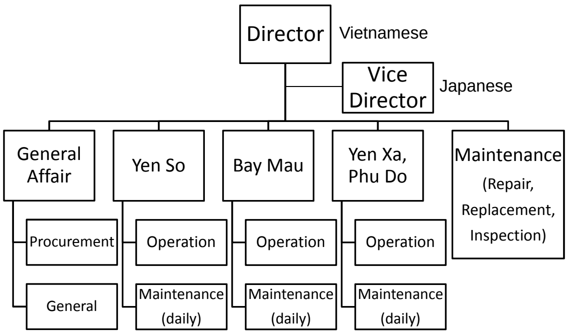
TOR-2: Organizational Plan of JC

Oriental Consultants (OC), ORIX Corporation (ORIX), Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-2: Organizational Plan of JC

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)



TOR-2: Financial Plan of Joint Company

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

◆ **Conventional vs. IOMS by JC (as at 2022)**

Items	Conventional(A)		Joint Company(B)		Difference (B-A)	
	million VND	%	million VND	%	million VND	%
Direct Cost	442,730	89.7%	408,901	82.8%	-33,829	-7.6%
Utilities	176,687	35.8%	159,018	32.2%	-17,669	-10.0%
Chemicals	85,051	17.2%	76,546	15.5%	-8,505	-10.0%
Repairs	75,205	15.2%	67,684	13.7%	-7,520	-10.0%
Sludge disposal	51,504	10.4%	51,504	10.4%	0	0.0%
Small-scale replacement	16,755	3.4%	16,755	3.4%	0	0.0%
Labor	25,872	5.2%	25,872	5.2%	0	0.0%
Site establishment	8,378	1.7%	8,378	1.7%	0	0.0%
Other Expenses	3,279	0.7%	3,144	0.6%	-135	-4.1%
Overhead	28,777	5.8%	26,579	5.4%	-2,199	-7.6%
Provisional sum	22,137	4.5%	20,445	4.1%	-1,691	-7.6%
Profit	0	0.0%	20,445	4.1%	20,445	4.1%
Total	493,644	100.0%	476,370	96.5%	-17,274	-3.5%

Even the JC ensures a certain profit (5% of Direct Cost), HPC can reduce 3.5% of O&M cost.

TOR-2: Analysis for modification of legal system for IOMS by JC

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

	Circular 09/2009/TT-BXD ANNEX1	Hanoi Model (This Study)	Compliance
Duration	5 to 10 years	3-25 Years	To be Discussed
Scope	Drainage Sewerage Disposal of Sludge Asset Management, etc	Yen So STP Bay Mau STP Yen Xa STP Other STPs	Complied
Contract Type	Lump-Sum, or Unit price	Lump-Sum	Complied
Repair & Replacement cost	Partly included	Japanese Level 2,3 or full scale IMOS are recommended	Under Consideration
Regulating Body	Drainage/Sewerage system owner	Not Appointed	To be Discussed

TOR-2: Analysis for modification of legal system for IOMS by JC

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

<Decision 71: Issues>

●Article 2: Interpretation

Clause 4: The state participation portion is neither the contributed equity capital in the project enterprise nor …

●Article 9: State participation portion

Clause 2: The total stale participation portion must not exceed 30% of the total investment level of a project, except other cases decided by the Prime Minister.

JICA team's understanding and proposal

⇒ Decision 71 stipulates that the ceiling of the state participation portion at 30% of the total investment. It may cause a shortage of OM budget when the sewerage tariff level does not meets total OM costs.

⇒ Decision 71 does not stipulate the private sector's equity capital for the O&M contract case. We propose Joint Company's equity proportion is Vietnam: Japan = 50:50.

TOR-2:Conclusion

Oriental Consultants (OC) , ORIX Corporation (ORIX) , Nihon HELS Industry (HELS), PADECO, YOKOHAMA Water (YW)

Establishment of Joint Company - Summary

◆ Applying IOMS can be expected 7.6% reduction of WWTP O&M direct cost comparing with the conventional contract.

◆ HPC and Joint Company can share the profit of O&M cost reduction according to the capital share.

⇩

It is, therefore, recommendable to establish Joint Company to introduce IOMS.

Thank you very much for your attention!

Appendix 2 O&M Manual – Supplemental

O&M Manual – Supplemental

Wastewater Treatment Plant (CP-3 WORKS)

THOÁT NƯỚC HÀ NỘI

HSDC - Hanoi Sewerage and Drainage Company

Rev.	Date	Issued	Description
0	21st October 04	Ebara - Taisei	For Approval
A	15th March 05	Ebara - Taisei	For Approval
B	25th August 11	HSDC – JICA team	Supplemented by JICA study with HSDC

Table XX. Table of Contents of O&M Manual upgraded by JICA Team

	C-4.1. Panel Inside C-4.2. Float Level Switch C-4.3. Electrode Level Switch C-4.4. Ultrasonic Level Sensor / Magnetic Flow Meter / DO Meter C-4.5. Weir Flow Meter C-4.6. Others C-5. Device List C-5.1. Kim Lien WWTP C-5.2. Truc Bach WWTP C-5.3. Kim Lien Pumping Station C-5.4. North Thang Long WWTP
Original	**4. Trouble Shooting and Fault Finding** 4.1 Process 4.2 Control panel
Original	**5. Reference Documents** 5.7 Design calculation 5.8 Calculation of capacities 5.9 Motor and control list
Supplemental	**5S.A Reference Documents – Supplemental** A-1.Definitions of Technical terms A-1.1. Introduction A-1.2. Operation A-1.3. Electric equipment A-1.4. Instrumentation equipment

3S.A

Supplemental Manual

Operation Method

August 2011

TABLE OF CONTENTS

A-1. Supplement - Introduction

This manual is supplement for the original O&M manual. This is compiled based on the past operation information. Therefore, it is required to revise by change of wastewater influent and change of institutions.

A-2. Control parameters

A-2.1. Control parameters based on the past data

This chapter focuses on water quality parameters, which we set based on the past data. For targeted water levels of each tank which is important parameter, please refer to the original O&M manual.

(a) Kim Lien WWTP

Equipment	Control parameter	unit	Target minimum	Target maximum	Countermeasures
Reactor	DO	mg/L	2.5	3.5	Control aeration rate Maintenance of blower and diffuser
	MLSS	mg/L	2000	3000	Control excess sludge volume
	Anaerobic tank ORP	mV	---	-50	Control return sludge ratio Control aeration rate
	Anoxic tank ORP	mV	---	-50	Control recirculation ratio Control aeration rate
	Aerobic tank ORP	mV	100	---	Control aeration rate

(b) Truc Bach WWTP

Equipment	Control parameter	unit	Target minimum	Target maximum	Countermeasures
Reactor	DO	mg/L	2.5	3.5	Control aeration rate Maintenance of blower and diffuser
	MLSS	mg/L	1500	2000	Control excess sludge volume
	Anaerobic tank ORP	mV	---	-150	Control return sludge ratio Control aeration rate
	Anoxic tank ORP	mV	---	-150	Control recirculation ratio Control aeration rate
	Aerobic tank ORP	mV	50	---	Control aeration rate

(c) North Thang Long WWTP

Equipment	Control parameter	unit	Target minimum	Target maximum	Countermeasures
Reactor	DO	mg/L	2.0	3.0	Control aeration rate Maintenance of blower and diffuser
	MLSS	mg/L	2000	3000	Control excess sludge volume
	Anaerobic tank ORP	mV	---	-50	Control return sludge ratio Control aeration rate
	Aerobic tank ORP	mV	50	---	Control aeration rate

A-2.2. Additional proposal of the control parameters

Furthermore, the required control parameters are as follows. We recommend storing data and defining the proper control parameters for management.

Equipment	Control parameter	unit	Target minimum	Target maximum	Countermeasures
Influent	pH	—	6.5	8.0	(abnormal influent flow) Check waste water quality
Reactor	pH	—	6.0	7.4	Control aeration rate
Final settling tank	Sludge-liquid interface	m	---	0.5	Control excess sludge volume
Dehydrator	Water content	%	---	85(TB) 83(KL) 82 (NTL)	Control sludge volume of supply Control sludge conc. of supply Control polymer injection rate Control $FeCl_3$ injection rate Maintenance of dehydrator

A-3. Response to the characteristic of wastewater treatment plants

A-3.1. Truc bach and Kim Lien WWTPs

(a) total nitrogen value of effluent increases

Check the Ammonia nitrogen in effluent

Condition	Occasions	Countermeasures
Ammonia nitrogen is detected much. (The nitrification is not advancing)	DO is low	Increase aeration rate
	Actuation fault of blower, plugging of diffuser	Maintenance of blower and diffuser
	Lowering of pH by coagulant injection	Reduce coagulation injection rate
	Low MLSS conc.	Increase MLSS conc.
Ammonia nitrogen is not detected. (The denitrification is not advancing)	The BOD/N ratio of influent to the reactor is under 3.	･Bypass Primary settling tank ･Supply methane etc. to increase BOD
	ORP of Anoxic tank goes up	Reduce the rate of recycle water

A-3.2. North Thang Long WWTP

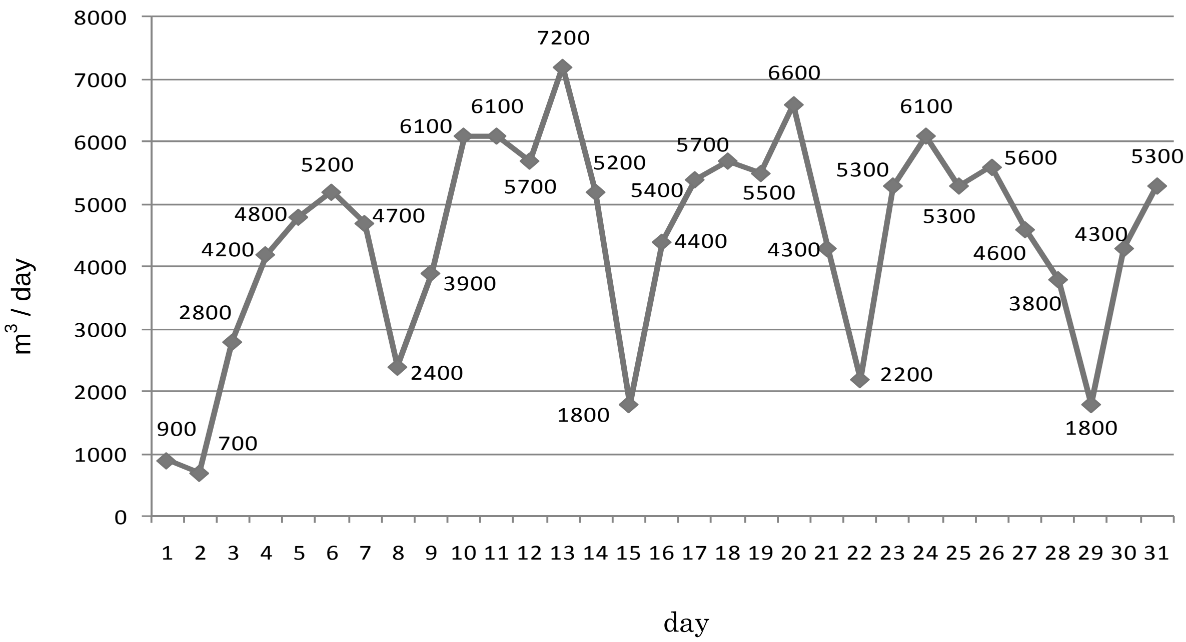
(a) The flow rate of influent

The correspondence to the increase in the flow rate of influent is indicated in the original manual. However, as shown in the following table, the present influent quality value and flow rate is a very small value as compared with a design value. Moreover, as shown in the following fig, the difference of the influent flow rate between weekday and holiday is large. When increasing the number of reactors according to the original manual, it is necessary to consider the quality of influent.

Table. F/M ratio

		Flow rate (m^3/day)	BOD (mg/L)	MLSS (mg/L)	Capacity of aeration tank (m^3)	F/M ratio (kgBOD/kgMLSSday)
Design		42000	132	2000	10512	0.26
present	Weekday	6500	50	2500	1752	0.07
	Holiday	2000	50	2500	1752	0.02
Using 2 trains of reactor	Weekday	6500	50	2500	3504	0.04
	Holiday	2000	50	2500	3504	0.01

Fig. Inlet Flow Rate (May 2011)



A-3.3. Common to the all the WWTPs

(a) The total phosphorus value of effluent increases

Check the ORP in Anaerobic tank

Condition	Occasions	Countermeasures
More than -50mv ORP	DO interfusion by rainfall	Increase coagulant ($FeCl_3$) injection rate (Be careful of excess injection)
	DO interfusion by return sludge	・Reduce return sludge ratio ・Reduce aeration rate
Under -50mv ORP	The BOD/P ratio of influent to the reactor is under 20.	・Bypass Primary settling tank ・Supply methane etc. to increase BOD
	Shortage of coagulant dosage	Increase coagulant ($FeCl_3$) injection rate (Be careful of excess injection)

(b) The floating sludge from bottom of final settling tank

Condition	Occasions	Countermeasures
Bubbling surface of brown colored sludge	NO_3-N is denitrified in bottom of FST	・Reduce aeration rate ・Reduce sludge retention time with high return sludge volume.
Surfacing of gray – black colored sludge	Sludge retention occurs for long time.	・Increase return sludge ratio ・Increase excess sludge volume ・Cleaning

(c) Abnormal activated sludge

Condition	Occasions	Countermeasures
Black colored sludge (Accumulation of a sulfide)	・Inflow of factory effluent ・Sludge retention occurs for long time	Removal of occasions
Many filamentous microorganism occur	Deposition of sludge in a pipe (It is easy to increase the filamentous microorganism.)	Removal of deposition of sludge in a pipe

A-4. Frequency of water analysis

In order to confirm adequate operation condition and good performance of equipment, it is necessary to check water quality on operation. After confirming of water quality, operation condition should be changed. Required inspection items of water quality for operation (plan) is shown below.

A-4.1. Truc bach and Kim Lien WWTPs

	Waste water influent	Primary Settling Tank	effluent	Recycle Flow
Appearance	○	○	○	○
Odor test	○	○	○	○
Water Temperature	○		○	
pH	○	○	○	○
BOD	△	△	△	
SS	△	△	△	
COD	△	△	△	
NO_3-N			△	
NH_4-N		△	△	
T-N	△	△	△	
T-P	△	△	△	
Residual Chlorine			△	
Coliform Group			△	

	Anaerobic Tank	Anoxic Tank	Aerobic Tank	Raw Sludge	Return Sludge	Dewatered Sludge
Appearance	○	○	○			
Water Temperature			○			
pH	○	○	○			
ORP	○	○	○			
DO			○			
SV			○			
MLSS			△			
TS				△	△	
Water content						△

○ : once every day △ : once every week

A-4.2. North Thang Long WWTP

	Waste water influent	effluent	Recycle Flow
Appearance	○	○	○
Odor test	○	○	○
Water Temperature	○	○	
pH	○	○	○
BOD	△	△	
SS	△	△	
COD	△	△	
NH_4-N		△	
T-N	△	△	
T-P	△	△	
Residual Chlorine		△	
Coliform Group		△	

	Anaerobic Tank	Aerobic Tank	Raw Sludge	Return Sludge	Dewatered Sludge
Appearance	○	○			
Water Temperature	○	○			
pH	○	○			
ORP	○	○			
DO		○			
SV		○			
MLSS		△			
TS			△	△	
Water content					△

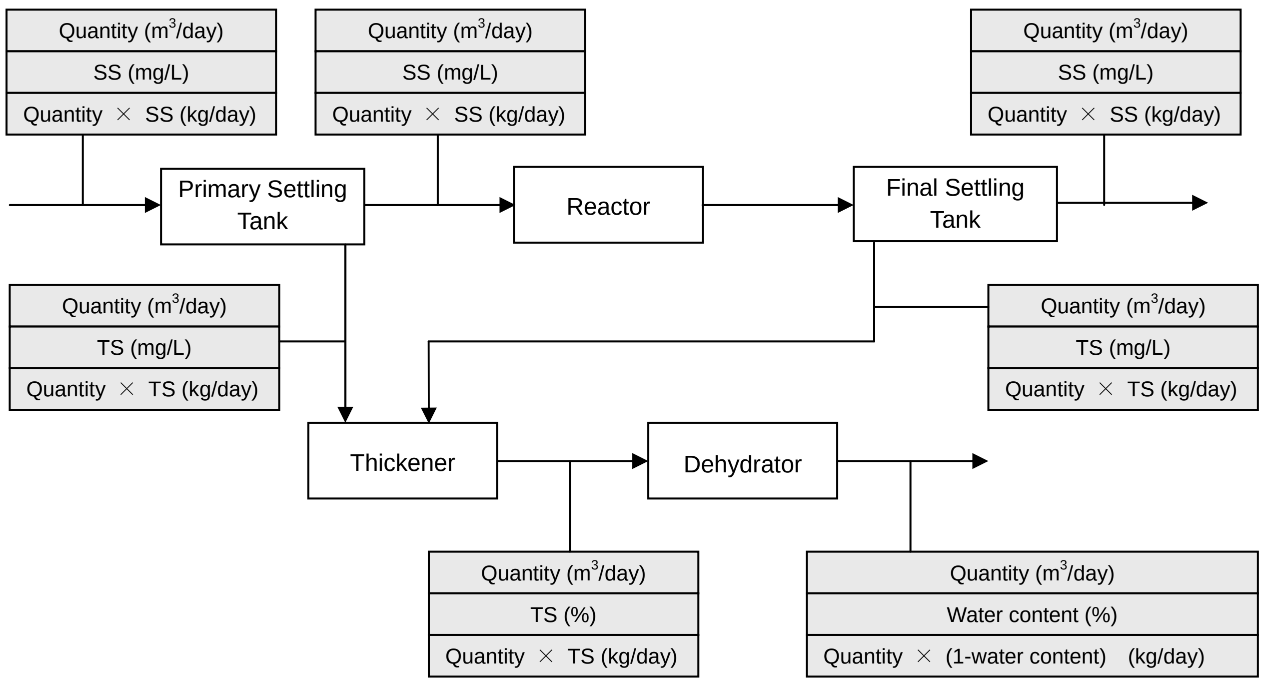
○ : once every day △ : once every week

A-4.3. Check based on solid balance

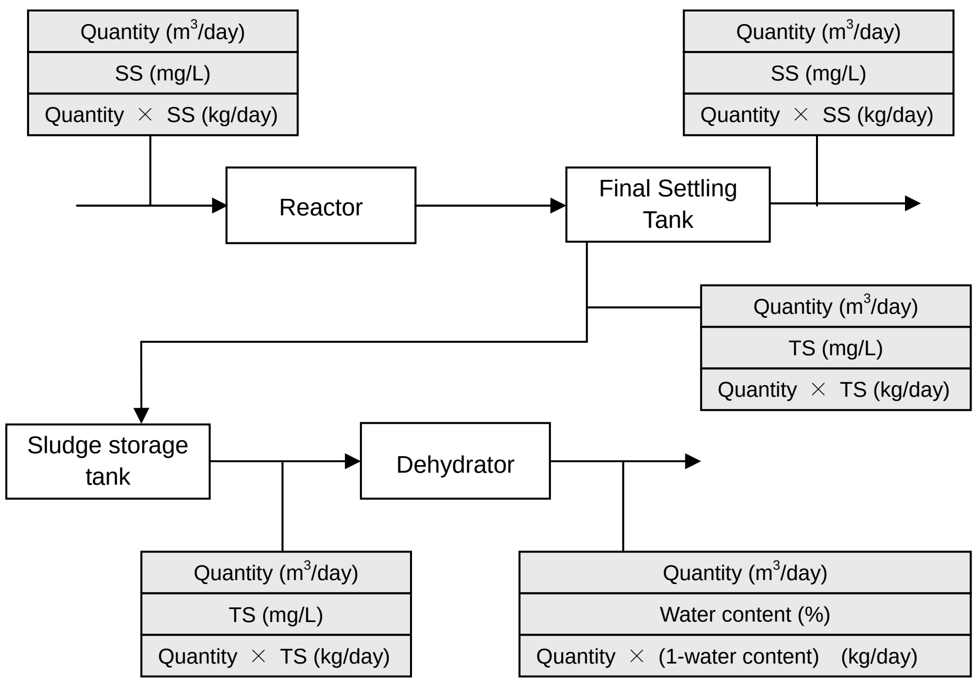
Sludge treatment implemented with checking solid balance for whole plant enable to produce good treated water.

Please check solid balance 4 times or more per year. A measurement items are shown below.

(a) Kim Lien and Truc Bach WWTP



(b) North Thang Long WWTP



3S.B

Supplemental Manual

Safety, Health & Contingency Plan

August 2011

TABLE OF CONTENTS

B-1. Measures for safety and health

B-1.1. Appropriate working clothes

Appropriate working clothes can prevent accident and improve working efficiency.

The workers should be provided with a complete change of work clothes to be worn during working hours. Gumboots should also be provided for the worker.

- Wear fitted (size-matched) working clothes
- Keep working clothes clean
- Do up buttons of sleeves
- Keep working clothes nice without open seam or tear
- Not to be undressed. It is dangerous
- Wear helmet and safety boots. Wear helmet properly

Good

Bad

(Source: HP of National Center for Teacher's Development)

B-1.2. Health management

The workers should be instructed to keep finger nails short and well trimmed, wash hands with soap and water before taking food and to keep fingers out of nose, mouth and eyes, because the hands carry most infections.

B-1.3. Display of emergency contact

Displayed emergency contact is helpful in case of accident. The contact list should contain addresses/ telephone numbers of hospitals and a police station. Necessary information should be simply listed.

B-1.4. Safety and health training

(a) Contents of training

It is important to provide trainings which are based on actual works and which improve hazard predictive ability.

(b) Evacuation training in case of disaster

In event of disaster, if pre-training on evacuation has been provided with personnel, it can minimize victims, damages, or disaster itself. Assuming fire, implement evacuation training.

B-2. Contingency plan

(a) Thermal conditions

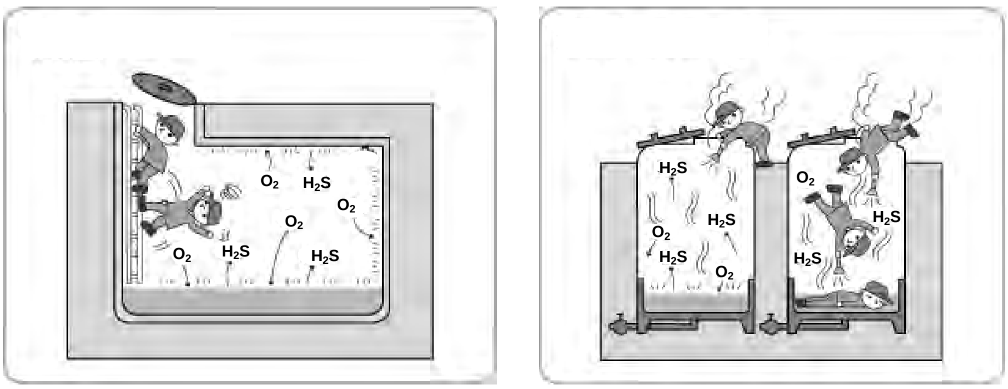
Keep temperature and humidity in appropriate level according to works and seasons. When working under high temperature and high humidity condition, take some measures such as taking breaks in cool places and taking some water and salt to prevent heatstroke.

(b) Hydrogen sulfide poisoning and oxygen deficiency

Hydrogen sulfide is generated by anaerobic decomposition of organic matters and sulfur oxide in sewage. In a sewer or a channel with low flow rate and in a tank, hydrogen sulfide is likely to generate and accumulate up to dangerously high level. At the same time, it is likely to consume oxygen and cause oxygen deficiency. Under such conditions, other gasses such as carbon monoxides and hydrogen cyanide may generate.

Check concentrations of each substance prior to works. If it is high, ventilate or take other measures to reduce the concentration below their allowable limits before starting works. Comply with relevant laws and regulations.

Keep temperature and humidity in appropriate level according to works and seasons. When working under high temperature and high humidity condition, take some measures such as taking breaks in cool places and taking some water and salt to prevent heatstroke.



(Source: Ministry of Health, Labour and Welfare, Japan)

(c) Somatic injury

Many kinds of rotating equipment are installed in WWTPs. Take cautions not to be involved. Fallings from high places or into tanks are frequently happened. These accidents can be avoided by installing safety fences, using ladders or safety belts appropriately and so on.

Attention not to be involved into rotating parts of a dehydrator.

(d) Handling of chemicals

Chemicals used in WWTP should be handled with thorough care because they are very dangerous if they contact on bodies and they may harm treatment facilities and surrounding environment of a plant if they are spilt.

Handle chemicals carefully with wearing rubber gloves, rubber long boots, and protective glasses to prevent chemicals from contacting with skin, eyes, and clothes. If chemicals on, cleanse thoroughly with running clean tap water.

If sodium hypochlorite and poly aluminum chloride or ferric chloride are mixed, they generate chlorine gas and it is very dangerous. In Kim-lien, pay attention in handling with them because their tanks are located in the same place, which means that it is danger once they are spilt.

Common chemicals used in WWTPs are as below.

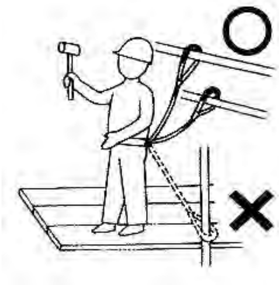
Sodium hypochlorite （NaClO）	－Colorless to yellow, characteristic breach odor, strong alkali liquid with specific gravity 1.2. Utilized as disinfectant for water treatment. －Highly corrosive and almost metals and natural fibers are eaten. Titanium, polyfulorocarbons, rigid polyvinyl chloride, and polyethylene are corrosion-resistance. －Eye contact causes severe pain. Immediately flush eyes with water otherwise cornea will be damaged. Skin contact causes inflammation. Inhalation of the mist irritates mucous membrane of the mouth, larynx, and pharyngeal tube and produces burning sensation and pain.
Ferric chloride （$FeCl_3$）	－Blackish brown, characteristic bleach odor, strong acid liquid with specific gravity 1.4. Utilized as disinfectant for water treatment. －Highly corrosive and almost metals and natural fibers are eaten. Titanium, polyfulorocarbons, rigid polyvinyl chloride, and polyethylene are resistant to corrosion. －Eye contact causes severe pain. Immediately flush eyes with water otherwise cornea will be damaged. Skin contact causes inflammation. Inhalation of the mist irritates mucous membrane of the mouth, larynx, and pharyngeal tube and produces burning sensation and pain
Polyaluminum chloride （$Al_2(OH)_nCl_{6-n}$）	－Faun colored, odorless, acid liquid with specific gravity 1.2. －Iron, aluminum, copper and alloy of these metals are gradually corroded. SUS316 and higher, hastelloy, vinyl chloride, and polyethylene are resistant to corrosion. －Skin contact causes inflammation. Eye and mucous membrane causes irritation.
Polymer	Currently used alon flock(C-525H) is cation polymer. Solution of cation polymer is acid and highly corrosive. Store in tanks made of rigid vinyl chloride, plastic such as FRP, stainless and so on.
Sodium hydroxide (NaOH)	－Colorless, strong alkali liquid with specific gravity 1.2. －Iron, copper, aluminum, and natural fibers are corroded. Vinyl chloride and polyethylene are resistant to corrosion. －Eye contact cause severe pain. Immediately flush eyes with water otherwise cornea will be damaged. Skin contact causes inflammation. Inhalation of the mist irritates mucous membrane of the mouth, larynx, and pharyngeal tube and produces burning sensation and pain.

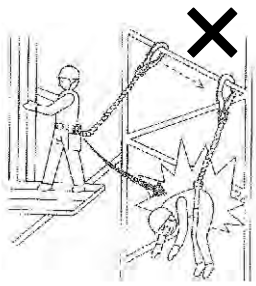
(e) Fire

As measures against fire, fire distinguishers should be installed. Fire distinguishers should be allocated to each place. Pay attention to effective periods of fire extinguishers. And evacuation trainings are effective.

(f) Safety belt

Wear a safety belt to prevent fallings during works at high place more than 2 meters. Also wear a safety belt for works in sludge tanks or manholes which has risk of oxygen deficiency.

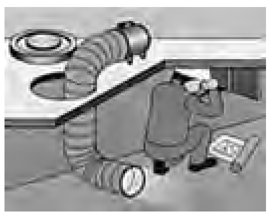




(Source: HP of Polymer Gear Co., Ltd)

(g) Ventilator

A ventilation device consists of a fan and a duct aiming to exchange oxygen deficient air and fresh air. There are two ways to send air: blowing air and exhausting air. Blowing air is more efficient as ventilation.



(Source: HP of Shizuoka Seiki Co., Ltd)

(h) First aid box

First aid box is used for small injury such as cut or burn. Place the box where easily accessed.

3S.C Supplemental Manual

Electric & Instrumentation Equipment Inspection / Maintenance

August 2011

TABLE OF CONTENTS

C-1. Introduction

This is the supplemental manual for the original one. This manual focuses on “Electric” and “Instrumentation” equipments. For other equipments, please refer to the original O&M manual.

C-2. Cautions

C-2.1. Qualified Electrician (also written in the original)

Only qualified electricians are permitted to maintain electrical equipments.

C-2.2. Power Cut-off Planning for Annual inspection

Planning power cut-off is very important to prevent electric shock and to keep worker’s safety.

(A) Power cut-off / resume schedule

Power cut-off / resume schedule Are as follows:

a. What time, power cut-off?

b. How long, power cut-off?

c. What time, resume power supply?

(B) Power Resume

Before resuming power supply, check following items:

a. All workers finished inspection and/or maintenance works.

b. Every each terminal is isolated.

c. Cross-check the number of used cleaning tools. Remaining used cleaning tools in the panel will be high risk of short circuit. If the number dose not match between before and after, find out all used cleaning tools.

C-2.3. Schedule Suspended

In rainy day, there is very high risk in inspection / maintenance works. If it rains on the planned date, inspection / maintenance works should be suspended. Occasional date is also needed to be included into an original inspection / maintenance plan in advance.

C-3. Monthly Inspection Items

C-3.1. Panel Outside

(A) Stain / Coating

a. Visually inspect if there is neither stain nor paint come-off on equipment.

b. If stain or paint come off is observed, scrape the surface and paint there.

(B) Deformation / Deterioration

a. Visually inspect if there is neither deformation nor deterioration on equipment.

b. If deformation or deterioration is observed, report to related authorities for repairing the defect.

(C) Fouling

a. Visually inspect if equipment is not severely fouled with dust or oil.

b. If observed fouling is severe, rub with dry cloth to clean the equipment.

(D) Confirmation of Indicated Values

a. Check an indicated value on an indicator of each panel.

b. Record checked values on every panel.

(E) Confirmation of Indicator Lamp

a. Pressing down a test button, confirm if the indicator lamp will be on.

b. If it doesn’t turn on, consider replacing the lamp.

C-3.2. Panel Inside

(A) Abnormal Noise

a. Aurally inspect if there is not abnormal noise such as buzzing on devices in each panel (such as circuit breaker, contactor, and relay) compared with usual sound.

b. When abnormal noise is detected, stop and resume related equipment and see if the noise stops.

c. After for a while, if it is still making a noise, replace the device.

(B) Vibration

Before checking vibration, remove your rings, watches, bracelets, anything metals from your fingers and wrists to prevent electric shock!

a. Conduct inspection with the sense of hearing and touch, and confirm if there is abnormal vibration on devices in each panel (such as circuit breaker, contactor, and relay) compared with usual sound.

b. When abnormal vibration is detected, stop and resume related equipment and see if the vibration stops. After for a while, if it is still making a vibration, replace the device.

(C) Abnormal Smell

a. Using sense of smell, confirm if abnormal smell such as burnt smell is not detected.

b. If abnormal smell is detected, see carefully if any device, wire, and terminal is not discolored or smoking.

c. If any abnormal part is observed, stop related equipment and replace the part.

(D) Generation of Heat

Before checking vibration, remove your rings, watches, bracelets, anything metals from your fingers and wrists to prevent electric shock!

a. Using sense of touch and comparing with usual state, confirm if devices are not overheated (such as circuit breaker, contactor, and relay) in each panel.

b. If generated heat is out of ordinary, replace the device.

C-3.3. Ultrasonic Level Sensor / Magnetic Flow Meter / DO Meter

(A) Error Code / Alarm

a. If indicator shows some error code and/or alarm signal, refer to manufacturer's manual.

b. If the device will not be fixed, report to related authorities and plan the urgent repairing / maintenance schedule.

(B) Incorrect Indication

a. If indicator is installed on a converter, check if the indicated value is correct.

b. If incorrect indication is seen, consider replacing the converter.

(C) Abnormal Smell

a. Using sense of smell, confirm if abnormal smell such as burnt smell is not detected.

b. If any abnormal part is observed, stop related equipment immediately and report to related authorities for the part replacement.

(D) Generation of Heat

a. Using sense of touch and comparing with usual state, confirm if converters are not overheated.

b. If generated heat is out of ordinary, report to related authorities and replace the converter.

C-3.4. Manometer

(A) Incorrect Indication

a. Checking if the indicated value is correct and/or manometer is broken.

b. If incorrect indication and/or broken manometer are seen, report to related authorities and consider replacing plan.

C-3.5. Others

(A) Junction Box

a. Visually inspect if there is no deformation on a junction box.

b. If deformation is observed, report to related authorities and plan the junction box replacement.

(B) Junction Box Connector

a. Visually inspect if there is no damage on a junction box connector.

b. If junction box connector is damaged, report to related authorities and plan the junction box connector replacement.

(C) Cable

a. Visually inspect if there is no damage on a cable.

b. If the cable is damaged, report to related authorities and plan the cable replacement.

C-4. Annual Inspection Items

Before starting annual inspection, cut off power supply by qualified electrician.

C-4.1. Panel Inside

(A) Loose Terminal

a. Using an insulated screwdriver, confirm tightness with sense of touch.

b. If the terminals are loose, re-torque them. Pay attention not to wrench off the bolt.

(B) Cleaning

a. Clean inside of panel and inner devices while power supply is cut off.

b. After power supply is cut off (just before starting cleaning), check voltage at energized parts to prevent electric shock.

(C) Performance Test of Protective Relay

“Performance Test” needs power supply. Follow qualified electrician and be careful to prevent electric shock.

a. Pressing down a test button, confirm performance of each protective relay, such as ground-fault circuit interrupter and thermal relay.

b. If it doesn’t work, consider replacing the protective relay.

c. Performance test procedure should follow to manufacturer’s manual.

C-4.2. Float Level Switch

When opening the tank, take care to not inbreathe some gas!

(A) Cleaning

a. Lifting up float level switch and clean it with water.

(B) Performance Test

a. Lift up float switch and checking if that works correctly (relay makes or breaks).

b. Check if relay performance (make/break) is referring to the diagram drawing.

C-4.3. Electrode Level Switch

When opening the tank, take care not to inbreathe some gas and/or chemicals.
Electrode switch is often used for chemical tanks. Some chemicals damage human body. For preventing injury, taking goggle (for eye), mask (for not inbreathing) and gloves (for hands) is very important.

(A) Cleaning

a. Checking the electrode level switch if some garbage there.

b. If some garbage is observed, remove it.

(B) Performance Test

a. Lifting up whole electrode level switch with terminal socket and short common electrode.

b. Check electrode with some electrical conductors if relay works correctly (make or break)

c. Check if relay performance (make/break) is referring to the diagram drawing.

C-4.4. Ultrasonic Level Sensor / Magnetic Flow Meter / DO Meter

(A) Indicated Value

a. Cross-check the indicated value between the local and the center.

b. If the values are not identical, report to related authorities and consider of the manufacturer's maintenance and/or calibration.

(B) Replace Consumables

a. Replace consumables.

b. Consumables to be replaced should be according to "Equipment Manual by EBARA".

c. Consumable replacement procedure should follow to manufacturer's manual.

C-4.5. Weir Flow Meter

(A) Indicated Value

a. Cross-checking the indicated value between the local and the center.

b. If the indicated values are not identical, report to related authorities and consider of the manufacturer's maintenance and/or calibration.

C-4.6. Others

(A) Junction Box Connector

a. With sense of touch, inspect if there are connectors loosen.

b. If connectors are loose, re-torque them by hand.

C-5. Device List

Following device lists show panels and instrumentation devices for monthly and annually inspection.

C-5.1. Kim Lien WWTP

(A) Panels

Tag	Name	Notes
LP-1	Local Control Panel	outside
LP-2	Local Control Panel	outside
LP-3	Local Control Panel	outside
LP-4	Local Control Panel	inside
LP-5	Local Control Panel	outside
LP-6	Local Control Panel	inside
LP-7	Local Control Panel	inside
SVP	Supervisory Panel	inside
LTDP	L/T Distribution Panel	inside
PS-LTDP	Low Tension Distribution Panel	inside

(B) Instrumentation Devices

Tag	Name	Type
K-LS2	Equalization Tank Level	float level switch
K-LS3	PST Scum Pit Level	float level switch
K-LS4A	Reactor Level	float level switch
K-LS4B	Reactor Level	float level switch
K-LS5	FST Scum Pit Level	float level switch
K-LS6	NaClO Storage Tank Level	electrode level switch
K-LS7	Sludge Reservoir Level	float level switch
K-LS8	Polymer Tank Level	electrode level switch
K-LS9	Dehydrator Room Drainage Tank Level	float level switch
K-LS10	Filtrate Return Pit Level	float level switch
K-LS11	Recycle Water Pit Level	float level switch
K-LS12	Coagulant Storage Tank Level	electrode level switch
K-LIA1	Equalization Tank Level	ultrasonic level sensor
K-FI1	Grit Chamber Air Flow	manometer
K-FI3A	Recirculation Pump Flow	magnetic flow meter
K-FI3B	Recirculation Pump Flow	magnetic flow meter
K-FI4	Effluent Flow	weir flow meter
K-FI5A	Reactor Air Flow	manometer
K-FI5B	Reactor Air Flow	manometer
K-FIQR4	ET Transfer Pump Flow	magnetic flow meter
K-FIQ1	PST Sludge Flow	magnetic flow meter

K-FIQ2	WAS Flow	magnetic flow meter
K-DOI1A	Reactor DO	
K-DOI1B	Reactor DO	

C-5.2. Truc Bach WWTP

(A) Panels

Tag	Name	Notes
LP-1	Local Control Panel	outside
LP-2	Local Control Panel	outside
LP-3	Local Control Panel	outside
LP-4	Local Control Panel	inside
LP-5	Local Control Panel	outside
LP-6	Local Control Panel	inside
LP-7	Local Control Panel	inside
LTDP	L/T Distribution Panel	inside
SVP	Supervisory Panel	inside

(B) Instrumentation Devices

Tag	Name	Type
T-LS1	Truc Bach Influent Pump Pit Level	float level switch
T-LS2	Equalization Tank Level	float level switch
T-LS3	PST Scum Pit Level	float level switch
T-LS4A	Reactor Level	float level switch
T-LS4B	Reactor Level	float level switch
T-LS5	FST Scum Pit Level	float level switch
T-LS6	NaClO Storage Tank Level	electrode level switch
T-LS7	Sludge Reservoir Level	float level switch
T-LS8	Polymer Tank Level	
T-LS9	Dehydrator Room Drainage Tank Level	float level switch
T-LS10	Filtrate Return Pit Level	
T-LS11	Recycle Water Pit Level	float level switch
T-LS12	Coagulant Storage Tank Level	electrode level switch
T-LS13	Effluent Pump Pit Level	
T-LIA1	Equalization Tank Level	ultrasonic level sensor
T-FI1	Grit Chamber Air Flow	manometer
T-FI3A	Recirculation Pump Flow	magnetic flow meter
T-FI3B	Recirculation Pump Flow	magnetic flow meter
T-FI4	Effluent Flow	weir flow meter
T-FI5A	Reactor Air Flow	manometer
T-FI5B	Reactor Air Flow	manometer

T-FIQR1	ET Transfer Pump Flow	magnetic flow meter
T-FIQ1	PST Sludge Flow	magnetic flow meter
T-FIQ2	WAS Flow	magnetic flow meter
T-DOIR1A	Reactor DO	
T-DOIR1B	Reactor DO	

C-5.3. Kim Lien Pumping Station

(A) Panel

Tag	Name	Notes
PS-LTDP	Low Tension Distribution Panel	inside

(B) Instrumentation Device

Tag	Name	Type
K-LS1	Kim Lien PS Level	float level switch

C-5.4. North Thang Long WWTP

(A) Panels

Tag	Name	Notes
SVP	Supervisory Panel	inside
LVIP	Low Voltage Incoming Panel	inside
CSP	Changeover Switch Panel	inside
LVDP	Low Voltage Distribution Panel	inside
PSSP	Primary Sludge Scraper Panel	outside
AFSSP	Anaerobic & Final Sludge Scraper Panel	outside
SAP-1	Surface Aeration Panel-1	outside
SAP-2	Surface Aeration Panel-2	outside
SAP-3	Surface Aeration Panel-3	outside
SAP-4	Surface Aeration Panel-4	outside
CMBP	Channel Mixing Blower Panel	inside
DP	Deodorization Panel	outside
GCP	Grit Chamber Panel	inside
LPP	Lift Pump Panel 1-3	inside
PSP	Primary Sludge Panel	inside
RWP	RAS & WAS Panel	inside
WSSP	Water Supply System Panel	inside
FWP	Filter Water Panel	inside
STP-1	Sludge Treatment Panel -1	inside
STP-2	Sludge Treatment Panel -2	inside
DWP	Dewaterer Panel	inside
	Cake Hopper Control Panel	inside
	Deodorization Control Panel	outside
	Charger No.1 Cubicle	inside
	Charger No.2 Cubicle	inside

(B) Instrumentation Devices

Tag	Name	Type
LCA1	Grit Chamber Level	electrode level switch
LCA2-1	Pump Well Level	electrode level switch
LCA2-2	Pump Well Level	electrode level switch
LICA3	Pump Well Level	ultrasonic level sensor
LCA4	Secondary Effluent Tank Level	electrode level switch
LCA5	Filtered Water Tank Level	electrode level switch
LCA6	Mixed Sludge Storage Tank Level	float level switch
LICA7	Mixed Sludge Storage Tank Level	ultrasonic level sensor
LCA8	Filtrate Tank Level	float level switch
LCA9	NaClO Storage Tank Level	
LCA10	FeCl3 Storage Tank Level	
LCA11	Polymer Tank Level	float level switch
LCA12	NaClO Storage Tank Level	float level switch
LCA13	NaOH Storage Tank Level	float level switch
LC14	Deep Well Level	
LCA15	Water Supply Unit Tank Level	electrode level switch
LCA16	NaClO Storage Tank Level for Well Water	electrode level switch
LCA17	FeCl3 Storage Tank Level for Well Water	electrode level switch
LCA18	Chemical Scrubber Level	
DOI-1	Reactor DO	
DOI-2	Reactor DO	
FIQ1	Pump Well Flow	magnetic flow meter
FIQ2-1	FST RAS Flow	magnetic flow meter
FIQ2-2	FST RAS Flow	magnetic flow meter
FIQ3	PST Sludge Flow	magnetic flow meter
FIQ4	FST WAS Flow	magnetic flow meter
FIQ5	Effluent Flow	weir flow meter
pHI-1	NaOH Storage Tank pH	
RS-1	No.1 Lifting Pump Rotation Speed	
RS-2	No.2 Lifting Pump Rotation Speed	

5S.A Reference Documents - Supplemental

A-1. Definitions of Technical terms

August 2011

TABLE OF CONTENTS

A-1.1. Introduction

Following definitions of technical terms are supplemental for original O&M manuals. If you can't find the technical term what you would like to know, please refer to the original O&M manuals.

A-1.2. Operation

(A) Water temperature

If water temperature rises, the activity of microorganisms will also go up. Therefore, the efficiency of wastewater treatment increases. On the other hand, decomposition and generating of hydrogen sulfide also increase. The design value of the water temperature of these WWTPs is 20℃ to 30℃.

(B) Appearance

Check tint and shade of color, and existence of floating matter and foaming. By checking a daily change, abnormalities are found quickly

(C) Odor test

The odor of wastewater is generated by decomposition of organic matter. The main odor ingredients are ammonia, methyl mercaptan, trimethylamine, acetaldehyde, hydrogen sulfide, and dimetyl sulfide. By checking a daily change, abnormalities are found quickly.

(D) pH

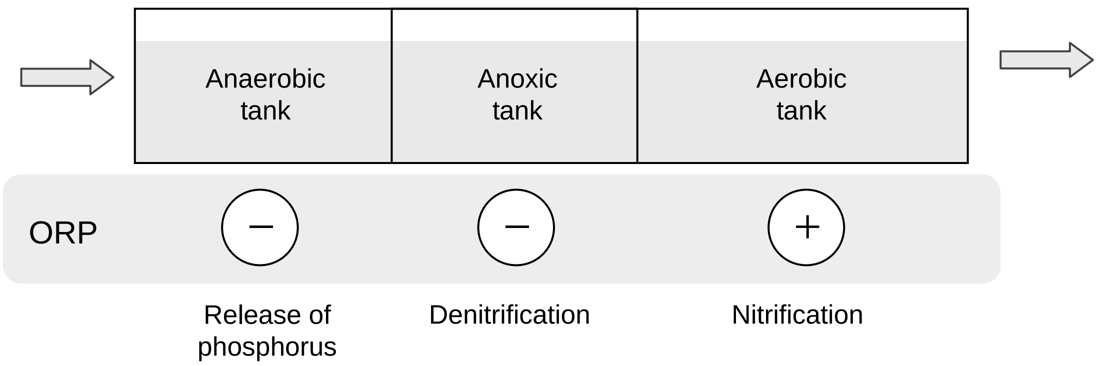
Express acid / neutral / alkali in numerical values. Suitable pH value for biological treatment is 7.2 - 7.4.

(E) DO (dissolved oxygen)

Concentration of oxygen dissolved in water. The concentration is affected by water temperature. DO is an important parameter for operating aeration tanks.

(F) ORP (oxidation-reduction potential)

Express oxidation-reduction potential. In living cells, anaerobic cells have high potential and anaerobic cells have low potential. Therefore ORP in an anaerobic tank and an anoxic tank should be kept low. ORP in an aerobic tank should be controlled so as to keep positive.



(G) BOD (biological oxygen demand)

BOD is a parameter to determine water pollutant index. It is oxygen consumption when microorganisms utilize in oxidizing water pollutant under a certain condition. High BOD indicates more pollutants in water.

(H) SS (suspended solid)

SS is one of parameter to see water pollutants. Solids suspended in water.

(I) Nitrogen（In wastewater）

Nitrogen change forms by nitrifying bacteria and denitrifying bacteria through processes in WWTP. Treatment states can be assessed by measuring concentrations of each form of nitrogen.

- Total nitrogen
  - Inorganic nitrogen compound
    - Ammonia nitrogen — From urine
    - Nitrite nitrogen — Generated by oxidizing ammonium
    - Nitrate nitrogen — Generated by oxidizing nitrite
  - Organic nitrogen compound — From protein and amino acid. Decompose into ammonia nitrogen by biological treatment

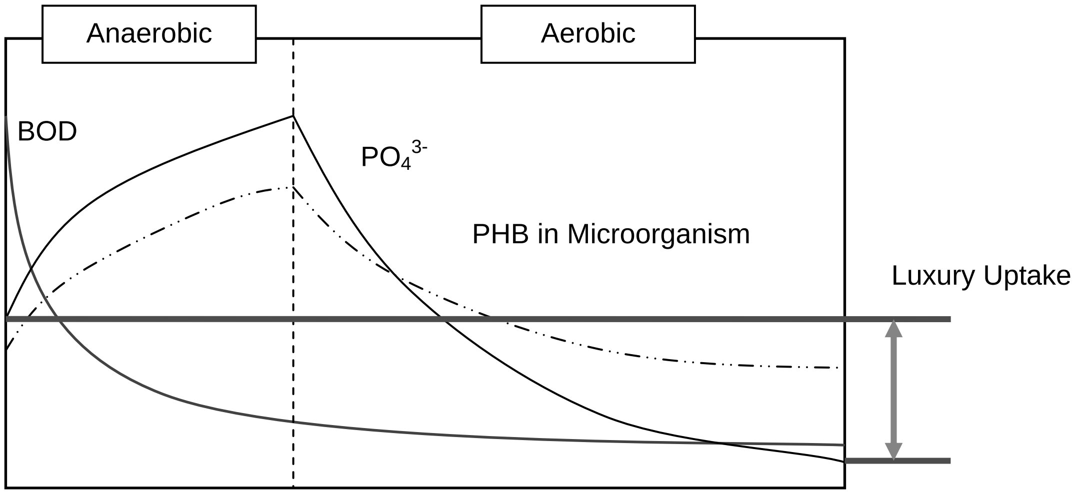
(J) Phosphorus

Phosphorus included in human waste, detergent, and manure flows into wastewater treatment plant. Being treated in anaerobic tank and the following aerobic tank, PO_4^{3-} is accumulated in cells of microorganism as granular polyphosphate.

Bacteria returned to anaerobic tank from final settling tank take organic matters in mixed liquor and accumulate it as PHB (poly-β-hydroxy butyrate) in the cell. At the same time, transform polyphosphate into phosphate ion and release it into mixed liquor.

After returning to the aerobic tank, bacteria then oxidize PHB in the cell. By using the energy obtained through oxidation, bacteria store more phosphate as polyphosphate in the cell than released in anaerobic tank

Bacteria other than nitrification bacteria are heterotrophic bacterium, which requires organic matters to survive and multiplication.



(K) BOD:N:P ratio

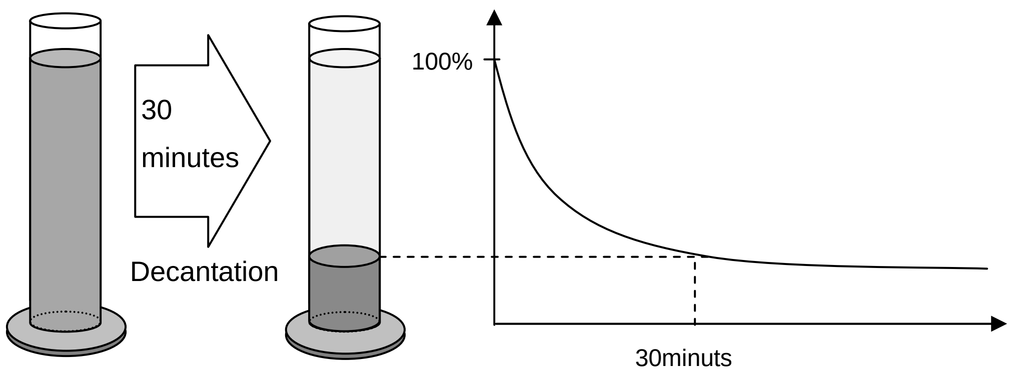
The ratio of BOD, nitrogen and phosphorous in influent. In biological wastewater treatment process, it is supposed as nutritional balance required for multiplication of a microbe that BOD:N:P is 100:5:1. Moreover, BOD/N ratio required for denitrification is over 3. BOD/P ratio required for removal of phosphorus is over 20.

(L) MLSS

Concentration of activated sludge in an aeration tank. Appropriate MLSS values change according to plants and seasons. Check MLSS regularly and designate target values of MLSS.

(M) SV

Sample 1 litter of mixed liquor and decant it in a measuring cylinder for 30 minutes. SV is percentage of settled sludge volume to mixed liquor. It is an important parameter to estimate sludge settleability in a final settling tank.



(N) SVI

Calculate with the following equation. SVI expresses sludge settleability and sludge consolidation characteristics. Around 100 of SVI is preferable.

$$SVI = SV(\%) \times 10000 / MLSS(mg/L)$$

(O) Microorganism

Kinds of microorganisms appeared in activated sludge are relevant to treatment conditions. However, treatment conditions should be assessed by not only microorganisms but also overall aspects including other water qualities.

Group	Major indicating microorganism	Characteristics
Non-activated sludge organisms	Uronema, Colpidium, Glaucoma, Oicomonas, Bodo, Dexiotrichides, Oaramecium	Performance of activated sludge: not enough Efficiency of decomposing organics: low.
Intermediate activated sludge organisms	Litonotus, Loxophyllum, Chilodonella, Oxytricha, Trachelophyllum	Performance of activated sludge: almost enough Efficiency of decomposing organics: Unstable
Activated sludge organisms	Aspidisca, Vorticella, Epistylis, Carchesium, Opercularia, Zoothamnium, Philodina, Rotaria	Performance of activated sludge: Stable Efficiency of decomposing organics: High

(P) Coliform Group

Gram-negative, asporogenic single rod bacteria. A general term for aerobic / facultative bacteria which decomposes lactose into gasses and acid. The number of coliform group is a parameter to determine purifying effect of WWTP and hygienic safety of effluent. Design values of the number of coliform groups is < 20,000MPN / 100mL.

(Q) Residual Chlorine

For purpose of disinfection of treated water, sodium hypochlorite is dosed in a disinfection tank. Concentration of sodium hypochlorite decreased as it is consumed in disinfection. Concentration of remained sodium hypochlorite is called concentration of residual chlorine.

When coliform increases, dosage of sodium hypochlorite should be increased. However, high concentration of residual chlorine in treated water affects biological environment in receiving water body. It is preferable to keep residual chlorine under 0.1 mg/L at outlet of a disinfection tank.

(R) Water content

Percentage of water contents by weight to sludge or dewatered sludge cake. Deteriorated (high) water contents indicates that sludge condition deteriorates, sludge supply volume is improper, chemical dosage is not appropriate, tension of filter cloth is not suitable, and filter cloth is clogged.

(S) Organic loading and ratio of food to microorganisms (F/M)

Amount of BOD which is treated per unit of sludge by day. F / M is expressed as the following equation.

F / M = QS / VX

Where

Q = flow rate

S = concentrate of BOD_5 of influent

V = Reactor volume

X = MLSS

(T) Return sludge ratio

Return sludge is sludge which is returned from a final settling tank to a reactor in order to keep MLSS concentration. Return sludge ration is expressed as the following equation.

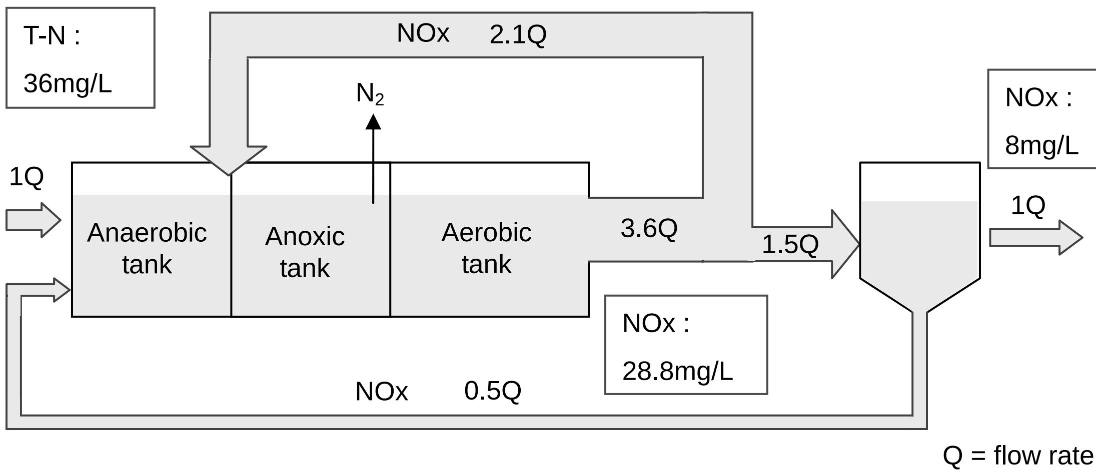
Return sludge ratio = Return sludge volume / Influent volume into a reactor×100

(U) Recirculation ratio

Recirculation is to circulate a part of nitrification mixed liquor from an aerobic tank to an anoxic tank. The supplementary explanations to the existing manual are as follows.

Design value of total nitrogen contained in influent to the reactor is 36 mg/L. It is designed that 80% of the total nitrogen is nitrified in the reactor. Therefore, NOx-N contained in effluent of the reactor is to be 28.8 mg/L. And designed concentration of NOx-N in effluent from the final sedimentation tank is 8mg/L. To remove NOx-N further more, circulate water into the reactor.

As a result, recirculation ratio is calculated as 28.8/8-1=2.6, which is designed in the existing manual. This is described in a diagram below. It is important for operational management to check proceeding of nitrification at outfall of the reactor.



(V) Sludge-liquid interface

Interface which can clearly divide settled sludge and supernatant in a settling tank. When interface is high, it is easy to cause the outflow of sludge. Moreover it is easy to decompose sludge. Therefore, managing with the lowest possible value is desirable.

(W) Mass balance

Details of checking of mass balance are described in the existing manual of North-Tang Long. It is the most important operational subject for wastewater treatment to treat sludge properly.

A-1.3. Electric Equipments

A-1.3.1. Panel Equipments

(A) MCCB (Molded Case Circuit Breaker)

MCCB turns on / cuts off the circuit by manual. In the case of circuit have over-load and/or short, MCCB trips that circuit automatically.

(B) ELR (Earth Leakage Relay)

Checking circuit if no earth leakage is happening. If earth leakage happens, ELR trips the circuit and alarms equipment fault.

(C) ELCB (Earth Leakage Circuit Breaker)

This equipment has both functions of MCCB and ELR in one molded case.

(D) Thermal Relay

Checking circuit if no over-load is happening. If over-load happens, Thermal Relay trips the circuit and alarms equipment fault.

(E) Relay

Relay is one of the components of automatic control circuit. Some relay have indicator lamp when it works. By this indicator lamp, qualified electrician can grasp current automatic control condition with control diagram drawing.

(F) Time Switch

Time Switch is one of the components of automatic control circuit. This makes equipments on/off control by setting time in auto mode.

(G) Controller

Controller is the main device of automatic control circuit.

A-1.4. Instrumentation Equipments

A-1.4.1. Flow Meter

(A) Magnetic type

Measuring pipe flow quantity. This type is often installed in influent pipes, return sludge pipe, waste sludge pipe and so on.

(B) Weir type

Measuring canal flow quantity. This type is often installed to effluent flow canals.

A-1.4.2. DO Meter

(A) Measuring device for DO (Dissolved Oxygen) value in the aeration tank.

A-1.4.3. Level Sensor

Measuring water, chemical and sludge level with the sensor. This device is installed for automatic control. We can grasp water, chemical and sludge level numerically.

A-1.4.4. Level Switch

(A) Float type

Making / breaking contact with floatation of the switch. We can make automatic control by the control circuit with these making/ breaking contacts.

(B) Electrode type

Making / breaking contact with conduction of liquid. We can make automatic control by the control circuit with these making/ breaking contacts.

Data Entry Sheet - Equipment List

Equipment name	Facility name	Classification	Style	Installed year	Contractor

Data Entry Sheet – Equipment

Item Name	Description
Equipment name	
Plant name	
Installed location	
Status of use	
Facility name	
Classification of facility	
Installed year	
Expected lifetime	
Depreciation period	
Construction name	
Contractor	
Main Equipment	
Panel number for Electrical Instrumentation	
Style	
Style number	
Production number	
Manufacturer name	
Production date	
Specification	
Notes	
Accessory	
Name	
Quantity	
Style	
Style number	
Production number	
Manufacturer name	
Production date	
Specification	
Notes	

Data Entry Sheet - Equipment 【Accessories】

Equipment name		Facility name			

Name	Quantity	Specification	Style	Style number	Production number	Manufacturer name	Production date	Notes

Data Entry Sheet - Book List

BookNo	Title1	Title2	Year	Volume	Location

Data Entry Sheet - Spare parts List

Parts Name	Specifications	Manufacturer	Unit	Storage location	Notes

Data Entry Sheet - Spare parts

Facility Name		
Classification		
Parts Name		
Specifictions		
Manufacturer		
Storage location		
Unit		
Notes		

Object of stock management	Yes / No
Order Volume	
Maximum storage quantity	
Minimum storage quantity	

Data Entry Sheet - Stock List

Item Name	Specification	Strage location	Unit	Present stock quantity	Minimum stock quantity

Data Entry Sheet - Construction List

Construction number	Construction name	Year	Contractor

Data Entry Sheet – Construction

Item Name	Description
Construction number	
Construction name	
Year	
Facility name	
Location of construction	
Classification of construction	
Overview of construction	
Contractor	
Contract amount	
Contract date	
Completion date	
Notes	
Target Equipment	
No.1 Equipment Name, Amount, Notes	
No.2 Equipment Name, Amount, Notes	
No.3 Equipment Name, Amount, Notes	
No.4 Equipment Name, Amount, Notes	
No.5 Equipment Name, Amount, Notes	
No.6 Equipment Name, Amount, Notes	

Data Entry Sheet – Operating hours of machine

Monthly

Day	Day of Week	Machine Name									
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
Total											

Data Entry Sheet – Maintenance

Monthly

Date	Day of Week	Equipment1 Name					Equipment2 Name					Equipment2 Name				
		Power supply voltage (V)	Current value (A)	Insulation resistance (Ω)			Power supply voltage (V)	Current value (A)	Insulation resistance (Ω)			Power supply voltage (V)	Current value (A)	Insulation resistance (Ω)		
				U–E	V–E	W–E			U–E	V–E	W–E			U–E	V–E	W–E

Data Entry Sheet - Maintenance List

Maintenance number	Maintenance name	Year	Contractor

Data Entry Sheet – Maintenance

Item Name	Description
Maintenance number	
Maitenance name	
Year	
Facility name	
Location of maintenance	
Overview of maintenance	
Contractor	
Contract amount	
Contractor	
Contract date	
Completion date	
Notes	
Target Equipment	
No.1 Equipment Name, Date, Amount, Notes	
No.2 Equipment Name, Date, Amount, Notes	
No.3 Equipment Name, Date, Amount, Notes	
No.4 Equipment Name, Date, Amount, Notes	
No.5 Equipment Name, Date, Amount, Notes	
No.6 Equipment Name, Date, Amount, Notes	

Monthly Water Quality Report 1/10

Day	Day of week	Weather	Rainfall	Flow rate			wastewater influent							
				wastewater influent volume	recycle flow volume	primary effluent volume	water temperature	transparency	pH	SS	COD	BOD	T-N	T-P
			mm	m^3	m^3	m^3	℃	cm	-	mg/L	mg/L	mg/L	mg/L	mg/L
Target/Setting Value		---	---											
		---	---											
1	Sun													
2	Mon													
3	Tue													
4	Wed													
5	Thu													
6	Fri													
7	Sat													
8	Sun													
9	Mon													
10	Tue													
11	Wed													
12	Thu													
13	Fri													
14	Sat													
15	Sun													
16	Mon													
17	Tue													
18	Wed													
19	Thu													
20	Fri													
21	Sat													
22	Sun													
23	Mon													
24	Tue													
25	Wed													
26	Thu													
27	Fri													
28	Sat													
29	Sun													
30	Mon													
31	Tue													
Sum	---	---	#	#	#	#	---	---	---	---	---	---	---	---
Max	---	---	#	#	#	#	#.#	#	#.#	#	#	#	#.#	#.#
Min	---	---	#	#	#	#	#.#	#	#.#	#	#	#	#.#	#.#
Avg	---	---	#	#	#	#	#.#	#	#.#	#	#	#	#.#	#.#

Monthly Water Quality Report 2/10

Day	Day of week	Primary settling tank							
		transparency	pH	SS	COD	BOD	NH_4-N	T-N	T-P
		cm	-	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Target/Setting Value									
1	Sun								
2	Mon								
3	Tue								
4	Wed								
5	Thu								
6	Fri								
7	Sat								
8	Sun								
9	Mon								
10	Tue								
11	Wed								
12	Thu								
13	Fri								
14	Sat								
15	Sun								
16	Mon								
17	Tue								
18	Wed								
19	Thu								
20	Fri								
21	Sat								
22	Sun								
23	Mon								
24	Tue								
25	Wed								
26	Thu								
27	Fri								
28	Sat								
29	Sun								
30	Mon								
31	Tue								
Sum	---	---	---	---	---	---	---	---	---
Max	---	#	#.#	#	#	#	#.#	#.#	#.#
Min	---	#	#.#	#	#	#	#.#	#.#	#.#
Avg	---	#	#.#	#	#	#	#.#	#.#	#.#

Monthly Water Quality Report 3/10

Day	Day of week	Reactor A water temperature	Reactor A pH	Reactor A DO	Reactor A SV_{30}	Reactor A MLSS	Reactor A SVI	Reactor A anaerobic tank ORP	Reactor A anoxic tank ORP	Reactor A aerobic tank ORP	Reactor A BOD-SS loading	Reactor A SRT
		℃	-	mg/L		mg/L		mV	mV	mV	Kg/kg・day	Day
Target/Setting Value												
1	Sun											
2	Mon											
3	Tue											
4	Wed											
5	Thu											
6	Fri											
7	Sat											
8	Sun											
9	Mon											
10	Tue											
11	Wed											
12	Thu											
13	Fri											
14	Sat											
15	Sun											
16	Mon											
17	Tue											
18	Wed											
19	Thu											
20	Fri											
21	Sat											
22	Sun											
23	Mon											
24	Tue											
25	Wed											
26	Thu											
27	Fri											
28	Sat											
29	Sun											
30	Mon											
31	Tue											
Sum	---	---	---	---	---	---	---	---	---	---	---	---
Max	---	#.#	#.#	#.#	#	#	#	#	#	#	#.##	#.#
Min	---	#.#	#.#	#.#	#	#	#	#	#	#	#.##	#.#
Avg	---	#.#	#.#	#.#	#	#	#	#	#	#	#.##	#.#

Monthly Water Quality Report 4/10

Day	Day of week	Reactor B water temperature	pH	DO	SV_{30}	MLSS	SVI	anaerobic tank ORP	anoxic tank ORP	aerobic tank ORP	BOD-SS loading	SRT
		℃	-	mg/L		mg/L		mV	mV	mV	Kg/kg・day	Day
Target/Setting Value												
1	Sun											
2	Mon											
3	Tue											
4	Wed											
5	Thu											
6	Fri											
7	Sat											
8	Sun											
9	Mon											
10	Tue											
11	Wed											
12	Thu											
13	Fri											
14	Sat											
15	Sun											
16	Mon											
17	Tue											
18	Wed											
19	Thu											
20	Fri											
21	Sat											
22	Sun											
23	Mon											
24	Tue											
25	Wed											
26	Thu											
27	Fri											
28	Sat											
29	Sun											
30	Mon											
31	Tue											
Sum	---	---	---	---	---	---	---	---	---	---	---	---
Max	---	#.#	#.#	#.#	#	#	#	#	#	#	#.##	#.#
Min	---	#.#	#.#	#.#	#	#	#	#	#	#	#.##	#.#
Avg	---	#.#	#.#	#.#	#	#	#	#	#	#	#.##	#.#

Monthly Water Quality Report 5/10

Day	Day of week	Reactor A							Reactor B						
		supplied air flow		internal recycle		Return activated sludge			supplied air flow		internal recycle		Return activated sludge		
		volume	rate	volume	rate	concentration	volume	ratio	volume	rate	volume	rate	concentration	volume	ratio
		Nm^3	times	m^3	%	mg/L	m^3	%	Nm^3	times	m^3	%	mg/L	m^3	%
Target/Setting Value															
1	Sun														
2	Mon														
3	Tue														
4	Wed														
5	Thu														
6	Fri														
7	Sat														
8	Sun														
9	Mon														
10	Tue														
11	Wed														
12	Thu														
13	Fri														
14	Sat														
15	Sun														
16	Mon														
17	Tue														
18	Wed														
19	Thu														
20	Fri														
21	Sat														
22	Sun														
23	Mon														
24	Tue														
25	Wed														
26	Thu														
27	Fri														
28	Sat														
29	Sun														
30	Mon														
31	Tue														
Sum	---	#	---	#	---	---	#	---	#	---	#	---	---	#	---
Max	---	#	#.#	#	#	#	#	#	#	#.#	#	#	#	#	#
Min	---	#	#.#	#	#	#	#	#	#	#.#	#	#	#	#	#
Avg	---	#	#.#	#	#	#	#	#	#	#.#	#	#	#	#	#

Monthly Water Quality Report 6/10

Day	Day of week	Final settling tank						
		Sludge-liquid interface						transparency
		1-1	1-2	1-3	2-1	2-2	2-3	
		m	m	m	m	m	m	cm
Target/Setting Value								
1	Sun							
2	Mon							
3	Tue							
4	Wed							
5	Thu							
6	Fri							
7	Sat							
8	Sun							
9	Mon							
10	Tue							
11	Wed							
12	Thu							
13	Fri							
14	Sat							
15	Sun							
16	Mon							
17	Tue							
18	Wed							
19	Thu							
20	Fri							
21	Sat							
22	Sun							
23	Mon							
24	Tue							
25	Wed							
26	Thu							
27	Fri							
28	Sat							
29	Sun							
30	Mon							
31	Tue							
Sum	---	---	---	---	---	---	---	---
Max	---	#.#	#.#	#.#	#.#	#.#	#.#	#
Min	---	#.#	#.#	#.#	#.#	#.#	#.#	#
Avg	---	#.#	#.#	#.#	#.#	#.#	#.#	#

Monthly Water Quality Report 7/10

Day	Day of week	Final effluent												
		water temperature	transparency	SS	COD	BOD	NH_4-N	NO_3-N	T-N	T-P	quantity of coliform group	residual chlorine	sodium hypochlorite feeding volume	sodium hypochlorite feeding ratio
		℃	cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MPN/100mL	mg/L	L	mg/L
Target/Setting Value														
1	Sun													
2	Mon													
3	Tue													
4	Wed													
5	Thu													
6	Fri													
7	Sat													
8	Sun													
9	Mon													
10	Tue													
11	Wed													
12	Thu													
13	Fri													
14	Sat													
15	Sun													
16	Mon													
17	Tue													
18	Wed													
19	Thu													
20	Fri													
21	Sat													
22	Sun													
23	Mon													
24	Tue													
25	Wed													
26	Thu													
27	Fri													
28	Sat													
29	Sun													
30	Mon													
31	Tue													
Sum	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Max	---	#.#	#	#	#.#	#	#.#	#.#	#.#	#.#	#	#.#	#	#
Min	---	#.#	#	#	#.#	#	#.#	#.#	#.#	#.#	#	#.#	#	#
Avg	---	#.#	#	#	#.#	#	#.#	#.#	#.#	#.#	#	#.#	#	#

Monthly Water Quality Report 8/10

Day	Day of week	Raw sludge				Waste activated sludge			Gravity thickening sludge			
		pH	concentration	drained volume	solids volume	concentration	drained volume	solids volume	pH	concentration	drained volume	solids volume
		-	%	m^3	DS-kg	%	m^3	DS-kg	-	%	m^3	DS-kg
Target/Setting Value												
1	Sun											
2	Mon											
3	Tue											
4	Wed											
5	Thu											
6	Fri											
7	Sat											
8	Sun											
9	Mon											
10	Tue											
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21	Sat											
22	Sun											
23	Mon											
24	Tue											
25	Wed											
26	Thu											
27	Fri											
28	Sat											
29	Sun											
30	Mon											
31	Tue											
Sum	---	---	---	#	#	---	#	#	---	---	#	#
Max	---	#.#	#.#	#	#	#.#	#	#	#.#	#.#	#	#
Min	---	#.#	#.#	#	#	#.#	#	#	#.#	#.#	#	#
Avg	---	#.#	#.#	#	#	#.#	#	#	#.#	#.#	#	#

Monthly Water Quality Report 9/10

Day	Day of week	Storage tank sludge				dewatered sludge					Filtered water SS	grid	screenings
									chemical				
		pH	concentration	Supplying volume	solids volume	Water content	sludge volume	solids volume	Adding ratio	volume			
		-	%	m^3	DS-kg	%	m^3	DS-kg	(TS%)	kg	mg/L	kg	kg
Target/Setting Value													
1	Sun												
2	Mon												
3	Tue												
4	Wed												
5	Thu												
6	Fri												
7	Sat												
8	Sun												
9	Mon												
10	Tue												
11	Wed												
12	Thu												
13	Fri												
14	Sat												
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25	Wed												
26	Thu												
27	Fri												
28	Sat												
29	Sun												
30	Mon												
31	Tue												
Sum	---	---	---	#	#	---	#	#	---	#.#	---	#	#
Max	---	#.#	#.#	#	#	#	#	#	#.#	#.#	#	#	#
Min	---	#.#	#.#	#	#	#	#	#	#.#	#.#	#	#	#
Avg	---	#.#	#.#	#	#	#	#	#	#.#	#.#	#	#	#

Monthly Water Quality Report 10/10

Day	Day of week	Comments on water treatment	Comments on sludge treatment
1	Sun		
2	Mon		
3	Tue		
4	Wed		
5	Thu		
6	Fri		
7	Sat		
8	Sun		
9	Mon		
10	Tue		
11	Wed		
12	Thu		
13	Fri		
14	Sat		
15	Sun		
16	Mon		
17	Tue		
18	Wed		
19	Thu		
20	Fri		
21	Sat		
22	Sun		
23	Mon		
24	Tue		
25	Wed		
26	Thu		
27	Fri		
28	Sat		
29	Sun		
30	Mon		
31	Tue		

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TRAINING MANUAL
FOR
TRAINING OF EMPLOYER'S STAFF

Wastewater Treatment Plant (CP-3 WORKS)

UNDER
THANG LONG NORTH - VAN TRI
URBAN INFRASTRUCTURE DEVELOPMENT PROJECT

Rev.	Date	Description	Prepared by	Checked by	Approved by
A	15 March 05	For Approval	I. Tsuneda	H. Suzuki	J. Sato
0	21 October 04	For Approval	I. Tsuneda	Y. Shinoyama	J. Sato

Revision 2
16 Nov 2004

CONTENTS

(VOLUME 1 OF 6)

1. Explanation of Wastewater Treatment Plant

2. Equipment List

3. Operation and Maintenance

1. EXPLANATION OF WASTEWATER TREATMENT PLANT

This manual is provided to assist the technical and operating personnel for the operation and maintenance of the mechanical and electrical equipment supplied for the Wastewater Treatment Plant.

Every care is taken to give safe and effective operating for operation, and equipment manufacturer's literature is provided and should have read carefully before any operation and maintenance.

The operating condition of all the equipment must be check under the basic instruction of this manual.

1.1 Introduction

The WTP shall be designed for daily flow of 38000 m3, excluding infiltration.

The minimum design flow of the WTP upon completion of the works on this Plant, is anticipated to be around 4,000m3/day. The effect of this shall be taken account of in the Design of the Plant, operating and control systems so that the WTP will operate effectively with these lower volume and so that no portion of the WTP is made redundant for excessive times or deteriorate through under use.

The WTP is to be designed to treat wastewater from the Project area to effluent discharge standard - Class A (the Vietnam Regulation TCVN5495-1995) requirements as follows;

Origin of incoming sewage; Sewage collected from North Thang Long area
Mostly domestic sewage, including partial industrial wastewater

Capacity of the treatment plant
Sewage flow; 38,000 m3/d (excluding ground water infiltration)
Daily flow; 42,000 m3/d (including 4,000 m3/d ground water infiltration)
Peaking factor; 2-2.5 (= Hourly maximum flow / Daily flow)
(It means Hourly Max. Flow is up to 105,000m3/d)

Water quality conditions;

Parameter	Unit	Influent	Effluent
Temperature			—
pH			
BOD_5	mg/l		
SS	mg/l		
COD	mg/l		
Nitrogen	mg/l		
Phosphorus	mg/l		
Coliform	No/100ml	$10 - 10^9$	5000

Note;

a. The effluent water quality is based on the Vietnam Regulation TCVN5495-1995 discharge standard – Class A.

b. The other water qualities of Influent mentioned in the Vietnam Regulation TCVN 5495-1935 but not described here are assumed as equal to or less than the required discharge water qualities.

1.2 Basic process Description

Inlet Works; Grit removal, Screenings removal, Lifting pump
Water treatment; Activated sludge process consists of Primary sedimentation,
Bio-reactor (Anaerobic/Aerobic), Final sedimentation, Disinfection
(Note; "Bio-reactor" is a more snitable word than "Aeration tank" for this process. In this section, "Bio-reactor" is utilized in place of "Aeration tank".)
Sludge treatment; Mechanical thickening & Belt-press dewatering (nnit machine)

1.3 Design concept

- Two main streams for water treatment (Northern and Southern areas)
- Six minor streams for water treatment are prepared to cope with fluctuation of the incoming flow
- Anaerobic/aerobic process is combined in order to prevent sludge bulking and to remove phosphorus
- Re-use treated water partially as process water
- Deodorization system is installed

1.4 Summary of the design basis and main equipment

Location of facilities are shown on the attachment sheet (XJ01H1065-00-221) (page 12)

a. **Inlet works** (Grit Chamber Facility, Lift Pump Facility)

Water surface load; 1,800 m/d (against peak flow)
Number of grit chambers; 3

b. **Wastewater treatment** (Wastewater Treatment Facility, Disinfection Facility)

Primary sedimentation tank water surface load; 50 m/d (against daily flow)
Bio-reactor (Aeration Tank) hydraulic retention time; 8 hr (anaerobic 1.5 hr + aerobic 6.5 hr)
Final sedimentation tank water surface load; 25m/d
Number of water treatment streams; 6
Disinfection tank hydraulic retention time; 15 min
Number of water treatment streams; 2
Note; All the load is calculated based on the daily flow.
Number of disinfection tank ; 1

c. **Sludge treatment** (Sludge Treatment Facility, Sludge Storage Facility)

Sludge thickening and dewatering; Belt-press dewatering (combined with thickening)
Solid Load ; 200kgDS/meter/hr
Sludge storage; storage of the dewatered sludge in the cake stock yard
Operation condition; 24hrs/day (continuous operation)
Number of dewaterers / thickeners; 2 Nos (including 1 No stand-by)

d. **Water supply system** (Water Supply Facility)

Water supply system capacity; 15 m3/d for 33 people/day
Number of well for source ground water; 1
Treatment of the water; rapid filtration with Mn coated media

e. **Deodorization system** (Deodorization Facility)

Deodorization system capacity: 50 m3/min
Number of chemical scrubber for deodorization; 1

1.5 Explanation of each facility

1) **Inlet Works** (Grit Chamber Facility, Lift Pump Facility)

Inlet works facilities consist of three grit chambers and three coarse/fine screens. Each grit chamber contains three sand pumps.
Coarse screenings are removed by the manual screens.
Grit settles in each of the pits and lifted by the sand pumps and will be separated in the grit separator.
Fine screenings will be removed by the automatic screens and conveyed automatically by the conveyor.
All the screenings and grit will be stored in the containers and will be lifted to the trucks by the hoist when the collecting trucks will come.
Total 4 No pumps are provided as the main lift pumps in the grit chamber. The two pumps will be equipped with variable speed motors and the remaining two will be equipped with fixed speed motors. Combination of number control of the pumps in operation and speed control of the variable speed motor pumps ensure the flexible operation of the lift pumps maintaining the grit chamber water level within the reasonable range.

2) **Wastewater Treatment** (Wastewater Treatment Facility, Disinfection Facility)

Judging from the water quality requirements and process selected, main purpose of the treatment is to remove BOD5, SS, and COD.
Effluent water quality limit values for Nitrogen (30mg/l) and Phosphorus (4mg/l) can be achieved by excess sludge extraction from water treatment process, in which Nitrogen and Phosphorus are included in a certain percentage (Nitrogen; approximately 5%, Phosphorus approximately 1%).
Conventional activated sludge process is sufficient and suitable for the above purpose.
In order to improve the sludge settle ability (in other words to avoid sludge bulking) in the final sedimentation tank, A/O process is incorporated in the water treatment. The first zone of each bio-reactor is anaerobic to suppress the development of filamentous bacteria. The following three zones are aerobic to oxidize the organic components.

Effluent COD limit value (50mg/l) will be achieved on the assumption that most of COD component is biodegradable. There is no mention of industrial wastewater mixing ratio and the process requirement is conventional activated sludge process. The selection of COD removal process from industrial wastewater shall be designed based on the actual loading and the chemical components. This Plant design does not include the process to remove the un-biodegradable chemical components in the industrial wastewater.

Generally, BOD5 concentration will be tested with addition of nitrification inhibitor (CBOD5). This is a normal way of testing of the secondary effluent in the United States of America (Standard Methods for the Examination of Water and Wastewater; APHA 1995), in Europe (EU water directive; 91/271/EEC) and in Japan as well. This method is applied in order to avoid the influence of nitrification during the BOD testing, which might double (or more) the BOD5 values originated from the remaining organic pollutants in the effluent.

Phosphorus removal can be enhanced by adding chemicals ($FeCl_3$) to the water.

Water treatment system consists of two streams and each stream will be further divided to three units. Total six units will be provided for water treatment (number of the tanks is six for primary sedimentation tanks, bio-reactors, and final sedimentation tanks)
The initial incoming flow; 4,000m3/d can be treated by one of water treatment units (treatment capacity; approx. 6,300 m3/d) and fluctuation of the incoming flow can be treated with six water treatment units satisfactorily. More systems (than present 6 numbers) require more equipment, more maintenance and more cost. Six units of water treatment facility are suitable for this project.

For primary sedimentation tanks, the sludge scrapers will be of circular type and a by-pass line is provided for temporary use.
In some cases, removal of SS in primary sedimentation tanks will adversely affect the bio-treatment in the bio-reactor (Aeration Tank) (for example, if the effluent from primary sedimentation tank has too weak strength in BOD and SS, the MLSS in the bio-reactor might have poor settling characteristics).
In such a case, partial (or total) by-pass of incoming sewage through primary sedimentation tank will be one of the possible solutions.

