Socialist Republic of Vietnam

JICA SURVEY ON EXAMINATION OF MONITORING METHODOLOGY FOR INDICATOR OF SDG 6.3.1 IN VIETNAM

FINAL REPORT

March 2019

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.

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19-007

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Abbreviations

ASTM	American Society for Testing and Materials
BOD	Biochemical oxygen demand
BUSADCO	Ba Ria-Vung Tau City Drainage and Urban Development One Member Limited Company
CITENCO	HCMC Urban Environment Co., Ltd.
COD	Chemical Oxygen Demand
DAWAKO	Da Nang Water Supply JSC
DDC	Da Nang Drainage and Wastewater Treatment Company
DOC	Department of Construction
DONRE	Department of Natural Resources and Environment
FSM	Fecal Sludge Management
GIS	Geographic Information System
GSO	General Statistical Office
HAWACOM	Hanoi Water Supply Co., Ltd.
HSDC	Hanoi Sewerage and Drainage Company
IcR	Inception Report
JICA	Japan International Cooperation Agency
JST	JICA Survey Team
LPCD	Litres Per Capita per Day
MOC	Ministry of Construction
MOH	Ministry of Health
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
O&M	Operation and Maintenance
ODA	Official Development Assistance
QCVN	National Technical Regulations
SADCO	Sewerage and Drainage Company
SAWACO	Saigon Water Supply One Member Co., Ltd.
SDGs	Sustainable Development Goals
SECO	Swiss Secretariat for Economic Affairs
SS	suspended solids
ST	Septic Tank
TCVN	Vietnam National Standards
TCXD	Construction Standards
UDC	Ho Chi Minh City Urban Drainage Co., Ltd.
URENCO	Hanoi Urban Environmental Company
UTWMU	Urban Technical Infrastructure Works Maintenance Unit
VEA	Vietnam Environmental Administration
WHO	World Health Organization
WWTP	Waste Water Treatment Plant

Summary of JICA Survey on Examination of Monitoring Methodology for Indicator of SDG 6.3.1

1 Background and Objects of the Survey

Following the Millennium Development Goals (MDGs), a new framework, "Sustainable Development Goals" (SDGs) guides global development policy and funding for the next 15 years. In September 2015, the United Nations General Assembly adopted the Sustainable Development Goals (SDGs), which consist of 17 goals and 169 targets, to address wide ranging issues to be comprehensively solved in economic, social and environmental fields. Among the SDGs, SDG 6 aims to ensure availability and sustainable management of water and sanitation, and SDG 6.3 aims to improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally by 2030. SDG indicator 6.3.1 is used to assess the safe level of wastewater treatment.

To evaluate achievement of the goals and targets set, clear and feasible monitoring methodology should be developed. Under these conditions, World Health Organization (WHO) has formulated the draft proposal on the Protocol for Step-by-Step Monitoring Methodology for Indicators of SDG 6.3.1: proportion of wastewater safely treated. Based on the proposed protocol and tested it in five countries including Vietnam. The preliminary work for testing it as a part of a pilot project has been started, in cooperation with Ministry of Construction (MOC). The results and lessons obtained from the testing will be used for finalization of the methodology for Vietnam.

Japan International Cooperation (JICA) has conducted many projects and contributed to improvement of sanitation in Vietnam. In this context, JICA decided to collaborate with WHO for examination of monitoring methodology for indicator of SDG 6.3.1 and began the captioned survey (the Survey) from October 2017.

One of the most important roles of the monitoring of SDG 6.3.1 is not only to monitor the status of safely treated water worldwide, but also to contribute to the improvement of water environmental management in each country. For instance, by monitoring SDG indicator 6.3, the policy makers, project implementation organization and citizens can understand and recognize the present situation of water environment and treatment condition of domestic, commercial and industrial wastewater, and the progress of the improvement of ambient water quality and wastewater treatment. Also for project implementation to achieve SDG 6.3, monitoring SDG indicator is useful to evaluate and compare the cost-effectiveness of each project.

The objectives of the Survey are to propose an appropriate and feasible monitoring methodology, to identify difficulties, gaps and important issues to conduct the monitoring activities related to SDG 6.3.1 in Vietnam, and give feedback for the refinement of the monitoring methodology proposed for the indicator of SDG 6.3.1 by WHO.

This summary section covers the following areas.

- Proposed Methodology on SDG6.3.1 in Vietnam
- Existing Issues on Methodology on SDG6.3.1 in Vietnam
- Trial Estimation of SDG6.3.1 in Vietnam
- Findings in Vietnam and Recommendations for Other Countries
- Recommendations for the monitoring of SDG indicator 6.3.1 and the achievement of SDG 6.3

2 Findings of the Survey

2.1 Laws and Regulations related to Wastewater Management

Industrialization and urbanization in Vietnam during last 30 years has proceeded rapidly, and legislation on wastewater management has been enacted. The main laws and regulations for wastewater management in Vietnam are summarized in the following table.

Table-1 Main Laws and Regulations related to Wastewater Management

No.	Name of Laws and Regulations
1	Law on Environment (2014)
2	Law on Water Resources (2012)
3	Decree 19/2015 on Guidelines for Implementation of Law on Environment
4	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
5	Decree 38/2015/ND-CP on Waste Management
6	Decree 154/2016/ND-CP on Environmental Protection Fees for Wastewater
7	Circular 04/2015/TT-BXD on Implementation of Decree 80/2014/ND-CP
8	Circular 58/2015TTLT-BYT-BTNMT on Providing Guidance on Medical Waste Management
9	Law on Inspection (2010)

Source: JST

In Vietnam, effluent standards are prepared for domestic, commercial and industrial wastewater as shown in the table below. For domestic and commercial wastewater, QCVN14:2008/BTNMT is adopted. For industrial wastewater, generally, QCVN40:2011/BTNMT is adopted, and there are several effluent standards on specific industries.

Table-2 List of Effluent Standards

Category				Wastewater (WW) Discharge Sources	WW Treatment Plant (WWTP)	Effluent Standards for WW
A	Household			Black and grey water	Septic Tank	QCVN 14:2008/BTNMT
					WWTP	QCVN 14:2008/BTNMT
B	Economic Activity	Commercial		Restaurants, Super	Decentralized WWTP	QCVN 14:2008/BTNMT
				Markets, Hotels, etc.	Centralized WWTP	
		Secondary industry		Factories	WWTP	QCVN40:2011/BTNMT
			Industrial Zone	Economic Zones, Industrial Parks,	Decentralized WWTP(IZ)	QCVN40:2011/BTNMT
			Specific Industry	Textile Dying	On-site WWTP	QCVN 13MT:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Paper and pulp	On-site WWTP	QCVN 12MT:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Bioethanol processing	On-site WWTP	QCVN 60:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Aquatic products processing	On-site WWTP	QCVN 11MT:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Natural rubber processing	On-site WWTP	QCVN 01:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Steel Industry	On-site WWTP	QCVN 52:2013/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
			Mining Area			QCVN40:2011/BTNMT
			Craft Village			QCVN40:2011/BTNMT
		Livestock facility			On-site WWTP	QCVN 62MT:2016/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
		Hospital			On-site WWTP	QCVN 28:2010/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT

Source: JST

2.2 Responsibilities on Wastewater Management

The main central governmental organizations on wastewater management are MOC and MONRE. The Decree on Water Drainage and Wastewater Treatment (No.80/2014/ND-CP) stipulates responsibility of the concerned organizations as follows.

a) MOC: To manage water drainage and wastewater treatment in urban areas, concentrated rural residential areas nationwide.
b) MONRE: To manage environmental protection, water resources, river basin management and pollution control in water drainage and discharge of wastewater into the environment nationwide, especially for industrial wastewater.
c) MARD: To manage wastewater affecting irrigation water.
d) MOH: To manage wastewater affecting human health.

2.3 Domestic Wastewater Management

(1) Off-site Treatment

JICA Survey Team (JST) obtained the list of centralized wastewater treatment plants in service in Vietnam as of 2017. It shows 39 WWTPs are present in major cities and have total treatment capacity of 908,000 m3/day. In three major cities of Hanoi, Ho Chi Minh and Da Nang City, several WWTPs in each city have been developed and the share of those three cities is 68% of current total treatment capacity in Vietnam. In addition to those three cities, both of Bac Ninh and Binh Duong provinces have another 9% of the total treatment capacity. Those five cities/provinces cover approximately 80% of the total current treatment capacity of WWTPs in Vietnam. Among the 39 facilities, JST collected data and information on wastewater quality monitoring by questionnaire survey to 20 facilities. The obtained data showed that the actual inflow rate has reached at 70% or more of the design inflow rate at each WWTP and effluent quality has satisfied design requirements of water quality standard in general, although some WWTPs should be checked further for any figures exceeding allowable values. In general, JST consider that the O&M management of WWTP is properly executed in Vietnam. JST will continue collection of the specific data for the remaining WWTPs.

Through the survey, JST found that some operating contractors having all raw data on O&M of WWTPs belong to the private sector but JST faced difficulty to approach those private companies and obtain data from them because of contractual confidentiality. Hence JST contacted management agencies of the target cities/provinces and found a variety of report formats, and sometimes specific information on operation conditions which should be integrated into the authorized format.

(2) On-Site Treatment

Septic tank is the most popular sanitation pre-treatment equipment in Vietnam. It is often made from bricks (for individual houses), or reinforced concrete (for individual houses and public buildings). Tanks often are sealed by concrete base and cement mortar. Households often place the tank in the basement, surrounded by the foundation. Tanks often consists of two or three chambers. The first, a receiving chamber, often is built with largest portion of the total tank volume, making space for solids accumulation and anaerobic digestion. Total volume of the HH septic tank depends on available space and funding availability. The total volume often ranges from 1.5 to 5 m3. According to the information in collected literature by the Survey, removal efficiency of septic tank is often ranging from 10% to 50% for BOD and

SS. Septic tanks installed in Vietnam show low treatment efficiencies and thus don't contribute as much as expected to water pollution control in urban environments.

Septage from most septic tanks is not emptied regularly. Illegal dumping of emptied sludge is a very common practice in all cities in Vietnam. There are no national laws governing the collection and treatment of septage yet. All desludging operators in urban areas are only required to obtain a business license to run the business. There is a mix of state-owned, limited liability companies and private companies providing desludging service. Due to a lack of treatment infrastructure, service providers usually dispose of septage in drains, fish farms, and waterways.80% of funding for those projects is coming from the ODA grants and loans (WB, 2006). Septage management components have been also initiated in some cities such as Nam Dinh (Swiss funding), Ha Long, Da Nang and Hai Phong (WB funding), etc.

Many "Johkasou" (an apparatus that uses microorganisms to sanitize impurities contained within household wastewater) are installed as another on-site facility in Vietnam. According to the survey conducted by Johkasou System Association (Japan), a total 1,037 units of Johkasou have been installed in Vietnam: 612 units of large scale types and 425 units of small and medium size types. Also there are many pilot facilities sponsored by Japanese government, etc.

(3) Industrial Wastewater

In Vietnam, each provincial DONRE has responsibility to check wastewater management by factories and commercial facilities through environmental check and inspection. At the same time, factories and commercial facilities have responsibility to monitor their own discharged wastewater quality and quantity. Basically, DONRE and factories/commercial facilities conduct the required actions. In this Survey, wastewater quality and quantity data and information were collected by questionnaire survey to the factories and commercial facilities with cooperating provincial DONRE in Vinh Phuc and Ha Nam province. The following table outlines collected information through the questionnaire survey. From the survey result, it can be said that the monitoring data is basically available from each facility. Also, through the Survey, JST found it was not easy to collect monitoring information from all target facilities due to lack of systemized information collecting system of central government. It is necessary to develop such system for conducting SDG6.3.1 monitoring work.

Table-3 Questionnaire Survey Results on Available Monitoring Data on Factories and Commercial Facilities in Vinh Phuc Province

Categories	Number of Facility	Number of facilities that provided:					Wastewater discharge standard
		Wastewater volume	BOD5	COD	Heavy Metal	Total Coliform	
Treatment of Domestic Wastewater	**1**	1	1	0	0	1	QCVN 1 : 2008/BTNMT
Bastaf – Treatment of Domestic Wastewater from residential area in rural	**10**	10	0	0	0	0	QCVN 14: 2008/BTNMT
Treatment of Industrial Wastewater	**4**	4	4	4	4	3	QCVN 40:2011/BTNMT
Petroleum Store and	**5**	5	0	1	1	0	QCVN

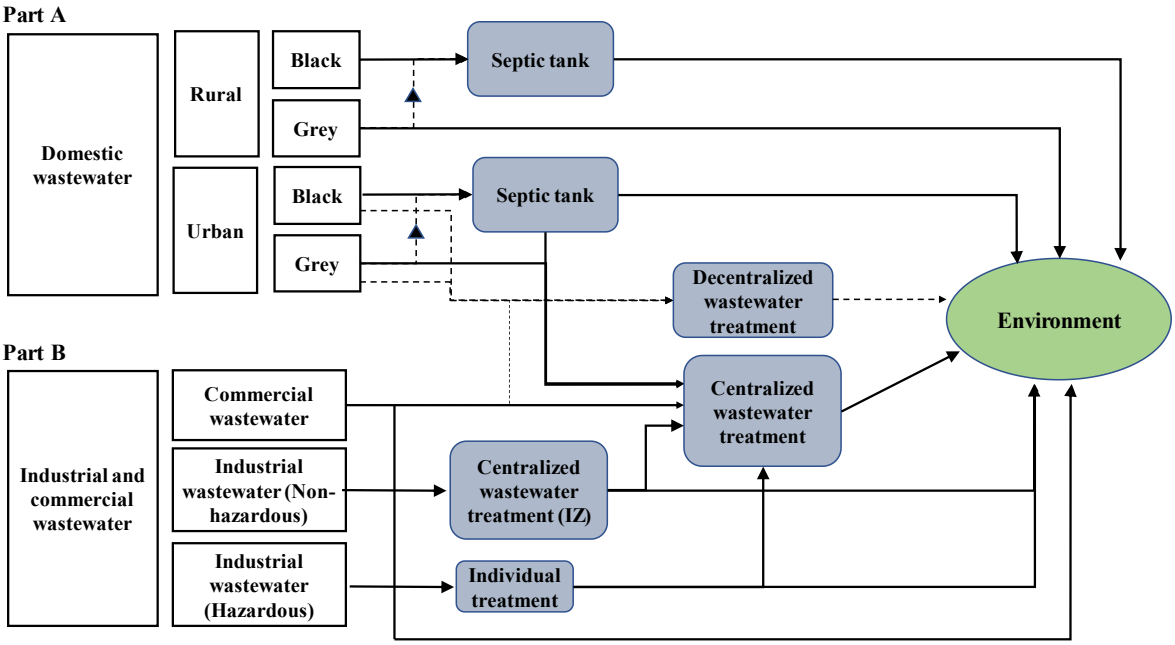
Categories	Number of Facility	Number of facilities that provided:					Wastewater discharge standard
		Wastewater volume	BOD5	COD	Heavy Metal	Total Coliform	
Station							29:2010/BTNMT
Breeding pigs	**9**	9	3	3	*0*	*3*	*QCVN 62 :2016/BTNMT*
Examination and Treatment	**11**	11	10	10	1	10	QCVN 28: 2010/BTNMT
Business, trade and services	**4**	4					**(-)**
Textile, Dyeing and Garment	**5**	5	4	3	2	2	QCVN 13: 2008/BTNMT
Producing paper and paper products	**4**	3	4	3	1	3	QCVN 12: 2008/BTNMT
Producing animal feeds and fertilizers	**5**	5	4	3	2	4	QCVN 40:2011/BTNMT
Producing Steel Billets	**5**	4	4	3	2	2	QCVN 52: 2013/BTNMT
Mechanics, Assembly and Electronics	**13**	13	13	11	7	12	QCVN 40:2011/BTNMT
Producing Beverages	**1**	1	1	1	1	1	QCVN 40:2011/BTNMT
Others (Production of Building Materials....)	**23**	23	20	13	9	19	QCVN 40:2011/BTNMT
Total	**100**	**98**	**68**	**55**	**31**	**60**	

Source：JST

3 Proposed Methodology on SDG6.3.1 in Vietnam

3.1 Proposal on Classification of Each Type of Wastewater and Treatment Method

To propose calculation methods for obtaining monitoring indicator figures, the flow of wastewater treatment should be identified by each type of wastewater. The wastewater handled by the Survey can be classified into three categories: (a) domestic wastewater, (b) commercial wastewater, and (c) industrial wastewater. In addition, the wastewater treatment systems applied in Vietnam are also identified as follows: (i) centralized wastewater treatment plant, (b) decentralized wastewater treatment facilities, (c) septic tank, and (d) pre-treatment facility of hazardous substances. Considering combination of the type of wastewater and treatment systems, the flow of wastewater is summarized for calculating monitoring indicators of SDG 6.3.1. Tentative ideas of wastewater flows are described in the following figure.



Note: The lines show main flow of wastewater.
Source：JST

Figure 1 Tentative Wastewater Flow Diagram

3.2 Proposal on Calculating Methods for Obtaining Monitoring Indicator Figures by Types of Wastewater and Treatment Methods

Considering the existing situation found through the survey, the following calculation methods are proposed for estimation of monitoring indicator SDG6.3.1.

3.2.1 Methodology of Estimation of SDG6.3.1 Monitoring Indicator

(1) Generated Domestic Wastewater

The amount of generated domestic wastewater was calculated by the following equation.

[Generated Wastewater] = [Population] x [Daily water consumption per capita (L/cap/day)]

Population information was obtained by GSO's published statistical yearbook. Currently, various figures of daily water consumption per capita were confirmed by the several literatures and fieldwork in this survey. It is desirable to determine unified daily water consumption per capita in Vietnam.

(2) Safely Treated Domestic Wastewater

(a) Safely Treated Wastewater by Centralized Wastewater Treatment Plant with Satisfying Wastewater Discharge Standard

According to this survey result, effluent of centralized wastewater treatment plants operated in Vietnam generally satisfy wastewater discharge standards. The amount of the treated wastewater by centralized wastewater treatment plant satisfying wastewater discharge standard was calculated by the following equations.

Option a) [Safely Treated by Centralized Wastewater Treatment Plant] = [Actual sewered population] x [Daily water consumption per capita (L/cap/day)]

Option b) [Safely Treated by Centralized Wastewater Treatment Plant] = [Actual capacity of centralized wastewater treatment plant]

Option c) [Safely Treated by Centralized Wastewater Treatment Plant] = [Actual treated wastewater of centralized wastewater treatment plant]

Based on the result in this survey, it is not always easy to collect information for confirming existing sewered population from DOC or each WWTP operation company. In such case, designed capacity of the treatment plant or actual inflow rate to the plant were referred and used for estimation.

Each option mentioned above would be adopted depending on available data and information. In the survey, JST collected actual treated wastewater amount from several treatment plant, but could not collect it from all target plants.

Regarding actual sewered population, it was difficult to identify the population in designed service area due to lack of information collecting measures relating to service area map, population in the area, and so on. When SDG6.3.1 monitoring is implemented, MOC needs to collect required information, considering the selected options for calculation of safely treated wastewater.

(b) Safely Treated Wastewater by De-Centralized Wastewater Treatment Plant with Satisfying Wastewater Discharge Standard

The de-centralized domestic wastewater treatment system, such as the facilities explained in section 2.3(1) as “Jokasho” system, also contribute to safely treated wastewater. The amount was calculated by the following equation.

[Treated by De-Centralized Wastewater Treatment Plant] = [Population treated by de-centralized wastewater system] x [Daily water consumption per capita (L/cap/day)]

For counting the treated wastewater by this kind of de-centralized wastewater system, wastewater treatment performance of each facility should be checked with Vietnamese discharge standards or design criteria, and treated wastewater quality monitoring should be conducted.

(c) Safely Treated Wastewater by On-site Wastewater Treatment Facilities with Satisfying Wastewater Discharge Standard

The amount of the treated wastewater by on-site wastewater treatment facilities satisfying wastewater discharge standards was calculated by the following equation.

[Safely treated by On-site Wastewater Treatment Plant] = [Population connected on-site treatment system] x [Daily water consumption per capita (L/cap/day)]

Some local administrative bodies such as Hai Phong city has a database of on-site treatment systems. The information was used for SDG6.3.1 monitoring activity. In addition, it is required to confirm updated status of existing information stored by the expected information sources.