In the bio-reactors (Aeration Tanks), mixers will be provided for anaerobic zones and surface aerators will be provided for aerobic zones. Surface aerators will be operated intermittently (by timer setting) according to the strength of the incoming sewage and actual treatment requirements.

For final sedimentation tanks, the sludge scrapers will be of circular type and a flocculation zone is provided to ensure the flocculation of the mixed liquor for solid/liquid separation in the final sedimentation tanks. Flocculation zone, which is a channel between bio-reactors and final sedimentations are aerated gently by the channel aeration blower. By this gentle aeration, flocculation of the mixed liquor is accelerated before entering the final sedimentation tanks.

Disinfection is carried out by dosing sodium hypo-chlorite (10% liquid) into the tank. After the contact time of 15 minutes, the pathogens in the wastewater will be reduced to the safe level for health.

Final effluent from the water treatment process will be further treated by micro-strainer and sand filtration for the recycle use in the treatment plant. The use is for polymer make-up water, sludge dewaterer washing and other miscellaneous purposes (tank washing etc). The capacity of strained water is approx. 1,000 m3/d and the capacity of filtered water is approx.300 m3/d, which is sufficient for the above purposes.

3) **Sludge Treatment** (Sludge Treatment Facility, Sludge Storage Facility)
Sludge thickening and dewatering are incorporated into one unit machine.
Thickening will be carried out on the belt thickener, which is installed at the top of the belt-press dewaterer. Thickened sludge will be supplied to the belt-press dewaterer just under the belt thickener and will be dewatered up to around 82 % water content.

One number dewaterer can treat the whole sludge produced from the water treatment process and total two dewaterers will be provided including one stand-by equipment.

The dewatered sludge will be transferred to the cake hopper at stockyard and stored before the truck will come and collect the sludge for the final disposal.

$FeCl_3$ dosing facilities (storage tank and dosing pumps) are provided in the sludge treatment building.
For sludge dewatering process, polymer dosing is sufficient for normal operation. However, $FeCl_3$ dosing will improve the dewatered cake charateristics (water content / odor emission etc.) when it will be required.
$FeCl_3$ dosing to water treatment will also enhance the removal of Phosphorus from the treated effluent as explained previously.

In order to improve the working conditions in the cake stockyard, odorous gas will be extracted from the cake hopper at stockyard. Deodorization system with chemical scrubber is installed. In addition, the extracted gas will be introduced to the mixed liquid channel through the channel aeration blowers and the odor components will be adsorbed to the sludge and decomposed biologically, thus reducing the odor emission from the treatment plant.

4) **Water Supply System** (Water Supply Facility)
Well water is treated and supplied for the domestic use in the plant area.

Well water is coming from the newly constructed well and will be treated to almost same level as the usual use water in office "except drinking purpose". This water will be utilized for domestic use of the operators including laboratory water supply and others.

Water consumption for domestic use is estimated as 10 m3/d. Adding the water use for laboratory and other miscellaneous purposes, water supply system is designed for 15 m3/d capacity.

The water treatment process consists of oxidation by sodium hypochlorite and subsequent filtration with the Mn coated sand, which is basically the same as the water purification process. Generally, iron is removed by oxidation of iron ion followed by sedimentation. Manganese is removed by chlorination followed by contact oxidation using manganese sand filtration.

5) Deodorization System (Deodorization Facility)

Deodorization system has a deodorization fan, a chemical scrubber and chemical injection equipment.

Using chemicals ($NaClO$ i.e. Sodium hypochlorite and $NaOH$ i.e. Sodium hydroxide), reduce smelly air (odor gas) from several main places in the plant (grit camber, primary sedimentation tank, mixed sludge storage tank, dewaterer, cake hopper etc.)

The chemicals are mixed and sprayed in the scrubber. Smelly air is wash out with chemicals and become clean by chemical reaction immediately.

6) Data Logging System

This system is provided for monitoring and data logging of CP-3 Plant Operation.

The system is set at the Control Room located in Administration Building. All signal are sent from Supervisory Panel and local panel, power is supplied through Uninterruptible Power Supply.(UPS)

Data shall be recorded in CPU and could be stored in Compact Disc. Data could be displayed and printed out by two printers.

Function outline and utilization were introduced as below.

(1) Monitoring of the plant operation condition

Operation staff shall understand the whole plant operation condition by monitoring display information. (Each equipment's operation status, flow capacity, pH information, etc.) And most effective and economical operation could be planned.

(2) Alarm and trouble information monitoring

Every alarm information shall be monitored and recorded to Data Logger System. Because of this alarm function, the quick counter action could be possible by operation staff. And from the long terms accumulated alarm data, each equipment maintenance period or consumable parts life for replacing shall be expected. These will be the useful data for planning the maintenance work and making budget plan for the replacing parts.

(3) Recording the Operation data

Recorded data in Data Logger system could be used for various purposes. From incoming sewage flow sum data, daily and weekly sewage treatment plan could be made. And ether data shall be help for operation management. For example, RAS flow data could be monitored for arranging the return sludge ratio to be settled. Electrical power consumption record shall be used for checking the electrical power cost for wastewater treatment.

(4) Long term operation data

From the long-term plant operation data, future wastewater treatment demand could be expected. From this consideration, future expansion plan or budget plan could be made. And these data shall be the useful database of wastewater treatment plant operation. It could be used for the next new wastewater treatment plant construction.

Detail function was introduced as follows.

【Function Table】

Main Function	Function	Functional Description
Monitoring	System Figures	The entire plant as a system is displayed with image graphics. The facilities monitored will be displayed periodically or during every operation situation, failure/alarm state or for measuring water flow, levels, etc.
	Trend Graph	The process measurement data of water flow, levels, etc are displayed by a trend graph. The trend graph can display current and past varieties at all times.
	Monitoring List	The process measurement value of running/stopping, and failure /alarm states, as well as water flow and level is displayed in real time and list form.
	Operation Alarm Message	During equipment operation/stopping time and damage outbreaks, details are displayed in message form. Moreover, the alarm sound informs of a damage outbreak.
Record Function	Operation/Alarm History	Operation/stopping and failure/alarm history data can be saved over a long period of time.
	List	When recording the process measurement data of water flow and level etc, the list format can be automatically displayed and printed at the same time.
	Saving CD/RW	Trend graph data, application data, lists, operation/alarm history etc can all be saved on CD/RW. Data that has been saved on a CD can also be displayed again and again.
	Screen Copy	The screen displayed can be copied and color printed.

1.6 Design Condition

1) Flow Rate

Daily Maximum Flow Qdmax : 42,000 (38,000+4000) $m^3/d = 29.2m^3/min$ *(design flow rate)*

Hourly Maximum Flow Qhmax : $105,000m^3/d$ (42000 x 2.5) = $72.9m^3/min$

Initial Flow Qdini : $4,000m^3/d = 2.8m^3/min$ (approx.)

NB: The intruding flow form the ground is estimated to be $4,000m^3/d$ which will not affect BOD or SS incoming load.

2) Water Quality

(1) Influent Water Quality (Max Tolerance)

Temperature	:	< 40
pH	:	6 - 9
BOD_5	:	< 240 mg/*l*
		220 mg/*l* *(design value)*
SS	:	< 200 mg/*l*
		190 mg/*l* *(design value)*
COD	:	< 350 mg/*l*
Nitrogen	:	< 40mg/*l*
Phosphorus	:	< 5mg/*l*
Coliform	:	10^6-10^9 MPN/100m*l*

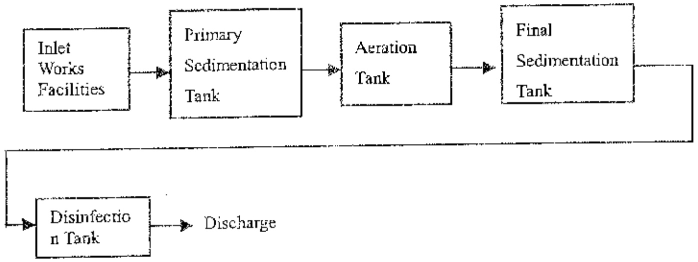
(2) Effluent Water Quality (Class A requirement)

pH	:	6 - 9
BOD_5	:	20mg/*l*
COD	:	50mg/*l*
SS	:	50mg/*l*
Total Nitrogen	:	30mg/*l*
Total-Phosphorus	:	4mg/*l*
Coliform	:	5,000 MPN/100m*l*

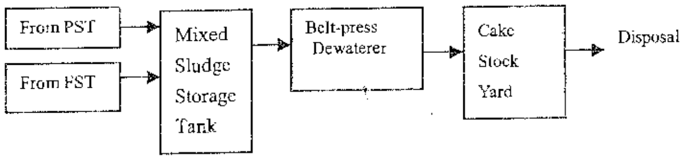
3) **Basic Block Flow**

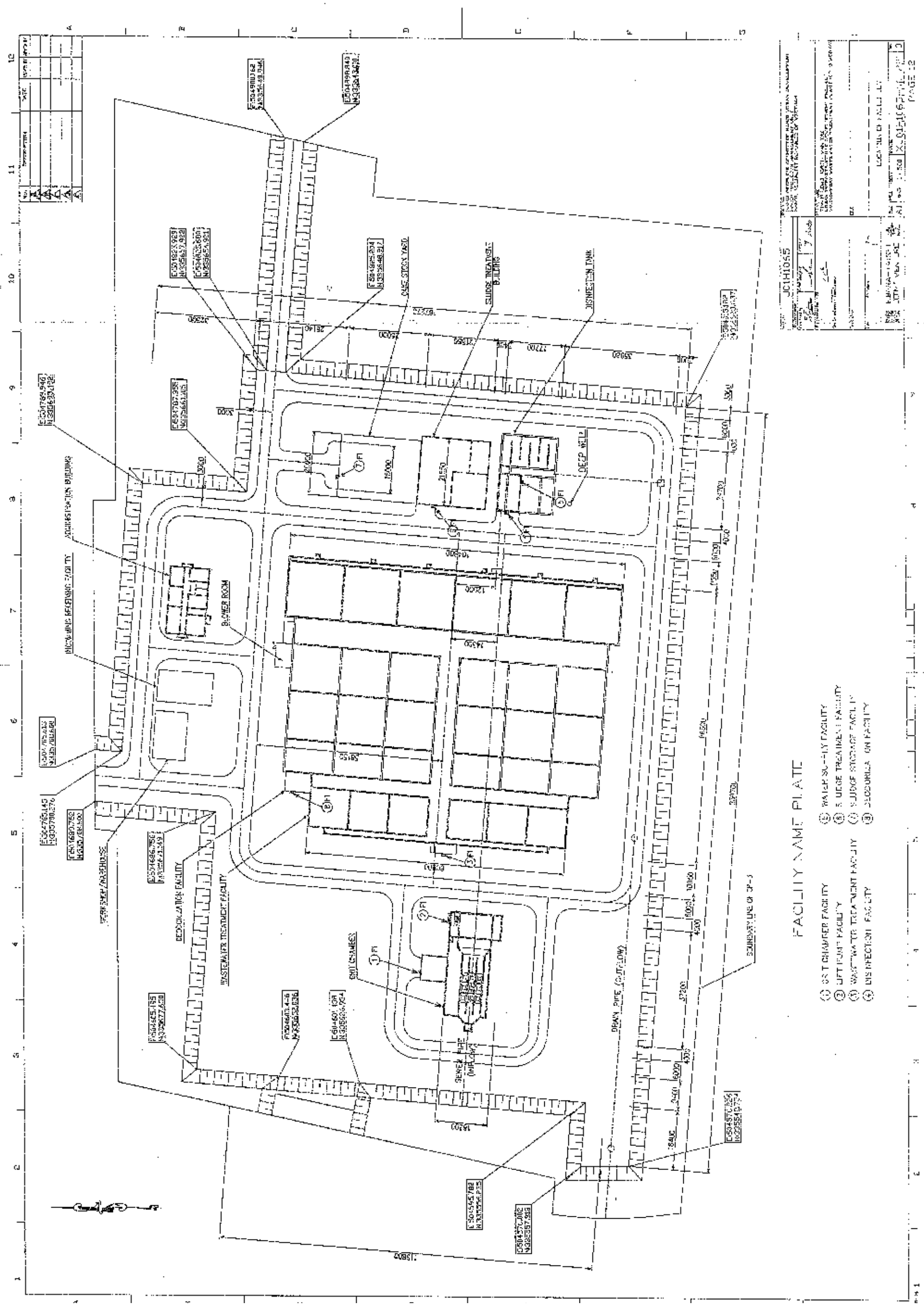
For this Plant, CONVENTIONAL ACTIVATED SLUDGE PROCESS is applied because the concentration of Nitrogen and Phosphorous in the Influent is not a significant factor.

Wastewater Treatment Facilities



Sludge Treatment Facilities





NO.	EQUIPMENT	MODEL	SPECIFICATION	Quantity duty	Quantity standby	Q'ty total	Cap'y kW	T kW	OPERATION contin.	OPERATION batch	OPERATION h/d	OPERATION note	GENERATOR Back-up Yes	GENERATOR Back-up kW
	2.1 Grit Chamber facility (reference diagram : -104)													
M1-01	Inflow gate	Emergency closing gate	W1,000mm x H1,500mm	1	0	1	0.75	0.75	-		1		Y	0.75
M1-02	Grit chamber inflow gate	Manually operated gate	W600mm x H600mm	3	0	3	-	-	-	-	-		-	-
M1-03	Coarse screen	Manually operated bar screen	W2,000mm x CP100mm	3	0	3	-	-	-	-	-		-	-
M1-04	Grit pump	Submersible grit pump	50mmD x 0.5m3/min x 10m	9	0	9	3.7	33.3	-		1	10min/2hr	Y	33.3
M1-05	Grit separator	Screw grit conveyor	0.5m3/min	1	0	1	0.25	0.25	-		6	60min/2hr	Y	0.25
M1-06	Grit container	Movable container	0.3m3	1	1	2	-	-	-	-	-		-	-
M1-07	Fine screen	Continuous raking	W2,000mm x CP20mm	3	0	3	0.75	2.25	-		6	15min/hr	Y	2.25
M1-08	Fine screenings conveyor	Conveyor	W 0.6m x L 10m	1	0	1	2.2	2.2	-		6		Y	2.2
M1-09	Screenings container	Movable container	0.3m3	2	2	4	-	-	-				-	-
M1-10	Grit chamber outflow stoplog	Rectangular stoplog	W2,000mm x H2,000mm	3	0	3	-	-	-		-		-	-
M1-11	Grit pump hoist	Movable crane with chain block	1ton x 3m (1.17kW+0.2kW)	1	0	1	1.37	1.37	-		1		-	1.37
M1-12	Container hoist	Motorized Geared trolley chain block	1ton x 5m (1.17kW+0.2kW)	1	0	1	1.37	1.37	-		1		-	1.37
	2.2 Lift pump facility (reference diagram : -104)													
M2-01	Lift pump (1)	Volute type mixed flow pump	500 x 400mmD x 27m3/min x 10mAq	2	0	2	75	150	-		12	level control	Y	150
M2-02	Lift pump (2)	Volute type mixed flow type variable speed	500 x 400mmD x 27m3/min x 10mAq	1	1	2	75	75		-	24	level control, speed vary with WL	Y	75
M2-03	Discharge valve	Motor driven sluice valve	400mmD	3	1	4	1.5	4.5	-		0.5		Y	4.5
M2-04	Drainage pump	Submersible wastewater pump	65mmD x 0.3m3/min x 15mAq	1	0	1	2.2	2.2	-		2		Y	2.2
M2-05	Lift pump hoist	Motorized Geared trolley chain block	5ton x 8m (2.5kW+0.75kW)	1	0	1	3.25	3.25	-		0.5		-	-
	2.3 Water Treatment Facility (reference diagram : -105)													
M3-01	PST inflow gate	Manually operated gate	400mmD	6	0	6	-	-	-	-	-		-	-
M3-02	Primary sedimentation tank sludge scraper	Rotating scraper	12m sq x H3.0m	6	0	6	0.37	2.22		-	24		Y	2.22
M3-03	Primary sludge valve	Motor driven sluice valve	100mmD	6	0	6	0.75	4.5	-		0.5		Y	4.5
M3-04	Primary sludge pump	Centrifugal non-clog pump	80x80mmD x 0.35m3/min x 6mAq	1	1	2	5.5	5.5		-	3	timer	Y	5.5
M3-05	PST bypass gate	Manually operated gate	W1,000mm x H1,050mm	1	0	1	-	-	-	-	-		-	-
M3-06	Reactor inflow weir	Movable weir	W500mm x H500mm	6	0	6	-	-	-	-			-	-
M3-07	RAS flow control weir	Movable weir	W500mm x H500mm	6	0	6	-	-	-	-	-		-	-
M3-08	Anaerobic tank mixer	Vertical shaft propeller mixer	Turbine diameter 1500mm	6	0	6	4.0	24		-	24		Y	24
M3-09	Surface aerator	Vertical shaft mixer	Impeller diameter 1800mm	12	0	12	37	444	-		20	timer control for low flow	Y	222
M3-10	Channel mixing blower	Rotary blower	14m3/min x 3mAq	1	1	2	15	15		-	24		Y	15
	Gas filter	For suction of channel aeration blower	200mmD	1	0	1	-	-	-	-	-		-	-
M3-11	Blower hoist	Geared trolley chain block	1ton x 4m	1	0	1	-	-	-		1		-	-
M3-12	FST inflow valve	Butterfly valve	600mmD	6	0	6	-	-					-	-
M3-13	Final sedimentation tank sludge scraper	Rotating scraper	17m sq x H3.5m	6	0	6	0.37	2.22		-	24		Y	2.22
M3-14	RAS pump	Centrifugal non-clog pump	250mmD x 7.5m3/min x 6mAq	4	0	4	18.5	74		-	24		Y	37
M3-15	WAS extraction valve	Motor driven butterfly valve	150mmD	2	0	2	0.16	0.32	-		1	timer	Y	0.32
M3-16	Drainage pump	Submersible wastewater pump	65mmD x 0.3m3/min x 15mAq	5	0	5	2.2	11			1		Y	11
M3-17	PST inflow channel stoplog	Rectangular stoplog	W1,500mm x H2,000mm	2	0	2	-	-	-	-	-		-	-
M3-18	Bypass channel stoplog	Rectangular stoplog	W2,000mm x H1,500mm	1	0	1	-	-	-	-	-		-	-
M3-19	Reactor inflow channel stoplog	Rectangular stoplog	W1,000mm x H1,500mm	2	0	2	-	-	-	-	-		-	-
M3-20	FST inflow channel stoplog	Rectangular stoplog	W1,800mm x H2,500mm	2	0	2	-	-	-	-	-		-	-

(15)

NO.	EQUIPMENT	MODEL	SPECIFICATION	Quantity duty	Quantity standby	Q'ty total	Cap'y kW	T kW	OPERATION contin.	OPERATION batch	OPERATION h/d	OPERATION note	GENERATOR Back-up Yes	GENERATOR Back-up kW
	2.4 Disinfection Facility (reference diagram : -106)													
M4-01	Disinfection tank inflow gate	Manually operated gate	W1,100mm x H1,100mm	1	0	1	-	-	-	-	-		-	-
M4-02	Disinfection tank bypass gate	Manually operated gate	W1,100mm x H1,100mm	1	0	1	-	-	-	-	-		-	-
M4-03	NaClO storage tank	Vertical tank	$8.0 m^3$	1	0	1	-	-	-	-	-		-	-
M4-04	NaClO dosing pump	Diaphragm pump	25mmD x 1.1 to 2.7L/min x 20mAq	1	1	2	0.4	0.4			24		Y	0.4
M4-05	NaClO dosing pump for well water	Diaphragm pump	15mmD x 0.01 to 0.029L/min x 20mAq	1	1	2	0.016	0.016		-	24		Y	0.016
M4-06	NaClO storage tank for well water	PVC tank	50 Liters	1	0	1	-	-	-	-	-		-	-
	2.5 Water Supply Facility (reference diagram : -106)													
M5-01	Spray pump	Centrifugal pump	80 x 65mmD x 0.7m3/min x 22mAq	1	1	2	5.5	5.5		-	24		Y	5.5
M5-02	Auto-strainer for spray pump	Automatic backwashing type	100mmD x 0.7m3/min	1	0	1	0.2	0.2		-	24		Y	0.2
M5-03	Sand filter supply pump	Centrifugal pump	65 x 50mmD x 0.3m3/min x 12mAq	1	1	2	1.5	1.5	-		16	level control	Y	1.5
M5-04	Auto-strainer for sand filter	Automatic backwashing type	80mmD x 0.3m3/min	1	0	1	0.2	0.2	-		10	timer	Y	0.2
M5-05	Sand filter	Rising flow moving bed type	1.4mD x 310m3/day	1	0	1	-	-	-		10	WL	-	-
M5-06	Air compressor for sand filter	Pressure-switch type	720NL/min x 0.93MPa	1	1	2	7.5	7.5	-		10	timer & interlock with sand filter	Y	7.5
M5-07	(N/A)												-	-
M5-08	Water supply unit for wastewater treatment facility	Pressure tank type	40 x 50mmD x 0.4m3/min x 46.4mAq	2	0	2	3.0	6	-		10	pressure switch control	Y	6
M5-09	Water supply unit for sludge treatment facility	Pressure tank type	40 x 50mmD x 0.5m3/min x 40.5mAq	2	0	2	2.2	4.4	-		4		Y	4.4
M5-10	Belt washing pump	Centrifugal pump	9.5m3/h x 67 mAq	1	1	2	3.0	3.0		-	24	Interlock with dewaterer	-	-
M5-11	Sand filter supply pump from deep well	Submersible well pump	65mmD x 0.38 m3/min x 42mAq	1	0	1	5.5	5.5	-		8	level control	Y	5.5
M5-12	Sand filter for domestic water	Pressure sand filter	0.8mD x 15m3/day	1	0	1	-	-	-	-	-		-	-
M5-13	Water supply unit for domestic use	Pressure tank type	32 x 50mmD x 0.02m3/min x 30mAq	1	1	2	0.75	0.75	-		10	pressure switch control	Y	0.75
M5-14	Drainage pump	Submersible wastewater pump	65mmD x 0.3m3/min x 15mAq	2	0	2	2.2	4.4	-		1		Y	4.4

(26)

NO	EQUIPMENT	MODEL	SPECIFICATION	Quantity duty	Quantity standby	Q'ty total	Q'ty kW	T-kW	OPERATION contin	OPERATION batch	OPERATION h/d	OPERATION note	GENERATOR Back-up Yes	GENERATOR Back-up kW
2.6 Sludge Treatment Facility (reference diagram : -107)														
M6-01	Mixed sludge mixer	Submersible propeller mixer	350mmD x 75ºN x 250m3	1	0		5.0	5		-	24		Y	5
M6-02	Mixed sludge pump	Progressive cavity pump	125mmD x 10 to 50 m3/hr x 20mAc (=2 bar)	1	1	2	7.5	7.5			24	Interlock with dewaterer	-	-
M6-03	Sludge dewaterer	Belt press Filter	220kg/m/hr x W1.5m (330kg/hr)	-	1	2	(1.5)	1.3	-	-	24	Interlock with dewaterer	-	-
	Flocculator	Flocculator with mixer	350L	1	1	2	0.27	0.57		-	24	Interlock with dewaterer	-	
M6-04	Cake conveyor (1)	Screw conveyor	275mmD x 12mL	1	0	1	4.0	4.0			24		-	-
M6-05	Cake conveyor (2)	Screw conveyor	275mmD x (6mL - 3mL)	1	0	1	5.5	5.5		-	24		-	-
M6-06	Cake hopper	Pneumatic driven cut gate type	10m3, power cylinde 1.5kW x 2	1	0	1	3.0	3.0	-	-	[illegible]		-	-
M6-07	Automatic polymer make-up unit	Constant chemical feeder and dissolution tank	1~2 l/min	1	0	1	1.68	1.68		-	24	Interlock with dewaterer	-	-
	Polymer feeder	Constant chemical feeder		1	0	1	-	-	-		2		-	-
M6-08	Polymer dosing pump	Progressive cavity pump	0.4 to 2 m3/hr x 20mAq (=2 bar)	1	1	2	1.1	1.1		-	24	Interlock with dewaterer	-	-
M6-09	$FeCl_3$ storage tank	FRP tank	9m3	1	0	1	-	-	-	-	-		-	-
M6-10	$FeCl_3$ dosing pump	Diaphragm pump	25mmD x 1.0 to 3.0L/min x 20mAq	1	1	2	0.4	0.4	-		-	only use at necessary case	-	-
M6-11	$FeCl_3$ dosing pump for well water	Diaphragm pump	15mmD x 0.7 to 2 ml/min x 20mAq	1	1	2	0.016	0.016			8		Y	0.016
M6-12	Air compressor for sludge treatment facility	Pressure-switch type	204 NL/min x 0.7 Mpa (Max. 1.0MPa)	1	1	2	1.5	1.5		-	24	Interlock with dewaterer	-	-
M6-13	Air dryer	Refrigerating type	420NL/min x 0.7MPa (Max 1.3MPa)	1	0	1	0.22	0.22		-	24		-	-
M6-14	Filtrate pump	Centrifugal non-clog pump	125x100mmD x 2.5m3/min x 10mAq	1	1	2	11	11			8		-	-
M6-15	Drainage pump	Submersible wastewater pump	65mmD x 0.3m3/min x 15mAq	2	0	2	2.2	4.4			2		Y	4.4
M6-16	Sludge dewaterer hoist	Geared trolley chain block	2ton x 6m (2.5kW-0.4kW)	2	0	2	2.9	5.8	-		0.5		-	-
M6-17	Maintenance hoist	Geared trolley chain block	1ton x 10m	1	0	1		-	-	-	-		-	-
M6-18	$FeCl_3$ storage tank for well water	PVC tank	50 Liters	-	0	1	-	-	-	-	-		-	-
2.7 Sludge storage facility (reference diagram : -107)														
M7-01	Shovel loader	Shovel loader	2 ton	1	0	1	-	-	-	-	-			
M7-02	Drainage pump	Submersible wastewater pump	65mmD x 0.3m3/min x 15mAq	2	0	2	2.2	4.4	-		2		Y	4.4
M7-03	Maintenance crane	Chain block	2 ton x 10m	1	0	1	-	-	-	-	-		-	
M7-04	Tripod	For the support of maintenance crane	length 2.0m	1	0	1	-	-	-	-	-		-	
2.8 Deodorization facility (reference diagram : -108)														
M8-01	NaClO storage tank	PE tank	1 m3 (1080 L)	1	0	1	-	-	-	-	-		-	-
M8-02	NaClO dosing pump	Diaphragm pump	68.3mL/min x 1.6MPa	1	[illegible]	2	0.022	0.022	-		-		-	-
M8-03	NaOH storage tank	PE tank	1 m3 (1080 L)	1	0	1	-	-		-	-		-	-
M8-04	NaOH dosing pump	Diaphragm pump	12.3mL/min x 1.0MPa	1	[illegible]	2	0.017	0.017			-		-	-
M8-05	Circulating pump	Magnetic pump	400 l/min x 17.5m	1	[illegible]	2	1.5	1.5		-	24		-	-
M8-06	Mist Separator		50m3/min	1	0	1	-	-	-	-	-		-	-
M8-07	Deodorization fan	FRP centrifugal fan	350mmD x 50m3/min x 1.5kPa	1	0	1	4.0	4.0		-	24		-	-
M8-08	Chemical scrubber	Vertical scrubber	50m3/min	1	1	1	-	-	-		1	emergency	-	-
												Subtotal		647
2.9 Generator Room facility														
M9-01	Oil supply pump	Fuel for generator		1	0	1	3.7	3.7	-		1	emergency	Y	3.7
M9-02	Service tank	Oil tank for generator	1500L, Storage tank 5000L	1	0	1	-		-		-		-	
M9-03	Emergency Generator	Diesel engine generator	1300kVA		1	1	-		-		-		-	

3A OPERATION MANUAL

3.1 General

3.1.1 Preparation for Operation

Confirm that the following preparations are finished before operation.

(1) Cleaning works for all facility is finished.
(2) Oil and Grease of related equipment is filled.
(3) All chemical is filled with Chemical Tank or Cylinder.
(4) Electric Power is on.
(5) Master breaker on the all Panel switch on.
(6) Control breaker on the all Panel switch on.
(7) Each motor breaker on the all Panel switch on.

3.1.2 General Instruction

(1) Before start the Plant operation, always confirm the following item.
- Select the operation number of lift pump, aeration, sedimentation facility.
- Confirm the chemical dosing ratio
- Confirm the open condition of the aeration inlet valve and sedimentation inlet gate.

With operating the well pump, start the chemical dosing and make inlet siphon of filter facility. Adde in VN version

(2) Water sampling and analysis should be done periodically with following the regulation. For daily operation, observe pH value (6.0~9.0) in Aerobic tank, Sedimentation tank and DO value (0.3~1.0 mg/l) in Aerobic tank carefully.

(3) Chemical purchase arrangement shall be done timely. Keep watch the remaining FeCl3, NaOCl, NaOH and Polymer in chemical tank and store yard.

3.1.3 General Caution

(1) **Chemicals** Handle carefully the dangerous chemical FeCl3, NaOCl, and NaOH solution. Suitable chemical protection goods are suggested to handle these chemicals. In case of contact to these chemicals, immediately wash out by clean water.

(2) **Operation Mode** Some equipment have Remote mode or Auto mode. In these operation modes, there is a possibility of sudden equipment start by sequentially or remote operation from center control panel. During the maintenance or individual operation confirmation, use Local mode for safety reason.

(3) **Confirmation of valve condition (Open - Close)** Before every pump operation confirm the open condition of every suction side and discharge side valve. Valve full close condition shall be make serious damages for the pumps and piping facility. These are common for water pump, sludge pump, and chemical pump. Lift pump have automatic motorized discharge valve. These valve is controlled automatically open before pump start.

(4) **Power Failure** In case of power failure, Generator shall be started automatically in Auto mode. After commercial power was recovered, power supply shall be changed back to commercial power supply line and Generator shall be stopped automatically. After changing the power supply source, restart the necessary equipment. Because all equipment will be stopped by control circuit power cut down.

(5) **Initial years operation (Beginning period)** Especially the initial years operation, each equipment load will be quite low condition. During that period, maintenance operation is recommended. This operation will keep rotating equipment in good condition. One time per 1 month shall be effective.

(6) **Seal water** Some pumps need shaft seal water (filtered water in this plant). At start, if necessary, the clean water is provided from deep well temporarily to filtered water tank. Confirm each stop valve open condition before operation. Some other pumps without seal water are self- seal type. During operation, confirm that water dropped from shaft seal point. If water capacity is too much, tighten the grand packing. The detail are explained in their own manufacture's operation manual each.

(7) **Strainers** Strainers (manual cleaning type with mesh) are provided to chemical inlet pipe line to storage tank and Auto-strainers are provides to treated water line for re-use water at down stream of pressurized water pump discharge. Periodically, check and clean up these strainers.

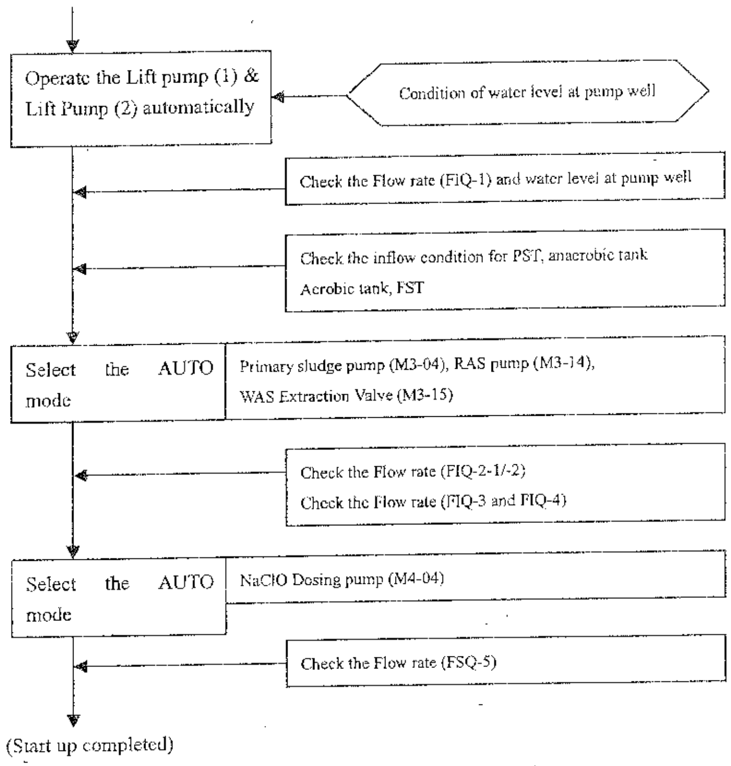
3.1.4 Overall Operation Flow chart

As overall operation flow chart to easy understanding, outline operation is shown as follows. Equipment list will be referred to Vol 1 of 5 section 5 Reference documents.

(1) Wastewater Treatment operation flow chart

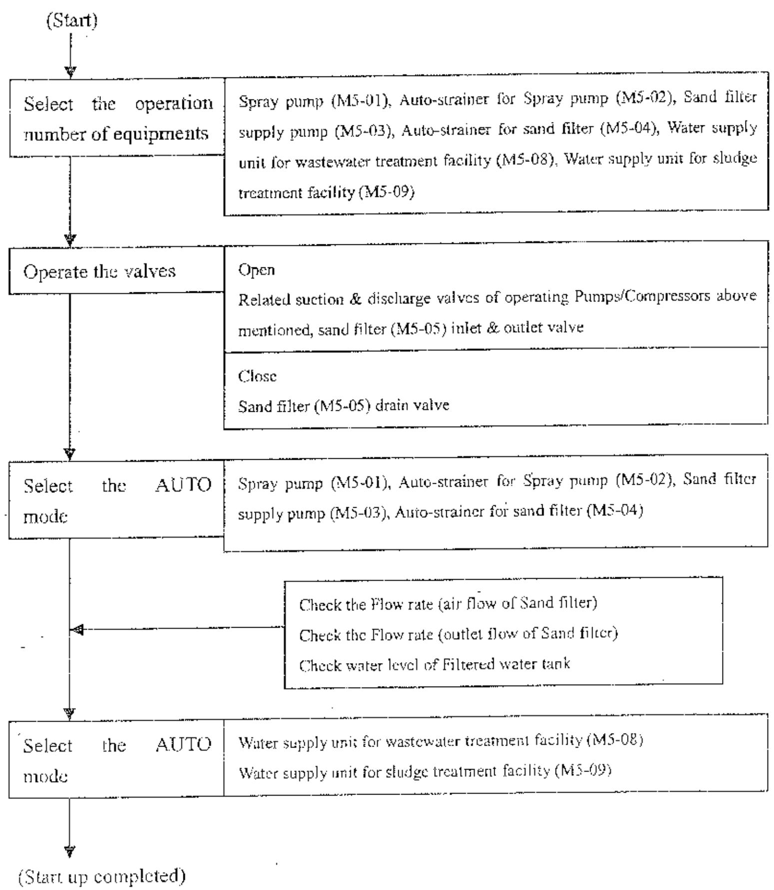
(Start)

Target volume ?	Refer to the attached recommended basic operation number list (refer to Page25) VNversion : P26
Select the operation number of equipments	Lift pump (1) (M2-01), Lift pump (2) (M2-02), Grit pump (M1-04), Grit separator (M1-05), Fine screen (M1-07), Fine screenings conveyor (M1-08), Primary sedimentation tank sludge scraper (M3-02), Anaerobic tank mixer (M3-08), Surface aerator (M3-09), Final sedimentation tank sludge scraper (M3-13), Primary sludge pump (M3-04), RAS pump (M3-14), Channel mixing blower (M3-10), NaClO dosing pump (M4-04)
Operate the gate & valves	Open for required to use stream (1~6) Related suction & discharge valves of operating Pumps/Blowers above mentioned, suction & discharge valves around Flow meter (FIQ-1), Grit chamber inflow gate (M1-02), PST inflow gate (M3-01), Reactor inflow weir (M3-06), RAS flow control weir (M3-07) FST inlet valve, disinfection tank inflow gate (M4-01)
	Close PST Bypass gate (M3-05) Disinfection tank by pass gate (M4-02) Chemical tank drain valves Concrete tank drain valves
Select the AUTO mode	Lift pump (1) (M2-01), Lift pump (2) (M2-02), inflow gate (M1-01) Fine screen (M1-07), Fine screenings conveyor (M1-08)



(2) Water supply operation flow chart

(a) Treated water (Effluent)



(b) Deep well water operation flow chart

(Start)

Select the operate number of equipments	Water supply unit for domestic use (M5-13), NaClO dosing pump for well water (M4-05), $FeCl_3$ storage tank for well water (M6-13)
Operate the valves	Open: Related suction & discharge valves of operating Pumps above mentioned, inlet & outlet sand filter for Domestic water (M5-12). Close: Sand filter for Domestic water (M5-12) drain valve Sand filter for Domestic water (M5-12) backwash in & out Sand filter for Domestic water (M5-12) by pass valve Drain valve of Treated water tank (M5-13)
Select the AUTO mode	Water supply unit for domestic use (M5-13), NaClO dosing pump for well water (M4-05), FeCl3 dosing pump for well water (M6-11)

Check the Flow rate inlet flow of sand filter for Domestic water

Check the treated condition of Deep well water treatment facility

Check water supply condition at administration building

(Start up completed)

(3) Sludge treatment operation flow chart

(Start)

Target treatment volume a day of sludge	Refer to the attached recommended basic operation time list and actual WAS extraction conditions. Check timer for desludge operation from PST & RAS pipe line
Select the operate number of equipment	WAS extraction valve (M3-15), Primary sedimentation tank (M3-02), Primary sludge valve (M3-04), RAS pump (M3-14), Belt washing pump (M5-10), Mixed sludge pump (M6-02), Sludge dewaterer (M6-03-1), Flocculator (M6-03-2), Polymer dosing pump (M6-08), FeCl3 dosing pump (M6-10), Air compressor for sludge treatment facility (M6-12), Filtrate pump (M6-14)
Operate the valves	Open Related suction & discharge valves of operating Pumps/Compressors above mentioned: Close Chemical tank drain valves Concrete tank drain valves
Selected the AUTO mode	WAS extraction valve (M3-15), Primary sedimentation tank (M3-02), Primary sludge valve (M3-04), RAS pump (M3-14), Belt washing pump (M5-10), Mixed sludge pump (M6-02), Sludge dewaterer (M6-03-1), Flocculator (M6-03-2), Polymer dosing pump (M6-08), FeCl3 dosing pump (M6-10), Air compressor for sludge treatment facility (M6-12), Filtrate pump (M6-14)

Check the flow rate (sludge supply)

↓

Adjust chemical design rate — By variable dial of chemical pumps

← Check the floccuration condition of sludge pellet & dewatered sludge cake condition.

↓

(Start up completed)

← Check cake storage condition in cake hopper

↓

Discharge sludge cake — Cake hopper (M6-06) cut gate open operation

(4) Deodorization operation flow chart

(Start)

↓

Select manual mode

↓

Select the operate number of equipment
- NaClO dosing pump (M8-02)
- NaOH dosing pump (M8-04)
- Circulating pump (M8-05)

↓

Operate the valves

Open
- Related suction & discharge valves of operating Pumps above mentioned:
- Suction and delivery valves around Deodorization fan (M8-08)
- All damper at odor gas suction point

Close
- Chemical tank drain valves

↓

Selected the AUTO mode

← Check the treatment condition of facility
PH, scrubber and tank level

↓

Adjust damper balance

↓

(Start up completed)

(5) Drainage pumps operation flow chart

(Start)

↓

Operate the valves	Open Related discharge valves of operating Pumps Discharge:
Power supply to drain pumps	Drainage pump (M2-04), (M3-16), (M5-14), (M6-15), (M7-02)

↓

(Start up completed)

Target volume and recommended basic operation number of equipments for WTP

Target volume m^3/d	Total No.	4000–7000	7000–14000	14000–21000	21000–28000	28000–35000	35000–42000	
M1-04 Grit pump	9	3		6		9		
M1-07 Fine screen	3	1		2		3		
M2-01 Lift pump (1)	2	1				2		Q Hourly max. $72.9m^3/min$ as $42000m^3/d$ ope.
M2-02 Lift pump (2)	2	1 (other 1 is "standby")						Pump $27m^3/min$
M3-02 PST scraper	6	1	2	3	4	5	6	
M3-08 Anaerobic mixer	6	1	2	3	4	5	6	
M3-09 Surface Acrator	12	2	4	6	8	10	12	
M3-13 FST s	6	1	2	3	4	5	6	
M3-14 RAS pump	4	1	2		3	4		for 100% Return

Operating time of Dewatering Operation M6-03 Sludge Dewaterer	Max. Ope Time 24 Hr.	4	8	12	16	20	24	Duty : 1 unit (standby : 1 unit)

3.2 Grit Chamber Facility

3.2.1 Operation Procedure

(1) Open the Inlet valve of Lift Pump (1) by manual
(2) Open the Inlet valve of Lift Pump (2) by manual
(3) Open the Inlet and Outlet Valves around Flow meter (FIQ-1) by manual
(4) Operate the Screenings Conveyor "AUTO"
(5) Operate the Fine Screen "AUTO" by manual
(6) Open the Grit Chamber Inflow Gate by manual
(7) Operate the Lift Pump (1) "AUTO"
(8) Operate the Lift Pump (2) "AUTO"
(9) Operate the Inflow Gate "AUTO"
(10) Confirm the water level of Pump Well
(11) Operate the Grit Separator "AUTO"
(12) Operate the Grit Pump "AUTO"

3.2.2 Equipment Operation

(1) Fine Screen Conveyor (M1-08)
Turn the switch of Fine Screen Conveyor to MANUAL or AUTO at Grit Chamber Panel (GCP)
Manual Operation
RUN – STOP
Auto Operation
RUN Pre-start for Fine Screen automatically with signal.
STOP Timer delay stop after RUN

(2) Fine Screen (M1-07)
Turn the switch of Fine Screen to MANUAL or AUTO at Grit Chamber Panel (GCP)
Manual Operation
RUN - STOP
Auto Operation
RUN Timer operates grit Pump automatically with Intermittent running signal.

above Incoming Sewage Pit HWL by LA-1
STOP Timer delay stop after RUN

(3) Lift Pump (1) (M2-01) (Fixed Speed)
Turn the switch of Lift Pump to LOCAL or REMOTE at Lift Pump Panel (LPP)
Manual Operation
RUN – STOP
Interlock below Lifting Pump Pit LLWL by LA-2 or LA-3
Auto Operation
RUN selected pump as first start
above Lifting Pump Pit H1WL by LA-2 or LA-3
selected pump as second start
above Lifting Pump Pit H2WL by LA-2 or LA-3
STOP selected pump as first start
below Lifting Pump Pit L2WL by LA-2 or LA-3
selected pump as second start
below Lifting Pump Pit L2WL by LA-2 or LA-3

(4) Lift Pump (2) (M2-02) (Variable Speed)
Turn the switch of Lift Pump to LOCAL or REMOTE at Lift Pump Panel (LPP)
Manual Operation
RUN – STOP
Interlock below Lifting Pump Pit LLWL by LA-2 or LA-3
Auto Operation
RUN 70% output
above Lifting Pump Pit M1WL by LA-2 or LA-3
80% output
above Lifting Pump Pit M2WL by LA-2 or LA-3
90% output
above Lifting Pump Pit M3WL by LA-2 or LA-3
100% output
above Lifting Pump Pit M4WL by LA-2 or LA-3

STOP below Lifting Pump Pit L1WL by LA-2 or LA-3

(5) Inflow Gate (M1-01)
Turn the switch of Inflow Gate to LOCAL or REMOTE at Grit Chamber Panel (GCP)
Manual Operation
OPEN - CLOSE
Interlock above Incoming Sewage Pit HWL by LA-1

above Lifting Pump Pit HHHWL by LA-2,3

Auto Operation

OPEN	below Incoming Sewage Pit HWL by LA-1
CLOSE	above Incoming Sewage Pit HHWL by LA-1
	above Lifting Pump Pit HHWL by LA-2
	above Lifting Pump Pit HHWL by LA-3
	in case of Electricity Fault, CLOSEaction by gravity

When the Inflow Gate closes by certain cause, Operator should push the open button of the gate after checking.

When the gate closed by Electricity Fault (Power Failure), the gate can be opened again by manual operation with mechanical clutch release after recovery of power.

This gate can be opened by order at Supervisory Panel (SVP) as REMOTE mode

(6) Grit Separator (M1-05)

Turn the switch of Grit Separator to MANUAL or AUTO at Grit Chamber Panel (GCP)

Manual Operation

RUN – STOP - INCH

Auto Operation

RUN Pre-start for Grit Pump automatically with signal.

STOP Timer delay stop after RUN

10 min/2 hr = 90 min/2 h

60 min/2 h

(7) Grit Pump (M1-04)

Turn the switch of Grit Pump to MANUAL or AUTO at Grit Chamber Panel (GCP)

Manual Operation

RUN – STOP

Interlock above Incoming Sewage Pit LLWL by LA-1

Auto Operation

Timer operates Grit Pump automatically with Intermittent running signal.

3.2.3 Caution and Instruction

(1) The Inflow Gate is very important equipment for this Wastewater Treatment Plant. Because, this gate can shut out influent from pipeline connected to this plant. For this purpose, if the power failure coming, the gate will be falling down by self-weight with gravity force and keep the plant safely before mentioned. Daily check of the gate condition by visual at site and electrical signal are much important work. Usual condition of this gate is OPEN without wrong signal.

(2) To protect the Grit Pump from dry operation, low water cut-off function is provided. In case of auto-stop by low water level, Grit Pump can be started with auto reset by timer after water level recovered to normal water level.

(3) High water level alarm is provided in incoming sewage pit. If Screens (Coarse and Fine) are clogged with rubbish (small wooden piece or vinyl film etc.) the upper current position's water level will be raised and High water level alarm will be functioned. Clean the rubbish on the screen. If High water level alarm is coming frequently, adjust operating timer of Fine Screens (running timer to longer, interval timer to shorter)

(4) Check the grit and screenings in containers and exchange the containers in a short cycle. This grit and screenings will be transported immediately and appropriately by truck to outside of the plant.

3.3 Lift Pump Facility

3.3.1 Operation Procedure

(1) Open the inlet and outlet valves of the magnetic flow meter (FIQ-1) by manual
(2) Open the inlet valve of the Lift Pump (1) and Lift Pump (2) by manual
(3) Operate the Discharge Valve "AUTO"
(4) Operate the Lift Pump (1) "AUTO"
(5) Operate the Lift Pump (2) "AUTO"
(6) Check the flow rate indicated at the magnetic flow meter (FIQ-1)

3.3.2 Equipment Operation

(1) Discharge Valve (M2-03)

Turn the switch of Discharge Valve to LOCAL or REMOTE at Lift Pump Panel (LPP)

Manual Operation

OPEN – CLOSE

Auto Operation

Discharge Valve is operated with Lift Pump automatically.

OPEN Pre-open for Lift Pump start with signal.

CLOSE Lift Pump STOP

(2) Lift Pump (1) (M2-01) (Fixed Speed)

Turn the switch of Lift Pump to LOCAL or REMOTE at Lift Pump Panel (LPP)

Manual Operation

RUN – STOP

Interlock below Lifting Pump Pit LLWL by LA-2 or LA-3

Auto Operation

RUN selected pump as first start

above Lifting Pump Pit H1WL by LA-2 or LA-3

selected pump as second start

above Lifting Pump Pit H2WL by LA-2 or LA-3

STOP selected pump as first start

below Lifting Pump Pit L2WL by LA-2 or LA-3

selected pump as second start

below Lifting Pump Pit L2WL by LA-2 or LA-3

(3) Lift Pump (2) (M2-02) (Variable Speed)

Turn the switch of Lift Pump to LOCAL or REMOTE at Lift Pump Panel (LPP)

Manual Operation

RUN – STOP

Interlock below Lifting Pump Pit LLWL by LA-2 or LA-3

Auto Operation

RUN 70% output

above Lifting Pump Pit M1WL by LA-2 or LA-3

80% output

above Lifting Pump Pit M2WL by LA-2 or LA-3

90% output

above Lifting Pump Pit M3WL by LA-2 or LA-3

100% output

above Lifting Pump Pit M4WL by LA-2 or LA-3

STOP below Lifting Pump Pit L1WL by LA-2 or LA-3

3.3.3 Caution and Instruction

(1) The water level balance in the pit is changed depend on the number of operating Lift pumps and influent flow rate. Incoming flow is fluctuated as daily and hourly. Operator decides the number of operating fix speed pump and "first start pump" in order to minimize frequency of RUN-STOP times per hour (usually Max. 5 times for one pump) The pit volume is not so large retentive of huge sewage to run the Lift Pump without variable speed control. The one variable speed pump, therefore, must be used at any time.

(2) To protect the Lift Pump from dry operation, low water cut-off function is provided. In

case of auto-stop by low water level, Lift Pump can be started after water level recovered to normal water level again. If Low water level alarm is coming frequently, check the grit chamber facilities.

(3) High water level alarm is provided in pump well. If pump capacity is not enough to send sewage to Primary Sedimentation Tank, add operating fixed speed pump (Max capacity is available by two fixed speed pumps and one variable speed pump).

3.4 Wastewater Treatment Facility

3.4.1 Operation Procedure

(1) Open the PST Inflow Gate my manual.

(2) If Primary Sedimentation Tank (PST) is empty, waiting for the water level of the tank becoming full.

"Do not start scum skimmer when the tank is not full!"

(2) Confirm the water coming into PST through the inlet pipe.

(3) Confirm PST is filled up with the water.

(4) Open the Manual Sludge Valve of the sludge discharge pipe.

(5) Open the Inlet and Outlet Valves of the magnetic flow meter (FIQ-3) by manual

(6) Operate the Primary Sludge Valve "AUTO"

(7) Operate the Primary Sedimentation Tank Sludge Scraper "RUN"

(8) Operate the Primary Sedimentation Tank Scum Skimmer "RUN"

(9) Open the Inlet and Outlet Valves around Primary Sludge Pump by manual.

(10) Operate the Primary Sludge Pump "AUTO"

(11) Open (Falling down) the Reactor Inflow Weir by manual.

(12) If Anaerobic Tank is empty, waiting for the water level of the tank becoming full.

"Do not start Anaerobic Tank Mixer when the tank is not full!"

(13) Confirm the water coming into Anaerobic Tank through the inlet channel.

The tanks (Anaerobic Tanks and Aerobic Tanks) are connected at bottom and upper openings.

(14) Confirm Anaerobic Tank is filled up with the water.

(15) Operate the Anaerobic Tank Mixer "RUN"

(16) If Aerobic Tank is empty, waiting for the water level of the tank becoming full.

"Do not start Surface Aerator when the tank is not full!"

(17) Confirm the water coming into Aerobic Tank through the openings on the wall.

(18) Confirm Aerobic Tank is filled up with the water.

(19) Operate the Surface Aerator "RUN"

(20) Open the FST Inflow Valve for Final Sedimentation Tank (FST) by manual

(21) If Final Sedimentation Tank (FST) is empty, waiting for the water level of the tank becoming full.

"Do not start scum skimmer when the tank is not full!"

(22) Confirm the water coming into FST through the inlet pipe (center pillar).
(23) Confirm PST is filled up with the water.
(24) Open the Manual Sludge Valve of the sludge discharge pipe.
(25) Operate the Final Sedimentation Tank Sludge Scraper "RUN"
(26) Operate the Final Sedimentation Tank Scum Skimmer "RUN"
(27) Open the Inlet and Outlet Valves around RAS Pump by manual.
(28) Open the Inlet and Outlet Valves of the magnetic flow meter (FIQ-2-1 or/and FIQ-2-2) by manual
(29) Open (Falling down) the RAS Flow Control Weir by manual.
(30) Operate the RAS Pump "RUN"
(31) Check the flow rate indicated at the magnetic flow meter (FIQ-2-1 or/and FIQ-2-2)
(32) Adjust balance of RAS distribution into each operating Anaerobic Tank.
(33) Open the Inlet and Outlet Valves of the magnetic flow meter (FIQ-4) by manual
(34) Operate the WAS extraction valve "AUTO"
(35) If necessary (in case of the flock is to small dispersed by the Surface Aerator and settling condition of sludge is not good), operate the Channel Mixing Blower to ensure the condition of flocculation of activated sludge flock in to the final sedimentation tank.
(36) Open the Inlet and Outlet Valves around Channel Mixing Blower by manual.
(37) Open air suction damper in odor pipeline.
(38) Operate the Channel Mixing Blower "RUN"

3.4.2 Equipment Operation

(1) Primary Sludge Valve (M3-03)

Turn the switch of Primary Sludge Valve to MANUAL or AUTO at Primary Sludge Panel (PSP).

Manual Operation

OPEN - CLOSE

Auto Operation

OPEN Automatically open with Primary Sludge pump running signal

STOP Automatically close with Primary Sludge pump running signal

(2) Primary Sedimentation Tank Scraper (M3-03-1)

Press the push button switch of Primary Sedimentation Tank Scraper at Primary Sludge

Scraper Panel (PSSP).

Manual Operation only

RUN - STOP

for mechanical checking purpose only

INCH: short run

(3) Primary Sedimentation Tank Scum Skimmer (M3-02-2)

Turn the switch of Primary Sedimentation Tank Scum Skimmer to MANUAL or AUTO at Primary Sludge Scraper Panel)

RUN - STOP

Automatic Operation

RUN Automatically running with Primary Sedimentation Tank Scraper running signal)

STOP Automatically stop with Primary Sedimentation Tank Scraper running signal)

(4) Primary Sludge Pump (M3-04)

Turn the switch of Primary Sludge Pump to MANUAL or AUTO at Primary Sludge Panel (PSP).

Manual Operation

RUN - STOP

Interlock Primary Sludge Valve condition

above Mixed Sludge Storage Tank BHWL by LA-6, LA-7

Auto Operation

RUN Timer operates Primary Sludge Pump automatically with Intermittent opening signal.

STOP Running signal OFF

(5) Anaerobic Tank Mixer (M3-08)

Press the push button switch of Anaerobic Tank Mixer at Anaerobic & Final Sludge Scraper Panel (AFSSP).

RUN - STOP

(6) Surface Aerator (M3-09)

Turn the switch of Surface Aerator to MANUAL or AUTO at Surface Aerator Panel (SAP).

Manual Operation

RUN - STOP

Auto Operation

RUN Timer operates Surface Aerator automatically with Intermittent starting signal.

STOP Running signal OFF

(7) Final Sedimentation Tank Scraper (M3-13-1)

Press the push button switch of Final Sedimentation Tank Scraper at Anaerobic & Final Sludge Scraper Panel (AFSSP).

Manual Operation only

RUN – STOP

for mechanical checking purpose only

INCH: short run

(8) Final Sedimentation Tank Scum Skimmer (M3-02-2)

Turn the switch of Final Sedimentation Tank Scum Skimmer to MANUAL or AUTO at Anaerobic & Final Sludge Scraper Panel

Manual Operation

RUN – STOP

Automatic Operation

RUN Automatically running with Primary Sedimentation Tank Scraper running signal) FST Scraper

STOP Automatically stop with Primary Sedimentation Tank Scraper running signal)

(9) RAS Pump (M3-14)

Press the push button switch of RAS Pump at RAS & WAS Panel (RWP).

Manual Operation only

RUN – STOP

(10) WAS Extraction Valve (M3-15)

Turn the switch of WAS Extraction Valve to MANUAL or AUTO at RAS & WAS Panel (RWP).

Manual Operation

OPEN – CLOSE

Auto Operation

OPEN Timer operates WAS Extraction Valve automatically with intermittent opening signal.

STOP Timer operates WAS Extraction Valve automatically with Intermittent closing signal.

(11) Channel Mixing Blower (M3-18)

Press the push button switch of Channel Mixing Blower at Channel Mixing Blower Panel

(CMB).

Manual Operation only

RUN – STOP

3.4.3 Caution and Instruction

(1) Sedimentation Tanks (PST and FST) have scum-collecting device. It is functioned correctly as floating media. If the tank will be drained, this system must be stopped. **"The Scum Skimmer can not be used, when the tank is not full"**

(2) Sludge discharge valve shall be open by timer control in Auto mode. For proper capacity of sludge discharge, adjust the timer No.41 48 on "Timer setting table". These timers are located in Primary sludge Panel (PSP) In case of sludge blanket floating-up phenomenon was observed, increase the open time of discharge valve or decrease the discharge cycle time.

(3) Rotating agitator as like Anaerobic Tank Mixer and Surface aerator cannot start with condition of the impeller is out of water i.e. free spinning.

"The Anaerobic Tank Mixer can not be used, when the tank is not full"

"The Surface Aerator can not be used, when the tank is not full"

(4) DO sensor should be checked carefully. Periodical sensor wash is recommended to keep the accuracy of sensing value.

3.5 Disinfection Facility

3.5.1 Operation Procedure

(1) Open the Outlet Valves of the NaClO Storage Tank by manual.

(2) Open the Inlet and Outlet Valves around NaClO Dosing Pump by manual.

(3) Open the Valve of NaClO dosing point at Disinfection Tank by manual.

(4) Close the Valve of NaClO dosing point at Disinfection Tank Bypass Channel by manual.

"Do Not Close both valves at the same time. Minimum one valve must be OPEN "

(5) Open the Disinfection Tank Inflow Gate by manual.

(6) Close the Disinfection Tank Bypass Gate by manual.

"Do Not Close both gates at the same time. Minimum one gate must be OPEN "

(7) Confirm the water coming into Disinfection Tank through the inlet pipe and channel.

(8) Operate the NaClO Dosing Pump "RUN"

(9) Confirm dial value of NaClO Dosing Pump to set dosing ratio.

(10) From experiential point of view, generally, it is said that if residential free chlorine after 15 minutes contact of treated water and NaClO is more than approx. 0.1 mg/l, disinfection is effective.

(11) Confirm over flow from Disinfection Tank.

(12) Check the flow rate indicated at the magnetic flow meter (FIQ-5)
It is not necessary that the indicated current discharge flow (FIQ-5) is equal to inlet flow (FIQ-1) by reason of time lag.

3.5.2 Equipment Operation

(1) NaClO Dosing Pump (M4-04)
Press the push button switch of NaClO Dosing Pump at Water Supply System Panel (WSSP).
Manual Operation only
RUN – STOP
Interlock below NaClO Storage Tank LLWL by LA-9

3.5.3 Caution and Instruction

(1) Handle carefully the dangerous chemical NaOCl solution (strong alkali). Suitable chemical protection goods are suggested to handle these chemicals. In case of contact to these chemicals, immediately wash out by clean water.

3.6 Water Supply Facility

3.6.1 Operation Procedure

(1) Close the Outlet Valve of Sand Filter Supply Pump from Deep Well by manual.
(2) Open the Bypass Valve (Flush Out Valve i.e. Drain valve) of Sand Filter Supply Pump from Deep Well by manual.
(3) Close the All Valves (Inlet, Outlet and Drain etc.) around Sand Filter for Domestic Water by manual.
(4) Operate Sand Filter Supply Pump from Deep Well "RUN"
(5) Confirm the pump running and check the pressure gauge indicate value (more than Approx. 0.5MPa).
(6) Open slowly the Outlet Valve of Sand Filter Supply Pump from Deep Well by manual.
(7) Confirm the water coming out from Bypass Valve (Flush Out Valve i.e. Drain valve) of Sand Filter Supply Pump from Deep Well.

(8) Check the condition of the well water. If it is clean without mad or small sand, step to next stage. If it is not clean, flush out the well water until it is clean.
(9) Operate Sand Filter Supply Pump from Deep Well "STOP"
(10) If the well water includes "Fe : more than 0.3 mg/l " or "Mn : more than 0.1 mg/l", the chemical ($FeCl_3$, NaClO) will be injected as explained as following steps.
(11) Open the Outlet Valves of Chemical pumps ($FeCl_3$ Dosing Pump for Well Water, NaClO Dosing Pump for Well Water) and Valves at injection point by manual.
(12) Operate Chemical Pumps ($FeCl_3$ Dosing Pump for Well Water, NaClO Dosing Pump for Well Water) "AUTO "
(13) Open the Outlet Valves around Sand Filter for Domestic Water by manual.
(14) Operate Sand Filter Supply Pump from Deep Well "RUN"
(15) Open slowly the Inlet Valves around Sand Filter for Domestic Water by manual.
(16) Adjust flow rate to designed value (0.07 m^3/min)
(17) Operate Sand Filter Supply Pump from Deep Well "AUTO"
(18) Adjust dosing ratio of chemicals by dial at each dosing pumps.
(19) Confirm the water coming into Treated Water Tank of Water Supply Unit for Domestic Use from Sand Filter for Domestic Water.
(20) Check the condition of the treated well water. If it is clean with low level Fe (< 0.3 mg/l) and Mn (, 0.1 mg/l), step to next stage. If it is not clean, flush out the treated well water from tank drain until it is clean.

(21) If differential pressure (between Inlet and Outlet of Sand filter for Domestic Water) is too high compared with usual value, or filtration flow is too small compared with usual value, backwash is required. The backwash operation is operated manually.
(22) For the backwash operation, same pump (i.e. Sand Filter Supply Pump from Deep Well) is used.
(23) Operate Sand Filter Supply Pump from Deep Well "STOP"
(24) Close the Inlet and Outlet Valves around Sand Filter for Domestic Water by manual.
(25) Open the Backwash Outlet Valves around Sand Filter for Domestic Water by manual.
(26) Operate Sand Filter Supply Pump from Deep Well "RUN"
(27) Open slowly the Backwash Inlet Valves around Sand Filter for Domestic Water by manual.
(28) Adjust flow rate to designed value (0.3 m^3/min)
(29) Confirm Backwash flow and moving sand view in the tank through the sight glass of the filter tank body.
(30) Open slowly the Surface Wash Inlet Valves around Sand Filter for Domestic Water by manual.

(31) Adjust flow rate to designed value (0.38 m^3/min) (Backwash: 0.3 m3/min, Surface Wash: 0.08 m3/min)
(32) After continuous backwash (Max. 10 minutes), Operate Sand Filter Supply Pump from Deep Well "STOP"
(33) Operate again usual filtration.

(34) Close Drain Valve of tank of Water Supply Unit for Domestic Use by manual.
(35) Open the Inlet Valves around Water Supply Unit for Domestic Use by manual.
(36) Operate Water Supply Unit for Domestic Use "AUTO " at their own panel (Unit Control Panel by side of Machine)
(37) Confirm pump running of the Water Supply Unit for Domestic Use.
(38) Confirm pressurized with the pump and stop at designed pressure (MAX. approx. 0.3MPa)
(39) Open slowly the Outlet Valves around Water Supply Unit for Domestic Use by manual. The treated water is sent to using point at administration building and workshop / warehouse. If pressure is down below pre-set value adjusted, automatically run the pump again up to designed pressure.

(40) Confirm the water coming into Secondary Effluent Tank (i.e. Disinfection Tank Inlet Channel) through the inlet pipe.
(41) Open the Outlet Valves of the Secondary Effluent by manual.
(42) Open the Inlet and Outlet Valves around Spray Pump by manual.
(43) Open the Inlet and Outlet Valves around Auto-Strainer for Spray Pump by manual.
(44) Operate Auto-Strainer for Spray Pump "AUTO"
(45) Operate Spray Pump "RUN"

(46) Open the Outlet Valves of the Secondary Effluent by manual.
(47) Open the Inlet and Outlet Valves around Auto-Strainer for Sand Filter by manual.
(48) Operate Auto-Strainer for Sand Filter "AUTO"
(49) Open the Inlet Valves around Sand Filter by manual.
(50) Close the Outlet Valves around Sand Filter by manual.
(51) Confirm the Drain valve of Sand Filter CLOSE
(52) Supply electric power to Air Compressor for Sand Filter.
(53) Confirm air pressure is steady about 0.3 MPa (3 kgf/cm2)
(54) Open the Inlet and Outlet Valves around Sand Filter Supply Pump by manual.
(55) Operate Sand Filter Supply Pump "RUN "
(56) Open slowly the Inlet Valves around Sand Filter by manual.

(57) Adjust flow rate to designed value (0.22 m^3/min)
(58) Confirm the water coming into Filtered Water Tank through the pipe from Sand Filter.
(59) Operate Sand Filter Supply Pump "AUTO "
(60) Open the Outlet Valves of the Filtered Water Tank by manual.
(61) Open the Inlet Valves around Water Supply Unit for Wastewater Treatment Facility by manual.
(62) Operate Water Supply Unit for Wastewater Treatment Facility "AUTO " at their own panel (Unit Control Panel by side of Machine)
(63) Confirm pump running of the Water Supply Unit for Wastewater Treatment Facility.
(64) Confirm pressurized with the pump and stop at designed pressure (MAX. approx. 0.4MPa)
(65) Open slowly the Outlet Valves around Water Supply Unit for Wastewater Treatment Facility by manual. The filtered water is sent to using point. If pressure is down below pre-set value adjusted, automatically run the pump again up to designed pressure.
(66) Open the Inlet Valves around Water Supply Unit for Sludge Treatment Facility by manual.
(67) Operate Water Supply Unit for Sludge Treatment Facility "AUTO " at their own panel (Unit Control Panel by side of Machine)
(68) Confirm pump running of the Water Supply Unit for Sludge Treatment Facility.
(69) Confirm pressurized with the pump and stop at designed pressure (MAX. approx. 0.4MPa)
(70) Open slowly the Outlet Valves around Water Supply Unit for Sludge Treatment Facility by manual. The filtered water is sent to using point. If pressure is down below pre-set value adjusted, automatically run the pump again up to designed pressure.

3.6.2 Equipment Operation

(1) Sand Filter Supply Pump from Deep Well (M5-11)
Turn the switch of Sand Filter Supply Pump from Deep Well to MANUAL or AUTO at Filter Water Panel (FWP).
Manual Operation
RUN – STOP
Interlock below Deep Well LWL by LA-14
above Water Supply Unit Tank HWL by LA-15
Auto Operation
RUN Continuous operation automatically with condition signal.
STOP Running signal OFF

(2) $FeCl_3$ Dosing Pump for well water (M6-11)

Turn the switch of $FeCl_3$ Dosing Pump for well water to MANUAL or AUTO at Water Supply system Panel (WSSP).

Manual Operation

RUN – STOP

Interlock below $FeCl_3$ Storage Tank for Well Water LLWL by LA-17

Auto Operation

RUN Automatically running with Sand Filter Supply Pump from Deep Well

STOP Running signal OFF

Interlock below $FeCl_3$ Storage Tank for Well Water LLWL by LA-17

(3) NaClO Dosing Pump for well water (M4-05)

Turn the switch of NaClO Dosing Pump for well water to MANUAL or AUTO at Water Supply system Panel (WSSP).

Manual Operation

RUN – STOP

Interlock below NaClO Storage Tank for Well Water LLWL by LA-16

Auto Operation

RUN Automatically running with Sand Filter Supply Pump from Deep Well running signal

STOP Running signal OFF

Interlock below NaClO Storage Tank for Well Water LLWL by LA-16

(4) Water Supply Unit for Domestic Use (M5-13)

Self Auto Operation by Unit Panel by side of Water Supply Unit. Power is supplied from Filter Water Panel (FWP).

Manual Operation at unit panel supplied by vendor

RUN – STOP

Auto Operation

RUN pressure switch detected start level

STOP pressure switch detected stop level

(5) Auto-strainer for Spray Pump (M5-02)

Self Auto Operation by Unit Panel by side of Auto-strainer. Power is supplied from Filter Water Panel (FWP).

Manual Operation at unit panel supplied by vendor

RUN – STOP

Auto Operation

RUN Automatically running with Spray pump running signal

STOP Running signal OFF

(6) Spray Pump (M5-01)

Turn the switch of Spray Pump to MANUAL or AUTO at Filter Water Panel (FWP)).

Manual Operation

RUN – STOP

Interlock below Secondary Effluent Tank LLWL by LA-4

Auto Operation

RUN Continuous operation automatically with condition signal.

STOP Below Secondary Effluent Tank LWL by LA-4

(7) Auto-strainer for Sand Filter (M5-04)

Self Auto Operation by Unit Panel by side of Auto-strainer. Power is supplied from Filter Water Panel (FWP).

Manual Operation at unit panel supplied by vendor

RUN – STOP

Auto Operation

RUN Automatically running with Sand Filter Supply Pump running Signal

STOP Running signal OFF

(8) Air compressor for Sand Filter (M5-06)

Self Auto Operation by pressure switch by side of compressor. Power is supplied from Filter Water Panel (FWP).

Auto Operation (Self control)

RUN pressure switch detected start level

STOP pressure switch detected stop level

(9) Sand Filter Supply Pump (M5-03)

Turn the switch of Sand Filter Supply Pump to MANUAL or AUTO at Filter Water Panel (FWP).

Manual Operation

RUN – STOP

Interlock below Secondary Effluent Tank LLWL by LA-4

above Filtered Water Tank HHWL by LA-5

Auto Operation

RUN Continuous operation automatically with condition signal.
above Secondary Effluent Tank HWL by LA-4

STOP
below Secondary Effluent Tank LLWL by LA-4
above Filtered Water Tank HHWL by LA-5

(10) Water Supply Unit for Wastewater Treatment Facility (M5-08)
Self Auto Operation by Unit Panel by side of Water Supply Unit. Power is supplied from Filter Water Panel (FWP).
Manual Operation at unit panel supplied by vendor
RUN – STOP
Auto Operation
RUN pressure switch detected start level
STOP pressure switch detected stop level

(11) Water Supply Unit for Sludge Treatment Facility (M5-09)
Self Auto Operation by Unit Panel by side of Water Supply Unit. Power is supplied from Filter Water Panel (FWP).
Manual Operation at unit panel supplied by vendor
RUN – STOP
Auto Operation
RUN pressure switch detected start level
STOP pressure switch detected stop level

(12) Belt Washing Pump (M5-10)
Turn the switch of Belt Washing Pump to HAND or AUTO at Dewaterer Panel
Manual Operation
HAND = RUN
Auto Operation
RUN Continuous operation automatically with condition signal
STOP Command Signal OFF

3.6.3 Caution and Instruction

(1) Filtered water from deep well is served for domestic use (sanitary, floor washing) only. It is treated for washing purpose and so on at administration building, workshop and warehouse.

"The treated water should be used for service water,

Not for drinking water"

Even if it is come from Water Supply unit for Domestic Use

"Do not drink this treated water"

(2) From the first starting stage of this plant, the pump seal water is also required, therefore, if the Sand Filter (M5-05) is not operated yet at that stage. Use Well water to fill the Filtered Water Tank instead of filtered water from effluent line.

(3) Filter operation should be in Auto mode. Filtered water (both type of plant effluent and deep well) should be checked carefully and daily. Periodical back wash is recommended to keep the correct function of Sand Filter for Domestic Use.

(4) Sand Filter (for effluent re-use) is continuous self-backwash type. Periodical adjustment of self cleaning balance and condition is recommended to keep the correct function of Sand Filter

(5) Periodical analysis of treated water is recommended to keep the correct function of these items mentioned above.

(6) According to a schedule, Check the consumptions and remaining volume of chemicals in the storage tanks and warehouse and purchase the chemicals.

(7) Handle carefully the dangerous chemical $FeCl_3$ and NaOCl solution. Suitable chemical protection goods are suggested to handle these chemicals. In case of contact to these chemicals, immediately wash out by clean water.

(8) Make drain periodically from two Air compressor unit air tank. Especially hot season, every day's drain is recommended. Air dryer shall be drained automatically.

(9) Self control unit depend on detected pressure condition automatically controls auto-strainers, Water supply units and Compressors. These might be started suddenly. During any maintenance work, cut off the MCCB in control panel.

3.7 Sludge Treatment Facility

3.7.1 Operation Procedure

(1) The pumps at Primary Sedimentation Tanks and Final Sedimentation Tanks transport the sludge of this plant to Mixed Sludge Storage Tank. Before beginning of sludge treatment operation, make plan of sludge treatment (estimated sludge volume of Primary Sludge "PS" and Waste Activated Sludge "WAS" and daily balanced operating hours of dewaterer)

(2) Close Drain Valve of Mixed Sludge Storage Tank

(3) Confirm the Sludge coming through the inlet pipe. It is timer operation as "AUTO"
(4) If Mixed Sludge Mixer is not submerged in the sludge, waiting for the sludge level of the tank becoming 800 mm above the top of mixer.

"Do not start Mixed Sludge Mixer when the mixer is not submerged!"

(5) Operate the Mixed Sludge Mixer "AUTO"
(6) Confirm the stored sludge condition in Cake Hopper through the Maintenance Hatch
(7) Operate cut gate of Cake Hopper "CLOSE"
(8) Operate Cake Conveyor (2)-2 [SCREW CONVEYOR 3] "AUTO"
(9) Operate Cake Conveyor (2)-1 [SCREW CONVEYOR 2] "AUTO"
(10) Operate Cake Conveyor (1) [SCREW CONVEYOR 1] "AUTO"

(11) Close Drain Valve of Filtrate Tank
(12) Open the Manual Sludge Valve of the sludge suction pipe from Filtrate Tank.
(13) Open the Inlet and Outlet Valves around Filtrate Pump.
(14) Operate the Filtrate Pump "AUTO"

(15) Supply electric power to Air Compressor for Sludge Treatment.
(16) Confirm air pressure is steady about 0.6 MPa (6 kgf/cm2, 6 bar)

(17) Open the Outlet Valves of the FeCl3 Storage Tank.
(18) Open the Iolet and Outlet Valves around FeCl3 Dosing Pump.
(19) Operate FeCl3 Dosing Pnmp [FeCl PUMP] "AUTO"
(20) Close Drain Valve of Antomatic Polymer Make-up Unit
(21) Preparation Polymer Powder for Automatic Polymer Make-up Unit

"Selection of Polymer Brand shall be confirmed by chemical expert of sludge treatment!"

(22) Close the Outlet Valve of the tank.
(23) Confirm coming make-up water to connect the Automatic Polymer Make-up Unit.
(24) Operate [POLYMER SCREW] "AUTO"
(25) Operate [POLYMER MIXER] "AUTO"
(26) Operate [FILLING VALVE] "AUTO"
(27) Operate [TRANSFER VALVE] "AUTO"
(28) Operate Automatic Polymer Make-up Unit [POLYMER UNIT] "AUTO"
(29) Operate [POLYMER UNIT] "START"
(30) Confirm correct operation and solved polymer.
(31) Open the Inlet and Outlet Valves around Polymer Dosing Pump.
(32) Operate Polymer Dosing Pump [POLYMER PUMP] "AUTO"

(33) Open the Manual Sludge Valve of the sludge suction pipe from Mixed Sludge Storage Tank.
(34) Open the Inlet and Outlet Valves around Mixed Sludge Pump.
(35) Operate the Mixed Sludge Pump [SLUDGE PUMP] "AUTO"
(36) Open valves around magnetic flow meter in the line of feed sludge to dewaterer.
(37) Operate [FLOCCURATOR] "AUTO"
(38) Open the Manual Valve of suction pipe from the Filtered Water Tank.
(39) Open the Inlet and Outlet Valves around Belt Washing Pump.
(40) Operate the Belt Washing Pump [WATER PUMP] "AUTO"
(41) Operate [PRESSING UNIT] "AUTO"
(42) Operate [BELT THICKENER] "AUTO"
(43) Operate [PRESSING UNIT] "START"
(44) Confirm the mixed sludge coming into flocculator and being stirred slowly.
(45) Check the pellet of sludge in the flocculator.
(46) Check the proper operation and control on steering device of belt.
(47) Check the washing spray condition
(48) Check the thickening and dewatering condition
(49) Check the correct transportation of dewatered sludge cake up into the Cake Hopper.

3.7.2 Equipment Operation

(1) Mixed Sludge Mixer (M6-01)

Turn the switch of Mixed Sludge Mixer to MANUAL or AUTO at Sludge Treatment Panel (STP).

Manual Operation

RUN – STOP

Auto Operation

RUN above Mixed Sludge Storage Tank MWL by LA-6, LA-7

(2) Cake Hopper (M6-06)

Local Manual Operation by Unit Panel by side of Cake Hopper. Power is supplied from Sludge Treatment Panel (STP).

Manual Operation only at unit panel supplied by vendor

OPEN – CLOSE

(3) Cake Conveyor (2)-2: (Horizontal) (M6-05-2)

Turn the switch of Cake Conveyor to HAND or AUTO at Control Panel of Sludge Dewaterer supplied by vendor.

Manual Operation

HAND = RUN

Auto Operation

RUN related equipment should be selected "AUTO"

(4) Cake Conveyor (2)-1: (Vertical) (M6-05-1)

Turn the switch of Cake Conveyor to HAND or AUTO at Control Panel of Sludge Dewaterer supplied by vendor.

Manual Operation

HAND = RUN

Auto Operation

RUN related equipment should be selected "AUTO"

(5) Cake Conveyor (1) (M6-04)

Turn the switch of Cake Conveyor to HAND or AUTO at Control Panel of Sludge Dewaterer supplied by vendor.

Manual Operation

HAND = RUN

Auto Operation

RUN related equipment should be selected "AUTO"

(6) Filtrate Pump (M6-14)

Turn the switch of Filtrate Pump to MANUAL or AUTO at Sludge Treatment Panel (STP).

Manual Operation

RUN – STOP

Auto Operation

RUN Continuous operation automatically with condition signal.

Interlock below Filtrate Tank LLWL by LA-8

above Incoming Sewage Pit HWL by LA-1

(7) Air Compressor for Sludge Treatment Facility (M6-12)

Self Auto Operation by pressure switch by side of compressor. Power is supplied from Sludge Treatment Panel (STP).

Auto Operation (Self control)

RUN pressure switch detected start level

STOP pressure switch detected stop level

(8) Air Dryer (M6-13)

Self-Operation. Power is supplied from Sludge Treatment Panel (STP).

(9) FeCl3 Dosing Pump (M6-10)

Turn the switch of FeCl3 Dosing Pump to HAND or AUTO at Control Panel of Sludge Dewaterer supplied by vendor.

Manual Operation

HAND = RUN

Auto Operation

RUN related equipment should be selected "AUTO"

(10) Automatic Polymer Make-up Unit (M6-07)

Turn the switch of Automatic Polymer Make-up Unit to HAND or AUTO at Control Panel of Sludge Dewaterer supplied by vendor.

Manual Operation

HAND = RUN

Auto Operation

RUN related equipment should be selected "AUTO"

(11) Polymer Dosing Pump (M6-08)

Turn the switch of Polymer Dosing Pump to HAND or AUTO at Control Panel of Sludge Dewaterer supplied by vendor.

Manual Operation

HAND = RUN

Auto Operation

RUN related equipment should be selected "AUTO"

(12) Mixed Sludge Pump (M6-02)

Turn the switch of Mixed Sludge Pump to MANUAL or AUTO at Control Panel of Sludge Dewaterer supplied by veudor.

Manual Operation

RUN - STOP

Auto Operation

RUN above Mixed Sludge Storage Tank LLWL by LA-6, LA-7

(13) Flocculator (M6-03-2)

Turn the switch of Flocculator to HAND or AUTO at Control Panel of Sludge Dewaterer supplied by vendor.

Manual Operation

HAND = RUN

Auto Operation

RUN related equipment should be selected "AUTO"

(14) Sludge Dewaterer (M6-03-1)

Turn the switch of Sludge Dewaterer to HAND or AUTO at Control Panel of Sludge Dewaterer supplied by vendor.

Manual Operation

HAND = RUN for BELT THICKENER

HAND = RUN for BELT PRESS

Auto Operation

RUN related equipment should be selected "AUTO"

3.7.3 Caution and Instruction

(1) Inside of sludge tank and cake hopper end so on are Hazardous zone. If maintenance staff wants to go into the tanks, must check the concentration level of Oxygen and dangerous gases (Methane, H_2S etc.)

(2) Two sets of Dewaterer system have two sets of Mixed Sludge Pumps and Polymer Dosing Pumps and FeCl3 Dosing Pumps with only one feeding pipe. Check the route properly before the system start.

(3) If Progressive cavity pump (Mixed Sludge Pump and Polymer Dosing Pump) run with dry condition (no feed operation), in a short time, rotor and stator are damaged by high temperature caused rubbing each other.

(4) Slow rotating equipment has very strong force of rolling up. Do not maintenance without partner. And understand the position of emergency stop switch. Confirm the power cut off, especially, these equipment before maintenance start.

3.8 Sludge Storage Facility

3.8.1 Operation Procedure

(1) Cake Hopper is prepared to store the sludge for a short time (a few hours) before transportation by truck.

(2) Usually, Check the storage condition of the sludge cake in the Cake Hopper. Before Cake Hopper is full, draw out the cake and bring out it directly on the truck to out side of the plant area.

(3) Operate cut gate of bottom of Cake Hopper manually "OPEN"-"STOP"-"CLOSE"

3.8.2 Equipment Operation

(1) There are no Item control from the Panel

3.8.3 Caution and Instruction

(1) Operate Shovel Loader by licensed and skilled staff.

(2) Open slowly the cut gate step by step to draw out the sludge cake.

(3) Dewatered sludge cake will be also separate water and cake even after storage in the

Hopper. And additional decomposition will be occurred in the period of storage and as a result, some water is kept in the sludge cake. The strong spatter may be coming from on the truck. It is normal phenomena of these plants. Be careful of operation on drawing out the sludge from the Cake Hopper

3.9 Deodorization Facility

3.9.1 Operation Procedure

(1) Open related dampers in odor pipe line.