Another issue identified is that effluent from on-site facilities are considered as unsuitable wastewater quality according to this survey result. To recognize treated wastewater as safe, management of on-site treatment system should be improved.

(3) Generated Industrial Wastewater

The amount of generated industrial wastewater was confirmed by inventory data using the following equation.

[Generated Wastewater] = [Inventory of wastewater from industrial zone and industrial cluster] + [Inventory of wastewater from factories outside industrial zone and industrial cluster] + [Inventory of wastewater from commercial facilities]

Generally, information of industrial zone and industrial cluster is managed by each provincial Economic Management Board or Industrial Zone Management Board. On the other hand, the information of factories outside industrial zone and industrial cluster, and commercial facilities are managed by each provincial DONRE. For collecting required information, both organization's work is essential.

(4) Safely Treated Industrial Wastewater

The amount of safely treated industrial wastewater was confirmed by inventory data using the following equation.

[Treated Wastewater by Industrial and Commercial Wastewater Treatment Plant] = [Inventory of well-treated wastewater from industrial zone and industrial cluster] + [Inventory of well-treated wastewater from factories outside industrial zone and industrial cluster] + [Inventory of well treated wastewater from commercial facilities]

3.2.2 Expected Data and Information Collected from the Concerned Organization

The expected data and information collected from the concerned organization are shown below.

Table-4 Expected Data and Information Collected from the Concerned Organization

Organization	Generated Wastewater		Treated Wastewater	
	Domestic Wastewater	Industrial and Commercial Wastewater	Domestic Wastewater	Industrial and Commercial Wastewater
MOC	- Daily water consumption per capita (L/cap/day)	-	- List of centralized and main de-centralized wastewater treatment plant - List of service company operating centralized and main de-centralized wastewater treatment plant - Collecting and summarizing data and information from DOC or Service company	-
DOC (or service company)	-	-	- Map of sewered area, serviced population, actual treated wastewater amount by centralized/de-centralized wastewater treatment plant - Treated water quality data by centralized and de-centralized wastewater treatment plant	-
MONRE	-	- List of industrial zone and industrial cluster - Collecting and summarizing data and information from DONRE and concerned organizations such as Economic Management Board	-	- Collecting and summarizing data and information from DONRE and concerned organizations such as Economic Management Board
DONRE and provincial Economic Management Board		- List of - Amount of generated wastewater by industrial zone and industrial cluster - Amount of generated wastewater (or wastewater discharge permission) from factories outside industrial zone and industrial cluster		- Amount of well-treated wastewater by industrial zone and industrial cluster - Amount of well-treated wastewater from factories outside industrial zone and industrial cluster
GSO	- Number of household equipping septic tank	- List of industrial zone and industrial cluster - Number of factories and commercial facilities	- Sample of treated water quality - Status of desludging	-

Source：JST

4 Existing Issues on Methodology on SDG6.3.1 in Vietnam

Through this survey, the following information was found.

(1) Items to be Discussed for Better SDG Monitoring

- Some required data and information for SDG indicator monitoring seems scattered, and difficult to collect. For better SDG indicator monitoring, information collecting, storing and sharing system should be developed.

Requirement to enhance wastewater monitoring data and information system

Through the survey, the following data was found for enhancing wastewater monitoring data and information system

Table-5 Expected Actions for Enhancing Wastewater Monitoring Data and Information System

Type of Wastewater	Information to be collected	Concerned Organization		Relevant Law
		National Level	Local Level	
Domestic Wastewater				
Centralized wastewater system	Amount of actual wastewater treatment and treated wastewater quality data and information should be centralized to MOC	MOC	DOC and concerned drainage and sanitation companies	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
De-centralized wastewater treatment system	Population treated by de-centralized wastewater treatment system and treated wastewater quality data and information should be centralized to MOC	MOC	DOC and companies in charge of de-centralized wastewater treatment system	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
On site treatment system	Data and information on-site treatment system should be updated and summarized.	GSO, MOH, MOC	DOC and concerned drainage and sanitation companies	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
Industrial Wastewater				
Industrial Zone	Amount of actual discharged and treated wastewater treatment and treated wastewater quality data and information should be centralized to MONRE	MONRE	Industrial Zone Management Boada and DONRE	LEP Decision 140/2018/QD-Ttg
Outside industrial zone	Amount of actual discharged and treated wastewater treatment and treated wastewater quality data and information should be centralized to MONRE	MONRE	DONRE	LEP Decision 140/2018/QD-Ttg

Source：JST

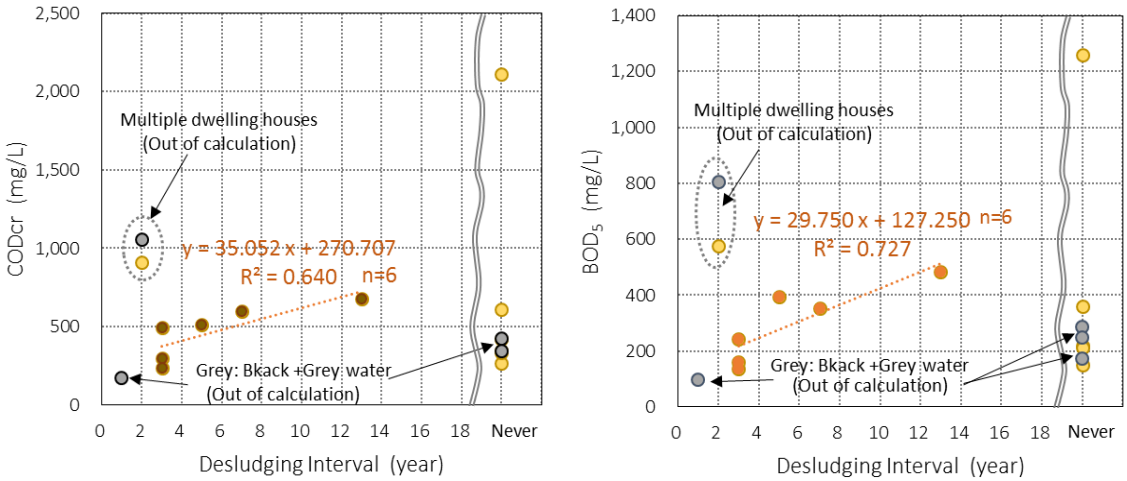
- Wastewater quality standards that were referred for SDG indicator monitoring have been developed in Vietnam. It is recommended that evaluation criteria on treated domestic wastewater by on-site treatment system should be clarified.
- For developing SDG indicator monitoring, issues to be solved should be summarized, and step-by-step approach should be adopted.

(2) Items to be Discussed for Better Water Environmental Management

- Treated wastewater quality by on-site treatment system needs to be improved by enhancement of management activity, such as development of proper desludging system.

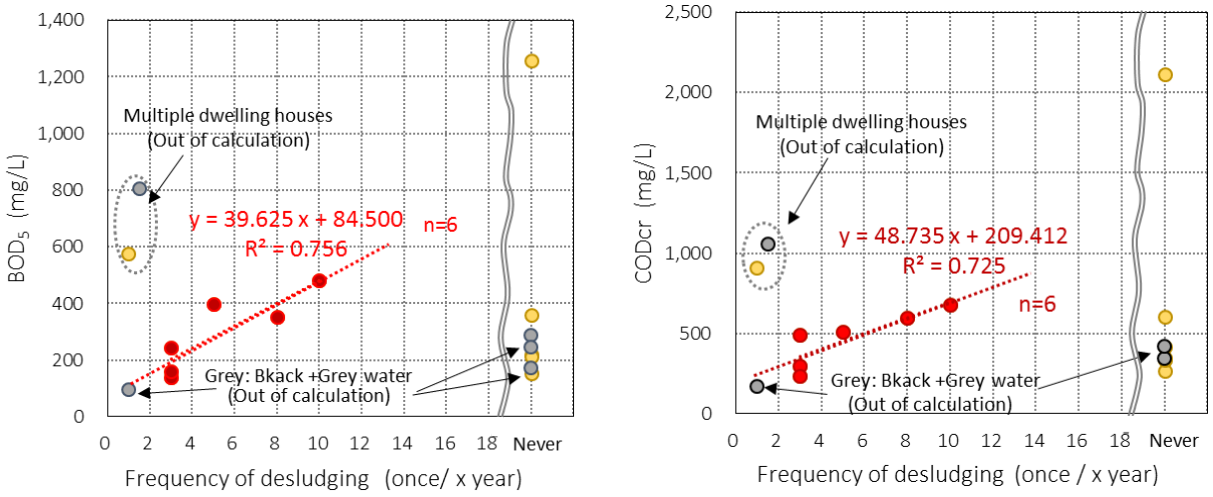
Summary on analyzing effluent water quality of septic tank as on-site treatment facility

According to this survey results, septic tank is not able to meet the BODCOD standards (Note: Standard values of BOD are 30 mg/L for Class A, and 50 mg/L for Class B in QCVN14/2008/BTNMT). Thus, septic tank is not able to treat domestic wastewater safely. On the other hand, desludging is very important to improve effluent water quality of septic tanks.



Source：JST

Figure 2 Relationship between Desludging Interval and Effluent Water Quality from Septic Tank



Source：JST

Figure-3 Relationship between Frequency of Desludging and Effluent Water Qualityfrom Septic Tank

The following table shows the survey results of inflow and outflow of the wastewater from and to septic tanks treating black wastewater. Although number of samples are limited, the removal rate of pollutants in the septic tanks are affected by frequency of desludging. As a result of the Survey, it is recommended to conduct proper sludge treatment for improvement of domestic wastewater management.

Table-6 Estimated Removal Ratio by Existing On-site Treatment System

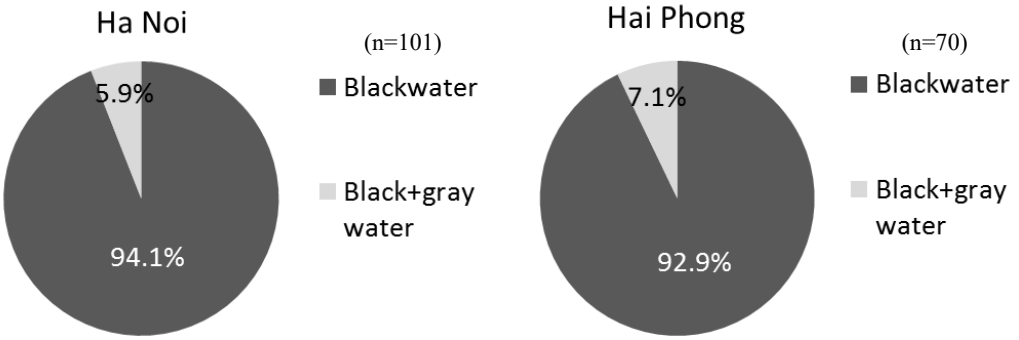
Household	Parameters	Inflow loads (Ave.) (g/day)	Outflow loads (Ave.) (g/day)	Removal ratios (%)	Condition of Desludging
Ha Noi Urban HN1HM1 8 persons Desludge Never	BOD_5	73.4	54.5	25.83	Not conducted so far
	COD	100.9	77.2	23.47	
	SS	63.1	29.9	52.56	
	NH_4-N	21.19	15.65	26.17	
	T-N	45.61	36.24	20.54	
	T-P	8.527	7.712	9.56	
Ha Noi Rural HN2TR1 6 persons Desludge 2008	BOD_5	85.7	33.3	61.18	Desludged in 2008 (General frequency of desluding is once in 10 years)
	COD	133.5	54.3	59.31	
	SS	55.8	13.8	75.72	
	NH_4-N	24.31	17.82	26.72	
	T-N	50.02	28.87	42.29	
	T-P	11.390	9.332	18.07	

Source：JST

Type of wastewater treated by septic tank

Regarding the type of wastewater flows into septic tank, most septic tanks treat blackwater only as shown in Figure-4.

Only about 6% of septic tanks in Ha Noi and 7% of septic tanks treat black water and greywater according to our interview survey as shown below.



Source：JST

Figure-4 Type of Wastewater Treated by Septic Tank in Ha Noi and Hai Phong

Based on the survey result mentioned above, almost all grey water in rural areas outside of coverage area of centralized wastewater treatment plant is discharged to environment without proper treatment. The following table shows the estimated result of pollution load of black and grey domestic wastewater. It is necessary to improve grey domestic wastewater management system for better wastewater management in the future.

Table-7 Results of Pollution Load Estimation per Units Based on the Survey

Type	Households	Index	Ranges of values (g/cap/day)	Average (g/cap/day)	Other Survey [1] (g/cap/day)	Japanese standard [3] (g/cap/day)
Human Waste (Black water)	Ha Noi Urban (HN1HM1)	BOD_5	5.84 - 16.06	11.22	-	18.0
		COD	8.12 - 22.12	15.4	-	10.0
		T-SS	5.16 – 16.32	9.66	-	20.0
		T-N	5.24 - 8.78	6.84	6.3	9.0
		T-P	1.07 - 1.42	1.28	0.9	0.9
	Ha Noi Rural (HN2TR1)	BOD_5	11.46 - 24.11	15.92		18.0
		COD	17.23 - 34.95	24.68		10.0
		T-SS	8.69 - 13.32	10.37		20.0
		T-N	8.50 - 10.42	9.28	6.1	9.0
		T-P	1.80 - 2.44	2.11	1.0	0.9
Grey Water	Hai Phong Urban (HP1DK1)	BOD_5	24.8 - 61.91	47.33	-	40.0
		COD	76.38 - 130.30	105.84	37.0 [2]	17.0
		T-SS	10.71 - 20.64	16.35	29.9 [2]	25.0
		T-N	2.12 - 3.31	2.87	1.0 [2]	2.0
		T-P	0.28 - 0.43	0.35	0.6 [2]	0.4

Source：JST

1) Sybille Busser et al, 2007. Characteristics and Quantities of Domestic Wastewater in Urban and Peri Urban households in Ha Noi, Technical University of Zurich, Switzerland.
2) Results of the urban area in Ha Noi by the above study.
3) Japan Sewage Works Association, 2009. Japanese Sewer design guidelines

5 Trial Estimation of SDG6.3.1 in Vietnam

(1) Generated Domestic Wastewater

By the calculation methods proposed in section 3.2.1, tentatively the SDG monitoring indicator was calculated as follows.

[Generated Wastewater] = [Population] x [Daily water consumption per capita (L/cap/day)]

Table-8 Estimated Amount of Generated Domestic Wastewater

Area	Population	Daily water consumption per capita (L/cap/day)	Generated Wastewater Amount (m3/day)
Urban area	31,067,500	150	4,660,125
Rural area	60,642,300	80	4,851,384
Total	91,709,800	-	9,511,509

Source：JST

Note: (1) Population was confirmed by Statistical Year Book 2015, published by GSO.
(2) Adopted daily water consumption per capita was from WHO pilot project report in Vietnam.

(2) Safely Treated Domestic Wastewater

In this survey, effluent of centralized wastewater treatment plants operated in Vietnam generally satisfy wastewater discharge standards. Also, designed volume of 39 of the centralized wastewater treatment system operated in Vietnam was confirmed as 907,950 m3/day. Regarding the wastewater treated by on-site treatment system, it is considered as unsuitable wastewater quality according to this survey result because of almost no desludging and its treatment performance. Therefore, tentatively, the amount of safely treated domestic wastewater is considered as 907,950 m3/day, where 39 of the centralized wastewater treatment systems are fully operated. Comparing with estimated amount of generated domestic wastewater, the ratio of safe wastewater is approximately 10% of generated wastewater amount. The figure collected by this survey includes the treatment systems collecting wastewater by interceptor system. In Vietnam, currently, interceptor system is the main one for collecting wastewater, and the system also contributes to safe treatment of domestic wastewater. To save the initial construction cost, interceptor system is widely used in Vietnam. However, this system has several disadvantages such as no improvement of living environment of existing channel, low concentration of inflow wastewater quality to WWTP, necessity of cleaning of existing channel and removal of existing septic tank, etc.

Among the wastewater treatment systems confirmed for Canh Doi and Nam Vien WWTP in Ho Chi Minh City, many have separate systems. The amount of treated wastewater is 25,000 m3/day. Comparing with estimated amount of generated domestic wastewater, the ratio of safe wastewater is approximately 0.3% of generated wastewater amount.

Table-9 Estimated Amount of Safely Treated Wastewater (Tentative)

Area	Amount (m3/day)	Ratio of Safely Treated Wastewater (%)
Generated Domestic Wastewater	9,511,509	-
Treated Wastewater	907,950	10
Treated Wastewater (separate system only)	25,000	0.3

Source：JST

(3) Generated Industrial Wastewater

The amount of generated industrial wastewater can be collected by inventory survey. In this survey, JET could not collect industrial wastewater information in all provinces of Vietnam; only 7 provinces wastewater information were confirmed as shown in Table-10. Total amount of discharged wastewater from 7 provinces was 602,375 m^3/day, according to the information provided by MONRE.

The amount of industrial turnover of 7 provinces was about 67% of the total turnover in Vietnam. It is considered that the generated wastewater amount is in proportion to the amount of turnover. Therefore, considering the amount of industrial wastewater of 7 provinces to be 602,375 m^3/day, the amount of generated industrial wastewater is around 905,000 m^3/day in the whole of Vietnam.

Table-10 Collected Inforamtion of Generated Industrial Wastewater from MONRE

Province	Wastewater Amount (m3/day)
Tp. Hồ Chí Minh	193,760
Bình Dương	136,000
Hà Nội	75,000
Bắc Ninh	65,000
Bà Rịa – Vũng Tàu	42,560
Nghệ An	26,578
Ninh Bình	13,000
Đồng Tháp	12,477
Khánh Hòa	10,000
Thanh Hóa	28,000
Total	602,375

Source：JST

(4) Safely Treated Industrial Wastewater

The amount of safely treated industrial wastewater can be confirmed by the information of environmental check and inspection conducted provincial DONRE and the concerned organization. In this survey, JET could not collect the desired information from provinces. Therefore, the following rough estimation was conducted.

According to the inventory survey results conducted for 6 provinces (Thai Nguyen, Bac Giang, Bac Ninh, Bing Duong, and Dong Nai province and Ho Chi Minh city) by the JICA Project for Strengthening Capacity of Water Environmental Management in River Basin, 90 % of the surveyed facilities have wastewater treatment plants, and around 80% of treated effluent satisfies wastewater discharge standards. Based on this information, the amount of safely treated industrial wastewater is around 650,000 m3/day.

6 Findings in Vietnam and Recommendations to Other Countries

An Expert Group Meeting (EGM) on Global Wastewater Monitoring for the SDGs to discuss methodology for estimating SDG6.3.1 was held on March 1-2. The discussion results were summarized as “Report of An Expert Group Meeting on Global Wastewater Monitoring for the SDGs” The discussion results of the EGM and the proposal by this survey were compared and are summarized in the following Table.

Tabl-11 Comparison of Discussion Results by the EGM and Proposal by This Survey

Description in Report of Expert Group Meeting (EGM)	Findings and Issues in Vietnam	Recommendations to Other Countries
Methodological Issues		
It was concluded that for the indicator 6.3.1, percentage wastewater treated should be expressed in flowrates rather than populations. The update proposal proposes the use of wastewater flows estimated by applying a factor for all households with both piped and non-piped water supply. This ensures that the denominator includes estimates for both black and greywater generated by all households.	The proposal by this survey adopts same methodology proposed by the EGM. Regarding water usage amount, this survey proposes to use daily water consumption per capita, same as proposal of Annex I of the EGM. It is considered that the proposed methodology can cover both black and greywater, and both piped and non-piped water supply.	The proposal by the EGM could be applied for other countries.
Although wastewater flowrates should be measured for the indicator, the indicator should also report on the organic loads from all wastewater from domestic and industrial sources, as data becomes available. This is required to apportion responsibility for pollution, and to enable linkages to 6.3.2 to be progressively articulated.	Organic pollution load is estimated by monitoring results in Vietnam.	For the countries which does not have monitoring system on organic pollutants, it is required to examine way of establishment of monitoring system for SDG indicator monitoring.
It was considered that greywater (wastewater produced by domestic settings excluding faucal matter) exerted a significant impact on ambient water quality and must be included in (or compensated for) in 6.3.1 calculations.	The proposed methodology of this survey covers grey water.	For each country, impact of grey water should be examined.
Urban runoff frequently includes a significant proportion of grey water.	The proposed methodology of this survey considers treated wastewater collected by interceptor system. It is used to examine impact of grey water included in urban runoff.	Same condition in Vietnam could be examined where combined system on domestic wastewater treatment is applied.
The definition of 'safe treatment', and if it should be defined by technology or performance, was discussed. It was concluded that performance-based estimates are preferred where available and can follow the compliance to the national standards.	In Vietnam, wastewater standards are regulated, and performance-based estimate is possible. However, in case of performance base, specific treatment process (technology) to satisfy the performance is needed. (For instance, it seemed that Septic Tank treated wastewater e does not meet the standards, even if regular sludge removal is conducted). On the other hand, in case of technology base, the performance of specific treatment process (technology) should be	For the countries which does not have wastewater discharge standards, it is required to start the activity to develop such standard immediately, and safely treated wastewater could be calculated by combination of performance base and technology base.

Description in Report of Expert Group Meeting (EGM)	Findings and Issues in Vietnam	Recommendations to Other Countries
	evaluated and examined	
There is currently no agreed universal standard of parameter values.	Ditto	Ditto
At the present, few countries have treatment standards for treatment of fecal sludges and wastewater from onsite facilities, delivered to treatment works, by methods other than sewers. This means using the classification of "treated to national standards" will be a limiting factor in collecting this data.	In Vietnam, some concerned organizations managing treatment of fecal sludges in local administrative bodies such as SADCO in Hai Phong city, has data and information of desludging activity. Besides, the data and information needs to be updated periodically.	For other centuries who do not have proper monitoring system on fecal sludges treatment, it is requested to develop a system for monitoring on this item.
The stepwise approach for progressive wastewater monitoring was presented, with the aim of reducing the monitoring burden, particularly where resource constrained countries experienced difficulties.	Based on the Survey, necessity of enhancement of systematic data and information management system was confirmed. For enhancement management system, the stepwise approach is needed.	For other countries, the stepwise approach is needed.
Data Issues		
It was agreed that there was a significant scarcity of data for industrial wastewater production and treatment. Although many regulators and utilities (and some industries) have this data, it is difficult to access.	Vietnam has same data issues pointed out in the EGM. It is necessary to improve for collecting and storing required information.	For other countries who have same issue, it is necessary to improve for collecting and storing required information.
Data for on-site systems is only available in a small number of countries.	In Vietnam, some concerned organizations managing treatment of fecal sludges in local administrative bodies such as SADCO in Hai Phong city, has data and information of desludging activity. Besides, the data and information needs to be updated periodically.	For other centuries who do not have proper monitoring system on fecal sludges treatment, it is requested to develop a system for monitoring on this item.
Data sharing between institutions within a country is not regularly undertaken.	Vietnam has same data issues pointed out in the EGM. It is necessary to improve existing condition on data sharing.	For other countries who have same issue, it is necessary to improve existing condition on data sharing.
Proposal for global wastewater monitoring for the SDGs		
The 6.3.1 indicator combines 2 sub-indicators: *6.3.1a Percentage of safely treated domestic wastewater flows* *6.3.1b Percentage of safely treated industrial wastewater flows* These 2 sub-indicators do not capture all wastewater flows. They miss the wastewater flows discharged by institutions	The proposal by this survey adopts same methodology proposed by the EGM.	For other countries, the proposal by this survey adopts same methodology proposed by the EGM.

Description in Report of Expert Group Meeting (EGM)	Findings and Issues in Vietnam	Recommendations to Other Countries
(schools, public health facilities, etc.) and by non-industrial commercial activities discharging to public sewers. However, it is likely that efforts to halve 6.3.1a and 6.3.1b in a country will also result in improving treatment of wastewater produced by these polluters. As such, if workable, they seem to fit the requirements of SDG indicators.		
Their combination will be possible at a later stage when data becomes available on their respective pollution loads (BOD5)	In Vietnam, generally, BOD5 is monitored at treatment facilities. Therefore, The SDGs monitoring by this indicator is available.	For other countries which does not have monitoring system on organic pollutants, it is required to examine way of establishment of monitoring system for SDG indicator monitoring.
	In case of interceptor system mostly used in Vietnam, wastewater collection area and wastewater treated population is not clear, and water quality of existing drainage channels and streams usually does not meet the standard.	Safely treated wastewater collected by Interceptor System would be estimated by the different method from that of sewer connected system (Design or actual flow rate of WWTP), and it is necessary to establish the data collection system (MOC, DOC, GSO, PC, service provider, etc.)
b) FLOWS released to an on-site system (improved septic tanks or pits) that includes treatment compliant with national and local standards (BOD removal from water before discharge) c) FLOWS released to an on-site system that is emptied regularly through pumping and septage is transferred to a treatment plant where is treated in compliance with local standards	Treatment performance of Septic Tank would be insufficient even if sludge in the tank would be emptied regularly through pumping and septage would be transferred to a treatment plant (Needs further study)	It is necessary to specify the on-site system that includes treatment compliant with national and local standards (Septic Tank?, Johkasou, Decentralized system) As the data of on-site system such as Joukasou and other type of decentralized system of which treatment performance meets the standards has not been collected by JMP, it is necessary to establish the data collection system for such kind of on-site system. (MOC, DOC, GSO, PC, Service provider, etc.)

Description in Report of Expert Group Meeting (EGM)	Findings and Issues in Vietnam	Recommendations to Other Countries
There is not enough country data currently available on compliance with discharge permits.	Not enough data concerning total generated wastewater and safely treated wastewater	Producing of consistent industrial wastewater inventories Institutional arrangement and capacity development for monitoring of effluent water quality (Inspection) Creating the database relating to EIA, Inventory, Monitoring (Inspection), Penal Provision, etc. It is necessary to establish the data collection system (MONRE, DONRE) In case of Industrial Wastewater connected to public WTTP (MONRE/DONRE, or MOC/, DOC, GSO, PC, WTTP O&M Service provider, etc.)

Source：JST

7 Discussed Point on Monitoring Methodology and Indicator Achievement for SDG 6.3.1 with Relevant Organizations in Hai Phong City

(1) Discussed Point on SDG 6.3.1 Monitoring Methodology with Relevant Organizations in Hai Phong City

Part A: Domestic Wastewater

Currently, it is better to apply for simple calculation manner using available information.

- For centralized treatment system, currently interceptor collection system is applied, and population in the serviced area can be estimated with available information such as population density, statistical data, or existing database information. When piped sewer system is developed, database on households connected with centralized wastewater system will be necessary.
- For septic tank, data on houses, of which ST is equipped, and sludge is removed, are required.

Part B: Industrial Wastewater

Pollution source inventory

- Hai Phon DONRE developed pollution source database. It is expected to update the inventory periodically.

Use of information collected through environmental check and inspection and EIA

(2) Discussed Point on Achievement of SDG 6.3.1 Indicator with Relevant Organizations in Hai Phong City

- Relational Planning: Zoning of sewerage systems and on-site systems, Step wise approach for sewerage system development from transition stage to final stage
  - In March 2018, Hai Phong city designated a zoning plan of on-site and off-site treatment

system by Decision no.626/QĐ-UBND on Approval of Sewerage Planning to 2025, vision towards 2050.

- Regarding sewerage system development, realistic scenario should be adopted with final goal and target in mind.

- Technology: Improvement of septage treatment
  - Improvement of Tang Cat Sludge Treatment Plant to reduce sludge to be treated
  - Future possibility to treat not only BOD but also nutrients such as N and P
- Financial Mechanism: Way of usage of wastewater discharge charge
- Institutional Arrangement: A mechanism to integrate required data and information for SDG monitoring needs to be developed.
  - Identification of leading organization for SDG6.3.1 indicator monitoring
  - Possibility to use available existing information such as database operated by Water Supply Company in Hai Phong City
- Law and Regulation: Setting necessary level of wastewater treatment considering water quality condition at intake point and surrounding water environment and pollution load

8 Discussions with Concerned Stakeholders

On 30 May 2018, under the charring of MOC, a workshop was held to share outcomes of the survey, and to discuss for proceeding SDG 6.1.3 monitoring. The summary of the workshop is shown in the table below.

Tabl-12 Summary of the Workshop on 30 May 2018

Items	Contents
1. Date and Time	Date: Wednesday, May 30, 2018 Time: 8.30 a.m – 12.30 a.m
2. Venue	Movenpick Hotel, 83A Ly Thuong Kiet, Hoan Kiem, Hanoi
3. Participants (Person)	ATI (MOC): 5, WHO HQ Geneva: 1, WHO Vietnam: 1, JICA HQ: 2, JICA Vietnam: 2, JICA in MOC: 1, JICA Study Team: 2, JICA Expert Office in MOC: 1, Directorate of Water Resources (MARD): 2, National University of Civil Engineering: 3, JICA in MONRE: 1, Foreign Statistics and International Cooperation Dept. (GSO): 3, HEMA (MOH): 3, Hanoi DOC: 3, NCERWASS – MONRE: 1, BORDA Vietnam: 1, Hanoi Sewerage & Drainage Co.: 2, Center for Information (MOC): 1, Institute of Occupational Health & Environment (IOHE): 2, VWSA: 1 (Total: 38)
4. Main Agenda	1. Opening remarks 2. SDGs background and overview of the Pilot Study for testing methodology of wastewater monitoring for indicators of SDG 6.3.1 and WHO global perspective in wastewater monitoring. 3. Methodology and Results of pilot study and recommendations for wastewater monitoring in Vietnam 4. JICA activities on SDG Indicator 6.3.1

Items	Contents
	5. Discussion on the results of the pilot study and viewpoints of the JICA and WHO HQ 6. Brief introduction of GCF concept note and next steps of wastewater monitoring in Vietnam 7. Discussion on GCF Concept Note and next steps for Vietnam 8. Summary and conclusions
5. Discussion	・The study report states around 1,000 Johkasou units installed in Vietnam. If this figure is the number of Johkasou only, then other decentralized facilities should be also considered. ・Cross-check with water supply amount at the local level might help to identify. JICA and WHO should consider the cross-check method. (IESE) Black water normally goes to septic tanks, but a part of it still goes out directly to the environment, so the proposed wastewater diagram needs to be revised. ・Vietnam's GSO can propose the needs of water reuse indicator in the upcoming IAEG Meeting in October 2018. Final approval of this new indicator will take place only in 2020 when the full revision of the current indicator framework is completed. ・The study results are based on a really tiny number of samples, leading to illogic and unreliability, which is though acceptable in such short implementation duration. ・It is necessary to choose a proper option of de-centralized treatment system to be applied. It is also necessary to consider an appropriate available technology considering required treated level in accordance with water quality of received bodies. ・Our survey is a pilot study to show the important issues and topics, and further study will be required in this field. ・It is recommended that GSO will modify questionnaire of annual household living standard survey to collect information related to septic tank wastewater to update required data and information for SDG6.3.1 monitoring regularly. ・It is recommended that the survey team should consider monitoring and calculating hospital wastewater separately from, industrial and commercial wastewater, and enhance the reliability of the survey results. ・The survey on decentralized systems with the volume and quality of wastewater should be implemented. This is a good chance for Vietnamese government and organizations to take act. ・In case of lack of resources for a nation-wide survey on wastewater treatment, it can be done at least at the regional level using lessons learned from other countries. ・It is recommended that the survey team considers which parameter should be used and allowable concentration level to determine safely treated wastewater. ・The toxicity of each type of wastewater should be considered and assessed in the context of Vietnam's sanitation to identify which factors affect Vietnam's environment. This should be done by not only JICA and WHO survey team, but Vietnamese ministries and sectors. ・In short, there are three priorities that need to be done, i.e. baseline setting, finalization of the SDG 6.3.1 baseline, and development and finalization of the GCF Concept Note. Instead of the 12-year timeline, WHO, JICA and Vietnam

Items	Contents
	should work as a team together in one year on those three priorities to assess how much we make progress. ・With all precious comments from Vietnamese counterparts, the pilot study in Vietnam will contribute much to the global SDG monitoring methodology.

Source：JST

On 27 February 2019, under the charring of MOC, a final seminar was held to share outcomes of the survey, and to discuss for proceeding SDG 6.1.3 monitoring. The summary of the workshop is shown in the table below.

Tabl-13 Summary of the Final Seminar on 27 February 2019

Items	Contents
1. Date and Time	Date: Wednesday, February 27, 2019 Time: 8.30 a.m – 12.00 a.m
2. Venue	Movenpick Hotel, 83A Ly Thuong Kiet, Hoan Kiem, Hanoi
3. Participants (Person)	ATI (MOC): 5, JICA HQ: 2, JICA Vietnam: 2, JICA in MOC: 1, JICA Study Team: 2, JICA Expert Office in MOC: 1, JICA VSC; 1, National University of Civil Engineering: 2, JICA in MONRE: 1, Foreign Statistics and International Cooperation Dept. (GSO): 2, Hanoi DOC: 1, Hai Phong DOC: 1, Hai Phong SADCO: 2、Hai Phong Water Supply Company: 1, Hai Phong DONRE:1, RWSSP:2, NCERWASS – MONRE: 1, BORDA Vietnam: 1, , Institute of Occupational Health & Environment (IOHE): 2, VWSAE: 2, NGO:4 (Total: 36)
4. Main Agenda	1. Current situation of Wastewater Management in Vietnam (Toward the Achievement of SDG 6.3.1) 2. Results of pilot project study 3. Planned/implementedactivitieson SDG6.3.1 monitoring and achievement 4. Recommendation on enhancement of SDG6.3.1 monitoring and wastewater management 5. Worldwide trend on SDG6.3.1 monitoring framework
5. Discussion	・Currently, investments in WWTPs in industrial zones get much interest from private sector and that can be learned to step by step privatize the public sewerage system. This requires the macro management especially in financial policy/mechanism by both central and local governments, as well as awareness enhancement. (Hai Phong Water Supply Company) ・To effectively privatize the wastewater sector, it is significantly important to have concrete legislation for easy management. (ATI) ・It is important to develop the financial mechanism which should be proper and transparent to get interest from private sector, and task an risk sharing as well as good balance between water supply, wastewater management and septage management. (JICA HQ) ・It is necessary to focus on rural WW treatment, which should be paid more attention to so that the proposed monitoring methodology can be useful nationwide. (NUHE) ・It is necessary to examine resource recovery and waste reuse towards achievement of a green economy which Vietnamese Government is committed to follow. (NUHE)

Items	Contents
	・For SDG6.3.1, monitoring methodology and measures to achieve the indicator should be interrelated. That means solutions should be suggested after the study on how to assess wastewater that is safely treated. (NGO) ・The proposed monitoring methodology is a bit complicated and should be simplified, e.g. the ratio of treated wastewater is the total capacity of WWTP divided by the total amount of tap water supply. (JICA Advisor in MOC) ・MOC should proactively participate in WEPA and AWaP for firstly partnership and secondly enhancement of knowledge and information on effective WW management. This idea is strongly recommended to be included in the final report. (JICA Advisor in MOC) ・A good way to move forward in achievement of SDG 6.3.1 is setting the final goal and finding practical steps to gradually get to it, both of which are essential to make it happen. (JICA HQ)

Source：JST

9 Recommendations for the Monitoring of SDG Indicator 6.3.1 and the Achievement of SDG 6.3

SDG indicator 6.3.1 is defined as the proportion of wastewater safely treated. The monitoring of indicator SDG 6.3.1 is useful to recognize the present situation and the progress regarding safely treated wastewater and to evaluate the effectiveness of the project and/or the policy for the achievement of SDG. The safely treated wastewater can be realized by well-designed facilities which are managed properly with regular quality monitoring based on the appropriate planning and legal framework. To conduct the monitoring of SDG indicator effectively and to actualize proper wastewater treatment and accelerate achieving SDG 6.3.1, the following factors including recommendations are important.

I. Monitoring of SDG Indicator SDG 6.3.1

Reliable, consistent and, whenever possible, disaggregated data are essential to stimulate political commitment, inform policy-making and decision-making, and trigger well-placed investments towards health, environment and economic gains (SDG 6 Synthesis Report on Water and Sanitation).

1) Institutional and Management Arrangements: Clear demarcation on role of central and local government for SDG indicator monitoring
   Related ministries: MOC, DOC (Urban and concentrated rural residential areas; Domestic wastewater: On-site, Off-site)
   MONRE, DONRE (Industrial Wastewater)
   MOC or MONRE (Industrial Wastewater connected to public WTTP)
   MARD, DARD (Rural Areas; Domestic wastewater: On-site, Off-site)
   GSO (SDG 6.2, JMP)
2) Capacity Development for SDG indicators monitoring
3) Financial System for monitoring cost to obtain required information for SDG indicator monitoring
4) Analyzing and disaggregating data relating to domestic wastewater treated by off-site and on-site systems and industrial wastewater:
   (1) Domestic Wastewater (Off-site)

- Sewer connected system: Data collection of SDG Indicator 6.2 would be applicable. (Population base)
- Interceptor system mostly used in Vietnam (Interceptor Sewers which are constructed along main river receive the wastewater from existing numerous drainage channels and streams connected to the river and convey it to a WWTP) :

  Wastewater collection area and wastewater treated population is not clear.

  Water quality of existing drainage channels and streams usually does not meet the standard, because treatment performance of Septic Tank is insufficient, and most Septic Tanks treat only human excreta. In addition, the pollution load of grey water which is not usually treated by Septic Tanks would be higher than that of human excreta.

RECOMMENDATIONS:

- Safely treated wastewater collected by Interceptor System would be estimated by a different method from that of sewer connected system (Design or actual flow rate of WWTP)
- In case of interceptor system, it is necessary to establish the data collection system (MOC, DOC, GSO, PC, Service provider, etc.)

(2) Domestic Wastewater (On-site)

- Treatment performance of Septic Tank would be insufficient even if sludge in the tank is emptied regularly through pumping and septage should be transferred to a treatment plant (Needs further study)

RECOMMENDATIONS:

- It is necessary to specify the on-site system that includes treatment compliant with national and local standards (Septic Tank, Johkasou, Decentralized system)
- Since the data of on-site system such as Joukasou and other types of decentralized system in which treatment performance meets the to standards has not been collected by JMP, it is necessary to establish a data collection system for such kind of on-site system. (MOC, DOC, GSO, PC, Service provider, etc.)
- If the data of Septic Tank collected by JMP is used in SDG 6.3.1, it's necessary to evaluate and examine the treatment performance of Septic Tank whether the effluent water quality meets the standards or not.

(1) and (2) Domestic Wastewater (Off-site and On-site)

RECOMMENDATIONS:

- Safely treated wastewater should be calculated by combination of performance and technology analysis. (Specific treatment process (technology) is needed to satisfy performance, and the performance of specific treatment process (technology) should be evaluated and examined.)
- Level of safely treated wastewater should be decided based on the condition of receiving water body related with SDG 6.3.1 (Good Ambient Water Quality)

(3) Industrial Wastewater

- Not enough data concerning total generated wastewater and safely treated wastewater

RECOMMENDATIONS:

- Producing of consistent industrial wastewater inventories
- Institutional arrangement and capacity development for monitoring of effluent water quality (Inspection)
- Creating a database relating to EIA, Inventory, Monitoring (Inspection), Penal Provision, etc.
- It is necessary to establish the data collection system (MONRE, DONRE)
  In case of Industrial Wastewater connected to public WTTP, collection should be by MONRE/DONRE, or MOC/, DOC, GSO, PC, WTTP O&M Service provider, etc.

II. Achievement of SDG 6.3

1) Technology Options: Wastewater treatment process, Reliable facilities and equipment, O&M measures.

RECOMMENDATIONS:

- For safely treated wastewater, specific treatment process (technology) to meet the effluent water quality standards should be requested, and the performance of specific treatment process (technology) should be evaluated and examined.
- Based on the evaluation of the treatment process (technology), formulation of design and O&M manual would be requested to treat wastewater safely and steadily.
- Innovation in technology will accelerate the efficiency of wastewater treatment and management and have an impact on existing systems.

2) Institutional Arrangements including capacity development.

RECOMMENDATIONS:

- Clear demarcation on role of central and local government, public utility, and private sector for the achievement of SDG 6.3.1 in respect of planning, design, construction, O&M, and management of treatment systems for domestic commercial and industrial wastewater.
- Necessity of capacity development (the process by which individuals, organizations, institutions, and societies develop "abilities" (individually and collectively) to perform functions, solve problems, and set and achieve objectives. (UNDP)

3) Legal System: Formulation of legal system and enforcement of the law in the following areas.