(2) Close the Drain Valve of Chemical Scrubber

(3) Open the Inlet and Outlet Valves around the Circulating Pump.

(4) Operate the Circulating Pump "RUN"

(5) Open the Inlet and Outlet Valves around NaClO Dosing Pump.

(6) Operate the NaClO Dosing Pump "AUTO"

(7) Open the Outlet Valves of the NaClO Storage Tank.

(8) Open the Inlet and Outlet Valves around NaClO Dosing Pump.

(9) Open the Inlet and Outlet Valves around NaOH Dosing Pump.

(10) Operate the NaOH Dosing Pump "AUTO"

(11) Confirm again open condition of related dampers in odor pipeline.

(12) Open the Inlet and Outlet Valves around the Deodorization Fan.

(13) Operate the Deodorization Fan "RUN"

(14) Adjust air balance manually with damper

3.9.2 Equipment Operation

(1) NaClO Dosing Pump (M8-02)

Turn the switch of NaClO Dosing Pump to AUTO or MANUAL at Control Panel of deodorization Facility supplied by vendor.

Manual Operation

START- STOP

Interlock below NaClO Storage Tank LLWL by LA-12

Auto Operation

START Timer operates NaClO Dosing Pump automatically with intermittent opening signal.

STOP Timer operates NaClO Dosing Pump automatically with Intermittent closing signal.

(2) NaOH Dosing Pump (M8-04)

Turn the switch of NaOH Dosing Pump to AUTO or MANUAL t Control Panel of deodorization Facility supplied by vendor.

Manual Operation

START - STOP

Interlock below NaOH Storage Tank LLWL by LA-13

Auto Operation

START below pH sensor indicate 10

STOP above pH sensor indicate 10.6

(3) Circulating Pump (M8-05)

Turn the switch of Circulating Pump to AUTO or MANUAL at Control Panel of deodorization Facility supplied by vendor.

Manual Operation

START - STOP

Interlock below Chemical Scrubber LLWL by LA-18

Auto Operation

START Pre-start before Deodorization Fan start

(4) Deodorization Fan (M8-07)

Turn the switch of Deodorization Fan AUTO or MANUAL at Control Panel of deodorization Facility supplied by vendor.

Manual Operation

START - STOP

Auto Operation

START Timer delay start after Circulating Pump start

STOP Circulating Pump stop.

3.9.3 Caution and Instruction

(1) Handle carefully the dangerous chemical NaOCl and NaOH solution (strong alkali). Suitable chemical protection goods are suggested to handle these chemicals. In case of contact to these chemicals, immediately wash out by clean water.

(2) According to a schedule, Check the consumptions and remaining volume of chemicals in the storage tanks and warehouse and purchase the chemicals.

(3) pH sensor should be checked carefully. KCl solution should be kept in bottle connected with sensor. And periodical adjustment by using standard solution and sensor wash are recommended to keep the accuracy of sensing value.

		checked date	02-Oct-03
Work No.	AA0007	prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)		
Sheet Name	Instrument List (1/2)		

Tag No.	Service Name	Unit	Diagram Refer to
FIQ-1	Incoming Sewage Flow	1	-104 V5/6 7.8
FIQ-2-1, 2	-Return Activated Sludge Flow	2	-105 V6/6 7.9
FIQ-3	Primary Sludge Flow	1	-105 V6/6 7.10
FIQ-4	Waste Activated Sludge Flow	1	-105 V6/6 7.10
FIQ-5	Effluent Flow	1	-106 V5/6 7.6
DOI-1-1, 1	-Aeration Tank DO	2	-105 V5/6 7.1
PHIC-1	Chemical Scrubber	1	-108 V4/6 10.5, 10.6
LCA-1	Incomming Sewage Pit (Channel)	1	-104 V5/6 7.4
LCA-2	Lift Pump Pit (Back up)	1	-104 V5/6 7.4
LICA-3	Lift Pump Pit (Main use)	1	-104 V5/6 7.6
LCA-4	Secondary Effluent Tank	1	-106 V5/6 7.4
LCA-5	Filter Water Tank	1	-106 V5/6 7.4
LCA-6	Mixed Sludge Storage Tank	1	-107 V5/6 7.5
LICA-7	Mixed Sludge Storage Tank	1	-107 V5/6 7.6
LCA-8	Filtrate Tank	1	-107 V5/6 7.5
LCA-9	NaClO Storage Tank	1	-106 V5/6 7.3
LCA-10	FeCl3 Storage Tank	1	-107 V5/6 7.3
LCA-11	Polymer Make-up Unit	1	-107 V3/6 1.7
LCA-12	Deodorization Facility NaClO Stor	1	-108 V4/6 10.9
LCA-13	Deodorization Facility FeCl3 Stor	1	-108 V4/6 10.9
LCA-14	Deep Well	1	-106 V2/6 2.10
LCA-15	Water supply Unit	1	-106 V4/6 14
LCA-16	NaClO Storage Tank for Well Water	1	-106 V5/6 7.3
LCA-17	FeCl3 Storage Tank for Well Water	1	-107 V5/6 7.3
LCA-21	Drainage Pit (Primary north)	1	-104 V2/6 2.4
LCA-22	Drainage Pit	1	-105 V2/6 2.4
LCA-23	Drainage Pit	1	-105 V2/6 2.4
LCA-24	Drainage Pit	1	-105 V2/6 2.4
LCA 25	Drainage Pit	1	-105 V2/6 2.4

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Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument List (2/2)				

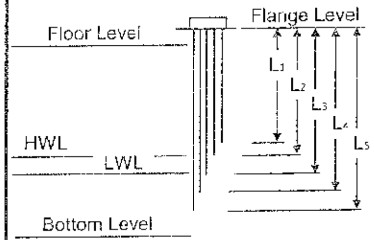
checked date 02-Oct-03

Tag No.	Service Name	Unit	(Standard Set by)	Diagram	Refer to
LCA-26	Drainage Pit	1	Pump supplier	-105	V2/6 2.4
LCA-27	Drainage Pit	1	Pump supplier	-106	V2/6 2.4
LCA-28	Drainage Pit	1	Pump supplier	-106	V2/6 2.4
LCA-29	Drainage Pit	1	Pump supplier	-107	V2/6 2.4
LCA-30	Drainage Pit	1	Pump supplier	-107	V2/6 2.4
LCA-31	Drainage Pit	1	Pump supplier	-107	V2/6 2.4
LCA-32	Drainage Pit	1	Pump supplier	-107	V2/6 2.4

Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

checked date 02-Oct-03

Tag No. / Servi LCA-1 Incoming Sewage Pit



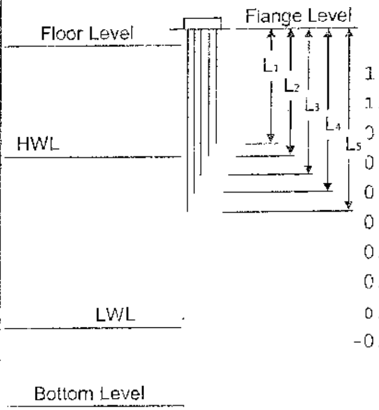
Flange: JIS 10K 125A

Flange Level =	-1350	(FL + 150)		
Floor Level =	-1500			(mm)
(HH)	-2425	(HWL + 300)	L_1 =	1075
(H)	-2725	(BL + 675)	L_2 =	1375
(L)	-3300	(BL + 100)	L_3 =	1950
(common)			L_4 =	1950
			L_5 =	(N/A)
Normal HWL =	-2725	(BL + 675)	Hourly maximum	
LWL =	-3300	(BL + 100)		
Bottom Level =	-3400			

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-2 Lift Pump Pit (* Back up system for LCIA-3 Electrode Type)

Flange: JIS 10K 125A



					(mm)
	Flange Level =	-1350	(FL + 150)		
	Floor Level =	-1500			
1.44	(HH)	-2425	= LCA-1 (HH)	L_1 =	1075
1.00	HWL (H_2)	-2725	F.S.Pump Start	L_2 =	1375
0.85	(H_1)	-2825	F.S.Pump Start	L_3 =	1475
0.74	(M_4)	-2900	S. Pump (100%)	L_4 =	1550
0.59	(M_3)	-3000	/.S. Pump (90%)	L_5 =	1650
0.44	(M_2)	-3100	/.S. Pump (80%)	L_6 =	1750
0.30	(M_1)	-3200	/.S. Pump Start	L_7 =	1850
0.15	(L_2)	-3300	Fixed Pump Stop	L_8 =	1950
0.00	LWL (L_1)	-3400	Normal Stop WL	L_9 =	2050
-0.07	(LL)	-3450	Pump Interlock W.	L_{10} =	2100
	(common)			L_{11} =	2100

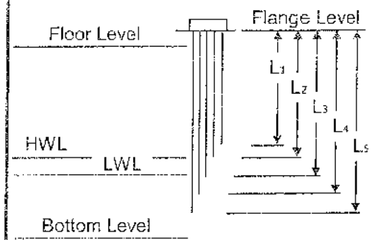
LWL Normal Stop WL =	-3400	(COP + 2.5xD + β) β=100
Pump Interlock WL =	-3450	(COP + 2.5xD + α) α=50
Pump Suction Limit =	-3450	(COP + 2.5xD)
Bottom Level =	-5400	

Tag No. / Servi LCIA-3 Lift Pump Pit (* Usual use system Ultra Sonic Type)

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-4 Secondary Effluent Tank

Flange: JIS 10K 125A



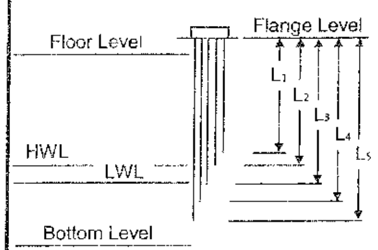
				(mm)
Flange Level =	350	(FL + 150)		
Floor Level =	200			
(HH)	-405	(HWL + 100	L_1 =	755
(H)	-2250	Pump Start OK	L_2 =	2600
(L)	-2750	Normal Stop WL	L_3 =	3100
(LL)	-2800	Pump Interlock WL	L_4 =	3100
(common)			L_5 =	3100

Normal HWL =	-505	(BL + 3295) Hourly maximum
Normal WL =	-788	(BL + 3012) Daily maximum
LWL Normal Stop WL =	-2750	(COP + 2.5xD + β) β=88
Pump Interlock WL =	-2800	(COP + 2.5xD + α) α=38
Pump Suction Limit =	-2838	(COP + 2.5xD)
Bottom Level =	-3800	

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-5 Filtered Water Tank

Flange: JIS 10K 125A



Flange Level =	350 (FL + 150)			
Floor Level =	200			(mm)
(HH)	-700 (HWL + 100		L_1 =	1050
(H)	-800 Start Inisialize		L_2 =	1150
(L)	-3050 Normal Stop WL		L_3 =	3400
(LL)	-3100 Pump Interlock WL		L_4 =	3400
(common)			L_5 =	3400

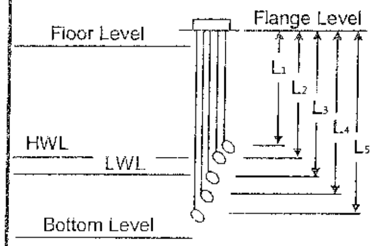
Normal HWL = -800 (BL + 3000) Overflow Top -300

LWL Normal Stop WL = -3050 (COP + F + 1.5xD + β) β=103
Pump Interlock WL = -3100 (COP - F + 1.5xD + α) α=53
Pump Suction Limit = -3153 (COP - F + 1.5xD)
Bottom Level = -3800

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-6 Mixed Sludge Storage Tank (* Back up system for LICA-7 Fright Level Type)

Flange: JIS 10K 125A



Flange Level =	550 (FL + 150)			
Floor Level =	400 w/ cinder @200			(mm)
(HH)	-1200 (HWL + 100		L_1 =	1750
(H)	-1300 Start Inisialize		L_2 =	1850
(M)	-3500 Mixer Interlock WL		L_3 =	4050
(L)	-4600 Normal Stop WL		L_4 =	5150
(LL)	-4650 Pump Interlock WL		L_5 =	5200

Normal HWL = -1300 (BL + 3700) Overflow BOP -200
Mixer Interlock WL = -3500 (BL + 1500)
LWL Normal Stop WL = -4600 (COP - F - L + 1.5xD + β) β=102
Pump Interlock WL = -4650 (COP - F - L + 1.5xD + α) α=52
Pump Suction Limit = -4702 (COP - F - L + 1.5xD)
Bottom Level = -5000

Tag No. / Servi LICA-7 Mixed Sludge Storage Tank (* Usual use system Ultra Sonic Type)

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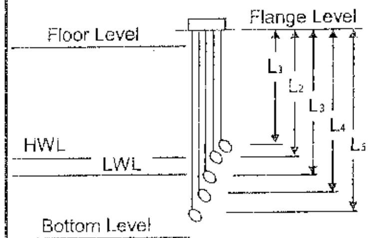
				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-8 Filtrate Tank

Flange: JIS 10K 125A



Flange Level =	550 (FL + 150)			
Floor Level =	400 w/ cinder @200			(mm)
(HH)	-1200 (HWL + 100		L_1 =	1750
(H)	-3300 Start Inisialize		L_2 =	3850
(L)	-4450 Normal Stop WL		L_3 =	5000
(LL)	-4500 Pump Interlock WL		L_4 =	5050
			L_5 =	

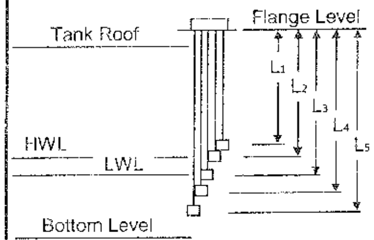
Normal HWL = -1300 (BL + 3700) Overflow BOP -200

LWL Normal Stop WL = -4450 (COP - F_f - L + 1.5xD + β) β=105
Pump Interlock WL = -4500 (COP - F -L + 1.5xD + α) α=55
Pump Suction Limit = -4555 (COP - F - L + 1.5xD)
Bottom Level = -5000

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-9 NaClO Storage Tank (M4-3, 8 m^3, approx. 2.3 x 2.8H)

Flange: JIS 10K 125A



Flange Level =	3650 (TR + 150)			
Tank Roof =	3500 (BL + 2800)			(mm)
(HH)	2800 (HWL + 100		L_1 =	850
(H)	2700 Start Inisialize		L_2 =	950
(L)	950 Normal Stop WL		L_3 =	2700
(LL)	900 Pump Interlock WL		L_4 =	2750
			L_5 =	

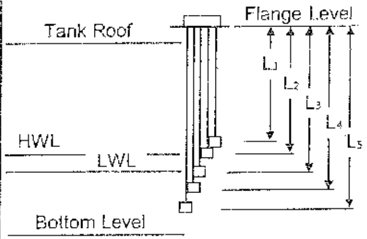
Normal HWL = 2700 (BL + 2000) Overflow COP -100

LWL Normal Stop WL = 950 (COP + 1.5xD + β) β=112
Pump Interlock WL = 900 (COP + 1.5xD + α) α=62
Pump Suction Limit = 838 (COP + 1.5xD)
Bottom Level = 700

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-10 $FeCl_3$ Storage Tank (M6-9, 9 m^3, approx. 2.3 x 2.9H)

Flange: JIS 10K 125A



Flange Level =	3850	(TR + 150)			
Tank Roof =	3700	(BL + 2900)			(mm)
(HH)	3100	(HWL + 100		L_1 =	750
(H)	3000	Start Inisialize		L_2 =	850
(L)	1070	Normal Stop WL		L_3 =	2780
(LL)	1020	Pump Interlock WL		L_4 =	2830
				L_5 =	

Normal HWL = 3000 (BL + 2200) Overflow COP -250

LWL Normal Stop WL = 1070 (COP + 1.5xD + β) β=112
Pump Interlock WL = 1020 (COP + 1.5xD + α) α=62
Pump Suction Limit = 958 (COP + 1.5xD)
Bottom Level = 800

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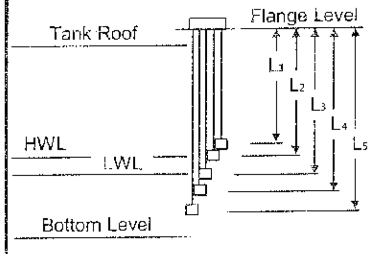
EBARA TAISEI JOINT VENTURE 3.10 Data Sheet of Electrical Instruments Page 61 of 115

checked date 02-Oct-03
Work No. AA0007 prepared by I. H.
Plant name Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)
Sheet Name Instrument (Level sensor)

Tag No. / Servi LCA-10 $FeCl_3$ Storage Tank (M6-9, 9 m^3, approx. 2.3 x 2.9H)
Flange: JIS 10K 125A



Flange Level = 3850 (TR + 150)
Tank Roof = 3700 (BL + 2900) (mm)
(HH) 3100 (HWL + 100 L_1 = 750
(H) 3000 Start Inisialize L_2 = 850
(L) 1070 Normal Stop WL L_3 = 2780
(LL) 1020 Pump Interlock WL L_4 = 2830
L_5 =

Normal HWL = 3000 (BL + 2200) Overflow COP -250

LWL Normal Stop WL = 1070 (COP + 1.5xD + β) β=112
Pump Interlock WL = 1020 (COP + 1.5xD + α) α=62
Pump Suction Limit = 958 (COP + 1.5xD)
Bottom Level = 800

printed on 16/11/04

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

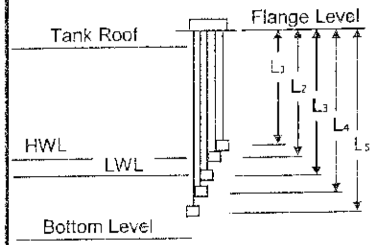
Tag No. / Servi LCA-11 Automatic Polymer Make-up Unit (M6-7) (Supplied by Vendor of Dewatering Unit)

Please see Vendor's Operation manual for detail

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-12 Deodorization Facility NaClO Storage Tank (M8-1, 1 m^3, approx. 1.0 x 1.4H)

Flange: JIS 10K 125A



Flange Level =	2100 (TR + 150)			
Tank Roof =	1950 (BL + 1400)			(mm)
(HH)	1750 (HWL + 100		L_1 =	350
(H)	1650 Start Inisialize		L_2 =	450
(L)	825 Normal Stop WL		L_3 =	1275
(LL)	775 Pump Interlock WL		L_4 =	1325
			L_5 =	

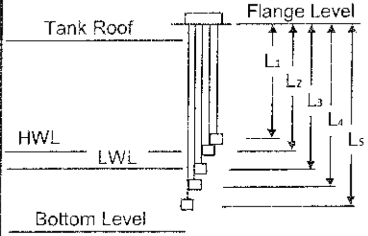
Normal HWL = 1650 (BL + 1100) Overflow COP -100

LWL Normal Stop WL = 825 (COP + 1.5xD + β) β=102
Pump Interlock WL = 775 (COP + 1.5xD + α) α=52
Pump Suction Limit = 723 (COP + 1.5xD)
Bottom Level = 550

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-13 Deodorization Facility NaOH Storage Tank (M8-3, 1 m^3, approx. 1.0 x 1.4H)

Flange: JIS 10K 125A



Flange Level =	2100	(TR + 150)			
Tank Roof =	1950	(BL + 1400)			(mm)
(HH)	1750	(HWL + 100		L_1 =	350
(H)	1650	Start Inisialize		L_2 =	450
(L)	825	Normal Stop WL		L_3 =	1275
(LL)	775	Pump Interlock WL		L_4 =	1325
				L_5 =	

Normal HWL = 1650 (BL + 1100) Overflow COP -100

LWL Normal Stop WL = 825 (COP + 1.5xD + β) β=102
Pump Interlock WL = 775 (COP + 1.5xD + α) α=52
Pump Suction Limit = 723 (COP + 1.5xD)
Bottom Level = 550

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-14 Deep Well (M5-11) (Supplied by Vendor of Pump)

Please see Vendor's Operation manual for detail

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LCA-15 Water Supply Unit for Domestic Use (Supplied by Vendor of Pump)

Please see Vendor's Operation manual for detail

				checked date	02-Oct-03
Work No.	AA0007			prepared by	I. H.
Plant name	Hanoi People's Committee / Wastewater Treatment Plant (CP-3 Works)				
Sheet Name	Instrument (Level sensor)				

Tag No. / Servi LC-21 Drainage Pit (Pump Well) (Supplied by Vendor of Pump)

Please see Vendor's Operation manual for detail

Tag No. / Servi	LC-22	Drainage Pit (Primary North)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-23	Drainage Pit (Primary South)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-24	Drainage Pit (Aeration Tank)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-25	Drainage Pit (Final North)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-26	Drainage Pit (Final South)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-27	Drainage Pit (DSB North)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-28	Drainage Pit (DSB South)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-29	Drainage Pit (Cake Stock Yard East)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-30	Drainage Pit (Cake Stock Yard West)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-31	Drainage Pit (STB North)	(Supplied by Vendor of Pump)
Tag No. / Servi	LC-32	Drainage Pit (STB South)	(Supplied by Vendor of Pump)

3.11 Timer Setting Table

Timer Setting Table (1/3)

No.	Panel Name	Timer Name	Type	Purpose	Range	Set Value
1	CSP	27T	H3CR-H8L	Power Fault	0.05m-12m	5s
2		84T	H3CR-A8	Commercial Power	0.05s-300h	5s
3	GCP	52TE2	H3CR-F8N	Grit Pump A Intermittent Time	0.05s-30h	ON:10m OFF:2h
4		52TE3	H3CR-F8N	Grit Pump B Intermittent Time	0.05s-30h	ON:10m OFF:2h
5		52TE4	H3CR-F8N	Grit Pump C Intermittent Time	0.05s-30h	ON:10m OFF:2h
6		52TE5	H3CR-F8N	Grit Pump D Intermittent Time	0.05s-30h	ON:10m OFF:2h
7		52TE6	H3CR-F8N	Grit Pump E Intermittent Time	0.05s-30h	ON:10m OFF:2h
8		52TE7	H3CR-F8N	Grit Pump F Intermittent Time	0.05s-30h	ON:10m OFF:2h
9		52TE8	H3CR-F8N	Grit Pump G Intermittent Time	0.05s-30h	ON:10m OFF:2h
10		52TE9	H3CR-F8N	Grit Pump H Intermittent Time	0.05s-30h	ON:10m OFF:2h
11		52TE10	H3CR-F8N	Grit Pump I Intermittent Time	0.05s-30h	ON:10m OFF:2h
12		1TE11	H3CR-A	Grit Separator Off Delay	0.05s-300h	1h
13		52TE12	H3CR-F8N	Fine Screen A Intermittent Time	0.05s-30h	ON:0.25h OFF:1h
14		1TE12	H3CR-A	Fine Screen A Off Delay	0.05s-300h	30m
15		52TE13	H3CR-F8N	Fine Screen A Intermittent Time	0.05s-30h	ON:0.25h OFF:1h
16		1TE13	H3CR-A	Fine Screen B Off Delay	0.05s-300h	30m
17		52TE14	H3CR-F8N	Fine Screen A Intermittent Time	0.05s-30h	ON:0.25h OFF:1h
18		1TE14	H3CR-A	Fine Screen C Off Delay	0.05s-300h	30m
19		1TE15	H3CR-A	Fine Screen Conveyer Off Delay	0.05s-30h	30m
20		33WT1LL	H3YN-4	Incoming Sewage Pit Level LL	0.1s-10m	5s
21		33WT1H	H3YN-4	Incoming Sewage Pit Level H	0.1s-10m	5s
22		33WT2LL	H3YN-4	Lift Pump Pit Level LL	0.1s-10m	5s
23		33WT2M2	H3YN-4	Lift Pump Pit Level M2	0.1s-10m	5s
24		33WT2M3	H3YN-4	Lift Pump Pit Level M3	0.1s-10m	5s
25		33WT2M4	H3YN-4	Lift Pump Pit Level M4	0.1s-10m	5s
26		33WT2HH	H3YN-4	Lift Pump Pit Level HH	0.1s-10m	5s
27		BZTE1	H3CR-A8	Buzzer Stop 1	0.05s-300h	30s
28		BZTE2	H3CR-A8	Buzzer Stop 2	0.05s-300h	30s
29		84TGCP1	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
30		84TGCP2	H3CR-A8	Common Circuit Power On	0.05s-300h	20s
31		84TGCP3	H3CR-A8	Common Circuit Power On	0.05s-300h	30s
32	LPP	19TF1	H3CR-G8L	Y-Δ Timer of Lilt Pump A-1	0.5s-120s	5s
33		42TF1	H3YN-4	Lilt Pump A-1 Running	0.1s-10m	3s
34		19TF2	H3CR-G8L	Y-Δ Timer of Lilt Pump A-2	0.5s-120s	5s
35		42TF2	H3YN-4	Lilt Pump A-2 Running	0.1s-10m	3s
36		84TLPP1	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
37		84TLPP2	H3CR-A8	Common Circuit Power On	0.05s-300h	20s
38		84TLPP3	H3CR-A8	Common Circuit Power On	0.05s-300h	30s
39		BZTF	H3CR-A8	Buzzer Stop	0.05s-300h	30s
40	PSSP	BZTG	H3CR-A8	Buzzer Stop	0.05s-300h	30s
41	PSP	1TH4	H3YN-4	Primary Sludge Valve A	0.1s-10m	60s
42		1TH5	H3YN-4	Primary Sludge Valve B	0.1s-10m	60s
43		1TH6	H3YN-4	Primary Sludge Valve C	0.1s-10m	60s
44		1TH7	H3YN-4	Primary Sludge Valve D	0.1s-10m	60s
45		1TH8	H3YN-4	Primary Sludge Valve E	0.1s-10m	60s
46		1TH9	H3YN-4	Primary Sludge Valve F	0.1s-10m	60s
47		21THG	H3YN-4	Primary Sludge Valve Close	0.1s-10m	3s
48		84TPSP	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
49		BZTH	H3CR-A8	Buzzer Stop	0.05s-300h	30s

Timer Setting Table (2/3)

No.	Panel Name	Timer Name	Type	Purpose	Range	Set Value
50	AFSSP	BZTJ	H3CR-A8	Buzzer Stop	0.05s-300h	30s
51	SAP-1	52TK1	H3CR-F8N	Surface Aerator A Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
52		19TK1	H3CR-G8L	Y-Δ Timer of Surface Aerator A	0.5s-120s	5s
53		42TK1	H3YN-4	Surface Aerator A Running	0.1s-10m	3s
54		52TK3	H3CR-F8N	Surface Aerator B Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
55		19TK3	H3CR-G8L	Y-Δ Timer of Surface Aerator B	0.5s-120s	5s
56		42TK3	H3YN-4	Surface Aerator B Running	0.1s-10m	3s
57		52TK5	H3CR-F8N	Surface Aerator C Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
58		19TK5	H3CR-G8L	Y-Δ Timer of Surface Aerator C	0.5s-120s	5s
59		42TK5	H3YN-4	Surface Aerator C Running	0.1s-10m	3s
60		84TSAP11	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
61		84TSAP12	H3CR-A8	Common Circuit Power On	0.05s-300h	20s
62		BZTK	H3CR-A8	Buzzer Stop	0.05s-300h	30s
63	SAP-2	52TL1	H3CR-F8N	Surface Aerator D Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
64		19TL1	H3CR-G8L	Y-Δ Timer of Surface Aerator D	0.5s-120s	5s
65		42TL1	H3YN-4	Surface Aerator D Running	0.1s-10m	3s
66		52TL3	H3CR-F8N	Surface Aerator E Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
67		19TL3	H3CR-G8L	Y-Δ Timer of Surface Aerator E	0.5s-120s	5s
68		42TL3	H3YN-4	Surface Aerator E Running	0.1s-10m	3s
69		52TL5	H3CR-F8N	Surface Aerator F Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
70		19TL5	H3CR-G8L	Y-Δ Timer of Surface Aerator F	0.5s-120s	5s
71		42TL5	H3YN-4	Surface Aerator F Running	0.1s-10m	3s
72		84TSAP21	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
73		84TSAP22	H3CR-A8	Common Circuit Power On	0.05s-300h	20s
74		BZTL	H3CR-A8	Buzzer Stop	0.05s-300h	30s
75	SAP-3	52TM1	H3CR-F8N	Surface Aerator G Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
76		19TM1	H3CR-G8L	Y-Δ Timer of Surface Aerator G	0.5s-120s	5s
77		42TM1	H3YN-4	Surface Aerator G Running	0.1s-10m	3s
78		52TM3	H3CR-F8N	Surface Aerator H Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
79		19TM3	H3CR-G8L	Y-Δ Timer of Surface Aerator H	0.5s-120s	5s
80		42TM3	H3YN-4	Surface Aerator H Running	0.1s-10m	3s
81		52TM5	H3CR-F8N	Surface Aerator J Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
82		19TM5	H3CR-G8L	Y-Δ Timer of Surface Aerator J	0.5s-120s	5s
83		42TM5	H3YN-4	Surface Aerator J Running	0.1s-10m	3s
84		84TSAP31	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
85		84TSAP32	H3CR-A8	Common Circuit Power On	0.05s-300h	20s
86		BZTM	H3CR-A8	Buzzer Stop	0.05s-300h	30s
87	SAP-4	52TL1	H3CR-F8N	Surface Aerator K Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
88		19TL1	H3CR-G8L	Y-Δ Timer of Surface Aerator K	0.5s-120s	5s
89		42TL1	H3YN-4	Surface Aerator K Running	0.1s-10m	3s
90		52TL3	H3CR-F8N	Surface Aerator L Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
91		19TL3	H3CR-G8L	Y-Δ Timer of Surface Aerator L	0.5s-120s	5s
92		42TL3	H3YN-4	Surface Aerator L Running	0.1s-10m	3s
93		52TL5	H3CR-F8N	Surface Aerator M Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
94		19TL5	H3CR-G8L	Y-Δ Timer of Surface Aerator M	0.5s-120s	5s
95		42TL5	H3YN-4	Surface Aerator M Running	0.1s-10m	3s
96		84TSAP31	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
97		84TSAP32	H3CR-A8	Common Circuit Power On	0.05s-300h	20s
98		BZTN	H3CR-A8	Buzzer Stop	0.05s-300h	30s
99	CMBP	19TP1	H3CR-G8L	Y-Δ Timer of Channel Mixing Blower A	0.5s-120s	5s
100		42TP1	H3YN-4	Channel Mixing Blower A Running	0.1s-10m	3s
101		19TP3	H3CR-G8L	Y-Δ Timer of Channel Mixing Blower B	0.5s-120s	5s
102		42TP3	H3YN-4	Channel Mixing Blower B Running	0.1s-10m	3s
103		BZTP	H3CR-A8	Buzzer Stop	0.05s-300h	30s

Timer Setting Table (3/3)

No.	Panel Name	Timer Name	Type	Purpose	Range	Set Value
104		19TQ1	H3CR-G8L	Y-Δ Timer of RAS Pump A	0.5s-120s	5s
105		42TQ1	H3YN-4	RAS Pump A Running	0.1s-10m	3s
106		19TQ3	H3CR-G8L	Y-Δ Timer of RAS Pump B	0.5s-120s	5s
107		42TQ3	H3YN-4	RAS Pump B Running	0.1s-10m	3s
108		19TQ5	H3CR-G8L	Y-Δ Timer of RAS Pump C	0.5s-120s	5s
109	RWP	42TQ5	H3YN-4	RAS Pump C Running	0.1s-10m	3s
110		19TQ7	H3CR-G8L	Y-Δ Timer of RAS Pump D	0.5s-120s	5s
111		42TQ7	H3YN-4	RAS Pump D Running	0.1s-10m	3s
112		52TQ9	H3CR-F8N	WAS Extraction Valve A Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
113		52TQ10	H3CR-F8N	WAS Extraction Valve B Intermittent Time	0.05s-30h	ON:0.5h OFF:1h
114		84TRWP	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
115		BZTQ	H3CR-A8	Buzzer Stop	0.05s-300h	30s
116		33WT9LL	H3YN-4	NaClo Storage Tank Level LL	0.1s-10m	5s
117		33WT9H	H3YN-4	NaClo Storage Tank Level H	0.1s-10m	5s
118	WSSP	33WT16LL	H3YN-4	NaClo Storage Tank For Well Water Level LL	0.1s-10m	5s
119		33WT16H	H3YN-4	NaClo Storage Tank For Well Water Level H	0.1s-10m	5s
120		BZTR1	H3CR-A8	Buzzer Stop 1	0.05s-300h	30s
121		BZTR2	H3CR-A8	Buzzer Stop 2	0.05s-300h	30s
122		5TS7	H3CR-A8	Air Compressor A Off Delay	0.05s-300h	30s
123		5TS8	H3CR-A8	Air Compressor B Off Delay	0.05s-300h	30s
124		33WT4LL	H3YN-4	Secondary Effluent Tank Level LL	0.1s-10m	5s
125		33WT5LL	H3YN-4	Filtered Water Tank Level LL	0.1s-10m	5s
126		33WT5HH	H3YN-4	Filtered Water Tank Level HH	0.1s-10m	5s
127		33WT14L	H3YN-4	Deep Well Level L	0.1s-10m	5s
128	FWP	33WT14H	H3YN-4	Deep Well Level H	0.1s-10m	5s
129		33WT15HL	H3YN-4	Water Supply Unit For Domestic Use Level HL	0.1s-10m	5s
130		33WT15LL	H3YN-4	Water Supply Unit For Domestic Use Level LL	0.1s-10m	5s
131		33WT15HH	H3YN-4	Water Supply Unit For Domestic Use Level HH	0.1s-10m	5s
132		BZTS1	H3CR-A8	Buzzer Stop 1	0.05s-300h	30s
133		BZTS2	H3CR-A8	Buzzer Stop 2	0.05s-300h	30s
134		84TFWP	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
135		33WT6LL	H3YN-4	Mixed Sludge Storage Tank Level LL	0.1s-10m	5s
136		33WT6HH	H3YN-4	Mixed Sludge Storage Tank Level HH	0.1s-10m	5s
137		33WT10LL	H3YN-4	FeCl3 Storage Tank Level LL	0.1s-10m	5s
138		33WT10H	H3YN-4	FeCl3 Storage Tank Level H	0.1s-10m	5s
139	STP-1	33WT17LL	H3YN-4	NaClo Storage Tank Level LL	0.1s-10m	5s
140		33WT17H	H3YN-4	NaClo Storage Tank Level H	0.1s-10m	5s
141		BZTT1	H3CR-A8	Buzzer Stop 1	0.05s-300h	30s
142		BZTT2	H3CR-A8	Buzzer Stop 2	0.05s-300h	30s
143		84TSTP1	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
144		19TU1	H3CR-G8L	Y-Δ Timer of Filtrate Pump A	0.5s-120s	5s
145		42TU1	H3YN-4	Filtrate Pump A Running	0.1s-10m	3s
146		19TU3	H3CR-G8L	Y-Δ Timer of Filtrate Pump B	0.5s-120s	5s
147	STP-2	42TU3	H3YN-4	Filtrate Pump B Running	0.1s-10m	3s
148		BZTU1	H3CR-A8	Buzzer Stop 1	0.05s-300h	30s
149		BZTU2	H3CR-A8	Buzzer Stop 2	0.05s-300h	30s
150		84TSTP2	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
151		33WT12LL	H3YN-4	NaClo Storage Tank Level LL	0.1s-10m	5s
152		33WT12H	H3YN-4	NaClo Storage Tank Level H	0.1s-10m	5s
153		33WT13LL	H3YN-4	NaOH Storage Tank Level LL	0.1s-10m	5s
154		33WT13HH	H3YN-4	NaOH Storage Tank Level HH	0.1s-10m	5s
155	DP	33WT18L	H3YN-4	Chemical Scrubber Tank Level L	0.1s-10m	5s
156		33WT18H	H3YN-4	Chemical Scrubber Tank Level H	0.1s-10m	5s
157		BZTV1	H3CR-A8	Buzzer Stop 1	0.05s-300h	30s
158		BZTV2	H3CR-A8	Buzzer Stop 2	0.05s-300h	30s
159		84TDP	H3CR-A8	Common Circuit Power On	0.05s-300h	10s
160	SVP	BZTW	H3CR-A8	Buzzer Stop 2	0.05s-300h	30s

Hanoi Urban Infrastructure Development Project
CP-3 Works Wastewater Treatment Plant

Date : ________

3.12 DAILY CHECK SHEET

Sampling Date : ________

Operation Condition

Lift Pump: ________ units (Flow rate ________ m3/min) (________ m3/day)

Operating Condition

Return Sludge ________ m3/min ________ R.S.Ratio ________ % (________ %

NaClO ________ % , dosing rate ________ mg/l . stroke ________ %

FeCl 3 ________ % , dosing rate ________ mg/l . stroke ________ %

Sludge Treatment

Treated Sludge ________ m3/min (________ m3/hr) Operated hour ________ hr

Sampling Time										
Sampling Point	Raw water	Aerobic Tank	Treated water							
pH	o	o	o							
Temperature (oC)	o	o	o							
DO (mg/l)	o	o	o							
SS (mg/l)	o	-	o							
COD (mg/l)	o	-	o							

Checked by : ________ Prepared by : ________

3.B Maintenance

3.13 Maintenance of equipment

Periodic inspection and maintenance of main equipment are shown as below.
Detail inspection and maintenance should be referred to the manufacturer's manual parts.

3.14 Grit Chamber facility

3.14.1 Inflow gate (M1-01)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 4)

Inspection point	Inspection method	Acceptance Criteria	Frequency
Operating condition	Normal operation	The gate leaf is smooth.	Daily
Vibration and noise	Fingering and listening	No extreme vibration or noises are to be perceived.	Daily
Opening indicator	Visual inspection	The indication of the needle is accurate.	Daily
Stem	Visual inspection	The threaded portion is to be free from any scuffing and wear.	Periodically
Reduction gear or actuator	Visual inspection (Detach the plug)	The reduction gear or actuator is not to soak in water.	Periodically
Steady rest	Visual inspection	No breakage or wear is to be found.	Periodically
Seat (Gate leaf)	Visual inspection	No breakage or wear is to be found.	Periodically
Motor	Visual inspection	The insulation resistance is to be 1 Ohm or above.	Periodically

3.14.2 Grit chamber inflow gate (M1-02)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)

Inspection point	Inspection method	Acceptance Criteria	Frequency
Operating condition	Normal operation	The gate leaf is smooth	Daily
Vibration and noise	Fingering and listening	No extreme vibration or noises are to be perceived.	Daily
Opening indicator	Visual inspection	The indication of the needle is accurate.	Daily

Stem	Visual inspection	The threaded portion is to be free from any scuffing and wear.	Periodically
Reduction gear or actuator	Visual inspection (Detach the plug)	The reduction gear or actuator is not to soak in water.	Periodically
Steady rest	Visual inspection	No breakage or wear is to be found.	Periodically
Seat (Gate leaf)	Visual inspection	No breakage or wear is to be found.	Periodically

3.14.3 Grit pump (M1-04)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.1)

(1) Daily inspection	Electric current and swing range of ammeter pointer should be checked daily.
(2) Periodic inspection	(a) Measurement of the insulation resistance shall be performed once a month. (b) Lubricating oil shall be checked once every 200hours or 6 months. (c) Overhauling shall be performed once every two to three years so as to keep the longer service life of the pump.

3.14.4 Grit separator (M1-05)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 12)

(1) Weekly inspection	(a) Ensure the unit is in its proper operating condition. (b) No unusual sounds are audible. (c) There is no buildup nor rags or other contaminates obstructing the operation.
(2) Yearly lubrication and Maintenance required	(d) Measurement of the insulation resistance shall be performed once a month. (e) Lubricating oil shall be checked once every 200hours or 6 months. (f) Overhauling shall be performed once every two to three years so as to keep the longer service life of the pump.

3.14.5 Fine screen (M1-07)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 2)

Dairy inspection	(a) Check whether any rubbish are staying in the shank on the bottom of the water channel or not.

	(b) Check whether any abnormal noise or overheating are generated during the running or not. (c) Take care of occurrence of the over current caused by the overloading or other reason. (d) Check whether there are any looseness of the bolts and nuts or not. (e) Check the timing between the revolution of the eccentric roll and the running of the rakes.

3.14.6 Fine screenings conveyor (M1-18)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 3)

(1) Weekly inspection and maintenance	(a) Check of abnormal vibration or noise. (b) Check of temperature of the tell housing packing box with thermometer (not by hand).
(2) Monthly inspection and maintenance.	(a) Clean the conveyor inside and outside. (b) Check the line for wear. (c) Check gland packing box for leaks. (d) Check the spiral for any excessive wear or unusual damage.
(3) Half yearly inspection and maintenance	(a) Check all fasteners. (b) Check all trough welds. (c) Check the oil level in the gearbox and its color. (d) Check the control system, i.e. emergency stop, sequential control etc.

3.14.7 Grit pump hoist (M1-11)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.2)

(1) Daily inspection	(c) Lubrication of the load chain (d) Twisting of the chain shall be corrected (e) Chain bucket must be secured properly.
(c) Monthly inspection including lubrication and maintenance.	( ) Body, Hooks, Load chain, Lubricant, Limit switch, Brakes, Electrical components, and others shall be checked according to the O/M manual of the manufacturer. ( ) Test run shall be done after the inspection.

3.14.8 Container hoist (M1-12)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.2)

The same as 3.4.1.7.

3.15 Lift pump facility

3.15.1 Lift pump(1) (M2-01)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.2)

Daily checks	(1)Current If the ammeter reading exceeds the motor rating listed on the data plate or is abnormally lower than usual, it is an indication of a problem. (2)Voltage Voltage should be within ±10% of the rated value throughout operation. (3)Vibration Check for abnormal vibrations. (4)Protective devices Check protective devices by reading the panel indicator.	
Monthly checks	(1)Discharge pressure Check pump discharge pressure and discharge flow rate (if flowmeter is provided). (2) Insulation resistance Operation is safe as long as insulation resistance is more than 1.5MΩ. If higher than 1.5MΩ, but this occurs after a sharp decline from a certain value, check the cables, and/or overhaul is required.	
Annual checks	(1)Appearance check Check cables, bolts and nuts, external surface conditions for abnormal conditions.	
	(2)Mechanical seal (a)Upper Unplug the "leak check" in the intermediate casing of the pump. (b)Lower Unplug the "oil port" and "air vent" and drain all internal oil.	
Overhaul	(1)Cable disposition (2)Details of overhaul (e) Complete disassembly, inspection and cleaning of pump. (f) Inspection of starter coil and insulation test. (g) Replacement of worn and damaged parts. (h) Functional tests. (i) Performance tests.(If required)	Every third year

3.15.2 Lift pump(2) (M2-02)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.3)
The same as 3.4.2.1

3.15. 3 Discharge valve (M2-03)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 7.1)

(1) Weekly inspection and maintenance	(a) If there is any visible leakage detected at the stem, the stuffing box should be tightened slightly. (b) The gland packing should be checked to ensure no foreign particle are deposited.
(2) Monthly lubrication and maintenance	( ) The gate valve shall be operated once a month. ( ) The shaft and the actuators shall be greased once a month.
(3) Other lubrication and maintenance	(a) The lubricant in the gear housing shall be exchanged after 6 to 8 years after the start of operation.

3.15.4 Drainage pump (M2-04)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.4)

Daily inspections	(1)Check current and ammeter fluctuation
Monthly inspections	Measure the insulation resistance.The value should be more than 1M ohm. If resistance starts to fall rapidly even with an initial indication of over 1M ohm, this may be an indication of trouble and repair work is required.
Annual inspections	The service life of the mechanical seal can be prolonged by replacing the oil in the mechanical seal chamber once a year.

Recommended interval of replacement as follows.

Replacement part	Replacement guide	Frequency
Mechanical seal	When ever oil in mechanical seal chamber is clouded	Annually
Oil filler plug gasket	When ever oil is replaced or inspected	A half yearly
Lubricating oil	When ever clouded or dirty	A half yearly
O-ring	When ever pump is overhauled	Annually

3.15.5 Lift pump hoist (M2-05)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.2)
The same as 3.4.1.7

3.16 Wastewater treatment facility

3.16.1 PST inflow gate (M3-01)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.4.1.2

3.16.2 PST sludge scraper (M3-02)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 1.1)

(1) Operation	(a) The scraper shall be operated continuously when the tank is filled with wastewater. (b) If the scraper will be stopped longer than 5 hours, the tank shall be drained and cleaned before restarting of the operation.
(2) First maintenance and maintenance	(a) First maintenance shall be carried out after 3 to 6 months of continuous operation. (b) Tension of the collector, rotatin of the idler, and tightness of the attachment screws and bolts shall be checked.
(3) Yearly maintenance	(a) Tightness and wear of the collector chain shall be checked. (b) The pulling sleeves of the sprocket wheel shall be replaced when the thickeness of the sleeve is less than 16mm. (c) Idler wheel wear shall be replaced, when the hole diameter is more than 65mm. Attachment screws and bolts shall be tightly connected.

3.16.3 Primary sludge valve (M3-03)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 7.2)
The same as 3.4.2.3.

3.16.4 Primary sludge pump (M3-04)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.5)

Bearing	Normal period of replacing bearing oil shall be 2 months for continuous operation.

Motor	Daily inspection items such as appearance, sound, odor and other. Monitoring temperature of the motor and its vicinity Vibration conditions of the motor and its vicinity

3.16.5 PST bypass gate (M3-05)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)

The same as 3.4.1.2

3.16.6 Reactor inflow wear (M3-06)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)

The same as 3.4.1.2

3.16.7 RAS flow control wear (M3-07)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)

The same as 3.4.1.2

3.16.8 Anaerobic tank mixer (M3-08)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 1)

Cooling	To ensure adequate cooling of the motor and gearbox, deposits of dirt and dust on the surfaces of the units must be removed at frequent intervals.
Frequency of oil change	The lubricating oil level should be checked at regular intervals. The first oil change should be carried out after approx. 5000 hours initial operation and thereafter, under normal operating conditions, the oil should be changed every 5000 operating hours. In the case of intermittent operation, the oil must be changed at least once every three years.
Motor Bearings	Ball bearings should be re-greased every 10,000 operating hours.

3.16.9 Surface aerator (M3-09)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 6)

Gear units

Observe/check gear unit noise for changes	From time to time, more often during operation if possible

Observe/check oil temperature	From time to time, more often during operation if possible
Oil level check	monthly
Check gear unit for leakage	monthly
Initial oil change after startup	After approx. 10000 operating hours, at the latest after 3 years
Subsequent oil changes	Every 3 years or 10000 operating hours
Relubrication of anti-friction bearings	Jannualy or every 5000 operating hours
Clean ventilator filter	Every 3 months
Clean drive	According to the degree of contamination
Check all fixing screws for tightness	At least once a year
Carry out complete inspection of gear unit	At least once a year

Electric Motor

Component	Daily	Weekly	Every 3 months	Yearly	Every 3 years
-Complete motor	-Check the noise and the vibration levels.		-Drain condensed water	-Retighten the bolts.	-Dismantle the motor. Check spare parts.
- Winding of the stator and rotor				-Visual inspection. Measure insulation resistance.	-Cleanliness: check the fastenings and the slot wedges; measure the insulation resistance.
-Bearings	-Check the noise level.	-Regrease; for intervals see the greasing plate.			-Clean the bearings. Replace them, if required, check bearing liner and replace it, if required (sleeve bearing) check sleeve race(shaft) and rebuild, if required.
-Terminal boxes and grounding lugs.				-Clean the inside area retighten the bolts.	-Clean the inside area retighten the bolts.

-Coupling : follow the maintenance instructins contained in the manual of the coupling manufacturer.		-After the first week of operation: check the alignment and fastening.		-Check alignment and fastening.	-Check alignment and fastening.
-Monitoring devices.	-Record the measurement values.				-If possible, disassemble and check its operating condition.
-Filter.			-Clean it, if required.	-Clean it, if required.	-Clean it.
-Slip rings area.		-Inspect the cleanliness and clean it, if required.		-Check the cleanliness and clean it, if required.	
-Slip rings.		-Check surface and contact area.			
-Brushes.		-Check and replace them when 2/3 of their height is worn.			
-Air/air heat exchanger.					-Clean the pipes of the heat exchanger.

3.16.10 Channel mixing blower (M3-10)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 3)

Belt	Tension adjustment shall be as follows : 1st adjustment ; 16-24 hours after starting the operation. 2nd adjustment; 48-72 hours after starting the operation. 3rd adjustment; 1 week after starting the operation.

Lubricating grease and oil	a. Grease shall be renewed every three months. b. Oil shall be changed as follows : 1st change ; 100 hours after starting the operation. 2nd change ; 700 hours after starting the operation. And thereafter, change oil every 2500 hours of operation.
Daily inspection	(1) Inspect the volume of the lubricating oil. (2) Inspect the discharge pressure. (3) Inspect the amperage of power.
Every 3 months inspection	(1) Change the lubricating oil. (2) Renew the grease (3) Clean the filter. (4) Adjust the tension of belts. (5) Inspect the safety valve. If it doesn't relieve even at 7% higher pressure, dismantle, clean and adjust the safety valve.
Yearly inspection	(1)Change the belts.
Every 2 years inspection	(1)Change the oil seals.
Every 3 years inspection	(1)Change the bearings.

3.16.11 Blower hoist (M3-11)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.1)

(1) Daily maintenance	(a) Cleaning and lubricating of the hoist. (b) Store the hoist correctly against the rain and moisture.
(2) Yearly inspection including lubrication and maintenance.	(a) Load chains and hooks shall be replaced, in case the specified dimension excesses the permissible limit. (b) The hoist shall be thoroughly lubricated.

3.16.12 FST inflow valve (M3-12)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 7.3)

(1) Yearly inspection and maintenance	(a) Tightness of the flange bolts and actuator connecting bolts shall be ensured. (b) No specific routine lubrication is required.

3.16.13 Final sedimentation tank sludge scraper (M3-13)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 1.2)
The same as 3.4.3.2

3.16.14 RAS pump (M3-14)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.6)
The same as 3.4.3.4

3.16.15 WAS extraction valve (M3-15)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 7.4)

(1) Monthly inspection and maintenance	(a) The valve shall be operated once a month.
(2) Yearly inspection and maintenance	(a) Tightness of the flange bolts and actuator connecting bolts shall be ensured . (b) The paint condition shall be checked and touch-up work shall be done if required.

3.17 Disinfection facility

3.17.1 Disinfection tank inflow gate (M4-01)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.4.1.2

3.17.2 Disinfection tank bypass gate (M4-02)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.4.1.2

3.17.3 NaClO storage tank (M4-03)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 8)

(1) Daily inspection	(a) Crack or hurt on the tank surface, abnormal deformation of the tank shall be checked (b) Any leakage at joint positions, any crack or damage on the nozzles, fittings, flanges, or valves shall be checked
(2) Monthly inspection	(a) Any crack, discoloring, or hurt inside the tank shall be checked

	(b) Support frames, valves, manholes, level gauge, air vent shall be inspected according to the O/M manual of the manufacturer.

3.17.4 NaClO dosing pump (M4-04)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.11.1)

(1) Daily inspection	(1) Check whether the pump operates smoothly, without generating any abnormal noise or vibration. (2) Check to be sure the discharge pressure, discharge flow rate, and motor power supply voltage do not fluctuate during pump operation. (3) Check for no leakage. (4) Check the drive unit for oil loss and leakage. (5) If a spare pump is available, activate it from time to time to keep it ready for use any time.
(2)Periodic inspection	(1) Valve Unit Check the valve balls, valve seats and valve guides every 6 months. (2) Diaphragm Check the diaphragm every 6 months. (3) Oil Check oil once every 6 months or more. Time to be replaced ... Replace oil first time in 500 hours operation after start. After that replace every 2,000 to 3,000 hours operation.

3.17.5 NaClO dosing pump for well water (M4-05)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.11.2)
Daily check

No.	Check point	Details	How to check

1	Does pump lift liquid normally?	Is liquid normally fed? Is suction pressure/discharge pressure at normal level? Has liquid undergone quality change, crystallization, or solidification?	By flow meter or visual inspection. Check nameplate. By visual inspection
2	Abnormal noise or vibration?	Abnormal noise or vibration may result from abnormal functioning of pump.	By visual and audio inspection
3	Is there liquid leakage or air suction at any joint on pump or piping?	Tighten joint where leakage has occurred. Excessive air bubbles in discharged liquid mean air suction has been caused in system. Examine the piping and tighten joint which leaks.	By visual inspection

3.18 Water supply facility

3.18.1 Spray pump (M5-01)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.7)

Daily inspection	(1)Pressure or current variations (2)Use ISO VG46 Replace lubricating oil 300hours after trial operation. Replace lubricating oil once every 3 months, or as required, according to oil conditions. (3)The maximum allowable bearing operating temperature should not exceed 80 . (4)For mechanical seal type For packing type (5)vibration

3.18.2 Auto-strainer for spray pump (M5-02)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 4)

(1) Daily inspection and maintenance	(a) Check of abnormal noise, vibration, liquid leakage and temperature. (b) Check of the lubrication conditions. (c) Check and record of the differential pressure with automatic backwash operation. (d) Check and record of the electric current.
(2) Yearly inspection and maintenance	(a) Check of the insurance resistance. (b) Check of function of the automatic back wash valve. (c) Check of function of the differential pressure switch. (d) Overhaul of the strainer is recommended for every 2 to 3 years.

3.18.3 Sand filter supply pump (M5-03)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.8)
The same as 3.4.5.1

3.18.4 Auto-strainer for sand filter (M5-04)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 4)
The same as 3.4.5.2

3.18.5 Sand filter (M5-05)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 13)

(1) Daily inspection and maintenance	(e) Raw water incoming flow, air supply flow, sand circulation flow, treated effluent water quality, and filtration pressure loss shall be checked and recorded according to the O/M manual of the manufacturer.
(2) Yearly inspection and maintenance	(e) Wear of air supply pipe, sand quantity, sand contamination, and conditions inside the filtration tank shall be checked and recorded according to the O/M manual of the manufacturer.

3.18.6 Air compressor for sand filter (M5-06)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 6)

(1) Daily inspection and maintenance	(a) Drainage of the air tank, check of abnormal vibration or noise. (b) Check and record of the pressure gauge, function of the auto drain trap.

(2) Monthly inspection and maintenance	(a) Check of status of the bolt, screw, and belt with tightening or adjusting if necessary. (b) Disassembling and cleaning of the auto drain trap, filter, and condenser.
(3) Yearly maintenance	(a) Overhauling of the compressor according to the manufacturer's O/M manual.

3.18.7 Water supply unit for wastewater treatment facility (M5-08)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 14)

(1) Daily inspection and maintenance	(a) Check and record of the electric current, operational pressure, and discharge flow. (b) Check of the abnormal noise, vibration and temperature. (c) Check and record of the pressure gauge, function of the auto drain trap.
(2) Monthly inspection and maintenance	(a) Lubrication to the pumps and motors shall be done according to the manufacturer's O/M manual.
(3) Yearly maintenance	(a) Check of function of control panel. (b) Thorough check of the conditions of pump, valves, piping, fittings, and pressure tank

3.18.8 Water supply unit for sludge treatment facility (M5-09)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 14)

The same as 3.4.5.7

3.18.9 Belt washing pump (M5-10)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.11)

Dairy inspection	(j) Check the pump, piping and shaft seal for leaks. (k) Check for abnormal noise or vibration from pump or motor. (l) Check that the pump is pumping and that the discharge pressure is steady.
Monthly inspection	(a) Check oil level

3.18.10 Sand filter supply pump from deep well (M5-11)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.10)

Periodic inspection as follows.

Checking Item	Checking frequency
Check of current value	Once a day
Check of discharge volume	Once a week
Check of vibration and noise	Once a week
Check of insulation resistance	Once a month
Check of water level in well	-

3.18.11 Water supply unit for sludge treatment facility (M5-13)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 14)

The same as 3.4.5.7

3.19 Sludge treatment facility

3.19.1 Mixed sludge mixer (M6-01)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 1.2)

Period	Item	Methods	Measures
Every 1 month	Rating current	Check the change of current.	If the current increase gradually, -Remove the dust -Check the abnormal sounds by the operation in the air. The vibration becomes larger, check by operating.
Every 3 months	Insulation resistance	Measure the insulation resistance between each phase(U,V,W) and grounding wire by using 500 V megger as shown in right.	(1) 20MΩ or over Pump operation can be kept on. (2) 1MΩ to 20MΩ Pump operation can be kept on but motor and cables must be checked as soon as possible. (3) 1MΩ or under Pump operation is prohibited.
Every 6 months	Wear of the bearing	Check the rattling by turning the propeller by hand. Check the abnormal sounds by the operation in the air.	If there is rattling, check the cause. If there is rattling in the bearing, exchange.

	Wear of the propeller	Check the exterior by visual.	Exchange by the condition.
	Wear of the draft ring	Check the exterior by visual.	Exchange in the case of the wear is excessive or may be break before the next inspection.
	Wear of the latex seal and the oil seal	Check the exterior by visual.	Exchange in the case of the wear is excessive or may be break before the next inspection.
Every 1 year	Looseness of the outer bolts	Tighten more.	Tighten more.
	Corrosion of the chain	Check the exterior by visual.	Exchange.
	Oil exchange		Exchange all.
Every 2 years	Overhauling		Exchange the seal parts

3.19.2 Mixed sludge pump (M6-02)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.11)

Dairy inspection	(a) Check the pump, piping and shaft seal for leaks. (b) Check for abnormal noise or vibration from pump or motor. (c) Check that the pump is pumping and that the discharge pressure is steady.
Monthly inspection	(a) Check oil level

3.19.3 Sludge dewaterer (M6-03)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.2 to1.6)

Dairy inspection	Before starting the operation (b) Check that presses are clean (belts, trays, equipment, etc.) (c) Remove foreign objests from the belts (d) Check air pressure (tensioning > 3 bar, steeing > 4 bar) (m)Check water pressure (>6 bar) After operation (a) Wash the press properly (trays, rollers, componers etc.)
Weekly inspection	(e) Check nozzles (remove blocks) (f) Check oil level in aeration system
Monthly inspection	Check the aeration system (remove water if necessary from the system from both water filter and cylinders) (a) Check oil condition and level in motors

	(b) Check condition of belts (c) Check condition of gaskets and scrapers (d) Check bearings (lubricate roll bearings and cog wheels) (e) Check condition of other accessories (clean if necessary)

3.19.4 Cake conveyor (1),(2) (M6-04, M6-05)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.8)

Screw Conveyer S-C 215

Dairy inspection	(a) Check that the inspection hatches and other openings over movable parts are in position and are closed (b) Check that inlets and outlets are not blocked
Weekly inspection	(a) Follow the lubrication schedule (b) Check that safety equipment fuuctions, both mechanically and electrically. Also check the function-controlled breakers. (c) Check and lubricate the shaft seal shaft sealing- radial. Use appropriate grease. If the seals continue to leak, replace them immediately (d) Chek that shaft seal shaft sealing- gland is sealed, if not increase the tension on the gland seals by tightening the tension screws. (e) Clean any corrosive or damaging substances off the outside of the trough. Also ensure that the stainless exterior of the conveyor does not come into contact with ordinary carbon steel, as discolouring can easily occur.
Monthly inspection	(a) Follow the lubrication schedule (b) Inspect wear inset, spiral and parts that can come into contact with the spiral with regard to wear and possible deformation. If wear or deformation are considered to be serious, take action or cotact the supplier. (c) Chek the shaft sealing- radual does not leak. If it does, replace it immediately. (d) Chek that shaft seal shaft sealing- gland is sealed, if not increase the tension on the gland seals by tightening the tension screws.If it continues to leak, replace the seal rings in it immediately. (e) Check the motor gearbox, especially as regards seals of the hollow sheaft. If these leak from the gearbox, they should be replaced immediately and the oil topped up.
6-months	(a) Follow the lubrication schedule (b) Check that no screw have come loose, especially on the drive unit,

	drive axle, leg supports and other important parts wher vibration can occur.
	(c) Check the oil level and the grease in the gearbox and follow the maintenance schedule from the supplier of the drive unit.
	(d) A complete run-through of the mechanical and electrical componets and fuctions, immediate action if any abnormal wear is discovered.

3.19.5 Cake hopper (M6-06)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 5)

(1) Daily inspection and maintenance	(a) Check of the conditions of the cake hopper and cut gate for sludge sticking or bolt loosening. (b) Check of the operational conditions of the electrical cylinder whether it is operated smoothly and flexible joint is not damaged.
(2) Yearly inspection and maintenance	(a) Thorough check of the hopper and drive whether there are any corrosion or abrasion. (b) Check of the conditions of rubber packing of the cut gate, looseness of the connection pin of the drive, and position of the stroke. (c) Check of the inside of the hopper after discharging all of the sludge in the hopper.

3.19.6 Automatic polymer make-up unit (M6-07)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.7)

Dairy inspection	Before starting the operation (a) Check that there are no foreign particles in the tank. Before charging any polymer or water During operation (a) Check that the polymer dosing pump rotates in the right direction. After operation (a) Check that there is not chunky of polymer in the bottom of the tank.

3.19.7 Polymer dosing pump (M6-08)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.11)

The same as 3.4.6.2

3.19.8 FeCl3 dosing pump (M6-10)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 2.11.1)

The same as 3.4.4.4

3.19.9 FeCl3 dosing pump for well water (M6-11)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 2.11.2)

The same as 3.4.4.5

3.19.10 Air compressor for sludge treatment facility (M6-12)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.10)

(1) Weekly inspection and maintenance	(a) Check oil level. (b) Drain condensate from air receiver or pulsation damper
(2) 6 monthly inspection and maintenance	(a) Test safety valve and relief vale (b) Inspect air filter
(3) Yearly maintenance	(a) Replace air filter and blow-off silencer (b) Change of oil
(4) 2 yearly maintenance	(a) Replace check valve or unloader (b) Replace valve discs

3.19.11 Filtrate pump (M6-14)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.9)

Daily inspection	(1)Pressure or current variations (2)Replace bearing lubrication oil when it becomes cloudy or its viscosity drops. As a general guide, replace oil once a week when pump operation is first begun, and once every six months to a year. (3)The maximum allowable bearing operating temperature should not exceed 80 . (4)If the motor exterior becomes too hot to touch with the hand, stop operation immediately and inspect. (5)Grand packing leakage should be kept to a steady drip or trickle(approx.20 ml/min). Do not tighten packing excessively or unevenly, or when pump is stopped. (6)vibration (7)Use pressure, compound or vacuum gauge of diaphragm type.

3.19.12 Sludge dewaterer hoist (M6-16)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.2)

The same as 3.4.2.4

3.19.13 Maintenance hoist (M6-17)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.1)
The same as 3.4.3.11

3.20 Sludge storage facility

3.20.1 Shovel loader (M7-01)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 18)

(1) Every 50 hours of operation	(a) Change engine oil aud oil filter (initial 50hrs only). (b) Check battery electrolyte level, electric wiring and fuses, and the transmission for oil level. (c) Drain off water and foreign matter from the fuel tank.
(2) Every 100 hours of operation	(a) Apply grease to center hinge pins (upper and lower), load handling system pins, axle support pins, and steering cylinder pins
(3) Every 250 hours of operation	(a) Change engine oil and oil filter (b) Cehck fan belts for tension, battery electrolyte for specific gravity. (c) Grease center bearing and propeller shafts (d) Change transmission oil with filter and axle oil (initial 250 hours only)
(4) Every 500 hours of operation	(a) Change hydraulic oil tank return filter, fuel filter, transmission oil filter, and HST charge filter. (b) Check injection nozzle and retighten the wheel bolts. (c) Clean axle housing air breather, radiator and oil cooler core.
(5) Every 1000 hours of operation	(a) Clean feed pump strainer and transmission air breather. (b) Adjust valve clearance and measure compression pressure (c) Check starter and alternator for wear (d) Change brake oil, transmission oil, load handling system, and double edges for wear. (e) Grease break pedal.
(6) Every 2000 hours of operation	(a) Change coolant (LLC). 2000hrs or one year whichever comes first.

	(b) Change axle oil. (c) Drain hydraulic oil tank, change hydraulic oil, clean suction filter (d) Check break disc for wear.

3.20.2 Maintenance crane (M7-03)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item11.1)
The same as 3.4.3.11

3.20.3 Tripod (M7-04)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item9)

Operation	No special requirement for routine maintenance. Caution is required for each operation to keep 70 degrees vertical inclination of each leg.

3.21 Deodorization facility

3.21.1 Deodorization facility (M8-01 to -08)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 10)

(1) Daily inspection and maintenance	(a) Check and record of the liquid level of NaOH and NaClO in each storage tank. (b) Check noise, vibration, and temperature rise of each rotating machine. (c) Check and adjust the circulation flow. (d) Check the water level of the wet scrubber sump, pH meter value, and differential pressure across the wet scrubber.
(2) Weekly inspection and maintenance	(a) PH sensor calibration.
(3) Monthly inspection and maintenance	(a) Check V-belt tension of the deodorization fan. (b) Check of spray condition of the wet scrubber (c) Cleaning of the control panel
(4) 6 monthly inspection and maintenance	(a) Greasing of deodorization fan bearing
(5) Yearly inspection and maintenance	(a) Repainting of metal parts (b) Cleaning of packings

3.22 Generator room facility

3.22.1 Emergency generator (M9-03)

(Refer to the Operation and Maintenance manual Vol 5 of 6, Item 4)

(1) Daily inspection and maintenance	(a) Check the cooling system coolant Level. (b) Clean or replace the engine air cleaner element (Dual element). (c) Inspect the engine air cleaner service indicator. (d) Clean the engine air precleaner. (e) Check the engine oil level. (f) Walk-Around inspection.
(2) Every 3000 service hours or 3 years	(a) Add the cooling system coolant extender (ELC).
(3) Every 6000 service hours or 6 years	(a) Change the cooling system coolant (ELC).
(4) First 19000L (5000 US gal) of fuel or 250 service hours	(a) Inspect and adjust the engine valve lash. (b) Clean and inspect the magnetic pickups.
(5) Every 19000L (5000 US gal) of fuel or 250 service hours	(a) Check the battery electrolyte level. (b) Test and add the cooling system supplemental coolant additive (SCA) (c) Clean the engine crankcase breather. (d) Change the engine oil and filter. (e) Lubricate the fan drive bearing. (f) Clean or replace the fuel system secondary filter. (g) Inspect the hoses and clamps. (h) Clean the radiator.
(6) PM level 2 – Every 76000L (20000 US gal) of fuel or 1000 service hours	(a) Check the engine protective devices. (b) Check and lubricate fuel control linkage.
(7) PM level 3 – Every 228000L (60000 US gal) of fuel or 3000 service hours	(a) Change the cooling system coolant (DEAC). (b) Replace the cooling system water temperature regulator. (c) Inspect the crankshaft vibration damper. (d) Inspect the engine months. (e) Inspect and adjust the engine valve lash. (f) Inspect the engine valve rotator. (g) Inspect the turbocharger.

(8) Every 379000L (100000 US gal) of fuel or 5000 service hours	(a) Inspect the alternator. (b) Test and exchange the fuel injection nozzles. (c) Clean and inspect the magnetic pickups. (d) Inspect the starting motor. (e) Inspect the water pump.

3.C Maintenance for non-operation period (Non-income flow)

3.23 Maintenance of equipment

If the plant will be stopped long period (more than 1 month), the periodic inspection and maintenance of main equipment are shown as below.
Detail inspection and maintenance should be referred to the manufacturer's manual parts.

3.24 Grit Chamber facility

3.24.1 Inflow gate (M1-01)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 4)

Inspection point	Inspection method	Acceptance Criteria	Frequency
Operating condition (Open / Close)	Normal operation	The gate leaf is smooth. (by hand and motor short time)	1 time / month
Vibration and noise	Fingering and listening	No extreme vibration or noises are to be perceived.	1 time / month
Opening indicator	Visual inspection	The indication of the needle is accurate.	1 time / month
Stem	Visual inspection	The threaded portion is to be free from any scuffing and wear.	1 time / month
Motor	Visual inspection	The insulation resistance is to be 1 Ohm or above.	1 time / month

3.24.2 Grit chamber inflow gate (M1-02)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)

Inspection point	Inspection method	Acceptance Criteria	Frequency
Operating condition (Open / Close)	Normal operation	The gate leaf is smooth.	1 time / month

3.24.3 Grit pump (M1-04)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.1)

Periodic inspection (1 time / month)	(a) Keep dry condition on the floor. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (1 second) once per month.

3.24.4 Grit separator (M1-05)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 12)

Periodic inspection (1 time / month)	(a) Keep dry condition in the tank. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (5 or 10 second) once per month.

3.24.5 Fine screen (M1-07)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 2)

Periodic inspection (1 time / month)	(a) Keep dry condition in the tank. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (5 or 10 second) once per month.

3.24.6 Fine screenings conveyor (M1-18)

(Refer to the Operation aud Maintenance manual Vol 4 of 6, Item 3)

Periodic inspection (1 time / month)	(a) Keep dry condition in the conveyor. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (5 or 10 second) once per month.

3.24.7 Grit pump hoist (M1-11)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.2)

Periodic inspection (1 time / month)	(a) Keep dry condition on the beam. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (5 or 10 second) once per month.

3.24.8 Container hoist (M1-12)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.2)
The same as 3.24.7.

3.25 Lift pump facility

3.25.1 Lift pump(1) (M2-01)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.2)

Periodic inspection (1 time / month)	(a) Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (5 or 10 second) once per month.

3.25.2 Lift pump(2) (M2-02)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.3)
The same as 3.25.1

3.25. 3 Discharge valve (M2-03)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 7.1)

Periodic inspection (1 time / month)	(a) Measurement of the insulation resistance shall be performed once a month. (b) Operate in a short time (full open & close) once per month.

3.25.4 Drainage pump (M2-04)
" IMPORTANT CAUTION "
All drainage pump must be under operating condition at any time !
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.4)

Daily inspections	(1)Check current and ammeter fluctuation
Monthly inspections	Measure the insulation resistance.The value should be more than 1M ohm. If resistance starts to fall rapidly even with an initial indication of over 1M ohm, this may be an indication of trouble and repair work is required.
Annual inspections	The service life of the mechanical seal can be prolonged by replacing the oil in the mechanical seal chamber once a year.

Recommended interval of replacement as follows.

Replacement part	Replacement guide	Frequency
Mechanical seal	When ever oil in mechanical seal chamber is clouded	Annually
Oil filler plug gasket	When ever oil is replaced or inspected	A half yearly
Lubricating oil	When ever clouded or dirty	A half yearly
O-ring	When ever pump is overhauled	Annually

3.25.5 Lift pump hoist (M2-05)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.2)
The same as 3.24.7.

3.26 Wastewater treatment facility

3.26.1 PST inflow gate (M3-01)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.24.2

3.26.2 PST sludge scraper (M3-02)
" IMPORTANT CAUTION "
Don't start scraper without care after long term stop condition!
Don't start scum skimmer when the tank is not full !
Check First in the tank!
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 1.1)

Periodic inspection (1 time / month)	(a) Keep dry condition in the tank. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (1 or 2 round) once per month.
	(c) The scraper shall be operated continuously when the tank is filled with wastewater. (d) If the scraper will be stopped longer than 5 hours, the bottom sludge in the tank shall be drained or wastewater and sludge in the tank shall be replace to clear water. (e) If start the scraper after long-stop condition, the tank shall be drained and cleaned before restarting of the operation.
	Scum skimmer drive cannot start when the tank is not full. (f) If scum skimmer drive doesn't be operated for long time (longer than 1 month), the skimmer shall be dismantled from driving chain.

3.26.3 Primary sludge valve (M3-03)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 7.2)
The same as 3.25.3.

3.26.4 Primary sludge pump (M3-04)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.5)

Periodic inspection (1 time / month)	(a) Wastewater and sludge in the casing of pump shall be replaced to clear water or keep dry condition in the casing. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (1 or 2 second) once per month.

3.26.5 PST bypass gate (M3-05)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.24.2

3.26.6 Reactor inflow wear (M3-06)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.24.2

3.26.7 RAS flow control wear (M3-07)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.24.2

3.26.8 Anaerobic tank mixer (M3-08)
" IMPORTANT CAUTION "
Don't start mixer without care after long term stop condition!
Don't operate mixer more than a few seconds when the tank is not full !
At first, Check in the tank!
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 1)

Periodic inspection (1 time / month)	(a) If stop the mixer for long time, keep clear water in the tank or keep dry condition in the tank. Measurement of the insulation resistance shall be performed once a month. (b) Test Run with short period (1 or 2 second) once per month.

3.26.9 Surface aerator (M3-09)
" IMPORTANT CAUTION "
Don't start Surface aerator without care after long term stop condition!
Don't operate Surface aerator more than a few seconds when the tank is not full !
At first, Check in the tank!
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 6)

Periodic inspection (1 time / month)	(a) If stop the mixer for long time, keep clear water in the tank or keep dry condition in the tank. Measurement of the insulation resistance shall be performed once a month. (b) Oil level check before Test Run. (c) Test Run with short period (1 or 2 second) once per month.

3.26.10 Channel mixing blower (M3-10)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 3)

Periodic inspection (1 time / month)	(a) Measurement of the insulation resistance shall be performed once a month. (b) Oil level check before Test Run. (c) Belt tension adjustment shall be done before start the blower (d) Test Run with short period (1 or 2 second) once per month.

3.26.11 Blower hoist (M3-11)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.1)

Periodic inspection (1 time / month)	(a) Keep dry condition on the beam. (b) Operate by hands and check lubricated condition once per month.

3.26.12 FST inflow valve (M3-12)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 7.3)

Periodic inspection (1 time / month)	(a) Check tightness of the flange bolts. (b) Operate by hands and check open close condition once per month.

3.26.13 Final sedimentation tank sludge scraper (M3-13)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 1.2)
The same as 3.26.2.

3.26.14 RAS pump (M3-14)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.6)
The same as 3.26.4

3.26.15 WAS extraction valve (M3-15)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 7.4)

Periodic inspection (1 time / month)	(c) Tightness of the flange bolts and actuator connecting bolts shall be ensured. (d) Operate by hands and check open close condition once per month.

3.27 Disinfection facility

3.27.1 Disinfection tank inflow gate (M4-01)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.24.2
3.27.2 Disinfection tank bypass gate (M4-02)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 5)
The same as 3.24.2

3.27.3 NaClO storage tank (M4-03)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 8)

Periodic inspection (1 time / month)	(a) Any leakage at joint positions, any crack or damage on the nozzles, fittings, flanges, or valves shall be checked (b) Tightness of the fixing bolts shall be ensured. (c) Any crack, discoloring, or hurt inside the tank shall be checked. (d) Support frames, valves, manholes, level gauge, air vent shall be inspected according to the O/M manual of the manufacturer. (e) If the tank is not be used for long time, keep clear water in the tank or keep dry condition in the tank.

3.27.4 NaClO dosing pump (M4-04)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.11.1)

Periodic inspection (1 time / month)	(a) If the chemical pump is not be used for long time, keep clear water in the pump and pipes or keep dry condition in it. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (5 or 10 second) once per month.

3.27.5 NaClO dosing pump for well water (M4-05)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.11.2)

Periodic inspection (1 time / month)	(a) If the chemical pump is not be used for long time, keep clear water in the pump and pipes or keep dry condition in it. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (5 or 10 second) once per month.

3.28.1 Spray pump (M5-01)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.7)

Periodic inspection (1 time / month)	(a) Treated water in the casing of pump shall be replaced to clear water or keep dry condition in the casing. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (1 or 2 second) once per month.

3.28.2 Auto-strainer for spray pump (M5-02)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 4)

Periodic inspection (1 time / month)	(a) Treated water in the casing of strainer shall be replaced to clear water or keep dry condition in the casing. Measurement of the insulation resistance shall be performed once a month. (b) Test Run with short period (1 or 2 second) once per month.

3.28.3 Sand filter supply pump (M5-03)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.8)
The same as 3.26.4

3.28.4 Auto-strainer for sand filter (M5-04)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 4)
The same as 3.28.2

3.28.5 Sand filter (M5-05)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 13)

Periodic inspection (1 time / month)	(a) Treated water in the filter body shall be replaced to clear water or keep dry condition in it. (b) Test Run with clear water and air (1 or 2 hours) once per month.

3.28.6 Air compressor for sand filter (M5-06)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 6)

Periodic inspection (1 time / month)	(a) Measurement of the insulation resistance shall be performed once a month. (b) Oil level check before Test Run. (c) Belt tension adjustment shall be done before start the compressor (c) Test Run with short period (5 or 10 minutes) once per month.

	(d) Check the maximum pressure at motor stop point. (e) Open the bottom plug and drain water from air tank

3.28.7 Water supply unit for wastewater treatment facility (M5-08)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 14)

Periodic inspection (1 time / month)	(a) Treated water in the pump and pressure tank shall be replaced to clear water or keep dry condition in it. (b) Test Run with clear water (1 or 2 hours) once per month / or test run of pump with short period (1 or 2 second) once per month

3.28.8 Water supply unit for sludge treatment facility (M5-09)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 14)
The same as 3.28.7

3.28.9 Belt washing pump (M5-10)
(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.11)

Periodic inspection (1 time / month)	(a) Treated water in the casing of pump shall be replaced to clear water or keep dry condition in the casing. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (1 or 2 second) once per month.

3.28.10 Sand filter supply pump from deep well (M5-11)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.10)
Keep this pump as "Auto Operation"
Periodic inspection as follows.

Checking Item	Checking frequency
Check of current value	Once a day
Check of discharge volume	Once a week
Check of vibration and noise	Once a week
Check of insulation resistance	Once a month
Check of water level in well	-

3.28.11 Sand filter for domestic water (M5-12)

Periodic inspection as follows.

Checking Item	Checking frequency
Check of differential pressure	Once a week at operating time
Check of discharge volume	Once a week at operating time
Check the condition of treated water	Once a day

3.28.12 Water supply unit for sludge treatment facility (M5-13)
(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 14)
The same as 3 28.7

3.29 Sludge treatment facility

3.29.1 Mixed sludge mixer (M6-01)
(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 1.2)

Periodic inspection (1 time / month)	(a) Sludge in the tank shall be replaced to clear water or keep dry condition on the floor. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (1 or 2 second) once per month.

3.29.2 Mixed sludge pump (M6-02)
" IMPORTANT CAUTION "
Don't start Mixed sludge pump without care after long term stop condition!
Don't operate Mixed sludge pump more than a few seconds when the pump is dry!
At first, Check in the pipeline!
(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.11)

Periodic inspection (1 time / month)	(a) Sludge in the tank shall be replaced to clear water. Measurement of the insulation resistance shall be performed once a month. (b) Run with **clear water** in a short period (1 or 2 second) once per month.

3.29.3 Sludge dewaterer (M6-03)
(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.2 to1.6)

Periodic inspection (1 time / month)	For long time stop period on dewaterer, Release the pressure for tensioning of belts. Before starting the operation (test run 1time per month) (a) Check that presses are clean (belts, trays, equipment. etc)

	(b) Remove foreign objects from the belts (c) Check nozzles (remove blocks) (d) Check oil level in aeration system (e) Check air pressure (tensioning > 3 bar, steeing > 4 bar) (f) Check water pressure (>6 bar) After operation (g) Wash the press properly (trays, rollers, componets etc.)

3.29.4 Cake conveyor (1),(2) (M6-04, M6-05)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.8)

Screw Conveyer S-C 215

Periodic inspection (1 time / month)	(a) Keep dry condition in the conveyor. Measurement of the insulation resistance shall be performed once a month. (b) Run with short period (5 or 10 second) once per month.

3.29.5 Cake hopper (M6-06)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 5)

Periodic inspection (1 time / month)	(a) Keep dry condition in the hopper. Measurement of the insulation resistance shall be performed once a month.(power cylinder). (b) Operate full open / close (1 or 2 times) once per month.

3.29.6 Automatic polymer make-up unit (M6-07)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1 7)

Periodic inspection (1 time / month)	(a) Treated water in the tank shall be replaced to clear water or keep dry condition. Measurement of the insulation resistance shall be performed once a month. (b) Run each part unit motor **without water** in a short time (1 or 2 seconds) without polymer powder once per month.

3.29.7 Polymer dosing pump (M6-08)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.11)

The same as 3.29.2

3.29.8 FeCl3 dosing pump (M6-10)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 2.11.1)

The same as 3.27.4

3.29.9 FeCl3 dosing pump for well water (M6-11)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 2.11.2)

The same as 3.27.5

3.29.10 Air compressor for sludge treatment facility (M6-12)

(Refer to the Operation and Maintenance manual Vol 3 of 6, Item 1.10)

Periodic inspection (1 time / month)	(d) Measurement of the insulation resistance shall be performed once a month. (e) Oil level check before Test Run. (f) Belt tension adjustment shall be done before start the compressor (f) Test Run with short period (5 or 10 minutes) once per month. (g) Check the maximum pressure at motor stop point. (h) Open the bottom plug and drain water from air tank

3.29.11 Filtrate pump (M6-14)

(Refer to the Operation and Maintenance manual Vol 2 of 6, Item 2.9)

Periodic inspection (1 time / month)	(c) Treated water in the casing of pump shall be replaced to clear water or keep dry condition in the casing. Measurement of the insulation resistance shall be performed once a month. (d) Run with short period (1 or 2 second) once per month.

3.29.12 Sludge dewaterer hoist (M6-16)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.2)

The same as 3.27.4

3.29.13 Maintenance hoist (M6-17)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 11.1)

The same as 3.27.11

3.30 Sludge storage facility

3.30.1 Shovel loader (M7-01)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 18)

Periodic inspection (1 time / 2 weeks)	(a) Check buttery and break fluid oil. (b) Start Engine and keep idling condition of engine for approx. 10 minutes.

3.30.2 Maintenance crane (M7-03)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item11.1)
The same as 3.26.11

3.30.3 Tripod (M7-04)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item9)

Periodic inspection (1 time / month)	(a) Visual check for safety operation.

3.31 Deodorization facility

3.31.1 Deodorization facility (M8-01 to -08)

(Refer to the Operation and Maintenance manual Vol 4 of 6, Item 10)

Periodic inspection (1 time / month)	(a) Drain the chemicals in the tank, pumps and pipes. (b) Cap on the PH censor (c) Keep dry condition in the scrubber. Measurement of the insulation resistance shall be performed once a month. (d) Run pumps and fan with short period (1 or 2 second) once per month.

3.32 Generator room facility

3.32.1 Emergency generator (M9-03)

(Refer to the Operation and Maintenance manual Vol 5 of 6, Item 4)

Periodic inspection (1 time / month)	(a) Check the cooling system coolant Level. (b) Check the engine air cleaner element (Dual element). (c) Inspect the engine air cleaner service indicator. (d) Clean the engine air precleaner. (e) Check the engine oil level. (f) Walk-Around inspection.

4 TROUBLE SHOOTING AND FAULT FINDING

4.1 PROCESS

	Facility Name	Trouble description	Reason	How to improve
	Grit Chamber Facility	Grit Chamber Level "HH"	Clogging of Screens (Coarse or Fine)	Remove Choking rubbish
			Remaining grit in the pit	Use grit pump to remove grit
2	Lifting Pump Facility	Grit Chamber Level "HH" or Pump Well level "HH"	Number of operating Lift Pumps	Increase operating pumps
3	Water Treatment Facility			
3a	Sedimentation Facility (Primary S.T.)	Bad condition of Activated Sludge operation	Influent is too thin Low level BOD, SS etc.	Adjust of operating streams Block infiltration at inlet pipe net work Use by path gate (Open)
3b	Aeration Facility	Bad condition of Activated Sludge operation	Bad Coagulation small or light flock	Check DO at aerobic tank Adjust number of operating surface aerator.
			Stuck sludge at bottom	Adjust number and time of operating surface aerator.
		pH is too low	Nitrification is occured	Adjust number and time of operating surface aerator. (Reduce DO value)
		Unusual forming	Clogging of spray holes	Remove scale or sand
	Facility Name	Trouble description	Reason	How to improve

3c	Sedimentation Facility (Final S.T.)	Bad condition of Activated Sludge operation	Floating sludge (by De-nitrification)	Check DO Adjust number and time of operating surface aerator. (Reduce DO value) (Reduce sludge volume in F.S.T)
			Floating sludge (by sludge decay)	Check DO Adjust number and time of operating surface aerator. (Increase DO value) (Reduce sludge volume in F.S.T)
			Bad Coagulation small or light flock	Use air blowing at inlet channel
			Unsuitable sludge discharge volume	If discharge volume was too much, sludge blanket shall not be kept and sludge shall be over flown. Adjust discharge interval and discharge time.
4	Disinfection Facility	Chemical (NaClO) leakage	Check the packing and diaphragm of NaClO pump and pipe line	Replace the packing or diaphragm
5	Water Supply Facility	Sand Filter over flow	Clogging of sand by SS	Check back wash condition (Air drift and sand washing condition)
		Auto-strainer "Fault"	Clogging of strainer mesh by SS	Remove scale or sand
		Auto-strainer "Fault"	Clogging of strainer mesh by SS	Remove scale or sand
	Facility Name	Trouble description	Reason	How to improve

	Water Supply Facility	Choking of Sand Filter for Domestic Water	Clogging of filter media by SS	Remove clogging material (manual back wash)
		Sand Filter for Domestic Water	Too low NaClO dosing ratio before filtration	Check NaClO dosing system
		Low removal ratio of Manganese	Manganese sand performance was low	Dose high concentrate of NaClO and check the treatment condition
		Sand Filter for Domestic Water Flow out of anthracite during the back wash process	Too strong back wash	Reduce volume of back wash (Nominal:0.6m/min)
6	Sludge Treatment Facility			
6a	Mixed Sludge Storage Tank	Tank Level "HH" sludge was coming to surface	Treated Sludge volume was not enough	Adjust Dewaterer operation time and interval
6b	Cake conveyor	Sticky sludge stuck the conveyor	Sticky sludge stuck in the conveyor	Remove sludge in the conveyor
6c	Cake Hopper	Stuck sludge in the hopper	Discharged Sludge volume was not enough	Discharge sludge in the hopper
7	Deodorization Facility	pH in scrubber is too low or too high	Wrong operation of valve or pump	Check the pump discharge and valve opening condition.

4.2 CONTROL PANEL

No	Alarm	Indication	Reason	How to Improve
1	SVP Supervisory Panel	<GCP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<LPP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<PSSR> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<PSP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<AFSPP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<CMBP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<RWP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<WSSP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<FWP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<DP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<RMU> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<GP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<BCP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<SAP-1> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<SAP-2> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<SAP-3> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it

No	Alarm	Indication	Reason	How to Improve
	SVP Supervisory Panel	<SAP-4> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<STRP-1> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<STP-2> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<BP-4> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<BP-5> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<LVIP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<CSP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		<LVDP> FAULT	Breaker Trip or Thermal Trip	Check fault equipment and maintain / repair it
		INCOMING SEWAGE PIT LEVEL HIGH	See 4.1 process 1.	See 4.1 process 1.
		LIFT PUMP PIT LEVEL HIGH	See 4.1 process 2.	See 4.1 process 2.
		LIFT PUMP PIT LEVEL LOW	Over Drain the Pit	Check Lift Pump Operating Condition
		SECONDARY EFFLUENT TANK LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check Valve Opening
		SECONDARY EFFLUENT TANK LEVEL LOW	Over Drain the Tank	Check Tank Liquid Level Check Valve Opening
		FILTERED WATER TANK LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check Valve Opening
		FILTERED WATER TANK LEVEL LOW	Over Drain the Tank	Check Tank Liquid Level Check Valve Opening

No	Alarm	Indication	Reason	How to Improve

	SVP Supervisory Panel	DEEP WELL LEVEL HIGH	Well level high condition	Check well water Level Check Valve Opening
		DEEP WELL LEVEL LOW	Over Drain Operation in the well	Check well water Level Check Valve Opening
		NaClO STORAGE TANK LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check chemical receiving operation
		NaClO STORAGE TANK LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level Check chemical receiving operation
		NaClO STORAGE TANK FOR WELL WATER LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level Check chemical receiving operation
		MIXED SLUDGE STORAGE TANK LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check Valve Opening
		MIXED SLUDGE STORAGE TANK LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level Check chemical receiving operation
		FILTRATE TANK LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check Valve Opening
		FILTRATE TANK LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level
		FeCl3 STORAGE TANK LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check chemical receiving operation

No	Alarm	Indication	Reason	How to Improve
	SVP Supervisory Panel	FeCl3 STORAGE TANK LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level Check chemical receiving operation
		NaClO STORAGE TANK FOR WELL WATER LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level Check chemical receiving operation
		Deodorization Facility NaClO STORAGE TANK LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check chemical receiving operation
		Deodorization Facility NaClO STORAGE TANK LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level Check chemical receiving operation
		Deodorization Facility NaOH STORAGE TANK LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check chemical receiving operation
		Deodorization Facility NaOH STORAGE TANK LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level Check chemical receiving operation
		WATER SUPPLY UNIT LEVEL HIGH	Tank over flow	Check Tank Liquid Level Check Valve Opening
		WATER SUPPLY UNIT LEVEL LOW	Over Drain operation the Tank	Check Tank Liquid Level
		POLYMER MAKE-UP UNIT LEVEL HIGH	Package Alarm	Check the unit with Local Condition
		POLYMER MAKE-UP UNIT LEVEL LOW	Package Alarm	Check the unit with Local Condition

CONTENTS

(5.7 Design Calculation)

5.7 Design Calculation

This calculation is in accordance with the latest published edition of the design guidelines of the Japan Sewage Works Agency and the Japan Sewage Works Association.

(1) Grit Removal

1) Grit Removal

Type	:	Grit Chamber
Design Condition		
Water surface area loading	:	approx. 1800$m^3/m^2 \cdot d$ (to hourly maximum flow)
Retention Time	:	30~60 sec.
Effective Depth	:	at least 30 cm
No. of Tanks	:	3
Required Tank Volume	:	$12.2m^3$ ~$24.3m^3$
Tank Dimension	:	$^{W}2.0m \times {}^{L}9.5m \times {}^{H}0.675m$ x 3 nos
Volume of Each Tank	:	$12.8m^3$/each
Retention Time	:	79 sec. (to daily maximum flow) 32 sec. (to hourly maximum flow)

(2) Screening Removal

1) Coarse Screen

Type	:	Manual Operated Bar Screen
Openings	:	100mm
Quantity	:	3

2) Fine Screen

Type	:	Continuous Raking Fine Screen
Openings	:	20mm
Quantity	:	3

(3) Primary Sedimentation Tank

Type	:	Radial Flow Sedimentation Tank
Design Condition		
Surface Loading	:	35~70$m^3/m^2 \cdot d$ (to daily maximum flow)

Effective Water Depth	:	2.5~4.0m
No. of Tanks	:	6
Required Tank Surface Area	:	$600\sim1200m^2$
Tank Dimension	:	12.0m square x ^{H}3.0m x 6 nos
Surface Loading	:	$49m^3/m^2$ d(to daily maximum flow)

Note; A by-pass line is provided for the primary Sedimentation tank for initial flow and maintenance purpose.

(4) Aeration Tank (Anaerobic Tank & Aerobic Tank)

1) Anaerobic Tank

Type	:	Rectangular tank with mechanical mixing system
Required Retention Time	:	1~2 hr
No. of Tanks	:	6
Required Tank Volume	:	$V=42,000m^3/d \times (1\sim2)/24hr/d \times 1/6 = 292m^3 \sim 583m^3$
Tank Dimension	:	^{W}14.8m x ^{L}9.9m x ^{H}4.0m x 6 nos
Tank Volume	:	$586m^3$/each
Retention Time	:	2.0hr (to daily maximum flow)

2) Aerobic Tank

Type	:	Rectangular tank with mechanical aeration system
Required Retention Time	:	6 ~ 7 hr
Water depth	:	4 m
No. of Tanks	:	6
Required Tank Volume	:	$V=42,000m^3/d \times (6\sim7) / 24hr/d \times 1/6 = 1750 \sim 2042m^3$
Tank Dimension	:	^{W}14.8m x ^{L}29.6m x ^{H}4.0m x 6 nos
Tank Volume	:	$1752m^3$/each
Retention Time	:	6.0hr (to daily maximum flow)
Set up of MLSS concentration	:	1500 ~ 2000mg/l

3) Total Retention Time of Reactor

T = 2.0 + 6.0 = 8.0 hr (to daily maximum flow)

4) Required Oxygen Volume

4)-1. Required Oxygen for BOD reduction

$D_B = 0.6 \times (132\text{-}20) \times 42000 \times 10^{-3}$

= 2822kg/d

4)-2. Required oxygen for activated sludge endogenous respiration.

Endogenous respiration is 0.12kg/kg/d for activated sludge.

$D_E = 0.12 \times 1600 \times 10^{-3} \times 10{,}500$

= 2016kg/d

4)-3. Required Oxygen to keep 1.5mg/l in aeration tank

$D_0 = 1.5 \times 42{,}000 \times (1+0.5) \times 10^{-3}$

= 95 kg/d

4)-4. Total Oxygen Demand (AOR) Field Oxygen Transfer Rate

$D_T = D_B+D_E+D_0$

= 2822+2016+95

= 4933 kg/d

4)-5. Total Oxygen Demand (SOR) Cleaned Water Oxygen Transfer Rate

$SOR = (AOR \times Csw \times r) / (1.024^{(T-20)} \times \alpha \times (\beta \times Cs \times r - Ca))$

Where

Csw	: Oxygen saturation concentration in clean water at temperature 20°C	8.84
r	: Rectification factor for water depth	r = 1.19
T	: Temperature of Water	20
α	: Ratio of the oxygen transfer rate in the waste to that in clear water at the same temperature	0.70
β	: Ratio of oxygen saturation concentration in the waste to that in clear water	0.90
Cs	: Oxygen saturation concentration in clean water at temperature T	8.84
Ca	: Residual dissolved oxygen concentration in the waste water	1.5

SOR : $= (4933 \times 8.84 \times 1.19) / ((1.024^{20-20}) \times 0.7 \times (0.9 \times 8.84 \times 1.19 - 1.5))$

= 9299kg/d (387 kg/h)

5) Required Surface Aerator Power

PW = SOR / 24 / 0.8 / 1.8 / 12

= 22.4 kW

Where

Efficiency of surface aerator : 0.8

Minimum Oxygenation Efficiency : 1.8 kgO_2 / kWh

Selected surface aerator

Type	:	Vertical shaft mixer
Power	:	30 kW
Quantity	:	12 for 6 series

(5) Final Sedimentation Tank

Type	:	Radial Flow Sedimentation Tank
Design Condition		
Surface Loading	:	20 ~ 30m^3/m^2 d
Effective Water Depth	:	2.5 ~ 4.0m
No. of Tanks	:	6
Required Total Tank Surface Area	:	1400 ~ 2100 m^2
Tank Dimension	:	17.0m Square x ^{H}3.5m x 6 nos
Tank Surface Area	:	289 m^2/each
Surface Loading	:	24.2 m^3/m^2 d (to daily maximum flow)

(6) Disinfection Tank

Type	:	Chlorine Contact Tank
Design Condition		
Retention Time	:	15min (to daily maximum flow)
No. of Tanks	:	1
Required Tank Volume	:	438 m^3
Tank Dimension	:	^{W}2.6 m x ^{L}62.4 m x ^{H}3.0 m x 1 no.
Tank Volume	:	491 m^3
Retention Time	:	16.8 min (to daily maximum flow)

(7) Sludge Treatment

Design Condition

Sludge Volume

(1) From Primary Sedimentation Tank: 4178 kg/d

Where

Moisture content: 98.0%

Volume of PST sludge = PST sludge weight ×100/(100-98.0)÷1000

= 209 m^3/d

(2) From Final Sedimentation Tank

WAS = 3338 kg/d

Volume of WAS sludge = WAS weight ×100/(100-99.4)÷1000

= 556m^3/d

Total sludge generation:

Total sludge (DS) = PST sludge + WAS= 7516 kg/d

Total sludge volume (liquid) = 765 m^3/d

WAS: Waste activated sludge

PST: Primary sedimentation tank

(3) Mixed sludge storage tank

Type	:	Rectangular concrete tank
Design Condition		
Retention Time	:	6 hr
No. Of Tanks	:	1
Required Tank Volume	:	191 m^3
Tank Dimension	:	^{W}10.0 m x ^{L}10.0 m x ^{H} 2.2 m (eff. depth) x 1 no.
Tank Volume	:	220 m^3
Retention Time	:	6.9 hr

(4) Sludge dewaterer

Type	:	Belt press filter with sludge thickening system
Design Condition		
Solid Volume	:	7516 kg/d
Sludge Volume	:	765 m^3/d
Belt Filter Press Capacity	:	200 kg/m hr
Operating Hour	:	7 days/week, 24hrs/day
No. of Belt Filter Press	:	2 No (1 no. for standby)
Required Belt Filter Press Width	:	7516 kg/d x 7/7 / 200kg/m hr x 24hr/d =1.56 m

Selected dewaterer

Type	:	Belt Press Filter
Belt Width	:	1.6m
Quantity	:	2 no (1 no. for standby)

Dewatered Cake Volume: 7140 kg/d x 100 x 10^{-3} / (100-82) = 40 m^3/d

Assuming moisture content of dewatered sludge is preferred to be 82%.

(8) Odor Treatment Facility

1. Design Condition

1) Treatment Facility : Water Treatment Facility
2) Deodorization Method : Chemical Scrubber (Sodium hydroxide + sodium hypochlorite)
3) Treatment Flow Rate : 50 m^3/min
4) Treated gas temperature : 30 °C
5) Odorous Substance
   - Note : The odor reference data is quoted from Japan Sewage Works Agency's design guide book for mechanical facilities, Chapter 9 for Odor Facilities (Page 9-6)

Table – 1 Concentration of odorous substance

Typical main gas component for calculation

Gas Component		Inlet odor concentration (ppm)	Target Value (ppm)
Hydrogen Sulphide	H_2S	0.06	0.02
Methyl Mercaptan	CH_3SH	0.004	0.002
Methyl Sulphide	$(CH_3)_2S$	0.05	0.01
Dimethyl Sulphide	$(CH_3)_2S_2$	0.03	0.005

6) Velocity through the chemical scrubber : About 1.3 m / sec.
7) Washing Liquid : Sodium Hydroxide + Sodium Hypochlorite

Sodium Hydroxide	PH :	10
	Concentration :	25 %
	Specific Gravity :	1.28
Hypochlorite	Effective concentration : 300 mg/liters	

8) Liquid – Gas Ratio : 3.0 liters / Nm^3 (2.3 kg / kg)

2 Calculation of Capacity

2-1 Chemical Scrubber

(1) Scrubber Cross Section Area : A (m^2)

$$A = 50\ m^3/min \times \frac{1}{60\ sec / min} \times \frac{1}{1.3\ m/ sec} \approx 0.64\ m^2$$

Required square area is 0.64 m^2 therefore, the diameter for scrubber 0.9 m is used.

(2) The actual velocity is Lv

$$Lv = \frac{50\ m^3 / min}{60\ sec/min \times 0.9\ m \times 0.9\ m \times \pi/4} = 1.31\ m / sec$$

(3) Packing layer thickness : T (m)

Actual velocity (Lv) : 1.31 m / sec
Gas – Liquid contact time : 1.5 sec
T = 1.31 m/sec x 1.5 sec = 1.97 m
Therefore, contact media length 2.0 m is used.

(4) Circulating liquid volume

Gas flow rate : G (kg / m^2h)

$$G = 50\ m^3 / min \times \frac{273}{(273 + 30)} \times 1.29\ kg / Nm^3 \times 60\ min / h \times \frac{1}{0.9\ m \times 0.9\ m \times \pi/4}$$

= 5494 kg / m^2h

Liquid / gas ratio : L / G = 3 liters / Nm^3 2.3 kg / kg
Therefore, the circulating liquid volume L' (Liters/min) is

L' = 2.3 kg/kg x 5494 kg/m^2h x 0.9 m x 0.9 m x π/4 = 8038.36 kg / h = 134 liters / min

(5) Chemical scrubber pressure drop

From the data on pressure drop in the packing material, it is determined that the pressure drop per packing layer is 145 Pa/m.
Furthermore, the pressure drop for the eliminator in the scrubber is 73.5 Pa per set

The scrubber pressure drop is (145 X 2 + 73.5) X 1.2 = 436.2 Pa

where 1.2 is safety factor

2-2 Make-up water volume

(1) Evaporation volume W1

W1 = 3370.4 kg/h X (0.02718 kg/kg-DG – 0.02151 kg/kg-DG) = 19.1 kg/h ≒ 0.32 liters/min

Therefore W1 = 0.3 Liters/min is used.

(2) Sodium hydroxide + sodium hypochlorite scrubber circulation tank make-up water volume is W2

W2 is 3 % of circulating liquid volume

W2 = L X 0.03 ≒ 140 liters/min X 0.03 = 4.2 liters/min

Therefore, new water supply for the Sodium hydroxide + sodium hypochlorite scrubber circulation tank is

W1 + W2 = 4.5 liters/min

New water supply volume 5 liters/min is used.

2-3 Chemical use volume

2-3-1 Sodium hypochlorite

In the Sodium hydroxide + sodium hypochlorite scrubber, hydrogen sulphide, methyl mercaptan, dimethyl sulphide and dimethyl disulphide are removed.

(1) The reaction with hydrogen sulphide

$H_2S + 4\ NaClO + 2\ NaOH \quad Na_2SO_4 + 4\ NaCl + 2\ H_2O$

(2) The reaction with methyl mercaptan

$CH_3SH + 3\ NaClO + NaOH \quad CH_3SO_3Na + 3\ NaCl + H_2O$

(3) The reaction with dimethyl sulphide

$(CH_3)_2S + 2\ NaClO \quad (CH_3)_2SO_2 + 2\ NaCl$

(4) The reaction with dimethyl disulphide

$(CH_3)_2S2 + 5\ NaClO + 2\ H_2O \quad 2\ CH_3SO_3H + 5\ NaCl$

The quantity of sodium hypochlorite consumed in the reaction with each substance can be calculated with the following formula :

$$Yn = Q\ X\ \frac{273}{273+30}\ X\ Cn\ X\ 10^{-3}\ X\ \frac{1}{22.4\ Nm^3}\ X\ M\ X\ 74.5\ kg/mol$$

Yn : The quantity of sodium hypochlorite consumed by each substance (g / min)

Q : Quantity of gas to be treated (m^3/min)

Cn : Concentration of untreated odor in each substance (ppm)

M : Mole number of sodium hypochlorite required to cause reaction

(1) The quantity consumed by hydrogen sulphide : Y1 (g / min)

$$Y_1 = 50\ m^3/min\ X\ \frac{273}{273+30}\ X\ 0.06\ X\ 10^{-3}\ X\ \frac{1}{22.4\ Nm^3/mol}\ X\ 4\ X\ 74.5\ g/mol$$

$= 0.036$ g/min

(2) The quantity consumed by methyl mercaptan : Y2 (g / min)

$$Y_2 = 50\ m^3/min\ X\ \frac{273}{273+30}\ X\ 0.004\ X\ 10^{-3}\ X\ \frac{1}{22.4\ Nm^3/mol}\ X\ 3\ X\ 74.5\ g/mol$$

$= 0.002$ g / min

(3) The quantity consumed by dimethyl sulphide : Y3 (g / min)

$$Y_3 = 50\ m^3/min \times \frac{273}{273+30} \times 0.05 \times 10^{-3} \times \frac{1}{22.4\ Nm^3/mol} \times 2 \times 74.5\ g/mol$$

$= 0.015\ g/min$

The quantity consumed by dimethyl disulphide : Y_4 (g / min)

$$Y_4 = 50\ m^3/min \times \frac{273}{273+30} \times 0.03 \times 10^{-3} \times \frac{1}{22.4\ Nm^3/mol} \times 5 \times 74.5\ g/mol$$

$= 0.022\ g/min$

(4) The quantity required to maintain the circulating liquid at 300 mg/liters of available chlorine : Y_5 (g/min)

$$Y_5 = 5\ liters/min \times 300\ mg/l \times 10^{-3} \times \frac{74.5}{71} = 1.4\ g/min$$

(5) The quantity of natural decomposition in the gases during washing is 1 ppm. The quantity of sodium hypochlorite is Y_6 (g/min)

$$Y_6 = 50\ m^3/min \times \frac{273}{273+30} \times 1 \times 10^{-3} \times \frac{74.5\ g/mol}{22.4\ Nm^3/mol} = 0.15\ g/min$$

The quantity of sodium hypochlorite consumed at Sodium hydroxide + sodium hypochlorite scrubber : Y_A (g/min)

$Y_A = Y_1 + Y_2 + Y_3 + Y_4 + Y_5 + Y_6 = 1.64\ g/min$

If the sodium hypochlorite has effective chlorine concentration of 10 % and has a specific gravity of 1.1, the total quantity of use is Y_t

$$Y_t = 1.64\ g/min \times \frac{1}{0.10 \times 1.1} = 14.9\ ml/min$$

2-3-2 Sodium hydroxide

In the Sodium hydroxide + sodium hypochlorite scrubber, hydrogen sulphide, methyl mercaptan, and carbon gas are removed.

(1) The reaction with hydrogen sulphide

$H_2S + 4\ NaClO - 2\ NaOH \quad Na_2SO_4 + 4\ NaCl + 2\ H_2O$

(2) The reaction with methyl mercaptan

$CH_3SH + 3\ NaClO + NaOH \quad CH_3SO_3Na + 3\ NaCl + H_2O$

(3) The reaction with carbon dioxide

$CO_2 + 2\ NaOH \quad Na_2CO_3 + H_2O$

The quantity of sodium hydroxide consumed in the reaction with each substance can be calculated with the following formula :

$$Zn = Q \times \frac{273}{273+30} \times Cn \times 10^{-3} \times \frac{1}{22.4\ Nm^3} \times M \times 40\ kg/mol$$

Zn : The quantity of sodium hydroxide consumed by each substance (g / min)

Q : Quantity of gas to be treated (m^3/min)

Cn : Concentration of untreated odor in each substance (ppm)

M : Mole number of sodium hypochlorite required to cause reaction

The quantity consumed by hydrogen sulphide : Z_1 (g/min)

$$Z_1 = 50\ m^3/min \times \frac{273}{273+30} \times 0.06 \times 10^{-3} \times \frac{1}{22.4\ Nm^3/mol} \times 2 \times 40\ g/mol$$

$= 0.01\ g/min$

(1) The quantity consumed by methyl mercaptan : Z_2 (g/min)

$$Y_2 = 50\ m^3/min \times \frac{273}{273+30} \times 0.004 \times 10^{-3} \times \frac{1}{22.4\ Nm^3/mol} \times 2 \times 40\ g/mol$$

$= 0.001\ g/min$

(2) The quantity reacting with the carbon dioxide present in the original odorous substance is taken to be equivalent to 0.5 % of carbon dioxide concentration : Z_3 (g/min)

If 500 ppm represents carbon gas concentration, then

$$Z_3 = 50\ m^3/min \times \frac{273}{273+30} \times 500 \times 10^{-3} \times \frac{1}{22.4\ Nm^3/mol} \times 2 \times 40\ g/mol \times 0.005$$

$= 0.402\ g/min$

(3) The quantity required to maintain the circulating liquid at pH = 10 : Z_4 (g/min)

$$Z_4 = 5\ liters/min \times 40\ mg/l \times \frac{1}{10000} = 0.018\ g/min$$

The quantity of sodium hydroxide consumed at chemical scrubber : Z (g /min)

$Z = Z_1 + Z_2 + Z_3 + Z_4 = 0.431\ g/min$

If the concentration of sodium hydroxide being used is 25 % and has a specific gravity of 1.28, the total quantity of use Z_t

$Z_t = 0.431\ g/min \times \frac{1}{\quad} = 1.34\ ml/min$

0.25 X 1.28

2-4 Main Equipment Capacity Calculation

4-1 Sodium hypochlorite storage tank

It is fixed at the quantity necessary for 7 days of use.

Y_t X 1440 min/day X 7 days X 10^{-3} = 150 liters

Sodium hypochlorite storage tank specifications : set at 200 liters

4-2 Sodium hydroxide storage tank

It is fixed at the quantity necessary for 7 days of use.

Z_t X 1440 min/day X 7 days X 10^{-3} = 14 liters

Sodium hydroxide storage tank specifications : set at 20 liters

4-3 Sodium hypochlorite dosing pump

The quantity of sodium hypochlorite used at chemical scrubber : Yt

Yt = 14.9 ml/min

In consideration of the regulation of the diaphragm pump and irregular conditions, such as operation commencement time, the discharge capacity is set at 4 times the quantity needed regularly.

Yt X 4 = 59.6 ml/min

Sodium hypochlorite dosing pump specifications : set at 60 ml/min.

4-4 Sodium hydroxide dosing pump

The quantity of sodium hydroxide used at chemical scrubber : Zt

Zt = 1.34 ml/min

In consideration of the regulation of the diaphragm pump and irregular conditions, such as operation commencement time, the discharge capacity is set at 4 times the quantity needed regularly.

Zt X 4 = 5.4 ml/min

Sodium hypochlorite dosing pump specifications : set at 6 ml/min

5.8 CALCULATION OF CAPACITY

CP-3 WORKS: WASTEWATERTREATMENT PLANT

NORTH THANG LONG-VAN TRI URBAN INFRUSTRUCTURE DEVELOPMENT PROJECT

CONTENTS

1 BASIC CONDITIONS

1-1 BASIC ITEMS

(1) Name : CP-3 Works Wastewater Treatment Plant

(2) Land Area : Approximately 4 ha

(3) Elevation : approx. 20.0 m

(4) Inlet Pipe Level : -3.2 m

(5) Collection System : Combined system

(6) Treatment Method : [Sewage Treatment] Advanced Conventional Activated Sludge
[Sludge Treatment] Thickener + Dehydrator

(7) Effluent Point : Red River (Song Hong)

(8) Effluent Point Water Level : approx. -2.9 m

(9) Target Year : 2004

1-2 DESIGN POPULATION

Design Population : 150,000 PE (Population Equivalent for **NEW** plant)

150,000 PE (Population Equivalent for **EXISTING** plant)

1-3 DESIGN SEWAGE FLOW

(1) Daily Maximum	42,000	m^3/day
(2) Hourly Maximum	105,000	m^3/day

1-4 DESIGN SEWAGE QUALITY

BOD (INFLUENT)	220	mg/L
SS (INFLUENT)	190	mg/L
BOD (EFFLUENT)	20	mg/L
SS (EFFLUENT)	20	mg/L

2 DESIGN CALUCLATION

2-1 DESIGN CONDITIONS AND CRITERIA

2-1-1 DESIGN SEWAGE FLOW

ITEM	m^3/day	m^3/hr	m^3/min	m^3/sec
Daily Maximum (Q_1)	42,000 (Q_{1-D})	1,750 (Q_{1-H})	29.17 (Q_{1-M})	0.486 (Q_{1-S})
Hourly Maximum (Q_2)	105,000 (Q_{2-D})	4,375 (Q_{2-H})	72.92 (Q_{2-M})	1.215 (Q_{2-S})

(Peak factor: 2.5)

2-1-2 DESIGN SEWAGE QUALITY

ITEM	INFLUENT (mg/L)	Primary Treatment		Secondary Treatment		Total Removal
		Removal Ratio	EFFLUENT (mg/L)	Removal Ratio	EFFLUENT (mg/L)	
BOD (Q_1BOD)	220	40.0%	132	84.8%	20	91%
SS (Q_1SS)	190	50.0%	95	78.9%	20	89%

Remarks:

1. Effluent BOD5 with addition of nitrification inhibitor.
2. Effluent SS is target figure.

2-2 MASS BALANCE CALCULATION

2-2-1 DESIGN CONDITION

Inlet Quantity of Sewage	m^3/d	42,000
Inlet SS of Sewage	mg/l	190
Outlet SS (target figure)	mg/l	20
Recovery of Primary Sludge	%	50
Concentration of Primary Sludge	%	2.0
Gross Yield Coefficient	%	100.0
Concentration of Waste Activated Sludge	%	0.6
Recovery Ratio of Sludge Dewaterer (target figure)	%	95.0
Water Content of Cake	%	82.0

2-2-2 RESULT

2-2-2.1 PRIMARY SEDIMENTATION TANK

Primary Sludge Concentration	%	2.0
Primary Sludge	kg/d	4,178
Primary Sludge Quantity	m^3/d	209

2-2-2.2 FINAL SEDIMENTATION TANK

Waste Activated Sludge Concentration	%	0.6
Waste Activated Sludge	kg/d	3,338
Waste Activated Sludge Quantity	m^3/d	556

2-2-2.5 MIXED SLUDGE

Mixed Sludge Concentration	%	1.0
Mixed Sludge	kg/d	7,516
Mixed Quantity	m^3/d	765

2-2-2.6 SLUDGE DEWATERER

Water Content of Cake	%	82.0
Cake	kg/d	7,140
Cake Quantity	m^3/d	40
Filtrate SS	kg/d	376
Filtrate Quantity	m^3/d	726

2-2-2.7 INLET CONDITION TO PRIMARY SEDIMENTATION TANK

Quantity	m^3/d	42,726
SS	kg/d	8,356

CP-3 Works: Wastewater Treatment Plant

2-2-2.8 INLET CONDITION TO AERATION TANK

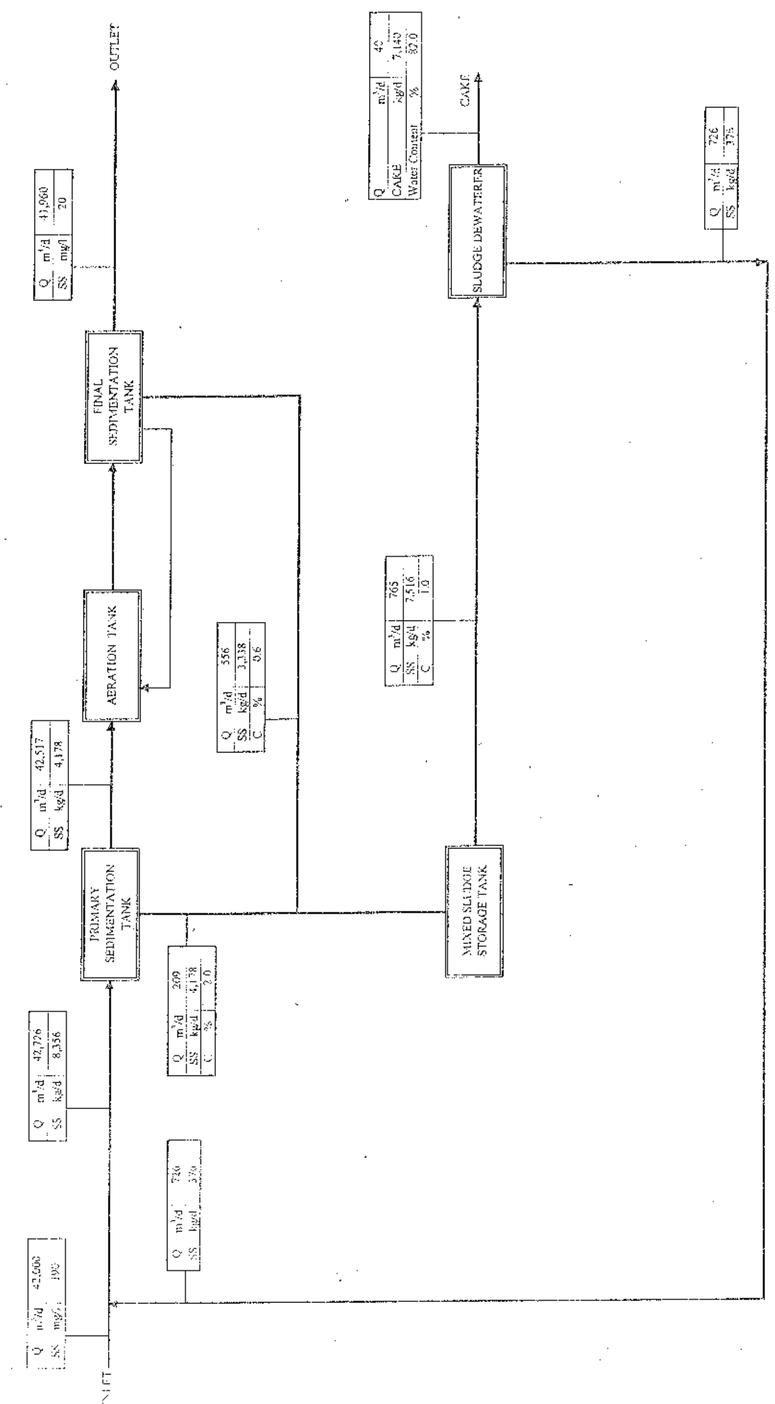
Quantity	m^3/d	42,517
SS	kg/d	4,178

2-2-2.9 RETURN FROM SLUDGE DEWATERER

Quantity	m^3/d	726
SS	kg/d	376

2-2-2.10 EFFLUENT WATER

Quantity	m^3/d	41,960
SS	kg/d	839



2-2-3 MASS BALANCE DIAGRAM

2-3 Capacity Calculation

M1 Grit Chamber Facility

ITEM	SYMBOL	DESIGN
M1-1 Inflow gate		
1.Design Condition		
Design Flow	$Q_{2\text{-}S}$	1.215 m^3/sec (Hourly Maximum)
Type		Emergency Closing Gate
Unit Number	UN	Ope. 1 unit, Stand-by 0 unit, Total 1 unit
2.Design Criteria		
Average Velocity	v	Approximately 1 m/sec
3.Calculation		
Dimension Width	W	Arrangement W : H = 1 : 1.5 W = 1.0 m
Velocity	v	$Q_{2\text{-}S}$ / (W x H x UN) = 0.8 m/sec Approximately 1.0m/sec …OK
4.Specification		W 1,000mm x H 1,500mm x 1unit x 2.2kW
M1-2 Grit Chamber Inflow Gate		
1.Design Condition		
Design Flow	$Q_{2\text{-}S}$	1.215 m^3/sec (Hourly Maximum)
Type		Manually Operated Gate
Unit Number	UN	Ope. 3 units, Stand-by 0 unit, Total 3 units
2.Design Criteria		
Average Velocity	v	Approximately 1 m/sec
3.Calculation		
Dimension Width	W	Arrangement W : H = 1 : 1 W = 0.6 m
Velocity	v	$Q_{2\text{-}S}$ / (W^2 x UN) = 1.1 m/sec Approximately 1.0m/sec …OK
4.Specification		W 600mm x H 600mm x 3units

ITEM	SYMBOL	DESIGN
M1-3 Coarse Screen		
1.Design Condition		
Design Flow	$Q_{2\text{-}S}$	1.215 m^3/sec (Hourly Maximum)
Type		Manually Operated Bar Screen
Unit Number	UN	Ope. 3 units, Stand-by 0 unit, Total 3 units
Screen Opening	OP	100 mm
2.Design Criteria		
Screen Face Velocity	v	0.3 m/sec to 0.45 m/sec
3.Calculation		
Required Section Area	A	$Q_{2\text{-}S}$ / (v x UN) = 0.90 m^2 to 1.35 m^2
Dimension Depth	H	Water Level 0.675 m
Width	W	A / H = 1.3 m to 2.0 m therefore 2.0 m
4.Specification		W 2,000mm x OP 100mm x 3units
M1-4 Grit Pump		
1.Design Condition		
Type		Submersible Grit Pump
Unit Number	UN	Ope. 9 units, Stand-by 0 unit, Total 9 units
Pit Volume	Vo	13 m^3
2.Design Criteria		
Operation Time	T	1 to 3 min against Pit Volume
3.Calculation		
Discharge Flow Per Unit	QU	Vo / UN / T = 0.48 m^3/min to 1.44 m^3/min therefore 0.5 m^3/min
Total Pump Head	H	10 m
4.Specification		Dia.80mm x 0.5m^3/min x 10m x 3.7kW x 9 units

ITEM	SYMBOL	DESIGN
M1-5 Grit Separator		
1.Design Condition		
Type		Screw Grit Conveyor
Unit Number	UN	Ope. 1 unit; Stand-by (storage) 0 unit; Total 1 unit
Capacity	Vo	0.5 m^3/min
2.Specification		0.5m^3/min x 0.75kW x 1 unit
M1-6 Grit Container		
1.Design Condition		
Design Flow	Q_{1-D}	42,000 m^3/d (Dairy Maximum)
Type		Movable Container
Unit Number	UN	Ope. 1 unit; Stand-by 1 unit; Total 2 units
Storage days	SD	1 day
2.Design Criteria		
Unit Grit Generation Volume	UG	0.001 $m^3/1000m^3$ to 0.02 $m^3/1000m^3$
3.Calculation		
Design Grit Volume	Qr	$Q_{1-D} \times 10^{-3} \times UG$ = 0.04 m^3/day to 0.84 m^3/day
Container Volume	V1	Qr x SD = 0.04 m^3 to 0.84 m^3 therefore 0.3 m^3
4.Specification		0.3m^3 x 2units

CP-3 Works: Wastewater Treatment Plant

ITEM	SYMBOL	DESIGN
M1-7 Fine Screen		
1.Design Condition		
Design Flow	Q_{2-S}	1.215 m^3/sec (Hourly Maximum)
Type		Continuous Raking
Unit Number	UN	Ope. 3 units; Stand-by 0 unit; Total 3 units
Screen Opening	OP	20 mm
2.Specification		W 2,000mm x OP20mm x 1.5kW x 3units
M1-8 Fine Screenings Conveyor		
1.Design Condition		
Design Flow	Q_{2-S}	105,000 m^3/day (Hourly Maximum)
Type		Conveyor
Unit Number	UN	Ope. 1 unit; Stand-by 0 unit; Total 1 unit
2.Design Criteria		
Unit Screenings Generation Volume	US	0.001 $m^3/1000m^3$ to 0.015 $m^3/1000m^3$
Operating Time	T	3 min/hr (minimum)
Allowance of Capacity	Al	50 %
3.Calculation		
Design Screenings Volume	Qr	Q_{2-S} x US / 1000 = 0.11 m^3/day to 1.58 m^3/day
Design Conveying Capacity	V	(Qr / 24) x (1/T) x (100+Al)/100 = 0.002 m^3/min to 0.03 m^3/min (= 2.0 m^3/hr) therefore 2.0 m^3/hr
4.Specification		2.0 m^3/hr x L 10m x 2.2kW

ITEM	SYMBOL	DESIGN
M1-9 Screenings Container		
1.Design Condition		
Design Flow	Q_{1-D}	42,000 m^3/d (Dairy Maximum)
Type		Container
Unit Number	UN	Ope. 2 unit; Stand-by 2 unit; Total 4 units
Storage days	SD	1 day
2.Design Criteria		
Unit Screenings Generation Volume	US	0.001 $m^3/1000m^3$ to 0.015 $m^3/1000m^3$
3.Calculation		
Design Screening Volume	Qr	$Q_{1-D} \times 10^{-3} \times US$ = 0.04 m^3/day to 0.63 m^3/day
Container Volume	VI	Qr x SD = 0.04 m^3 to 0.63 m^3; therefore 0.3 m^3
4.Specification		$0.3m^3$ x 4 units

M2 **Lift Pump Facility**

ITEM	SYMBOL	DESIGN
M2-1,2 Lift pump		
1.Design Condition		
Design Flow	Q_{2-M}	72.9 m^3/min (Hourly Maximum)
Type		Volute Type Mixed Flow Pump
Unit Number	UN	Ope. 3 units; Stand-by 1 unit; Total 4 units
Pump Suction Velocity	v1	1.5 m/sec to 3.0 m/sec
Outlet Header Velocity	v2	1.3 m/sec to 2.0 m/sec
2.Calculation		
Discharge Flow Per Unit	qd	Q_{2-M} / UN = 24.3 m^3/min; therefore 27 m^3/min
Pump Dia.	D1	$146 \times (qd / v1)^{1/2}$ = D1 = 438 mm to 619 mm; therefore 500 mm
Header Pipe Dia.	D2	$146 \times (Q_{2-M} / v2)^{1/2}$ = D2 = 882 mm to 1093 mm; therefore 1,000 mm
Total Pump Head	H	10 m
4.Specification		Dia.500mm x 27m^3/min x 10m x 75kW x 4units

M3 Wastewater Treatment Facility

ITEM	SYMBOL	DESIGN
M3-2 Primary Sedimentation Tank Sludge Scraper		
1.Design Condition		
Design Flow	Q_{1-D}	42,000 m3/day (Daily Maximum)
Type		Rotating Scraper
Unit Number	UN	6 units
Dimension		12m sq x H 3.0m
2.Specification		12m sq x H3.0m x 2.2kW x 6units
M3-4 Primary Sludge Pump		
1.Design Condition		
Sludge volume	Vo	209 m^3/day
Type		Centrifugal Non-clog Pump
Unit Number	UN	Ope. 1 unit; Stand-by 1 unit; Total 2 units
2.Design Criteria		
Operation Time	T	12 hr/day
3.Calculation		
Discharge Flow	QU	Vo/ (T x 60) / UN = 0.29 m^3/min; therefore 0.35 m^3/min
Total Pump Head	H	12 m
4.Specification		Dia. 80mm x 0.35m^3/min x 12m x 5.5kW x 2units

13/35

ITEM	SYMBOL	DESIGN
M3-5 PST Bypass Gate		
1.Design Condition		
Design Flow	Q_{2-S}	1.215 m^3/sec (Hourly Maximum)
Type		Manually Operated Gate
Unit Number	UN	Ope. 1 unit; Stand-by 0 unit; Total 1 unit
2.Design Criteria		
Average Velocity	v	Approximately 1 m/sec
3.Calculation		
Dimension Width	W	Arrangement W : H = 1 : 1; W = 1.0 m
Velocity	v	Q_{2-S} / (W x H x UN) = 1.2 m/sec; Approximately 1.0m/sec ...OK
4.Specification		W 1,000mm x H 1,000mm x 1unit
M3-8 Anaerobic Tank Mixer		
1.Design Condition		
Type		Vertical Shaft Propeller Mixer
Unit Number	UN	Ope. 6 units; Store 0 unit; Total 6 units
Dimention of Anaerobic Tank		
Width	W	14.8 m
Length	L	9.9 m
Water depth	H	4.0 m
Tank Volume	Vo	W x L x H = 586 m^3
2.Design Criteria		
Required Power per Unit Volume	W	6 w/m^3
3.Calculation		
Required Power per Unit	PW	Vo x W / 1000 = 3.5 kW; therefore 3.7 kW
4.Specification		3.7kW x 6 units

14/26

ITEM	SYMBOL	DESIGN					
M3-9 Surface Aerator							
1.Design Condition							
Standard Oxygen Demand	SOR	387 kgO_2/hr					
Type		Vertical Shaft Mixer					
Unit Number	UN	Ope.		Store		Total	
		12	units	0	unit	12	units
2.Design Criteria							
Aeration Efficiency	E_p	1.8 kgO_2/kWh					
Efficiency of Surface Aerator	α	0.8					
3.Calculation							
Required Power	PW	SOR / (α x E_p x UN) =				22.4 kW	
		therefore				30 kW	
4.Specification		30kW x 12units					

15/36

ITEM	SYMBOL	DESIGN					
M3-10 Channel Mixing Blower							
1.Design Condition							
Channel Volume	V_A	1,400 m^3					
Type		Rotary Blower					
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	1	unit	2	units
2.Design Criteria							
Unit Aeration Flow	UA	0.3 $m^3/hr/m^3$		to		1.0 $m^3/hr/m^3$	
3.Calculation							
Design Air Flow per Unit	QU	VA x UA / 60 / UN=		7.0 m^3/min to		23.3 m^3/min	
		therefore				14 m^3/min	
Pressure	H	30 kPa					
4.Specification		$14m^3/min$ x 30kPa x 15kW x 2units					

16/36

ITEM	SYMBOL	DESIGN
M3-13 Final Sedimentation Tank Sludge Scraper		
1.Design Condition		
Design Flow	$Q_{2\text{-}D}$	42,000 m^3/day (Daily Maximum)
Type		Rotating Scraper
Unit Number	UN	6 units
Dimension		17m sq x H 3.5m
2.Specification		17m sq x H3.5m x 3.7kW x 6units
M3-14 Return Sludge Pump		
1.Design Condition		
Design Flow	$Q_{1\text{-}M}$	29.2 m^3/min (Daily Maximum)
Type		Centrifugal Non-clog Pump
Unit Number	UN	Ope. 4 units / Stand-by 0 unit / Total 4 units
2.Design Criteria		
Return Sludge Ratio	RSR	100 %(Max.)
Operation Time	T	24 hr/day
3.Calculation		
Discharge Flow	QU	$Q_{1\text{-}M}$ x (RSR/100) / UN= 7.29 m^3/min therefore 7.3 m^3/min
Total Pump Head	H	6 m
4.Specification		Dia. 250mm x 7.3m^3/min x 6m x 18.5kW x4units

M4 Disinfection Facility

ITEM	SYMBOL	DESIGN
M4-3 NaClO Storage Tank		
1.Design Condition		
Type		Vertical Tank
Design Flow	$Q_{1\text{-}D}$	42,000 m^3/day
Used Chemical		Sodium Hypochlorite (NaClO)
Unit Number	UN	1 unit
2.Design Criteria		
Average Dosage Rate	Ir	3 mg/L
Dissolution Concentration	C_0	10 WT%
Retention Time	T	7 days
NaClO Specific Gravity	SG	1.1
3.Calculation		
Average Consumption	Q	$Q_{1\text{-}D}$ x Ir x 10^{-6} x 100 / C_0 / SG = 1.15 m^3/day
Tank Volume	Vo	Q x T / UN = 8.0 m^3
4.Specification		8.0m^3 x 1 unit
M4-4 NaClO Dosing Pump		
1.Design Condition		
Type		Diaphragm Pump
Design Flow	$Q_{1\text{-}D}$	42,000 m^3/day (Daily Maximum)
Design Flow	$Q_{2\text{-}D}$	105,000 m^3/day (Hourly Maximum)
Unit Number	UN	Ope. 1 unit / Stand-by 1 unit / Total 2 units
2.Design Criteria		
Maximum Dosage Rate	Ir	4 mg/L
Dissolution Concentration	C_0	10 WT%
NaClO Specific Gravity	SG	1.1
3.Calculation		
Discharge Flow per Unit	QU	Q x Ir x 10^{-6} x 100 / C_0 / SG / 24 / 60 / UN = 1.1 L/min to 2.7 L/min
4.Specification		Dia. 20mm x 1.1 to 2.7 L/min x 20m x 0.2kW x 2 units

ITEM	SYMBOL	DESIGN					
M4-5 NaClO Dosing Pump for Well Water							
1.Design Condition							
Type		Diaphragm Pump					
Design Flow of Well Pump	Q	0.07	m^3/min				
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	1	unit	2	units
2.Design Criteria							
Dosage Rate	Ir	30	mg/L				
Dissolution Concentration	C_0	10	WT%				
NaClO Specific Gravity	SG	1.1					
Control range	CR	50	% to	150	%		
3.Calculation							
Discharge Flow per Unit	QU	Q x Ir x 10^{-3} x 100 / C_0 / SG x CR /100 / UN =		0.010 L/min		0.029 L/min	
4.Specification		Dia. 15mm x 0.010 to 0.029L/min x 20m x 0.2kW x 2 units					

19/36

M5 Water Supply Facility

ITEM	SYMBOL	DESIGN					
M5-1 Spray Pump							
1.Design Condition							
Type		Centrifugal Pump					
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	1	unit	2	units
Nozzle Number	UN1	13	nozzles/train				6 trains
				therefore			78 units
2.Design Criteria							
Required Water Volume	Vo	8 L/min/nozzle					
3.Calculation							
Discharge Flow Per Unit	QU	Vo x UN1/1000 =		0.62 m^3/min			
			therefore	0.7 m^3/min			
Total Pump Head	H	22 m					
4.Specification		Dia. 80 x 65mm x 0.7m^3/min x 22m x 5.5kW x 2unit					
M5-2 Auto-strainer for Spray Pump							
1.Design Condition							
Type		Automatic Backwashing Type					
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	0	unit	1	unit
Spray Pump Discharge Flow	Q	0.7	m^3/min				
2.Design Criteria							
Capacity		Equivalent to Spray Pump					
3.Specification		Dia. 100mm x 0.7m^3/min x 0.4kW x 1unit					

20/36

ITEM	SYMBOL	DESIGN					
M5-3 Sand Filter Supply Pump							
1.Design Condition							
Type		Centrifugal Pump					
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	1	unit	2	units
Diameter of Sand Filter	D	1.4	m				
Filtration Area	A	1.5	m^2				
2.Design Criteria							
Maximum Filtration Rate	LV	300	m/day				
2.Calculation							
Discharge Flow Per Unit	QU	LV x A / 24 / 60 / UN =				0.32 m^3/min	
				therefore		0.3 m^3/min	
Total Pump Head	H	12 m					
3.Specification		Dia. 65 x 50mm x 0.3m^3/min x 12m x 1.5kW x 2units					
M5-4 Auto-strainer for Sand Filter							
1.Design Condition							
Type		Automatic Backwashing Type					
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	_0	unit	1	unit
Sand Filter Supply Pump Discharge Flow	Q	0.3	m^3/min				
2.Design Criteria							
Capacity		Equivalent to Sand Filter Supply Pump					
3.Specification		Dia mm x 0.3m^3/min x 0.4 kW x 1unit					

21/36

ITEM	SYMBOL	DESIGN					
M5-5 Sand Filter							
1.Design Condition							
Type		Rising Flow Moving Bed Type					
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	0	unit	1	unit
Required Filtered Water Flow	Q	(From Table2. Utility Water Calculation Sheet)					
		Average Consumption per day				309 m^3/day	
2.Design Criteria							
Filtration Rate	LV	200	m/day				
3.Calculation							
Required Filtration Area	A	Q / LV		1.55	m^2		
			therefore	1.5	m^2		
4.Specification		Dia. 1,400mm x 302m^3/day x 1unit					
M5-6 Air Compressor for Sand Filter							
1.Design Condition							
Type		Pressure-switch Type					
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	1	unit	2	unit
Filtration Area	A	1.5	m^2				
2.Design Criteria							
Air Wash Flow	Q	120	NL/m^2				
Required Air Pressure	P	0.3	MPa				
Allowance	Al	50	%				
Maximum Pressure	P1	0.93	MPa				
3.Calculation							
Air Flow	QU	Q x (0.1 + P) / 0.1 / UN x (1 + Al / 100) =				720 NL/min	
					therefore	720 NL/min	
4.Specification		720NL/min x 0.93MPa					

22/36

ITEM	SYMBOL	DESIGN
M5-8 Water Supply Unit for Wastewater Treatment Facility		
1.Design Condition		
Type		Pressure Tank Type
Number of Pump	UN	Ope. 2 units; Stand-by 0 unit; Total 2 units
Required Water Supply Flow	Q	from Utility Water Calculation Sheet 267 L/min
2.Design Criteria		
Allowance	AI	50 %
3.Calculation		
Discharge Flow per Unit	QU	$Q \times 10^{-3} \times (100+AI) / 100 =$ 0.40 m^3/min therefore 0.4 m^3/min
Total Pump Head	H	39 m
4.Specification		Dia. 50 x 65mm x 0.4m^3/min x 39m x (5.5kW x 2) x 1unit
M5-9 Water Supply Unit for Sludge Treatment Facility		
1.Design Condition		
Type		Pressure Tank Type
Number of Pump	UN	Ope. 2 units; Stand-by 0 unit; Total 2 units
Required Water Supply Flow	Q	from Utility Water Calculation Sheet 198 L/min
2.Design Criteria		
Allowance	AI	50 %
3.Calculation		
Discharge Flow per Unit	QU	$Q \times 10^{-3} \times (100+AI) / 100 =$ 0.30 m^3/min therefore 0.3 m^3/min
Total Pump Head	H	39 m
4.Specification		Dia. 50 x 65mm x 0.3m^3/min x 39m x (5.5kW x 2) x 1unit

ITEM	SYMBOL	DESIGN
M5-10 Belt Washing Pump		
1.Design Condition		
Type		Centrifugal Pump
Unit Number	UN	Ope. 1 unit; Stand-by 1 unit; Total 2 units
Required flow	Q	0.14 m^3/min (Manufacture Spec. 8.5m^3/h or 0.14m^3/min)
2.Calculation		
Discharge Flow Per Unit	QU	Q / UN = 0.14 m^3/min therefore 0.14 m^3/min
Total Pump Head	H	69 m
3.Specification		Dia. 40mm x 0.14m^3/min x 69m x 3.0kW x 2units
M5-11 Sand Filter Supply Pump from Deep Well		
1.Design Condition		
Type		Submersible Well Pump
Unit Number	UN	Ope. 1 unit; Stand-by 0 unit; Total 1 unit
Filtration Area	A	0.5 m^2
2.Design Criteria		
1) Filtration		
Filtration Rate	LV	200 m/day
2) Backwash		
Backwash Rate	BR	0.6 m/min
Surface Washing Rate	SR	0.15 m/min
Total Wash Rate	WR	BR + SR = 0.75 m/min = 1080 m/day
3.Calculation		
1) Filtration		
Discharge Flow Per Unit	QU	A x LV / UN / 24 / 60 = 0.07 m^3/min
2) Backwash		
Discharge Flow Per Unit	QU	A x WR / UN = 0.38 m^3/min therefore 0.38 m^3/min
Total Pump Head	H	42 m
4.Specification		Dia. 65mm x 0.38m^3/min x 42m x 5.5kW x 1unit

ITEM	SYMBOL	DESIGN
M5-12 Sand Filter for Domestic Water		
1.Design Condition		
Type		Pressure Sand Filter
Unit Number	UN	Ope. 1 unit; Stand-by 0 unit; Total 1 unit
Unit Water Supply Flow	QU	300 L/day/people
The number of staff	PE	33 people
Required Water Supply Flow	Qr	QU x PE /1000 = 10 m^3/day; therefore 15 m^3/day = 0.010 m^3/min
2.Design Criteria		
Filtration Rate	LV	200 m/day
3.Calculation		
Required Section Area	A	Qr / LV = 0.08 m^2; therefore 0.5 m^2
4.Specification		Dia. 800mm x 15m^3/day
M5-13 Water Supply Unit for Domestic Use		
1.Design Condition		
Type		Pressure Tank Type
Number of Pump	UN	Ope. 1 unit; Stand-by 1 unit; Total 2 unit
Required Water Supply Flow	Qr	0.010 m^3/min
2.Calculation		
Allowance	Al	50 %
Discharge Flow per Unit	QU	Qr x (100+Al) / 100 = 0.02 m^3/min
Total Pump Head	H	30 m
3.Specification		Dia. 32mm x 0.02m^3/min x 30m x (2.2kW x 2) x 1unit

M6 Sludge Treatment Facility

ITEM	SYMBOL	DESIGN
M6-1 Mixed Sludge Mixer		
1.Design Condition		
Type		Submersible Propeller Mixer
Unit Number	UN	Ope. 1 unit; Store 0 unit; Total 1 unit
Mixed Sludge Tank Volume	Vo	250 m^3 (W10.0m x L10.0m x H2.5m x 1tank)
2.Design Criteria		
Required Power per Unit Volume	W	6 w/m^3
3.Calculation		
Required Power per Unit	PW	Vo x W / 1000 / UN = 1.5 kW; therefore 4.0 kW
4.Specification		250m^3 x 4.0kW x 1 unit (Based on Manufacture's Information)
M6-2 Mixed Sludge Pump		
1.Design Condition		
Type		Progressive Cavity Pump
Unit Number	UN	Ope. 1 unit; Stand-by 1 unit; Total 2 units
Sludge Dewaterer Capacity	Q	32 m^3/hr (765 m3/day)
2.Design Criteria		
Control Range	CR	50 % to 150 %
3.Calculation		
Discharge Flow per Unit	QU	Q x CR / 100 / UN = 16 m^3/hr to 48 m^3/hr
Total Pump Head	H	14 m
4.Specification		16 to 48 m^3/hr x m x 7.5kW x 2units

ITEM	SYMBOL	DESIGN
M6-3 Sludge Dewaterer		
1.Design Condition		
Type		Belt Press Filter
Inlet SS Load	S1	7,516 kg/day = 313 kg/hr
Inlet Sludge Volume	Vo	765 m^3/day
Sludge Solids Content	Ssc	1.0 %
Unit Number	UN	Ope. 1 unit; Stand-by 1 unit; Total 2 units
2.Design Criteria		
Solid Load per Unit	SL	200 kg/m/hr
Operation Time	T1	7 days/week
	T2	24 hours/day
3.Calculation		
Belt Width	W	S1 x (7 / T1) x (1 / T2) / SL = 1.57 m; therefore 1.6 m
Solid Load per Unit	SL1	SL x W= 320 kg/hr
Sludge Dewatering Capacity	Q	SL1 x 100 / Ssc x 10^{-3} = 32 m^3/hr
4.Specification		320kg/hr x Total 2.6kW x 2units

27/36

ITEM	SYMBOL	DESIGN
M6-4, 5 Cake Conveyor (1), (2)		
1.Design Condition		
Type		Screw Conveyor
Unit Number	UN	3 unit
Solid Load of Dewaterer	SL1	320 kg/hr
2.Design Criteria		
Maximum Control Range of Dewaterer	CR	150 %
Water Content of Cake	WC	82 %
3.Calculation		
Design Conveying Capacity	V	SL1 x CR / 100 x 100 / (100-WC) / 1000 = 2.7 m^3/hr; therefore 2.7 m^3/hr
4.Specification		2.7 m^3/hr x 4.8kW
M6-6 Cake Hopper		
1.Design Condition		
Type		Motorized or Pneumatic Driven Cut Gate Type
Unit Number	UN	1 unit
Cake	W1	7140 kg/day
Cake quantity	V1	39.7 m^3/day or 1.7 m^3/h
2.Design Criteria		
Storage Hours (Hopper)	SH	6 hrs
3.Calculation		
Hopper Volume	V0	V1 x SH / UN = 9.9 m^3; therefore 10 m^3
4.Specification		10m^3 x 1unit

28/36

ITEM	SYMBOL	DESIGN
M6-7 Automatic Polymer Make-up Unit		
Dissolution Tank		
1.Design Condition		
Type		Vertical Tank
Inlet SS Load	S2	7,516 kg/day
Unit Number	UN	1 unit
Solid Load of Dewaterer	SLd	320 kg/hr
2.Design Criteria		
Dosage rate per DS(Dewatering)	Ird	0.7 %
Retention Time (Dissolving Time)	T	1.5 hr
Dissolving Concentration	DC	0.2 %
3.Calculation		
Polymer Consumption (Dewatering)	W2	S2 x Ird/100 = 52.6 kg/day
Tank Volume	Vo	SLd x Ird / DC x 10^{-3} x T / UN = 1.7 m^3/tank therefore 2.0 m^3/tank
Polymer Consumption Weight	C	Vo x 10^3x DC/100 = 4.0 kg/tank
4.Specification		$2m^3$ x 1.1kW x 1 unit
Polymer Feeder		
1.Design Condition		
Type		Constant Chemical Feeder
Unit Nmber	UN	1 unit
Polymer Consumption	W2	52.6 kg/day
Polymer Density	SG	0.5 kg/L
2.Design Criteria		
Feeding Time	T	12 hr
Allowance	AL	200 %
Storage Days (Hopper)	SD	more than 0.5 day = 12 hr
3.Calculation		
Feeder Capacity	Q	W2 / T / 60 / SG x (100 + AL) / 100 = 0.44 L/min or more
Hopper Volume	V0	W2 x SD / UN / SG = 53 L therefore 80 L
4.Specification		80L x 0.18 kW x 1unit

ITEM	SYMBOL	DESIGN
M6-8 Polymer Dosing Pump		
1.Design Condition		
Type		Progressive Cavity Pump
Unit Number	UN	Ope. 1 unit; Stand-by 1 unit; Total 2 units
Solid Load of Dewaterer	SL	320 kg/hr
2.Design Criteria		
Dosage rate per DS	Ir	0.7 %
Dissolution Concentration	DC	0.2 %
Control range	CR	50 % to 150 %
3.Calculation		
Discharge Flow per Unit	QU	SL x Ir / DC x 10^{-3} x CR / 100 / UN = 0.6 m^3/hr to 1.7 m^3/hr
Total Pump Head	H	20 m
4.Specification		Dia 25mm x 0.6 to 1.7m^3/hr x 20m x 1.1kW x 2units
M6-9 $FeCl_3$ Storage Tank		
1.Design Condition		
Type		FRP Tank
Unit Number	UN	1 unit
Retention Time	T	3 Days
Used Chemical		$FeCl_3$ (Ferric Chloride)
$FeCl_3$ Specific Gravity	SG	1.4 kg/L
Inlet SS Load	S1	7,516 kg/day
2.Design Criteria		
Dosage Rate per DS	Ir	20 %
Dissolution Concentration	DC	38 %
2.Calculation		
Average Consumption	Q	S1 x Ir / DC / SG x 10^{-3} = 2.8 m^3/day
Tank Volume	Vo	Q x T /UN = 8.48 m^3 therefore 9 m^3
3.Specification		$9m^3$ x 1unit

ITEM	SYMBOL	DESIGN					
M6-10 $FeCl_3$ Dosing Pump							
1.Design Condition							
Type		Diaphragm Pump					
Solid Load of Dewaterer	SL	320	kg/hr				
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	1	unit	2	units
2.Design Criteria							
Dosage rate per DS	Ir	20	%				
Dissolution Concentration	DC	38	%				
$FeCl_3$ Specific Gravity	SG	1.4	kg/L				
Control Range	CR	50	% to	150	%		
3.Calculation							
Discharge Flow per Unit	QU	SL x Ir / DC / SG / 60 x CR / 100 / UN =		1.0	L/min to	3.0	L/min
Total Pump Head	H	20 m					
3.Specification		Dia 25mm x 1.0 to 3.0 L/min x 20m x 0.2kW x 2units					

ITEM	SYMBOL	DESIGN					
M6-11 $FeCl_3$ Dosing Pump for Well Water							
1.Design Condition							
Type		Diaphragm Pump					
Design Flow of Well Pump	Q	0.07	m^3/min				
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	1	unit	2	units
2.Design Criteria							
Dosage Rate	Ir	10	mg/L				
Dissolution Concentration	DC	38	WT%				
$FeCl_3$ Specific Gravity	SG	1.4	kg/L				
Control range	CR	50	% to	150	%		
3.Calculation							
Discharge Flow per Unit	QU	Q x Ir x 10^{-3} x 100 / DC / SG x CR / 100 / UN =		0.0007	L/min to	0.0020	L/min
Total Pump Head	H	20 m					
4.Specification		Dia. 15mm x 0.0007 to 0.0020L/min x 20m x 0.2kW x 2 units					

31/36

ITEM	SYMBOL	DESIGN					
M6-12-1 Air Compressor for Slugde Treatment Facility							
1.Design Condition							
Type		Pressure-Switch Type					
Unit Number	UN	Ope.		Stand-by		Total	
		1	unit	1	unit	2	units
Air Flow for Polymer Make-up Unit	Q1	1	NL/min				
Required Air Pressure	P1	0.6	MPa				
Air Flow for Belt Thickener	Q2	15	NL/min				
Required Air Pressure	P2	0.6	MPa				
Air Flow for Dewaterer	Q3	15	NL/min				
Required Air Pressure	P3	0.6	MPa				
Air Flow for Cake Hopper	Q4	45	NL/min				
Required Air Pressure	P4	0.6	MPa				
2.Design Criteria							
Allowance	Al	50	%				
Maximum Pressure	P1	0.93	MPa				
3.Calculation							
Air Flow per Unit	QU	(Q1 x (0.1 + P1) / 0.1 + Q2 x (0.1 + P2) / 0.1 + Q3 x (0.1 + P3) / 0.1 + Q4 x (0.1 + P4) / 0.1) / UN x (1 + Al / 100) =				798	NL/min
					therefore	800	NL/min
4.Specification		800NL/min x 0.93MPa x 2units					

32/36

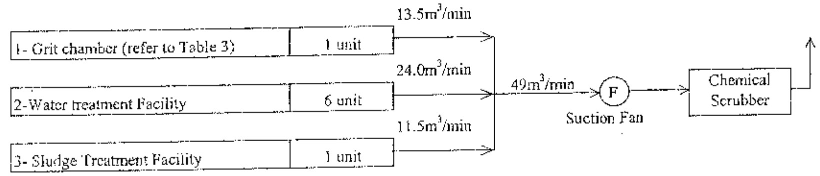
ITEM	SYMBOL	DESIGN
M6-14 Filtrate Pump		
1.Design Condition		
Type		Centrifugal Non-clog Pump
Unit Number	UN	Opc. 1 unit; Stand-by 1 unit; Total 2 units
Filtrate Tank Volume	Vo	213 m^3 (W8.5m x L10.0m x H2.5m x 1tank)
2.Design Criteria		
Operation Time	T	90 min against Filtrate Tank Volume
3.Calculation		
Discharge Flow Per Unit	QU	Vo / T / UN = 2.36 m^3/min therefore 2.5 m^3/min
Total Pump Head	H	10 m
4.Specification		Dia.150mm x 2.5m^3/min x 10m x 15kW x 2units

2-3 Capacity Calculation

Detail refer to Odor Treatment Calculation Sheets

M8 Odor Control

ITEM	SYMBOL	DESIGN
M8-8 Chemical Scrubber		
1.Design Condition		
Type		Chemical Scrubber
Unit Number	UN	Opc. 1 unit; Stand-by 0 unit; Total 1 unit
Odor Gas Flow	Q	50 m^3/min



ITEM	SYMBOL	DESIGN
2.Design Criteria		
Superficial Linear Velocity	LV	1.31 m/sec
Contact Time	CT	1.5 sec
3.Calculation		
Required Sectional Area	H	Q/LV/60= 0.64 m^2
Filler Thickness	D	LV x CT = 2.0 m
4. Specification		50 m^3/min x 1unit

ITEM	SYMBOL	DESIGN
M8-7 Suction Fan		
1.Design Condition		
Type		FRP Centrifugal Fan
Unit Number	UN	Ope. 1 unit / Stand-by 0 unit / Total 1 unit
Odor Gas Flow	Q	50 m^3/min
2.Calculation		
Total Fan Head	H	From Table1. Friction Loss Calculation Sheet 1.5 kPa
3. Specification		50m^3/min x 1.5kPa x 3.7kW x 1unit
M8-6 Mist Separator		
1.Design Condition		
Type		Inertia impact type
Unit Number	UN	Ope. 1 unit / Stand-by 0 unit / Total 1 unit
Odor Gas Flow	Q	50 m^3/min
M8-5 Circulating Pump		
1.Design Condition		
Type		Magnetic Pump
Design Flow		140 liters/min
Unit Number		Ope. 1 unit / Stand-by 1 unit / Total 2 units
2.Specification		140 L/min x 15m x 1.5kW x 2 units
M8-4 NaOH Dosing Pump		
1.Design Condition		
Type		Diaphragm Pump
Design Flow		6 ml/min
Unit Number	UN	Ope. 1 unit / Stand-by 1 unit / Total 2 units
2.Specification		6 ml/min x 0.98MPa x 1.5kW x 2 units

ITEM	SYMBOL	DESIGN
M8-3 NaOH Storage Tank		
1.Design Condition		
Type		Vertical Tank
Design Flow	Q_{1-D}	1.34 ml/min
Used Chemical		Sodium Hydroxide (NaOH)
Unit Number	UN	1 unit
2.Design Criteria		
Dissolution Concentration	C_0	25 WT%
Retention Time	T	7 days
NaClO Specific Gravity	SG	1.28
3.Calculation		
Average Consumption	Q	14 liters/ for Retention Time (7 days)
Tank Volume	Vo	20 liters
4.Specification		20 liters x 1 unit
M8-2 NaClO Dosing Pump		
1.Design Condition		
Type		Diaphragm Pump
Design Flow		60 ml/min
Unit Number		Ope. 1 unit / Stand-by 1 unit / Total 2 units
2.Specification		60 ml/min x 1MPa x 1.5kW x 2 units
M8-1 NaClO Storage Tank		
1.Design Condition		
Type		Vertical Tank
Design Flow		14.90 ml/min
Used Chemical		Sodium Hypochlorite (NaClO)
Unit Number		1 unit
2.Design Criteria		
Dissolution Concentration		10 WT%
Retention Time		7 days
NaClO Specific Gravity		1.1
3.Calculation		
Consumption		150 liters/ for Retention Time (7 days)
Tank Volume		200 liters
4.Specification		200 liters x 1 unit

Hanoi Urban Infrastructure Development Project
CP-3 Works Wastewater Treatment Plant

5.9 MOTOR AND CONTROL LIST

Page 1 of 4
Ebara Taisei Joint Venture

NO.	EQUIPMENT	Quantity duty	standby	total	V	kW	T-kW	contin	batch	Control Description	Local panel	Supervisory Panel	Data Logger	Machine Panel	h/d	note	Generator coverage Yes	kW
	1 Grit Chamber facility																	
M1-1	Inflow gate	1	0	1		0.75	0.75	-		Drop action by gravity at power failure, Normal Open Condition, LA-1: Interlock (close condition), LCA-2, LCIA-3	LP-G-1	SP-1	DLS	-	1		Y	0.75
M1-2	Grit chamber inflow gate	3	0	3		-	-	-	-						-		-	-
M1-3	Coarse screen	3	0	3		-	-	-	-						-		-	-
M1-4	Grit pump	9	0	9		3.7	33.3	-		Timer ON-OFF, LA-1: Interlock, (Reset by timer)	LP-G-1	SP-1	DLS	-	1	10min/2hr	Y	33.3
M1-5	Grit separator	1	0	1		0.25	0.25	-		ON: pre start for M1-4, OFF: Timer delay	LP-G-1	SP-1	DLS	-	6	50min/2hr	Y	0.25
M1-6	Grit container	1	1	2		-	-	-	-						-		-	-
M1-7	Fine screen	3	0	3		0.75	2.25	-		Timer ON-OFF or ON: LA-1 & OFF: Timer delay	LP-G-1	SP-1	DLS	-	6	15min/hr	Y	2.25
M1-8	Fine screenings conveyor	1	0	1		2.2	2.2	-		ON: pre start for M1-7, OFF: Timer delay	LP-G-1	SP-1	DLS	-	6		Y	2.2
M1-9	Screenings container	2	2	4		-	-	-	-						-		-	-
M1-10	Grit chamber outflow stoplog	3	0	3		-	-								-		-	-
M1-11	Grit pump hoist	1	0	1		1.37	1.37								1		-	1.37
M1-12	Container hoist	1	0	1		1.37	1.37	-		Power supply only	-	-	-	-	1		-	1.37
	2 Lift pump facility																	
M2-1	Lift pump (1)	2	0	2		75	150	-		LCA-2, LCIA-3, Interlock:M2-3 closed	LP-G-2	SP-1	DLS	-	12	level control	Y	150
M2-2	Lift pump (2)	2	1	3		75	75		-	LCA-2, LCIA-3, Interlock:M2-3 closed	LP-G-2	SP-1	DLS	-	24	level control, speed	Y	75
M2-3	Discharge valve	3	1	4		1.5	4.5	-		Pre-open for related pumps	LP-G-2	SP-1	DLS	-	0.5		Y	4.5
M2-4	Drainage pump	1	0	1		2.2	2.2	-		Power supply only, Self control w/ bulb type switch (LC-21)	LP-G-2	-	-	-	1		Y	2.2
M2-5	Lift pump hoist	1	0	1		3.25	3.25	-		Power supply only	-	-	-	-	0.5		-	-
	3 Water Treatment Facility																	
M3-1	PST inflow gate	3	0	3		-	-	-									-	-
M3-2-1	Primary sedimentation tank sludge scraper	6	0	6		0.25	1.5				LP-W-2		DLS		24		Y	1.5
M3-2-2	Primary sedimentation tank scum skimmer	6	0	6		0.12	0.72	○	-		LP-W-2	-	DLS		24		Y	0.72
M3-3	Primary sludge valve	6	0	6		0.75	4.5	-	-	Pre-open for related pumps	LP-W-2	-	DLS	-	0.5		Y	4.5
M3-4	Primary sludge pump	1	1	2		5.5	5.5		-	Timer, Interlock:M3-3 closed, LCA-5 NOT HH, LCA-7 NOT HH	LP-W-2	-	DLS	-	5	timer	Y	5.5
M3-5	PST bypass gate	1	0	1		-	-	-	-									
M3-6	Reactor inflow weir	6	0	6		-	-	-	-								-	-
M3-7	RAS flow control weir	6	0	6		-	-	-	-								-	-
M3-8	Anaerobic tank mixer	6	0	6		4.0	24		-		LP-W-2	-	DLS		24		Y	24
M3-9	Surface aerator	12	0	12		37	444	-			LP-W-2	SP-1	DLS	-	20	timer control for DO	Y	222
M3-10	Channel mixing blower	1	1	2		15	15		-		LP-W-5		DLS		24		Y	15
	Gas filter	1	0	1			-											

Hanoi Urban Infrastructure Development Project
CP-3 Works Wastewater Treatment Plant

5.9 MOTOR AND CONTROL LIST

Page 2 of 4
Ebara Taisei Joint Venture

NO.	EQUIPMENT	Quantity duty	standby	total	V	kW	T-kW	contin	batch	Control description	Local panel	Supervisory Panel	Data Logger	Machine Panel	h/d	note	Generator coverage Yes	kW
M3-11	Blower hoist	1	0	1		-	-	-		Power supply only	-	-	-					
M3-12	FST inflow valve	6	0	6		-	-	-	-						-		-	-
M3-13-1	Final sedimentation tank sludge scraper	6	0	6		0.25	1.5		-		LP-W-2	-	DLS	-	24		Y	2.25
M3-13-2	Final sedimentation tank scum skimmer	6	0	6		0.12	0.72	○	-		LP-W-2	-	DLS		24		Y	0.72
M3-14	RAS pump	4	0	4		18.5	74		-		LP-W-5	-	DLS	-	24		Y	74
M3-15	WAS extraction valve	2	0	2		0.16	0.32	-		Timer, Interlock: LCA-6 NOT HH, LICA-7 NOT HH	LP-W-5	-	DLS	-	2	timer	Y	0.32
M3-16	Drainage pump	5	0	5		2.2	11	-		Power supply only, Self control w/ bulb type switch (LC-)	LP-W-	-	-		1		Y	11
M3-17	PST inflow channel stoplog	2	0	2		-			-						-		-	-
M3-18	Bypass channel stoplog	1	0	1		-	-	-	-						-		-	-
M3-19	Reactor inflow channel stoplog	2	0	2					-						-		-	-
M3-20	FST inflow channel stoplog	2	0	2		-	-	-										-
	4 Disinfection Facility																	
M4-1	Disinfection tank inflow gate	1	0	1		-	-	-	-						-		-	-
M4-2	Disinfection tank bypass gate	1	0	1		-	-	-	-						-		-	-
M4-3	NaClO storage tank	1	0	1		-	-	-	-						-		-	-
M4-4	NaClO dosing pump	1	1	2		0.4	0.4		-	Interlock:LCA-9 LL	LP-D-1	-	DLS	-	24		Y	0.4
M4-5	NaClO dosing pump for well water	1	1	2		0.016	0.016		-	Synchronized with M5-11, Interlock:LCA-9 LL	LP-D-1	-	DLS	-	24		Y	0.016
M4-6	NaClO storage tank for well water	1	0	1		-	-								-			
	5 Water Supply Facility																	
M5-1	Spray pump	1	1	2		5.5	5.5		-	Interlock:LCA-4 L(on), H(OS)	LP-D-3	-	DLS	-	24		Y	5.5
M5-2	Auto-strainer for spray pump	1	0	1		0.2	0.2		-	Synchronized with M5-1 (i.e. : back wash start available when M5-1 is running), back wash start by self control panel	LP-D-3		DLS	MP-D-4	24		Y	0.2
M5-3	Sand filter supply pump	2	1	2		1.5	1.5	-		Interlock:LCA-4 L, LCA-5 H	LP-D-1	-	DLS		16	level control	Y	1.5
M5-4	Auto-strainer for sand filter	1	0	1		0.2	0.2	-		Synchronized with M5-3 (i.e. : back wash start available when M5-3 is running), back wash start by self control panel	LP-D-3		DLS	MP-D-5	10	timer	Y	0.2
M5-5	Sand filter	1	0	1		-	-	-							10	W.L.	-	-
-	Two solenoid valves(V-M5-5-1, V-M5-5-2)	2	0	2						Air line solenoid valves(V-M5-5-1, V-M5-5-2) open when LC-5 L, close when LC-5 H	LP-D-3						-	-
M5-6	Air compressor for sand filter	1	1	2		7.5	7.5			Power supply only, self control by mounted pressure switch	LP-D-1		DLS		10	timer & interlock with sand filter	Y	7.5
M5-7	(N/A)																	
M5-8	Water supply unit for wastewater treatment facility	2	0	2		3.0	6	-		Power supply, Self-control by in-line pressure (single alternate), Interlock:LCA-5 L	LP-D-1		DLS	MP-D-4	12	pressure control	Y	6
M5-9	Water supply unit for sludge treatment facility	2	0	2		2.2	4.4			Power supply, Self-control by in-line pressure (single alternate), Interlock:LCA-5 L			DLS	MP-D-2	6		Y	4.4
M5-10	Belt washing pump	1	1	2		2.0	2		-	Synchronized with M6-3			DLS	MP-S-1	24	interlock with dissolver	-	-

Hanoi Urban Infrastructure Development Project
CP-3 Works Wastewater Treatment Plant

5.9 MOTOR AND CONTROL LIST

Page 3 of 4
Ebara-Taisei Joint Venture

NO.	EQUIPMENT	Quantity duty	Q'ty standby	total	V	Cap'y kW	T-kW	contin	batch	Control description	Panel Location: Local	Panel Location: Data Logger	Panel Location: Machine Panel	h/d	note	GENERATOR COVERAGE Yes	kW
M5-11	Sand filter supply pump for wash water	1	0			5.5	5.5			Interlock:LC-14 LL(cut H(OK)), LC-15 H(cut) L(OK)	LP-D-3	DLS	-	8	level control	Y	5.5
M5-12	Sand filter for domestic water	1	0	1										-			-
M5-13	Water supply unit for domestic use	1	1	2		0.75	0.75	-		Power supply: Self-control by in-line pressure (parallel alternate), Interlock:LCA-15 LL(cut) L(OK)	-	DLS	MP-D-3	0	pressure switch control	Y	0.75
M5-14	Drainage pump	2	0	2		2.2	4.4	-		Power supply only, Self control w/ bulb type switch (LC-)	LP-W-	-	-			Y	4.4

6 Sludge Treatment Facility

NO.	EQUIPMENT	Quantity duty	Q'ty standby	total	V	Cap'y kW	T-kW	contin	batch	Control description	Panel Location: Local	Panel Location: Data Logger	Panel Location: Machine Panel	h/d	note	GENERATOR COVERAGE Yes	kW
M6-1	Mixed sludge mixer	1	0	1		5.0	5		-	Interlock:LCA-6 M, LCIA-7 M	LP-S-1	DLS	-	24		Y	5
M6-2	Mixed sludge pump	1	1	3		7.5	7.5			Synchronized with M6-3, Interlock:LCA-6 L, LCIA-7 L	-	DLS	MP-S-1	24	Interlock with dewaterer	-	-
M6-3-1	Sludge dewaterer	1	1	2		1.3	1.3		-	Interlock: related machines (M6-2, M6-4, M6-7, M6-8, M6-10) are under operating condition (NOT fault).	-	DLS	MP-S-1	24	Interlock with dewaterer	-	-
M6-3-2	Flocculator	1	1	2		0.37	0.37		-	Synchronized with M6-2	-	DLS	MP-S-1	24	Interlock with dewaterer	-	-
M6-4	Cake conveyor (1)	1	0	1		4	4		-	Pre-start for M6-3, Stop:Timer delay	-	DLS	MP-S-1	24		-	-
M6-5-1	Cake conveyor (2) (vertical)	1	0	1		1.5	1.5		-	Pre-start for M6-4, Stop:Timer delay	-	DLS	MP-S-1	24		-	-
M6-5-2	Cake conveyor (3) (horizontal)	1	0	1		1.1	1.1			Pre-start for M6-4, Stop:Timer delay	-	DLS	MP-S-1	24		-	-
M6-6	Cake hopper	1	0	1		3.0	3.0	-	-	Power supply only (Max. 5kW)	-	-	MP-S-2	1		-	-
M6-7	Automatic polymer make-up unit	1	0	1		1.68	1.68		-	Power supply only	-	DLS	MP-S-1	24	Interlock with dewaterer	-	
	Polymer feeder	1	0	1		-	-	-		Power supply only	-	DLS	MP-S-1	2		-	
M6-8	Polymer dosing pump	1	1	2		1.1	1.1		-	Synchronized with M6-3, Interlock:LCA-11 LL	-	DLS	MP-S-1	24	Interlock with dewaterer	-	-
M6-9	FeCl3 storage tank	1	0	1			-	-	-					-			-
M6-10	FeCl3 dosing pump	1	1	2		0.4	0.4	-		Synchronized with M6-3, Interlock:LCA-10 LL	-	DLS	MP-S-1	-	only use at necessary case		-
M6-11	FeCl3 dosing pump for well water	1	1	2		0.016	0.016	-		Synchronized with M5-11, Interlock:LCA-10 LL	LP-C-2	DLS		8		Y	0.016
M6-12	Air compressor for sludge treatment facility	1	1	2		1.5	1.5		-	Power supply only, self control by mounted pressure switch	-	DLS	MP-S-1	24	Interlock with dewaterer	-	-
M6-13	Air dryer	1	0	1	100	0.22	0.22			Power supply only	-	-	-	24		-	-
M6-14	Filtrate pump	1	1	2		1.1	1.1	-		LCA-8 H (ON), L (OFF), Interlock:LCA-2 HH, LCIA-3 HH	LP-S-2	DLS	-	8			-
M6-15	Drainage pump	2	0	2		2.2	2.2	-		Power supply only, Self control w/ bulb type switch (LC-)	LP-W-	-	-	2		Y	4.4
M6-16	Sludge dewaterer hoist	2	0	2		2.9	5.9			Power supply only	-	-	-	0.5			
M6-17	Maintenance hoist	1	0	1		-	-	-	-							-	-
M6-18	FeCl3 storage tank for well water	1	0	1		-	-	-	-							-	-

7 Sludge storage facility

NO.	EQUIPMENT	Quantity duty	Q'ty standby	total	V	Cap'y kW	T-kW	contin	batch	Control description	Panel Location: Local	Panel Location: Data Logger	Panel Location: Machine Panel	h/d	note	GENERATOR COVERAGE Yes	kW
M7-1	Shovel loader	1	0	1										-			-

(59)

Hanoi Urban Infrastructure Development Project
CP-3 Works Wastewater Treatment Plant

5.9 MOTOR AND CONTROL LIST

Page 4 of 4
Ebara-Taisei Joint Venture

NO.	EQUIPMENT	Quantity duty	Q'ty standby	total	V	Cap'y kW	T-kW	contin	batch	Control description	Panel Location: Local	Panel Location: Data Logger	Panel Location: Machine Panel	h/d	note	GENERATOR COVERAGE Yes	kW
M7-2	Drainage pump	2	0	2		2.2	4.4	-		Power supply only, Self control w/ bulb type switch (LC-)	LP-W-		-	2		Y	4.4
M7-3	Maintenance crane		0			-	-	-	-					-		-	-
M7-4	Tripod	1	0	1										-		-	-

8 Deodorization facility

NO.	EQUIPMENT	Quantity duty	Q'ty standby	total	V	Cap'y kW	T-kW	contin	batch	Control description	Panel Location: Local	Panel Location: Data Logger	Panel Location: Machine Panel	h/d	note	GENERATOR COVERAGE Yes	kW
M8-1	NaClO storage tank		0	1		-	-	-	-					-		-	-
M8-2	NaClO dosing pump	1	1	2		0.022	0.022	-		Timer ON OFF, Interlock:LCA-12 LL	LP-W-6	DLS	-	-		-	-
M8-3	NaOH storage tank	1	0	1										-		-	-
M8-4	NaOH dosing pump	1	1	2		0.017	0.017	-		PHIC-1	LP-W-6	DLS	-	-		-	-
M8-5	Circulating pump	1	1	2		1.5	1.5			Interlock:LCA-16 LL	LP-W-6	DLS	-	24		-	-
M8-7	Mist Separator	1	0	1		-	-	-	-					-		-	-
M8-8	Deodorization fan	1	0	1		4	4		-		LP-W-6	DLS	-	24		-	-
															Subtotal		648

9 Generator Room facility

NO.	EQUIPMENT	Quantity duty	Q'ty standby	total	V	Cap'y kW	T-kW	contin	batch	Control description	Panel Location: Local	Panel Location: Data Logger	Panel Location: Machine Panel	h/d	note	GENERATOR COVERAGE Yes	kW
M9-1	Oil supply pump	1	0	1		3.7	3.7			Level signal from M9-2	LP-E-1	DLS		1	emergency	Y	3.7
M9-2	Service tank	1	0			-	-	-	-					-		-	-
M9-3	Emergency Generator	0	1	1										-		-	-

(60)

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TRAINING MANUAL
FOR
TRAINING OF EMPLOYER'S STAFF
II. Monitoring Control and Automation System (MCAS) User's Manual

Wastewater Treatment Plant (CP-3 WORKS)

UNDER
THANG LONG NORTH - VAN TRI
URBAN INFRASTRUCTURE DEVELOPMENT PROJECT

A	15 March 05	For Approval	I. Tsunoda	H. Suzuki	J. Sato
0	21 October 04	For Approval	I. Tsunoda	Y. Shimoyama	J. Sato
Rev.	Date	Description	Prepared by	Checked by	Approved by

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Document Name	USERS MANUAL
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Project Name	THANG LONG NORTH-VANRI URBAN INFRASTRUCTURE DEVELOPMENT PROJECT 38,000m3/DAY WASTE WATER TREATMENT PLANT (CP-3 WORKS)
Project Number	XJ01H1065-70-ED703(R020009211)
System Name	MCAS/DATA LOGGER

REV.	PAGE	DATE	CHECK	DESCRIPTION
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3				
2				
1				

ISSUE	Electric & Control Department
CHECK	DESCRIPTION
	Y.Aikawa

Rev	Date	Person in Charge	Revision history
0	'04/9/4	Aikawa	First edition
1	'04/10/25	Aikawa	1) Page 2: The system configuration drawing cleared. 2) Page 2: '17 inch TFT' changed into '19 inch TFT' 3) Page 3: Power Supply Cable Diagram added. 4) Page 4: Communication cable Diagram added. 5) Page 5: UPS Connection Cable Diagram added. 6) Page 2,6,7,40:Color laser printer changed into Inkjet and laser(mono color) printer. 7) Page 10,12,14,16,20,23,24,25,26,27,28,30,32,33,34,36: Display figure changed. 8) Page 41: UPS 'Input AC100V' changed into ' Input AC200V'.