Effluent water quality regulation and monitoring

Environmental water quality standard

Management of wastewater treatment systems (On-site, Off-site, Industrial wastewater)

4) Public relation and/or Citizen's Participation

5) Financial System and Mechanism for Sanitation and wastewater management: For construction and O&M Cost for sanitation and domestic, commercial and industrial wastewater treatment, "The efficiency of existing financial resources and mobilizing additional and innovative forms of domestic and international finance must be increased." (SDG 6 Synthesis Report on Water and Sanitation)

RECOMMENDATIONS:

- Establishment of construction and O&M cost-sharing principles (3T: Tariff, Tax, Transfer)
- Increase of the awareness and understanding of citizens as tax payers and users
- Necessity of asset management by taking the following aspects into consideration
  Long-term basis forecast of income and expenditures considering the lifespan of the facilities and the increased number of users.
  Appropriate economic management based on tangible business objectives, precise business analysis and future business prospects.
  Accountability and disclosure of management information to the citizens, tax payers and

users who bear user charge.

6) Planning: Establishment of planning procedure and methods to reflect SDG indicator monitoring result and linkage of SDG indicators and policy

RECOMMENDATIONS:

- Stepwise approach: Example of Haiphong: Promotion of septage management (SDG 6.2) and sewage works (SDG 6.3)
- Basin-wide planning can be developed by "pollution load analysis". By pollution load analysis, the effect of several treatment processes on ambient water quality can be assessed and based on the coordination of stakeholders (allocation of requested reduction of pollution load to meet the environmental water quality standards among stakeholders/ pollution source sector), effective treatment systems planned (on-site or off-site system and its service area, effective treatment processes, etc.) for the river basin to meet the environmental water quality standards. The analysis requires data on the generated and discharged load (pollution load of human excreta and grey water, performance of treatment process) and the run-off ratio in the river basin.
- Formulation of short, middle and long term planning reflecting the indicator to achieve SDG 6.3 based on the effective strategy and policy relating to above mentioned aspects (Planning: Establishment of planning procedure and methods to reflect SDG indicator monitoring result and linkage of SDG indicators and policy)

7) Linking and disseminating national, regional and global information and knowledge

- WEPA: Water Environment Partnership in Asia

  WEPA is a knowledge network program established in 2004 with 13 countries in Asia. This program aims to improve the water environment in Asia by providing partner countries with necessary, relevant information and knowledge to strengthen water environmental governance.

- AWaP: Asia Wastewater Management Partnership

  AWaP was proposed at The Third Asia-Pacific Water Summit (11 - 12 December 2017 in Myanmar). This partnership will organize a regular meeting to share good practices and technologies, provide knowledge and know-how through web-based information platform, and tackle with common issues in collaborative projects of partner countries. Establishment of AWaP is scheduled for July 2018.

The issues which are covered by AWAP will be include the above-mentioned aspects (Technology Option, Institutional Arrangements including Capacity Development, Legal System, Public Relation and Financial System and Mechanism) for achieving SDG 6.3.1 excluding Formulation and Monitoring of Environmental Water Quality Standards and Industrial Wastewater Regulation and Monitoring which are covered by WEPA for mainly achieving SDG 6.3.2.

10 Future Direction for the Achievement of SDG 6.3.1 in Vietnam

Based on the results of the study, especially final recommendation and conclusion, it is important to consider detailed activities relating to the recommended issues to move forward for the achievement of SDG6.3.1.

In this case. based on the results of the study, it is considered that future activities to formulate the guideline to MOC and provincial / city PC regarding following issues is effective for the submission of the report on SDG indicator to GSO requested by newly decided prime minister's decision (Circular no.03/2019/TT-BKHĐT), development of national planning of wastewater management, and AWaP activities.

1. Definition of SDG
2. Monitoring Methodology (Part A Domestic Wastewater)
3. Achievement of SDG
    2) Planning: Stepwise approach; Final stage and Transition stage (Interceptor)

For other issues, it is effective to discuss and examine the future activities how to accomplish "National Action Plan for the Implementation of the 2030 Sustainable Development Agenda" in the newly formulated study group or task force consisting of central and local government, project implementing organization, service provider, university, research institute, private sector, etc. taking into consideration of the analysis of current situation in Vietnam and experiences in Japan described in the study and ongoing JICA project relating to VSC. watershed management, etc.

As for the study group, depending on the issues, formulation of two types study group (Technology Study Group and Policy Study Group) will be effective to discuss and examine the future activities.

2. Monitoring Methodology

Part B Industrial Wastewater (Technology Study Group)

3. Achievement of SDG
    1) Policy making (Policy Study Group)
    2) Planning: National Wastewater Management Plan (Policy Study Group)
    3) Technology Development and Evaluation (Technology Study Group)
    4) Financial Mechanism (Policy Study Group)
    5) Public Relation (Policy Study Group)
    6) Institutional Arrangement: PPP (Policy Study Group), Capacity Development (Technology Study Group)
    7) Legal System (Policy Study Group)

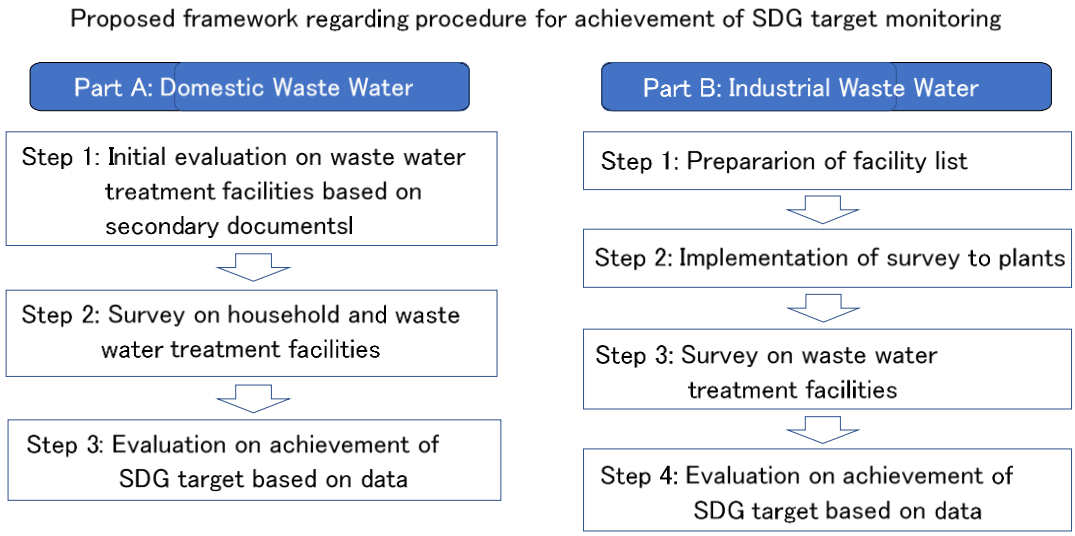
1 Outline of Survey

1.1 Background of the Survey

In September 2015, the UN General Assembly adopted the Sustainable Development Goals (SDGs), which consist of 17 goals and 169 targets, to address wide ranging issues to be comprehensively solved in economic, social and environmental fields. Among the SDGs, the SDG 6 aims to ensure availability and sustainable management of water and sanitation. The SDG 6 has several targets such as the safe level of management of sanitation service (indicator 6.2.1), the safe level of wastewater treatment (indicator 6.3.1), and the assessment of the ambient water qualities in water bodies (indicator 6.3.2). The SDGs aims at achievement of goals and targets by 2030. To evaluate achievement of the goals and targets set, clear and feasible monitoring methodology should be developed.

Under these conditions, World Health Organization (WHO) has formulated the draft proposal on the Protocol for Step-by-Step Monitoring Methodology for Indicators of SDG 6.3.1: proportion of wastewater safely treated. Based on the proposed protocol, WHO tested it in five countries including Vietnam. The preliminary work for the testing as a part of pilot project has been started in cooperation with Ministry of Construction (MOC). The results and lessons obtained from the testing will be used for finalization of the methodology for Vietnam.

Japan International Cooperation Agency (JICA) has conducted many projects and contributed to improvement of sanitation wastewater management in Vietnam. In this context, JICA decided to collaborate with WHO for examination of monitoring methodology for indicator of SDG 6.3.1, and has started the survey on wastewater management and treatment in Vietnam (the Survey) from October 2017.



Source："Step-by-step monitoring methodology for SDG Indicator 6.3.1: Proportion of wastewater safely treated"

Figure 1-1 Proposed Monitoring Framework for SDG Indicator 6.3.1

1.2 Objectives of the Survey （Part 1）

The objectives of the Survey are:

- To propose appropriate and feasible monitoring methodology.

- To identify difficulties, gaps and important issues to conduct the monitoring activities related to SDG 6.3.1 in Vietnam and give feedback for the refinement of the monitoring methodology proposed for the indicator of SDG 6.3.1 by WHO.

1.3 Period of the Survey

The period of the Survey is from October 2017 to March 2019.

1.4 Main Activities Planned in the Survey

The planned main activities in the Survey are:

- Trial activity on collecting required information and data for (a) domestic wastewater and (b) industrial and commercial wastewater by field works.
- Interview with the concerned organizations that would engage in the monitoring activity for the indicator of SDG 6.3.1, to identify available information and data for the monitoring activity.
- Preliminary estimation of indicator values on "safely treated wastewater" with supposed condition of wastewater generation, treatment and discharge, based on the collected information and data through trial activity.

1.5 Target Areas of Field Work for Trial Information and Data Collection

The target areas of fieldwork for the trial information and data collection are tentatively as follows: Hanoi City, Hai Phong City and another province in northern Vietnam, such as Vin Phuc province, Ha Nam province or Nam Dinh province.

1.6 Concerned Organizations for the Survey

JICA Survey Team (JST) supposes the following organizations as the concerned ones to be cooperated for the Survey tentatively.

MOC, VEA (MONRE), MOH, General Statistical Office (GSO), Concerned organizations of target areas of fieldwork such as DONRE, DOC, industrial park management board, water supply company and wastewater management company.

2 Results of Project Activities

2.1 Survey Works on Wastewater Management and Treatment in Vietnam

2.1.1 Legal Aspects and Concerned Organizations Related to Wastewater Management

(1) Laws and Regulations

Industrialization and urbanization in Vietnam during the last 30 years has proceeded rapidly, and legislation on wastewater management has been enacted. The main laws and regulations for wastewater management in Vietnam is summarized in the following table.

Table 2-1 Main Laws and Regulations Related to Wastewater Management

No.	Name of Laws and Regulations
1	Law on Environment (2014)
2	Law on Water Resources (2012)
3	Decree 19/2015 on Guidelines for Implementation of Law on Environment
4	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
5	Decree 38/2015/ND-CP on Waste Management
6	Decree 154/2016/ND-CP on Environmental Protection Fees for Wastewater
7	Circular 04/2015/TT-BXD on Implementation of Decree 80/2014/ND-CP
8	Circular 58/2015TTLT-BYT-BTNMT on Providing Guidance on Medical Waste Management
9	Law on Inspection (2010)

Source: JST

(2) Decree on Wastewater Drainage and Wastewater Treatment (No.80/2014/ND-CP)

The Decree on Water Drainage and Wastewater Treatment (No.80/2014/ND-CP) stipulates provides for water drainage and wastewater treatment activities in urban areas, industrial parks, economic zones, export-processing zones and hi-tech parks, and concentrated rural residential areas as well as rights and obligations of organizations, individuals and households engaged in water drainage and wastewater treatment in the Vietnam. The regulated contents by the decree are summarized below.

The decree defines on-site treatment as follows:

a) On-site treatment: usually applied for private households with total amount of wastewater of less than 50m^3/day. Equipment/treatment station must be placed within the premises of the households.
b) Treatment by group: usually applied for adjacent households with total amount of wastewater combined from 50 to 200 m^3/day. Depending on specific conditions, wastewater treatment station may be placed within the premises of the households or at a separate position convenient for collection of wastewater from the households.
c) Treatment by zone: usually applied within a specific administrative division with total amount of wastewater from 200 m^3/day at night to 1,000 m^3/day. Positions of the wastewater treatment station must conform to construction planning or drainage planning approved by competent authorities.

Regarding the matters above, Provincial People's Committees decide choice of appropriate decentralized wastewater treatment solutions by relying on sources of wastewater, receiving waters, economic conditions, topography, and capability of management and operation of wastewater treatment system in the locality.

The decree also defines the management of fecal sludge concretely. MOC has responsibility on providing guidance on calculating and managing the costs of collection, carry and treatment of waste sludge in drainage systems and septic tanks.

Table 2-2 Decree on Water Drainage and Wastewater Treatment (No.80/2014/ND-CP)

Chapter	Article	Clause
1.General Provisions	2.Interpretation of terms	8. Domestic wastewater means wastewater generated from such human activities of daily living as eating, drinking, bathing, washing, toileting, etc. 9. Other wastewater means used water other than domestic wastewater.
	4.Provisions on technical regulations on wastewater	5. In case of decentralized wastewater treatment, based on absorptive capacity and use purposes of receiving waters, the MONRE shall promulgate technical regulations on wastewater discharged from decentralized treatment systems into receiving waters applicable to small-scale and simple-technology wastewater treatment solutions with easy-to-manage, -operate and -maintain equipment to clean wastewater at the required level.
2.Investment in Development of Water Drainage Systems	16.Criteria for selection of wastewater treatment technologies	Based on specific local conditions, provincial-level People's Committees shall decide to select applicable criteria from the following items. 1. Wastewater treatment effectiveness: To meet the required degree of cleaning wastewater, taking into account the self-cleaning capacity of receiving waters. 2. Construction land saving. 3. Management, operation and maintenance requirements corresponding to local management and operation capacity and qualifications. 4. Reasonability of investment expenses, taking into account the reliance on imported technologies. 5. Suitability with climatic, terrain, geological and hydrological conditions of the areas and capacity of receiving waters. 6. Safety and environmental friendliness. 7. Possibility for future capacity increase or treatment effectiveness improvement. 8. Capacity for stable operation upon abnormal changes in the quality of input water and weather and climate change. 9. Generation and treatment of sludge. 10. Energy conservation and re-use of treated wastewater and sludge.
3. Management and Operation of Drainage System	21. The management of detent ion basins	3. The discharge of wastewater generated from manufacture, commerce, domestic activities or other activities into detention basins must be strictly controlled according to the regulations.
	23. Provisions on decentralized wastewater treatment	4. The Ministry of Construction shall guide the management of decentralized wastewater treatment.
	25. Management of waste sludge	2. Waste sludge is classified as follows: a) According to origin: waste sludge generated from drainage systems (sewer network and wastewater treatment plants) and waste sludge generated in septic tanks
		3. Criteria for the selection of technology of waste sludge treatment
		5. Pump, carry and treatment of waste sludge in septic

Chapter	Article	Clause
		tanks
		6. The Ministry of Construction shall provide guidance on calculating and managing the costs of collection, carry and treatment of waste sludge in drainage systems and septic tanks
	28. Suspension of drainage service provision	1. If a domestic household violates the regulations on drainage management, it shall be punished according the regulations of the Law. The drainage unit must not stop the drainage service provision in any case, except the cases regulated in the clauses in the operation contract.
		4. In case the drainage service provision need to be temporarily stopped for reparation and upgrade the drainage system, the drainage unit must notify the relevant discharging entities about the reason and time of the temporary stop; at the same time, the drainage unit must provide a temporary drainage method in order not to cause impact on manufacture, business and domestic activities of the discharging entities and to minimize the environmental pollution.
4. Connection to Drainage Systems	32. Regulations on wastewater discharge at the connection points	1. Discharging entities are allowed to discharge domestic wastewater into the drainage system through connection points.
5. Drainage Service Price	38. Pricing drainage service 39. Determination of volume of wastewater	The basic thinking way of pricing drainage service and determination of volume of wastewater are prescribed.
6. State management Responsibilities for Water Drainage and Wastewater Treatment	45. Responsibilities of ministries and sectors	1. The MOC shall perform the state management of water drainage and wastewater treatment in urban areas, concentrated rural residential areas and industrial parks nationwide. 2. The MONRE shall perform the state management of environmental protection, water resources, river basin management and pollution control in water drainage and discharge of wastewater into the environment nationwide 3. The MARD
	46. Responsibilities of provincial-level People's Committees	Within the ambit of their tasks and powers, to perform the state management of water drainage and wastewater treatment operations in localities under their management 2. To guide the creation of databases on water drainage and wastewater treatment

Source: Decree No. 80/2014/ND-CP

(3) Law on Environment Protection (LEP)

The amended LEP establishes jurisdictions, roles, and responsibilities for all levels of government, regulatory agencies, and regulated entities and activities. It also provides coverage for the application of pollution management policy tools and the basis for environmental standards, including those for waste discharge and the requirements for environmental authorization by means of SEA, EIA and EPC.

The amended LEP has strong provisions for dealing with production and service establishments causing environmental pollution either through pecuniary penalties or suspension of activities, until the necessary mitigating and treatment measures have been completed. If there is damage to the lives or health of people, or damage to property or the interests of organizations and individuals, those who suffer damage are to be compensated in accordance with stipulations in the Law, relocate such establishments to places suitable to

environmental load capacity; or ban the operation. In addition, the amended LEP provides a comprehensive basis for managing water quality in Vietnam.

To ensure the environmental protection, the amended LEP stipulates specific environmental protection measures to be taken at pollution sources of manufacturing, business and service activities. All pollution generators must comply with legal requirements stipulated in the amended LEP. The responsibilities of pollution generators engaged in manufacturing, business and service activities are defined clearly in the Article 35 of amended LEP. Among the regulated items, environmental reporting is stated as one of activities to be done by each enterprise.

(4) Law on Inspection

The Law on Inspection was promulgated on June 24, 2004. The Law governs general rules of various inspections carried out by State inspection agencies comprising: a) organization, tasks and powers of state inspection agencies, b) inspection activities, c) people's inspection, and d) implementation provisions.

In the connection of water pollution control, the Law regulates the forms of environmental inspection in Article 34 and 45 as follows:

a) Inspection activities are conducted in forms of programmed or planned inspection and unexpected inspection.
b) Programmed or planned inspection shall be conducted according to the approved programs or plans.

Unexpected inspection shall be conducted upon detecting signs of law violation by agencies, organizations or individuals, under requirements of the settlement of complaints and denunciations, or according to assignments by the heads of State management agencies.

(5) Effluent Standards

In Vietnam, effluent standards are prepared for domestic, commercial and industrial wastewater as shown in the table below. For domestic and commercial wastewater, QCVN14:2008/BTNMT is adopted. For industrial wastewater, generally, QCVN40:2011/BTNMT is adopted, and there are several effluent standards on specific industries.

Table 2-3 List of Effluent Standard

Category				Wastewater (WW) Discharge Sources	WW Treatment Plant (WWTP)	Effluent Standards for WW
A	Household			Black and grey water	Septic Tank	QCVN 14:2008/BTNMT
					WWTP	QCVN 14:2008/BTNMT
B	Economic Activity	Commercial		Restaurants, Super	Decentralized WWTP	QCVN 14:2008/BTNMT
				Markets, Hotels, etc.	Centralized WWTP	
		Secondary industry		Factories	WWTP	QCVN40:2011/BTNMT
			Industrial Zone	Economic Zones, Industrial Parks,	Decentralized WWTP(IZ)	QCVN40:2011/BTNMT
			Specific Industry	Textile Dying	On-site WWTP	QCVN 13MT:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Paper and pulp	On-site WWTP	QCVN 12MT:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Bioethanol processing	On-site WWTP	QCVN 60:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Aquatic products processing	On-site WWTP	QCVN 11MT:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Natural rubber processing	On-site WWTP	QCVN 01:2015/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
				Steel Industry	On-site WWTP	QCVN 52:2013/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
			Mining Area			QCVN40:2011/BTNMT
			Craft Village			QCVN40:2011/BTNMT
		Livestock facility			On-site WWTP	QCVN 62MT:2016/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT
		Hospital			On-site WWTP	QCVN 28:2010/BTNMT
					Centralized WWTP	QCVN40:2011/BTNMT

Source: JST

(6) Concerned Organizations on Wastewater Management

Central Level

Main central governmental organizations on wastewater management are MOC and MONRE. As mentioned before, the Decree on Water Drainage and Wastewater Treatment (No.80/2014/ND-CP) stipulates their responsibility as follows.

e) MOC: To perform the state management of water drainage and wastewater treatment in urban areas, concentrated rural residential areas and industrial parks nationwide.

f) MONRE: To perform the state management of environmental protection, water resources, river basin management and pollution control in water drainage and discharge of wastewater into the environment nationwide

Local Level

At the local level, several organizations take in charge of each activity concerning of wastewater management. The concerned organizations are different by province, and some activities are privatized.