Table of contents

Introduce

Thank you for choosing our monitor system.
We carefully produced this system so that you can utilize it safely. However, it is possible that the system will not work properly because of your wrong operation.
Moreover, unexpected accident maybe is led to.
Therefore, please read all the content on the operation, setup and warning about the system in this manual carefully and operate following the instruction.
If there is any other problem about our production, please contact with us. The addresses are listed in " ".

Attention to Safety

(1) The "Note" in this manual is about how to operate properly. If it is not observed, direct and indirect damages to the system might be caused. Please pay attention to it.

(2) The particular warning and instruction of this product are included in the manual, please operate the system after read the content carefully.

The types and definitions of "warning" are as follows:

Danger : **Danger indicates a hazardous situation, which will result in death, serious personal injury if the safety instruction is ignored. It is very urgent situation.**

Warning: **Warning indicates a hazardous situation, which can result in death, serious personal injury if the safety instruction is ignored.**

Caution: **Caution means a serious situation, which will or can cause personal injury or property damage.**

Caution

1) Utilization of Computer and Healthy Management

The main trouble on healthy during using computer is the uncomfortable feelings of muscle and eyes. To avoid muscle exhaustion, firstly, it is necessary to make a comfortable working environment. Otherwise, it is also necessary to have a periodical rest.

To use computer comfortably, Please be sure that you have enough space around you, thus you can change pose freely to comfort yourself.

[Exhaustion of eyes]

Looking at a close object for long time is the cause of exhaustion of eyes. Looking at an object less than 6m away will highly strain eyes. In addition, insufficient illumination will also cause eyes exhaustion.

Including using computer, When you do certain job in which you have to keep looking at a close object for long time such as reading or working, you should better consider about the brightness of your illumination equipments and often take a look at a far object to rest your eyes. Moreover, don't forget to have periodical eye examinations.

[To avoid uncomfortable feelings of body and eyes exhaustion]

- Please adjust your desk and chair to fit your body, so that you can keep comfortable pose.
- To rest your muscle and eyes, have a little break periodically to relax yourself.
- It is ideal that you have a comfortable chair with adjustment system. Adjust your chair to make your thighs horizontal, your feet can touch the ground sufficiently and your back be supported by your waist.
- Make the keyboard and the mouse in the same height. In addition, bend your elbows into a rectangle. If it is necessary to make your chair higher, put your feet on a plat thus your feet can touch the ground sufficiently.
- When you are in operation situation, make the top of the operation window a little higher or lower than your eyes. It is usual to make distance between your eyes and the display in 45~70.
- Adjust the direction of the screen to avoid the light of the windows or the light fixtures in your room to illuminate on your screen.

[To avoid exhaustion]

- If you feel tired, change your sitting pose, stand up and extend your body.
- Make sure that you have enough space around the keyboard and the mouse so that you can operate comfortably.
- Often cleaning the screen of your computer can prevent the reflection of lights.

2) The caution on the operation of the computer

- Put the system in a plat and stable place.
- Hold the connector or the plug when you attach or remove the cable. (avoid to hold the cord when you pull.)
- Attach or remove the cable or components after cutting off power. If not, it will cause troubles.
- Do not insert the connectors forcibly. Please check the connector to make sure the type of the port is same as it when you join them.
- Do not put food or drip liquid on the computer and the mouse and the keyboard. If there is any food or liquid, make sure to cut off power before cleaning. It is possible to have it fixed, according to the level of stain.
- Put away from the place in sun light and rain.
- Do not cover the vent hole in the system. If the system is not ventilated well enough, it will become overheated and the performance will be affected. This situation will also cause troubles.

3) The caution on operation of Switchboard for controlling

Danger	Operation
1 Do not remove the cover of the dashboard, rechargeable part and connector.	● May get an electric shock.
2 Do not touch the rechargeable part, the shutters, the body of the mold machine.	● May get an electric shock.
4 Do not touch the space heater and resistor.	● May get burned.

Caution	Operation
1 Let professionals operate and manage the system.	● May get an electric shock, injured and cause troubles.
2 Before operating, read the related documents carefully.	● May get an electric shock or cause troubles.
3 Before deal with the inside machine, read the manual carefully. (If there is any problem which is not in the manual. Please contact with us.)	● May get an electric shock or cause troubles.
4 Do not open the door when the system is running.	● May get an electric shock.
5 Do not touch the rechargeable part when you open the door and operate inside.	● May get an electric shock.
6 Do not occupy the suction port and exhaust port.	● May be overheated or cause troubles.
7 Do not remove the attachment and the plug when the system is running.	● May cause troubles and wrong operation.
8 Do not put sticks or fingers into the opening.	● May get injured or cause troubles
9 Do not pull the relay when the system is running.	● May cause an accident by wrong operation or crisis non operation.
10 Do not remove the cable connector of the print wire board.	● May cause an accident or wrong operation.
11 Do not touch the inside print wire board.	● May cause troubles.
12 Please set all the switches to the right mode(automated, remote and so on).	● May cause the indirect damages or troubles by non operation.
13 Please set all the timers in the right time.	● May cause wrong operation or troubles.
14 Please set the thermal and 3E relay correctly.	● May cause wrong operation or troubles.
15 Please change the components with change date in time. (About the change date depended on life, please refer to the specific documents.) •battery •LCD •electrolytic condenser •other consumption	● May cause burned, troubles or poor performance.
16 Please use the specific exchange components.	● May cause burned, troubles or poor performance.

1. Functional Outline

1.1. Main Objective

These specifications are for the MCAS (Monitoring, Control, and Automation System/Data Logger) for monitoring the waste water treatment plant from the central surveillance center. Depending on the processed data, the MCAS/Data Logger makes precise and efficient monitoring and data recording of the plant from the central surveillance center possible.

1.2. Main Function

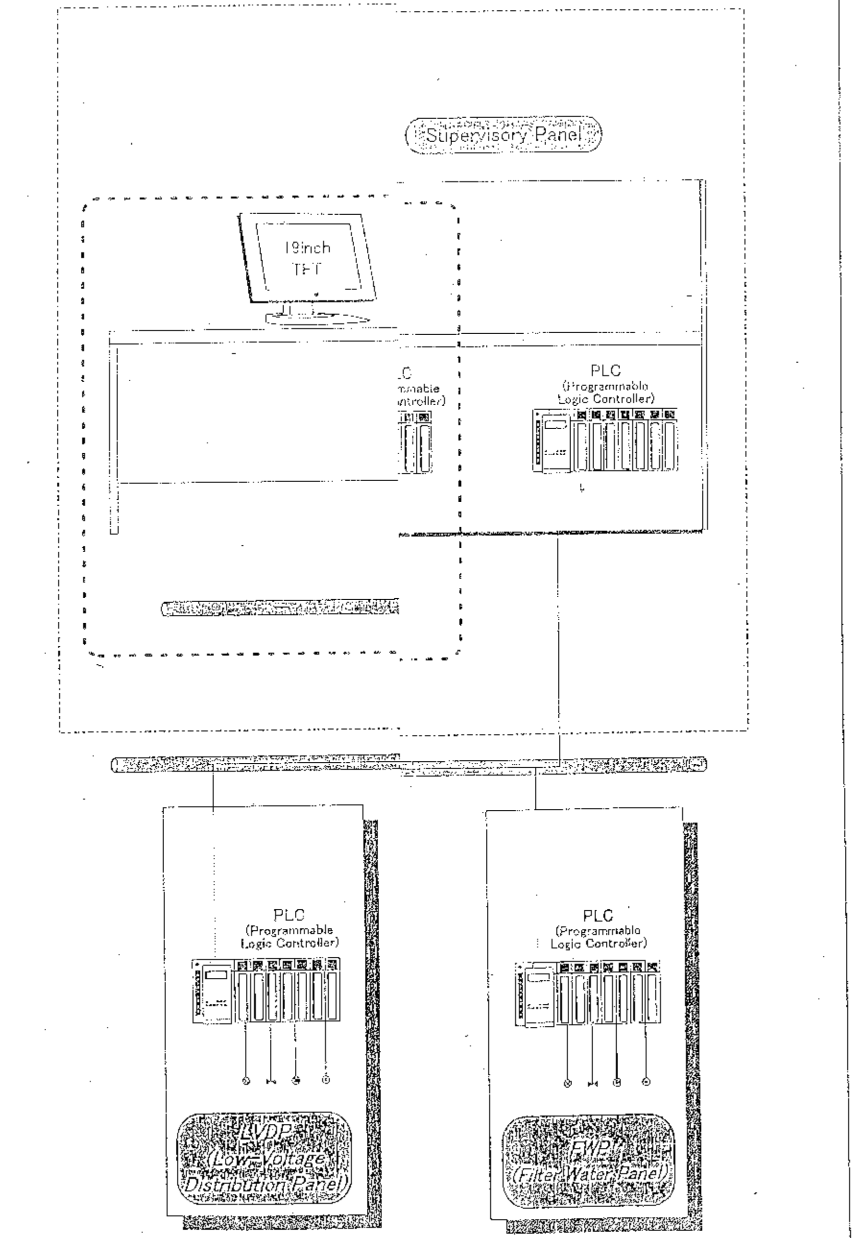
The table below explains the main function of the MCAS/Data Logger.

<Function Table>

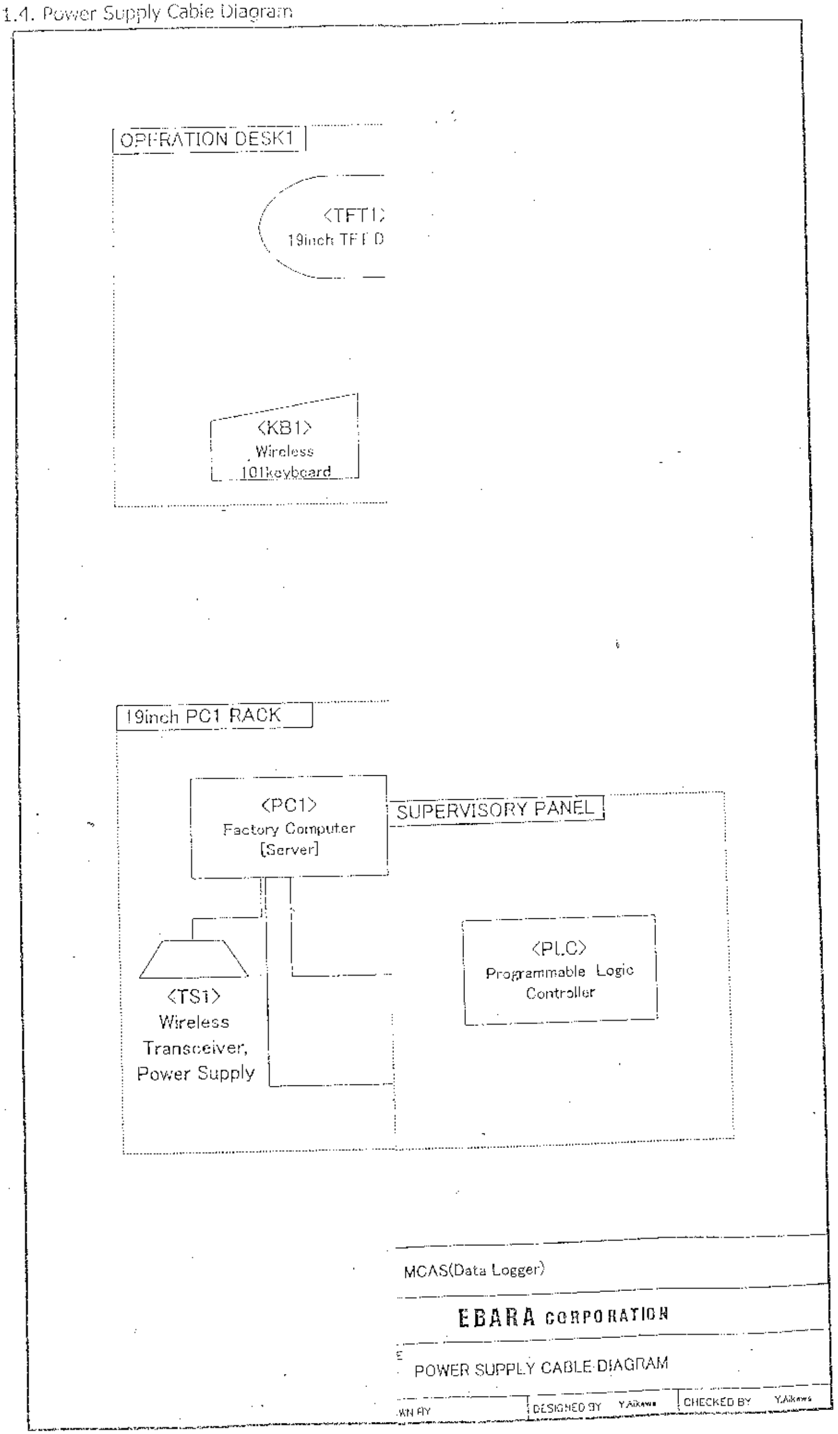
Main Function	Function	Functional Description
Monitoring	System Figures	The entire plant as a system is displayed with image graphics. The facilities monitored will be displayed periodically or during every operation situation, failure/alarm state or for measuring water flow, levels, etc..
	Trend Graph	The process measurement data of water flow, levels, etc are displayed by a trend graph. The trend graph can display current and past varieties at all times.
	Monitoring List	The process measurement value of running/stopping, and failure /alarm states, as well as water flow and level is displayed in real time and list form.
	Operation Alarm Message	During equipment operation/stopping time and damage outbreaks, details are displayed in message form. Moreover, the alarm sound informs of a damage outbreak.
Record Function	Operation/Alarm History	Operation/stopping and failure/alarm history data can be saved over a long period of time.
	List	When recording the process measurement data of water flow and level etc, the list format can be automatically displayed and printed at the same time.
	Saving CD/RW	Trend graph data, application data, lists, operation/alarm history etc can all be saved on CD/RW. Data that has been saved on a CD can also be displayed again and again.
	Screen Copy	The screen displayed can be copied and color printed.

1.3. System Configuration

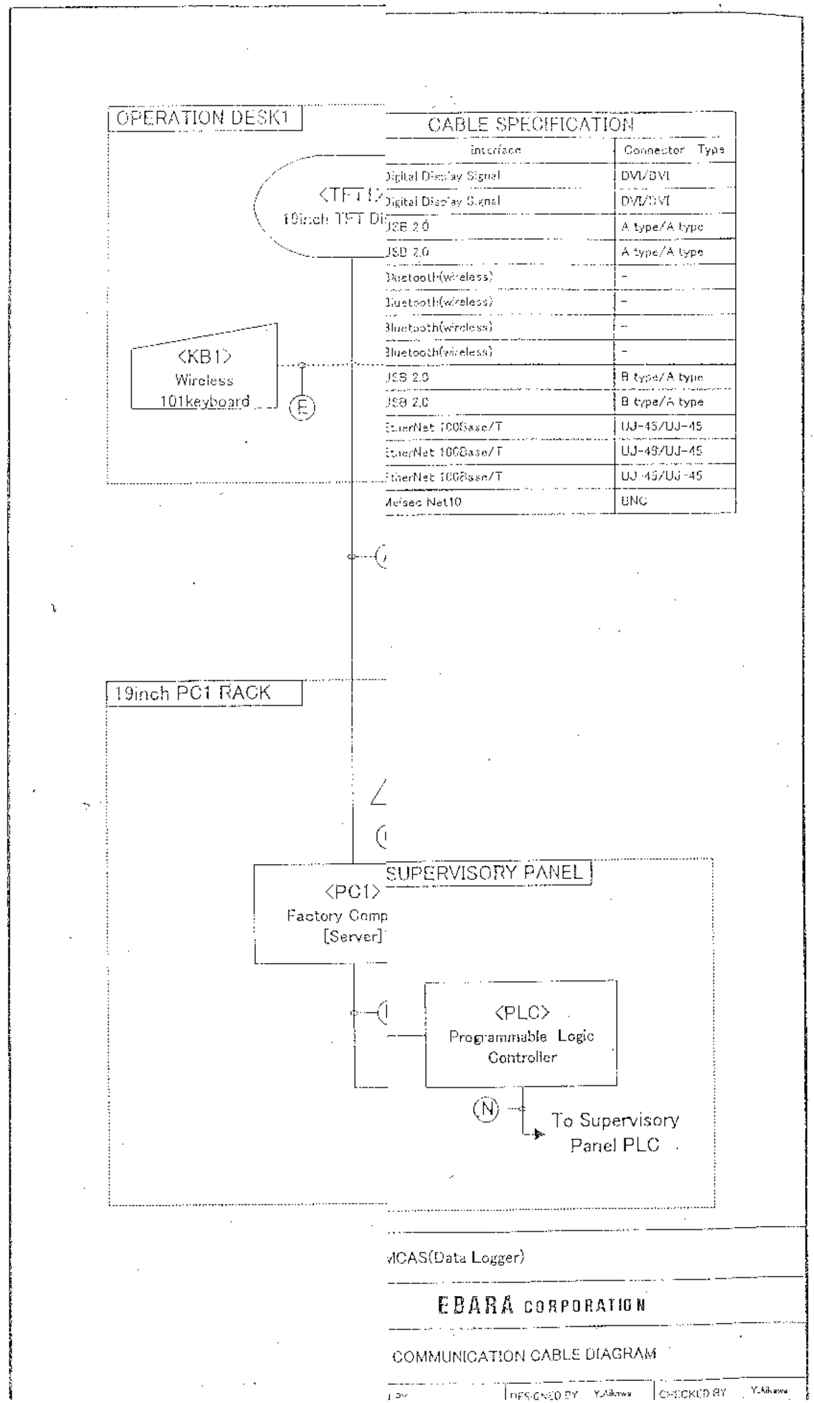
MCAS(Monitoring, Cor



1.4. Power Supply Cable Diagram



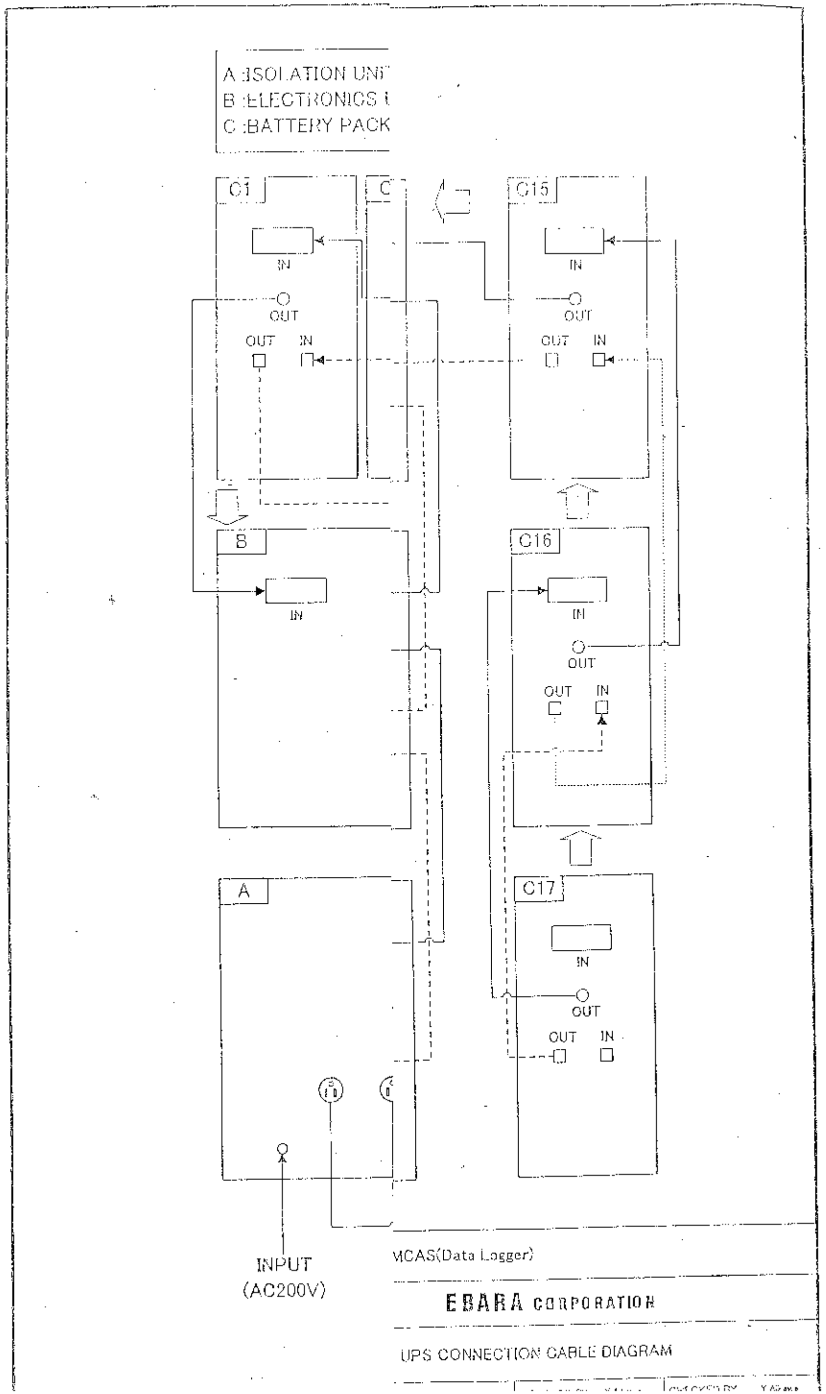
1.5. Communication cable Diagram



CABLE SPECIFICATION

Interface	Connector Type
Digital Display Signal	DVI/DVI
Digital Display Signal	DVI/DVI
USB 2.0	A type/A type
USB 2.0	A type/A type
Bluetooth(wireless)	-
Bluetooth(wireless)	-
Bluetooth(wireless)	-
Bluetooth(wireless)	-
USB 2.0	B type/A type
USB 2.0	B type/A type
EtherNet 100Base/T	UJ-45/UJ-45
EtherNet 100Base/T	UJ-45/UJ-45
EtherNet 100Base/T	UJ-45/UJ-45
Melsec Net10	BNC

1.6. UPS Connection Cable Diagram



1.7. Functional Outline of Each Device

The following explains the function of each apparatus.

Device Name	Function
TFT Keyboard Mouse	Equipment needed for surveillance and carrying out man-machine interface operations with the facilities. Both TFT1 and TFT2 have the same function, and they can display all surveillance screens.
CPU	Documents the collection and operation of process data (water flow and level measurement value, alarm point of contact data) collected from each input and output control device (PLC: Programmable Logic Controller). There are two PCs, PC1 and PC2. PC1 combines the data process function (server) and the display function (client). PC2 only has a display function.
Ink jet printer	Prints the screen lists.
Laser printer	Prints the report(Daily, Monthly, Annual)
Uninterruptible power Supply	When the electric current is cut off, it is the equipment that back ups the power supply of a system.
Input and Output Control Device (PLC: Programmable Logic Controller)	Performs input of collected process data ((water flow and level measurement value and alarm point of contact data) from various kinds of measuring instruments and equipment.

2. The system starting / stopping method

2.1. About Utilization

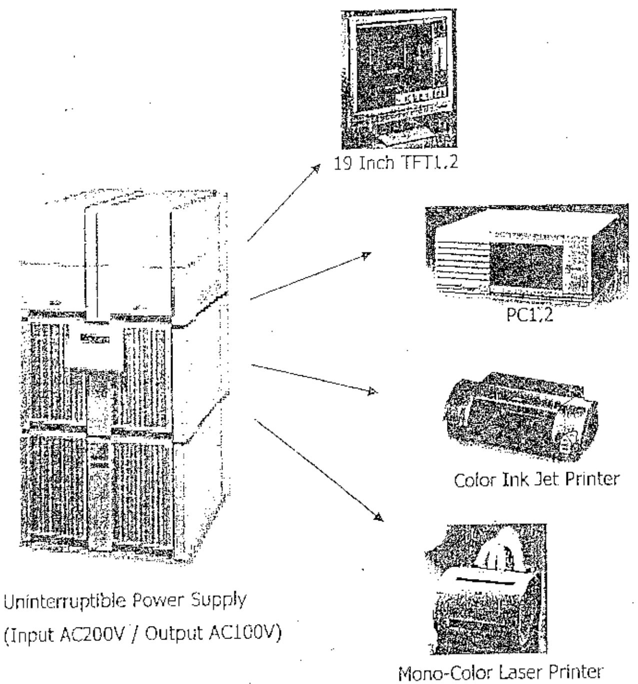
MCAS is usually employed by continuation operation, in order to perform the surveillance and automatic record of equipment.

When a system is suspended by maintenance etc., please supervise equipment by Supervisory Panel or Local Panel.

2.2. About the power supply

When the power supply stabilized by Uninterruptible Power Supply is supplied, MCAS (Monitoring, Control, and Automation System/Data Logger) has the power supply of a maximum of 4 hours [the time of notes:100% charge, and the case within battery exchange 3 year] backed up by Uninterruptible Power Supply by the unusual situations such as a power failure.

When a power failure lengthens, and please let the system stop. If a power supply is shut off during operation, record data files such as a list may be broke.

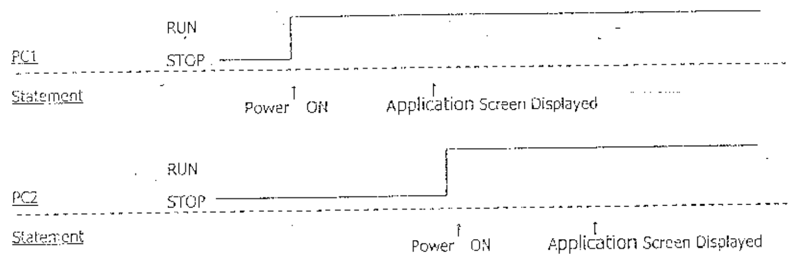


2.3. About starting up the system

If a PC is turned on, Windows XP starts up. After that the surveillance application is started automatically. The method of starting a system is only turning the power supply of the computer on. After about 3 minutes of turning on a power supply, A surveillance screen is displayed.

WARNING: PC1 combines the process data function (server) and the display function (client). PC2 is only a display function. After PC1 startups and a surveillance screen is displayed, Please startup PC2. After starting PC2, although it can start PC1, PC2 cannot take in data until PC1'startup be finished.

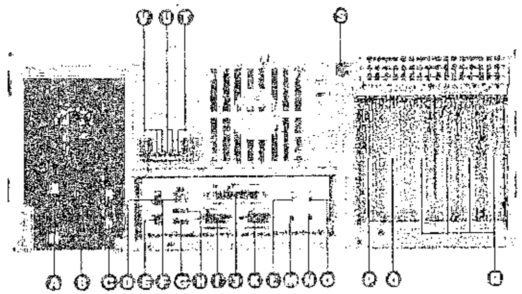
< The starting time sequence of a personal computer >



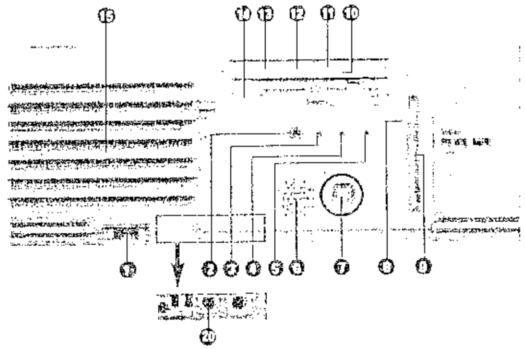
<The method of using power supply>

The power supply of a personal computer has a main power supply (B) in the back of a personal computer, and a sub power supply (7) is in the front of it. After turning on a main power supply (B) at the back at first, then, a sub power supply (7) is turned on in the front.

BACK PANEL



FRONT PANEL

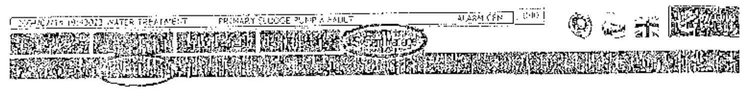


2.4. About stopping the system

How to stop the system and the application on the system for maintenance

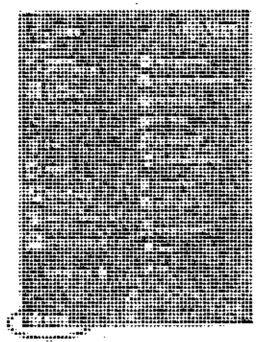
1) Only stop the surveillance application

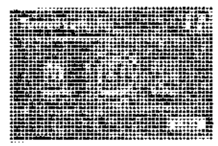
Please choose the `Exit' from the menu of `System Manage'. Only the surveillance application is stopped and the Windows XP is displayed.



2) Stop the computer

First, stop the surveillance application by the method in 1). Next, please choose ` end option' from `Start' menu of Windows XP. Window for checking an end is displayed, and if `Turn off' is chosen, the PC will be turned off after about 1 minute.





WARNING: Although the sub power supply (7) in the front of a main part is shut off, a main power supply (B) is not shut off at the back. When you shut off all the power supplies of a personal computer by the case, please don't not forget to a main power supply (B) on the back.

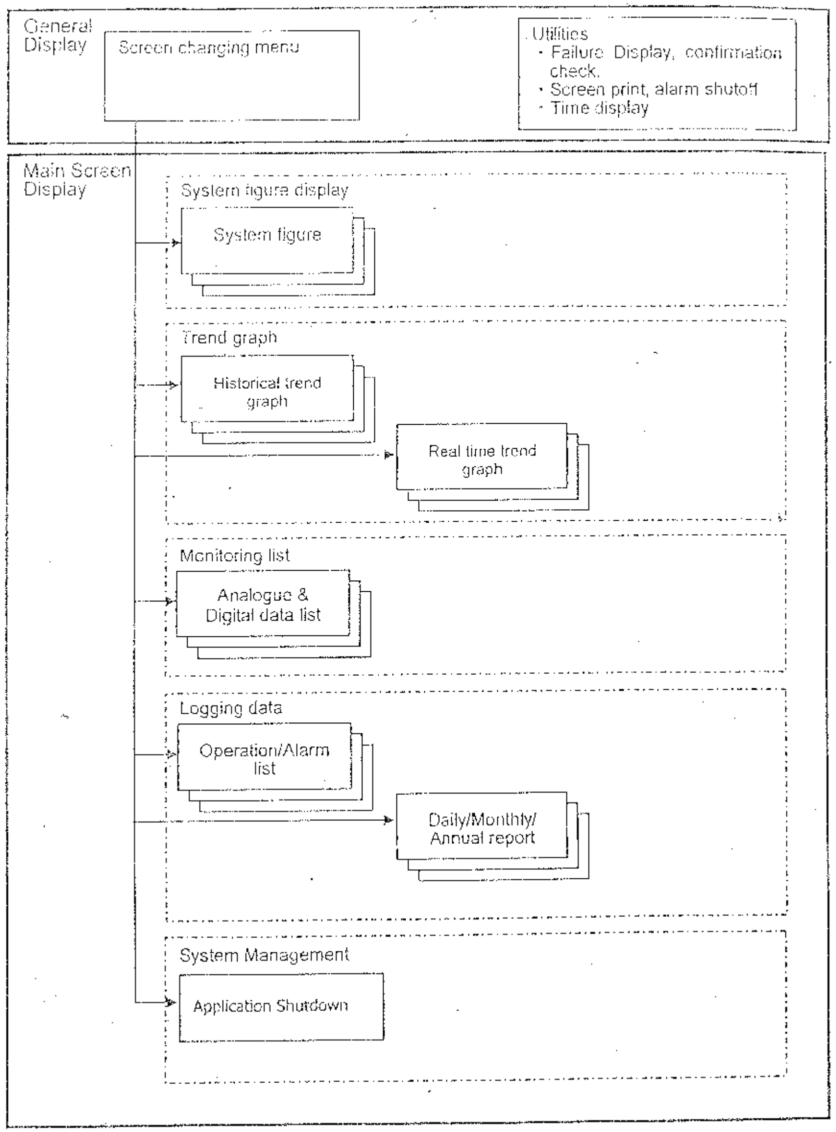
3) Restart the computer

Because window for checking an end be displayed on the last of operation of 2), then please choose `Restart'. In about 1 minute, the PC is turned off and it restarts automatically.

3. Screen Composition

3.1. Menu Composition

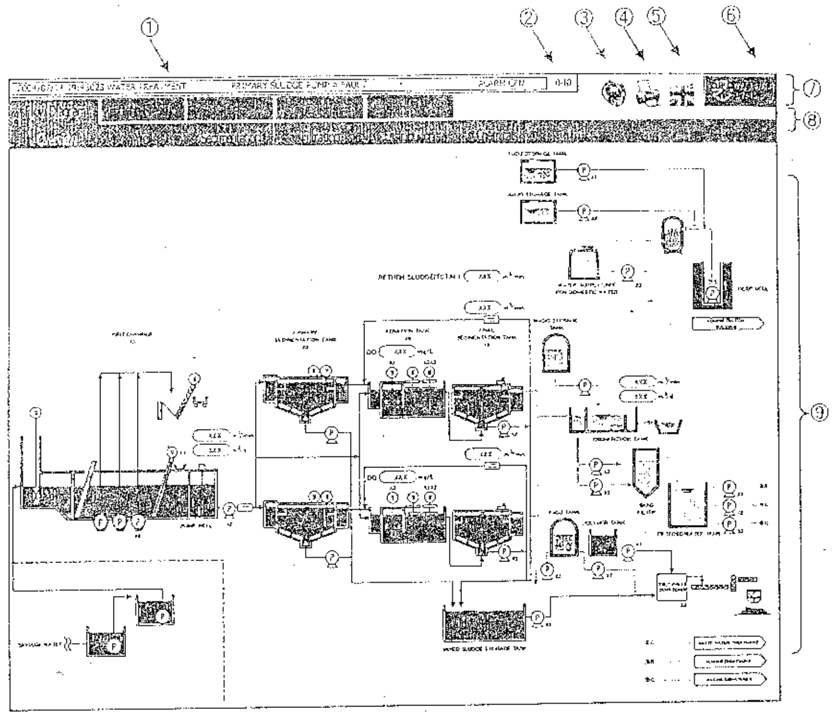
The following indicates the composition foundation of the operator console.



4. Main screen

The following explains the main frame displayed on the MCAS/Data Logger main screen.

<Screen Image: composition example of the main screen>



(1) Alarm/failure Display[①]

Alarm/failure currently generating will be displayed in message form. New alarm generating will trigger automatic updates.

(2) Number of Alarm Cases Displayed [②]

The number of alarm/failure cases currently generating will be displayed. As generating damages/alarm increase, so will the cases displayed. The reset button will make the displayed decrease.

(3) Alarm Shutoff Icon [③]

Shuts off alarm sound.

(4) Printer Icon [④]

Prints the current screen displayed on the CRT.

(5) Language change Icon [⑤]
It is the button which changes a character on display to English or the Vietnam language. When displaying in English, the Vietnam language or when displaying in the Vietnam language conversely, it changes to English.

(6) Date Display [⑥]
Displays the date and time of day. The display is analogue clock and digital clock.

(7) Screen Selection Button [⑦]
Selecting from the menu can change the screen display.

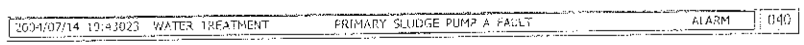
(8) Function Selection Button [⑧]
The function selection button is used when display setup is carried out in the selected screen as in ⑦.

(9) Main Screen [⑨]
The area that displays the selected screen from ⑧.

5. About alarm information and the check

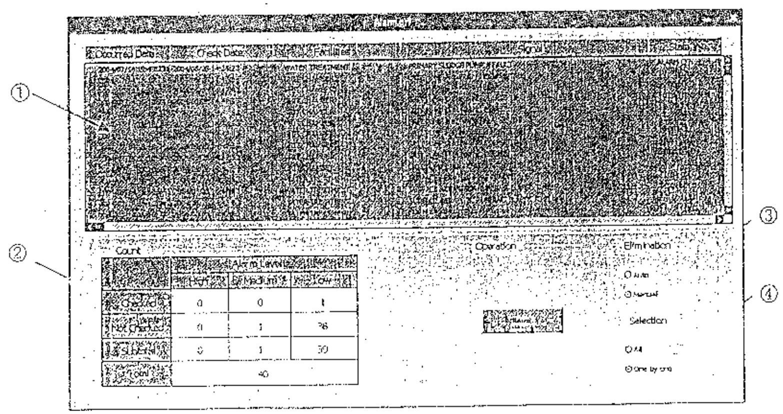
5.1. The information of the sound of the alarm
If failure occurs in equipment, alarm's sound will sound simultaneously from the speaker built in two sets of TFT Display, and the operator will be told.
In order to stop alarm's sound, please click the icon of the following figure of the screen upper part with a mouse. If the alarm's sound stop is operated at one of the two, both of the alarm's sound will be stopped.

5.2. Alarm/failure Display
No matter it is displaying which screen, the alarm is displayed on the common display area of the screen upper part, and the contents of Alarm/failure are informed immediately. Alarm/failure currently generating will be displayed in message form. New alarm generating will trigger automatic updates.
The number at the right end of alarm message is the failure number of cases under currently generating.



5.3. The check of Alarm/failure
If the above-mentioned alarm message is clicked with a mouse, the sub window of the following figure is displayed and the return by the failure and reset under generating can be checked.

The check screen of alarm is shown in the following figure.



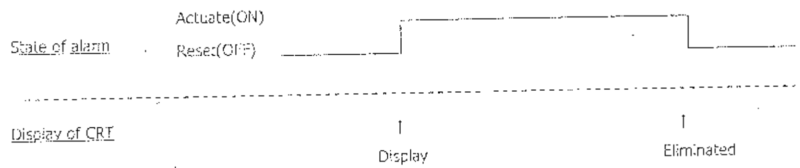
(1) The displayed item states the occurred date(YYY/MM/DD HH:MM:SS), checked date (YYY/MM/DD HH:MM:SS), facility name, signal name, and state.

(2) Failure has heavy failure and inside failure and light failure by the level. And there is checked failure and unchecked failure. The items are displayed with table's form by every number of cases.

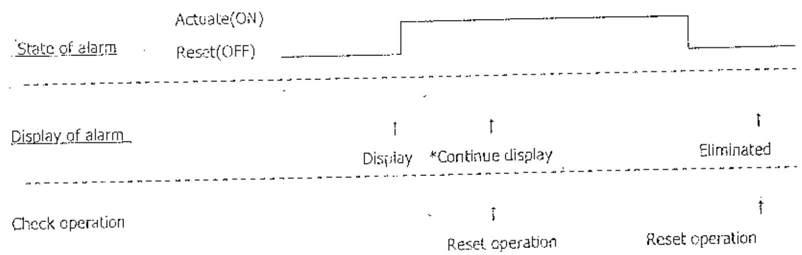
(3) Depending on the function selected switch, two types of restorations can occur. It is possible to cancel the message automatically or cancel by a confirmation check operation. Please choose `Manual' in the currently employment. And, please return to `Manual' by the work of a maintenance etc, and don't forget `Auto'.

About the timing by alarm is displayed or eliminated, in case of 'automatic', and 'manual operation' is expressed to the following figure.

In case of 'automatic' :



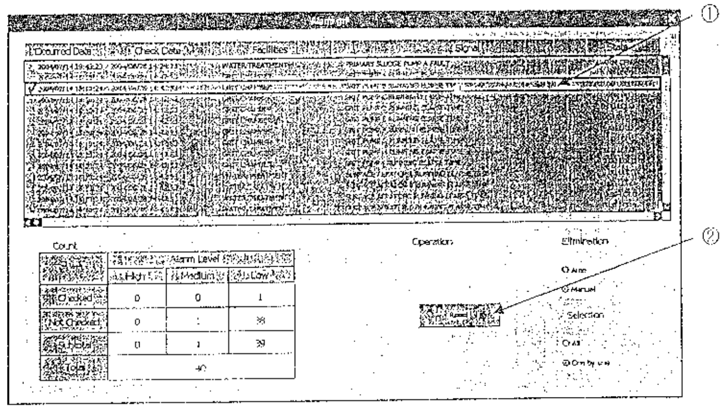
In case of 'manual' :



(4) It is the changeover switch of whether generated alarm is checked by all number-of-cases, or choosing a message at a time.

Now explain explains the check method of the failure about whether still be generating, or whether to have returned, In this case, it is a premise that `Manual' is chosen by ③.

1) The method of checking one at a time
The message that wants to check the return is double-clicked with a mouse. The selected failure is attached at the right of the message ✓ (Check mark). Next, the `Reset' button is pushed[②]. If it returned, the message disappears. If it doesn't return, a display will be remained.



2) The method of all check
`ALL' of Selection is changed. Next, `Reset' is pushed. All messages ✓ (check mark) is attached, and if it return, a message disappears, and if it has not returned, a display will be remained.

6. Surveillance of equipment System Figure

6.1. System Figure.

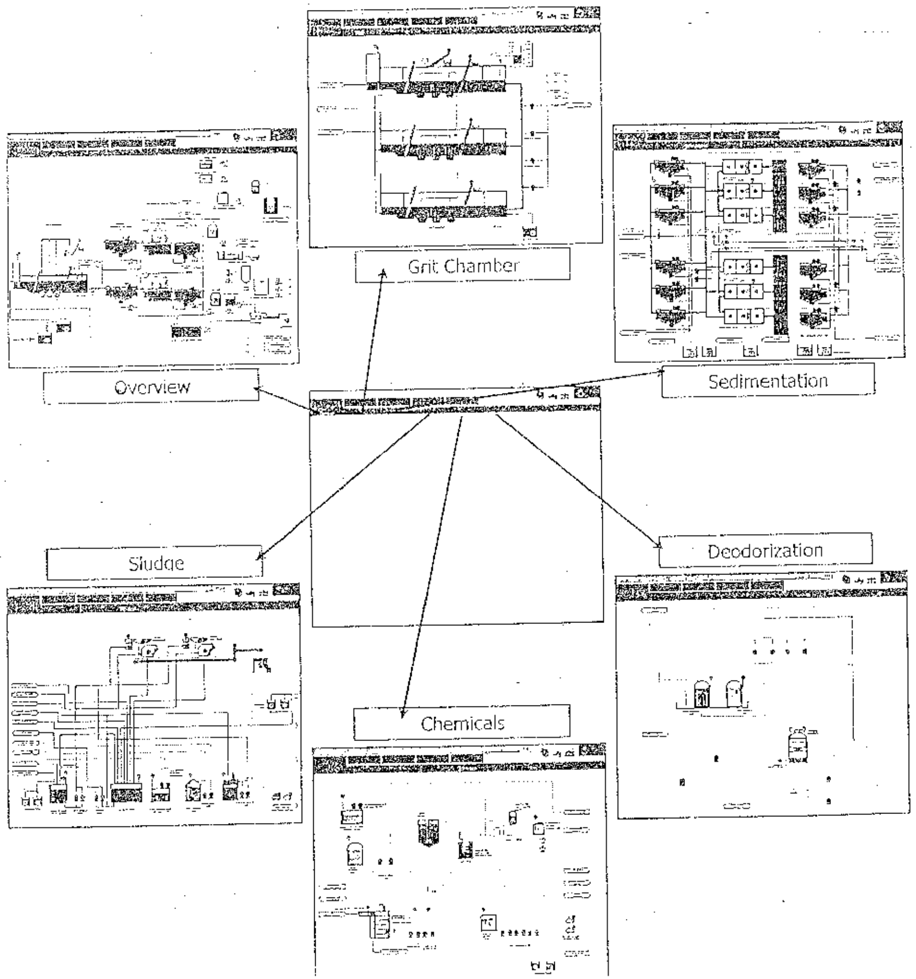
The system figure represents the facilities as a graphic screen. The operating condition is displayed as a symbol, and analogue measurement values are displayed digitally so that central surveillance of the plant is possible.

(1) The display method

System Figure has 6 screens. It can carry out from the following two kinds when displaying the screens.

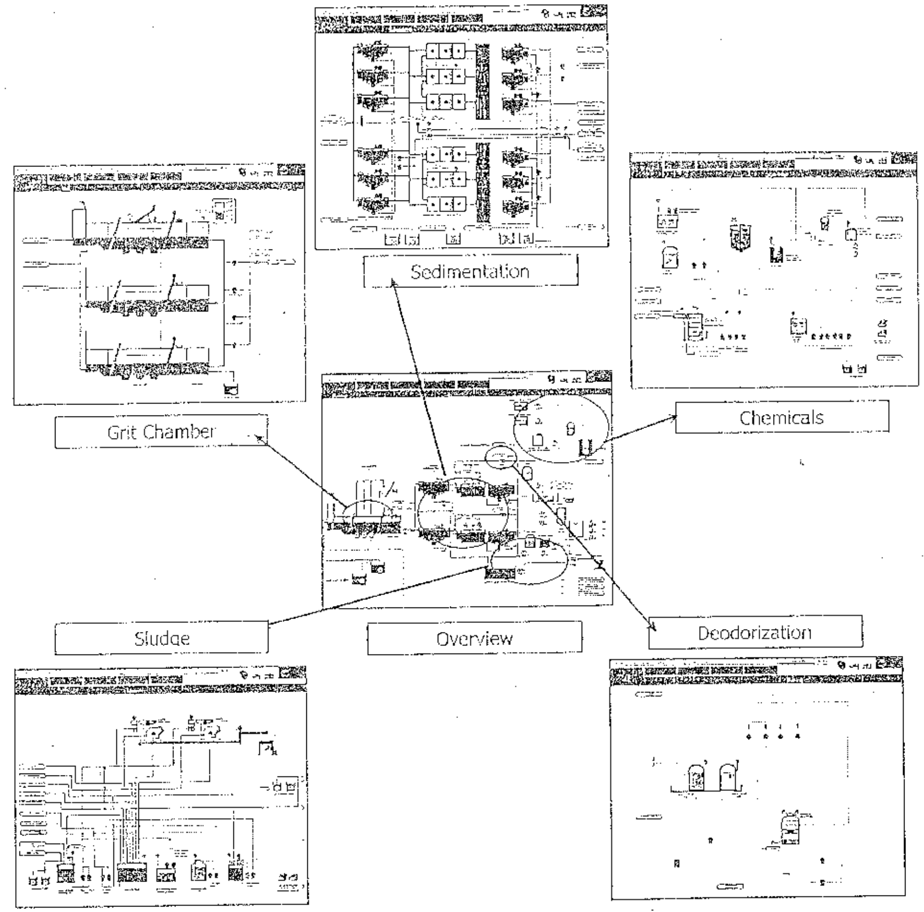
(2) The method of display from a menu

'Flow Diagram' is clicked with a mouse from a main menu. Next, an equipment name is clicked with a mouse from a sub menu.



(3) The method of display from the screen of Overview

The screen of Overview is displayed, and if with the mouse click the equipment to display, a screen will be displayed.



6.1.1. Standard Displaying Specifications

This explains the symbols displayed in the system figure and methods of displaying measurement data.

(1) Symbols (pumps, valves, etc)

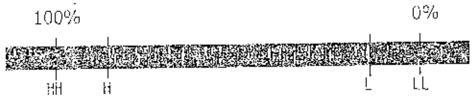
The following depends on the condition of the equipment (operation, shutdown, failure).

1) operation/open valve etc	display color:	green
2) shutdown	display color:	red
3) failure	display color:	blinking yellow

(2) Numerical Values (water flow, levels)

The digital value (numerical value) is displayed with the engineering unit conversion. The following is the color displayed depending on the condition.

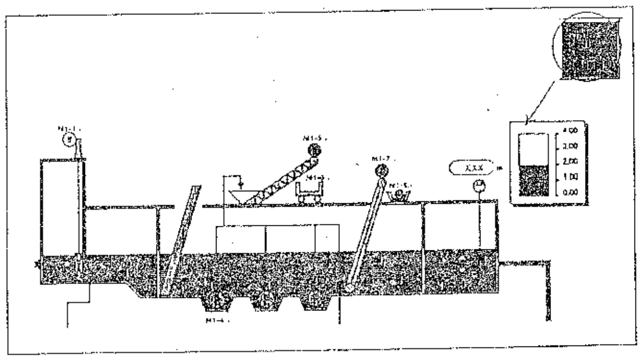
1) normal	display color:	green
2) deficient	display color:	red
	display format:	"*****"



6.1.2. Standard Displaying Specifications

Measurement data, such as water flow and levels, can be displayed by the image of meter and the display of a number.

Please click the icon of the meter shown in displaying at the upper right of Flow Diagram with a mouse, and when erased, please click again.



6.2. Real-time Trend Graph

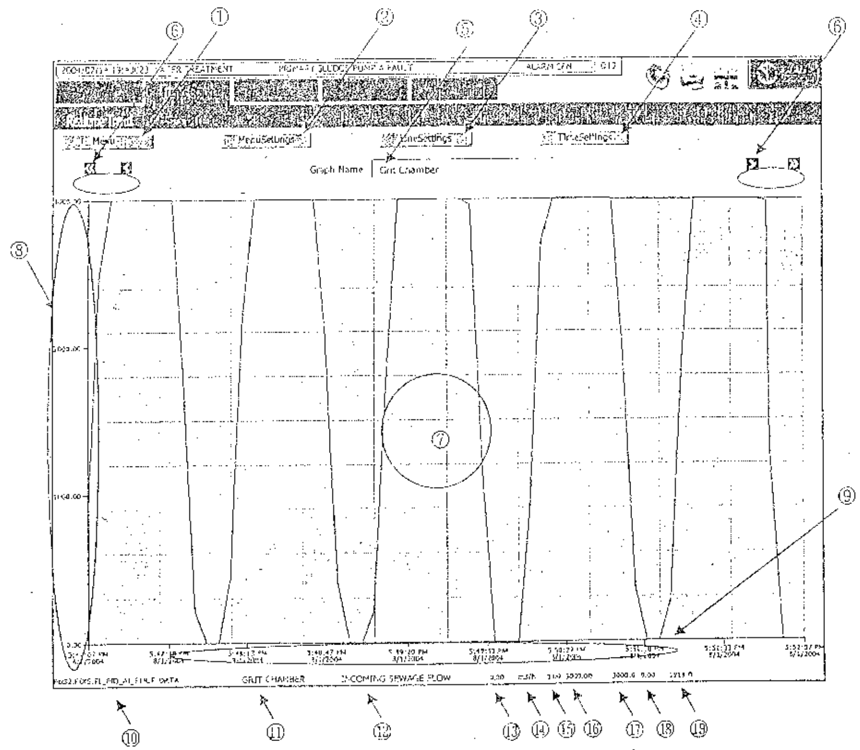
Analogue measurement data are displayed in graph form.

A real-time trend is a function for supervising flux and a water level by time change. It is the contents of a display and basic operation.

Now let's explain the contents of a display and basic operation.

6.2.1. Content of display and basic operation

The basic operation and the content of display are as followed.



(1) Screen selection button [①]

It is a button for choosing of the graph.

(2) The registration button of a screen name[②]

It is a button for registering and changing the name of a screen.

(3) Registration and change button of graph [③]
It is a button for registration and change of the graph.

(4) The setting button of displaying time [④]
It is a button for setting up time displaying on one screen. It can register to 30 screens.

(5) Screen name [⑤]
The name of the screen displayed now is displayed.

(6) Display of moving button [⑥]
By clicking the button with the mouse, the left button is to the past and the right button is to the future.

(7) Trend graph [⑦]
Analog data is displayed as trend graph. It can display to eight pieces. The display of trend graph is updated every 5 seconds.

(8) Memory[⑧]
The memory of trend graph is displayed. It can display to eight pieces. The color of the memory is identical with the color of corresponding trend graph.

(9) Time[⑨]
Time is displayed. Left-hand side is the time of the last, right-hand side is the time of the future.

(10) Tag code [⑩]
The tag code of an analog signal is displayed. The color of ⑩~⑲ is identical with the color of corresponding trend graph below.

(11) Equipment name [⑪]
The equipment name of an analog signal is displayed.

(12) Signal name [⑫]
The signal name of an analog signal is displayed.

(13) Data [⑬]
Trend graph is evaluated and displayed.

(14) Tag code [⑭]
The engineering unit (Unit) of the analog signal is displayed.

(15) Data[⑮]
0% of value of the analog signal is displayed.

(16) Data [⑯]
100% of value of the analog signal is displayed.

(17) Data[⑰]
The maximum of the trend graph currently displayed is displayed.

(18) Data[⑱]
The minimum of the trend graph currently displayed is displayed.

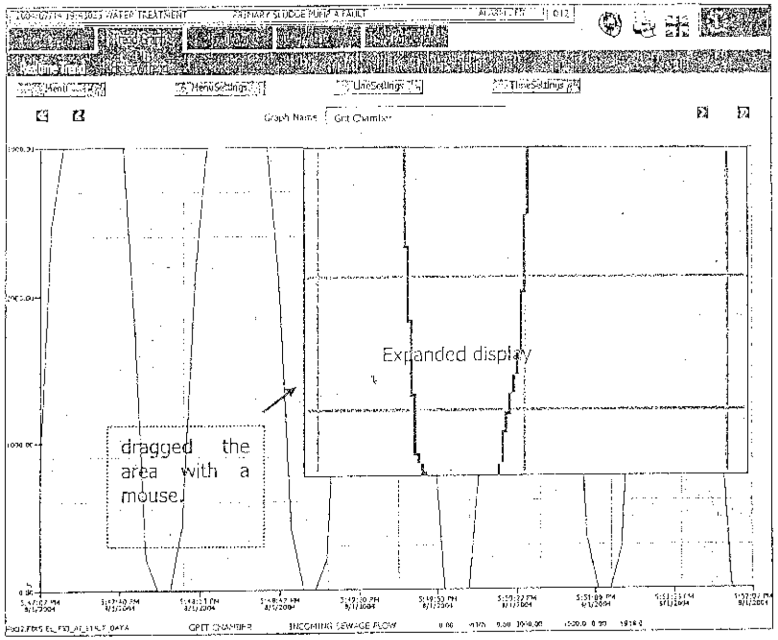
(19) Data[⑲]
The average value of the trend graph currently displayed is displayed.

6.2.2. Convenient function

About the trend graph, the graph can be expended, and the lines in the graph can be converted to numerical values.

(1) Expended display

If you click the area which you want to be expended, the area can be expended to display.



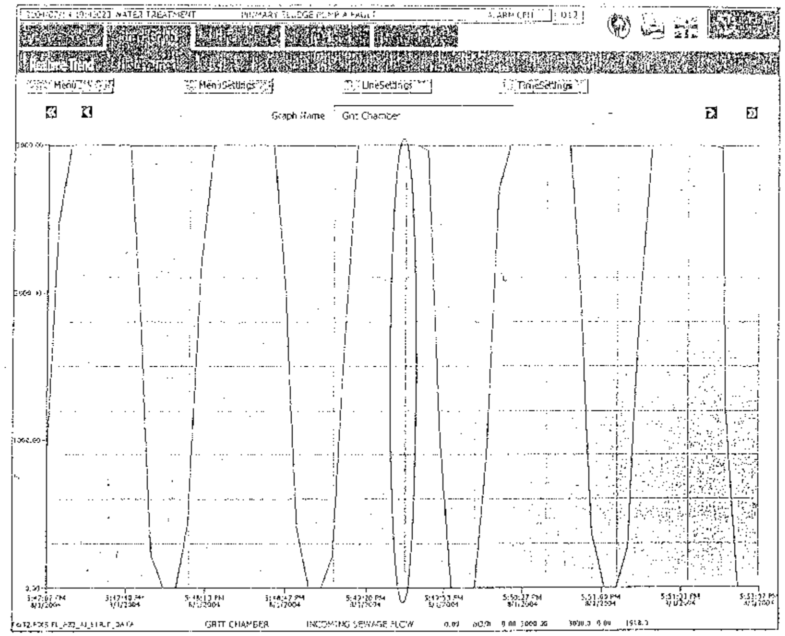
If you want to return to the original size, click the right button of the mouse.

It will return to the original display before expansion.

(2) graph digitalization

The value of trend graph can be evaluated and displayed. It is a convenient function when investigating what value the line of graph is concretely.

In order to have operated it, the vertical lines in the center of graph are dragging by the mouse(Operation of keeping a left button pushed with the mouse), moved to right and left. The values of the vertical lines in the center of graph and the line of graph intersect are displayed.

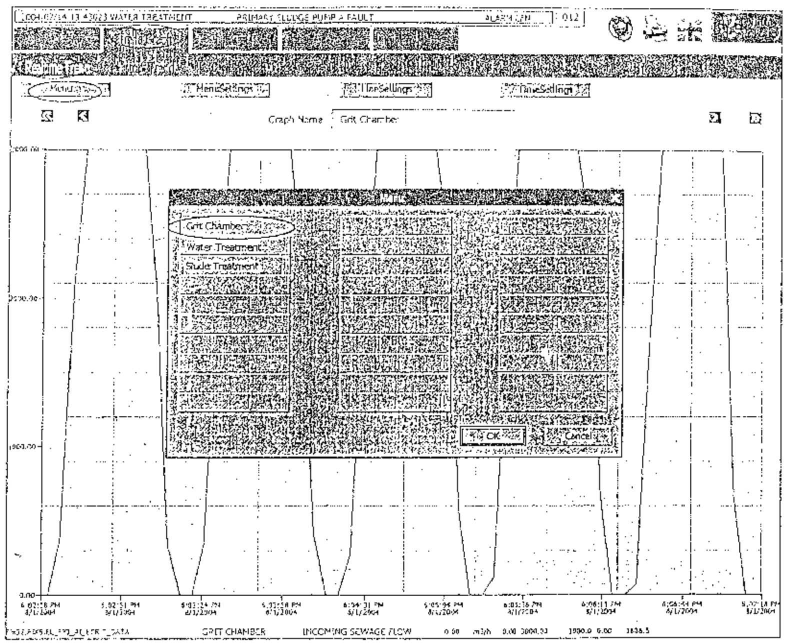


6.2.3. The operation method

If `Trend Graph' of the main menu is clicked and ` Real time Trend' of the sub menu is clicked next, it will change to the frame of graph.

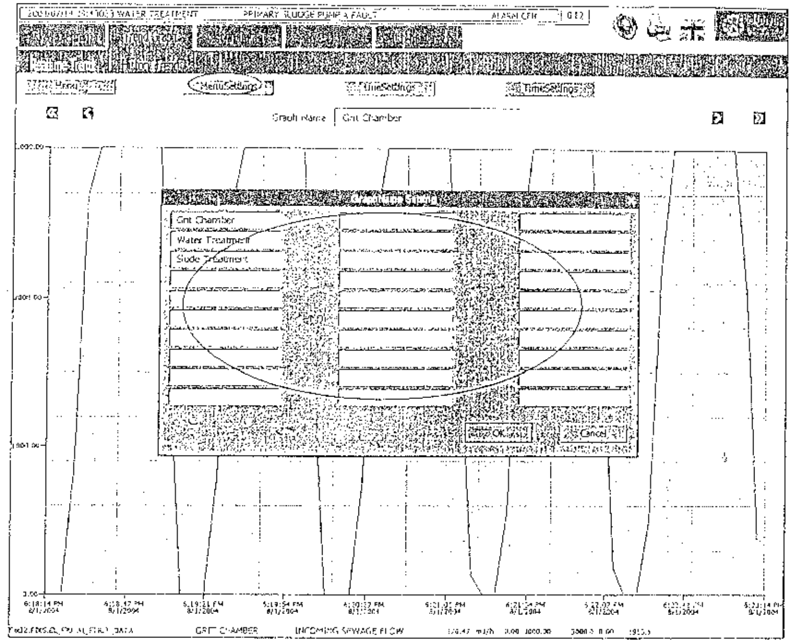
Next, since the sub window of the following figure will be displayed if a `Menu' menu is chosen, the graph displayed out of it is chosen.

The following figure indicates how the measured data are displayed.



6.2.4. the method of appending frames.

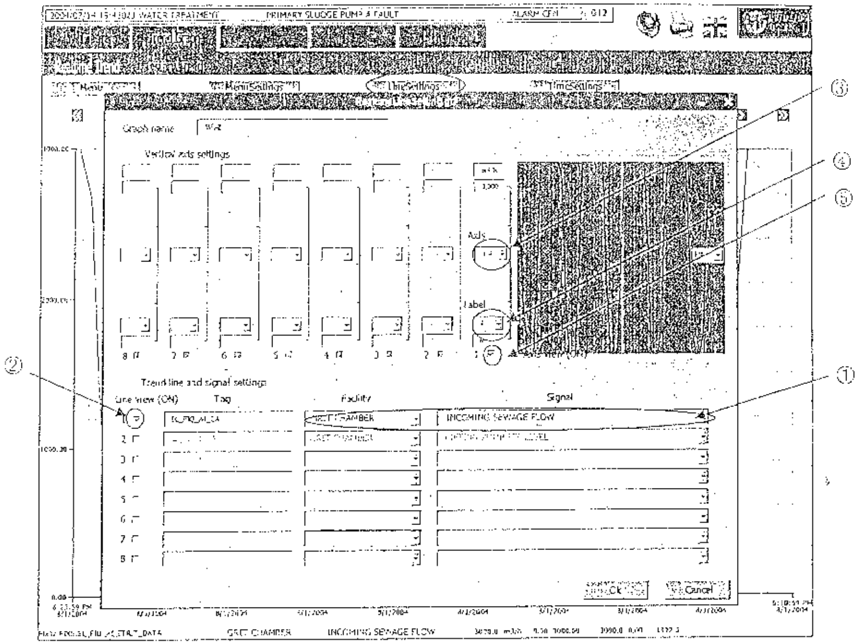
In order to log on a newly frame, please click `Menu Settings'. Since the sub window of the following figure is displayed, a graph frame can be logged on by inputting a graph name by the keyboard. It will be reflected also in other's display if it logs in one display.



6.2.5. The method of appending graph

The method of appending graph to a new frame or an already logged on frame is as followed.

Please click the `Graph Settings'. The sub window of the following figure is displayed.



(1) Selection of signal

Please choose the signal to append in the order of `Facility' `Signal' from the menu of ①. By clicking the check box of ②, the set-up signal can be made a display or un-displaying. It is a convenient function when only displayed signals to compare.

(2) Set up of memory

In order to make graph legible, the pointer of memory or numerical number can be set up for every graph.

③ define the number which divides the pointer.

④ set up the number of the numerical values to display.

It sets up whether ⑤ displays of memory or it does not carry out.

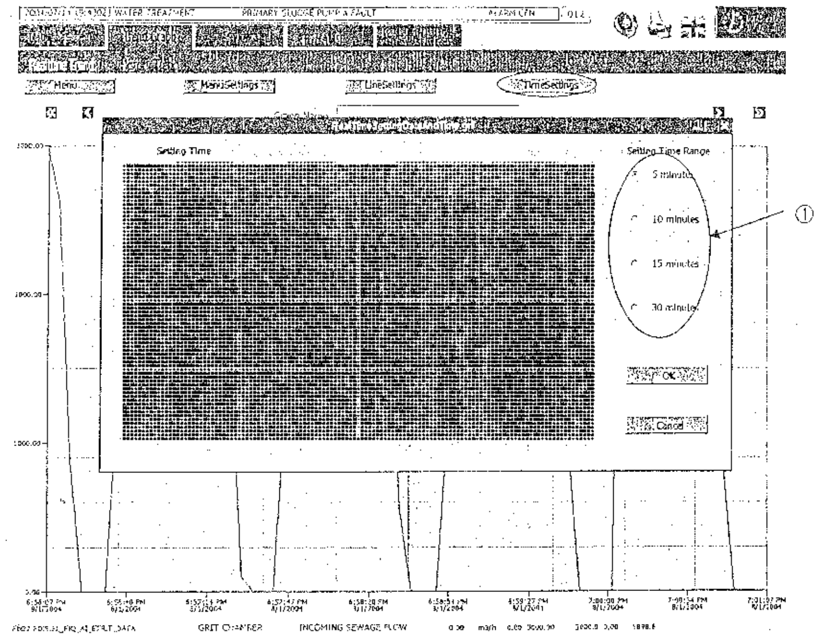
(3) Set up of time

It can set up whether it is the time scale of one frame.

Please click `Time Settings'. The sub window of the following figure is displayed.

There are 4 kinds of pattern which can be displayed in one frame, 5, 10, 15, and 30 of ①.

Since Real-time Trend uses many memories, record of long time cannot be performed. Although the data of a 30 minutes before can be seen in a cycle of 5 seconds, please see the Historical Trend when you want to see long-term data of a per several hours or several days.



7. Analysis and evaluation of employment

7.1. Practical Use of Data

In this system, record of failure or operation saves automatically. Moreover, data, such as flux, a water level, and the amount of electric power, is also saved automatically, and can be displayed as a list or trend graph. It can profit as a tool for acquiring the following information from such record data, when maintaining and managing equipment.

(1) Investigate the cause of failure

In order to maintain equipment safely, immediate disposal when failure occurs, and investigation of a cause serve as an important subject.

What thing occurred, in what state of operation record or trend graph, like these information can be serially acquired from record of failure.

(2) Evaluation of employment

It becomes an important subject for maintenance and management to employ equipment efficiently. From the record of operation or failure, and from a list or trend graph, it can be known how equipment is employed.

By analyzing and evaluating this information, the present problem can be discovered and the increase in efficiency of employment can be attained.

(3) Preventive maintenance

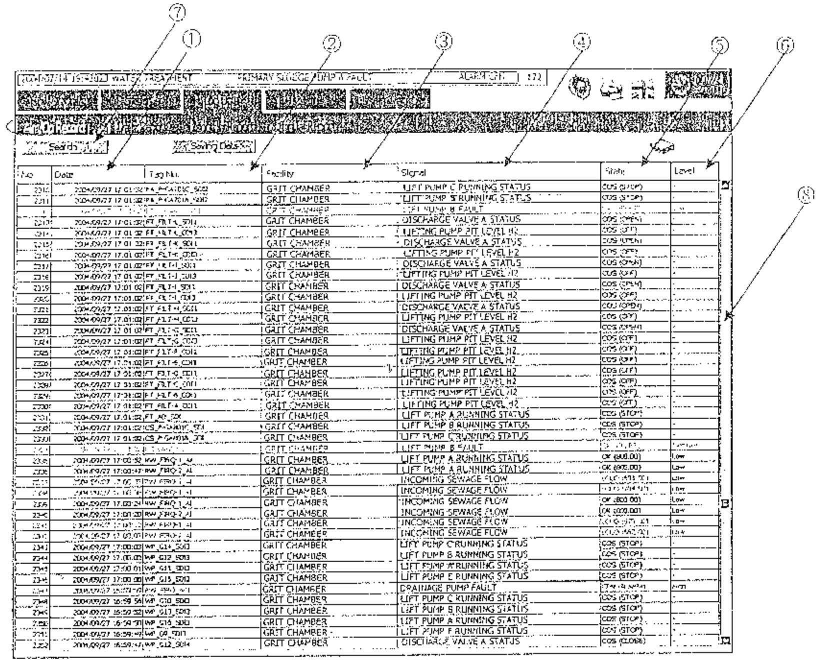
When a machine breaks down, it will become a serious damage on employment. If the prediction and maintenance can be performed before breaking down, equipment can be safely employed over the future. As information for that, data from a list, a trend graph, the record of operation or failure, is utilizable.

7.2. Operation/Alarm Records

Generating/return of failure, operation/stop of apparatus etc. can be saved and displayed automatically.

7.2.1. Operation method

'Log Data' is clicked out of a main menu. Next, 'Arm/Ope Record' is clicked out of a sub menu. The contents and basic operation to display are explained.



(1) Date[①]

Generating/return of failure, operation / stopped Date, and Time are displayed. The color attached by ①~⑥ has the next meaning.

- Black : Unchanging operation, shutdown state.
- Red : Failure/Alarm actuated
- Green : Failure/Alarm restored.

(2) Tag. No.[②]

Tag Code of signals are displayed.

(3) Facility[③]

The name of equipment is displayed.

(4) Signal[④]

The name of signal is displayed.

(5) State I[⑤]

The name of state is displayed.

(6) State I[⑥]

The alarm level is displayed.

(7) Search I[⑦]

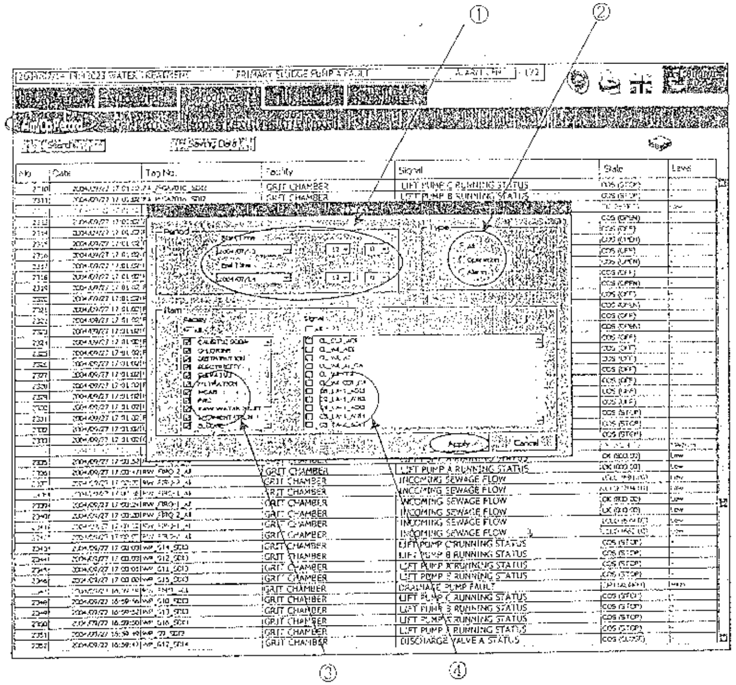
It is the button for referring by date or facility.

(8) Scroll button I[⑧]

It is a button for displaying the message to up or down.

7.2.2. Search

The button of 'Search on' can be pushed and it can refer by the date or equipment.



(1) Search Date[①]

Set the beginning and the end of the date to search .

(2) Select Signal Type[②]

Select 'Operation' to only search operation record such as starting, stopping.

Select 'Alarm' to only search the record of troubles and alarms.

Select 'All' to search all the record.

(3) Select Facility[③]

Select the facility to search. Select the facility by setting a checking mark(✓) at the checkbox of the name of the facility. More than one facility can be selected at one time.

Select 'All' to select all the facility.

After selecting equipment, please select signal too. If only select facility, nothing will be displayed.

(4) Select Signal[④]

Select the signal to search. Select the signal by setting a checking mark(✓) at the checkbox of the name of the signal. More than one signal can be selected at one time. Select 'All' to select all the signals. If click the 'OK', the record agree with the search condition (1)~(4) will be displayed.

7.3. Operation/Alarm Records

Automatically records the measurement data of the point of status while displaying in spread sheet format and printing.

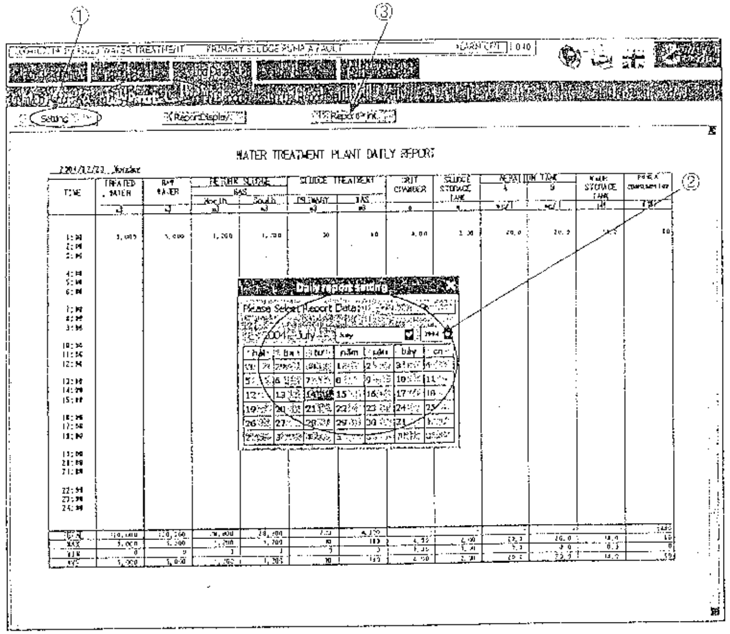
There are 3 kinds of forms, Daily report, Monthly report and Annual report.

7.3.1. Operation

The operation of the 3 kinds of forms is same. Here, daily report will be discussed as an example.

Click the "Log Data' in the main menu. Next, click the "Daily report' in the sub menu.

The content to be displayed and the basic operation are as followed.



(1) Display Date[①]
Click `Setting', sub window ② will be displayed.

(2) Set Date[②]
Select the date to search.

(3) Print[③]
Click `Report Print' to print the forms displayed.

7.4. Historical Trend Graph

Analogue measurement data are displayed in graph form.

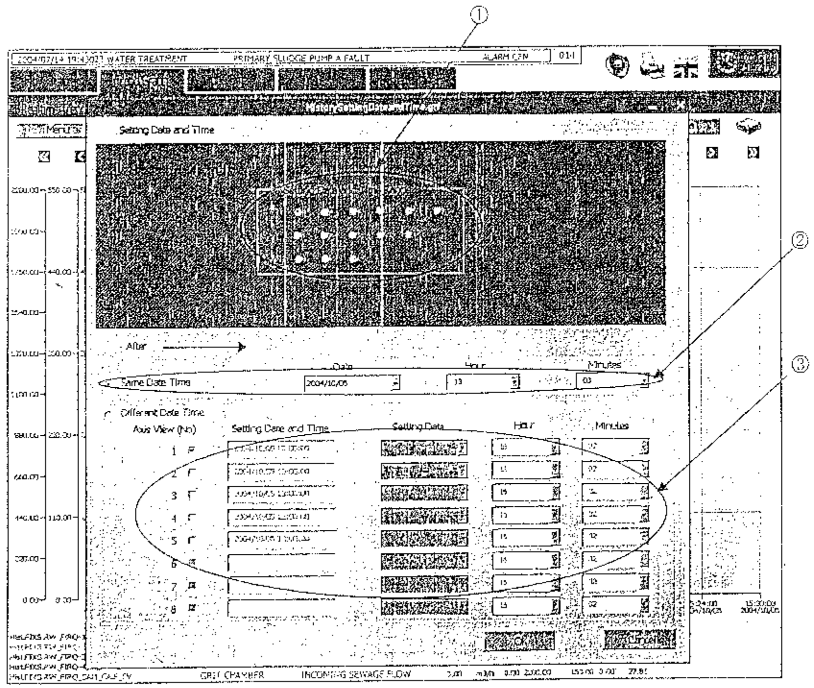
Historical Trend Graph the conventional display to save the flow and water level of long term(200 days) and analyze the trend by day, week, and month unit.

7.4.1. The content of display and basic operation

The basic operation is same as Real-time Trend Graph. Here, only the different function is discussed. About the basic operation, please refer to 'Real-time Trend'.

Click `Trend Graph' in the main menu. Next, click `History Trend' in the sub menu.

(1) Set Date[①]
The time-scale in the display1 can be set.
Please click `Time Settings'. The sub window as followed will be displayed:
The display patterns in the display 1 are 1,2,3,4,6,12 hour 1,2,3,7,14 day, 1,2, 3 month.



(2) Set the start date to be displayed [②]

To display more than one graph at the same time, select the date to be displayed here.

(3) Set the start date to be displayed [③]

To display the graphs at different time, select the date of every graph here.

For example, to compare the Distribution flow of today with that of 1 week ago and 2 weeks ago, use this item.

8. Check and maintenance of signal

8.1. Application of data

This system is mainly to monitor equipment by display the window in which all situations can be watched such as the flow diagram. In 'I/O List(Input/Output signal List)' window, the connection point signals such as running, troubles, and analog signals such as water level, flow can be checked.

Though the flow diagram is not used frequently; it can be used to keep the spot situation which is not monitored under real-time control.

It can be used to check and maintenance sensors and electrical circuit.

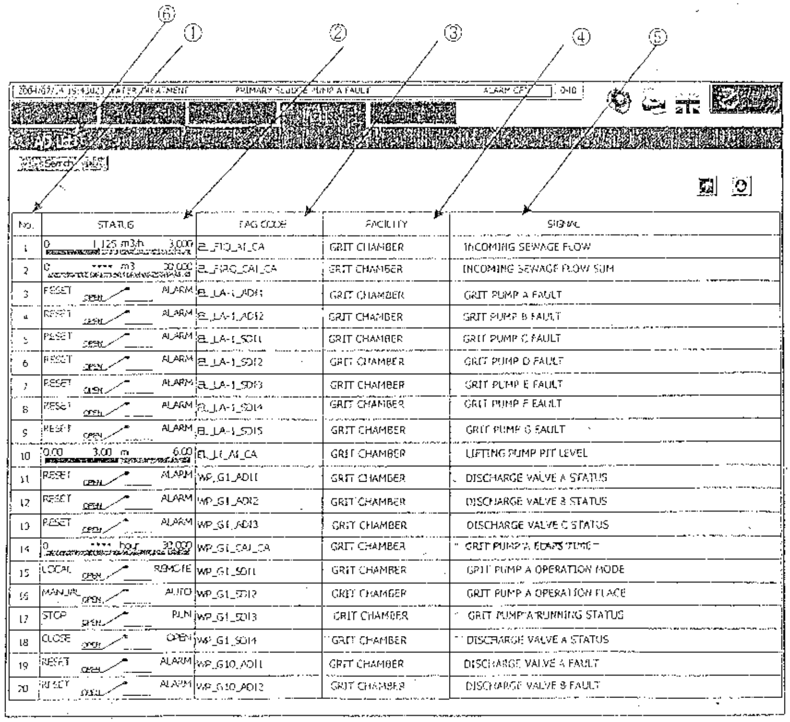
8.2. List Displaying

The point of status of operation/stopping, failure /alarm etc and analogue measurement data are displayed spread sheet format.

8.2.1. Operation

Click 'I/O List' in the main menu. Next, click 'A/D List' (Analogue and Digital List) in the sub menu.

The content to be displayed and the basic operation are as followed.



(1) Line number[①]
Display the number of line. In window 1, 20 items of signals can be displayed.

(2) Status[②]
When classifying the display pattern of the types of measurement data, the following 3 types are possible.

1) Point of status data : on/off data

2) Analogue data (instantaneous): instantaneous data of water flow, levels, etc.

3) Digital data (integrated) : flow, operation time, integrated data

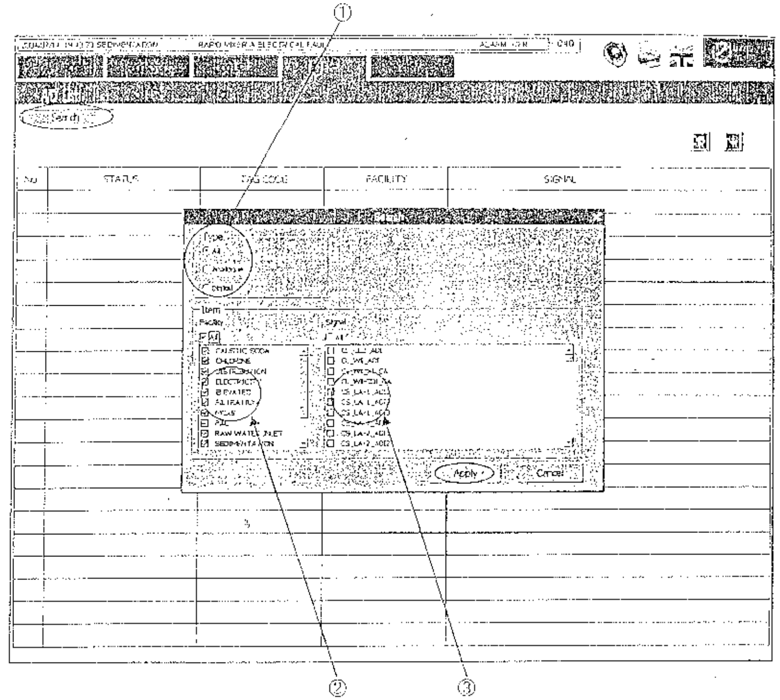
(3) Tag code[③]
Display the Tag Code of signals.

(4) Facility[④]
Display the name of facilities.

(5) Signal[⑤]
Display the name of signal.

(6) Search [⑥]
It is the button for referring by signal type or facility.

8.2.2. Search
Search by data type or facility and so on by pressing the 'Search' button.



(1) Select Signal Type[①]
To search analog signal such as water level, flow and so on, select 'analogue'.
To search digital signal such as trouble, running and so on, select 'Alarm'.
To display all the record, select 'All'.

(2) Select Facility[②]
Select the facility to search. Select the facility by setting a checking mark(✓) at the checkbox of the name of the facility. More than one facility can be selected at one time. Select 'All' to select all the facility.
After selecting equipment, please select signal too. If only select facility, nothing will be displayed.

(3) Select Signal[③]
Select the signal to search. Select the signal by setting a checking mark(✓) at the checkbox of the name of the signal. More than one signal can be selected at one time. Select 'All' to select all the signals. If click the 'OK', the record agree with the search condition (1)~(4) will be displayed.

9. Hardware Specification

9.1. Monitoring and Data Logging Room

(1) Surveillance Operation Desk X 2 Set
- Maker : itoki
- Model : CS-A148KEL-ZBW7
- Size : Outline Measurements:width1400(mm)Xdepth700(mm)X hight760(mm)
- Quality of Material : steel

- Accessories : Chair(OA Chair)
- Maker : Sanwa Supply
- Model : SNC-NET3BK

(2) CPU Rack X 2 Set
- Maker : ELECOM
- Model : HLD-W078
- Size : Outline Measurements width650(mm)Xdepth850(mm)X hight700(mm)
- Quality of Material : Steel

(3) Operation Processing Equipment X 2 Set
- Maker : NEC
- Model : FC-24V/SBZZ (Factory Personal Computer)
- CPU : P4 2.4 2GHz
- RAM : 1Gbyte
- HDD : 40Gbyte

- CD/RW : 24 X read speed / 8 X write speed
- Maker : Plexter Japan
- Model : PX-708A

- Wireless Keyboard and Mouse : 101key keyboard
- Maker : Logitec
- Model : diNovo Media Desktop

(4) Liquid Crystal Display X 2 Set
- Maker : EIZO(NANAO)
- Model : FlexScan L767-F
- Size : TFT 19 inches
- Resolution : Horizontal 1280 dot × Vertical 1024 dot
- Arm : LA-121-DD-GY

(5) Ink-jet printer X 1 Set
- Maker : CANON
- Model : PIXUS 9900i (color)
- Resolution : 2400 dpi
- Paper size : A3

(6) Laser printer X 1 Set
- Maker : CANON
- Model : LBP3200 (Monochrome)
- Resolution : 2400 dpi
- Paper size : A4

(7) HUB X 2 Set
- Maker : Allied Telesis
- Model : FS708XL
- Interface : 10Mbps/100Mbps X 8

(8) Cable X 1 Set
- LAN cable : 100BASE-T (3)
- Printer cable : USB (2)

(9) Surveillance Software X 2 Set

(10) Spare Parts
- CD/RW : 50 (650 Mbyte)
- A3 size paper : 3000 page
- A4 size paper : 3000 page
- Printer ink : 6 cartridge
- Printer Toner : 6 cartridge

9.2. Input Output Control Device (PLC: Programmable Logic Controller)

(1) Input Output Control Device (PL) X 1 Set

· Maker	:	Mitsubishi	
· Model	:	Q02CPU	X1
· Power unit	:	Q61P-A1	X1
· CPU unit	:	Q01CPU	X1
· Communication unit	:	QJ71BR11	X1
· Ethernet unit	:	QJ71E71-100	X1
· Digital input unit	:	QX40	X1
· Digital output	:	QY40P	X1
· Base unit	:	Q38B (8 slot)	X1

(2) PLC Software X 1 Set

9.3. Uninterruptible Power Supply

(1) Input Output Control Device (PL) X 1 Set

- · Maker : APC JAPAN
- · Max configurable power : 5,000VA
- · Model : Matrix-5000
- · Input output Voltage: Input 200V / Output 100V
- · Input output frequency : Input 50Hz / Output 50Hz
- · Isolation, Electronics Unit (X 1 Set)
  - size :width351(mm)×length/depth452(mm)×height452(mm)
- · Battery Unit (X 17 Set)
  - size :width175(mm)×length/depth452(mm)×height231(mm)
  - type :Spill proof, maintenance-free sealed lead-acid

(2) Power Management Software X 1 Set

10. Maintenance

10.1. Fixed exchange Parts

In seven years from the system introduction, we can maintain the product. Notes about maintenance are indicated to the following.

(1) No matter the maintenance contract is existed, the product is broken down by the following factor, the maintenance is paid service.

1) The causes of false operation method or use.

2) The causes of failure are factors other than this product

3) The causes are generated by reconstruction or repaired by the customer.

(2) About the failure after a product warranties period, when the maintenance contract is made according to the contents, if it has not connected, the maintenance is paid service.

(3) About this product, we recommend you to exchange the following parts periodically, when guaranteeing normal operation.

No.	Part name	Life	Method
1	Drive unit	Recommendation correspondence years : 2 years Life:5 years, Or it is the shorter one among total 20000H of switching on power.	Exchange
2	Floppy disk drive	Recommendation correspondence years : 2 years Life:5 years, Or it is the shorter one among total 15000H of switching on power.	Exchange
3	MO drive unit	Recommendation correspondence years : 2 years Life:5 years, Or it is the shorter one among total 15000H of switching on power.	Exchange
4	Drive unit with a built-in CD-ROM	Recommendation correspondence years : 2 years Life:5 years, Or it is the shorter one among total 15000H of switching on power.	Exchange
5	Front fan	Recommendation correspondence years : 3 years Life: Total 30000H of switching on power.	Exchange
6	Power supply unit fan	Recommendation correspondence years : 3 years Life: Total 30000H of switching on power.	Exchange the whole power supply unit.
7	Lithium battery	Recommendation correspondence years: 2 years or exhausting life Life : the shorter one of 2 years or the inside of backup time 5000H.	Exchange
8	UPS battery	Recommendation correspondence years: 3 years	Exchange

Appendix 3 Proposed Business Plan of Joint Company for IOMS

Oriental Consultants
ORIX Corporation
Nihon HELS Industry
PADECO
YOKOHAMA Water

Proposed Business Plan of Joint Company for IOMS

August 25, 2011

1. Objectives & Missions of the Joint Company

1.1 Objectives

- ✓ To implement IOMS in Hanoi
- ✓ To develop the standard IOMS model in Vietnam
- ✓ To promote the standard IOMS model throughout Vietnam with HSDC

1.2 Mission

- ✓ To provide users the sanitary environment
- ✓ To provide an efficient O&M of WWTPs
- ✓ To upgrade the skills of WWTP operators

2. Company

2.1 Company Ownership

- ✓ Hanoi People's Committee (HPC): Japanese Consortium (*1) = 50: 50
  *1 Japanese Consortium will consist of ORIX Corp, Nihon Hels Industry, and others.

2.2 Preparatory Cost before commencement of O&M work

- ✓ Our preparatory costs will be approximately 11,000 million VND which will be arranged by the contributed equity of each shareholder. The components of preparatory cost are listed below:

Preparatory Costs			
Preparatory Expenses	USD	VND	Remark
Legal	12,000	251,328,000	1,000USD*12 months
Phone/utilities deposits	500	10,472,000	
Licenses/tax deposit	5,000	104,720,000	
Brochures/sales literature	500	10,472,000	
Employee salaries (12 months)	225,837	4,729,920,000	Headquarters labor
Office Rental (12 months)	12,000	251,328,000	1,000USD*12 months
Car Rental (12 months)	6,000	125,664,000	500USD*12 months
Furniture and supplies	5,000	104,720,000	
Website development	1,500	31,416,000	
Miscellaneous	20,000	418,880,000	
Total Preparatory Expenses	288,337	6,038,920,000	
Preparatory Assets			
Cash Required	200,000	4,188,800,000	
Personal Computers	10,000	209,440,000	
Start-up Inventory	10,000	209,440,000	
Provisional Sum for Contingency	31,474	659,191,729	
Total Preparatory Assets	251,474	5,266,871,729	
Total Preparatory Costs	539,811	11,305,791,729	

2.3 Company Locations and Facilities

- ✓ Headquarters: One room in HSDC (Rental base)
- ✓ Branches: Each STP's site office (Provided by HPC)

3. Management

3.1 Management Board Member

A. President

- Qualification: Vietnamese, who shall be appointed by HPC subject to acceptance of the Japanese Consortium having enough experiences in the management of similar works.

- Task: He/she to have the right of representation of the company who shall be responsible for the entire aspects of the company including internal and external matters. He will have the lead role in making decisions that concern the well being of the Joint Company.

B. Vice president

- Qualification: Japanese shall be appointed by the Japanese consortium subject to acceptance of HPC having enough management experiences in similar works.
- Task: He/she shall be responsible for the financial aspects of the company including accounts payable, accounts receivables, and bookkeeping.

3.2 O&M Staff

C. Senior Advisor

- Qualification: Japanese to have enough experience of the IOMS of wastewater treatment plants, JICA's technical assistance might be utilized in this position.
- Task: He/she shall be knowledgeable of, and communicating the entire the O&M works in which he/she advises;
  - Monitoring O&M staff's progress.
  - Providing guidance for developing and achieving meaningful educational, professional, and personal goals for O&M staff.
  - Proactively involving O&M staff in their career planning process, self-reflection.

D. Director

- Qualification: Vietnamese who has a bachelor decree or higher of engineering and has enough experiences in the O&M works of wastewater treatment plants.
- Task: He/she shall represent the site office being responsible for entire aspects in the O&M works and administration of the wastewater treatment plant.

E. Vice Director

- Qualification: Vietnamese who has a bachelor decree or higher of engineering and has enough experiences in the similar works.
- Task: He/she shall be responsible for the technical aspects in the operation

and maintenance of each plant.

F. Engineer

- Qualification: Vietnamese to have a bachelor degree or higher in engineering or science or equivalent.
- Task: He/she shall be a superintendent of a part of O&M work.

G. Worker

- Qualification: Vietnamese to have a junior high school degree or higher.
- Task: He/she shall carry out a part of O&M work under the engineer.

3.3 General Staff

H. Secretary

- Qualification: Vietnamese to have a bachelor degree or higher having experiences of the similar job.
- Task: Bilingual secretary to support the management board member.

I. Procurement

- Qualification: Qualification: Vietnamese to have a bachelor degree or higher having experiences of the similar job.
- Task: Control the procurement and stock of consumables and spare parts.

J. Accountant

- Qualification: Vietnamese to have a high school degree or higher to have enough experiences of the accounting job.
- Task: Accounting and financial affairs.

K. General Staff

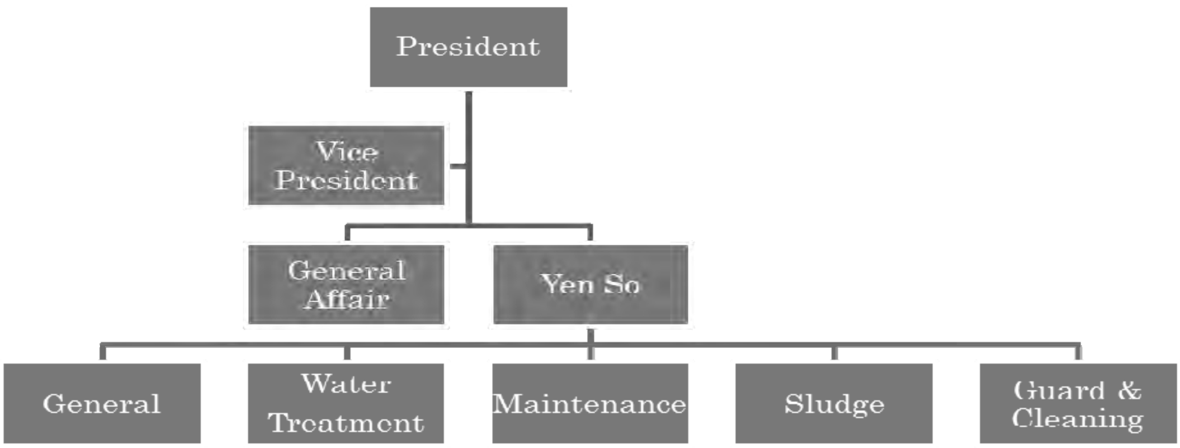
- Qualification: Vietnamese to have a junior high school degree or higher.
- Task: General affairs

3.4 Recruit Plan

- Total number of Staff is 84 including 3 management board members, 1 senior adviser.
- Resources will be recruited from DOC, HSDC, member companies of the Japanese Consortium.

Labor Type	Numbers (Persons)	Grade	Labor unit cost		Subtotal (year)	
			VND(month)	VND(year)	VND	US$
Unit price	-	-	2,000,000	24,000,000	-	-
Headquaters Labor Cost (A)						
President	1	10	20,000,000	240,000,000	240,000,000	11,459
Vice president	1	8	16,000,000	192,000,000	192,000,000	9,167
Secretary	1	5	10,000,000	120,000,000	120,000,000	5,730
Accountant	1	5	10,000,000	120,000,000	120,000,000	5,730
Procurement	1	4	8,000,000	96,000,000	96,000,000	4,584
General Staff	2	4	8,000,000	96,000,000	192,000,000	9,167
Senior Advisor	1	-	314,160,000	3,769,920,000	3,769,920,000	180,000
Sub-Total	8	-	-	-	4,729,920,000	225,837
Direct Labor Cost (B)						
Director	1	7	14,000,000	168,000,000	168,000,000	8,021
Vice Director	2	6	12,000,000	144,000,000	288,000,000	13,751
Manager	5	5	10,000,000	120,000,000	600,000,000	28,648
Engineer & Worker	70	4	8,000,000	96,000,000	6,720,000,000	320,856
Sub-Total	78	-	-	-	7,776,000,000	371,276
Total (A+B)	86	-	-	-	12,505,920,000	597,112

Framework of Joint Company



4. Financial Plan

4.1 Contributed Equity

- The contributed equity will consist of the preparatoty costs and operating fund to cover the preparatory period and half-year operating fund of Yen So WWTP. The preparatory costs are the costs of 12-month preparation time perior to commencement of O&M service in Yen So WWTP. Operating fund is to cover 6-month direct cost and overhead of O&M service in Yen So WWTP. The amount of contributed equity will be 83,000 million VND.

Total Amount of Contributed Equity for the Joint Company			
	USD	**VND**	**Remark**
Preparatory Costs	539,811	11,305,791,729	
Operating fund (6-month JC Cost of Yen So)	3,423,138	71,694,208,271	Direct Cost + Overhead
Total Equity	**3,962,949**	**83,000,000,000**	**JPY 328,924,752**

- Total contributed equity will be paid by HPC and Japanese Consortium in proportion to the equity contribution.

4.2 Projected Profit and Loss

- The table shown below summarizes the anticipated profit and loss for the first ten years. Year 2013 is the preparatory period. The commencement of O&M service in Yen So WWTP (Year 1) is in 2014.
- The sales of the company is the amount equal to the total costs required for O&M service in Yen So WWTP estimated by the JICA study team. Tariff revenue is not linked with the sales because the sewerage tariff will be short for the O&M service in the first ten years. It is anticipated the Government subsidy to compensate the deficit of the tariff revenue.

Projected Profit and Loss

(Million VND)	0	1	2	3	4	5	6	7	8	9	10
Items	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Sales (=Total JC's Cost)	0	156,852	156,852	156,852	352,856	421,769	461,576	476,370	476,370	476,370	476,370
Direct Cost	0	134,637	134,637	134,637	302,881	362,033	396,202	408,901	408,901	408,901	408,901
Utilities	0	53,706	53,706	53,706	131,995	159,018	159,018	159,018	159,018	159,018	159,018
Chemicals	0	26,934	26,934	26,934	65,210	76,546	76,546	76,546	76,546	76,546	76,546
Repairs	0	20,847	20,847	20,847	20,847	20,847	55,036	67,684	67,684	67,684	67,684
Sludge disposal	0	18,135	18,135	18,135	43,887	51,504	51,504	51,504	51,504	51,504	51,504
Small replacement	0	4,189	4,189	4,189	12,566	16,755	16,755	16,755	16,755	16,755	16,755
Labor	0	7,776	7,776	7,776	19,632	25,872	25,872	25,872	25,872	25,872	25,872
Site establishment	0	2,094	2,094	2,094	6,283	8,378	8,378	8,378	8,378	8,378	8,378
Inspection & Cleaning	0	418	418	418	1,253	1,671	1,515	1,515	1,515	1,515	1,515
Insurance	0	536	536	536	1,207	1,442	1,578	1,629	1,629	1,629	1,629
Other Expenses	0	954	954	954	2,460	3,114	3,094	3,144	3,144	3,144	3,144
Overhead	-11,306	8,751	8,751	8,751	19,687	23,532	25,753	26,579	26,579	26,579	26,579
Provisional sum	0	6,732	6,732	6,732	15,144	18,102	19,810	20,445	20,445	20,445	20,445
Profit before Tax	-11,306	6,732	6,732	6,732	15,144	18,102	19,810	20,445	20,445	20,445	20,445

4.3 Projected Cash Flow

- The table below shows the projected cash flow in one-year preparatoty period and the first ten years of the O&M service by the Joint Company.
- It is assumed that Vietnamese Corporate Income Tax will be exempted anticipating a incentive based on the Law on Corporate Income Tax.
- As a result of calculation, 10-year IRR (cash flow base) will be 10.7%. This figure shows the project is worth investing for both HPC and the Japanese Consortium.

Projected Cash Flow

	million VND	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
		0	1	2	3	4	5	6	7	8	9	10
Sources of Funds												
Pre-Operation												
Equity	83,000	83,000										
Debt	0	0										
Operation												
Revenues Received	3,612,235		156,852	156,852	156,852	352,856	421,769	461,576	476,370	476,370	476,370	476,370
Total Sources of Funds	3,695,235	83,000	156,852	156,852	156,852	352,856	421,769	461,576	476,370	476,370	476,370	476,370
Uses of Funds												
Operation												
O&M Costs	-3,100,631		-134,637	-134,637	-134,637	-302,881	-362,033	-396,202	-408,901	-408,901	-408,901	-408,901
Initial Expenses	-11,306	-11,306	0	0	0	0	0	0	0	0	0	0
Provisional Sum	-155,032		-6,732	-6,732	-6,732	-15,144	-18,102	-19,810	-20,445	-20,445	-20,445	-20,445
Overhead	-201,541		-8,751	-8,751	-8,751	-19,687	-23,532	-25,753	-26,579	-26,579	-26,579	-26,579
Total Uses of Funds	-3,468,510	-11,306	-150,120	-150,120	-150,120	-337,712	-403,667	-441,766	-455,925	-455,925	-455,925	-455,925
Cash Surplus	226,726	71,694	6,732	6,732	6,732	15,144	18,102	19,810	20,445	20,445	20,445	20,445
Equity IRR (Cash Surplus)												
Equity Subscribed	83,000	83,000										
Cash Attributable to Shareholders	155,032	0	6,732	6,732	6,732	15,144	18,102	19,810	20,445	20,445	20,445	20,445
Equity Cash Flow	72,032	-83,000	6,732	6,732	6,732	15,144	18,102	19,810	20,445	20,445	20,445	20,445
Project IRR	**10.69%**											

Appendix 4 O&M Cost Estimates

Yen So STP: Operation & Maintenance Cost

	Items				1	2	3	4	5	6
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630
				VND	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113
				VND	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000
3	Chemicals			US$	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908
				VND	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	865,903	865,903	865,903	865,903	865,903	865,903
				VND	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000
6	Repairs			US$	0	0	1,105,988	1,105,988	1,105,988	1,105,988
				VND	0	0	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	29,057	29,057	33,481	33,481	33,481	33,481
				VND	488,853,013	488,853,013	581,508,268	581,508,268	581,508,268	581,508,268
Total Direct Cost (1-10)				US$	7,293,205	7,293,205	8,403,617	8,403,617	8,403,617	8,403,617
				VND	122,702,106,293	122,702,106,293	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384
11	Provisional sum for contingency		(5%of1-10)	US$	364,660	364,660	420,181	420,181	420,181	420,181
				VND	6,135,105,315	6,135,105,315	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
12	Overhead		(6.5%of1-10)	US$	474,058	474,058	546,235	546,235	546,235	546,235
				VND	7,975,636,909	7,975,636,909	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400
13	Profit		(5%of1-10)	US$	364,660	364,660	420,181	420,181	420,181	420,181
				VND	6,135,105,315	6,135,105,315	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
Total Cost (1-13)				US$	8,496,584	8,496,584	9,790,214	9,790,214	9,790,214	9,790,214
				VND	142,947,953,831	142,947,953,831	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Unit Treatment Cost during contract period		(US$/m^3)	0.14
Amount of Influent per year (m3/year)	73,000,000	(VNDm^3)	2,293
		(JP¥m^3)	11.64

Yen So STP: Operation & Maintenance Cost

No.	Items			Unit	7	8	9	10	11	12
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630
				VND	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113
				VND	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000
3	Chemicals			US$	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908
				VND	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	865,903	865,903	865,903	865,903	865,903	865,903
				VND	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000
6	Repairs			US$	1,105,988	1,105,988	1,105,988	1,105,988	1,105,988	1,105,988
				VND	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	33,481	33,481	33,481	33,481	33,481	33,481
				VND	581,508,268	581,508,268	581,508,268	581,508,268	581,508,268	581,508,268
Total Direct Cost (1-10)				US$	8,403,617	8,403,617	8,403,617	8,403,617	8,403,617	8,403,617
				VND	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384
11	Provisional sum for contingency		(5%of1-10)	US$	420,181	420,181	420,181	420,181	420,181	420,181
				VND	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
12	Overhead		(6.5%of1-10)	US$	546,235	546,235	546,235	546,235	546,235	546,235
				VND	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400
13	Profit		(5%of1-10)	US$	420,181	420,181	420,181	420,181	420,181	420,181
				VND	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
Total Cost (1-13)				US$	9,790,214	9,790,214	9,790,214	9,790,214	9,790,214	9,790,214
				VND	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen So STP: Operation & Maintenance Cost

	Items				13	14	15	16	17	18
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630
				VND	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113
				VND	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000
3	Chemicals			US$	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908
				VND	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	865,903	865,903	865,903	865,903	865,903	865,903
				VND	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000
6	Repairs			US$	1,105,988	1,105,988	1,105,988	1,105,988	1,105,988	1,105,988
				VND	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	33,481	33,481	33,481	33,481	33,481	33,481
				VND	581,508,268	581,508,268	581,508,268	581,508,268	581,508,268	581,508,268
Total Direct Cost (1-10)				US$	8,403,617	8,403,617	8,403,617	8,403,617	8,403,617	8,403,617
				VND	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384
11	Provisional sum for contingency		(5%of1-10)	US$	420,181	420,181	420,181	420,181	420,181	420,181
				VND	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
12	Overhead		(6.5%of1-10)	US$	546,235	546,235	546,235	546,235	546,235	546,235
				VND	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400
13	Profit		(5%of1-10)	US$	420,181	420,181	420,181	420,181	420,181	420,181
				VND	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
Total Cost (1-13)				US$	9,790,214	9,790,214	9,790,214	9,790,214	9,790,214	9,790,214
				VND	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322

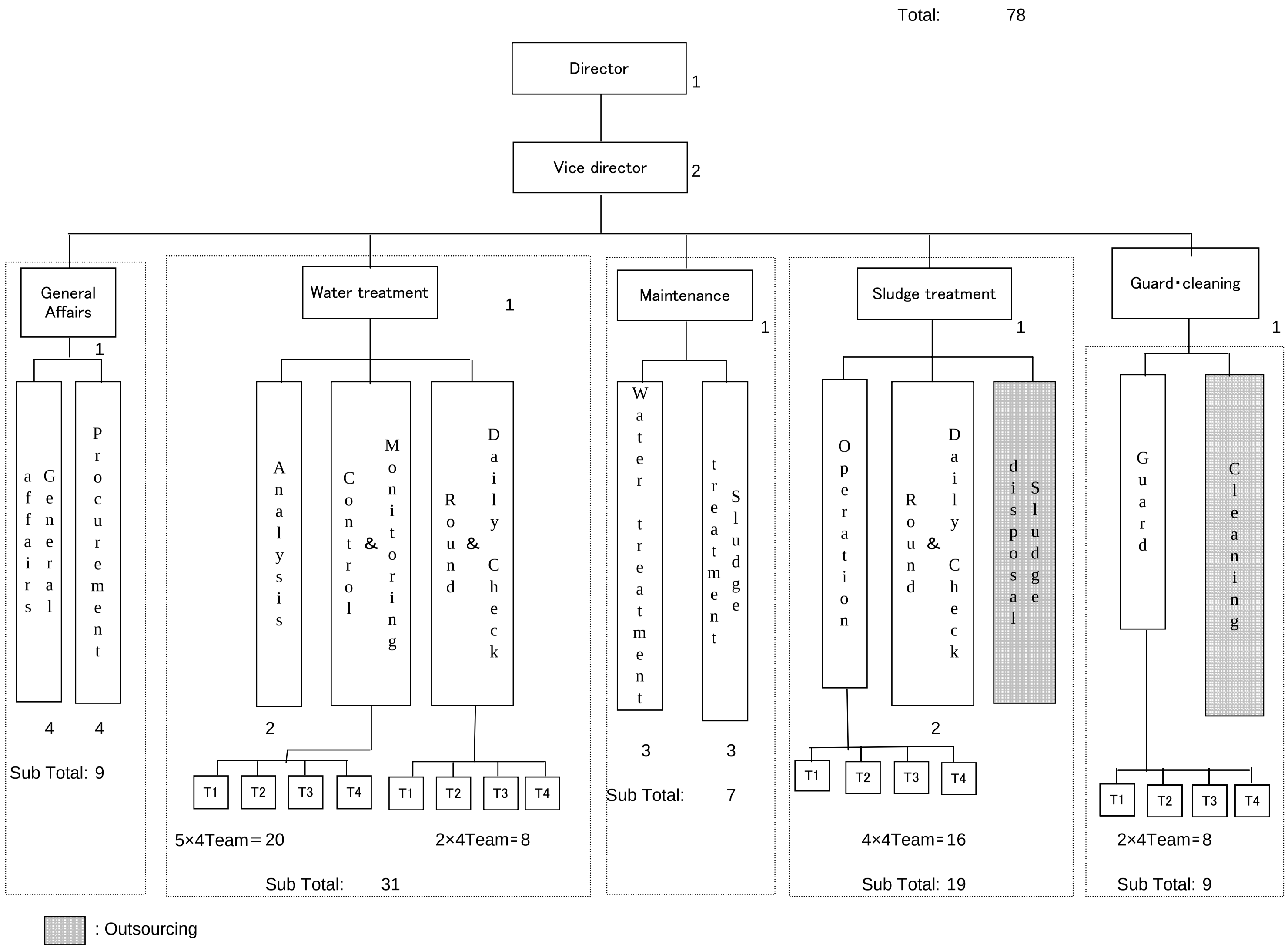
JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen So STP: Operation & Maintenance Cost

	Items				19	20	Sub Total
1	Labor cost			US$	371,276	371,276	7,425,516
				VND	7,776,000,000	7,776,000,000	155,520,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	55,512,605
				VND	58,132,800,000	58,132,800,000	1,162,656,000,000
		Oils(for emergency generator)		US$	23,575	23,575	471,500
				VND	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	85,562,265
				VND	59,673,740,000	59,673,740,000	1,193,474,800,000
3	Chemicals			US$	1,428,908	1,428,908	28,578,160
				VND	29,927,033,280	29,927,033,280	598,540,665,600
4	Legal inspection cost			US$	11,448	11,448	228,969
				VND	239,776,000	239,776,000	4,795,520,000
5	Sludge disposal cost			US$	865,903	865,903	17,318,067
				VND	18,135,480,000	18,135,480,000	362,709,600,000
6	Repairs			US$	1,105,988	1,105,988	19,907,785
				VND	23,163,813,836	23,163,813,836	416,948,649,040
7	Small-scall replacement			US$	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	170,000
				VND	178,024,000	178,024,000	3,560,480,000
9	Site establishment			US$	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	33,481	33,481	660,763
				VND	581,508,268	581,508,268	11,444,854,859
Total Direct Cost (1-10)				US$	8,403,617	8,403,617	165,851,525
				VND	145,958,575,384	145,958,575,384	2,872,658,569,499
11	Provisional sum for contingency		(5%of1-10)	US$	420,181	420,181	8,292,576
				VND	7,297,928,769	7,297,928,769	143,632,928,475
12	Overhead		(6.5%of1-10)	US$	546,235	546,235	10,780,349
				VND	9,487,307,400	9,487,307,400	186,722,807,017
13	Profit		(5%of1-10)	US$	420,181	420,181	8,292,576
				VND	7,297,928,769	7,297,928,769	143,632,928,475
Total Cost (1-13)				US$	9,790,214	9,790,214	193,217,026
				VND	170,041,740,322	170,041,740,322	3,346,647,233,466

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Framework plan for O&M of Yen So STP
Dewatering only in field of sludge treatment



Mass Balance

Influent

Q	200,000	m^3/d
SS	120	mg/L
DS	24.000	t/d

Influent

Inflow

Q	203,699	m^3/d
SS	133	mg/L
DS	27.075	t/d

Primary Settling Tank

Inflow

Q	202,887	m^3/d
SS	93	mg/L
DS	18.953	t/d

Activated Sludge Tank

Inflow

Q	284,041	m^3/d
SS	1,800	mg/L
DS	511.275	t/d

Final Settling Tank

Effluent

Q	199,351	m^3/d
SS	15	mg/L
DS	2.990	t/d

Effluent

Return Ratio 40 %

Sidestream

Q	3,699	m^3/d
SS	831	mg/L
DS	3.075	t/d

table for data of sidestream

Q	4,245
DS	3.501
SS	825

Primary Sludge

Q	812	m^3/d
SS	10,000	mg/L
DS	8.123	t/d

Return Sludge

Q	81,155	m^3/d
SS	4,500	mg/L
DS	492.322	t/d

Gravity Thickner

Mechanical Thickner

Excess Sludge

Q	3,535	m^3/d
SS	4,500	mg/L
DS	15.909	t/d

Gravity Thickened Sludge

Q	325	m^3/d
SS	20,000	mg/L
DS	6.498	t/d

Collection Ratio 80 %

Mechanical Thickened Sludge

Q	378	m^3/d
SS	40,000	mg/L
DS	15.114	t/d

Collection Ratio 95 %

Input

Q	703	m^3/d
SS	30,753	mg/L
DS	21.612	t/d

Collection Ratio 95 %

Dewatering Machine

Disposal

Cake

Q	103	m^3/d
SS	200,000	mg/L
DS	20.531	t/d

Moisture Contents 80 %

Supernatant

Q	487	m^3/d
SS	3,333	mg/L
DS	1.625	t/d

Supernatant

Q	3,158	m^3/d
SS	252	mg/L
DS	0.795	t/d

Supernatant

Q	600	m^3/d
SS	1,801	mg/L
DS	1.081	t/d

Modifying Point

1 primary sludge DS is calculated using collection ratio 30%
2 Return sludge & Excess sludge concentration is calculated using return ratio 40%
3 Side stream data is input manually from table under because avoiding recirculation problem in mass balance sheet.

1. Labor Cost

	Works items	Jobs Category	Numbers (Persons)	Grade	Labor unit cost		Sub total (year)		Remarks
					VND(month)	VND(year)	VND	US$	
	Unit price		1		2,000,000	24,000,000			
1	Director	-	1	7	14,000,000	168,000,000	168,000,000	8,021	
2	Vice Director	-	2	6	12,000,000	144,000,000	288,000,000	13,751	
3	General affairs	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		General	4	4	8,000,000	96,000,000	384,000,000	18,335	
		Procurement	4	4	8,000,000	96,000,000	384,000,000	18,335	
		Sub total	9				888,000,000	42,399	
4	Water treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water analysis	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Monitoring & Control	20	4	8,000,000	96,000,000	1,920,000,000	91,673	
		Daily check & Round	8	4	8,000,000	96,000,000	768,000,000	36,669	
		Sub total	31				3,000,000,000	143,239	
5	Maintenance	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water treatment	3	4	8,000,000	96,000,000	288,000,000	13,751	
		Sludge treatment	3	4	8,000,000	96,000,000	288,000,000	13,751	
		Sub total	7				696,000,000	33,231	
6	Sludge treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Operation	16	4	8,000,000	96,000,000	1,536,000,000	73,338	
		Daily check & Round	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Sludge disposal							Outsourcing
		Sub total	19				1,848,000,000	88,235	
7	Guards	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Guards	8	4	8,000,000	96,000,000	768,000,000	36,669	
		Cleaning							Outsourcing
		Sub total	9				888,000,000	42,399	
Total			78				7,776,000,000	371,276	

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.1 Electricity Consumption & Cost

【Estimating Condition】

Receiving Voltage(kV)	154 kV
Amount of Inlet(m^3/day)	200,000 m^3/day
Unit power consumption（kWh/m^3）	0.6 kWh/m^3
Power consumption（/day）	120,000 kWh/day
Power consumption（/month）	3,600,000 kWh

【Correction with time zones】

off peak hours	13 hr	1,950,000.0 (kWh)
low load hours	6 hr	900,000.0 (kWh)
peak hours	5 hr	750,000.0 (kWh)

【Consumption fee】

Cost by category	Industry		Irrigation		HSDC		Commerce	
	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)
off peak hours	935	1,823,250,000	690	1,345,500,000	1,139	2,221,050,000	1,648	3,213,600,000
low load hours	518	466,200,000	218	196,200,000	708	637,200,000	902	811,800,000
peak hours	1,825	1,368,750,000	1,269	951,750,000	2,061	1,545,750,000	2,943	2,207,250,000
Consumption fee(/month)		3,658,200,000		2,493,450,000		4,404,000,000		6,232,650,000
Consumption fee(/year)		43,898,400,000		29,921,400,000		52,848,000,000		74,791,800,000
VAT	10%	4,389,840,000	10%	2,992,140,000	10%	5,284,800,000	10%	7,479,180,000
Consumption fee including VAT		48,288,240,000		32,913,540,000		58,132,800,000		82,270,980,000

2.2 Diesel oil consumption for emergency electric generator

1. Condition

1	Electric power failure frequency	once per a week
2	Electric power failure time	1hr per a failure

Hereafter, it needs to calculate it with detail status of hanoi and apply cost estimation.

2. Estimation

Electric power failure frequency		Unit diesel oil usage	Total diesel oil usage	Unit diesel oil cost	diesel oil cost	
(times/week)	(times/year)	(L/1 blackout)	(L/year)	(VND/L)	(VND/y)	(US$/y)
1	52	450	23,400	21,100	493,740,000	23,574

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.3 Consumables

Fat and fatty oil	Grease
Supplies for recording	Indicator paper
	Chart paper
	Cartridge, Ribbon
	Ink, Pen
Maintenance supplies	Bolts, Nuts
	Packing
	V belt
	Bearing
	Coating materials
	Insulating tape
Lamp supplies	Display Lamp
	Fuse
	Lighting Lamp
	Mercury lamp
	Fluorescent lamp, tube
Supplies for daily water analysis	Instruments
	Chemicals
	Fuels
Supplies for planting works	Cutting blade for mower
	Fuels

1USD= 20944 VND

Total	50,000	USD/year
	1,047,200,000	VND/year

3. Chemical Demands

1. Estimation

1	**Polymer**						
	Amount of Sludge	Amount of Polymer		Unit price		Price for Polymer	
	(DS-t/d)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	VND/y)	(US$/y)
	20.53	411	150,015	167,552	8	25,135,313,280	1,200,120
2	**NaClO**(10%)						
	Additive rate	Amount of $NaOCl_3$		Unit price		Price for NaClO	
	(mg/L)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
	2	3,408	1,243,920	3,500	0.17	4,353,720,000	207,874
3	**$FeCl_3$**						
		Amount of $FeCl_3$		Unit price		Price for FeCl3	
		(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
		80	29,200	15,000	0.72	438,000,000	20,913
Total						29,927,033,280	1,428,907

2. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

4. Legal inspection cost

1. Condition

1 The number of implementaion without water quality analysis is once per year.

→ Hereafter, it needs to survey vietnam's law concerned official inspection and apply cost estimation.

2. Estimation

High-voltage Electricity		Crane		Elevator		Firefighting equipment		Total	
(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)
2,000	41,888,000	1,000	20,944,000		0.0	1,000	20,944,000	4,000	83,776,000

Water Quality Analysis
As TCVN5945-2005

Items	Frequency	Unit Cost		Cost	
(-)	(/year)	(VND)	(US$)	(VND)	(US$)
37	12	13,000,000	620.7	156,000,000	7,448

Total Cost

Cost	
(VND)	(US$)
239,776,000	11,448

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5. Sludge disposal

1. Condition

1 Sludge disposal is outsourced to URENCO, and method is landfill.

2. Estimation

Sludge generation		Unit disposal price		Disposal price	
(ws-t/d)	(ws-t/y)	(VND/t)	($/t)	(VND/y)	(US$/y)
112.9	41,217	440,000	21.1	18,135,480,000	865,903

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

6. Repairs

1USD= 20,944 VND

Initial Investment of Equipment		99,538,925	USD
		2,084,743,245,200	VND
Repair Cost for Equipment (20 years)	20%	19,907,785	USD
		416,948,649,040	VND
Annual Repair Cost (18-year average)		1,105,988	USD
		23,163,813,836	VND

7. Small-scale replacement

Small-scale replacement	200,000	(US$/year)
	4,188,800,000	VND/year

1USD= 20944

8. Cleaning and yard management

1 Outsourcing
2 Day working only

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Fixed staff

	Number	Unit Cost		Cost per year	
	(Persons)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	300	6,283,200	3,600	75,398,400
Worker	2	150	3,141,600	3,600	75,398,400

Temporary staff

	Number(Persons)				Work days		Unit Cost		Cost per year	
	Jan.	Apr.	Jul.	Nov.	(d/each)	(total days)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	1	1	1	5	20	15	314,160	300	6,283,200
Worker	5	5	5	5	5	100	10	209,440	1,000	20,944,000

Total cost for fixed staff and temporary staff

Cost per year	
(US$/m)	(VND/m)
8,500	178,024,000

9. Site Establishment

Office rental	0	Use site office
Rental car fee	40,000	(US$/year)
Telephone Fee	5,000	(US$/year)
Business equipment retal fee	10,000	(US$/year)
office supplies	30,000	(US$/year)
the others(water supply etc…)	15,000	(US$/year)
sum	100,000	(US$/year)
	2,094,400,000	(VND/year)

Innova	18,000	US$/year
Sedan	22,000	US$/year
1USD=	20944	VND/year

Yen Xa STP: Operation & Maintenance Cost

No.	Items			Unit	2017	2018	2019	2020	2021	2022	2023
	Items				1	2	3	4	5	6	7
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101
				VND	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000
		Oils(for emergency generator)		US$	371,276	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,168,377	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676
				VND	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000
3	Chemicals			US$	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999
				VND	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000
5	Sludge disposal cost			US$	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950
				VND	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000
6	Repairs			US$	0	0	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444
				VND	0	0	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	31,834	30,443	37,493	37,493	37,493	37,493	37,493
				VND	637,606,296	637,606,296	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841
	Total Direct Cost (1-10)			US$	7,990,384	7,641,292	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786
				VND	160,039,180,196	160,039,180,196	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186
11	Provisional sum for contingency		(5%of1-10)	US$	399,519	382,065	470,539	470,539	470,539	470,539	470,539
				VND	8,001,959,010	8,001,959,010	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159
12	Overhead		(6.5%of1-10)	US$	519,375	496,684	611,701	611,701	611,701	611,701	611,701
				VND	10,402,546,713	10,402,546,713	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807
13	Profit		(5%of1-10)	US$	399,519	382,065	470,539	470,539	470,539	470,539	470,539
				VND	8,001,959,010	8,001,959,010	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159
	Total Cost (1-13)			US$	9,308,797	8,902,105	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566
				VND	186,445,644,928	186,445,644,928	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Unit Treatment Cost during contract period			
		(US$/m^3)	0.11
Amount of Influent per year (m3/year)	98,550,000	(VNDm^3)	2,285
		(JP¥m^3)	9.15

Yen Xa STP: Operation & Maintenance Cost

					2024	2025	2026	2027	2028	2029	2030
	Items				8	9	10	11	12	13	14
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101
				VND	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676
				VND	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000
3	Chemicals			US$	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999
				VND	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000
5	Sludge disposal cost			US$	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950
				VND	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000
6	Repairs			US$	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444
				VND	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	37,493	37,493	37,493	37,493	37,493	37,493	37,493
				VND	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841
Total Direct Cost (1-10)				US$	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786
				VND	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186
11	Provisional sum for contingency		(5%of1-10)	US$	470,539	470,539	470,539	470,539	470,539	470,539	470,539
				VND	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159
12	Overhead		(6.5%of1-10)	US$	611,701	611,701	611,701	611,701	611,701	611,701	611,701
				VND	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807
13	Profit		(5%of1-10)	US$	470,539	470,539	470,539	470,539	470,539	470,539	470,539
				VND	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159
Total Cost (1-13)				US$	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566
				VND	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen Xa STP: Operation & Maintenance Cost

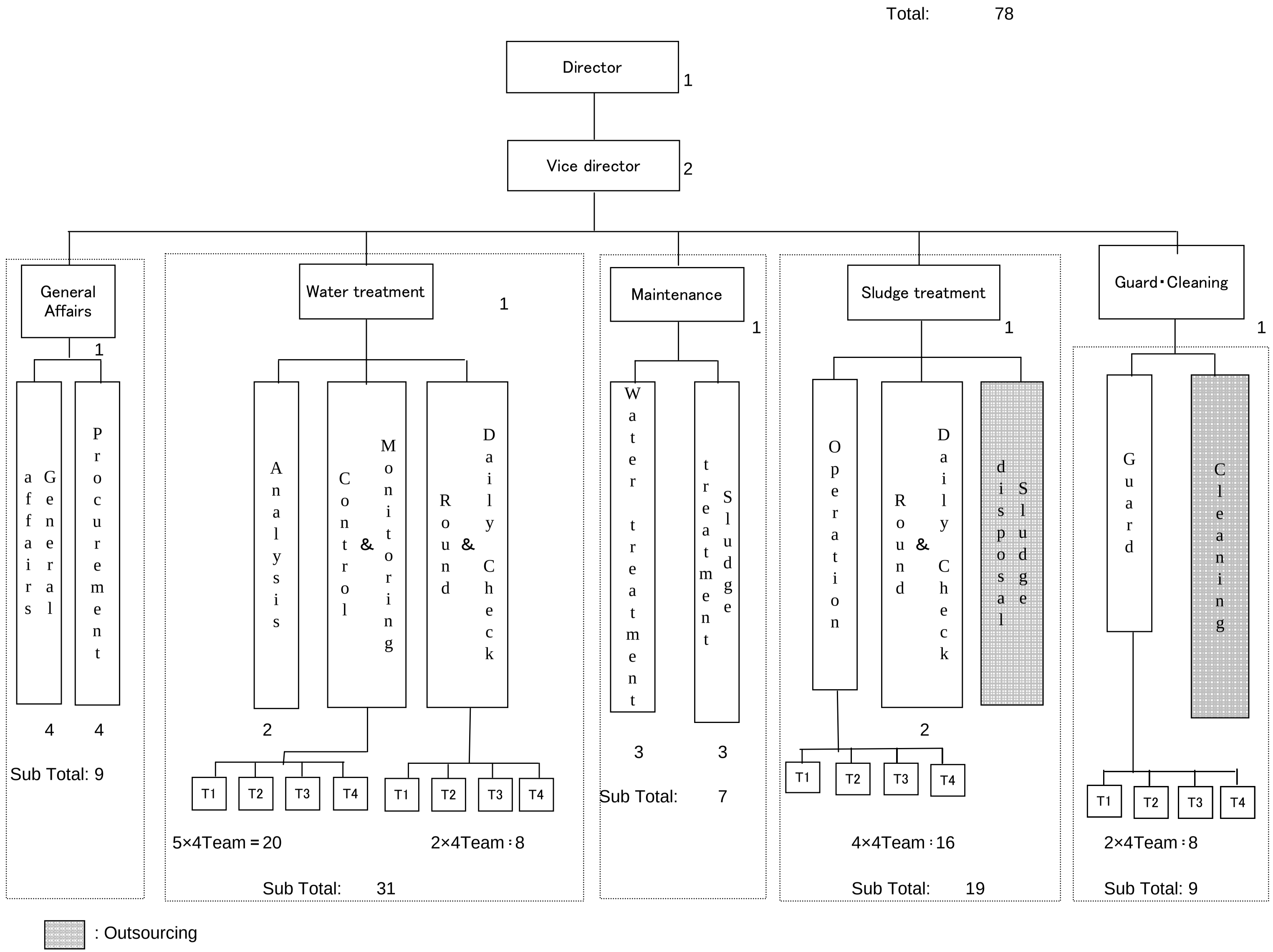
No.	Items			Unit	15 (2031)	16 (2032)	17 (2033)	18 (2034)	19 (2035)	20 (2036)	Sub Total
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276	7,425,516
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	155,520,000,000
2	Utilities	Electricity consumtion cost		US$	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	74,942,017
				VND	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	1,569,585,600,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	819,201
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	1,000,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	20,944,000,000
		Sub Total		US$	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	76,761,218
				VND	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	1,600,404,400,000
3	Chemicals			US$	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	38,599,980
				VND	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	808,437,478,000
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	228,969
				VND	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000	1,987,520,000
5	Sludge disposal cost			US$	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	23,378,992
				VND	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	489,649,600,000
6	Repairs			US$	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444	31,724,000
				VND	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	664,427,456,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	170,000
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	3,560,480,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	37,493	37,493	37,493	37,493	37,493	37,493	737,155
				VND	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841	15,398,603,736
	Total Direct Cost (1-10)			US$	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786	185,025,828
				VND	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	3,865,049,537,736
11	Provisional sum for contingency		(5%of1-10)	US$	470,539	470,539	470,539	470,539	470,539	470,539	9,251,291
				VND	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	193,252,476,887
12	Overhead		(6.5%of1-10)	US$	611,701	611,701	611,701	611,701	611,701	611,701	12,026,679
				VND	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	251,228,219,953
13	Profit		(5%of1-10)	US$	470,539	470,539	470,539	470,539	470,539	470,539	9,251,291
				VND	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	193,252,476,887
	Total Cost (1-13)			US$	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566	215,555,090
				VND	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	4,502,782,711,462

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

0

0

Framework plan for O&M of Yen Xa STP
Dewatering only in field of sludge treatment



Mass Balance

Influent

Q	270,000	m^3/d
SS	120	mg/L
DS	32.400	t/d

Influent

Sidestream

Q	4,994	m^3/d
SS	831	mg/L
DS	4.151	t/d

table for data of sidestream

Q	5,731
DS	4.726
SS	825

Inflow

Q	274,994	m^3/d
SS	133	mg/L
DS	36.551	t/d

Primary Settling Tank

Primary Sludge

Q	1,097	m^3/d
SS	10,000	mg/L
DS	10.965	t/d

Gravity Thickner

Gravity Thickened Sludge

Q	439	m^3/d
SS	20,000	mg/L
DS	8.772	t/d

Collection Ratio 80 %

Supernatant

Q	658	m^3/d
SS	3,333	mg/L
DS	2.193	t/d

Inflow

Q	273,897	m^3/d
SS	93	mg/L
DS	25.586	t/d

Activated Sludge Tank

Return Ratio 40 %

Return Sludge

Q	109,559	m^3/d
SS	4,500	mg/L
DS	664.636	t/d

Mechanical Thickner

Mechanical Thickened Sludge

Q	510	m^3/d
SS	40,000	mg/L
DS	20.403	t/d

Collection Ratio 95 %

Supernatant

Q	4,263	m^3/d
SS	252	mg/L
DS	1.074	t/d

Inflow

Q	383,456	m^3/d
SS	1,800	mg/L
DS	690.222	t/d

Final Settling Tank

Excess Sludge

Q	4,773	m^3/d
SS	4,500	mg/L
DS	21.477	t/d

Effluent

Q	269,125	m^3/d
SS	15	mg/L
DS	4.037	t/d

Effluent

Input

Q	949	m^3/d
SS	30,753	mg/L
DS	29.176	t/d

Collection Ratio 95 %

Dewatering Machine

Disposal

Supernatant

Q	810	m^3/d
SS	1,801	mg/L
DS	1.459	t/d

Cake

Q	139	m^3/d
SS	200,000	mg/L
DS	27.717	t/d

Moisture Contents 80 %

Modifying Point

1 primary sludge DS is calculated using collection ratio 30%
2 Return sludge & Excess sludge concentration is calculated using return ratio 40%
3 Side stream data is input manually from table under because avoiding recirculation problem in mass balance sheet.

1. Labor Cost

	Works items	Jobs Category	Numbers (Persons)	Grade	Labor unit cost		Sub total (year)		Remarks
					VND(month)	VND(year)	VND	US$	
	Unit price		1		2,000,000	24,000,000			
1	Director	-	1	7	14,000,000	168,000,000	168,000,000	8,021	
2	Vice Director	-	2	6	12,000,000	144,000,000	288,000,000	13,751	
3	General affairs	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		General	4	4	8,000,000	96,000,000	384,000,000	18,335	
		Procurement	4	4	8,000,000	96,000,000	384,000,000	18,335	
		Sub total	9				888,000,000	42,399	
4	Water treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water analysis	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Monitoring & Control	20	4	8,000,000	96,000,000	1,920,000,000	91,673	
		Daily check & Round	8	4	8,000,000	96,000,000	768,000,000	36,669	
		Sub total	31				3,000,000,000	143,239	
5	Maintenance	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water treatment	3	4	8,000,000	96,000,000	288,000,000	13,751	
		Sludge treatment	3	4	8,000,000	96,000,000	288,000,000	13,751	
		Sub total	7				696,000,000	33,231	
6	Sludge treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Operation	16	4	8,000,000	96,000,000	1,536,000,000	73,338	
		Daily check & Round	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Sludge disposal							Outsourcing
		Sub total	19				1,848,000,000	88,235	
7	Guards	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Guards	8	4	8,000,000	96,000,000	768,000,000	36,669	
		Cleaning							Outsourcing
		Sub total	9				888,000,000	42,399	
Total			78				7,776,000,000	371,276	

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.1 Electricity Consumption & Cost

【Estimating Condition】

Receiving Voltage(kV)	154	kV
Amount of Inlet(m^3/day)	270,000	m^3/day
Unit power consumption (kWh/m^3)	0.6	kWh/m^3
Power consumption (/day)	162,000	kWh/day
Power consumption (/month)	4,860,000	kWh

【Correction with time zones】

off peak hours	13	hr	2,632,500.0	(kWh)
low load hours	6	hr	1,215,000.0	(kWh)
peak hours	5	hr	1,012,500.0	(kWh)

【Consumption fee】

Cost by category	Industry		Irrigation		HSDC		Commerce	
	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)
off peak hours	935	2,461,387,500	690	1,816,425,000	1,139	2,998,417,500	1,648	4,338,360,000
low load hours	518	629,370,000	218	264,870,000	708	860,220,000	902	1,095,930,000
peak hours	1,825	1,847,812,500	1,269	1,284,862,500	2,061	2,086,762,500	2,943	2,979,787,500
Consumption fee(/month)		4,938,570,000		3,366,157,500		5,945,400,000		8,414,077,500
Consumption fee(/year)		59,262,840,000		40,393,890,000		71,344,800,000		100,968,930,000
VAT	10%	5,926,284,000	10%	4,039,389,000	10%	7,134,480,000	10%	10,096,893,000
Consumption fee including VAT		65,189,124,000		44,433,279,000		78,479,280,000		111,065,823,000

2.2 Diesel oil consumption for emergency electric generator

1. Condition

1	Electric power failure frequency	once per a week
2	Electric power failure time	1hr per a failure

Hereafter, it needs to calculate it with detail status of hanoi and apply cost estimation.

2. Estimation

Electric power failure frequency		Unit diesel oil usage	Total diesel oil usage	Unit diesel oil cost	diesel oil cost	
(times/week)	(times/year)	(L/1 blackout)	(L/year)	(VND/L)	(VND/y)	(US$/y)
1	52	450	23,400	21,100	493,740,000	23,574

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.3 Consumables

Fat and fatty oil	Grease
Supplies for recording	Indicator paper
	Chart paper
	Cartridge, Ribbon
	Ink, Pen
Maintenance supplies	Bolts, Nuts
	Packing
	V belt
	Bearing
	Coating materials
	Insulating tape
Lamp supplies	Display Lamp
	Fuse
	Lighting Lamp
	Mercury lamp
	Fluorescent lamp, tube
Supplies for daily water analysis	Instruments
	Chemicals
	Fuels
Supplies for planting works	Cutting blade for mower
	Fuels

1USD= 20944 VND

Total	50,000	USD/year
	1,047,200,000	VND/year

3. Chemical Demands

1. Estimation

1	**Polymer**						
	Amount of Sludge	Amount of Polymer		Unit price		Price for Polymer	
	(DS-t/d)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	VND/y)	(US$/y)
	27.72	555	202,575	167,552	8	33,941,846,400	1,620,600
2	**NaClO**(10%)						
	Additive rate	Amount of $NaOCl_3$		Unit price		Price for NaClO	
	(mg/L)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
	2	4,601	1,679,365	3,500	0.17	5,877,777,500	280,643
3	**$FeCl_3$**						
		Amount of $FeCl_3$		Unit price		Price for FeCl3	
		(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
		110	40,150	15,000	0.72	602,250,000	28,755
Total						40,421,873,900	1,929,998

2. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

4. Legal inspection cost

1. Condition

1 The number of implementaion without water quality analysis is once per year.

→ Hereafter, it needs to survey vietnam's law concerned official inspection and apply cost estimation.

2. Estimation

High-voltage Electricity		Crane		Elevator		Firefighting equipment		Total	
(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)
2,000	41,888,000	1,000	20,944,000		0.0	1,000	20,944,000	4,000	83,776,000

Water Quality Analysis

As TCVN5945-2005

Items	Frequency	Unit Cost		Cost	
(-)	(/year)	(VND)	(US$)	(VND)	(US$)
37	12	13,000,000	620.7	156,000,000	7,448

Total Cost

Cost	
(VND)	(US$)
239,776,000	11,448

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5. Sludge disposal

1. Condition

1 Sludge disposal is outsourced to URENCO, and method is landfill.

2. Estimation

Sludge generation		Unit disposal price		Disposal price	
(ws-t/d)	(ws-t/y)	(VND/t)	($/t)	(VND/y)	(US$/y)
152.4	55,642	440,000	21.1	24,482,480,000	1,168,950

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

6. Repairs

Initial Investment of Equipment		158,620,000	USD
		3,322,137,280,000	VND
Repair Cost for Equipment (20 years)	20%	31,724,000	USD
		664,427,456,000	VND
Annual Repair Cost (18-year average)		1,762,444	USD
		36,912,636,444	VND

1USD= 20,944 VND

144.2
1.1
158.62

7. Small-scale replacement

Small-scale replacement	200,000	(US$/year)
	4,188,800,000	VND/year

1USD= 20944

8. Cleaning and yard management

1 Outsourcing
2 Day working only

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Fixed staff

	Number	Unit Cost		Cost per year	
	(Persons)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	300	6,283,200	3,600	75,398,400
Worker	2	150	3,141,600	3,600	75,398,400

Temporary staff

	Number(Persons)				Work days		Unit Cost		Cost per year	
	Jan.	Apr.	Jul.	Nov.	(d/each)	(total days)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	1	1	1	5	20	15	314,160	300	6,283,200
Worker	5	5	5	5	5	100	10	209,440	1,000	20,944,000

Total cost for fixed staff and temporary staff

Cost per year	
(US$/m)	(VND/m)
8,500	178,024,000

9. Site Establishment

Office rental	0	Use site office
Rental car fee	40,000	(US$/year)
Telephone Fee	5,000	(US$/year)
Business equipment retal fee	10,000	(US$/year)
office supplies	30,000	(US$/year)
the others(water supply etc…)	15,000	(US$/year)
sum	100,000	(US$/year)
	2,094,400,000	VND/year

Innova	18,000	US$/year
Sedan	22,000	US$/year
1USD=	20944	VND/year

Ho Tay STP: Operation & Maintenance Cost

No.	Items			Unit	1	2	3	4	5	6	7
1	Labor cost			US$	194,805	194,805	194,805	194,805	194,805	194,805	194,805
				VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost		US$	259,059	259,059	259,059	259,059	259,059	259,059	259,059
				VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Total		US$	332,634	332,634	332,634	332,634	332,634	332,634	332,634
				VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals			US$	100,567	100,567	100,567	100,567	100,567	100,567	100,567
				VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	60,609	60,609	60,609	60,609	60,609	60,609	60,609
				VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs			US$	0	0	297,000	297,000	297,000	297,000	297,000
				VND	0	0	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site Establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	4,034	4,034	5,222	5,222	5,222	5,222	5,222
				VND	84,493,214	84,493,214	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686
	Total(1-10)			US$	1,012,598	1,012,598	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786
				VND	21,207,796,634	21,207,796,634	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106
11	Provisional sum for contingency		(5%of1-10)	US$	50,630	50,630	65,539	65,539	65,539	65,539	65,539
				VND	1,060,389,832	1,060,389,832	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
12	Overhead		(6.5%of1-10)	US$	65,819	65,819	85,201	85,201	85,201	85,201	85,201
				VND	1,378,506,781	1,378,506,781	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997
13	Profit		(5%of1-10)	US$	50,630	50,630	65,539	65,539	65,539	65,539	65,539
				VND	1,060,389,832	1,060,389,832	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
	Grand Total(1-13)			US$	1,179,677	1,179,677	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066
				VND	24,707,083,078	24,707,083,078	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Unit Treatment Cost during contract period		(US$/$m^3$)	0.28
Amount of Influent per year (m3/year)	5,475,000	(VNDm^3)	5,709
		(JP¥m^3)	23.28

Ho Tay STP: Operation & Maintenance Cost

	Items				8	9	10	11	12	13	14
1	Labor cost			US$	194,805	194,805	194,805	194,805	194,805	194,805	194,805
				VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost		US$	259,059	259,059	259,059	259,059	259,059	259,059	259,059
				VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Total		US$	332,634	332,634	332,634	332,634	332,634	332,634	332,634
				VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals			US$	100,567	100,567	100,567	100,567	100,567	100,567	100,567
				VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	60,609	60,609	60,609	60,609	60,609	60,609	60,609
				VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs			US$	297,000	297,000	297,000	297,000	297,000	297,000	297,000
				VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site Establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	5,222	5,222	5,222
				VND	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686
Total(1-10)				US$	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786
				VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106
11	Provisional sum for contingency		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
12	Overhead		(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	85,201	85,201	85,201
				VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997
13	Profit		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
Grand Total(1-13)				US$	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066
				VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713

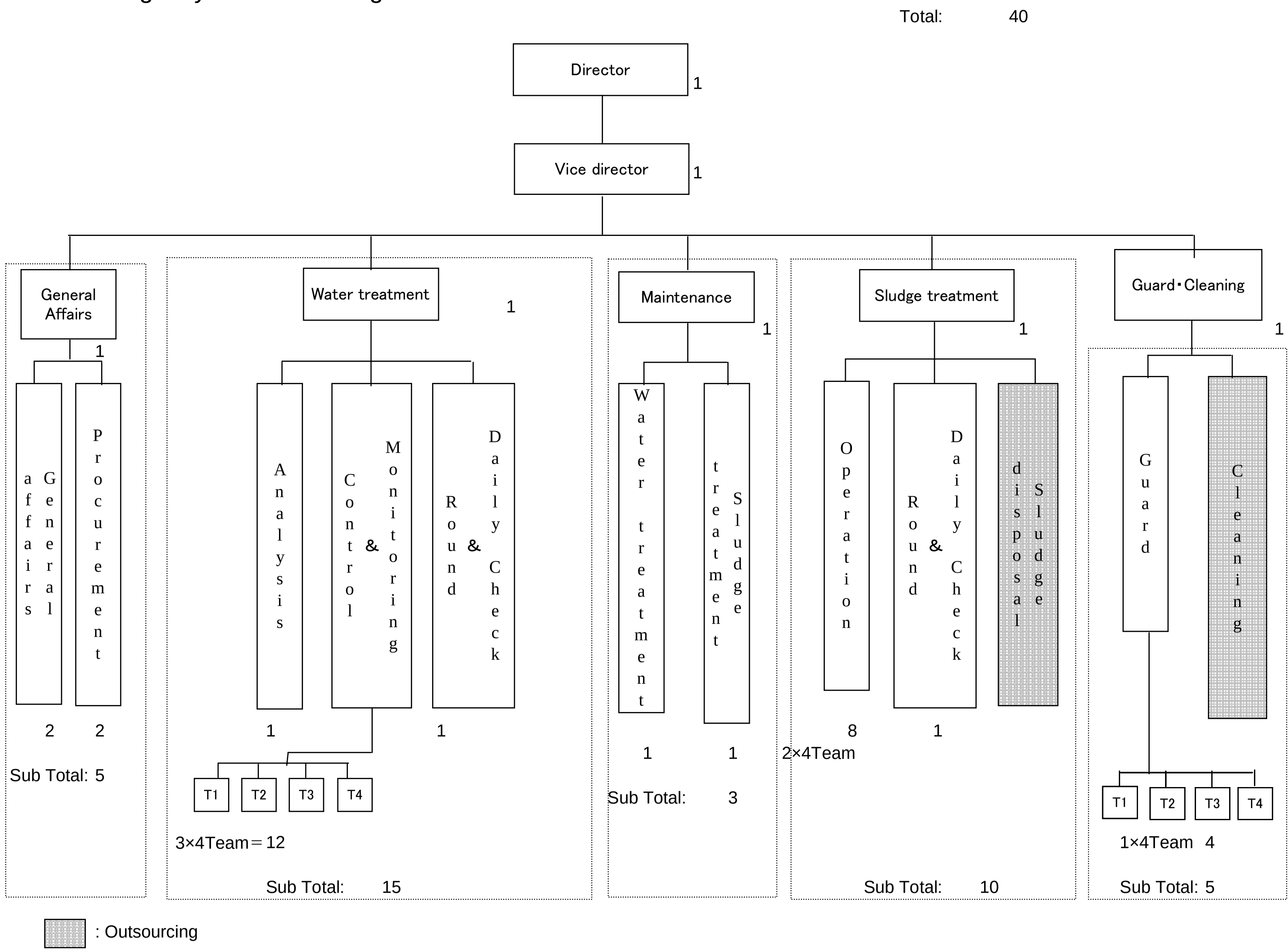
JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Ho Tay STP: Operation & Maintenance Cost

	Items			15	16	17	18	19	20	Sub Total
1	Labor cost		US$	194,805	194,805	194,805	194,805	194,805	194,805	3,896,104
			VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	81,600,000,000
2	Utilities	Electricity consumtion cost	US$	259,059	259,059	259,059	259,059	259,059	259,059	5,181,176
			VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	108,514,560,000
		Oils(for emergency generator)	US$	23,575	23,575	23,575	23,575	23,575	23,575	471,500
			VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	9,874,800,000
		Consumables	US$	50,000	50,000	50,000	50,000	50,000	50,000	1,000,000
			VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	20,944,000,000
		Total	US$	332,634	332,634	332,634	332,634	332,634	332,634	6,652,676
			VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	139,333,360,000
3	Chemicals		US$	100,567	100,567	100,567	100,567	100,567	100,567	2,011,340
			VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	42,124,708,400
4	Legal inspection cost		US$	11,448	11,448	11,448	11,448	11,448	11,448	228,969
			VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	4,795,520,000
5	Sludge disposal cost		US$	60,609	60,609	60,609	60,609	60,609	60,609	1,212,185
			VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	25,388,000,000
6	Repairs		US$	297,000	297,000	297,000	297,000	297,000	297,000	5,346,000
			VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	111,966,624,000
7	Small-scall replacement		US$	200,000	200,000	200,000	200,000	200,000	200,000	4,000,000
			VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance		US$	8,500	8,500	8,500	8,500	8,500	8,500	170,000
			VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	3,560,480,000
9	Site Establishment		US$	100,000	100,000	100,000	100,000	100,000	100,000	2,000,000
			VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance	(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	5,222	5,222	102,069
			VND	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	2,137,730,770
Total(1-10)			US$	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	25,619,343
			VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	536,570,423,170
11	Provisional sum for contingency	(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	1,280,967
			VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	26,828,521,158
12	Overhead	(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	85,201	85,201	1,665,257
			VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	34,877,077,506
13	Profit	(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	1,280,967
			VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	26,828,521,158
Grand Total(1-13)			US$	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	29,846,535
			VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	625,104,542,993

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Framework plan for O&M of Ho Tay STP
Dewatering only in field of sludge treatment



Mass Balance

Influent

Q	14,000	m^3/d
SS	120	mg/L

Influent

Sidestream

Q	259	m^3/d
SS	831	mg/L
DS	0.215	t/d

table for data of sidestream

Q	297
DS	0.245
SS	825

Inflow

Q	14,259	m^3/d
SS	133	mg/L
DS	1.895	t/d

Primary Settling Tank

Primary Sludge

Q	57	m^3/d
SS	10,000	mg/L
DS	0.569	t/d

Gravity Thickner

Gravity Thickened Sludge

Q	23	m^3/d
SS	20,000	mg/L
DS	0.455	t/d

Collection Ratio 80 %

Supernatant

Q	34	m^3/d
SS	3,333	mg/L
DS	0.114	t/d

Inflow

Q	14,202	m^3/d
SS	93	mg/L
DS	1.327	t/d

Activated Sludge Tank

Return Ratio 40 %

Return Sludge

Q	5,681	m^3/d
SS	4,500	mg/L
DS	34.463	t/d

Mechanical Thickner

Mechanical Thickened Sludge

Q	26	m^3/d
SS	40,000	mg/L
DS	1.058	t/d

Collection Ratio 95 %

Supernatant

Q	221	m^3/d
SS	252	mg/L
DS	0.056	t/d

Inflow

Q	19,883	m^3/d
SS	1,800	mg/L
DS	35.789	t/d

Final Settling Tank

Excess Sludge

Q	247	m^3/d
SS	4,500	mg/L
DS	1.113	t/d

Effluent

Q	13,955	m^3/d
SS	15	mg/L
DS	0.209	t/d

Effluent

Input

Q	49	m^3/d
SS	30,753	mg/L
DS	1.513	t/d

Collection Ratio 95 %

Dewatering Machine

Disposal

Supernatant

Q	42	m^3/d
SS	1,801	mg/L
DS	0.076	t/d

Cake

Q	7	m^3/d
SS	200,000	mg/L
DS	1.437	t/d

Moisture Contents 80 %

Modifying Point

1 primary sludge DS is calculated using collection ratio 30%
2 Return sludge & Excess sludge concentration is calculated using return ratio 40%
3 Side stream data is input manually from table under because avoiding recirculation problem in mass balance sheet.

1. Labor Cost

	Works items	Jobs Category	Numbers (Persons)	Grade	Labor unit cost		Sub total (year)		Remarks
					VND(month)	VND(year)	VND	US$	
	Unit price		1		2,000,000	24,000,000			
1	Director	-	1	7	14,000,000	168,000,000	168,000,000	8,021	
2	Vice Director	-	1	6	12,000,000	144,000,000	144,000,000	6,875	
3	General affairs	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		General	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Procurement	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Sub total	5				504,000,000	24,064	
4	Water treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water analysis	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Monitoring & Control	12	4	8,000,000	96,000,000	1,152,000,000	55,004	
		Daily check & Round	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Sub total	15				1,464,000,000	69,901	
5	Maintenance	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water treatment	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Sludge treatment	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Sub total	3				312,000,000	14,897	
6	Sludge treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Operation	8	4	8,000,000	96,000,000	768,000,000	36,669	
		Daily check & Round	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Sludge disposal							Outsourcing
		Sub total	10				984,000,000	46,982	
7	Guards	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Guards	4	4	8,000,000	96,000,000	384,000,000	18,335	
		Cleaning							Outsourcing
		Sub total	5				504,000,000	24,064	
Total			40				4,080,000,000	194,805	

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.1 Electricity Consumption & Cost

【Estimating Condition】

Receiving Voltage(kV)	154	kV
Amount of Inlet(m^3/day)	14,000	m^3/day
Unit power consumption (kWh/m^3)	0.8	kWh/m^3
Power consumption (/day)	11,200	kWh/day
Power consumption (/month)	336,000	kWh

【Correction with time zones】

off peak hours	13	hr	182,000.0	(kWh)
low load hours	6	hr	84,000.0	(kWh)
peak hours	5	hr	70,000.0	(kWh)

【Consumption fee】

Cost by category	Industry		Irrigation		HSDC		Commerce	
	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)
off peak hours	935	170,170,000	690	125,580,000	1,139	207,298,000	1,648	299,936,000
low load hours	518	43,512,000	218	18,312,000	708	59,472,000	902	75,768,000
peak hours	1,825	127,750,000	1,269	88,830,000	2,061	144,270,000	2,943	206,010,000
Consumption fee(/month)		341,432,000		232,722,000		411,040,000		581,714,000
Consumption fee(/year)		4,097,184,000		2,792,664,000		4,932,480,000		6,980,568,000
VAT	10%	409,718,400	10%	279,266,400	10%	493,248,000	10%	698,056,800
Consumption fee including VAT		4,506,902,400		3,071,930,400		5,425,728,000		7,678,624,800

2.2 Diesel oil consumption for emergency electric generator

1. Condition

1	Electric power failure frequency	once per a week
2	Electric power failure time	1hr per a failure

Hereafter, it needs to calculate it with detail status of hanoi and apply cost estimation.

2. Estimation

Electric power failure frequency		Unit diesel oil usage	Total diesel oil usage	Unit diesel oil cost	diesel oil cost	
(times/week)	(times/year)	(L/1 blackout)	(L/year)	(VND/L)	(VND/y)	(US$/y)
1	52	450	23,400	21,100	493,740,000	23,574

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.3 Consumables

Fat and fatty oil	Grease
Supplies for recording	Indicator paper
	Chart paper
	Cartridge, Ribbon
	Ink, Pen
Maintenance supplies	Bolts, Nuts
	Packing
	V belt
	Bearing
	Coating materials
	Insulating tape
Lamp supplies	Display Lamp
	Fuse
	Lighting Lamp
	Mercury lamp
	Fluorescent lamp, tube
Supplies for daily water analysis	Instruments
	Chemicals
	Fuels
Supplies for planting works	Cutting blade for mower
	Fuels

1USD= 20944 VND

Total	50,000 USD/year
	1,047,200,000 VND/year

3. Chemical Demands

1. Estimation

1	**Polymer**						
	Amount of Sludge	Amount of Polymer		Unit price		Price for Polymer	
	(DS-t/d)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	VND/y)	(US$/y)
	1.44	29	10,585	167,552	8	1,773,537,920	84,680
2	**NaClO**(10%)						
	Additive rate	Amount of $NaOCl_3$		Unit price		Price for NaClO	
	(mg/L)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
	2	239	87,235	3,500	0.17	305,322,500	14,578
3	**$FeCl_3$**						
		Amount of $FeCl_3$		Unit price		Price for $FeCl_3$	
		(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
		5	1,825	15,000	0.72	27,375,000	1,307
Total						2,106,235,420	100,565

2. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

4. Legal inspection cost

1. Condition

1 The number of implementaion without water quality analysis is once per year.

→ Hereafter, it needs to survey vietnam's law concerned official inspection and apply cost estimation.