Example of organizations engaging the concerned activities on wastewater management is shown in the table below.

Table 2-4 Example of Organizations Engaging Concerned Activities on Wastewater Management

	Water supply	Wastewater and sewer management	Solid waste management	Fecal sludge management (FSM)
Hanoi[1)]	Hanoi Water Supply Co. LTD (HAWACOM)	Hanoi sewerage and drainage company (HSDC)	Hanoi URENCO	URENCO +100- private
Hai Phong[2)]	Haiphong Water Supply One Member Co., Ltd	SADCO	Hai Phong URENCO	SADCO + 10 private
Son La[3)]	Son La water supply JSC	Son La URENCO (province)		URENCO+3 private
Hoa Binh[3)]	Hoa Binh water supply company JSC	Hoa Binh URENCO (province)		URENCO+1 private
Bac Ninh[3)]	Bac Ninh water supply and sewerage company (province)		Bac Ninh URENCO (province)	URENCO+4 private
Lang Son[3)]	Lang Son water supply and sewerage company (province)		Huy Hoang LSC company (private)	Huy Hoang + 3 private
Da Nang[4)]	Da Nang Water Supply JSC. (DAWACO)	Da Nang Drainage and Wastewater Treatment Company (DDC)	Da Nang URENCO	Da Nang URENCO
Ba Ria – Vung Tau[3)]	Ba Ria –Vung Tau water supply company JSC	BUSADCO (province)	URENCO Ba Ria (province)	URENCO+4 private
Ho Chi Minh[5)]	Saigon Water Supply One Member Co. Ltd. (SAWACO)	Ho Chi Minh City Urban Drainage Co., Ltd. (UDC)	HCMC Urban Environment Co., Ltd. (CITENCO)	CITENCO

Source: 1) Hearing results from HSDC and URENCO
2) Hearing results from SADCO
3)M. Bassan, N. Dao, V. A. Nguyen, C. Holliger, L. Strande, (2014) Technologies for sanitation: how to determine appropriate sludge treatment strategies in Vietnam,37th WEDC International Conference, Hanoi, Vietnam
4) JST
5) Ditto

(7) Guideline on Construction of Treatment Facility

Sewage Treatment Plant

Regarding the design guideline for the domestic wastewater treatment facility, JST has not obtained any officially promulgated design guideline by the Vietnamese local authority for the wastewater treatment facility although some design standards/requirements for the sewer pipe lines, civil structures as well as environmental protection are available. Hence JST recognizes that almost centralized wastewater treatment plants developed in Vietnam until now have been designed by application of authorized design guidelines in the international donor's country and/or empirical design parameters from the successfully completed wastewater treatment projects by the consultant/manufacturer. The following table shows the common design standards applied to the planning and designing of the sewage works in Vietnam.

Table 2-5 Common Design Standards for Sewage Works in Vietnam

Sector	Code	Title
Sewage	TCVN 7957: 2008	Drainage and sewerage - External Networks and

Sector	Code	Title
Technology		Facilities - Design Standard
	TCXD 188-1996	Urban waste water - Standard for discharge
	TCVN 5525: 1995	Water quality - General requirement for protection of underground Hater
	QCVN 07-2:2016/BXD	National Technical Regulation Technical Infrastructure Works Sewerage
Environment Protection	TCVN 7222-2002	General environmental requirements for central domestic (municipal) wastewater treatment plants
	TCVN 7221-2002	General environmental requirements for central industrial wastewater treatment plants
	Decision No.131/2006/ND-CP	Government on ODA project management

Source: JST

Septic Tank

According to the survey conducted by Hanoi University of Civil Engineering, the National Design Standard of Vietnam for Wastewater Systems, which applies mainly to urban areas, MOH has issued the manual for septic tank design, installation and O&M. MOC is also drafting the design code for the septic tank design and construction.

However, JST could not find the manual or the design code on septic tanks. Only technical standard on septic tank (TCVN 10334:2014) provided by Vietnam Concrete Association was confirmed, which is described below.

This standard regulates the technical requirements and test methods for the rigorous testing of the prefabricated thin wall reinforced concrete septic tank for toilets.

TCVN 10334: 2014 was developed based on the acceptable suitable technology solutions for the technology process to create prefabricated reinforced concrete products available in the technical infrastructure, approved by MOC. This TCVN is allowed to apply it to the whole country (according to Decision No.885/QD-BXD dated on 30/09/2011). At the same time, the application of the "Innovative septic tank" and "Rural Septic Tank" solutions of the Ba Ria - Vung Tau City Drainage and Urban Development One Member Limited Company (BUSADCO) Patent No.7717 may be used according to Decision No.9384/QD-SHTT dated 13 May 2009 and Patent Utility Solution No.1084 in accordance with Decision No. 37679/QĐ-SHTT dated 15/07/2013.

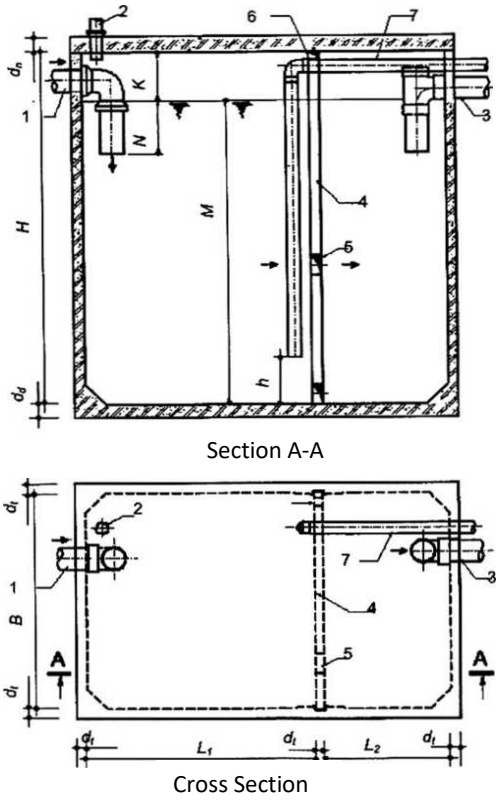
The technical standard for pre-cast thin wall reinforced concrete septic tanks is shown in the tables and figures below.

Table 2-6 Technical Standard for Pre-cast Thin Wall Reinforced Concrete Septic Tanks (TCVN 10334:2014)

Items		Contents
1	Scope	applies to prefabricated thin wall reinforced concrete septic tank (nominal thickness of no more than 70mm) for toilets
2	Terminology and definition	
	Septic tank	Tank for cleaning wastewater from toilet where the sedimentation and anaerobic decomposition processes are activated at the same time before being discharged to the common drainage system
	Storage compartment	Compartment where the most of scrum, and foam were kept for deposition, and anaerobic decomposition
	Settling compartment	Compartment receives the effluent from the storage compartment for continuous sedimentation and anaerobic digestion processes
	Liquid volume	v_{ur} – volume of compartment to store liquid and scrum
	Air space volume	$V_L K$ – The distance from above the liquid level to the face down of the tank lid.
	Height of air space	The distance from the level of the outlet pipe to the bottom of the tank lid

	Items	Contents
	Nominal dimension	The dimension of the circulation inside the septic tank (not including the partition), calculated by millimeters, is conventionally chosen as the basic size for the design of septic tanks
	Liquid depth	The distance from the bottom of the tank to the bottom of the outlet pipe.
	Depth of inlet end and outlet end	The distance from the inlet end and outlet end to the level of the outlet pipe
	Transfer port	The port maintains the flow of liquid between the compartments in the tank
	Air vent pipe	Pipe exhausts air from the tank or excrement pit into the environment
	Soak away	The land used to treat or contain waste water from the toilet
	Collecting tank	The tank contains wastewater from septic tanks, domestic wastewater and storm water reused to irrigate the plants
3	Classification, basic dimension, code	
	Classification	- Classified by structure: + One-compartment tank: sewage is kept and settled in the same compartment + Two-compartment tank: sewage is kept and settled in separate compartments - Classified by the technical infrastructure available in the area of use: + Septic tanks used in the areas having common drainage system + Septic tanks used in the areas having no common drainage system, otherwise known as rural septic tanks
	Basic dimensions	Shown in Figure A and Figure A' below
	Code	-TH: Septic tank. -1N, 2N: the number of compartments; - 0,50; 0,70; 0,90; 1,10; etc.: capacity of tank. For example: TH.1N.1.1: construed as one-compartment septic tank with capacity of 1.10 m^3
4	Technical requirements	Requirements on materials, dimensions and dimension deviation, appearance and defects, waterproof capacity, air tightness and pipes and accessories are shown in Figure A, Figure A', Table B and Table C below.
5	Testing method	
	Sampling	≥ 3 products
	Determination of size and deviation	Tank length, width, thickness, height and reinforced concrete thickness
	Determination of appearance and defects	Bumps, imprints, pores, cracks, and color change
	Determination of concrete strength	Following TCVN 3118: 1993 or TCVN 9490: 2012 (ASTM C900-06) or by a proper method agreed by the parties.
	Determination of water-proof capacity	Check whether percolation or droplets occur.
	Determination of air tightness	Check whether the vacuum pressure of 100 Pa is retained in 5 min in a tightly closed tank
6	Labeling, transportation, and maintenance	
	Labeling	Including: Manufacturer's name and address, Applied TCVNs, Product code according to Article 4.3, Product lot number, Production date, Stamp of quality check (barcode)
	Transport and Maintenance	Loading and transport is allowed only when concrete strength reaches at least 70% of the design.

Source: TCVN 10334:2014

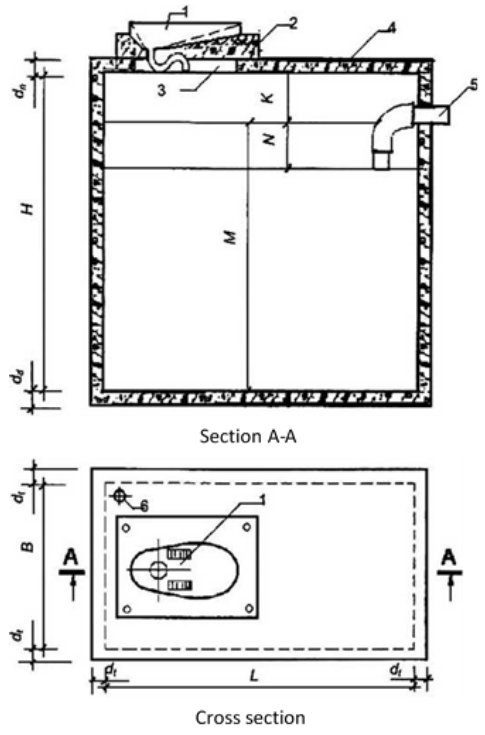


NOTE:

1 Port to connect the inlet pipe D150;
2 Port to connect the air vent pipe D32;
3 Port to connect the outlet pipe D150;
4 Partition;
5 Transfer port (round D150 or square 150mm X 150mm);
6 Air holes between compartments (round D40 or square 40mm X 40mm);
7 Dregs sucking tube D100;
L_1, L_2 Length of the first partition, second partition;
B Width.
H Height;
dt Thickness of wall;
d_d Thickness of bottom;
d,, Thickness of lid;
K Height of air column;
N Depth of inlet end and outlet end;
M Depth of water.
H Height of dregs sucking tube.

Source: TCVN 10334:2014

Figure 2-1 Two-compartment Septic Tank (as an example)



NOTE:

1 Toilet;
2 Platform of toilet;
3 Dregs tucking port, 300mm X 300mm;
4 Lid;
5 Port to connect the outlet pipe D150;
6 Port to connect the air vent pipe D32.
L Length;
B Width;
H Height;
dt Thickness of wall;
d_d Thickness of bottom;
d,, Thickness of lid;
M Height of water;
N Depth of outlet end;
K Height of air column.

Source: TCVN 10334:2014

Figure 2-2 Septic Tanks used in the Areas without Common Drainage System (e.g. rural septic tanks)

Table 2-7 Nominal Size and Allowable Deviation of Some Types of Septic Tanks

Code of tank	Volume V m³	Liquid volume v_n m³	Size and allowable deviation, mm										
			Length L	Allowable range of deviation	Length of section 1 L_1	Length of section 2 1-2	Width, B	Allowable range of deviation	Height is not less than H_1	Thickness of tank wall d,	Allowable range of deviation	Thickness of tank wall dd	Allowable range of deviation
TH.1N.0.50	0,50	0,44	800	±5	-	-	600	±5	1060	50	±3	70	+5 -2
TH.1N.0.70	0,70	0,62	850		-	-	800						
TH.1N.0.90	0,90	0,76	1050		-	-							
TH.1N.1.10	1,10	0,95	1050		-	-	1000						
TH.1N.1.10	1,10	0,95	1050		650	400	1000						
TH.2N.1.30	1,30	1,09	1200		800								
TH.2N.1.50	1,50	1,30	1450		1050								

NOTE:
1) Can be produced in other size, depend on customer's requirements
2) Length = total length of sections.

Source: TCVN 10334:2014

Table 2-8 Sizes and Other Requirements

Name	Requirement
1. Air space volume compared to liquid volume, *Vlk,* %, not less than	12,5
2. Air space height, K, mm, not less than	150
3. Depth of inlet end and outlet end, N, mm, not less than	300
4. Liquid depth, M, mm, not less than	900
5. Thickness of lid, *d,,,* mm, not less than	70
6. The axis of transfer port (round D150 or square 150mm X 150mm) located between the tank's height.	
7. If inlet pipe is installed at tank's wall, its level should be 50mm higher than that of outlet pipe.	
8. Air hole between compartments shall locate on partitions and close to the face down of the lid, round D40 or square 40 mm X 40 mm.	
9. Distance from mouth of sucking pipe to tank bottom is from 120 mm to 130 mm.	

Source: TCVN 10334:2014

2.1.2 Literature Survey on Wastewater Treatment Status in Vietnam

By reviewing existing document, outline of current status on wastewater treatment in Vietnam was confirmed. The resulting statistics are summarized below.

(1) Urban Area[1) 2) 3) 4)]

- There are 770 cities and towns in Vietnam. Total population of such urban areas is 33% of total population in Vietnam (Approx. 91 million population).
- 94% of urban population has access to household (HH) sanitation (toilet).
- 90% of HHs using septic tanks as a means of on-site treatment in urban area.
- 4% of septage disposed satisfactorily.

[1]Viet-Anh Nguyen, 2015. Wastewater management and technology needs in Vietnam
[2]Viet-Anh Nguyen, 2013. On-site Wastewater Treatment in Vietnam, Workshop on On-site Domestic Wastewater Treatment in Asia Tokyo, November 2013
[3]Document of MOC, 2017
[4]Dr. Duong Thanh An, 2013. Wastewater Management and Sanitation Practices in Vietnam

- 60% of HHs dispose of wastewater to a public combined drainage/sewerage system.
- 10% of collected drainage/ sewerage treated by centralized WWTPs.
- 39 municipal WWTPs currently in operation (total capacity: 907,950m^3/day).
- Currently some 32 new wastewater combined systems are in the design/construction phase.

(2) Rural Area[5)]

- 80% of HHs are with toilets, among them 60% are with hygienic toilets in 2012.
- 85% schools, 85% clinics, 50% rural markets, 80% PC buildings are with WSS facilities in 2012.

Table 2-9 Sanitation Coverage Rate

Area	Percent, %		
	No toilet	Public toilets	Separate toilets
Rural area	13.50	17.10	69.40
Urban area	3.78	3.31	82.91
Average	11.20	16.20	72.0

Source: Dr. Duong Thanh An, 2013. Wastewater Management and Sanitation Practices in Vietnam

2.1.3 Field Survey on Wastewater Management: Part A. Domestic Wastewater (Centralized Sewerage System and On-site Facilities)

(1) Survey on Domestic Wastewater Generation

JST requested water supply data to the Water Supply Companies of Hanoi and Haiphong Cities to obtain actual water consumption in different categories of the water users and to estimate impact of industrial/commercial wastewater to the overall wastewater generation. For reference, JST shows water consumption in the different water users in the service area of Hai Phong Water Supply Company as of 2011 in the following table.

Table 2-10 Water Consumption in the Service Area of Hai Phong Water Supply Cmpany in 2011

Parameter	Category of Customer			
	Domestic	Institutional	Industrial	Commercial
Population (persons)	809,168	-	-	-
Service Connection (nos)	226,900	1,206	2,237	6,850
Total Monthly Consumption (1,000 m^3)	2,738(74.8%)	237(6.5%)	419(11.5%)	268(7.3%)
Daily Consumption per Connection (m^3)	0.4	6.5	6.2	1.3
Daily Consumption per Person (LPCD)	112	-	-	-

Source: JST

As aforementioned, JST recognized that share of water consumption in the industrial and commercial sectors totaled approximately 20% of overall water consumption in the service area of Hai Phong Water Supply Company. This is almost the same ratio of wastewater that might be generated from those sectors. However, JST could not identify whether water usage of industrial park and industrial zone with large scale

[5]Viet-Anh Nguyen, 2013. On-site Wastewater Treatment in Vietnam, Workshop on On-site Domestic Wastewater Treatment in Asia Tokyo, November 2013

factories and commercial buildings were included or not. JST is trying to collect recent water supply data, but it has not been provided yet by the Water Supply Companies as of January 2018.

JST surveyed unit water consumption in Vietnam, which should be the principle parameter for the calculation of wastewater generation. The resulting example case from Hanoi City is shown in the following tables.

Table 2-11 Water Consumption Results from Each Study

No.	Water consumption (L/cap/day)	References
1	Urban: 200 Rural: 150	Water Supply-Distribution system and Facilities Design Standard, TCXDVN 33:2006/BXD(For domestic water in the special and first class cities in 2020)
2	Urban: 101	Viet-Anh Nguyen, 2013. On-site Wastewater Treatment in Vietnam, Workshop on On-site Domestic Wastewater Treatment in Asia Tokyo, November 2013.
3	Hanoi 146±58 (n=80)(Ave.)	Pham Nguyet Anh, 2014. Study on household wastewater characterization and septic tanks' function in urban areas of Vietnam, doctoral dissertation in Kyoto University.
4	Hanoi Urban:149 (n=48) Rural :145 (n=34) Haiphong Urban:132 (n=35) Rural :128 (n=34)	Based on our interview survey (December 2017) These are preliminary value (average).