2. Estimation

High-voltage Electricity		Crane		Elevator		Firefighting equipment		Total	
(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)
2,000	41,888,000	1,000	20,944,000		0.0	1,000	20,944,000	4,000	83,776,000

Water Quality Analysis
As TCVN5945-2005

Items	Frequency	Unit Cost		Cost	
(-)	(/year)	(VND)	(US$)	(VND)	(US$)
37	12	13,000,000	620.7	156,000,000	7,448

Total Cost

Cost	
(VND)	(US$)
239,776,000	11,448

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5. Sludge disposal

1. Condition

1 Sludge disposal is outsourced to URENCO, and method is landfill.

2. Estimation

Sludge generation		Unit disposal price		Disposal price	
(ws-t/d)	(ws-t/y)	(VND/t)	($/t)	(VND/y)	(US$/y)
7.9	2,885	440,000	21.1	1,269,400,000	60,609

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

6. Repairs

1USD= 20,944 VND

Initial Investment of Equipment		26,730,000	USD
		559,833,120,000	VND
Repair Cost for Equipment (20 years)	20%	5,346,000	USD
		111,966,624,000	VND
Annual Repair Cost (18-year average)		297,000	USD
		6,220,368,000	VND

7. Small-scale replacement

Small-scale replacement	200,000	(US$/year)
	4,188,800,000	VND/year

1USD= 20944

8. Cleaning and yard management

1 Outsourcing
2 Day working only

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Fixed staff

	Number	Unit Cost		Cost per year	
	(Persons)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	300	6,283,200	3,600	75,398,400
Worker	2	150	3,141,600	3,600	75,398,400

Temporary staff

	Number(Persons)				Work days		Unit Cost		Cost per year	
	Jan.	Apr.	Jul.	Nov.	(d/each)	(total days)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	1	1	1	5	20	15	314,160	300	6,283,200
Worker	5	5	5	5	5	100	10	209,440	1,000	20,944,000

Total cost for fixed staff and temporary staff

Cost per year	
(US$/m)	(VND/m)
8,500	178,024,000

9. Site Establishment

Office rental	0	Use site office
Rental car fee	40,000	(US$/year)
Telephone Fee	5,000	(US$/year)
Business equipment retal fee	10,000	(US$/year)
office supplies	30,000	(US$/year)
the others(water supply etc…)	15,000	(US$/year)
sum	100,000	(US$/year)
	2,094,400,000	VND/year

Innova	18,000	US$/year
Sedan	22,000	US$/year
1USD=	20944	VND/year

Bay Mau STP: Operation & Maintenance Cost

	Items			1	2	3	4	5	6	7
1	Labor cost		US$	194,805	194,805	194,805	194,805	194,805	194,805	194,805
			VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost	US$	259,059	259,059	259,059	259,059	259,059	259,059	259,059
			VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)	US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
			VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables	US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
			VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Total	US$	332,634	332,634	332,634	332,634	332,634	332,634	332,634
			VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals		US$	100,567	100,567	100,567	100,567	100,567	100,567	100,567
			VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost		US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
			VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost		US$	60,609	60,609	60,609	60,609	60,609	60,609	60,609
			VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs		US$	0	0	297,000	297,000	297,000	297,000	297,000
			VND	0	0	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000
7	Small-scall replacement		US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
			VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
			VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site Establishment		US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
			VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$	4,034	4,034	5,222	5,222	5,222	5,222	5,222
			VND	84,493,214	84,493,214	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686
	Total(1-10)		US$	1,012,598	1,012,598	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786
			VND	21,207,796,634	21,207,796,634	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106
11	Provisional sum for contingency	(5%of1-10)	US$	50,630	50,630	65,539	65,539	65,539	65,539	65,539
			VND	1,060,389,832	1,060,389,832	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
12	Overhead	(6.5%of1-10)	US$	65,819	65,819	85,201	85,201	85,201	85,201	85,201
			VND	1,378,506,781	1,378,506,781	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997
13	Profit	(5%of1-10)	US$	50,630	50,630	65,539	65,539	65,539	65,539	65,539
			VND	1,060,389,832	1,060,389,832	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
	Grand Total(1-13)		US$	1,179,677	1,179,677	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066
			VND	24,707,083,078	24,707,083,078	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Unit Treatment Cost during contract period		(US$/m³)	0.30
Amount of Influent per year (m3/year)	5,110,000	(VNDm³)	6,117
		(JP¥m³)	24.95

Bay Mau STP: Operation & Maintenance Cost

	Items				8	9	10	11	12	13	14
1	Labor cost			US$	194,805	194,805	194,805	194,805	194,805	194,805	194,805
				VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost		US$	259,059	259,059	259,059	259,059	259,059	259,059	259,059
				VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Total		US$	332,634	332,634	332,634	332,634	332,634	332,634	332,634
				VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals			US$	100,567	100,567	100,567	100,567	100,567	100,567	100,567
				VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	60,609	60,609	60,609	60,609	60,609	60,609	60,609
				VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs			US$	297,000	297,000	297,000	297,000	297,000	297,000	297,000
				VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site Establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	5,222	5,222	5,222
				VND	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686
	Total(1-10)			US$	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786
				VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106
11	Provisional sum for contingency		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
12	Overhead		(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	85,201	85,201	85,201
				VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997
13	Profit		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
	Grand Total(1-13)			US$	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066
				VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

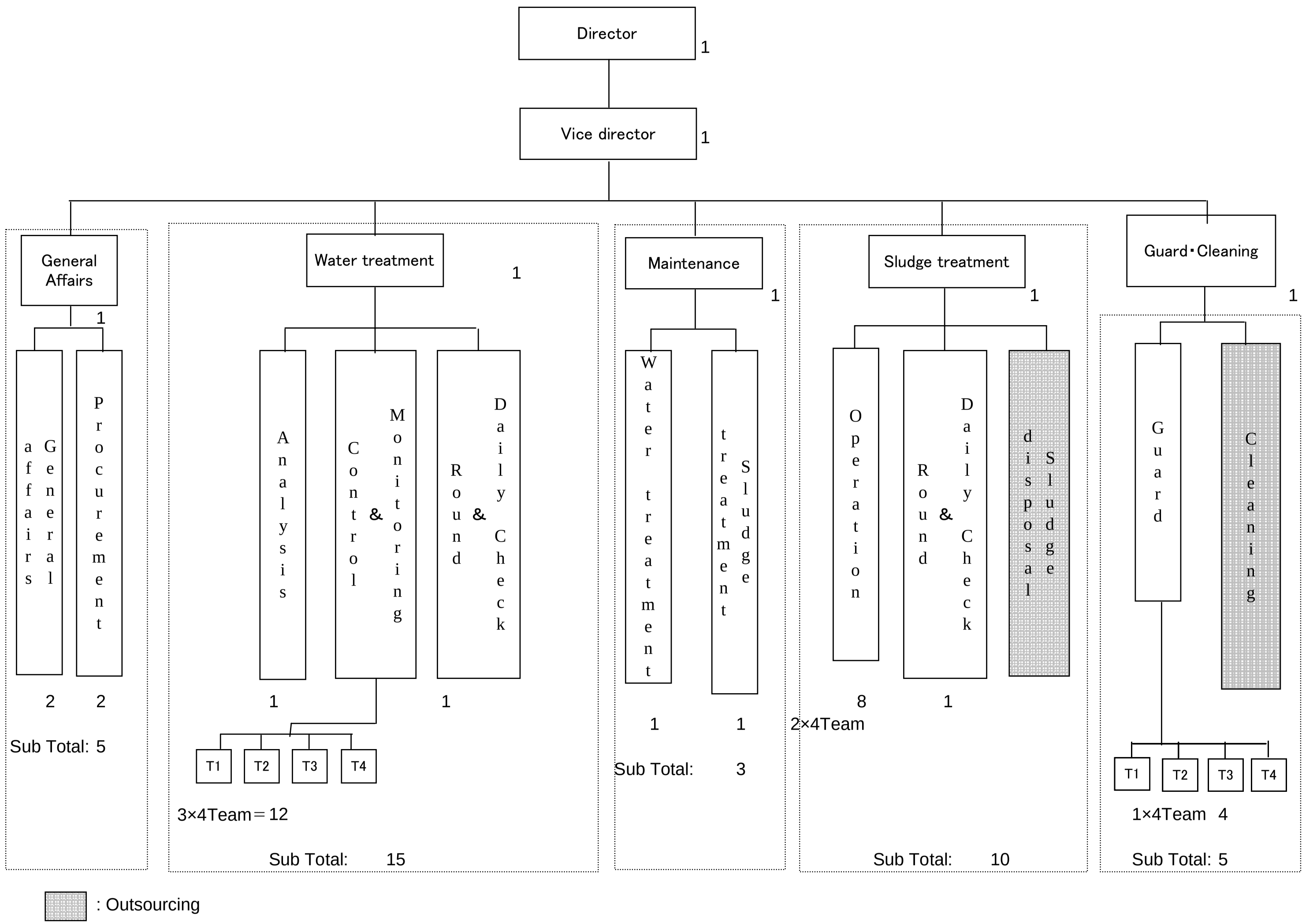
Bay Mau STP: Operation & Maintenance Cost

	Items				15	16	17	18	19	20	Sub Total
1	Labor cost			US$	194,805	194,805	194,805	194,805	194,805	194,805	3,896,104
				VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	81,600,000,000
2	Utilities	Electricity consumtion cost		US$	259,059	259,059	259,059	259,059	259,059	259,059	5,181,176
				VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	108,514,560,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	471,500
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	1,000,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	20,944,000,000
		Total		US$	332,634	332,634	332,634	332,634	332,634	332,634	6,652,676
				VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	139,333,360,000
3	Chemicals			US$	100,567	100,567	100,567	100,567	100,567	100,567	2,011,340
				VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	42,124,708,400
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	228,969
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	4,795,520,000
5	Sludge disposal cost			US$	60,609	60,609	60,609	60,609	60,609	60,609	1,212,185
				VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	25,388,000,000
6	Repairs			US$	297,000	297,000	297,000	297,000	297,000	297,000	5,346,000
				VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	111,966,624,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	170,000
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	3,560,480,000
9	Site Establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	5,222	5,222	102,069
				VND	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	2,137,730,770
Total(1-10)				US$	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	25,619,343
				VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	536,570,423,170
11	Provisional sum for contingency		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	1,280,967
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	26,828,521,158
12	Overhead		(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	85,201	85,201	1,665,257
				VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	34,877,077,506
13	Profit		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	1,280,967
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	26,828,521,158
Grand Total(1-13)				US$	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	29,846,535
				VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	625,104,542,993

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Framework plan for O&M of Bay Mau STP
Dewatering only in field of sludge treatment

Total: 40



Mass Balance

Influent

Q	14,000	m^3/d
SS	120	mg/L

Influent

Sidestream

Q	259	m^3/d
SS	831	mg/L
DS	0.215	t/d

table for data of sidestream

Q	297
DS	0.245
SS	825

Inflow

Q	14,259	m^3/d
SS	133	mg/L
DS	1.895	t/d

Primary Settling Tank

Primary Sludge

Q	57	m^3/d
SS	10,000	mg/L
DS	0.569	t/d

Gravity Thickner

Gravity Thickened Sludge

Q	23	m^3/d
SS	20,000	mg/L
DS	0.455	t/d

Collection Ratio 80 %

Supernatant

Q	34	m^3/d
SS	3,333	mg/L
DS	0.114	t/d

Inflow

Q	14,202	m^3/d
SS	93	mg/L
DS	1.327	t/d

Activated Sludge Tank

Return Ratio 40 %

Return Sludge

Q	5,681	m^3/d
SS	4,500	mg/L
DS	34.463	t/d

Mechanical Thickner

Mechanical Thickened Sludge

Q	26	m^3/d
SS	40,000	mg/L
DS	1.058	t/d

Collection Ratio 95 %

Supernatant

Q	221	m^3/d
SS	252	mg/L
DS	0.056	t/d

Inflow

Q	19,883	m^3/d
SS	1,800	mg/L
DS	35.789	t/d

Final Settling Tank

Excess Sludge

Q	247	m^3/d
SS	4,500	mg/L
DS	1.113	t/d

Effluent

Q	13,955	m^3/d
SS	15	mg/L
DS	0.209	t/d

Effluent

Input

Q	49	m^3/d
SS	30,753	mg/L
DS	1.513	t/d

Collection Ratio 95 %

Dewatering Machine

Disposal

Supernatant

Q	42	m^3/d
SS	1,801	mg/L
DS	0.076	t/d

Cake

Q	7	m^3/d
SS	200,000	mg/L
DS	1.437	t/d

Moisture Contents 80 %

Modifying Point

1 primary sludge DS is calculated using collection ratio 30%

2 Return sludge & Excess sludge concentration is calculated using return ratio 40%

3 Side stream data is input manually from table under because avoiding recirculation problem in mass balance sheet.

1. Labor Cost

	Works items	Jobs Category	Numbers (Persons)	Grade	Labor unit cost		Sub total (year)		Remarks
					VND(month)	VND(year)	VND	US$	
	Unit price		1		2,000,000	24,000,000			
1	Director	-	1	7	14,000,000	168,000,000	168,000,000	8,021	
2	Vice Director	-	1	6	12,000,000	144,000,000	144,000,000	6,875	
3	General affairs	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		General	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Procurement	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Sub total	5				504,000,000	24,064	
4	Water treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water analysis	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Monitoring & Control	12	4	8,000,000	96,000,000	1,152,000,000	55,004	
		Daily check & Round	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Sub total	15				1,464,000,000	69,901	
5	Maintenance	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water treatment	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Sludge treatment	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Sub total	3				312,000,000	14,897	
6	Sludge treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Operation	8	4	8,000,000	96,000,000	768,000,000	36,669	
		Daily check & Round	1	4	8,000,000	96,000,000	96,000,000	4,584	
		Sludge disposal							Outsourcing
		Sub total	10				984,000,000	46,982	
7	Guards	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Guards	4	4	8,000,000	96,000,000	384,000,000	18,335	
		Cleaning							Outsourcing
		Sub total	5				504,000,000	24,064	
Total			40				4,080,000,000	194,805	

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.1 Electricity Consumption & Cost

【Estimating Condition】

Receiving Voltage(kV)	154 kV
Amount of Inlet(m^3/day)	14,000 m^3/day
Unit power consumption（kWh/m^3）	0.8 kWh/m^3
Power consumption（/day）	11,200 kWh/day
Power consumption（/month）	336,000 kWh

【Correction with time zones】

off peak hours	13 hr	182,000.0 (kWh)
low load hours	6 hr	84,000.0 (kWh)
peak hours	5 hr	70,000.0 (kWh)

【Consumption fee】

Cost by category	Industry		Irrigation		HSDC		Commerce	
	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)
off peak hours	935	170,170,000	690	125,580,000	1,139	207,298,000	1,648	299,936,000
low load hours	518	43,512,000	218	18,312,000	708	59,472,000	902	75,768,000
peak hours	1,825	127,750,000	1,269	88,830,000	2,061	144,270,000	2,943	206,010,000
Consumption fee(/month)		341,432,000		232,722,000		411,040,000		581,714,000
Consumption fee(/year)		4,097,184,000		2,792,664,000		4,932,480,000		6,980,568,000
VAT	10%	409,718,400	10%	279,266,400	10%	493,248,000	10%	698,056,800
Consumption fee including VAT		4,506,902,400		3,071,930,400		5,425,728,000		7,678,624,800

2.2 Diesel oil consumption for emergency electric generator

1. Condition

1	Electric power failure frequency	once per a week
2	Electric power failure time	1hr per a failure

Hereafter, it needs to calculate it with detail status of hanoi and apply cost estimation.

2. Estimation

Electric power failure frequency		Unit diesel oil usage	Total diesel oil usage	Unit diesel oil cost	diesel oil cost	
(times/week)	(times/year)	(L/1 blackout)	(L/year)	(VND/L)	(VND/y)	(US$/y)
1	52	450	23,400	21,100	493,740,000	23,574

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.3 Consumables

Fat and fatty oil	Grease
Supplies for recording	Indicator paper
	Chart paper
	Cartridge, Ribbon
	Ink, Pen
Maintenance supplies	Bolts, Nuts
	Packing
	V belt
	Bearing
	Coating materials
	Insulating tape
Lamp supplies	Display Lamp
	Fuse
	Lighting Lamp
	Mercury lamp
	Fluorescent lamp, tube
Supplies for daily water analysis	Instruments
	Chemicals
	Fuels
Supplies for planting works	Cutting blade for mower
	Fuels

1USD= 20944 VND

Total	50,000 USD/year
	1,047,200,000 VND/year

3. Chemical Demands

1. Estimation

1	**Polymer**						
	Amount of Sludge	Amount of Polymer		Unit price		Price for Polymer	
	(DS-t/d)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	VND/y)	(US$/y)
	1.44	29	10,585	167,552	8	1,773,537,920	84,680
2	**NaClO**(10%)						
	Additive rate	Amount of $NaOCl_3$		Unit price		Price for NaClO	
	(mg/L)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
	2	239	87,235	3,500	0.17	305,322,500	14,578
3	**$FeCl_3$**						
		Amount of $FeCl_3$		Unit price		Price for $FeCl_3$	
		(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
		5	1,825	15,000	0.72	27,375,000	1,307
Total						2,106,235,420	100,565

2. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

4. Legal inspection cost

1. Condition

1 The number of implementaion without water quality analysis is once per year.

→ Hereafter, it needs to survey vietnam's law concerned official inspection and apply cost estimation.

2. Estimation

High-voltage Electricity		Crane		Elevator		Firefighting equipment		Total	
(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)
2,000	41,888,000	1,000	20,944,000		0.0	1,000	20,944,000	4,000	83,776,000

Water Quality Analysis
As TCVN5945-2005

Items	Frequency	Unit Cost		Cost	
(-)	(/year)	(VND)	(US$)	(VND)	(US$)
37	12	13,000,000	620.7	156,000,000	7,448

Total Cost

Cost	
(VND)	(US$)
239,776,000	11,448

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5. Sludge disposal

1. Condition

1 Sludge disposal is outsourced to URENCO, and method is landfill.

2. Estimation

Sludge generation		Unit disposal price		Disposal price	
(ws-t/d)	(ws-t/y)	(VND/t)	($/t)	(VND/y)	(US$/y)
7.9	2,885	440,000	21.1	1,269,400,000	60,609

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

6. Repairs

1USD= 20,944 VND

Initial Investment of Equipment		26,730,000	USD
		559,833,120,000	VND
Repair Cost for Equipment (20 years)	20%	5,346,000	USD
		111,966,624,000	VND
Annual Repair Cost (18-year average)		297,000	USD
		6,220,368,000	VND

7. Small-scale replacement

Small-scale replacement	200,000	(US$/year)
	4,188,800,000	VND/year

1USD= 20944

8. Cleaning and yard management

1 Outsourcing	JP¥/USD	83.15
2 Day working only	VND/US$	20,944
	JP¥/VND	0.00397

Fixed staff

	Number	Unit Cost		Cost per year	
	(Persons)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	300	6,283,200	3,600	75,398,400
Worker	2	150	3,141,600	3,600	75,398,400

Temporary staff

	Number(Persons)				Work days		Unit Cost		Cost per year	
	Jan.	Apr.	Jul.	Nov.	(d/each)	(total days)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	1	1	1	5	20	15	314,160	300	6,283,200
Worker	5	5	5	5	5	100	10	209,440	1,000	20,944,000

Total cost for fixed staff and temporary staff

Cost per year	
(US$/m)	(VND/m)
8,500	178,024,000

9. Site Establishment

Office rental	0	Use site office
Rental car fee	40,000	(US$/year)
Telephone Fee	5,000	(US$/year)
Business equipment retal fee	10,000	(US$/year)
office supplies	30,000	(US$/year)
the others(water supply etc…)	15,000	(US$/year)
sum	100,000	(US$/year)
	2,094,400,000	VND/year

Innova	18,000	US$/year
Sedan	22,000	US$/year
1USD=	20944	VND/year

Phu Do STP: Operation & Maintenance Cost

No.	Items			Unit	1	2	3	4	5	6	7
1	Labor cost			US$	297,937	297,937	297,937	297,937	297,937	297,937	297,937
				VND	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000
2	Utilities	Electricity consumtion cost		US$	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059
				VND	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634
				VND	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000
3	Chemicals			US$	601,395	601,395	601,395	601,395	601,395	601,395	601,395
				VND	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	363,655	363,655	363,655	363,655	363,655	363,655	363,655
				VND	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000
6	Repairs			US$	0	0	671,000	671,000	671,000	671,000	671,000
				VND	0	0	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	12,858	12,858	15,542	15,542	15,542	15,542	15,542
				VND	252,716,052	252,716,052	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748
	Total Direct Cost (1-10)			US$	3,029,428	3,029,428	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112
				VND	63,431,729,092	63,431,729,092	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788
11	Provisional sum for contingency		(5%of1-10)	US$	151,471	151,471	185,156	185,156	185,156	185,156	185,156
				VND	3,171,586,455	3,171,586,455	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339
12	Overhead		(6.5%of1-10)	US$	196,913	196,913	240,702	240,702	240,702	240,702	240,702
				VND	4,123,062,391	4,123,062,391	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841
13	Profit		(5%of1-10)	US$	151,471	151,471	185,156	185,156	185,156	185,156	185,156
				VND	3,171,586,455	3,171,586,455	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339
	Total Cost (1-13)			US$	3,529,284	3,529,284	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126
				VND	73,897,964,392	73,897,964,392	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Unit Treatment Cost during contract period		(US\$/m^3)	0.14
Amount of Influent per year (m3/year)	30,660,000	(VNDm^3)	2,893
		(JP¥m^3)	11.64

Phu Do STP: Operation & Maintenance Cost

	Items				8	9	10	11	12	13	14
1	Labor cost			US$	297,937	297,937	297,937	297,937	297,937	297,937	297,937
				VND	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000
2	Utilities	Electricity consumtion cost		US$	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059
				VND	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634
				VND	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000
3	Chemicals			US$	601,395	601,395	601,395	601,395	601,395	601,395	601,395
				VND	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	363,655	363,655	363,655	363,655	363,655	363,655	363,655
				VND	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000
6	Repairs			US$	671,000	671,000	671,000	671,000	671,000	671,000	671,000
				VND	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	15,542	15,542	15,542	15,542	15,542	15,542	15,542
				VND	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748
Total Direct Cost (1-10)				US$	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112
				VND	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788
11	Provisional sum for contingency		(5%of1-10)	US$	185,156	185,156	185,156	185,156	185,156	185,156	185,156
				VND	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339
12	Overhead		(6.5%of1-10)	US$	240,702	240,702	240,702	240,702	240,702	240,702	240,702
				VND	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841
13	Profit		(5%of1-10)	US$	185,156	185,156	185,156	185,156	185,156	185,156	185,156
				VND	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339
Total Cost (1-13)				US$	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126
				VND	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

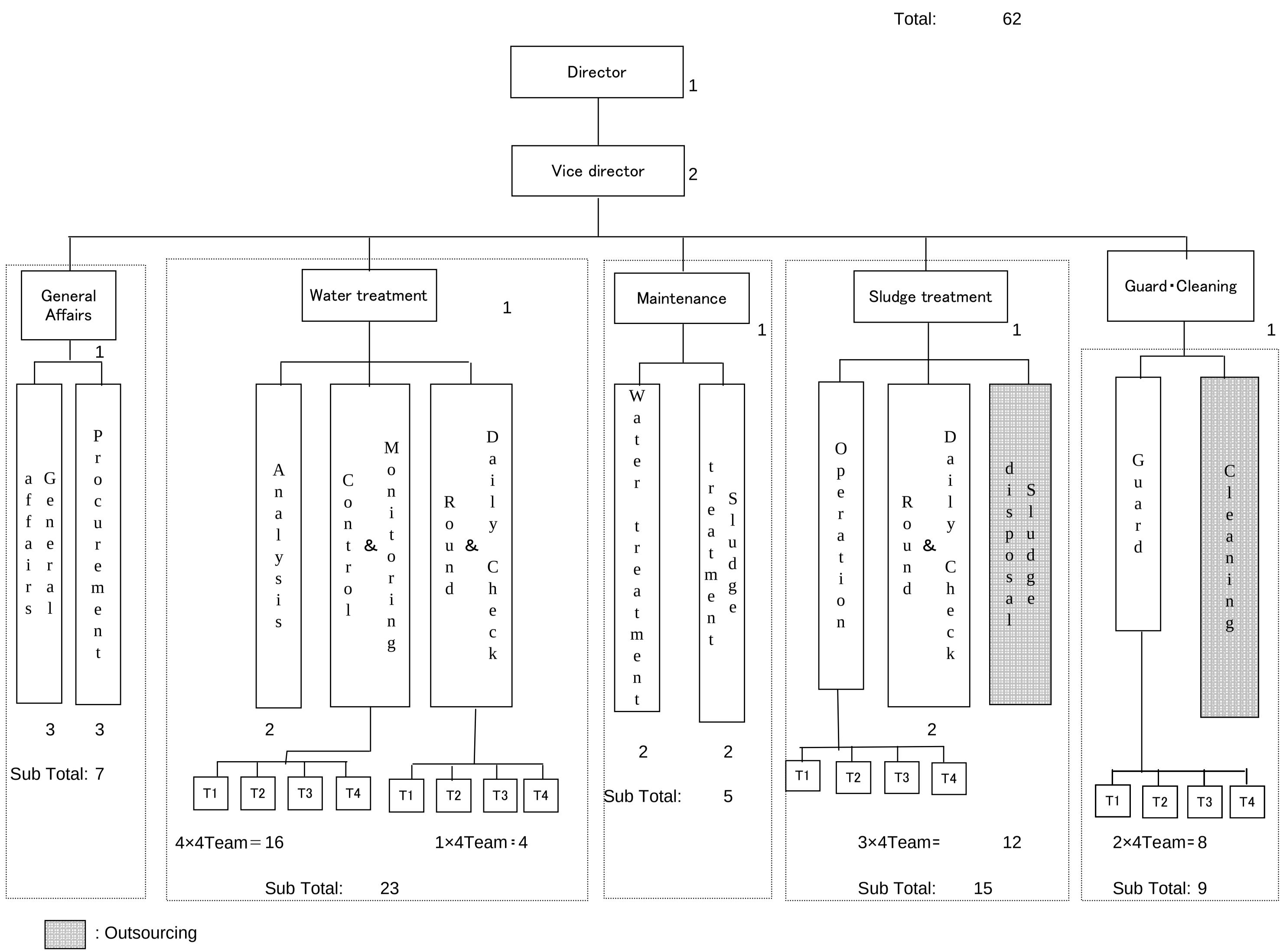
Phu Do STP: Operation & Maintenance Cost

	Items				15	16	17	18	19	20	Sub Total
1	Labor cost			US$	297,937	297,937	297,937	297,937	297,937	297,937	5,958,747
				VND	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	124,800,000,000
2	Utilities	Electricity consumtion cost		US$	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	27,201,176
				VND	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	569,701,440,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	471,500
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	1,000,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	20,944,000,000
		Sub Total		US$	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	28,672,676
				VND	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	600,520,240,000
3	Chemicals			US$	601,395	601,395	601,395	601,395	601,395	601,395	12,027,900
				VND	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	251,912,020,800
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	228,969
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	4,795,520,000
5	Sludge disposal cost			US$	363,655	363,655	363,655	363,655	363,655	363,655	7,273,109
				VND	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	152,328,000,000
6	Repairs			US$	671,000	671,000	671,000	671,000	671,000	671,000	12,078,000
				VND	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	252,961,632,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	170,000
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	3,560,480,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	15,542	15,542	15,542	15,542	15,542	15,542	305,473
				VND	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748	6,066,167,571
Total Direct Cost (1-10)				US$	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112	72,714,874
				VND	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	1,522,608,060,371
11	Provisional sum for contingency		(5%of1-10)	US$	185,156	185,156	185,156	185,156	185,156	185,156	3,635,744
				VND	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	76,130,403,019
12	Overhead		(6.5%of1-10)	US$	240,702	240,702	240,702	240,702	240,702	240,702	4,726,467
				VND	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	98,969,523,924
13	Profit		(5%of1-10)	US$	185,156	185,156	185,156	185,156	185,156	185,156	3,635,744
				VND	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	76,130,403,019
Total Cost (1-13)				US$	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126	84,712,828
				VND	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	1,773,838,390,332

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

0
0

Framework plan for O&M of Phu Do STP
Dewatering only in field of sludge treatment



Mass Balance

Influent

Q	84,000	m^3/d
SS	120	mg/L

Influent

Inflow

Q	85,554	m^3/d
SS	133	mg/L
DS	11.371	t/d

Primary Settling Tank

Inflow

Q	85,213	m^3/d
SS	93	mg/L
DS	7.960	t/d

Activated Sludge Tank

Inflow

Q	119,298	m^3/d
SS	1,800	mg/L
DS	214.736	t/d

Final Settling Tank

Effluent

Q	83,728	m^3/d
SS	15	mg/L
DS	1.256	t/d

Effluent

Return Ratio 40 %

Sidestream

Q	1,554	m^3/d
SS	831	mg/L
DS	1.291	t/d

table for data of sidestream

Q	1,783
DS	1.470
SS	825

Primary Sludge

Q	341	m^3/d
SS	10,000	mg/L
DS	3.411	t/d

Return Sludge

Q	34,085	m^3/d
SS	4,500	mg/L
DS	206.777	t/d

Gravity Thickner

Mechanical Thickner

Excess Sludge

Q	1,485	m^3/d
SS	4,500	mg/L
DS	6.682	t/d

Gravity Thickened Sludge

Q	136	m^3/d
SS	20,000	mg/L
DS	2.729	t/d

Collection Ratio 80 %

Mechanical Thickened Sludge

Q	159	m^3/d
SS	40,000	mg/L
DS	6.347	t/d

Collection Ratio 95 %

Input

Q	295	m^3/d
SS	30,753	mg/L
DS	9.076	t/d

Collection Ratio 95 %

Dewatering Machine

Disposal

Cake

Q	43	m^3/d
SS	200,000	mg/L
DS	8.623	t/d

Moisture Contents 80 %

Supernatant (Gravity Thickner)

Q	205	m^3/d
SS	3,333	mg/L
DS	0.682	t/d

Supernatant (Mechanical Thickner)

Q	1,326	m^3/d
SS	252	mg/L
DS	0.334	t/d

Supernatant (Dewatering Machine)

Q	252	m^3/d
SS	1,801	mg/L
DS	0.454	t/d

Modifying Point

1 primary sludge DS is calculated using collection ratio 30%
2 Return sludge & Excess sludge concentration is calculated using return ratio 40%
3 Side stream data is input manually from table under because avoiding recirculation problem in mass balance sheet.

1. Labor Cost

	Works items	Jobs Category	Numbers (Persons)	Grade	Labor unit cost		Sub total (year)		Remarks
					VND(month)	VND(year)	VND	US$	
	Unit price		1		2,000,000	24,000,000			
1	Director	-	1	7	14,000,000	168,000,000	168,000,000	8,021	
2	Vice Director	-	2	6	12,000,000	144,000,000	288,000,000	13,751	
3	General affairs	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		General	3	4	8,000,000	96,000,000	288,000,000	13,751	
		Procurement	3	4	8,000,000	96,000,000	288,000,000	13,751	
		Sub total	7				696,000,000	33,231	
4	Water treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water analysis	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Monitoring & Control	16	4	8,000,000	96,000,000	1,536,000,000	73,338	
		Daily check & Round	4	4	8,000,000	96,000,000	384,000,000	18,335	
		Sub total	23				2,232,000,000	106,570	
5	Maintenance	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Water treatment	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Sludge treatment	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Sub total	5				504,000,000	24,064	
6	Sludge treatment	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Operation	12	4	8,000,000	96,000,000	1,152,000,000	55,004	
		Daily check & Round	2	4	8,000,000	96,000,000	192,000,000	9,167	
		Sludge disposal							Outsourcing
		Sub total	15				1,464,000,000	69,901	
7	Guards	Manager	1	5	10,000,000	120,000,000	120,000,000	5,730	
		Guards	8	4	8,000,000	96,000,000	768,000,000	36,669	
		Cleaning							Outsourcing
		Sub total	9				888,000,000	42,399	
Total			62				6,240,000,000	297,937	

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.1 Electricity Consumption & Cost

【Estimating Condition】

Receiving Voltage(kV)	154 kV
Amount of Inlet(m^3/day)	84,000 m^3/day
Unit power consumption（kWh/m^3）	0.7 kWh/m^3
Power consumption（/day）	58,800 kWh/day
Power consumption（/month）	1,764,000 kWh

【Correction with time zones】

off peak hours	13 hr	955,500.0 (kWh)
low load hours	6 hr	441,000.0 (kWh)
peak hours	5 hr	367,500.0 (kWh)

【Consumption fee】

Cost by category	Industry		Irrigation		HSDC		Commerce	
	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)	Unit cost(VND)	sum(VND)
off peak hours	935	893,392,500	690	659,295,000	1,139	1,088,314,500	1,648	1,574,664,000
low load hours	518	228,438,000	218	96,138,000	708	312,228,000	902	397,782,000
peak hours	1,825	670,687,500	1,269	466,357,500	2,061	757,417,500	2,943	1,081,552,500
Consumption fee(/month)		1,792,518,000		1,221,790,500		2,157,960,000		3,053,998,500
Consumption fee(/year)		21,510,216,000		14,661,486,000		25,895,520,000		36,647,982,000
VAT	10%	2,151,021,600	10%	1,466,148,600	10%	2,589,552,000	10%	3,664,798,200
Consumption fee including VAT		23,661,237,600		16,127,634,600		28,485,072,000		40,312,780,200

2.2 Diesel oil consumption for emergency electric generator

1. Condition

1	Electric power failure frequency	once per a week
2	Electric power failure time	1hr per a failure

Hereafter, it needs to calculate it with detail status of hanoi and apply cost estimation.

2. Estimation

Electric power failure frequency		Unit diesel oil usage	Total diesel oil usage	Unit diesel oil cost	diesel oil cost	
(times/week)	(times/year)	(L/1 blackout)	(L/year)	(VND/L)	(VND/y)	(US$/y)
1	52	450	23,400	21,100	493,740,000	23,574

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

2.3 Consumables

Fat and fatty oil	Grease
Supplies for recording	Indicator paper
	Chart paper
	Cartridge, Ribbon
	Ink, Pen
Maintenance supplies	Bolts, Nuts
	Packing
	V belt
	Bearing
	Coating materials
	Insulating tape
Lamp supplies	Display Lamp
	Fuse
	Lighting Lamp
	Mercury lamp
	Fluorescent lamp, tube
Supplies for daily water analysis	Instruments
	Chemicals
	Fuels
Supplies for planting works	Cutting blade for mower
	Fuels

1USD= 20944 VND

Total	50,000 USD/year
	1,047,200,000 VND/year

3. Chemical Demands

1. Estimation

1	**Polymer**						
	Amount of Sludge	Amount of Polymer		Unit price		Price for Polymer	
	(DS-t/d)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	VND/y)	(US$/y)
	8.62	173	63,145	167,552	8	10,580,071,040	505,160
2	**$NaOCl_3$**(10%)						
	Additive rate	Amount of $NaOCl_3$		Unit price		Price for NaClO	
	(mg/L)	(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
	2	1,432	522,680	3,500	0.17	1,829,380,000	87,346
3	**$FeCl_3$**						
		Amount of $FeCl_3$		Unit price		Price for FeCl3	
		(kg/d)	(kg/y)	(VND/kg)	(US$/kg)	(VND/y)	(US$/y)
		34	12,410	15,000	0.72	186,150,000	8,888
Total						12,595,601,040	601,394

2. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

4. Legal inspection cost

1. Condition

1 The number of implementaion without water quality analysis is once per year.

→ Hereafter, it needs to survey vietnam's law concerned official inspection and apply cost estimation.

2. Estimation

High-voltage Electricity		Crane		Elevator		Firefighting equipment		Total	
(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)	(US$/y)	(VND/y)
2,000	41,888,000	1,000	20,944,000		0.0	1,000	20,944,000	4,000	83,776,000

Water Quality Analysis
As TCVN5945-2005

Items	Frequency	Unit Cost		Cost	
(-)	(/year)	(VND)	(US$)	(VND)	(US$)
37	12	13,000,000	620.7	156,000,000	7,448

Total Cost

Cost	
(VND)	(US$)
239,776,000	11,448

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5. Sludge disposal

1. Condition

1 Sludge disposal is outsourced to URENCO, and method is landfill.

2. Estimation

Sludge generation		Unit disposal price		Disposal price	
(ws-t/d)	(ws-t/y)	(VND/t)	($/t)	(VND/y)	(US$/y)
47.4	17,310	440,000	21.1	7,616,400,000	363,655

3. Exchange rates

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

6. Repairs

1USD= 20,944 VND

Initial Investment of Equipment		60,390,000	USD
		1,264,808,160,000	VND
Repair Cost for Equipment (20 years)	20%	12,078,000	USD
		252,961,632,000	VND
Annual Repair Cost (18-year average)		671,000	USD
		14,053,424,000	VND

7. Small-scale replacement

Small-scale replacement	200,000	(US$/year)
	4,188,800,000	VND/year

1USD= 20944

8. Cleaning and yard management

1 Outsourcing
2 Day working only

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Fixed staff

	Number	Unit Cost		Cost per year	
	(Persons)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	300	6,283,200	3,600	75,398,400
Worker	2	150	3,141,600	3,600	75,398,400

Temporary staff

	Number(Persons)				Work days		Unit Cost		Cost per year	
	Jan.	Apr.	Jul.	Nov.	(d/each)	(total days)	(US$/m)	(VND/m)	(US$/m)	(VND/m)
Manager	1	1	1	1	5	20	15	314,160	300	6,283,200
Worker	5	5	5	5	5	100	10	209,440	1,000	20,944,000

Total cost for fixed staff and temporary staff

Cost per year	
(US$/m)	(VND/m)
8,500	178,024,000

9. Site Establishment

Office rental	0	Use site office
Rental car fee	40,000	(US$/year)
Telephone Fee	5,000	(US$/year)
Business equipment retal fee	10,000	(US$/year)
office supplies	30,000	(US$/year)
the others(water supply etc…)	15,000	(US$/year)
sum	100,000	(US$/year)
	2,094,400,000	VND/year

Innova	18,000	US$/year
Sedan	22,000	US$/year
1USD=	20944	VND/year

5 STPs: Total Operation & Maintenance Cost (15 years)

Yen So in service

	Items				2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630
				VND	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113
				VND	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000
3	Chemicals			US$	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908
				VND	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	865,903	865,903	865,903	865,903	865,903	865,903
				VND	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000
6	Repairs			US$	0	0	1,105,988	1,105,988	1,105,988	1,105,988
				VND	0	0	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	29,057	29,057	33,481	33,481	33,481	33,481
				VND	488,853,013	488,853,013	581,508,268	581,508,268	581,508,268	581,508,268
	Total Direct Cost (1-10)			US$	7,293,205	7,293,205	8,403,617	8,403,617	8,403,617	8,403,617
				VND	122,702,106,293	122,702,106,293	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384
11	Provisional sum for contingency		(5%of1-10)	US$	364,660	364,660	420,181	420,181	420,181	420,181
				VND	6,135,105,315	6,135,105,315	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
12	Overhead		(6.5%of1-10)	US$	474,058	474,058	546,235	546,235	546,235	546,235
				VND	7,975,636,909	7,975,636,909	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400
13	Profit		(5%of1-10)	US$	364,660	364,660	420,181	420,181	420,181	420,181
				VND	6,135,105,315	6,135,105,315	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
	Total Cost (1-13)			US$	8,496,584	8,496,584	9,790,214	9,790,214	9,790,214	9,790,214
				VND	142,947,953,831	142,947,953,831	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5 STPs: Total Operation & Maintenance Cost

Yen Xa & Ho Tay in service

Bay Mau in service

Phu Do in service

No.	Items			Unit	2018 (7)	2019 (8)	2020 (9)	2021 (10)	2022 (11)	2023 (12)	2024 (13)
1	Labor cost			US$	937,357	937,357	1,132,162	1,132,162	1,430,099	1,430,099	1,430,099
				VND	19,632,000,000	19,632,000,000	23,712,000,000	23,712,000,000	29,952,000,000	29,952,000,000	29,952,000,000
2	Utilities	Electricity consumtion cost		US$	6,781,790	6,781,790	7,040,849	7,040,849	8,400,908	8,400,908	8,400,908
				VND	142,037,808,000	142,037,808,000	147,463,536,000	147,463,536,000	175,948,608,000	175,948,608,000	175,948,608,000
		Oils(for emergency generator)		US$	418,426	70,725	94,300	94,300	117,875	117,875	117,875
				VND	1,481,220,000	1,481,220,000	1,974,960,000	1,974,960,000	2,468,700,000	2,468,700,000	2,468,700,000
		Consumables		US$	150,000	150,000	200,000	200,000	250,000	250,000	250,000
				VND	3,141,600,000	3,141,600,000	4,188,800,000	4,188,800,000	5,236,000,000	5,236,000,000	5,236,000,000
		Sub Total		US$	8,779,124	8,431,423	8,764,057	8,764,057	10,197,691	10,197,691	10,197,691
				VND	146,660,628,000	146,660,628,000	153,627,296,000	153,627,296,000	183,653,308,000	183,653,308,000	183,653,308,000
3	Chemicals			US$	3,459,474	3,459,474	3,560,041	3,560,041	4,161,436	4,161,436	4,161,436
				VND	72,455,142,600	72,455,142,600	74,561,378,020	74,561,378,020	87,156,979,060	87,156,979,060	87,156,979,060
4	Legal inspection cost			US$	34,345	34,345	45,794	45,794	57,242	57,242	57,242
				VND	719,328,000	719,328,000	803,104,000	803,104,000	1,042,880,000	1,042,880,000	1,042,880,000
5	Sludge disposal cost			US$	2,095,462	2,095,462	2,156,071	2,156,071	2,519,727	2,519,727	2,519,727
				VND	43,887,360,000	43,887,360,000	45,156,760,000	45,156,760,000	52,773,160,000	52,773,160,000	52,773,160,000
6	Repairs			US$	1,105,988	1,105,988	3,165,433	3,165,433	3,462,433	3,462,433	4,133,433
				VND	23,163,813,836	23,163,813,836	66,296,818,280	66,296,818,280	72,517,186,280	72,517,186,280	86,570,610,280
7	Small-scall replacement			US$	600,000	600,000	800,000	800,000	1,000,000	1,000,000	1,000,000
				VND	12,566,400,000	12,566,400,000	16,755,200,000	16,755,200,000	20,944,000,000	20,944,000,000	20,944,000,000
8	Cleaning and yard maintennance			US$	25,500	25,500	34,000	34,000	42,500	42,500	42,500
				VND	534,072,000	534,072,000	712,096,000	712,096,000	890,120,000	890,120,000	890,120,000
9	Site establishment			US$	300,000	300,000	400,000	400,000	500,000	500,000	500,000
				VND	6,283,200,000	6,283,200,000	8,377,600,000	8,377,600,000	10,472,000,000	10,472,000,000	10,472,000,000
10	Insurance		(0.4%of1-9)	US$	69,349	67,958	80,230	80,230	94,276	94,276	96,960
				VND	1,303,607,778	1,303,607,778	1,560,009,009	1,560,009,009	1,837,606,533	1,837,606,533	1,893,820,229
	Total Direct Cost (1-10)			US$	17,406,599	17,057,507	20,137,788	20,137,788	23,465,404	23,465,404	24,139,088
				VND	327,205,552,213	327,205,552,213	391,562,261,309	391,562,261,309	461,239,239,873	461,239,239,873	475,348,877,569
11	Provisional sum for contingency		(5%of1-10)	US$	870,330	852,875	1,006,889	1,006,889	1,173,270	1,173,270	1,206,954
				VND	16,360,277,611	16,360,277,611	19,578,113,065	19,578,113,065	23,061,961,994	23,061,961,994	23,767,443,878
12	Overhead		(6.5%of1-10)	US$	1,131,429	1,108,738	1,308,956	1,308,956	1,525,251	1,525,251	1,569,041
				VND	21,268,360,894	21,268,360,894	25,451,546,985	25,451,546,985	29,980,550,592	29,980,550,592	30,897,677,042
13	Profit		(5%of1-10)	US$	870,330	852,875	1,006,889	1,006,889	1,173,270	1,173,270	1,206,954
				VND	16,360,277,611	16,360,277,611	19,578,113,065	19,578,113,065	23,061,961,994	23,061,961,994	23,767,443,878
	Total Cost (1-13)			US$	20,278,688	19,871,996	23,460,523	23,460,523	27,337,195	27,337,195	28,122,037
				VND	381,194,468,328	381,194,468,328	456,170,034,425	456,170,034,425	537,343,714,452	537,343,714,452	553,781,442,368

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5 STPs: Total Operation & Maintenance Cost

No.	Items			Unit	2025 (14)	2026 (15)	Sub Total	Average
1	Labor cost			US$	1,430,099	1,430,099	13,517,189	901,146
				VND	29,952,000,000	29,952,000,000	283,104,000,000	18,873,600,000
2	Utilities	Electricity consumtion cost		US$	8,400,908	8,400,908	86,303,597	5,753,573
				VND	175,948,608,000	175,948,608,000	1,807,542,528,000	120,502,835,200
		Oils(for emergency generator)		US$	117,875	117,875	1,408,576	93,905
				VND	2,468,700,000	2,468,700,000	22,218,300,000	1,481,220,000
		Consumables		US$	250,000	250,000	2,250,000	150,000
				VND	5,236,000,000	5,236,000,000	47,124,000,000	3,141,600,000
		Sub Total		US$	10,197,691	10,197,691	111,395,792	7,426,386
				VND	183,653,308,000	183,653,308,000	1,876,884,828,000	125,125,655,200
3	Chemicals			US$	4,161,436	4,161,436	43,419,658	2,894,644
				VND	87,156,979,060	87,156,979,060	909,380,136,220	60,625,342,415
4	Legal inspection cost			US$	57,242	57,242	515,180	34,345
				VND	1,042,880,000	1,042,880,000	9,697,920,000	646,528,000
5	Sludge disposal cost			US$	2,519,727	2,519,727	26,297,122	1,753,141
				VND	52,773,160,000	52,773,160,000	550,766,920,000	36,717,794,667
6	Repairs			US$	4,133,433	4,133,433	32,291,956	2,152,797
				VND	86,570,610,280	86,570,610,280	676,322,722,973	45,088,181,532
7	Small-scall replacement			US$	1,000,000	1,000,000	9,000,000	600,000
				VND	20,944,000,000	20,944,000,000	188,496,000,000	12,566,400,000
8	Cleaning and yard maintennance			US$	42,500	42,500	382,500	25,500
				VND	890,120,000	890,120,000	8,011,080,000	534,072,000
9	Site establishment			US$	500,000	500,000	4,500,000	300,000
				VND	10,472,000,000	10,472,000,000	94,248,000,000	6,283,200,000
10	Insurance		(0.4%of1-9)	US$	96,960	96,960	969,236	64,616
				VND	1,893,820,229	1,893,820,229	18,387,646,429	1,225,843,095
	Total Direct Cost (1-10)			US$	24,139,088	24,139,088	242,288,633	16,152,576
				VND	475,348,877,569	475,348,877,569	4,615,299,253,622	307,686,616,908
11	Provisional sum for contingency		(5%of1-10)	US$	1,206,954	1,206,954	12,114,432	807,629
				VND	23,767,443,878	23,767,443,878	230,764,962,681	15,384,330,845
12	Overhead		(6.5%of1-10)	US$	1,569,041	1,569,041	15,748,761	1,049,917
				VND	30,897,677,042	30,897,677,042	299,994,451,485	19,999,630,099
13	Profit		(5%of1-10)	US$	1,206,954	1,206,954	12,114,432	807,629
				VND	23,767,443,878	23,767,443,878	230,764,962,681	15,384,330,845
	Total Cost (1-13)			US$	28,122,037	28,122,037	282,266,257	18,817,750
				VND	553,781,442,368	553,781,442,368	5,376,823,630,470	358,454,908,698

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5 STPs: Total Operation & Maintenance Cost (20 years)

Yen So in service

	Items				2012 (1)	2013 (2)	2014 (3)	2015 (4)	2016 (5)	2017 (6)
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630
				VND	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113
				VND	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000
3	Chemicals			US$	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908
				VND	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	865,903	865,903	865,903	865,903	865,903	865,903
				VND	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000
6	Repairs			US$	0	0	1,105,988	1,105,988	1,105,988	1,105,988
				VND	0	0	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	29,057	29,057	33,481	33,481	33,481	33,481
				VND	488,853,013	488,853,013	581,508,268	581,508,268	581,508,268	581,508,268
	Total Direct Cost (1-10)			US$	7,293,205	7,293,205	8,403,617	8,403,617	8,403,617	8,403,617
				VND	122,702,106,293	122,702,106,293	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384
11	Provisional sum for contingency		(5%of1-10)	US$	364,660	364,660	420,181	420,181	420,181	420,181
				VND	6,135,105,315	6,135,105,315	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
12	Overhead		(6.5%of1-10)	US$	474,058	474,058	546,235	546,235	546,235	546,235
				VND	7,975,636,909	7,975,636,909	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400
13	Profit		(5%of1-10)	US$	364,660	364,660	420,181	420,181	420,181	420,181
				VND	6,135,105,315	6,135,105,315	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
	Total Cost (1-13)			US$	8,496,584	8,496,584	9,790,214	9,790,214	9,790,214	9,790,214
				VND	142,947,953,831	142,947,953,831	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5 STPs: Total Operation & Maintenance Cost

Yen Xa & Ho Tay in service

Bay Mau in service

Phu Do in service

				7	8	9	10	11	12	13
	Items			2018	2019	2020	2021	2022	2023	2024
1	Labor cost		US$	937,357	937,357	1,132,162	1,132,162	1,430,099	1,430,099	1,430,099
			VND	19,632,000,000	19,632,000,000	23,712,000,000	23,712,000,000	29,952,000,000	29,952,000,000	29,952,000,000
2	Utilities	Electricity consumtion cost	US$	6,781,790	6,781,790	7,040,849	7,040,849	8,400,908	8,400,908	8,400,908
			VND	142,037,808,000	142,037,808,000	147,463,536,000	147,463,536,000	175,948,608,000	175,948,608,000	175,948,608,000
		Oils(for emergency generator)	US$	418,426	70,725	94,300	94,300	117,875	117,875	117,875
			VND	1,481,220,000	1,481,220,000	1,974,960,000	1,974,960,000	2,468,700,000	2,468,700,000	2,468,700,000
		Consumables	US$	150,000	150,000	200,000	200,000	250,000	250,000	250,000
			VND	3,141,600,000	3,141,600,000	4,188,800,000	4,188,800,000	5,236,000,000	5,236,000,000	5,236,000,000
		Sub Total	US$	8,779,124	8,431,423	8,764,057	8,764,057	10,197,691	10,197,691	10,197,691
			VND	146,660,628,000	146,660,628,000	153,627,296,000	153,627,296,000	183,653,308,000	183,653,308,000	183,653,308,000
3	Chemicals		US$	3,459,474	3,459,474	3,560,041	3,560,041	4,161,436	4,161,436	4,161,436
			VND	72,455,142,600	72,455,142,600	74,561,378,020	74,561,378,020	87,156,979,060	87,156,979,060	87,156,979,060
4	Legal inspection cost		US$	34,345	34,345	45,794	45,794	57,242	57,242	57,242
			VND	719,328,000	719,328,000	803,104,000	803,104,000	1,042,880,000	1,042,880,000	1,042,880,000
5	Sludge disposal cost		US$	2,095,462	2,095,462	2,156,071	2,156,071	2,519,727	2,519,727	2,519,727
			VND	43,887,360,000	43,887,360,000	45,156,760,000	45,156,760,000	52,773,160,000	52,773,160,000	52,773,160,000
6	Repairs		US$	1,105,988	1,105,988	3,165,433	3,165,433	3,462,433	3,462,433	4,133,433
			VND	23,163,813,836	23,163,813,836	66,296,818,280	66,296,818,280	72,517,186,280	72,517,186,280	86,570,610,280
7	Small-scall replacement		US$	600,000	600,000	800,000	800,000	1,000,000	1,000,000	1,000,000
			VND	12,566,400,000	12,566,400,000	16,755,200,000	16,755,200,000	20,944,000,000	20,944,000,000	20,944,000,000
8	Cleaning and yard maintennance		US$	25,500	25,500	34,000	34,000	42,500	42,500	42,500
			VND	534,072,000	534,072,000	712,096,000	712,096,000	890,120,000	890,120,000	890,120,000
9	Site establishment		US$	300,000	300,000	400,000	400,000	500,000	500,000	500,000
			VND	6,283,200,000	6,283,200,000	8,377,600,000	8,377,600,000	10,472,000,000	10,472,000,000	10,472,000,000
10	Insurance	(0.4%of1-9)	US$	69,349	67,958	80,230	80,230	94,276	94,276	96,960
			VND	1,303,607,778	1,303,607,778	1,560,009,009	1,560,009,009	1,837,606,533	1,837,606,533	1,893,820,229
	Total Direct Cost (1-10)		US$	17,406,599	17,057,507	20,137,788	20,137,788	23,465,404	23,465,404	24,139,088
			VND	327,205,552,213	327,205,552,213	391,562,261,309	391,562,261,309	461,239,239,873	461,239,239,873	475,348,877,569
11	Provisional sum for contingency	(5%of1-10)	US$	870,330	852,875	1,006,889	1,006,889	1,173,270	1,173,270	1,206,954
			VND	16,360,277,611	16,360,277,611	19,578,113,065	19,578,113,065	23,061,961,994	23,061,961,994	23,767,443,878
12	Overhead	(6.5%of1-10)	US$	1,131,429	1,108,738	1,308,956	1,308,956	1,525,251	1,525,251	1,569,041
			VND	21,268,360,894	21,268,360,894	25,451,546,985	25,451,546,985	29,980,550,592	29,980,550,592	30,897,677,042
13	Profit	(5%of1-10)	US$	870,330	852,875	1,006,889	1,006,889	1,173,270	1,173,270	1,206,954
			VND	16,360,277,611	16,360,277,611	19,578,113,065	19,578,113,065	23,061,961,994	23,061,961,994	23,767,443,878
	Total Cost (1-13)		US$	20,278,688	19,871,996	23,460,523	23,460,523	27,337,195	27,337,195	28,122,037
			VND	381,194,468,328	381,194,468,328	456,170,034,425	456,170,034,425	537,343,714,452	537,343,714,452	553,781,442,368

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5 STPs: Total Operation & Maintenance Cost

					14	15	16	17	18	19	20
	Items				2025	2026	2027	2028	2029	2030	2031
1	Labor cost			US$	1,430,099	1,430,099	1,430,099	1,430,099	1,430,099	1,430,099	1,430,099
				VND	29,952,000,000	29,952,000,000	29,952,000,000	29,952,000,000	29,952,000,000	29,952,000,000	29,952,000,000
2	Utilities	Electricity consumtion cost		US$	8,400,908	8,400,908	8,400,908	8,400,908	8,400,908	8,400,908	8,400,908
				VND	175,948,608,000	175,948,608,000	175,948,608,000	175,948,608,000	175,948,608,000	175,948,608,000	175,948,608,000
		Oils(for emergency generator)		US$	117,875	117,875	117,875	117,875	117,875	117,875	117,875
				VND	2,468,700,000	2,468,700,000	2,468,700,000	2,468,700,000	2,468,700,000	2,468,700,000	2,468,700,000
		Consumables		US$	250,000	250,000	250,000	250,000	250,000	250,000	250,000
				VND	5,236,000,000	5,236,000,000	5,236,000,000	5,236,000,000	5,236,000,000	5,236,000,000	5,236,000,000
		Sub Total		US$	10,197,691	10,197,691	10,197,691	10,197,691	10,197,691	10,197,691	10,197,691
				VND	183,653,308,000	183,653,308,000	183,653,308,000	183,653,308,000	183,653,308,000	183,653,308,000	183,653,308,000
3	Chemicals			US$	4,161,436	4,161,436	4,161,436	4,161,436	4,161,436	4,161,436	4,161,436
				VND	87,156,979,060	87,156,979,060	87,156,979,060	87,156,979,060	87,156,979,060	87,156,979,060	87,156,979,060
4	Legal inspection cost			US$	57,242	57,242	57,242	57,242	57,242	57,242	57,242
				VND	1,042,880,000	1,042,880,000	1,042,880,000	1,042,880,000	1,042,880,000	1,042,880,000	1,042,880,000
5	Sludge disposal cost			US$	2,519,727	2,519,727	2,519,727	2,519,727	2,519,727	2,519,727	2,519,727
				VND	52,773,160,000	52,773,160,000	52,773,160,000	52,773,160,000	52,773,160,000	52,773,160,000	52,773,160,000
6	Repairs			US$	4,133,433	4,133,433	4,133,433	4,133,433	4,133,433	4,133,433	4,133,433
				VND	86,570,610,280	86,570,610,280	86,570,610,280	86,570,610,280	86,570,610,280	86,570,610,280	86,570,610,280
7	Small-scall replacement			US$	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
				VND	20,944,000,000	20,944,000,000	20,944,000,000	20,944,000,000	20,944,000,000	20,944,000,000	20,944,000,000
8	Cleaning and yard maintennance			US$	42,500	42,500	42,500	42,500	42,500	42,500	42,500
				VND	890,120,000	890,120,000	890,120,000	890,120,000	890,120,000	890,120,000	890,120,000
9	Site establishment			US$	500,000	500,000	500,000	500,000	500,000	500,000	500,000
				VND	10,472,000,000	10,472,000,000	10,472,000,000	10,472,000,000	10,472,000,000	10,472,000,000	10,472,000,000
10	Insurance		(0.4%of1-9)	US$	96,960	96,960	96,960	96,960	96,960	96,960	96,960
				VND	1,893,820,229	1,893,820,229	1,893,820,229	1,893,820,229	1,893,820,229	1,893,820,229	1,893,820,229
Total Direct Cost (1-10)				US$	24,139,088	24,139,088	24,139,088	24,139,088	24,139,088	24,139,088	24,139,088
				VND	475,348,877,569	475,348,877,569	475,348,877,569	475,348,877,569	475,348,877,569	475,348,877,569	475,348,877,569
11	Provisional sum for contingency		(5%of1-10)	US$	1,206,954	1,206,954	1,206,954	1,206,954	1,206,954	1,206,954	1,206,954
				VND	23,767,443,878	23,767,443,878	23,767,443,878	23,767,443,878	23,767,443,878	23,767,443,878	23,767,443,878
12	Overhead		(6.5%of1-10)	US$	1,569,041	1,569,041	1,569,041	1,569,041	1,569,041	1,569,041	1,569,041
				VND	30,897,677,042	30,897,677,042	30,897,677,042	30,897,677,042	30,897,677,042	30,897,677,042	30,897,677,042
13	Profit		(5%of1-10)	US$	1,206,954	1,206,954	1,206,954	1,206,954	1,206,954	1,206,954	1,206,954
				VND	23,767,443,878	23,767,443,878	23,767,443,878	23,767,443,878	23,767,443,878	23,767,443,878	23,767,443,878
Total Cost (1-13)				US$	28,122,037	28,122,037	28,122,037	28,122,037	28,122,037	28,122,037	28,122,037
				VND	553,781,442,368	553,781,442,368	553,781,442,368	553,781,442,368	553,781,442,368	553,781,442,368	553,781,442,368

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

5 STPs: Total Operation & Maintenance Cost

	Items			Sub Total	Average
1	Labor cost		US$	20,667,685	1,033,384
			VND	432,864,000,000	21,643,200,000
2	Utilities	Electricity consumtion cost	US$	128,308,134	6,415,407
			VND	2,687,285,568,000	134,364,278,400
		Oils(for emergency generator)	US$	1,997,951	99,898
			VND	34,561,800,000	1,728,090,000
		Consumables	US$	3,500,000	175,000
			VND	73,304,000,000	3,665,200,000
		Sub Total	US$	162,384,245	8,119,212
			VND	2,795,151,368,000	139,757,568,400
3	Chemicals		US$	64,226,838	3,211,342
			VND	1,345,165,031,520	67,258,251,576
4	Legal inspection cost		US$	801,390	40,070
			VND	14,912,320,000	745,616,000
5	Sludge disposal cost		US$	38,895,756	1,944,788
			VND	814,632,720,000	40,731,636,000
6	Repairs		US$	52,959,118	2,647,956
			VND	1,109,175,774,373	55,458,788,719
7	Small-scall replacement		US$	14,000,000	700,000
			VND	293,216,000,000	14,660,800,000
8	Cleaning and yard maintennance		US$	595,000	29,750
			VND	12,461,680,000	623,084,000
9	Site establishment		US$	7,000,000	350,000
			VND	146,608,000,000	7,330,400,000
10	Insurance	(0.4%of1-9)	US$	1,454,038	72,702
			VND	27,856,747,576	1,392,837,379
Total Direct Cost (1-10)			US$	242,288,633	16,152,576
			VND	4,615,299,253,622	307,686,616,908
11	Provisional sum for contingency	(5%of1-10)	US$	12,114,432	807,629
			VND	230,764,962,681	15,384,330,845
12	Overhead	(6.5%of1-10)	US$	15,748,761	1,049,917
			VND	299,994,451,485	19,999,630,099
13	Profit	(5%of1-10)	US$	12,114,432	807,629
			VND	230,764,962,681	15,384,330,845
Total Cost (1-13)			US$	282,266,257	18,817,750
			VND	5,376,823,630,470	358,454,908,698

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen So STP: Operation & Maintenance Cost

No.	Items			Unit	1 (2012)	2 (2013)	3 (2014)	4 (2015)	5 (2016)	6 (2017)
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630
				VND	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113
				VND	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000
3	Chemicals			US$	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908
				VND	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	865,903	865,903	865,903	865,903	865,903	865,903
				VND	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000
6	Repairs			US$	0	0	1,105,988	1,105,988	1,105,988	1,105,988
				VND	0	0	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	29,057	29,057	33,481	33,481	33,481	33,481
				VND	488,853,013	488,853,013	581,508,268	581,508,268	581,508,268	581,508,268
Total Direct Cost (1-10)				US$	7,293,205	7,293,205	8,403,617	8,403,617	8,403,617	8,403,617
				VND	122,702,106,293	122,702,106,293	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384
11	Provisional sum for contingency		(5%of1-10)	US$	364,660	364,660	420,181	420,181	420,181	420,181
				VND	6,135,105,315	6,135,105,315	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
12	Overhead		(6.5%of1-10)	US$	474,058	474,058	546,235	546,235	546,235	546,235
				VND	7,975,636,909	7,975,636,909	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400
13	Profit		(5%of1-10)	US$	364,660	364,660	420,181	420,181	420,181	420,181
				VND	6,135,105,315	6,135,105,315	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
Total Cost (1-13)				US$	8,496,584	8,496,584	9,790,214	9,790,214	9,790,214	9,790,214
				VND	142,947,953,831	142,947,953,831	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen So STP: Operation & Maintenance Cost

	Items				2018	2019	2020	2021	2022	2023
					7	8	9	10	11	12
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630
				VND	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113
				VND	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000
3	Chemicals			US$	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908
				VND	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	865,903	865,903	865,903	865,903	865,903	865,903
				VND	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000
6	Repairs			US$	1,105,988	1,105,988	1,105,988	1,105,988	1,105,988	1,105,988
				VND	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	33,481	33,481	33,481	33,481	33,481	33,481
				VND	581,508,268	581,508,268	581,508,268	581,508,268	581,508,268	581,508,268
Total Direct Cost (1-10)				US$	8,403,617	8,403,617	8,403,617	8,403,617	8,403,617	8,403,617
				VND	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384
11	Provisional sum for contingency		(5%of1-10)	US$	420,181	420,181	420,181	420,181	420,181	420,181
				VND	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
12	Overhead		(6.5%of1-10)	US$	546,235	546,235	546,235	546,235	546,235	546,235
				VND	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400
13	Profit		(5%of1-10)	US$	420,181	420,181	420,181	420,181	420,181	420,181
				VND	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
Total Cost (1-13)				US$	9,790,214	9,790,214	9,790,214	9,790,214	9,790,214	9,790,214
				VND	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen So STP: Operation & Maintenance Cost

	Items				2024	2025	2026	2027	2028	2029
	Items				13	14	15	16	17	18
1	Labor cost			US$	371,276	371,276	371,276	371,276	371,276	371,276
				VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630	2,775,630
				VND	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000	58,132,800,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113	4,278,113
				VND	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000	59,673,740,000
3	Chemicals			US$	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908	1,428,908
				VND	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280	29,927,033,280
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	865,903	865,903	865,903	865,903	865,903	865,903
				VND	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000	18,135,480,000
6	Repairs			US$	1,105,988	1,105,988	1,105,988	1,105,988	1,105,988	1,105,988
				VND	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836	23,163,813,836
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	33,481	33,481	33,481	33,481	33,481	33,481
				VND	581,508,268	581,508,268	581,508,268	581,508,268	581,508,268	581,508,268
Total Direct Cost (1-10)				US$	8,403,617	8,403,617	8,403,617	8,403,617	8,403,617	8,403,617
				VND	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384	145,958,575,384
11	Provisional sum for contingency		(5%of1-10)	US$	420,181	420,181	420,181	420,181	420,181	420,181
				VND	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
12	Overhead		(6.5%of1-10)	US$	546,235	546,235	546,235	546,235	546,235	546,235
				VND	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400	9,487,307,400
13	Profit		(5%of1-10)	US$	420,181	420,181	420,181	420,181	420,181	420,181
				VND	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769	7,297,928,769
Total Cost (1-13)				US$	9,790,214	9,790,214	9,790,214	9,790,214	9,790,214	9,790,214
				VND	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322	170,041,740,322

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen So STP: Operation & Maintenance Cost

	Items				2030 19	2031 20	Sub Total
1	Labor cost			US$	371,276	371,276	7,425,516
				VND	7,776,000,000	7,776,000,000	155,520,000,000
2	Utilities	Electricity consumtion cost		US$	2,775,630	2,775,630	55,512,605
				VND	58,132,800,000	58,132,800,000	1,162,656,000,000
		Oils(for emergency generator)		US$	23,575	23,575	471,500
				VND	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$	4,278,113	4,278,113	85,562,265
				VND	59,673,740,000	59,673,740,000	1,193,474,800,000
3	Chemicals			US$	1,428,908	1,428,908	28,578,160
				VND	29,927,033,280	29,927,033,280	598,540,665,600
4	Legal inspection cost			US$	11,448	11,448	228,969
				VND	239,776,000	239,776,000	4,795,520,000
5	Sludge disposal cost			US$	865,903	865,903	17,318,067
				VND	18,135,480,000	18,135,480,000	362,709,600,000
6	Repairs			US$	1,105,988	1,105,988	19,907,785
				VND	23,163,813,836	23,163,813,836	416,948,649,040
7	Small-scall replacement			US$	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	170,000
				VND	178,024,000	178,024,000	3,560,480,000
9	Site establishment			US$	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	33,481	33,481	660,763
				VND	581,508,268	581,508,268	11,444,854,859
Total Direct Cost (1-10)				US$	8,403,617	8,403,617	165,851,525
				VND	145,958,575,384	145,958,575,384	2,872,658,569,499
11	Provisional sum for contingency		(5%of1-10)	US$	420,181	420,181	8,292,576
				VND	7,297,928,769	7,297,928,769	143,632,928,475
12	Overhead		(6.5%of1-10)	US$	546,235	546,235	10,780,349
				VND	9,487,307,400	9,487,307,400	186,722,807,017
13	Profit		(5%of1-10)	US$	420,181	420,181	8,292,576
				VND	7,297,928,769	7,297,928,769	143,632,928,475
Total Cost (1-13)				US$	9,790,214	9,790,214	193,217,026
				VND	170,041,740,322	170,041,740,322	3,346,647,233,466

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen Xa STP: Operation & Maintenance Cost

					2012	2013	2014	2015	2016	2017	2018	2019	2020
	Items				0	0	0	0	0	0	1	2	3
1	Labor cost			US$							371,276	371,276	371,276
				VND							7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost		US$							3,747,101	3,747,101	3,747,101
				VND							78,479,280,000	78,479,280,000	78,479,280,000
		Oils(for emergency generator)		US$							371,276	23,575	23,575
				VND							493,740,000	493,740,000	493,740,000
		Consumables		US$							50,000	50,000	50,000
				VND							1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total		US$							4,168,377	3,820,676	3,820,676
				VND							80,020,220,000	80,020,220,000	80,020,220,000
3	Chemicals			US$							1,929,999	1,929,999	1,929,999
				VND							40,421,873,900	40,421,873,900	40,421,873,900
4	Legal inspection cost			US$							11,448	11,448	11,448
				VND							239,776,000	239,776,000	83,776,000
5	Sludge disposal cost			US$							1,168,950	1,168,950	1,168,950
				VND							24,482,480,000	24,482,480,000	24,482,480,000
6	Repairs			US$							0	0	1,762,444
				VND							0	0	36,912,636,444
7	Small-scall replacement			US$							200,000	200,000	200,000
				VND							4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$							8,500	8,500	8,500
				VND							178,024,000	178,024,000	178,024,000
9	Site establishment			US$							100,000	100,000	100,000
				VND							2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$							31,834	30,443	37,493
				VND							637,606,296	637,606,296	784,632,841
Total Direct Cost (1-10)				US$							7,990,384	7,641,292	9,410,786
				VND							160,039,180,196	160,039,180,196	196,942,843,186
11	Provisional sum for contingency		(5%of1-10)	US$							399,519	382,065	470,539
				VND							8,001,959,010	8,001,959,010	9,847,142,159
12	Overhead		(6.5%of1-10)	US$							519,375	496,684	611,701
				VND							10,402,546,713	10,402,546,713	12,801,284,807
13	Profit		(5%of1-10)	US$							399,519	382,065	470,539
				VND							8,001,959,010	8,001,959,010	9,847,142,159
Total Cost (1-13)				US$							9,308,797	8,902,105	10,963,566
				VND							186,445,644,928	186,445,644,928	229,438,412,311

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen Xa STP: Operation & Maintenance Cost

	Items			2021	2022	2023	2024	2025	2026	2027
	Items			4	5	6	7	8	9	10
1	Labor cost		US$	371,276	371,276	371,276	371,276	371,276	371,276	371,276
			VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost	US$	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101
			VND	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000
		Oils(for emergency generator)	US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
			VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables	US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
			VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total	US$	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676
			VND	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000
3	Chemicals		US$	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999
			VND	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900
4	Legal inspection cost		US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
			VND	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000
5	Sludge disposal cost		US$	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950
			VND	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000
6	Repairs		US$	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444
			VND	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444
7	Small-scall replacement		US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
			VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
			VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment		US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
			VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$	37,493	37,493	37,493	37,493	37,493	37,493	37,493
			VND	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841
	Total Direct Cost (1-10)		US$	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786
			VND	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186
11	Provisional sum for contingency	(5%of1-10)	US$	470,539	470,539	470,539	470,539	470,539	470,539	470,539
			VND	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159
12	Overhead	(6.5%of1-10)	US$	611,701	611,701	611,701	611,701	611,701	611,701	611,701
			VND	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807
13	Profit	(5%of1-10)	US$	470,539	470,539	470,539	470,539	470,539	470,539	470,539
			VND	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159
	Total Cost (1-13)		US$	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566
			VND	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen Xa STP: Operation & Maintenance Cost

No.	Items		Unit	2028	2029	2030	2031	2032	2033	2034
	Items			11	12	13	14	15	16	17
1	Labor cost		US$	371,276	371,276	371,276	371,276	371,276	371,276	371,276
			VND	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000	7,776,000,000
2	Utilities	Electricity consumtion cost	US$	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101	3,747,101
			VND	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000	78,479,280,000
		Oils(for emergency generator)	US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
			VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables	US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
			VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total	US$	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676	3,820,676
			VND	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000	80,020,220,000
3	Chemicals		US$	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999	1,929,999
			VND	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900	40,421,873,900
4	Legal inspection cost		US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
			VND	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000	83,776,000
5	Sludge disposal cost		US$	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950	1,168,950
			VND	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000	24,482,480,000
6	Repairs		US$	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444	1,762,444
			VND	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444	36,912,636,444
7	Small-scall replacement		US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
			VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
			VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment		US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
			VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$	37,493	37,493	37,493	37,493	37,493	37,493	37,493
			VND	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841	784,632,841
	Total Direct Cost (1-10)		US$	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786	9,410,786
			VND	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186	196,942,843,186
11	Provisional sum for contingency	(5%of1-10)	US$	470,539	470,539	470,539	470,539	470,539	470,539	470,539
			VND	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159
12	Overhead	(6.5%of1-10)	US$	611,701	611,701	611,701	611,701	611,701	611,701	611,701
			VND	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807	12,801,284,807
13	Profit	(5%of1-10)	US$	470,539	470,539	470,539	470,539	470,539	470,539	470,539
			VND	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159	9,847,142,159
	Total Cost (1-13)		US$	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566	10,963,566
			VND	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311	229,438,412,311

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Yen Xa STP: Operation & Maintenance Cost

No.	Items			Currency	2035 18	2036 19	2037 20	Sub Total
1	Labor cost			US$	371,276	371,276	371,276	7,425,516
				VND	7,776,000,000	7,776,000,000	7,776,000,000	155,520,000,000
2	Utilities	Electricity consumtion cost		US$	3,747,101	3,747,101	3,747,101	74,942,017
				VND	78,479,280,000	78,479,280,000	78,479,280,000	1,569,585,600,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	819,201
				VND	493,740,000	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000	1,000,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	20,944,000,000
		Sub Total		US$	3,820,676	3,820,676	3,820,676	76,761,218
				VND	80,020,220,000	80,020,220,000	80,020,220,000	1,600,404,400,000
3	Chemicals			US$	1,929,999	1,929,999	1,929,999	38,599,980
				VND	40,421,873,900	40,421,873,900	40,421,873,900	808,437,478,000
4	Legal inspection cost			US$	11,448	11,448	11,448	228,969
				VND	83,776,000	83,776,000	83,776,000	1,987,520,000
5	Sludge disposal cost			US$	1,168,950	1,168,950	1,168,950	23,378,992
				VND	24,482,480,000	24,482,480,000	24,482,480,000	489,649,600,000
6	Repairs			US$	1,762,444	1,762,444	1,762,444	31,724,000
				VND	36,912,636,444	36,912,636,444	36,912,636,444	664,427,456,000
7	Small-scall replacement			US$	200,000	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	170,000
				VND	178,024,000	178,024,000	178,024,000	3,560,480,000
9	Site establishment			US$	100,000	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	37,493	37,493	37,493	737,155
				VND	784,632,841	784,632,841	784,632,841	15,398,603,736
	Total Direct Cost (1-10)			US$	9,410,786	9,410,786	9,410,786	185,025,828
				VND	196,942,843,186	196,942,843,186	196,942,843,186	3,865,049,537,736
11	Provisional sum for contingency		(5%of1-10)	US$	470,539	470,539	470,539	9,251,291
				VND	9,847,142,159	9,847,142,159	9,847,142,159	193,252,476,887
12	Overhead		(6.5%of1-10)	US$	611,701	611,701	611,701	12,026,679
				VND	12,801,284,807	12,801,284,807	12,801,284,807	251,228,219,953
13	Profit		(5%of1-10)	US$	470,539	470,539	470,539	9,251,291
				VND	9,847,142,159	9,847,142,159	9,847,142,159	193,252,476,887
	Total Cost (1-13)			US$	10,963,566	10,963,566	10,963,566	215,555,090
				VND	229,438,412,311	229,438,412,311	229,438,412,311	4,502,782,711,462

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

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Ho Tay STP: Operation & Maintenance Cost

No.	Items		Unit	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Items			0	0	0	0	0	0	1	2	3
1	Labor cost		US$							194,805	194,805	194,805
			VND							4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost	US$							259,059	259,059	259,059
			VND							5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)	US$							23,575	23,575	23,575
			VND							493,740,000	493,740,000	493,740,000
		Consumables	US$							50,000	50,000	50,000
			VND							1,047,200,000	1,047,200,000	1,047,200,000
		Total	US$							332,634	332,634	332,634
			VND							6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals		US$							100,567	100,567	100,567
			VND							2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost		US$							11,448	11,448	11,448
			VND							239,776,000	239,776,000	239,776,000
5	Sludge disposal cost		US$							60,609	60,609	60,609
			VND							1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs		US$							0	0	297,000
			VND							0	0	6,220,368,000
7	Small-scall replacement		US$							200,000	200,000	200,000
			VND							4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$							8,500	8,500	8,500
			VND							178,024,000	178,024,000	178,024,000
9	Site Establishment		US$							100,000	100,000	100,000
			VND							2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$							4,034	4,034	5,222
			VND							84,493,214	84,493,214	109,374,686
	Total(1-10)		US$							1,012,598	1,012,598	1,310,786
			VND							21,207,796,634	21,207,796,634	27,453,046,106
11	Provisional sum for contingency	(5%of1-10)	US$							50,630	50,630	65,539
			VND							1,060,389,832	1,060,389,832	1,372,652,305
12	Overhead	(6.5%of1-10)	US$							65,819	65,819	85,201
			VND							1,378,506,781	1,378,506,781	1,784,447,997
13	Profit	(5%of1-10)	US$							50,630	50,630	65,539
			VND							1,060,389,832	1,060,389,832	1,372,652,305
	Grand Total(1-13)		US$							1,179,677	1,179,677	1,527,066
			VND							24,707,083,078	24,707,083,078	31,982,798,713

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Ho Tay STP: Operation & Maintenance Cost

	Items			2021	2022	2023	2024	2025	2026	2027
				4	5	6	7	8	9	10
1	Labor cost		US$	194,805	194,805	194,805	194,805	194,805	194,805	194,805
			VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost	US$	259,059	259,059	259,059	259,059	259,059	259,059	259,059
			VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)	US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
			VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables	US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
			VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Total	US$	332,634	332,634	332,634	332,634	332,634	332,634	332,634
			VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals		US$	100,567	100,567	100,567	100,567	100,567	100,567	100,567
			VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost		US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
			VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost		US$	60,609	60,609	60,609	60,609	60,609	60,609	60,609
			VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs		US$	297,000	297,000	297,000	297,000	297,000	297,000	297,000
			VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000
7	Small-scall replacement		US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
			VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
			VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site Establishment		US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
			VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	5,222	5,222	5,222
			VND	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686
	Total(1-10)		US$	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786
			VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106
11	Provisional sum for contingency	(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
			VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
12	Overhead	(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	85,201	85,201	85,201
			VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997
13	Profit	(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
			VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
	Grand Total(1-13)		US$	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066
			VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Ho Tay STP: Operation & Maintenance Cost

No.	Items			Currency	2028	2029	2030	2031	2032	2033	2034
	Items				11	12	13	14	15	16	17
1	Labor cost			US$	194,805	194,805	194,805	194,805	194,805	194,805	194,805
				VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost		US$	259,059	259,059	259,059	259,059	259,059	259,059	259,059
				VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Total		US$	332,634	332,634	332,634	332,634	332,634	332,634	332,634
				VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals			US$	100,567	100,567	100,567	100,567	100,567	100,567	100,567
				VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	60,609	60,609	60,609	60,609	60,609	60,609	60,609
				VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs			US$	297,000	297,000	297,000	297,000	297,000	297,000	297,000
				VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site Establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	5,222	5,222	5,222
				VND	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686
Total(1-10)				US$	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786
				VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106
11	Provisional sum for contingency		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
12	Overhead		(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	85,201	85,201	85,201
				VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997
13	Profit		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
Grand Total(1-13)				US$	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066
				VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Ho Tay STP: Operation & Maintenance Cost

	Items				2035 18	2036 19	2037 20	Sub Total
1	Labor cost			US$	194,805	194,805	194,805	3,896,104
				VND	4,080,000,000	4,080,000,000	4,080,000,000	81,600,000,000
2	Utilities	Electricity consumtion cost		US$	259,059	259,059	259,059	5,181,176
				VND	5,425,728,000	5,425,728,000	5,425,728,000	108,514,560,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	471,500
				VND	493,740,000	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000	1,000,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	20,944,000,000
		Total		US$	332,634	332,634	332,634	6,652,676
				VND	6,966,668,000	6,966,668,000	6,966,668,000	139,333,360,000
3	Chemicals			US$	100,567	100,567	100,567	2,011,340
				VND	2,106,235,420	2,106,235,420	2,106,235,420	42,124,708,400
4	Legal inspection cost			US$	11,448	11,448	11,448	228,969
				VND	239,776,000	239,776,000	239,776,000	4,795,520,000
5	Sludge disposal cost			US$	60,609	60,609	60,609	1,212,185
				VND	1,269,400,000	1,269,400,000	1,269,400,000	25,388,000,000
6	Repairs			US$	297,000	297,000	297,000	5,346,000
				VND	6,220,368,000	6,220,368,000	6,220,368,000	111,966,624,000
7	Small-scall replacement			US$	200,000	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	170,000
				VND	178,024,000	178,024,000	178,024,000	3,560,480,000
9	Site Establishment			US$	100,000	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	5,222	5,222	5,222	102,069
				VND	109,374,686	109,374,686	109,374,686	2,137,730,770
Total(1-10)				US$	1,310,786	1,310,786	1,310,786	25,619,343
				VND	27,453,046,106	27,453,046,106	27,453,046,106	536,570,423,170
11	Provisional sum for contingency		(5%of1-10)	US$	65,539	65,539	65,539	1,280,967
				VND	1,372,652,305	1,372,652,305	1,372,652,305	26,828,521,158
12	Overhead		(6.5%of1-10)	US$	85,201	85,201	85,201	1,665,257
				VND	1,784,447,997	1,784,447,997	1,784,447,997	34,877,077,506
13	Profit		(5%of1-10)	US$	65,539	65,539	65,539	1,280,967
				VND	1,372,652,305	1,372,652,305	1,372,652,305	26,828,521,158
Grand Total(1-13)				US$	1,527,066	1,527,066	1,527,066	29,846,535
				VND	31,982,798,713	31,982,798,713	31,982,798,713	625,104,542,993

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Bay Mau STP: Operation & Maintenance Cost

				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	Items			0	0	0	0	0	0	0	0	1	2
1	Labor cost		US$									194,805	194,805
			VND									4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost	US$									259,059	259,059
			VND									5,425,728,000	5,425,728,000
		Oils(for emergency generator)	US$									23,575	23,575
			VND									493,740,000	493,740,000
		Consumables	US$									50,000	50,000
			VND									1,047,200,000	1,047,200,000
		Total	US$									332,634	332,634
			VND									6,966,668,000	6,966,668,000
3	Chemicals		US$									100,567	100,567
			VND									2,106,235,420	2,106,235,420
4	Legal inspection cost		US$									11,448	11,448
			VND									239,776,000	239,776,000
5	Sludge disposal cost		US$									60,609	60,609
			VND									1,269,400,000	1,269,400,000
6	Repairs		US$									0	0
			VND									0	0
7	Small-scall replacement		US$									200,000	200,000
			VND									4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$									8,500	8,500
			VND									178,024,000	178,024,000
9	Site Establishment		US$									100,000	100,000
			VND									2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$									4,034	4,034
			VND									84,493,214	84,493,214
	Total(1-10)		US$									1,012,598	1,012,598
			VND									21,207,796,634	21,207,796,634
11	Provisional sum for contingency	(5%of1-10)	US$									50,630	50,630
			VND									1,060,389,832	1,060,389,832
12	Overhead	(6.5%of1-10)	US$									65,819	65,819
			VND									1,378,506,781	1,378,506,781
13	Profit	(5%of1-10)	US$									50,630	50,630
			VND									1,060,389,832	1,060,389,832
	Grand Total(1-13)		US$									1,179,677	1,179,677
			VND									24,707,083,078	24,707,083,078

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Bay Mau STP: Operation & Maintenance Cost

					2022	2023	2024	2025	2026	2027	2028
	Items				3	4	5	6	7	8	9
1	Labor cost			US$	194,805	194,805	194,805	194,805	194,805	194,805	194,805
				VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost		US$	259,059	259,059	259,059	259,059	259,059	259,059	259,059
				VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Total		US$	332,634	332,634	332,634	332,634	332,634	332,634	332,634
				VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals			US$	100,567	100,567	100,567	100,567	100,567	100,567	100,567
				VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost			US$	60,609	60,609	60,609	60,609	60,609	60,609	60,609
				VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs			US$	297,000	297,000	297,000	297,000	297,000	297,000	297,000
				VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site Establishment			US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance		(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	5,222	5,222	5,222
				VND	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686
	Total(1-10)			US$	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786
				VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106
11	Provisional sum for contingency		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
12	Overhead		(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	85,201	85,201	85,201
				VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997
13	Profit		(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
	Grand Total(1-13)			US$	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066
				VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Bay Mau STP: Operation & Maintenance Cost

	Items			2029 10	2030 11	2031 12	2032 13	2033 14	2034 15	2035 16
1	Labor cost		US$	194,805	194,805	194,805	194,805	194,805	194,805	194,805
			VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000
2	Utilities	Electricity consumtion cost	US$	259,059	259,059	259,059	259,059	259,059	259,059	259,059
			VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000
		Oils(for emergency generator)	US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
			VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables	US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
			VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Total	US$	332,634	332,634	332,634	332,634	332,634	332,634	332,634
			VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000
3	Chemicals		US$	100,567	100,567	100,567	100,567	100,567	100,567	100,567
			VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420
4	Legal inspection cost		US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
			VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost		US$	60,609	60,609	60,609	60,609	60,609	60,609	60,609
			VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000
6	Repairs		US$	297,000	297,000	297,000	297,000	297,000	297,000	297,000
			VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000
7	Small-scall replacement		US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
			VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
			VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site Establishment		US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
			VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	5,222	5,222	5,222
			VND	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686	109,374,686
	Total(1-10)		US$	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786	1,310,786
			VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106
11	Provisional sum for contingency	(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
			VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
12	Overhead	(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	85,201	85,201	85,201
			VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997
13	Profit	(5%of1-10)	US$	65,539	65,539	65,539	65,539	65,539	65,539	65,539
			VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305
	Grand Total(1-13)		US$	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066	1,527,066
			VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Bay Mau STP: Operation & Maintenance Cost

No.	Items			Unit	2036 17	2037 18	2038 19	2039 20	Sub Total
1	Labor cost			US$	194,805	194,805	194,805	194,805	3,896,104
				VND	4,080,000,000	4,080,000,000	4,080,000,000	4,080,000,000	81,600,000,000
2	Utilities	Electricity consumtion cost		US$	259,059	259,059	259,059	259,059	5,181,176
				VND	5,425,728,000	5,425,728,000	5,425,728,000	5,425,728,000	108,514,560,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	471,500
				VND	493,740,000	493,740,000	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000	50,000	1,000,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	20,944,000,000
		Total		US$	332,634	332,634	332,634	332,634	6,652,676
				VND	6,966,668,000	6,966,668,000	6,966,668,000	6,966,668,000	139,333,360,000
3	Chemicals			US$	100,567	100,567	100,567	100,567	2,011,340
				VND	2,106,235,420	2,106,235,420	2,106,235,420	2,106,235,420	42,124,708,400
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	228,969
				VND	239,776,000	239,776,000	239,776,000	239,776,000	4,795,520,000
5	Sludge disposal cost			US$	60,609	60,609	60,609	60,609	1,212,185
				VND	1,269,400,000	1,269,400,000	1,269,400,000	1,269,400,000	25,388,000,000
6	Repairs			US$	297,000	297,000	297,000	297,000	5,346,000
				VND	6,220,368,000	6,220,368,000	6,220,368,000	6,220,368,000	111,966,624,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	170,000
				VND	178,024,000	178,024,000	178,024,000	178,024,000	3,560,480,000
9	Site Establishment			US$	100,000	100,000	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	5,222	5,222	5,222	5,222	102,069
				VND	109,374,686	109,374,686	109,374,686	109,374,686	2,137,730,770
	Total(1-10)			US$	1,310,786	1,310,786	1,310,786	1,310,786	25,619,343
				VND	27,453,046,106	27,453,046,106	27,453,046,106	27,453,046,106	536,570,423,170
11	Provisional sum for contingency		(5%of1-10)	US$	65,539	65,539	65,539	65,539	1,280,967
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	26,828,521,158
12	Overhead		(6.5%of1-10)	US$	85,201	85,201	85,201	85,201	1,665,257
				VND	1,784,447,997	1,784,447,997	1,784,447,997	1,784,447,997	34,877,077,506
13	Profit		(5%of1-10)	US$	65,539	65,539	65,539	65,539	1,280,967
				VND	1,372,652,305	1,372,652,305	1,372,652,305	1,372,652,305	26,828,521,158
	Grand Total(1-13)			US$	1,527,066	1,527,066	1,527,066	1,527,066	29,846,535
				VND	31,982,798,713	31,982,798,713	31,982,798,713	31,982,798,713	625,104,542,993

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Phu Do STP: Operation & Maintenance Cost

	Items				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
					0	0	0	0	0	0	0	0	0	0	1
1	Labor cost			US$											297,937
				VND											6,240,000,000
2	Utilities	Electricity consumtion cost		US$											1,360,059
				VND											28,485,072,000
		Oils(for emergency generator)		US$											23,575
				VND											493,740,000
		Consumables		US$											50,000
				VND											1,047,200,000
		Sub Total		US$											1,433,634
				VND											30,026,012,000
3	Chemicals			US$											601,395
				VND											12,595,601,040
4	Legal inspection cost			US$											11,448
				VND											239,776,000
5	Sludge disposal cost			US$											363,655
				VND											7,616,400,000
6	Repairs			US$											0
				VND											0
7	Small-scall replacement			US$											200,000
				VND											4,188,800,000
8	Cleaning and yard maintennance			US$											8,500
				VND											178,024,000
9	Site establishment			US$											100,000
				VND											2,094,400,000
10	Insurance		(0.4%of1-9)	US$											12,858
				VND											252,716,052
Total Direct Cost (1-10)				US$											3,029,428
				VND											63,431,729,092
11	Provisional sum for contingency		(5%of1-10)	US$											151,471
				VND											3,171,586,455
12	Overhead		(6.5%of1-10)	US$											196,913
				VND											4,123,062,391
13	Profit		(5%of1-10)	US$											151,471
				VND											3,171,586,455
Total Cost (1-13)				US$											3,529,284
				VND											73,897,964,392

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Phu Do STP: Operation & Maintenance Cost

	Items		Unit	2023	2024	2025	2026	2027	2028	2029
				2	3	4	5	6	7	8
1	Labor cost		US$	297,937	297,937	297,937	297,937	297,937	297,937	297,937
			VND	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000
2	Utilities	Electricity consumtion cost	US$	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059
			VND	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000
		Oils(for emergency generator)	US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
			VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables	US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
			VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total	US$	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634
			VND	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000
3	Chemicals		US$	601,395	601,395	601,395	601,395	601,395	601,395	601,395
			VND	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040
4	Legal inspection cost		US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
			VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost		US$	363,655	363,655	363,655	363,655	363,655	363,655	363,655
			VND	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000
6	Repairs		US$	0	671,000	671,000	671,000	671,000	671,000	671,000
			VND	0	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000
7	Small-scall replacement		US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
			VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
			VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment		US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
			VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$	12,858	15,542	15,542	15,542	15,542	15,542	15,542
			VND	252,716,052	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748
	Total Direct Cost (1-10)		US$	3,029,428	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112
			VND	63,431,729,092	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788
11	Provisional sum for contingency	(5%of1-10)	US$	151,471	185,156	185,156	185,156	185,156	185,156	185,156
			VND	3,171,586,455	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339
12	Overhead	(6.5%of1-10)	US$	196,913	240,702	240,702	240,702	240,702	240,702	240,702
			VND	4,123,062,391	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841
13	Profit	(5%of1-10)	US$	151,471	185,156	185,156	185,156	185,156	185,156	185,156
			VND	3,171,586,455	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339
	Total Cost (1-13)		US$	3,529,284	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126
			VND	73,897,964,392	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Phu Do STP: Operation & Maintenance Cost

No.	Items			2030	2031	2032	2033	2034	2035	2036
				9	10	11	12	13	14	15
1	Labor cost		US$	297,937	297,937	297,937	297,937	297,937	297,937	297,937
			VND	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000
2	Utilities	Electricity consumtion cost	US$	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059
			VND	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000
		Oils(for emergency generator)	US$	23,575	23,575	23,575	23,575	23,575	23,575	23,575
			VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000
		Consumables	US$	50,000	50,000	50,000	50,000	50,000	50,000	50,000
			VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000
		Sub Total	US$	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634
			VND	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000
3	Chemicals		US$	601,395	601,395	601,395	601,395	601,395	601,395	601,395
			VND	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040
4	Legal inspection cost		US$	11,448	11,448	11,448	11,448	11,448	11,448	11,448
			VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000
5	Sludge disposal cost		US$	363,655	363,655	363,655	363,655	363,655	363,655	363,655
			VND	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000
6	Repairs		US$	671,000	671,000	671,000	671,000	671,000	671,000	671,000
			VND	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000
7	Small-scall replacement		US$	200,000	200,000	200,000	200,000	200,000	200,000	200,000
			VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000
8	Cleaning and yard maintennance		US$	8,500	8,500	8,500	8,500	8,500	8,500	8,500
			VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000
9	Site establishment		US$	100,000	100,000	100,000	100,000	100,000	100,000	100,000
			VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000
10	Insurance	(0.4%of1-9)	US$	15,542	15,542	15,542	15,542	15,542	15,542	15,542
			VND	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748
	Total Direct Cost (1-10)		US$	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112
			VND	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788
11	Provisional sum for contingency	(5%of1-10)	US$	185,156	185,156	185,156	185,156	185,156	185,156	185,156
			VND	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339
12	Overhead	(6.5%of1-10)	US$	240,702	240,702	240,702	240,702	240,702	240,702	240,702
			VND	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841
13	Profit	(5%of1-10)	US$	185,156	185,156	185,156	185,156	185,156	185,156	185,156
			VND	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339
	Total Cost (1-13)		US$	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126
			VND	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

Phu Do STP: Operation & Maintenance Cost

	Items				2037 16	2038 17	2039 18	2040 19	2041 20	Sub Total
1	Labor cost			US$	297,937	297,937	297,937	297,937	297,937	5,958,747
				VND	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	6,240,000,000	124,800,000,000
2	Utilities	Electricity consumtion cost		US$	1,360,059	1,360,059	1,360,059	1,360,059	1,360,059	27,201,176
				VND	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	28,485,072,000	569,701,440,000
		Oils(for emergency generator)		US$	23,575	23,575	23,575	23,575	23,575	471,500
				VND	493,740,000	493,740,000	493,740,000	493,740,000	493,740,000	9,874,800,000
		Consumables		US$	50,000	50,000	50,000	50,000	50,000	1,000,000
				VND	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	1,047,200,000	20,944,000,000
		Sub Total		US$	1,433,634	1,433,634	1,433,634	1,433,634	1,433,634	28,672,676
				VND	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	30,026,012,000	600,520,240,000
3	Chemicals			US$	601,395	601,395	601,395	601,395	601,395	12,027,900
				VND	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	12,595,601,040	251,912,020,800
4	Legal inspection cost			US$	11,448	11,448	11,448	11,448	11,448	228,969
				VND	239,776,000	239,776,000	239,776,000	239,776,000	239,776,000	4,795,520,000
5	Sludge disposal cost			US$	363,655	363,655	363,655	363,655	363,655	7,273,109
				VND	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	7,616,400,000	152,328,000,000
6	Repairs			US$	671,000	671,000	671,000	671,000	671,000	12,078,000
				VND	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	14,053,424,000	252,961,632,000
7	Small-scall replacement			US$	200,000	200,000	200,000	200,000	200,000	4,000,000
				VND	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	4,188,800,000	83,776,000,000
8	Cleaning and yard maintennance			US$	8,500	8,500	8,500	8,500	8,500	170,000
				VND	178,024,000	178,024,000	178,024,000	178,024,000	178,024,000	3,560,480,000
9	Site establishment			US$	100,000	100,000	100,000	100,000	100,000	2,000,000
				VND	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	2,094,400,000	41,888,000,000
10	Insurance		(0.4%of1-9)	US$	15,542	15,542	15,542	15,542	15,542	305,473
				VND	308,929,748	308,929,748	308,929,748	308,929,748	308,929,748	6,066,167,571
	Total Direct Cost (1-10)			US$	3,703,112	3,703,112	3,703,112	3,703,112	3,703,112	72,714,874
				VND	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	77,541,366,788	1,522,608,060,371
11	Provisional sum for contingency		(5%of1-10)	US$	185,156	185,156	185,156	185,156	185,156	3,635,744
				VND	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	76,130,403,019
12	Overhead		(6.5%of1-10)	US$	240,702	240,702	240,702	240,702	240,702	4,726,467
				VND	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	5,040,188,841	98,969,523,924
13	Profit		(5%of1-10)	US$	185,156	185,156	185,156	185,156	185,156	3,635,744
				VND	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	3,877,068,339	76,130,403,019
	Total Cost (1-13)			US$	4,314,126	4,314,126	4,314,126	4,314,126	4,314,126	84,712,828
				VND	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	90,335,692,308	1,773,838,390,332

JP¥/USD	83.15
VND/US$	20,944
JP¥/VND	0.00397

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Appendix 5 Questionnaire Surveys

2011/3/25

Outlines of Questionnaire Surveys

I. Methodology for the questionnaire survey for households (HH)

1) Objectives and Methodology

The survey conducts questionnaire survey with 100 samples in the form of interview. The sample households will be extracted from the households groups who will gain benefit from the project. To determine the fee for low-income households, the sampled households need to include the group.

2) Content of the survey (draft)

① HH profiles
- Age, Sex, Occupation, HH number, HH income, major source of income, and years of living in the area

② Awareness of sewerage facility (Yes or No question and comments)
- Water pollution is caused by wastewater discharge
- Role/benefits of sewage system: improve public health, mitigate storm water inundation, conserve water environment and resource, and create aesthetic urban view and recreation zone
- Ever heard of sewage facility role (i.e., by media, awareness program by governments and NGO)
- Ever discussed about the environmental protection and sewage facility among gamily

③ HH expenditure: an average (approximate) current monthly expenditure on following items.
- Food
- Foodstuff
- Fuel
- Outdoor meals
- Drinking & smoking
- Garment, hat, shoes, sandals
- Housing, electricity, water, sanitation
- Furniture
- Health care
- Travel, communication
- Education
- Culture, sport, recreation
- Others

④ Questions for willingness to pay for sewage water fee (WTP)
- Monthly amount of willingness to pay for sewage water fee with the description of

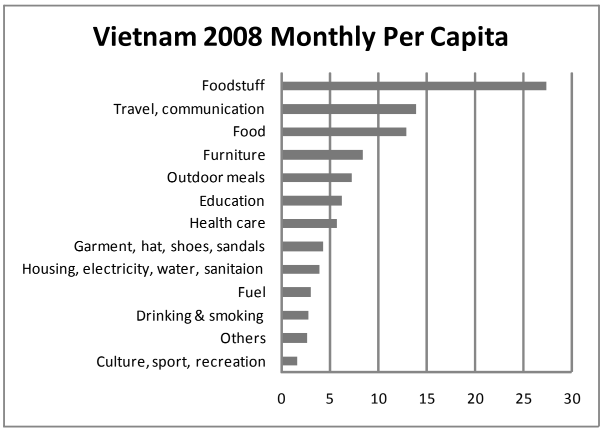
planned facilities (preferably with photos) with service conditions, and policy of O&M cost sharing by beneficiaries

- If respondents refused to answer the WTP, ask for reasons.

⑤ Questions for affordability to pay (ATP)

- Monthly amount of affordability to pay applying the following method.

The survey asks whether the respondents feel reasonable to pay the same amount(percentage) from their current expenditure for the following water and sewage charges showing the current percentage of expenditure as in the sample figure.



The above figure will be prepared reflecting the latest official HH expenditure data in Hanoi or Vietnam. The followings are the examples of questions used.

- Whether or not it is comfortable to pay water supply charge as equivalent as the cost for drinking. If answered “No”, ask which item is reasonable.
- Whether or not it is comfortable to pay sewage charge as equivalent as the cost for culture, sport, and recreation. If answered “No”, ask which item is reasonable.
- Whether or not it is comfortable to pay combined water supply and sewage charge as equivalent as the cost for fuel. If answered “No”, ask which item is reasonable.

3) Schedule of the survey (tentative)

Chief support surveyor (1 person, 35 days)	Support surveyor (4 persons, 8 day each)	Implementation schedule and activities of Tanaka(PADECO)
Survey preparation : 15days Activities: -Collect basic information -Proposal of survey plans including support surveyor recruitment	Survey preparation : 1days Activities: -Attend the briefing session for the survey to understand survey methodology	Middle April – Early May Activities: -Determining the sampling methodology and survey sites with the discussion and consultation with CP and

-Proposal of sampling methods and survey areas -Acquisition of research permission by CP -Translation of draft questionnaire and pre-testing -Carryout HH sampling, listing - Recruitment and training support surveyors at the briefing session -Reporting to the Japanese expert		Chief surveyor -Preparation of the draft questionnaire and finalization with CP and Chief surveyor (The communication/direction with chief support surveyor through emails and discussion in Hanoi during her stay in mid-April)
Survey Implementation: 8days Activities: -Supervising support surveyors and monitoring achievements -Reporting to the Japanese expert	Survey Implementation: 5days (25 household per surveyor) Activities: -Conduct HH interviews with questionnaire -Reporting the progress to the chief surveyor	Middle May Activities: -Supervise and monitor the survey implementation (will be on site in mid-May)
Follow up of the survey: 12days Activities: -Analysis of the result of the survey -translation of the result -Reporting to the Japanese expert - Follow up the survey if required	Follow up of the survey: 2days -Inputting the result of the survey and submit it to the chief surveyor	Late May – Early June Activities: -Receive the results from chief surveyor (preferably while in Hanoi) -Confirm the results and direct follow-ups if required (Communication will be via email after May)

Note: Chief support surveyor participate in both the survey for households and for commercial and industrial organization survey

4) Qualification and Tasks of Chief Surveyor

1. Qualification:

a) Knowledge and experiences of socio-economic status quo and survey implementation and analysis in Vietnam (preferably in Hanoi).
b) Knowledge of socially disadvantaged households (low-income HH) in Hanoi (where do they live and how much they earn etc.,)
c) English fluency for both written and oral communication with Japanese expert
d) Computer skills for report writing and research analysis (Word and Excel are must)
e) Internet access for communication as well as research
f) Familiarity with the governments' agencies (access to data and acquiring permission for the survey)
g) Leadership at the survey implementation including recruitment of support surveyors, training and monitoring

2. Tasks:
   a) Basic Information collection and preparation :
      - The latest existing official HH expenditure data in Hanoi (such as census results) in order to crate the survey figure (see an attached Excel file for the reference). If Hanoi specific data is not available, collect the latest national data.
      - The distribution of HH by income level in Hanoi in order to determine the percentage of sampling for the survey. The survey needs to include low-income HH to determine the fee for those HH. The percentages of HH in Hanoi as in the 5 income quintile in national data if data is available. If not, find out the districts where the lowest quintile HH reside (the lowest 25% (VDN275,000 or less than official urban poverty line for 2006-2010 of VND270,000 per month). See the statistic offices' website for further reference of existing data http://www.gso.gov.vn/default_en.aspx?tabid=515&idmid=5&ItemID=9647F
      - Collect the data and information of low-income HH in Hanoi such as definition (latest official poverty line set by the government) of Low-income HH and public measures for supports relate with waste water and water fee. Social welfare systems/benefits/financial supports for the Low-income HH relate with the project if there are any. According to the official statistics, 18% of HH in Vietnam is under the poverty line.
      - Suggest the methods considering the project targets area and possible affected households for 100 sampling (i.e., distribution of HH and survey districts). After the discussion with the CP and Japanese expert, carryout the sampling and prepare the lists.
      - Translation of Questionnaire prepared by the Japanese expert and pre-test of the Questionnaire

- Acquisition of research permission from the Authority if needed.
- Recruitment of support surveyors
- Briefing of support surveyors

b) Survey implementation: as in the above tale (details will be determined during the course of survey preparation in April)

c) Analysis and submission of report: as in the above tale(details will be determined during the course of survey preparation in April)

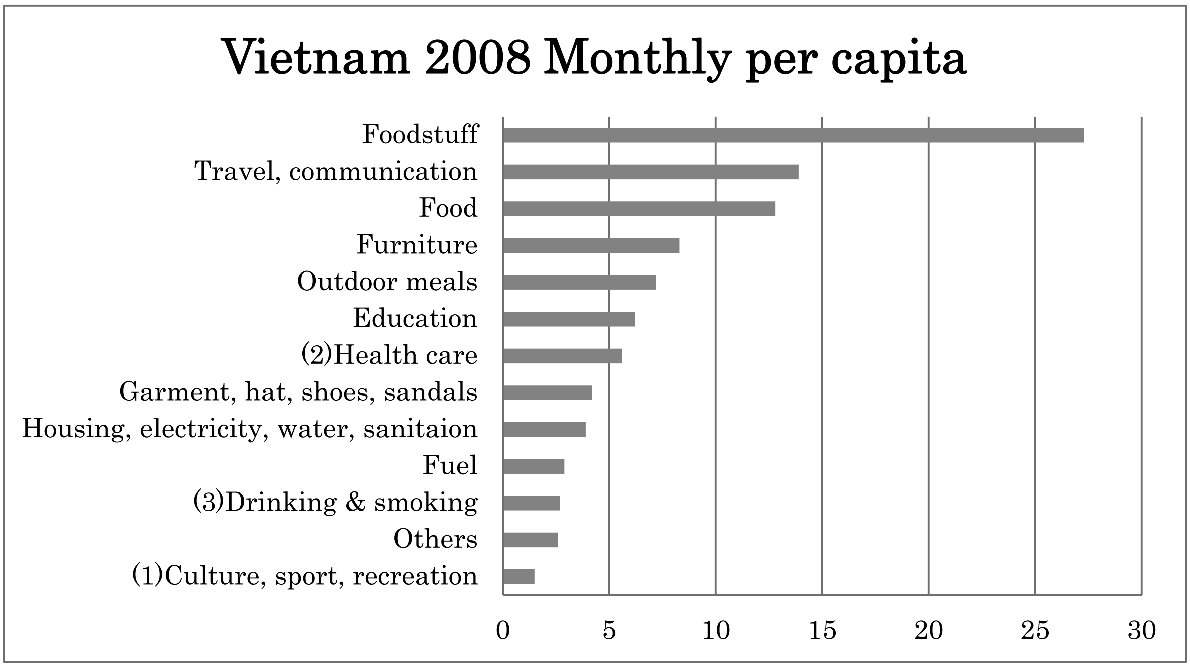
The end of the document

As of 18 April 2011
Nami Tanaka

Households Questionnaire

<table>
<tr><td>Sample No.:</td><td colspan="2">Date of Survey:</td><td colspan="2"></td></tr>
<tr><td>Surveyor:</td><td colspan="2">District name:</td><td colspan="2"></td></tr>
<tr><td colspan="5">Q1 Profile</td></tr>
<tr><td>Q1-1:Age (respondents)</td><td colspan="4"></td></tr>
<tr><td>Q1-2:Sex (respondents)</td><td colspan="2">Male</td><td colspan="2">Female</td></tr>
<tr><td>Q1-3: Position in the HH(respondents)</td><td colspan="4"></td></tr>
<tr><td>Q1-4:Occupation(respondents)</td><td colspan="4"></td></tr>
<tr><td>Q1-5:HH Family number</td><td colspan="4"></td></tr>
<tr><td>Q1-6:HH Monthly Income</td><td colspan="4">VND/Month</td></tr>
<tr><td>Q1-7: Who earns majority of the HH income and %</td><td colspan="4"></td></tr>
<tr><td colspan="5">Q2: Awareness of Sewage Facility</td></tr>
<tr><td>Q2-1: Are you connected to the sewage pipe?</td><td colspan="2">Yes</td><td>No</td><td>Unknown</td></tr>
<tr><td>Q2-2: How much do you pay for the environmental tariff?</td><td colspan="2">VND/Month</td><td colspan="2">Unknown</td></tr>
<tr><td>Q2-3: Do you know the environmental tariff (10% of the water tariff) is utilized for the sewage services?</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Q2-4 Do you know that water pollution is caused by wastewater discharge?</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td colspan="5">Q2-5: Do you know role of sewage systems as follows?</td></tr>
<tr><td>Q2-5(a): to improve sanitation and public health</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Q2-5(b):to mitigate storm water inundation</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Q2-5(c):to conserve water environment and water resource</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Q2-5(d): to create aesthetic urban view and recreation zone</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Q2-6: Have you ever heard of above sewage facility role?</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Q2-7: If yes for the Q2-6, please describe how? (i.e., media, awareness campaign by the governments, NGOs, and school (from children))</td><td colspan="4"></td></tr>
<tr><td>Q2-8: Have you ever discussed about the environmental protection and sewage facility among your family?</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
</table>

Q2-9: If yes for the Q2-8, please describe details of your discussion	
Q3: HH monthly expenditure (please indicate monthly mount)	
Q3-1: Food (staple food only)	VND/Month
Q3-2: Foodstuff	VND/Month
Q3-3: Fuel	VND/Month
Q3-4:Outdoor meals	VND/Month
Q3-5: Drinking & smoking	VND/Month
Q3-6: Garment, hat, shoes, sandals	VND/Month
Q3-7: Housing, electricity, water, sanitation (with breakdown as follows)	VND/Month
Q3-7(a):Housing	VND/Month
Q3-7 (b):Electricity	VND/Month
Q3-7 (c):Water	VND/Month
Q3-7 (d): Sanitation	VND/Month
Q3-8: Furniture	VND/Month
Q3-9: Health care	VND/Month
Q3-10: Travel, communication	VND/Month
Q3-11: Education	VND/Month
Q3-12: Culture, sport, recreation	VND/Month
Q3-13:Others	VND/Month
Q4: Willingness to pay for the sewage tariff	
Q4-1: How much are you willing to pay the sewage? (please indicate the monthly amount)	VND/Month
Q4-2: If you do not intend to pay the sewage tariff, please describe reasons.	
Q5: Please see the following HH expenditure figure and answer the following questions	



Q5-1: Are you comfortable to pay **sewage tariff** as equivalent as "culture, sports, recreation"?	Yes	No (Indicate alternative items and reason)
Q5-2: Are you comfortable to pay the **combined tariff for water and sewage** as equivalent as "health care"?	Yes	No (Indicate alternative items and reason)
Q5-3: Are you comfortable to pay the **water tariff** as equivalent as "drinking and smoking"?	Yes	No (Indicate alternative items and reason)

End of Questions

Thank you very much for your cooperation

Outlines of Questionnaire Surveys

I. Methodology for the questionnaire survey for commercial and industrial organization (CI)

1) Investigation Object and Methodology

The survey conducts questionnaire survey with 30 samples in the form of interview. The sample organizations will be extracted from commercial and industrial organizations which will gain benefit from the project. In extracting samples, it is considered that the samples include various categories of business

2) Content of the survey (draft)

① CI profiles

Name, location, contents of the business, profile of the representative (contact number, e-mail account etc.), establishment year and financial data (such as annual sale, capital stock, B/S or P/L etc.)

② Awareness of sewerage facility (Yes or No question and comments)

> Water pollution is caused by wastewater discharge

> Role/benefits of sewage system: improve public health, mitigate storm water inundation, conserve water environment and resource, and create aesthetic urban view and recreation zone

> Ever heard of sewage facility role (i.e., by media, awareness program by governments and NGO)

> Ever discussed about the environmental protection and sewage facility at the office

③ Questions for willingness to pay for sewage water fee (WTP)

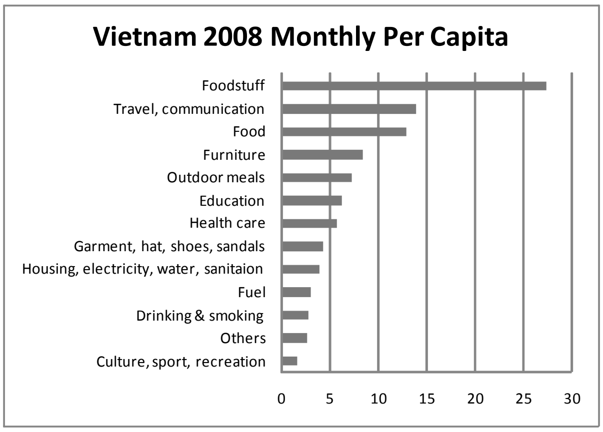
> Monthly amount of willingness to pay for sewage water fee with the description of planned facilities (preferably with photos) with service conditions, and policy of O&M cost sharing by beneficiaries

> If respondents refused to answer the WTP, ask for reasons.

④ Questions for affordability to pay (ATP)

Monthly amount of affordability to pay applying the following method.

The survey asks whether the respondents feel reasonable to pay the same amount (percentage) from their current expenditure for the following water and sewage charges showing the current percentage of expenditure as in the sample figure.



The above figure will be prepared reflecting the latest official CI expenditure data in Hanoi or Vietnam. According to the actual condition of the business condition, some items will be modified to coordinate with the survey for HH

3) Schedule of the survey

Chief support surveyor (1 person, 35 days)	Support surveyor (3persons, 12 day each)	Implementation schedule and activities of Tanaka(Yokohama Water)
Survey preparation : 15days Activities: -Collect basic information -Proposal of survey plans including support surveyor recruitment -Proposal of sampling methods and survey areas -Acquisition of research permission by C/P -Translation of draft questionnaire and pre-testing -Carryout CI sampling, listing - Recruitment and training support surveyors at the briefing session	Survey preparation : 2days Activities: -Attend the briefing session for the survey to understand survey methodology	Middle April – Early May Activities: -Determining the sampling methodology and survey sites with the discussion and consultation with C/P and Chief surveyor -Preparation of the draft questionnaire and finalization with C/P and Chief surveyor (The communication/direction with chief support surveyor through emails and discussion in Hanoi during his stay in mid-April)

-Reporting to the Japanese expert		
Survey Implementation: 8days Activities: -Supervising support surveyors and monitoring achievements -Reporting to the Japanese expert	Survey Implementation: 8days (10 organizations per surveyor) Activities: -Conduct CI interviews with questionnaire -Reporting the progress to the chief surveyor	Middle May (Supervise and direct the survey)
Follow up of the survey: 12days Activities: -Analysis of the result of the survey -translation of the result -Reporting to the Japanese expert - Follow up the survey if required	Follow up of the survey: 2days -Inputting the result of the survey and submit it to the chief surveyor	Late May – Early June (Direct and confirm the works in Hanoi. If necessary, communicate by email after going back to Japan)

Note: Chief support surveyor participate in both the survey for households and for commercial and industrial survey

4) Qualification and Tasks of Chief Surveyor

1. Qualification:

a) Knowledge and experiences of socio-economic status quo and survey implementation and analysis in Vietnam (preferably in Hanoi).

b) Knowledge of commercial and industrial organization in Hanoi (locations, foreign or domestic investment, and other economical conditions).

c) English fluency for both written and oral communication with Japanese expert

d) Computer skills for report writing and research analysis (Word and Excel are must)

e) Internet access for communication as well as research

f) Familiarity with the governments' agencies (access to data and acquiring permission for the survey)

g) Leadership at the survey implementation including recruitment of support surveyors, training and monitoring

2. Tasks:

a) Basic Information collection and preparation :

- The list of latest existing CI in Hanoi and its financial data (such as annual sales, capital stock, B/S or P/L etc.) in order to determine the survey targets. If Hanoi specific data is not available, collect the latest national data.
- Suggest the methods considering the social and economical concerns to contact with 30 sample organizations. After the discussion with the C/P and Japanese expert, carryout the sampling and prepare the lists.
- Translation of Questionnaire prepared by the Japanese expert and pre-test of the Questionnaire
- Acquisition of research permission from the Authority if needed.
- Recruitment of support surveyors
- Briefing of support surveyors

b) Survey implementation: as in the above tale (details will be determined during the course of survey preparation in April)

c) Analysis and submission of report: as in the above tale(details will be determined during the course of survey preparation in April)

Commercial & Industrial Organization Questionnaire

as of 08.04.2011

Classification of the Business: Sample No. :

Surveyor :

Date of Survey : District:

Q1 Profile

1-01 Name of the Organization

1-02 Address of the Organization

1-03 Contents of the Business

1-04 Name of the Respondent

1-05 Position of the Respondent in the organization

1-06 Number of the staff persons

Q2 Awareness of Sewage Facility

2-01 Do you know that water pollution is caused by wastewater discharge? Yes No

2-02 Do you know role of sewage systems as follows?

(a): to improve sanitation and public health Yes No

(b):to mitigate storm water inundation Yes No

(c):to conserve water environment and water resource Yes No

(d): to create aesthetic urban view and recreation zone Yes No

2-03 Have you ever heard of above sewage facility role Yes No

2-04 If yes for the Q2-03, please describe how?

(i.e.) media, awareness campaign by the governments, NGOs, and school (from children))

2-05 Have you ever discussed about the environmental protection and sewage facility at the office? Yes No

2-06 If yes for the Q2-05, please describe details of your discussion

Q3 Expenduture for water

3-01 Monthly consumption of water m3

3-02 Monthly payment for water VND

3-03 Maximun payment in the past several years VND

3-04 Minimum payment in the past several years VND

3-05 How much % are you using the water for business %

Q4 Willingness to pay

4-01 Which benefit are your organization will get from sewage system?

(a):Reduction of the bad smell Yes No

(b): Reduction of the disease Yes No

(c): Reduction of the maintenance of cleaning the trench Yes No

(d): Improving the toilet Yes No

(e): Enlargemet of the business Yes No

(f): Others

4-02 How much do you intend to pay for sewage fee, if you get the benefit as above?

Pleasel answer how much % in comparizon with payment to water (Q3-02)

1. same as now 2. more than 10% 3. more than 20% 4. more than 30%

5. more tha 40% 6. more than 50% 6. more than 60% 6. more than 70%

7. more than 80% 8. more tha 90% 9. more than 100% 10. Less than now

Q5 Affordability to pay

5-01 How much is your monthly sales VND

5-02 How much is your monthly expense VND

< contents of expense>

payment to buy the material	VND
payment to the staff	VND
payment to the machinary	VND
payment to for the electricity	VND
payment for location (rending house)	VND
tax payment	VND
other payments	
payment to [ ]	VND
payment to [ ]	VND
payment to [ ]	VND

5-03 How much can your organization pay for sewage system

Pleasel answer how much % in comparizon with payment to water (Q3-02)

1. same as now 2. more than 10% 3. more than 20% 4. more than 30%
5. more tha 40% 6. more than 50% 6. more than 60% 6. more than 70%
7. more than 80% 8. more tha 90% 9. more than 100% 10. Less than now

Q6 Unit rate for sewerage for CI organizations is set around 20% or more than that for households, to support the poor citizens in Hanoi.
How much unit rate for sewerage cost is acceptable for you to pay in comparison to the rate for household?"

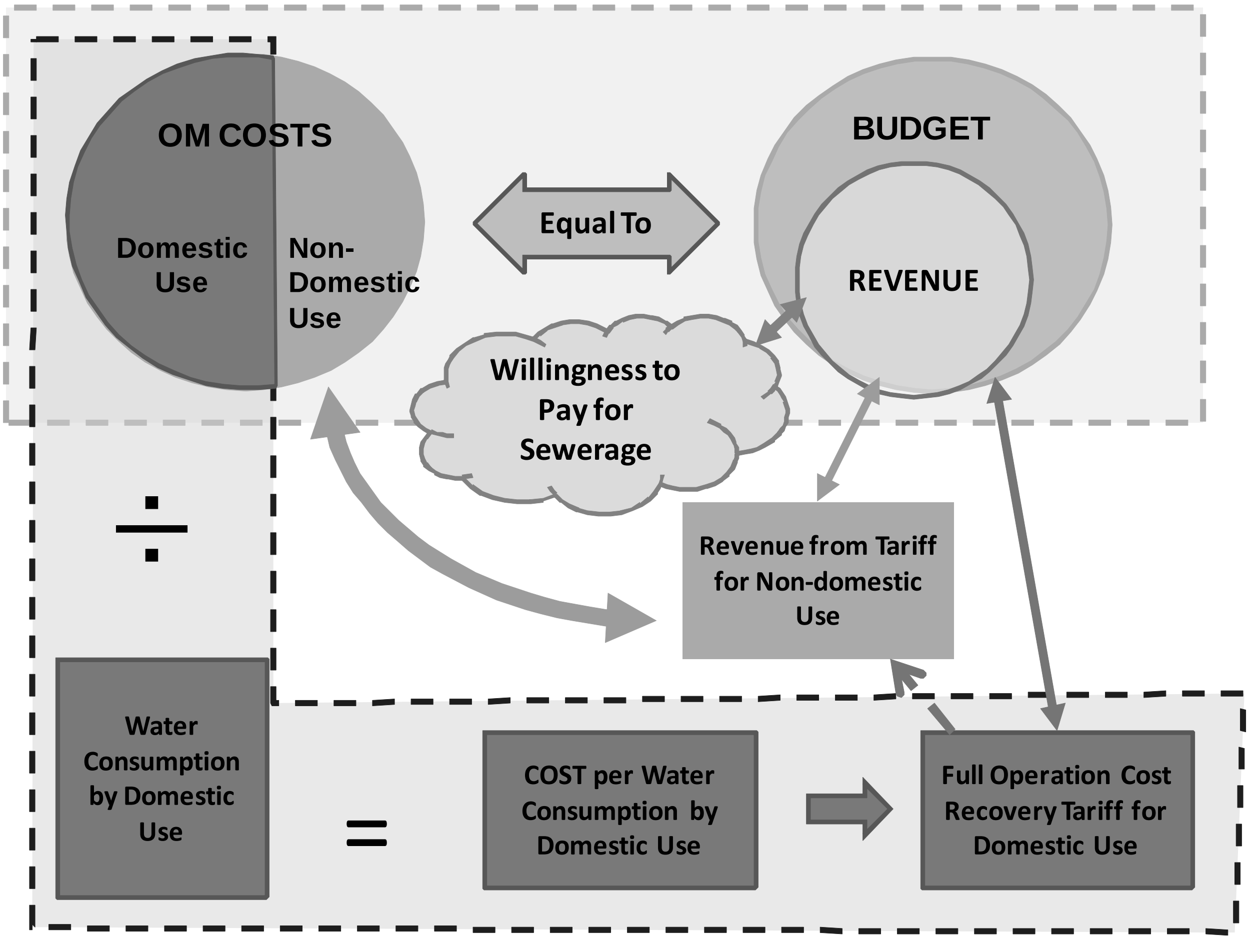
1 same as now (120%).
2 until 150% of unit rate for households
3 until 170% of unit rate for households
4 until 180% of unit rate for households
5 until 200% of unit rate for households
6 until 300% of unit rate for households
7 more than 300% of unit rate for households

Appendix 6 Calculation of Sewerage Tariff

<u>Calculation of Sewerage Tariff</u>

Summary

[Concept of Tariff Calculation]



- **The sewerage tariff for domestic use is set to cover the necessary costs of sewerage operation for domestic use in Hanoi.**

  The cost of sewerage operation is estimated by cost combinations for WWTP O&M, replacement, and depreciation, as well as the O&M cost of the associated sewer system. The necessary cost for domestic is established by the proportion of domestic sewage to non-domestic sewage.

- **In the analysis, tariffs are collected from (i) the service area of the WWTPs, or (ii) the whole Hanoi region.**

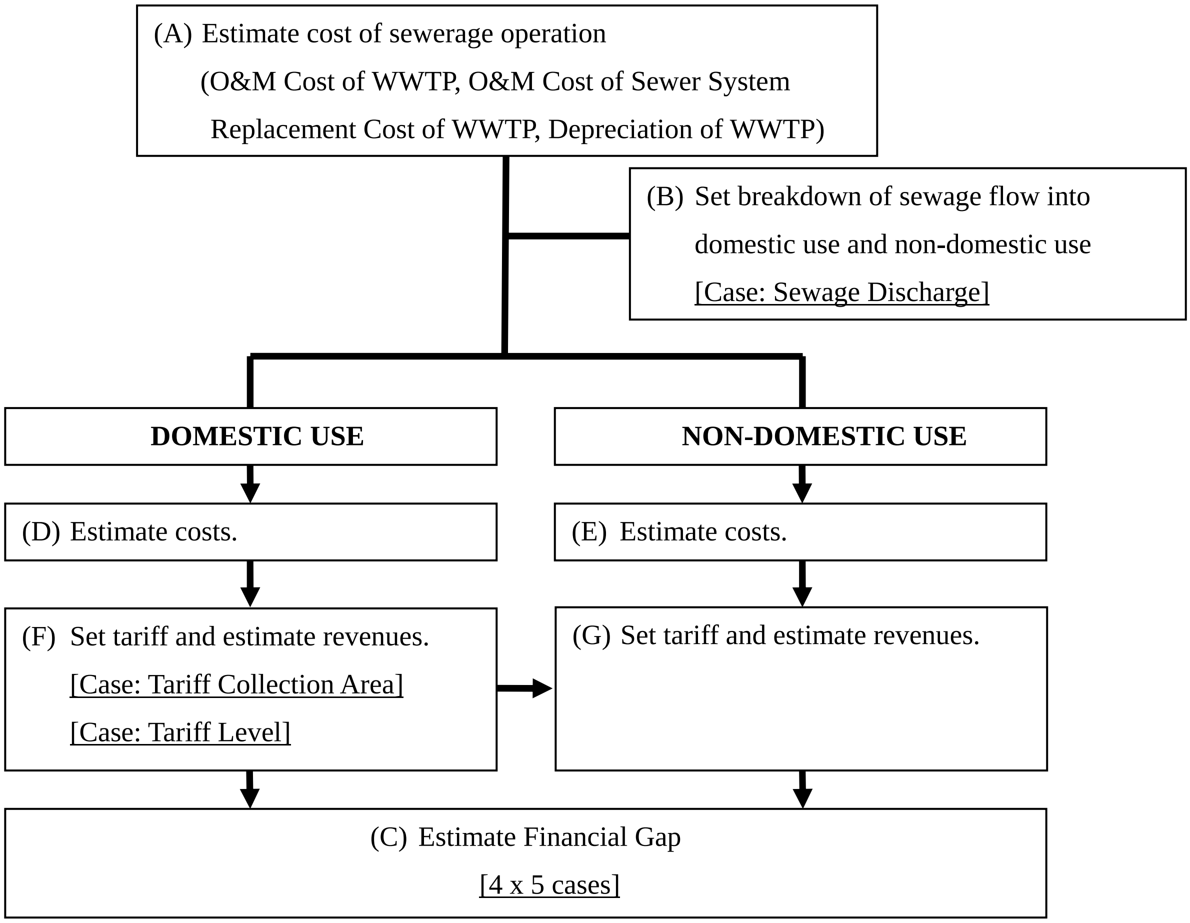
- **In the analysis, sewage will be discharged in accordance with (i) design of WWTPs, or (ii) actual water consumption in Hanoi.**

- **The sewerage tariff for non-domestic use is set in accordance with Decree No. 88/2007/ND-CP.**

  The sewerage tariff for non-domestic use is set as indicated in Decree 88/2007/ND-CP Article 53. Waste water from non-domestic use is assumed to be STT3 (COD 201-300 mg/l), and their adjustment coefficient (K) is 2.0. This indicates that the tariff for non-domestic use is twice as much as that for domestic use.

Based on these concepts, the tariff setup and financial gap in each case are estimated.

[Calculation Flow]



[Case]

The studied cases for tariff setup and financial gap estimation are summarized in the following table.

Case No.	Sewage Discharge	Tariff Collection Area
1	**190L**	**Service Area**
2	**190L**	**Whole Hanoi**
3	**153L**	**Service Area**
4	**153L**	**Whole Hanoi**

Note:

Sewage Discharge

190L: It is assumed that water consumption for domestic use is 190L/day person. This amount is assumed in accordance with the Plant Design of WWTPs. Sewage discharge is estimated based on the forecasted population in 2020.

153L: Water consumption for domestic use in the service area is 153L/day person, based on data provided by the water company. Sewage discharge is estimated based on current water consumption and population in Hanoi.

Tariff Collection Area

Service Area: Sewerage tariffs will be collected from the service area of the WWTPs.

Whole Hanoi: The sewerage tariffs will be collected from the whole Hanoi region. This area is separated into the urban area and the rural area. It is assumed that tariffs in the rural area are half the amount of the tariffs in the urban area, because the average income in the rural area is approximately 50% of the average income in the urban area.

In setting up the tariff for domestic, the following 5 levels are taken into consideration:

a. Willingness to Pay Level
b. O&M Cost of WWTPs Full Recovery Level
c. b + O&M Cost of Sewer System Full Recovery Level
d. c + Replacement Cost Full Recovery Level
e. d + Depreciation of WWTPs Full Recovery Level

[Results]

Case No.1

Sewage Discharge **190L**: Sewage is discharged in accordance with the Plant Design of WWTPs.

Tariff Collection Area **Service Area**: Sewerage tariff is collected from the service area of WWTPs.

No.	Tariff Level of Domestic	Tariff for Domestic Use in Urban	Tariff for Non-domestic Use in Urban	Necessary Cost	Revenue	Financial Gap (Revenue) - (Necessary Cost)	Financial Gap (Revenue) - (O&M Cost of WWTP)
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,111	2,221	44,555	21,713	-22,842	-22,842
b	O&M Cost of WWTP Full Recovery Level	2,871	5,743	44,555	56,137	11,582	11,582
c	b + O&M Cost of Sewer System Recovery Level	3,509	7,081	54,452	68,607	14,155	24,052
d	c+ Replacement Cost Recovery Level	4,768	9,536	73,985	93,218	19,233	48,663
e	d+ Depreciation of WWTPs Recovery Level	12,208	24,417	189,439	238,685	49,246	194,130

Case No.2

Sewage Discharge **190L**: Sewage is discharged in accordance with the Plant Design of WWTPs.

Tariff Collection Area **Whole Hanoi**: Sewerage tariff is collected from whole Hanoi.

No.	Tariff Level of Domestic	Tariff for Domestic Use in Urban	Tariff for Non-domestic Use in Urban	Necessary Cost	Revenue	Financial Gap (Revenue) - (Necessary Cost)	Financial Gap (Revenue) - (O&M Cost of WWTP)
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,135	2,270	44,555	42,461	-2,094	-2,094
b	O&M Cost of WWTP Full Recovery Level	1,475	2,951	44,555	55,194	10,639	10,639
c	b + O&M Cost of Sewer System Recovery Level	1,803	3,606	54,452	67,454	13,002	22,899
d	c+ Replacement Cost Recovery Level	2,450	4,900	73,985	91,651	17,667	47,096
e	d+ Depreciation of WWTPs Recovery Level	6,273	12,545	189,439	234,674	45,235	190,119

Case No.3

Sewage Discharge **153L:** Sewage is discharged in accordance with current water consumption and population in Hanoi.

Tariff Collection Area **Service Area**: Sewerage tariff is collected from service area of WWTPs.

No.	Tariff Level of Domestic	Tariff for Domestic Use in Urban	Tariff for Non-domestic Use in Urban	Necessary Cost	Revenue	Financial Gap (Revenue) - (Necessary Cost)	Financial Gap (Revenue) - (O&M Cost of WWTP)
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,111	2,221	44,555	17,807	-26,748	-26,748
b	O&M Cost of WWTP Full Recovery Level	3,577	7,153	44,555	57,345	12,790	12,790
c	b + O&M Cost of Sewer System Recovery Level	4,371	8,742	54,452	70,083	15,631	25,528
d	c+ Replacement Cost Recovery Level	5,939	11,878	73,985	95,224	21,239	50,669
e	d+ Depreciation of WWTPs Recovery Level	15,207	30,414	189,439	243,821	54,382	199,266

Case No.4

Sewage Discharge **153L**: Sewage is discharged in accordance with current water consumption and population in Hanoi.

Tariff Collection Area **Whole Hanoi**: Sewerage tariff is collected from whole Hanoi.

No.	Tariff Level of Domestic	Tariff for Domestic Use in Urban	Tariff for Non-domestic Use in Urban	Necessary Cost	Revenue	Financial Gap (Revenue) - (Necessary Cost)	Financial Gap (Revenue) - (O&M Cost of WWTP)
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month	Mil. VND/ month	mil. VND/month
a	Willingness to Pay Level	1,135	2,270	44,555	35,125	-9,430	-9,430
b	O&M Cost of WWTP Full Recovery Level	1,737	3,474	44,555	53,759	9,204	9,204
c	b + O&M Cost of Sewer System Recovery Level	2,123	4,246	54,452	65,700	11,248	21,145
d	c+ Replacement Cost Recovery Level	2,884	5,769	73,985	89,268	15,283	44,713
e	d+ Depreciation of WWTPs Recovery Level	7,385	14,771	189,439	228,571	39,132	184,016

[Recommendation for Tariff]

The JICA Team recommends that a tariff is introduced and increased via the following scenarios:

- A sewerage tariff is introduced in 2014 and at Willingness to Pay Level across the whole of Hanoi. Hence, the tariff for domestic use in the urban area 1,111 VND/m^3. The tariff for non-domestic use in the urban area should cost 2,221 VND/m^3. (Case No.3 a)
- The sewerage tariff should be increased every 5 years until it reaches the necessary cost for sewerage operation recovery level in 2024. The tariff for domestic use in the urban area would then be 15,207 VND/m^3. The tariff for non-domestic use in the urban area would then be 30,414 VND/m^3. (Case No.3 e)

In Case 3, the sewerage payment for the average household in each case becomes as follows:

No.	Tariff Level of Domestic	Tariff for Domestic Use in Urban	VAT	Water Consumption at Average Household in Urban Area	Monthly Sewerage Payment at Average Household in Urban Area
		A	B = A x 5%	C	D = (A+B) x C
		VND/m^3	VND/m^3	m^3/household/month	VND/household/month
a	Willingness to Pay Level	1,111	57	18.19	21,221
b	O&M Cost of WWTP Full Recovery Level	3,577	179	18.19	68,314
c	b + O&M Cost of Sewer System Recovery Level	4,371	219	18.19	83,492
d	c+ Replacement Cost Recovery Level	5,939	297	18.19	113,433
e	d+ Depreciation of WWTPs Recovery Level	15,207	760	18.19	290,436

Until the sewerage tariff catches up to the full sewerage operation cost recovery level in 2024, there will be a financial gap between revenue and cost. When the sewerage tariff is at the willingness to pay level, the gap will become VND 269,215/household/month (=290,436 – 21,221).

Detail of Calculation

i. Area Data in Hanoi

[Definition]

Urban Area: 11 districts (Ba Dihn, Hoan Kiem, Tay Ho, Long Bien, Cau Giay, Dong Da, Hai Ba Trung, Hoang Mai, Thanh Xuan, Ha Dong, Son Tay)

Rural Area: 18 districts

[Base Data]

Statistical Data in 2010 (Source: Hanoi Statistical Yearbook 2010)	Population	Gross Output of non-state industry
Urban	2,605,600	VND 17,307 billion.
Rural	4,012,300	VND 19,222 billion
Population of Hanoi in 2020 (Source: Prime Minister's Decision No. 1081/QD-TTG)		**8,000,000 person**

[Calculation]

District Data in 2010 (Source: Hanoi Statistical Yearbook 2010) **Gross Output of non-state industry per capita in Urban Area** = (Gross Output in Urban / Urban population) **Gross Output of non-state industry per capita in Rural Area** = (Gross Output in Rural / Rural population)	 **VND 6.64 mil. /capita** **VND 4.79 mil. /capita**
Ratio of Gross Output of non-state industry per capita in Rural Area to Urban Area = (Gross Output of non-state industry per capita in Rural Area) / (Gross Output of non-state industry per capita in Urban Area) = VND 4.79 mil. / VND 6.64 mil. = **0.72**	
Population of Hanoi in 2020 **Population of Urban Area in 2020** = 2,605,600 x 8,000,000 /(2,605,600+4,012,300) **Population of Rural Area in 2020** = 4,012,300 x 8,000,000 /(2,605,600+4,012,300)	 **3,149,800 person** **4,850,200 person**

ii. Sewerage Operation Costs

[Base Data]

Unit Rate of O&M Cost of Sewer System in 2007 (Source: Feasibility Study for the Construction Project of Central Large-Scaled Wastewater Treatment Plants for Hanoi Environmental Improvement, p8-7)	**VND 5.94 mil./ha/year**
Price Escalation in 2007 - 2010 (Source: World Economic Outlook Database)	Inflation in 2008 x Inflation in 2009 x Inflation in 2010 = 1.23115 x 1.06717 x 1.09207 = **1.43**
Duration of Use of Fixed Asset Machinery and Equipment (Source: Circular No. 203-2009-TT-BTC Appendix 1 "B-18 Other working machinery and equipment") Civil Works (Source: Circular No. 203-2009-TT-BTC Appendix 1 "F-4 Storehouses, tanks/reservoirs…")	Minimal duration of use: 5 years Maximal duration of use: 12 years Minimal duration of use: 5 years Maximal duration of use: 20 years

[Calculation]

Unit Rate of O&M Cost of Sewer System = Unit Rate of O&M Cost of Sewer System in 2007 x Price Escalation in 2007 - 2010 = VND 5.94 mil./ha/year x 1.43 = **VND 8.49 mil./ha/year**
Duration for Depreciation Machinery and Equipment: Average duration of use = (5+12)/2 = **8.5 years** Civil Works: Average duration of use = (5+20)/2 = **12.5 years**

Capacities of Wastewater Treatment Plants

Truc Bach WWTP	2,300 m^3/d
Kim Lien WWTP	3,700 m^3/d
North Thang Long WWTP	42,000 m^3/d
Ho Tay WWTP	15,000 m^3/d
Bay Mau WWTP	14,000 m^3/d
Yen So WWTP	200,000 m^3/d
Yen Xa WWTP	270,000 m^3/d
Phu Do WWTP	84,000 m^3/d

Note: Inflow of North Thang Long WWTP in 2010= (assumed) 6,500 m^3/d

O&M Cost and Replacement Cost of each WWTP
(Source a:JICA team estimates
b:Data from HSDC in 2010)

Note: Figures below are (O&M Cost : 15-year expenditure / 15 year, Replacement Cost: 20-year expenditure / 20 year)

WWTP	Capacity (m^3/day)	O&M Cost (mil. VND/year)	Replacement Cost (mil. VND/year)
Truc Bach WWTP	2,300	4,581 [b]	9,726 [a]
Kim Lien WWTP	3,700	5,732 [b]	10,082 [a]
North Thang Long WWTP	42,000	7,231 [b]	19,806 [a]
Ho Tay WWTP	15,000	29,682 [a]	13,996 [a]
Yen So WWTP	200,000	159,286 [a]	52,119 [a]
Bay Mau WWTP	14,000	29,682 [a]	13,996 [a]
Yen Xa WWTP	270,000	214,105 [a]	83,053 [a]
Phu Do WWTP	84,000	84,361 [a]	31,620 [a]
Total		**534,660**	**234,398**

O&M Cost for Sewer System of each WWTP
(Source: JICA team)

WWTP	Capacity (m^3/day)	Service Area (ha)	O&M Cost of Sewer System (mil. VND/year)
Truc Bach WWTP	2,300	39	331
Kim Lien WWTP	3,700	55	467
North Thang Long WWTP	42,000	3,282	27,864
Ho Tay WWTP	15,000	240	2,038
Yen So WWTP	200,000	2,951	25,054
Bay Mau WWTP	14,000	240	2,038
Yen Xa WWTP	270,000	4,634	39,343
Phu Do WWTP	84,000	2,547	21,624
Total			**118,759**

Depreciation of each WWTP
(Source a:JICA team estimates
b:Information from GAMUDA)

WWTP	Capacity (m^3/day)	Initial Investment: Machinery and Equipment (mil. VND)	Initial Investment: Civil Work (mil. VND)
Truc Bach WWTP	2,300	144,938 [a]	12,823 [a]
Kim Lien WWTP	3,700	164,616 [a]	13,642 [a]
North Thang Long WWTP	42,000	702,961 [a]	36,028 [a]
Ho Tay WWTP	15,000	559,833 [a]	35,982 [a]
Yen So WWTP	200,000	2,084,745 [b]	2,178,993 [b]
Bay Mau WWTP	14,000	559,833 [a]	35,982 [a]
Yen Xa WWTP	270,000	3,322,137 [a]	1,471,316 [a]
Phu Do WWTP	84,000	1,264,808 [a]	586,432 [a]
Total		**8,803,871**	**4,371,198**

Depreciation = VND 8,803,871 mil. /8.5 years + VND 4,371,198 mil. /12.5 year
= **VND 1,385,446 mil. /year**

iii. Other Basic Data

[Base Data]

Water Supply Data of WWTP Service Area in 2010 (Source: HAWACO & VIWACO)	Customers	Consumptions	Ann. Turnover
Domestic	488,106 connections	106,548,468 m^3/year	VND 472,693,637,079
Non-domestic - Commercial	6,947 connections	15,658,277 m^3/year	VND 187,899,324,000
Non-domestic - Industrial		6,775,231 m^3/year	VND 49,729,162,500
Non-domestic - Administrative		13,329,814 m^3/year	VND 75,979,939,800

Water Supply Data of Urban Area in 2010 (Source: HAWACO, VIWACO, Ha Dong WS Company & Son Tay WS Company)	Customers	Consumptions	Ann. Turnover
Domestic	558,174 connections	119,216,142 m^3/year	VND 529,534,540,079
Non-domestic - Commercial	8,227 connections	16,087,301 m^3/year	VND 193,165,701,000
Non-domestic - Industrial		9,925,002 m^3/year	VND 65,741,505,500
Non-domestic - Other		14,888,342 m^3/year	VND 84,751,944,800

VAT for Sewerage Tariff	5% of Sewerage Fee as same as the Water Supply Tariff System	
Willingness To Pay to the Sewerage Service as of 2011	Domestic	VND 21,212/Household
(based on the Interview Survey conducted by JICA Team in May 2011)	Commercial & Industries	VND 2,823,668/Entity

[Calculation]

Water Supply Data of WWTP Service Area in 2010 (Source: HAWACO & VIWACO) **Monthly Domestic Water Consumption per connection** = (Domestic consumption / Domestic connections) **Monthly Domestic Water Consumption per capita** = (Monthly Domestic Water Consumption per household / Average Household Family Number) = 17.80/3.92 **Ratio of (Domestic Consumption) : (Non-domestic Consumption)**	**18.19 m^3/Household** **4.64 m^3/capita** **74.9% : 25.1%**
Water Supply Data of Urban Area in 2010 (Source: HAWACO, VIWACO, Ha Dong WS Company & Son Tay WS Company) **Monthly Domestic Water Consumption per connection** = (Domestic consumption / Domestic connections) **Monthly Domestic Water Consumption per capita** = (Monthly Domestic Water Consumption per household / Average Household Family Number) = 17.80/3.92 **Ratio of (Domestic Consumption) : (Non-domestic Consumption)**	**17.80 m^3/Household** **4.54 m^3/capita** **74.5% : 25.5%**

iv. Sewerage Tariff Calculation to accord to Required Costs (WWTP Design Base)

Sewerage tariff and financial gap is calculated based on WWTP designs, whose target year is 2020.

Sewage Amount (Source: Feasibility Study for the Constructions Project of Central Large-scaled Wastewater Treatment Plants)	
Domestic	190L/capita day (190/247 = 76.9% of total amount)
Non-domestic	57L/capita day (57/247 = 23.1% of total amount)
Necessary Cost of 8 WWTP for Domestic	
O&M Cost of WWTPs	VND 534,660 mil. x 0.769 = VND 411,154 mil./year
O&M Cost of Sewer System	VND 118,759 mil. x 0.769 = VND 91,326 mil./year
Replacement Cost	VND 234,398 mil. x 0.769 = VND 180,252 mil./year
Depreciation of WWTPs	VND 1,385,446 mil. x 0.769 = VND 1,065,408 mil./year
Necessary Cost of 8 WWTP for Non-domestic	
O&M Cost of WWTPs	VND 534,660 mil. x 0.231 = VND 123,506 mil./year
O&M Cost of Sewer System	VND 118,759 mil. x 0.231= VND 27,433 mil./year
Replacement Cost	VND 234,398 mil. x 0.231= VND 54,146 mil./year
Depreciation of WWTPs	VND 1,385,446 mil. x 0.231= VND 320,038 mil./year

[Sewerage Tariff and Revenue Calculation for Domestic Operations – Tariff Collection Area: WWTP Service Area]

Wastewater Inflow to WWTP

Wastewater Inflow of WWTP = Capacity of WWTP / (Daily Maximum Factor = 1.312) / (Groundwater infiltration ratio = 1.1)
Sewerage Collection Rate = 80%
Ratio of (Domestic Consumption) : (Non-domestic Consumption) = 76.9% : 23.1%
Month = 365 / 12 day

Required Sewerage Tariff

Total Capacity of 7 WWTPs (Truc Bach, Kim Lien, Ho Tay, Bay Mau, Yen So, Yen Xa, Phu Do) = 589,000 m^3/day

Monthly Domestic Water Consumption in Service Area = (Total Capacity of 7 WWTPs) / (Daily Maximum Factor) / (Groundwater infiltration ratio) / (Sewerage Collection Rate) x (Domestic Water Consumption Rate)
= 589,000 m^3/day x 365/12 / 1.312 / 1.1 / 0.8 x 76.9%
= 11,932,646 m^3/month

Monthly Domestic Sewerage Tariff Revenue in Service Area = (Monthly Domestic Water Consumption in Service Area) x (Unit rate for Domestic)
= 11,932,646 m^3/month x (Unit rate for Domestic)

Monthly Sewerage Payment at Average Household = Average Household Water Consumption x Unit Rate for Domestic x (1+VAT)

<u>Tariff for WTP Level</u>
Monthly Sewerage Payment at Average Household = Willingness To Pay for the Sewerage Service
Average Household Water Consumption x Unit Rate for Domestic x (1+VAT) = Willingness To Pay for the Sewerage Service

Unit Rate for Domestic = Willingness To Pay to the Sewerage Service / Average Household Water Consumption / (1+VAT)
= 21,212/ 18.19 / 1.05 = VND 1,111/m^3

<u>Tariff for Cost Recovery Level</u>
Monthly Domestic Sewerage Tariff Revenue in Service Area = Necessary Cost for Sewerage Operation for Domestic
11,934,920 m^3/month x (Unit rate for Domestic) = Necessary Cost for Sewerage Operation for Domestic

Unit Rate for Domestic = Necessary Cost for Sewerage Operation for Domestic / 11,932,646

Results

		Tariff for Domestic -Urban	Revenue from Domestic	Necessary Cost for Domestic	Monthly Payment at Average HH in Urban
		VND/m^3	mil. VND/month	mil. VND/month	VND/HH/month
a	Willingness to Pay Level	1,111	13,252	34,263	21,212
b	O&M Cost of WWTP Full Recovery Level	2,871	34,263	34,263	54,841
c	b + O&M Cost of Sewer System Recovery Level	3,509	41,873	41,873	67,023
d	c+ Replacement Cost Recovery Level	4,768	56,894	56,894	91,065
e	d+ Depreciation of WWTPs Recovery Level	12,208	145,678	145,678	233,174

[Sewerage Tariff and Revenue Calculation of Domestic – Tariff Collection Area: whole Hanoi]

Tariff Collection	**Urban**	**Rural**
Tariff is collected by	Water Company	Peoples Committee of each District
Cost for Collection Fee	0% of total amount of sewerage tariff	8% of total amount of sewerage tariff (Note: Tariff Collection Fee is applied the formula of (8% of Domestic Water Tariff) as currently used by HAWACO & VIWACO.)

Domestic Water Consumption	Urban	Rural
Personal Consumption	4.54 m^3/ person month	4.00 m^3/ person month
	(Note: Water Supply Data of Urban Area)	(Note: Decree No. 88/2007/ND-CP Article 51, 1 b)
Population	3,149,800 person	4,850,200 person
Water Consumption	4.54 x 3,149,800 = 14,300,092 m^3/month	4.00 x 4,850,200 = 19,400,800 m^3/month

Sewerage Tariff Table

The unit rate for the sewerage tariff corresponds with the unit rate for domestic operations in the urban area (T_{ud}).

Urban		Rural	
Domestic	T_{ud}	Domestic	0.5 x T_{ud}

Note

- The unit rate for the rural region is 50% of the unit rate for the urban region. This is because the average income level in the rural area is almost 50% of the average income level in the urban area. Monthly income per capita in Old Hanoi is VND 1,719,600, and monthly income per capita in New Hanoi is VND 876,400. (Source: Hanoi Living Standards 2008)

T_{ud}: Unit Rate of Sewerage Tariff for Domestic in Urban

Revenue from Domestic = Unit Rate for Domestic in Urban x Water Consumption by Domestic in Urban x (1-Collection Fee Rate for Urban) + Unit Rate for Domestic in Rural x Water Consumption by Domestic in Rural x (1- Collection Fee Rate for Rural)

= T_{ud} x 14,300,092 x (1-0) + 0.5 x T_{ud} x 19,400,800 x (1-8%) = 23,224,460 x T_{ud}

Tariff for WTP Level

Monthly Sewerage Payment at Average Household = Willingness To Pay for the Sewerage Service

Average Household Water Consumption x Unit Rate for Domestic x (1+VAT) = Willingness To Pay for the Sewerage Service

Unit Rate for Domestic = Willingness To Pay to the Sewerage Service / Average Household Water Consumption in Urban Area / (1+VAT)

= 21,212/ 17.80 / 1.05 = VND 1,135/m^3

Tariff for Cost Recovery Level

Monthly Domestic Sewerage Tariff Revenue in Service Area = Necessary Cost for Sewerage Operation for Domestic

23,224,460 x (Unit rate for Domestic) = Necessary Cost for Sewerage Operation for Domestic

Unit Rate for Domestic = Necessary Cost for Sewerage Operation for Domestic / 23,224,460

Results

		Tariff for Domestic -Urban	Revenue from Domestic	Necessary Cost for Domestic	Monthly Payment at Average HH in Urban
		VND/m^3	mil. VND/month	mil. VND/month	VND/HH/month
a	Willingness to Pay Level	1,135	26,358	34,263	21,212
b	O&M Cost of WWTP Full Recovery Level	1,475	34,263	34,263	27,573
c	b + O&M Cost of Sewer System Recovery Level	1,803	41,873	41,873	33,698
d	c+ Replacement Cost Recovery Level	2,450	56,894	56,894	45,786
e	d+ Depreciation of WWTPs Recovery Level	6,273	145,678	145,678	117,235

[Sewerage Tariff and Revenue Calculation of Non-domestic – Tariff for Non-domestic is 2 times as much as Tariff for Domestic, Tariff Collection Area: WWTP Service Area]

Total Capacity of 7 WWTPs (Truc Bach, Kim Lien, Ho Tay, Bay Mau, Yen So, Yen Xa, Phu Do) = 589,000 m^3/day

Monthly Non-domestic Water Consumption in Service Area = (Total Capacity of 7 WWTPs) / (Daily Maximum Factor) / (Groundwater infiltration ratio) / (Sewerage Collection Rate) x (Non-domestic Water Consumption Rate) + (Waster Water inflow at North Thang Long WWTP) / (Groundwater infiltration ratio) / (Sewerage Collection Rate)

= 589,000 m^3/day x 365/12 / 1.166 / 1.1 / 0.9 x 23.1% + 6,500 m^3/day x 365/12 / 1.1 / 0.9

= 3,784,837 m^3/month

Monthly Non-domestic Sewerage Tariff Revenue in Service Area = (Monthly Non-domestic Water Consumption in Service Area) x (Unit rate for Non-domestic)

= 3,784,837 m^3/month x 2 x Unit rate for Domestic

Results

		Tariff for Domestic -Urban	Tariff for Non-domestic -Urban	Reve ue from Non-domestic	Necessar Cost for Non-domestic
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,111	2,221	8,461	10,292
b	O&M Cost of WWTP Full Recovery Level	2,871	5,743	21,875	10,292
	b + O&M Cost of Sewer System Recovery Level	3,509	7,018	26,733	12,578
d	c+ Replacement Cost Recovery Level	4,768	9,536	36,323	17,090
e	d+ Depreciation of WWTPs Recovery Level	12,208	24,417	93,006	43,760

[Sewerage Tariff and Revenue Calculation of Non-domestic – Tariff for Non-domestic is 2 times as much as Tariff for Domestic, Tariff Collection Area: whole Hanoi]

Sewerage Tariff Table

Unit rate of sewerage tariff is indicated by relationship with unit rate for domestic in urban (T_{ud}).

Urban		Rural	
Domestic	T_{ud}	Domestic	$0.5 \times T_{ud}$
Non-domestic	$2.0 \times T_{ud}$	Non-domestic	$1.0 \times T_{ud}$

Note

- The unit rate for non-domestic organization is established by Decree 88/2007/ND-CP Article 53. Waste water from non-domestic operations is assumed to be STT3 (COD 201-300 mg/l), and its adjustment coefficient (K) is 2.0.
- The unit rate for rural operations is 50% of the unit rate for urban operations. The reason is that average income in rural areas is almost 50% of average income in urban areas. The monthly income per capita in Old Hanoi is VND 1,719,600, and monthly income per capita in New Hanoi is VND 876,400. (Source: Hanoi Living Standards 2008)

Monthly Non-domestic Sewerage Tariff Revenue in whole Hanoi = Unit Rate for Non-domestic x Water Consumption by Non-domestic in Urban x (1- Collection Fee Rate for Urban) + Unit Rate for Non-domestic in Rural x Water Consumption by Non-domestic in Rural x (1- Collection Fee Rate for Rural)

$= 2.0 \times T_{ud} \times 4{,}894{,}600 \times (1\text{-}0) + T_{ud} \times 4{,}781{,}229 \times (1\text{-}8\%) = T_{ud} \times 14{,}187{,}932$

Results

		Tariff for Domestic -Urban	Tariff for Non-domestic -Urban	Revenue from Non-domestic	Necessary Cost for Non-domestic
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,135	2,270	16,102	10,292
b	O&M Cost of WWTP Full Recovery Level	1,475	2,951	20,931	10,292
c	b + O&M Cost of Sewer System Recovery Level	1,803	3,606	25,581	12,578
d	c+ Replacement Cost Recovery Level	2,450	4,900	34,757	17,090
e	d+ Depreciation of WWTPs Recovery Level	6,273	12,545	88,996	43,760

v. Sewerage Tariff Calculation to accord to Required Costs (Current Base)

Sewerage tariff and financial gap is calculated based on population and water consumption in 2010.

Sewage Amount	
(Source: Water Supply Data of WWTP Service Area in 2010, HAWACO & VIWACO)	
Domestic	74.9 % of total amount
Non-domestic	25.1% of total amount
Necessary Cost of 8 WWTP for Domestic	
O&M Cost of WWTPs	VND 534,660 mil. x 0.749 = VND 400,460 mil./year
O&M Cost of Sewer System	VND 118,759 mil. x 0.749 = VND 88,950 mil./year
Replacement Cost	VND 234,398 mil. x 0.749 = VND 175,564 mil./year
Depreciation of WWTPs	VND 1,385,446 mil. x 0.749 = VND 1,037,699 mil./year
Necessary Cost of 8 WWTP for Non-domestic	
O&M Cost of WWTPs	VND 534,660 mil. x 0.251 = VND 134,200 mil./year
O&M Cost of Sewer System	VND 118,759 mil. x 0.251= VND 29,809 mil./year
Replacement Cost	VND 234,398 mil. x 0.251= VND 58,834 mil./year
Depreciation of WWTPs	VND 1,385,446 mil. x 0.251= VND 347,747 mil./year

[Sewerage Tariff and Revenue Calculation of Domestic – Tariff Collection Area: WWTP Service Area]

Current Population in Service Area

District	Population [a]	Area [a]	Pop Density [a]	Area (km^2) [b]			Estimated by Current Population		
	K person	km^2	person/km^2	S-1	S-2	S-3	S-1	S-2	S-3
Ba Dinh	230.0	9.25	24,865		8.37			208,087	
Hoan Kiem	149.5	5.29	28,261	3.34			149,500		
Cau Giay	238.7	12.03	19,842			9.40			186,565
Dong Da	380.0	9.96	38,153		0.09			380,000	
Hai Ba Trung	306.0	10.09	30,327	7.97			306,000		
Hoang Mai	346.9	40.32	8,604	18.69	8.23		240,820	106,080	
Thanh Xuan	235.8	9.08	25,969	0.06	8.45	0.62	1,550	218,230	16,020
Ha Dong	241.9	48.34	5,004		50			2 ,519	
Tu Li n	429.4	75.63	5,678		1.18	15.45		6,709	87,692
Thanh Tri	204.8	62.93	3,254		7.93			25,793	
Total				30.06	48.74	25.47	697,870	967,418	290,276

a: Source Hanoi Statistical Yearbook 2010

b: Source: Partial Adjustment of Hanoi Drainage Master Plan (wastewater Drainage Plan), October, 2010

<u>Service WWTP</u>

S-1 Area: Yen So, Bay Mau

S-2 Area: Yen Xa, Kim Lien

S-3 Area: Phu Do

Service Population in Truc Bach WWTP: 0.39km^2 x 24,865 person/km^2 = 9,697 person

Service Population in Tay Ho WWTP: 697,870 person x 14,000 m^3/day /214,000 m^3/day = 45,655 person

(Note: It is assumed that service population of Tay Ho WWTP is same as service population of Bay Mau WWTP, because capacity of 2 WWTPs is almost same.)

Total Population in Service Area: 697,870 + 967,418 + 290,276 + 9,697 + 45,655 = 2,010,916 person

Required Sewerage Tariff

Monthly Domestic Water Consumption in Service Area = (Total Population in Service Area) x (Average Personal Water Consumption in Service Area)
= 2,010,916 person x 4.64 m^3/capita month
= 9,330,650 m^3/month

Monthly Domestic Sewerage Tariff Revenue in Service Area = (Monthly Domestic Water Consumption in Service Area) x (Unit rate for Domestic)
= 9,330,650 m^3/month x (Unit rate for Domestic)

Monthly Sewerage Payment at Average Household = Average Household Water Consumption x Unit Rate for Domestic x (1+VAT)

<u>Tariff for WTP Level</u>
Monthly Sewerage Payment at Average Household = Willingness To Pay to the Sewerage Service
Average Household Water Consumption x Unit Rate for Domestic x (1+VAT) = Willingness To Pay to the Sewerage Service

Unit Rate for Domestic = Willingness To Pay to the Sewerage Service / Average Household Water Consumption / (1+VAT)
= 21,212/ 18.19 / 1.05 = VND 1,111/m^3

<u>Tariff for Cost Recovery Level</u>
Monthly Domestic Sewerage Tariff Revenue in Service Area = Necessary Cost for Sewerage Operation for Domestic
9,330,650 m^3/month x (Unit rate for Domestic) = Necessary Cost for Sewerage Operation for Domestic

Unit Rate for Domestic = Necessary Cost for Sewerage Operation for Domestic / 9,330,650

Results

		Tariff for Domestic -Urban	Revenue from Domestic	Necessary Cost for Domestic	Monthly Payment at Average HH in Urban
		VND/m^3	mil. VND/month	mil. VND/month	VND/HH/month
a	Willingness to Pay Level	1,111	10,363	33,372	21,212
b	O&M Cost of WWTP Full Recovery Level	3,577	33,372	33,372	68,311
c	b + O&M Cost of Sewer System Recovery Level	4,371	40,784	40,784	83,484
d	c+ Replacement Cost Recovery Level	5,939	55,415	55,415	113,432
e	d+ Depreciation of WWTPs Recovery Level	15,207	141,889	141,889	290,443

[Sewerage Tariff and Revenue Calculation of Domestic – Tariff Collection Area: whole Hanoi]

Domestic Water Consumption	**Urban**	**Rural**
Personal Consumption	4.54 m^3/ person month (Note: Water Supply Data of Urban Area)	4.00 m^3/ person month (Note: Decree No. 88/2007/ND-CP Article 51, 1 b)
Population	2,605,600 person	4,012,300person
Water Consumption	4.54 x 2,605,600 = 11,829,424 m^3/month	4.00 x 4,012,300 = 16,049,200 m^3/month

T_{ud}: Unit Rate of Sewerage Tariff for Domestic in Urban

Revenue from Domestic = Unit Rate for Domestic in Urban x Water Consumption by Domestic in Urban x (1- Collection Fee Rate for Urban) + Unit Rate for Domestic in Rural x Water Consumption by Domestic in Rural x (1- Collection Fee Rate for Rural)

= T_{ud} x 11,829,424 x (1-0) + 0.5 x T_{ud} x 16,049,200 x (1-8%) = 19,212,056 x T_{ud}

Tariff for WTP Level

Monthly Sewerage Payment at Average Household = Willingness To Pay for the Sewerage Service

Average Household Water Consumption x Unit Rate for Domestic x (1+VAT) = Willingness To Pay for the Sewerage Service

Unit Rate for Domestic = Willingness To Pay to the Sewerage Service / Average Household Water Consumption in Urban Area / (1+VAT)

= 21,212/ 17.80 / 1.05 = VND 1,135/m^3

Tariff for Cost Recovery Level

Monthly Domestic Sewerage Tariff Revenue in Service Area = Necessary Cost for Domestic Sewerage Operation

19,212,056 x (Unit rate for Domestic) = Necessary Cost for Domestic Sewerage Operation

Unit Rate for Domestic = Necessary Cost for Sewerage Operation for Domestic / 19,212,056

Results

		Tariff for Domestic -Urban	Revenue from Domestic	Necessary Cost for Domestic	Monthly Payment at Average HH in Urban
		VND/m^3	mil. VND/month	mil. VND/month	VND/HH/month
a	Willingness to Pay Level	1,135	21,805	33,372	21,212
b	O&M Cost of WWTP Full Recovery Level	1,737	33,372	33,372	32,465
c	b + O&M Cost of Sewer System Recovery Level	2,123	40,784	40,784	39,676
d	c+ Replacement Cost Recovery Level	2,884	55,415	55,415	53,909
e	d+ Depreciation of WWTPs Recovery Level	7,385	141,889	141,889	138,034

[Sewerage Tariff and Revenue Calculation of Non-domestic – Tariff for Non-domestic is 2 times as much as Tariff for Domestic, Tariff Collection Area: WWTP Service Area]

Monthly Non-domestic Water Consumption in Service Area = (Monthly Domestic Water Consumption) x (Ratio of Non-domestic Consumption to Domestic Consumption) + (Waster Water inflow at North Thang Long WWTP) / (Groundwater infiltration ratio) / (Sewerage Collection Rate)

= 9,330,650 m^3/month x 25.1% / 74.9% + 6,500 m^3/day x 365/12 / 1.1 / 0.9

= 3,326,532 m^3/month

Monthly Non-domestic Sewerage Tariff Revenue in Service Area = (Monthly Non-domestic Water Consumption in Service Area) x (Unit rate for Non-domestic)

= 3,326,532 m^3/month x 2 x Unit rate for Domestic

Results

		Tariff for Domestic -Urban	Tariff for Non-domestic -Urban	Revenue from Non-domestic	Necessary Cost for Non-domestic
		VND/m^3	VND/m^3	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,111	2,221	7,444	11,183
b	O&M Cost of WWTP Full Recovery Level	3,577	7,153	23,974	11,183
c	b + O&M Cost of Sewer System Recovery Level	4,371	8,742	29,299	13,667
d	c+ Replacement Cost Recovery Level	5,939	11,878	39,809	18,570
e	d+ Depreciation of WWTPs Recovery Level	15,207	30,414	101,931	47,549

[Sewerage Tariff and Revenue Calculation of Non-domestic – Tariff for Non-domestic is 2 times as much as Tariff for Domestic, Tariff Collection Area: whole Hanoi]

Monthly Non-domestic Sewerage Tariff Revenue in whole Hanoi = Unit Rate for Non-domestic x Water Consumption by Non-domestic in Urban x (1- Collection Fee Rate for Urban) + Unit Rate for Non-domestic in Rural x Water Consumption by Non-domestic in Rural x (1- Collection Fee Rate for Rural)

$= 2.0 \times T_{ud} \times 4{,}048{,}997 \times (1\text{-}0) + T_{ud} \times 3{,}955{,}212 \times (1\text{-}8\%) = T_{ud} \times 11{,}736{,}789$

Results

		Tariff for Domestic -Urban	Tariff for Non-domestic -Urban	Revenue from Non-domestic	Necessary Cost for Non-domestic
		VND/m³	VND/m³	mil. VND/month	mil. VND/month
a	Willingness to Pay Level	1,135	2,270	13,321	11,183
b	O&M Cost of WWTP Full Recovery Level	1,737	3,474	20,387	11,183
c	b + O&M Cost of Sewer System Recovery Level	2,123	4,246	24,915	13,667
d	c+ Replacement Cost Recovery Level	2,884	5,769	33,853	18,570
e	d+ Depreciation of WWTPs Recovery Level	7,385	14,771	86,681	47,549

vi. Payment at Average Household

Case -3 e O&M Cost of WWTP, Replacement Cost, O&M Cost of Sewer System, and Depreciation of WWTP Full Cost Recovery Level

A. Water Consumption = 18.19 m^3/ month

B. Domestic Water Tariff = (16 x 3,478.26 + (18.19-16) x 4,086.96) x (1-8%) = VND 59,434

C. Domestic Sewerage Tariff = 18.19 x 15,207 = VND 276,615

D. Tariff Collection Fee = (16 x 3,478.26 + (18.19-16) x 4,086.96) x 8% = VND 5,168

E. VAT = (B + C +D) x 5% = VND 17,061

F. Environmental Protection Fee = (Domestic Water Tariff + Domestic Water Collection Fee) x 5% = VND 3,230

G. Payment Total = B + C + D + E + F = VND 361,508

Note1: The Tariff Collection Fee is applied to the formula of (8% of Domestic Water Tariff) as currently used by HAWACO & VIWACO.

Note2: The Environmental Protection Fee (EPF) after the sewerage tariff is assumed to be (Domestic Water Tariff + Collection Fee) x 5% that means (EPF before sewerage tariff – EPF allocated to sewage work)