Source: JST
Note: n indicates the number of data

Table 2-12 Design Unit Water Cnsumption in Hanoi City

Area	2010 (currently)		2020		2030		2050	
	%	(LPCD)	%	(LPCD)	%	(LPCD)	%	(LPCD)
A. Urban								
A.1. Central Urban								
A.1.1. Core centre (8 urban districts)								
1. Ba Đình	100%	150	100%	170	100%	180	100%	190
2. Hoàn Kiếm	100%	150	100%	170	100%	180	100%	190
3. Đống Đa	99%	150	100%	170	100%	180	100%	190
4. Hai Bà Trưng	100%	150	100%	170	100%	180	100%	190
5. Tây Hồ	80%	145	100%	160	100%	170	100%	190
6. Cầu Giấy	99.9%	145	100%	160	100%	170	100%	190
7. Thanh Xuân	98.5%	145	100%	160	100%	170	100%	190
8. Hoàng Mai	53%	145	100%	160	100%	170	100%	190
A.1.2. Area around Ring Roads (no.3-4) to the South of Red River								
1. Hà Đông District	90%	120	95%	160	100%	170	100%	190
2. Other	50%	90	95%	140	100%	160	100%	190
A.2.Urban areas and towns								
A.2.1.West								
1. Hòa lạc urban area	50%	120	90%	140	100%	160	100%	180
2. Xuân Mai urban area	50%	120	90%	130	100%	150	100%	170
3. Sơn Tây+Ba Vì Town	72%	130	90%	140	100%	160	100%	180
4. Phúc Thọ urban area	50%	130	90%	120	95%	140	100%	160
4. Quốc Oai urban area	50%	130	95%	120	100%	140	100%	160
5. Chúc Sơn urban area	50%	130	90%	120	95%	140	100%	160
Western towns	70%	130	90%	110	90%	120	100%	150
A.2.2.North								
6. Mê Linh urban area	60%	130	90%	130	100%	150	100%	160
7. Sóc Sơn urban area	60%	130	90%	140	100%	150	100%	160
8. Đông Anh-Cổ Loa urban area	70%	130	90%	140	100%	150	100%	160
Northern towns	70%	130	90%	110	90%	120	100%	150
A.2.3. East								

Area	2010 (currently)		2020		2030		2050	
	%	(LPCD)	%	(LPCD)	%	(LPCD)	%	(LPCD)
9. Long Biên District	85%	130	95%	150	100%	160	100%	180
10. Eastern towns (Trâu Quỳ, Yên Viên)	70%	130	90%	130	95%	150	100%	170
A.2.4. South								
11. Phú Xuyên urban area	70%	130	90%	120	100%	140	100%	160
12. Southern towns	85%	130	90%	110	90%	120	100%	150
B. Rural	55%	60	70%	90	90%	100	100%	120

Source: Master Plan for Hanoi Capital Drainage and Sewerage System to 2030 and vision to 2050

Hanoi City has developed Master Plan for Hanoi capital drainage and sewerage system to 2030 and vision to 2050, with short, middle and long terms water demand projection as aforementioned. Based on those design unit water consumption rates of domestic use in each district, non-domestic water consumption was estimated and then wastewater generation was finally estimated. For example, detail calculation of wastewater generation for Hanoi city by 2030 is shown in the following table.

Table 2-13 Calculation of Water Demand and Wastewater Generation in Hanoi City by 2030

Catchment	Design Unit Consumption for Water Supply									Design Unit Wastewater Generation				
	Domestic Use	Non-domestic Use						Water supply Standard		Conversion Ratio to Wastewater	Infiltrated Ground Water	Design Generation		
		Public & Commercial		Frequent Visitors		Industry & Craft						Average Daily	K-factor	Max. Daily
	(LPCD)	(%)	(LPCD)	(%)	(LPCD)	(%)	(LPCD)	(%)	(LPCD)	(%)	(%)	(LPCD)	K_{rg} = 1.15~1.3	(LPCD)
	(1)	(2)	(3) = (1) * (2)	(4)	(5)	(6)	(7) = (3) + (4) * (5) + (6) * (1)	(8)	(9) = {(1)+(7)} * (8)	(10)	(11)	(12) = (9) * (10) * {1+(11)}	(13)	(14)= (12) * (13)
A. CENTRAL URBAN														
1. Core center (Tô Lịch watershed) - S1 (Yên Sở WWTP) (*)	180	35	63	15	60	7	85	100	265	90	10	262	1.225	321
2. From Ring Road no. 2 to Nhuệ River and part of core center (Tô Lịch watershed and left bank of Nhuệ River) - S2, S3														
- S2 (Yên Xá WWTP) (*)	180	35	63	15	60	7	85	100	265	90	10	262	1.225	321
- S3 (Phú Đô WWTP) (*)	180	35	63	15	60	7	85	100	265	90	10	262	1.225	321
3. Newly-developed areas														
a. Right bank of Nhuệ River to Đáy River														
-S4 (Tây Sông Nhuệ WWTP)	170	35	60	15	60	7	81	100	251	90	10	248	1.225	304
-S5 (Phú Thượng WWTP)	170	35	60	15	60	7	81	100	251	90	10	248	1.225	304
- Ngũ Hiệp (Ngũ Hiệp WWTP)	170	35	60	15	60	7	81	100	251	90	10	248	1.225	304
- Vĩnh Ninh (Vĩnh Ninh WWTP)	170	35	60	15	60	7	81	100	251	90	10	248	1.225	304
- Đại Áng (Đại Áng WWTP)	170	35	60	15	60	7	81	100	251	90	10	248	1.225	304
b. Hà Đông District														
- Tân Hội (Tân Hội WWTP)	160	35	56	10	60	7	73	100	233	90	10	231	1.225	283
- Đức Thượng (Đức Thượng WWTP)	160	35	56	10	60	7	73	100	233	90	10	231	1.225	283
- Lại Yên (Lại Yên WWTP)	160	35	56	10	60	7	73	100	233	90	10	231	1.225	283
- Nam An Khánh (Nam An Khánh WWTP)	160	35	56	10	60	7	73	100	233	90	10	231	1.225	283
-Dương Nội (Dương Nội WWTP)	170	35	60	15	60	7	81	100	251	90	10	248	1.225	304
- Phú Lương (Phú Lương WWTP)	170	35	60	15	60	7	81	100	251	90	10	248	1.3	323
c. Long Biên District														
- LB1 (Ngọc Thụy WWTP)	160	35	56	10	60	7	73	100	233	90	10	231	1.225	283
- LB2 (Sài Đồng A WWTP)	160	35	56	10	60	7	73	100	233	90	10	231	1.225	283
- LB3 (An Lạc WWTP)	160	35	56	10	60	7	73	100	233	90	10	231	1.225	283
f. Gia Lâm - Yên Viên Area														
- GL1 (Đông Dư WWTP)	150	35	53	10	60	7	70	95	209	90	10	207	1.225	254
- GL2 (Phú Thị WWTP)	150	35	53	10	60	7	70	95	209	90	10	207	1.225	254
- GL3 (Yên Thường WWTP)	150	35	53	10	60	7	70	95	209	90	10	207	1.225	254
- GL4 (Yên Viên WWTP)	150	35	53	10	60	7	70	95	209	90	10	207	1.225	254
d. Đông Anh - Mê Linh Area														
- DA5 (Đại Thịnh WWTP)	150	35	53	10	60	7	70	100	220	90	10	218	1.225	268
- DA4 (Tiền Phong WWTP)	150	35	53	10	60	7	70	100	220	90	10	218	1.225	268
- DA3 (Bắc Thăng Long WWTP)	150	35	53	10	60	7	70	100	220	90	10	218	1.225	268
e. Đông Anh District														
- DA1 (Cổ Loa WWTP)	150	35	53	10	60	7	70	100	220	90	10	218	1.225	268
- Dục Tú (Dục Tú WWTP)	150	35	53	10	60	7	70	100	220	90	10	218	1.225	268
- DA2 (Sơn Du WWTP)	150	35	53	10	60	7	70	100	220	90	10	218	1.225	268
B. SATELLITE/ ECO URBAN														
1. Sơn Tây Township (Sơn Tây WWTP)	160	31	50	7	60	7	65	100	225	90	10	223	1.225	274
2. Hòa Lạc														
- HL1 (North Hòa Lạc WWTP)	160	31	50	7	60	7	65	100	225	90	10	223	1.225	274
- HL2 (South Hòa Lạc WWTP)	160	31	50	7	60	7	65	100	225	90	10	223	1.225	274
- HL3 (Hòa Lạc High-Tech WWTP)														
3. Quốc Oai														
- Q1 (Quốc Bắc Oai 1)	140	31	43	7	60	7	57	100	197	90	10	195	1.225	239
- Q2 (Quốc Nam Oai 2)	140	31	43	7	60	7	57	100	197	90	10	195	1.225	239
4. Xuân Mai	150	31	47	7	60	7	62	100	212	90	10	210	1.225	258
5. Phú Xuyên	150	31	47	7	60	7	62	100	212	90	10	210	1.225	258
6. Sóc Sơn														
- SS1 (Sóc Sơn WWTP)	150	31	47	7	60	7	62	100	212	90	10	210	1.225	258
- SS2 (Đông Xuân1 WWTP)	150	31	47	7	60	7	62	100	212	90	10	210	1.225	258
- SS3 (Đông Xuân2 WWTP)	150	31	47	7	60	7	62	100	212	90	10	210	1.225	258

Source: Master Plan for Hanoi Capital Drainage and Sewerage System to 2030 and vision to 2050

After multiplying aforementioned unit, wastewater generation with design population in each catchment, and daily wastewater amount was calculated.

(2) Survey on Sewerage Facilities

JST obtained the list of centralized wastewater treatment plants in service in Vietnam as of 2017, which shows 39 WWTPs are available in major cities and have total treatment capacity of 908,000 m^3/day. In the three major cities of Hanoi, Ho Chi Minh and Da Nang City, several WWTPs in each city have been developed and their share is 68% of current total treatment capacity in Vietnam. In addition to those three cities, both of Bac Ninh and Binh Duong provinces have another 9% of the total treatment capacity. Those five cities/provinces cover approximately 80% of the total current treatment capacity of WWTPs in Vietnam. JST considered that operation and management status of WWTPs in those five cities/provinces could represent nationwide status in Vietnam, and selected the target sites for the survey of the off-site treatment facilities taking the survey period and accessibility to the sites into account.

Table 2-14 Treatment Capacity among Existing WWTPs in Vietnam

No.	WWTP	Location	Year in Service	Capacity (m^3/day)	Coverage		
					Partial	City	Group
1	**Kim Lien**	**Hanoi**	**2005**	**3,700**	**0.41%**	**33.37%**	68.18%
2	**Truc Bach**		**2005**	**2,500**	**0.28%**		
3	**Yen So**		**2012**	**200,000**	**22.03%**		
4	**Ho Tay**		**2014**	**22,800**	**2.51%**		
5	**Bay Mau**		**2016**	**13,000**	**1.43%**		
6	**Cau Nga**		**2016**	**20,000**	**2.20%**		
7	**Bac Thang Long**		**2009**	**41,000**	**4.52%**		
8	**Binh Hung**	**TP Ho Chi Minh**	**2009**	**141,000**	**15.53%**	**21.59%**	
9	**Binh Hung Hoa**		**2008**	**30,000**	**3.30%**		
10	**Nam Vien**		**2009**	**15,000**	**1.65%**		
11	**Canh Doi**		**2007**	**10,000**	**1.10%**		
12	**Phu Loc**	**Da Nang**	**2006**	**40,000**	**4.41%**	**13.22%**	
13	**Ngu Hanh Son**		**2006**	**10,000**	**1.10%**		
14	**Son Tra**		**2006**	**10,000**	**1.10%**		
15	**Hoa Cuong**		**2006**	**40,000**	**4.41%**		
16	**Hoa Xuan**		**2015**	**20,000**	**2.20%**		
17	**TP Bac Ninh**	**Bac Ninh**	**2013**	**17,500**	**1.93%**	**5.56%**	16.94%
18	**Tu Son**		**2015**	**33,000**	**3.63%**		
19	TP Nha Trang	Khanh Hoa	2014	40,000	4.41%	4.41%	
20	**Thu Dau Mot**	**Binh Duong**	**2013**	**17,650**	**1.94%**	**3.82%**	
21	**TX Thuan An**		**2017**	**17,000**	**1.87%**		
22	Vinh	Nghe An	2013	25,000	2.75%	3.16%	
23	Cua Lo		2014	3,700	0.41%		
24	TP Vung Tau	Ba Ria- Vung Tau	2016	22,000	2.42%	2.42%	14.88%
25	TP Quy Nhon	Binh Dinh	2014	14,000	1.54%	1.54%	
26	TP Soc Trang	Soc Trang	2013	13,200	1.45%	1.45%	
27	TP Hai Duong	Hai Duong	2013	13,000	1.43%	1.43%	
28	Bai Chay - TP Ha Long	Quang Ninh	2007	3,500	0.39%	1.16%	
29	Ha Khanh - TP Ha Long		2009	7,000	0.77%		
30	TP Bac Giang	Bac Giang	2010	10,000	1.10%	1.10%	
31	TP Dong Hoi/Duc Ninh	Quang Binh	2014	10,000	1.10%	1.10%	
32	Buon Ma Thuot	Dak Lak	2006	8,500	0.94%	0.94%	
33	TP Da Lat	Lam Dong	2006	7,400	0.82%	0.82%	
34	Vinh Yen	TP Vinh Yen	2014	5,000	0.55%	0.55%	
35	TP Phan Rang	Ninh Thuan	2012	5,000	0.55%	0.55%	
36	Phan Thiet	Binh Thuan	2015	5,000	0.55%	0.55%	
37	TP Chau Doc	An Giang	2016	5,000	0.55%	0.55%	
38	Sam Son	Thanh Hoa	2015	4,000	0.44%	0.44%	
39	Ho Me	Ha Nam	2015	2,500	0.28%	0.28%	
			Total	907,950	100.00%	100.00%	100.00%

Source: JST provided referring to MOC information

JST firstly visited at Urban Technical Infrastructure Works Maintenance Unit (UTWMU) under Department of Construction of Hanoi City on 31 October 2017, and conducted interview survey on O&M management status. JST found that the current O&M works of WWTP, not only in Hanoi DOC but also other major cities in Vietnam, are executed in the contact with private or state-owned companies as selected via competitive bidding process. Hence specific O&M information and data is usually maintained by the operating company and reported to UTWMU monthly, quarterly and annually. JST collected an example of annual report in 2016 from UTWMU. However, there is almost no specific information of water quality monitoring in the report, so JST again requested monthly report of the representative months of dry and wet season in Hanoi. JST has not received further information yet.

JST also employed a local expert and commenced the survey from 5 December 2017. JST and the local expert visited together at TP Bac Ninh WWTP and conducted questionnaire survey on O&M management status by the operating company. The survey is still in progress in the southern Vietnam. JST have obtained several data and information as shown in the following table.

Table 2-15 Survey Result of Effluent Quality

No	WWTP	City/ Prov.	Capacity (m^3/day)	Survey Parameter							Design Standard	Remarks
				Inflow (m^3/day)	TSS (mg/L)	BOD_5 (mg/L)	COD (mg/L)	T-N (mg/L)	T-P (mg/L)	Coliform (MPN/100mL)		
1	Kim Lien	HN	3,700	3,700	5	9	-	17	0.4	-	TCVN 5945 / 2005, B	Data in 2009
2	Truc Bach		2,500	2,300	5	8	-	15	0.4	-	TCVN 5945 / 2005, B	Data in 2009
3	Yen So		200,000	174,000	-	-	-	-	-	-	QCVN 40 / 2011, B	No data provided
4	Ho Tay		22,800	-	-	-	-	-	-	-	-	No transferred.
5	Bay Mau		13,000	11,000	-	-	-	-	-	-	TCVN 7222 / 2002, II	No data provided
6	Cau Nga		20,000	-	-	-	-	-	-	-	-	No transferred.
7	Bac Thang Long		41,000	7,000	5	9	17	13	-	-	QCVN 40 / 2011, A	Data in 2012
8	Binh Hung	HCM	141,000	114,300	7.4	7.2	26.1	12.0	0.7	24	QCVN 14 / 2008, B	Data in 2017
9	Binh Hung Hoa		30,000	28,650	13~23	3~6	17~77	0.9~1.9	0.1~0.3	-	QCVN 14 / 2008, B	Data in 2017
10	Nam Vien		15,000	N/A	50	20	-	-	-	-	-	Data in 2017
11	CanhDoi		10,000	N/A	30	20	-	-	-	-	-	Data in 2017
12	PhuLoc	DN	40,000	34,000	58	54	87	19	2	-	QCVN 40 / 2011, B	Data in 2014
13	Ngu Hanh Son		11,600	N/A	51	41	62	14	2	-	QCVN 40 / 2011, B	Data in 2014
14	Son Tra		25,500	NA	45	113	190	29	6	-	QCVN 40 / 2011, B	Data in 2014
15	HoaCuong		47,600	37,000	65	51	83	20	2	-	QCVN 40 / 2011, B	Data in 2014
16	Hoa Xuan		20,000	18,000	8	10	-	-	-	-	-	Data in 2014
17	TP Bac Ninh	BN	17,500	14,800	7	8	14	13	2	-	QCVN 40 / 2011, B	Data in 2017
18	Tu Son		33,000	N/A	-	-	-	-	-	-	-	No data provided
19	Thu Dau Mot	BD	17,650	12,500	10~20	3~10	-	-	-	-	-	Data in 2017
20	TX ThuanAn		17,000	4,000	2~4	5~7	-	-	-	-	-	Data in 2017
QCVN 40/ 2011 / TT-BTNMT (Class A)				-	50	30	75	20	4	5,000		
QCVN 40/ 2011 / TT-BTNMT (Class B)				-	100	50	150	40	6	5,000		
QCVN 14/ 2008 / TT-BTNMT (Class B)				-	100	50	-	50	10	5,000		

Source: JST

The obtained data shows that the actual inflow rate has reached at 70% or more of the design inflow rate at each WWTP and effluent quality has satisfied design requirements of water quality standard in general, although some WWTPs should be checked further for figures in excess of allowable values. In general, JST

viewed the O&M management of WWTP is properly executed in Vietnam. JST will continue collection of the specific data of the remaining WWTPs.

Through the survey, JST has found that some operating contractors have all raw data on O&M of WWTPs belonging to the private sector but JST also faced difficulty to approach those private companies and obtain data from them because of contractual confidentiality. Hence JST contacted management agencies of the target cities/provinces and found a variety of the report formats covering specific information of the operation condition, which should be integrated into the authorized format.

For the information, JST has heard that Vietnamese Government is preparing Decree of Amending and Supplementing the Detailed regulations and Guidance of Enforcement of Environmental Protection Law at this moment. In it the online monitoring system would be required to report installation to the centralized WWTPs, industrial clusters and individual treatment system at a factory having the capacity equal to or more than 1,000 m^3/day in general. JST continues monitoring the progress of the preparation.

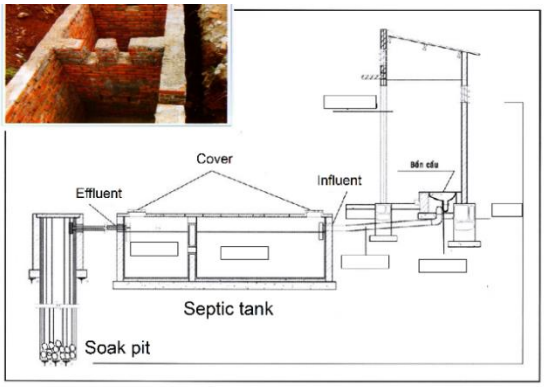
(3) Literature Survey on Onsite Treatment Facilities

In this section, progress of the field survey for septic tank as one of on-site facilities is described.

(a) Material and Structure of Septic Tank [6) 7) 8)]

Septic tank is the most popular sanitation pre-treatment equipment in Vietnam. It is often made from bricks (for individual houses) or reinforced concrete (for individual houses and public buildings). Tanks often are sealed with concrete base and cement mortar. Households often place the tank in the basement, surrounded by the foundation. Tanks often consists of two or three chambers. The first receiving chamber often is built with largest portion of the total tank volume, giving space for solids accumulation and anaerobic digestion. Total volume of the HH septic tank depends on available space and funding availability. The total volume often ranges from 1.5 to 5 m^3.

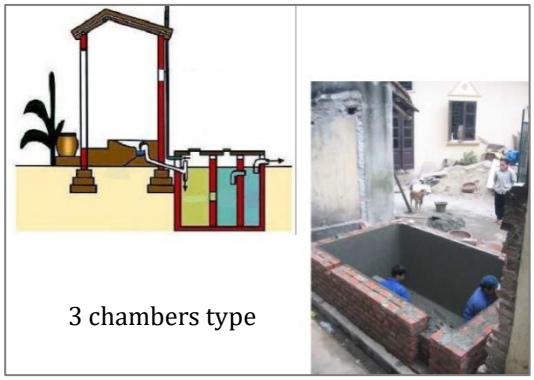
Calculated average septic tank volume in Hanoi is 2.6 m^3. The calculated average septic tank volume in Hai Phong is 1.9 m^3. According to the survey results in Da Nang, 68.6 % of septic tanks are self-constructed without any design plan, and 31.4% of them are from houses which are just bought or rented for use by current owners, so they do not have any information about the house's current septic tank state.



[6]Document of MOC, 2017

[7]Institute of environmental science and engineering (IESE), Hanoi University of Civil Engineering, 2011. Final Report on Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Vietnam

[8]Nguyen Duc Huynh et al., 2012. Study on current usage & management of septic tank & its sludge in households in Da Nang city, the collection of the 8th Student Conference Reports of Science Research - Da Nang University in 2012.



2 chambers type

Source: Viet-Anh Nguyen, 2013. On-site Wastewater Treatment in Vietnam, Workshop on On-site Domestic Wastewater Treatment in Asia Tokyo, November 2013

Figure 2-3 Examples of Septic Tanks

According to the survey by Pham Nguyet Anh of Kyoto University, characteristics of septic tanks in Hanoi are summarized in the table below.

Table 2-16 Characteristics of Septic Tanks (n=46) in Hanoi

Septic tank characteristic	Unit	Value	Vietnamese code
Tank size			
Avg. ± S.D.	m^3	3.4±1.24	> 3
Median	m^3	3.24	
Three chamber septic tank	%	100	>2
Tank shape			
Rectangular	%	97	
Round	%	3	
Number of user	people	5	
Non-desludging interval (Avg. ± S.D.)	year	10.2±4.0	

Source: Pham Nguyet Anh, 2014. Study on household wastewater characterization and septic tanks' function in urban areas of Vietnam, Thesis or Dissertation in Kyoto University
Note: Avg. and S.D. stand for average and standard deviation, respectively

(b) Removal Efficiency of Septic Tank [9) 10)]

Removal efficiency of septic tank is often ranging from 10% to 50% for BOD and SS. Septic tanks installed in Vietnam show low treatment efficiencies and thus don't contribute as much as expected to the water pollution control in the urban environments.

Though it does not meet effluent standard, and cities still cannot afford to build centralized wastewater treatment plants, HH septic tanks play a very important pre-treatment role.

(c) Treated Water Quality by Septic Tank

One example of effluent water quality from septic tank is as shown in the table below. Comparing with Vietnamese wastewater standard, QCVN 14: 2008, effluent from septic tank generally does not satisfy the domestic wastewater quality standard.

[9]Institute of environmental science and engineering (IESE), Hanoi University of Civil Engineering, 2011. Final Report on Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Vietnam

[10]Pham Nguyet Anh, 2014. Study on household wastewater characterization and septic tanks' function in urban areas of Vietnam, Thesis or Dissertation in Kyoto University

Table 2-17 Water Quality of Effluent from Septic Tank (unit: mg/L)

Parameter	Minimum	Average	Maximum
BOD	60	259	920
COD	91	413	1,780
SS	12	134	733
T-N	1.3	38	349
T-P	0.9	9.5	72.4

Source: Kankyo Bunseki Kenkyusho Co.,Ltd et al., 2016. Final report on Improvement of domestic wastewater treatment through transferring operation, maintenance and management techniques for "Johkasou"

Table 2-18 QCVN 14: 2008 National Technical Regulations on Domestic Wastewater (ref.)

No.	Parameter	Unit	A	B
1	pH	---	5 - 9	5 - 9
2	BOD5 (20 °C)	mg/L	30	50
3	Total suspended solids (TSS)	mg/L	50	100
4	Total dissolved solids	mg/L	500	1000
5	Sulfide (as H_2S)	mg/L	1.0	4.0
6	Ammonium (as N)	mg/L	5	10
7	Nitrate (NO_3^-)	mg/L	30	50
8	Animal fat and vegetable grease	mg/L	10	20
9	Total surface-active substances	mg/L	5	10
10	Phosphate (PO_4^{3-})	mg/L	6	10
11	Total coliforms	MPN/ 100mL	3.000	5.000

Source: QCVN 14: 2008

(d) Status of Septic Tank Sludge Management

In urban areas in Vietnam, septic tanks play an important pre-treatment role with combined sewers. However, septage from most septic tanks is not emptied regularly. Illegal dumping of emptied sludge is a very common practice in all cities in Vietnam.

There are no national laws governing the collection and treatment of septage yet. All desludging operators in urban areas are only required to obtain a business license to run the business. A mix of state-owned, limited liability companies and private companies provide desludging service. Due to a lack of treatment infrastructure, service providers usually dispose of septage in drains, fish farms, and waterways. 80% of funding for those projects is coming from the ODA grants and loans (WB, 2006). Septage management components have been also initiated in some cities such as Nam Dinh (Swiss funding), Ha Long, Da Nang and Hai Phong (WB funding), etc.

Lack of operations and maintenance (O&M) budgets to fund septage collection and treatment is a big challenge in the cities. Since septage collection companies often also collect solid waste, they commonly dispose of septage at landfills, as solid waste laws also do not address septage.

The private sector has a greater role in septic tank desludging, collection and disposal or treatment since public enterprises can collect only a part of fecal sludge generated. However, this business is not controlled by city authorities. Households are not encouraged to empty their tanks regularly. Furthermore, since most of septic tanks are located under the basement, households often prefer not to break their floor and pay to empty their tanks unless the tanks are clogged and overflowing. In order to reduce operation costs and due to the lack of septage treatment facilities, most private fecal sludge collectors conduct illegal dumping which contributes to pollution of the city environment with an adverse impact on public health.

Fecal sludge management (FSM) is insufficient in existing condition. However, some efforts in improvement of FSM are being made in certain provincial governments such as Hai Phong city. In Hai Phong city, scheduled desludging services is undertaken by Hai Phong Sewerage and Drainage Company. Required cost for FSM is covered by revenue from the wastewater fee (15%surcharge on the water bill). Some cities are taking part in the Vietnam–German Wastewater and Solid Waste Management Program (KfW and Swiss Secretariat for Economic Affairs [SECO] funds), which intends to provide free septic tank emptying services to households.

Emptying and delivery services, not septage treatment expenditure, can be recovered by the application of competitive fees for increased services. Critical factors for cost recovery depend on the selected technology for septage collection, treatment and reuse method, and an accepted market price for the compost product. It should be possible for private companies to make profits from septage services, thus creating a better regulatory environment. Models for payment by customers for septage management include direct payment to the service provider upon desludging or indirectly through water bills as part of the wastewater service. The latter approach would involve scheduled septic tank desludging by either public or private enterprises, but controlled by the city authority. For services beyond scheduled emptying, additional payment would be made to the service provider.

Example of analytical result of septage in Hanoi and Da Nang are as shown in the tables below.

Table 2-19 Septage Characteristics in Hanoi

Parameter	Measured (mg/L)			Reference
	Max	Min	Average	
BOD	22,400	12,200	16,033	M. Bassan, H. Harada, L. Schoebitz, L. Strande, N. Viet Anh, and V. T. Hoai An
COD	83,830	2,830	30,526	
SS	71,077	1,380	21,173	
NH_4-N	1,670	50	390	
T-N	1,670	180	1,285	
T-P	2,490	30	202	

Source: David Robbins, 2015. Co-treatment of Septage with Municipal Wastewater in Medium Sized Cities in Vietnam, SCE Aménagement & Environment for Cities Development Initiative for Asia

Table 2-20 Septage Characteristics in Da Nang

Parameter	Max	Min	Average
SV30 (%)	96	0	34.41
pH	8.2	7.3	7.8
Alkalinity (mg/L)	3,280	1,300	2,228
SS (mg/L)	73,200	1,750	36,523
BOD (mg/L)	24,800	389	12,949
COD (mg/L)	64,400	2,550	40,496
T-N (mg/L)	5,180	408	2,706
T-P (mg/L)	2,028.1	98.6	970.8
Coliform (MPN/100mL)	92×10^5	22×10^3	29×10^5

Source: Nguyen Duc Huynh et al., 2012. Study on current usage & management of septic tank & its sludge in households in Da Nang city, the collection of the 8th Student Conference Reports of Science Research - Da Nang University in 2012

(e) Example of Treatment and Utilization of Fecal Sludge

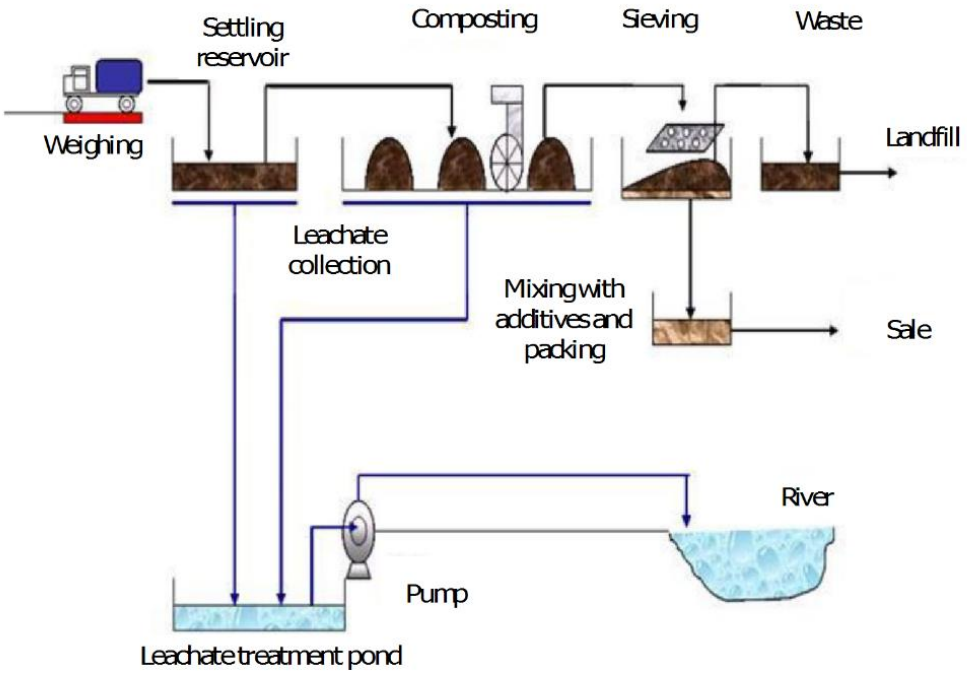
<Hai Phong>

Fecal sludge management is not a major business of Hai Phong SADCO. Besides scheduled desludging for households in the city by a part of collected wastewater fee, the income from desludging services does not cover the expenses. Hai Phong SADCO has to provide cross-subsidy for FSM activity.

In the Hai Phong SADCO's GIS database, 86,501 of the septic tanks in 4 urban districts are recorded to conduct scheduled desludging. Hai Phong SADCO is planning a desludging interval every 5 to 6 years for household septic tanks, and every 1 to 2 years for the communal houses (living apartments). All the expenses for desludging is covered by collected wastewater fee.

Hai Phong SADCO is also operating Trang Cat sludge treatment complex constructed by the WB project. Trang Cat treatment area is 5 ha, including 3 composting lines for sludge and organic wastes, 0.4 ha of settling pond, 1 ha of sludge drying bed, 0.6 ha of receiving pond, and 1.2 ha treatment ponds. The plant is equipped with modern tools like crane, mixing and turn over machines, sieving machines, and pumps, etc.

The amount of sludge brought to Trang Cat is ranging from 10,000 to 25,000 m^3 per year. The projected amount of treated sludge will be increased when the Environmental Sanitation Project, funded by JICA, is operational.

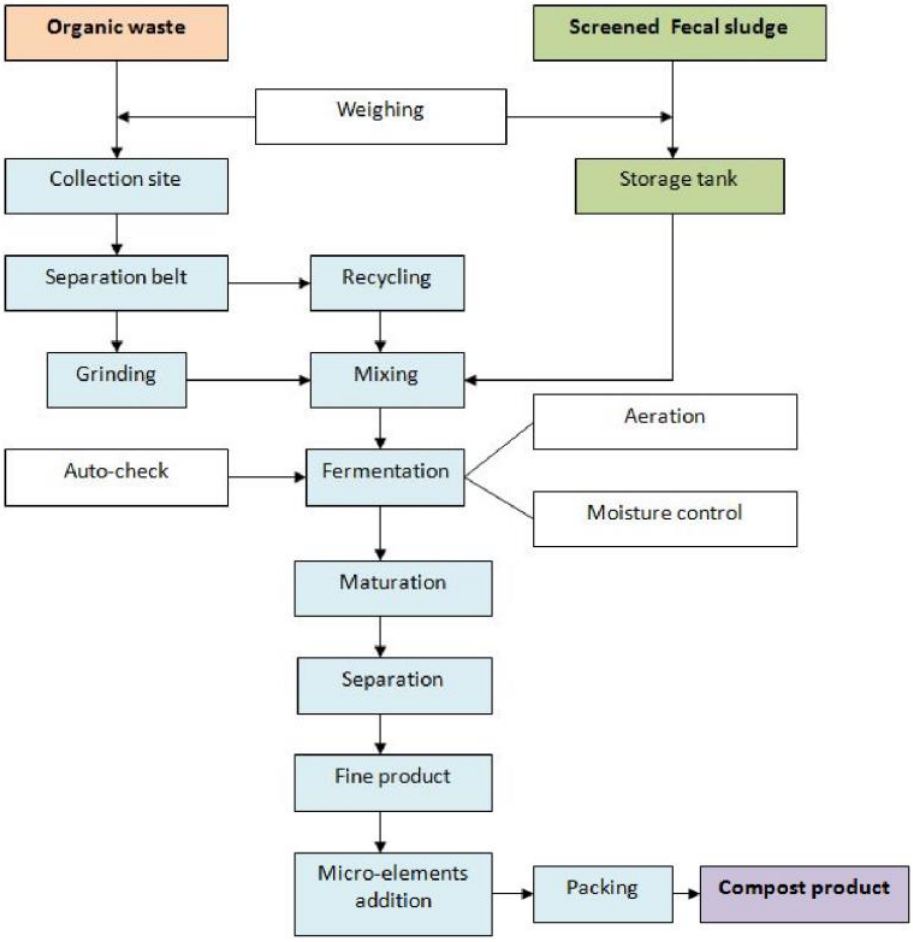


Source: Institute of environmental science and engineering (IESE), Hanoi University of Civil Engineering, 2011. Final Report on Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Vietnam

Figure 2-4 Process Line of FS Treatment in Trang Cat Plant

<Hanoi>

Fecal sludge collected by the Cau Dzien enterprise (or Hanoi URENCO 4) is mostly from public toilets. Solid waste brought into Cau Dzien is mostly from the city markets. The plant was built in 1992, and upgraded in 2002 by Spanish ODA loan. The design capacity of Cau Dzien composting plant is 13,600 tons/year. Fecal sludge is an additional material which is co-composted with separated market organic waste for the composting process. Theoretically input of fecal sludge into the composting pile at appropriate sludge/organic waste ratio provides more favorable environment of C/N ratio and moisture for the composting process, and it is expected to contribute to producing better quality of compost product. The current capacity of the plant is around 5,000 tons of compost per year.



Source: Institute of environmental science and engineering (IESE), Hanoi University of Civil Engineering, 2011. Final Report on Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Vietnam

Figure 2-5 Flowchart of Co-composting Process at Cau Dzien Waste Treatment Plant

There are 80 staff in the plant: 15 engineers, 5 vocational school graduates, and 60 workers from different departments dealing with organic waste collection, transportation, separation, compost production, marketing and sale of compost. FSM is only a small business of the plant. Even though the reported amount of sludge collected and brought to Cau Dzien is 50 tons/day, the team has found that the actual sludge brought into the plant is only 10 to 20 tons. There is no evidence during the survey that Cau Dzien has a constant number of fecal sludge trucks delivering. Compost product is produced from organic waste at Cau Dzien despite operation of fecal sludge composting process line.

According to the survey in Hanoi, the emptying frequency of once every 5 - 10 years covers 64% of the total surveyed households (300 households) in the urban area. The average desludging interval of septic tanks in Hanoi is 6.2 years. According to the same survey in Haiphong, the emptying frequency of once every 5 - 10 years covers 29% of the total surveyed households (232 households) only. About 6% of households emptied twice a year. The average desludging interval of septic tanks in Hai Phong is 4.4 years.

(f) Desludging Cost

According to the survey in Hanoi and Hai Phong, in most of cases, the desludging fee is higher than VND 500,000 (USD 24.30). Another survey result by a Japanese company's survey in Hanoi, reported the cost of desludging by private companies is from 200,000 to 300,000VND/m^3.

(g) Other On-Site Facilities

Johkasou as on-site wastewater treatment facility

Many "Johkasou" are installed as other on-site facility in Vietnam. According to the survey conducted Johkasou System Association (Japan), a total 1,037 units of Johkasou have been installed in Vietnam: 612 units of large scale types and 425 units of small and medium size types. However, there are many pilot facilities sponsored by Japanese government, etc.

KUBOTA Corporation and FUJI CLEAN Co, Ltd. are representative companies for Johkasou in Vietnam. Since effluent control regulation for the medical drainage was strengthened in Vietnam, KUBOTA has been trying to sell Johkasou to hospitals in Vietnam. KUBOTA exports 100 units of large-scale Johkaso per year from Japan, and it has already installed 800 units in total.

It is thought that all of facilities for hospitals are installed by KUBOTA as shown in Table 2-21.
On the other hand, FIJI CLEAN provides small-scale Johkasous for high-quality houses in Vietnam.

Table 2-21 Situation of Installing Johkasou in Vietnam

Area	Year of installation	No. of Plant	Scale	Purpose	Remarks
-	2010-2013	320	25-1,000 m^3/day	Hospital	
Hanoi	2011	480	For 5 people	Households	
Ditto	2012	1	5 m^3/day	Factory	Model project
-	2013	1	3.5 m^3/day	-	
-	2013	1	6 m^3/day	-	
-	2013	1	1 m^3/day	-	
Hanoi	2014	80	For 5 people	Household	
Ditto	2014	1	For 100 people	Kindergarten	METI project
-	2014	25	For 5,7,10 people	Hospital	
-	2014	1	For 21 people	Hospital	
-	2014	1	10 m^3/day	Hospital	
-	2014	33	25-800 m^3/day	Hospital	
-	2014	2	25-200m^3/day	Hospital	
-	2015	11	25-500m^3/day	Hospital	

Source: Kankyo Bunseki Kenkyusho Co.,Ltd et al., 2016.Improvement of domestic wastewater treatment through transferring operation, maintenance and management techniques for "Johkasou", Feasibility Survey with the Private Sector for Utilizing Japanese Technologies in ODA Projects

Wastewater treatment facilities (WWTF) for new high-rise condominiums as decentralized wastewater treatment facility

As examples of decentralized wastewater treatment facilities, the results of treated water quality by WWTF for new high-rise condominiums are shown in Tables 2-22 and 2-23. Also the example of treatment flow diagram of WWTF for the new high-rise condominium (Vinhome Times City- Park Hill in Hanoi) is shown in Figure 2-7. In this condominium, the sequencing batch reactor (SBR) method has been applied as

wastewater treatment method. In addition, the layout of WWTF for ECO-GREEN Condominium is shown in Figure 2-8. In this WWTF, anaerobic-aerobic activated sludge process (AO method) has been applied.

The treated water qualities of WWTFs for both of condominiums meet the domestic wastewater standard (QCVN 14/2008/BTNMT) as shown in Tables 2-22 and 2-23.

Table 2-22 Example of Treated Water Quality by WWTF for Condominium (Vinhome Times City- Park Hill in Ha Noi: 29/09/2016)

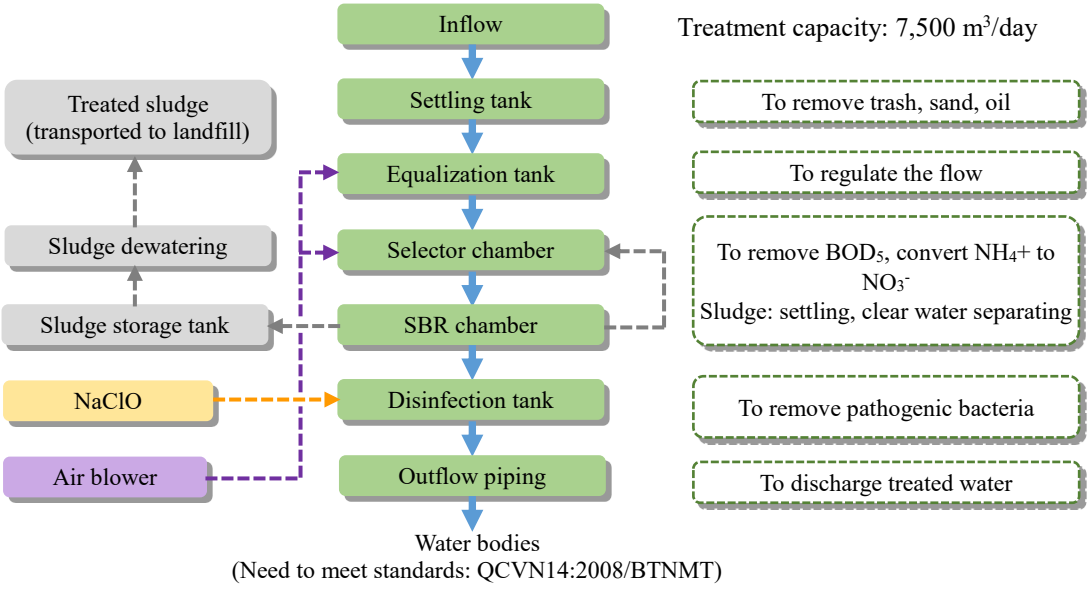
No.	Parameter	Unit	Before treatment	After treatment		QCVN14/2008 /BTNMT (B)
1	pH	-	7.5	**7.2**	✓	5-9
2	BOD_5 (20°C)	mg/L	300	**20**	✓	50
3	TSS	mg/L	282	**42**	✓	100
4	TDS	mg/L	821	**298**	✓	1,000
5	Sulfur	mg/L	2.3	**0.85**	✓	4.0
6	Ammonium	mg/L	39.5	**3.8**	✓	10
7	Nitrate (NO_3^-)	mg/L	43.8	**12.6**	✓	50
8	Vegetable oil and grease	mg/L	14.6	**2.0**	✓	20
9	Surfactant	mg/L	4.12	**0.93**	✓	10
10	Phosphate (PO_4^{3-})	mg/L	13.4	**4.2**	✓	10
11	Coliform	MPN/100mL	13,500	**2,100**	✓	5,000

Source: Management Company of this condominium. ✓ : Indicating to meet standards

Table 2-23 Example of Treated Water Quality by WWTF for Condominium (ECO-GREEN in Ha Noi: 4/10/2017)

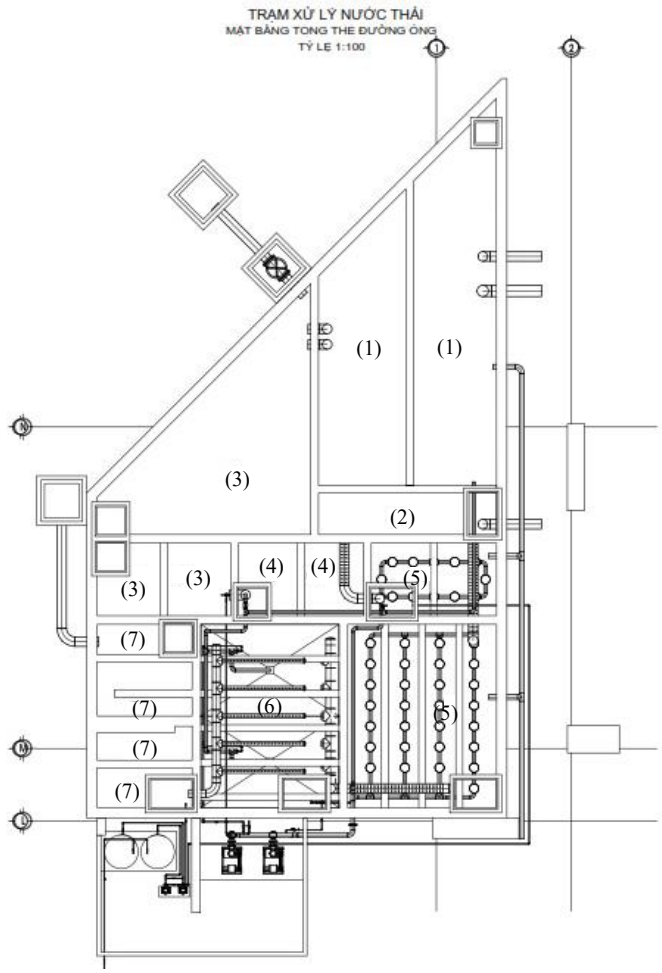
No.	Parameter	Method	Unit	Treated water quality		QCVN14/2008 /BTNMT (B)
1	pH	TCVN 6492:2011	-	**6.7**	✓	5-9
2	Total oil & grease	TCVN 5070:1995	mg/L	**0.6**	✓	20
3	Ammonium	SMEWW 4500 NH3-F 2012	mg/L	**8.91**	✓	10
4	BOD_5	TCVN 6001-1:2008	mg/L	**6**	✓	50
5	TSS	TCVN 6625:2000	mg/L	**6**	✓	100
6	TDS	QT-HT-02	mg/L	**457**	✓	1,000
7	Sulfur	SMEWW 4500-S2-.D:2012	mg/L	**< 0.01**	✓	4
8	Phosphate	TCVN 6202:2008	mg/L	**4.49**	✓	10
9	Nitrate	SMEWW 4500-NO3-.E:2012	mg/L	**16.34**	✓	50
10	Surfactant	SMEWW 5540:2012	mg/L	**0.07**	✓	10
11	Coliform	TCVN 6187-1:1996	MPN/100mL	**4,600**	✓	5,000

Source: Management Company of this condominium. ✓ : Indicating to meet standards



Source: Management Company of this condominium.

Figure 2-6 Treatment Flow Diagram of WWTF for Vinhome Times City- Park Hill Condominium



Treatment capacity: 550 m3/day

(1) Primary Settling tank
(2) Oil separation tank
(3) Equalization tank
(4) Anaerobic digestion treatment tank
(5) Aerobic digestion treatment tank
(6) Secondary settling tank
(7) Disinfection tank

Source: Management Company of this condominium

Figure 2-7 Layout of WWTF for ECO-GREEN Condominium and its Treatment Flow

(4) Field Survey of On-site Treatment Facilities

(a) Objectives of the Field Survey

The field survey of on-site treatment facility was conducted to confirm general usage condition of septic tanks, and to obtain analytical results of wastewater inflowing to and outflowing from the septic tanks in the urban area and local area of Hanoi City and Hai Phong City. Its features are described below.

(b) Method of Sampling in the Interview Survey

The number of interview survey samples is as follows.

Hanoi City:	Urban area; 60	rural area; 60	
Haiphong City:	Urban area; 40	rural area; 40	Total: 200 samples

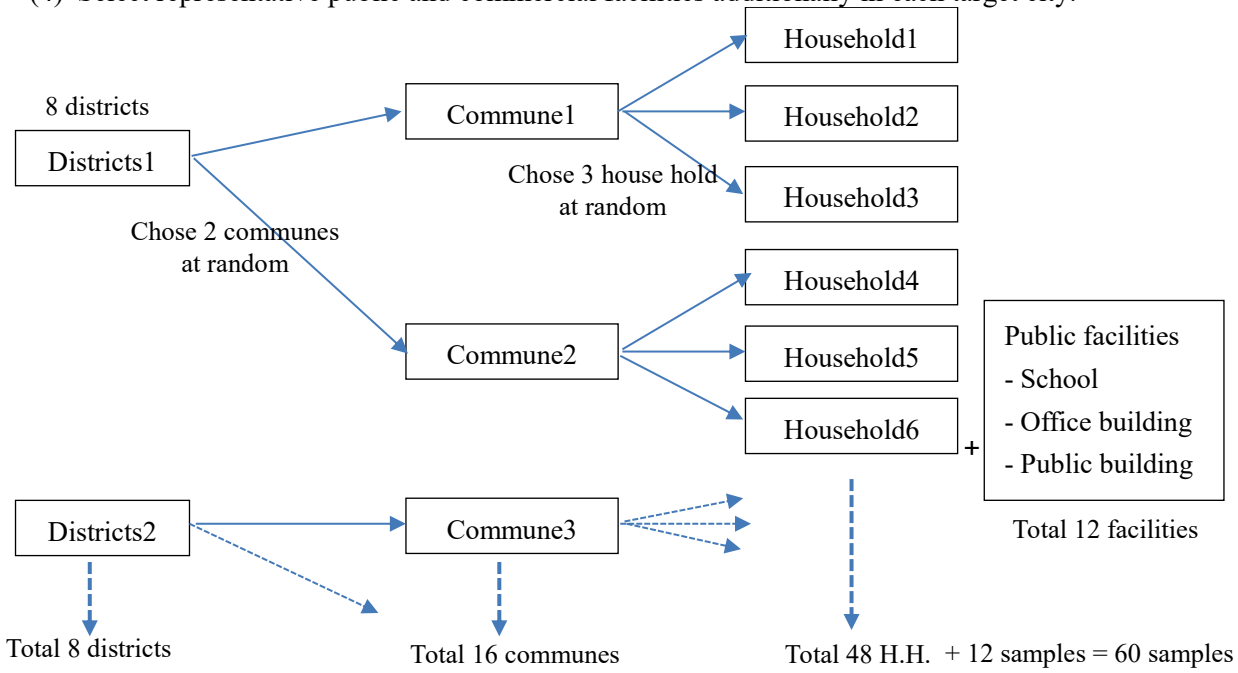
The target interviewees were selected by the following steps.

Urban area

(1) Compare population of each district, and select the districts recognized as typical urban area, where population is large, proceeding with urbanization, and increasing is remarkable.
(2) Select 2 communes randomly from all communes in the target districts.
(3) Select 3 households randomly in the selected communes.
(4) Select representative public and commercial facilities additionally in each target city.

Rural area

(1) Select the districts having the following characteristics: low population density, small fluctuation of population, high ratio of agricultural and forestry land, and positioned near the selected urban districts.
(2) Select 3 communes randomly from all communes in the target districts.
(3) Select 3 households randomly in the selected communes.
(4) Select representative public and commercial facilities additionally in each target city.



Source: JST

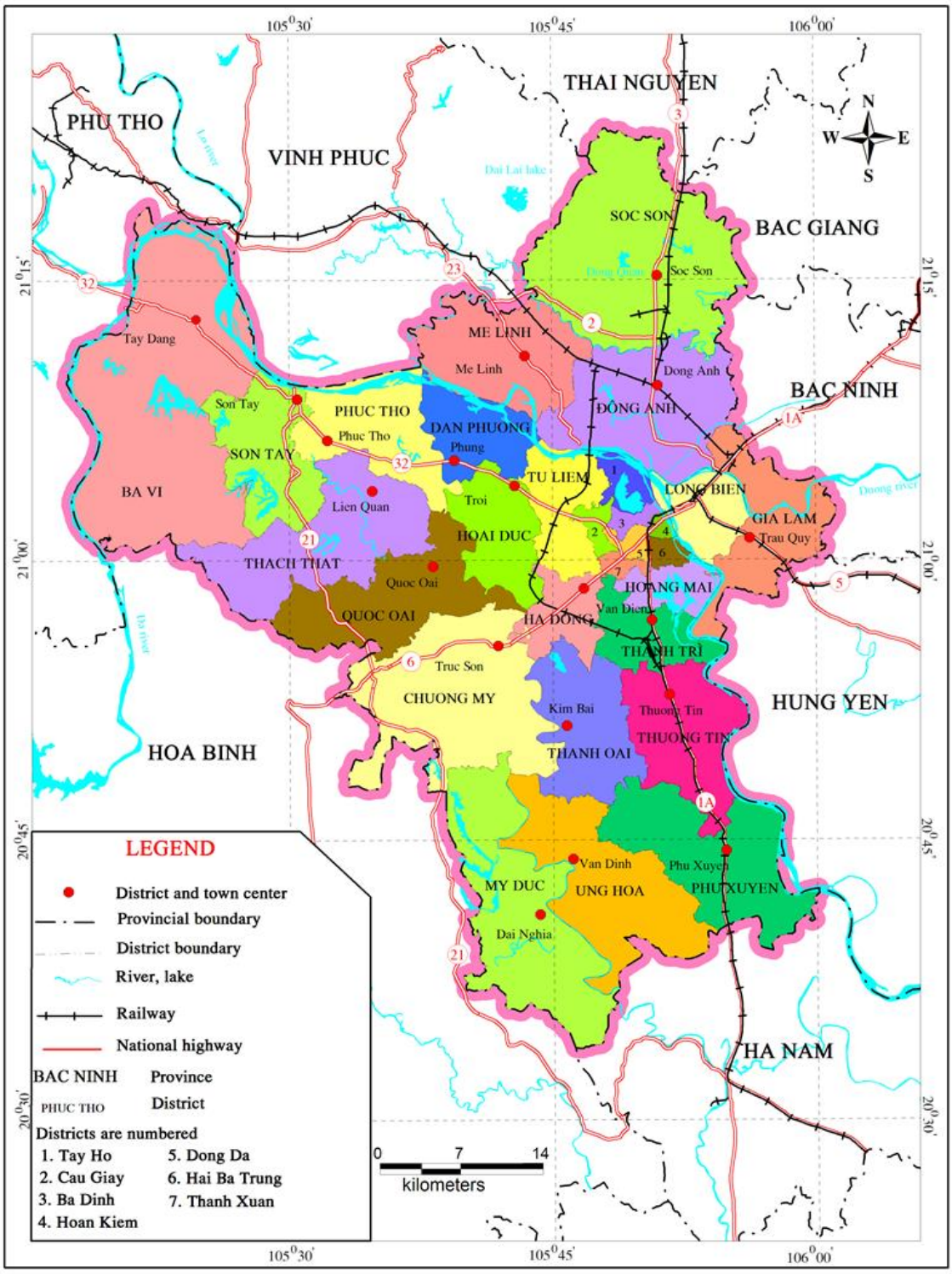
Figure 2-8 Example of Process for Selecting Survey Target

Based on the selection process mentioned above, 8 urban districts and 6 rural districts were selected as target districts in Hanoi, and 4 urban and 4 rural districts in Hai Phong, as shown in the tables and maps below.

Table 2-24 Selected Districts for On-site Treatment Field Survey in Hanoi

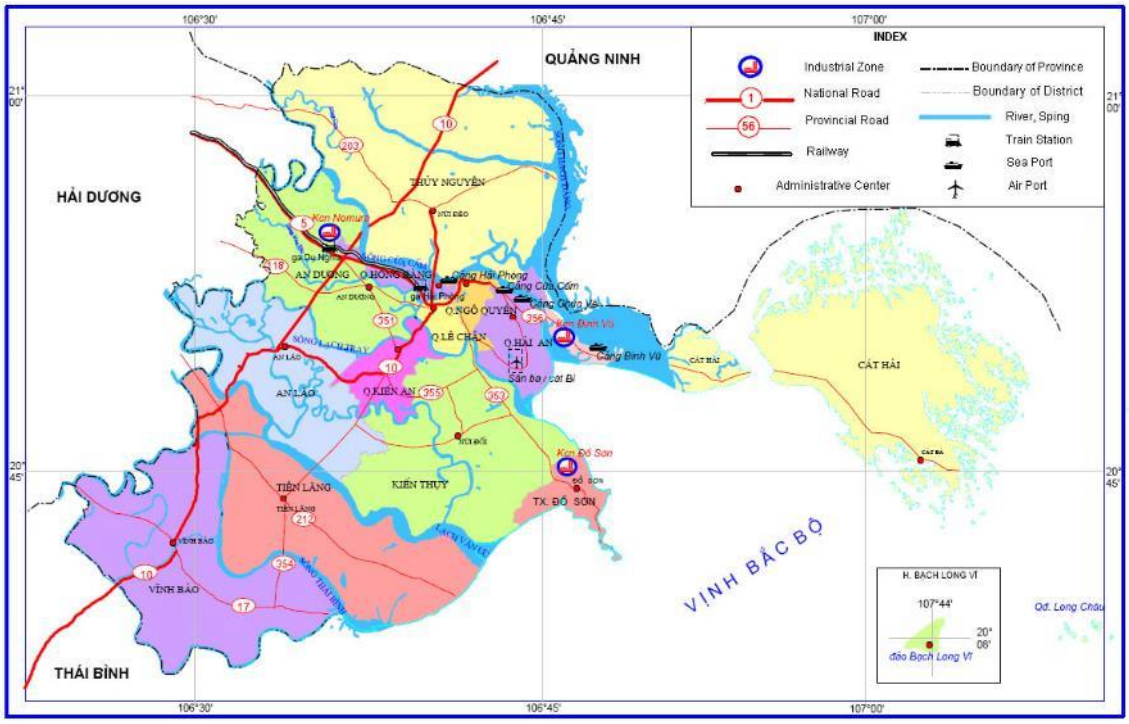
Provincial Cities/Districts	Wards	Area (km^2)	Population	Density (people/km^2)
1 town (Thị xã)				
Sơn Tây Town	15	117.43	147,800	1,259
12 urban districts (Quận)				
Ba Đình District	14	9.21	246,100	26,721
Bắc Từ Liêm District	13	45.32	328,600	7,251
Cầu Giấy District	8	12.32	266,300	21,615
Đống Đa District	21	9.95	417,800	41,990
Hai Bà Trưng District	20	10.26	317,200	30,916
Hà Đông District	17	49.64	312,300	6,291
Hoàn Kiếm District	18	5.29	160,500	30,340
Hoàng Mai District	14	40.32	385,000	9,549
Long Biên District	14	59.82	287,800	4,811
Nam Từ Liêm District	10	32.19	230,700	7,167
Tây Hồ District	8	24.39	164,100	6,728
Thanh Xuân District	11	9.09	282,000	31,023
Subtotal	157	307.8	3,398,400	11,041
17 rural districts (Huyện)				
Ba Vì District	30 + 1 town	423.00	279,000	660
Chương Mỹ District	30 + 2 towns	237.38	326,500	1,375
Đan Phượng District	15 + 1 town	78	160,100	2,053
Đông Anh District	23 + 1 town	185.62	380,800	2,052
Gia Lâm District	20 + 2 towns	116.71	270,700	2,319
Hoài Đức District	19 + 1 town	84.93	224,400	2,642
Mê Linh District	16 + 2 towns	142.46	222,600	1,563
Mỹ Đức District	21 + 1 town	225.25	190,500	846
Phú Xuyên District	26 + 2 towns	171.43	204,700	1,194
Phúc Thọ District	22 + 1 town	118.63	180,100	1,518
Quốc Oai District	20 + 1 town	151.13	184,100	1,218
Sóc Sơn District	25 + 1 town	304.76	334,200	1,097
Thanh Trì District	15 + 1 town	63.49	234,400	3,692
Thanh Oai District	20 + 1 town	123.87	195,300	1,577
Thạch Thất District	22 + 1 town	187.44	203,000	1,083
Thường Tín District	28 + 1 town	130.41	244,000	1,871
Ứng Hòa District	28 + 1 town	188.18	201,700	1,072
Subtotal	391 + 21 towns	2,932.69	4,036,100	1,376
Total	**563 + 21 towns**	**3,358.92**	**7,582,300**	**2,257**

Source: Hanoi Statistical Yearbook 2016 arget district



Source: https://sites.google.com/a/aag.org/mycoe-servirglobal/_/rsrc/1468867471299/dieu-thuy-tran/resize_HN.png

Figure 2-9 Hanoi City Map



Source: https://sites.google.com/a/aag.org/mycoe-servirglobal/_/rsrc/1468867471299/dieu-thuy-tran/resize_HN.png

Figure 2-10 Hai Phong City Map

Table 2-25 Selected Districts for On-site Treatment Field Survey in Hai Phong

District	Number of wards (communes and towns)	Area (km²)	Population	Density (people/km²)
Dương Kinh	6 wards	46.8	55,100	1,178
Đồ Sơn	7 wards	45.9	48,500	1,056
Hải An	8 wards	103.7	114,200	1,101
Kiến An	10 wards	29.6	110,700	3,736
Hồng Bàng	11 wards	14.5	107,000	7,389
Ngô Quyền	13 wards	11.3	173,700	15,314
Lê Chân	15 wards	11.9	223,000	18,729
Sub-Total (Urban Districts)	70 wards	263.7	832,200	3,156
An Dương	1 town + 15 communes	104.2	176,000	1,689
An Lão	2 towns + 15 communes	117.7	145,200	1,233
Bạch Long Vĩ	-	3.1	1,100	346
Cát Hải	2 towns + 10 communes	325.6	32,500	100
Kiến Thụy	1 town + 17 communes	108.9	138,800	1,275
Tiên Lãng	1 town + 22 communes	193.4	152,200	787
Vĩnh Bảo	1 town + 29 communes	183.3	179,400	979
Thủy Nguyên	2 towns + 35 communes	261.9	323,400	1,235
Sub-Total (Rural Districts)	10 towns + 143 communes	1,298.1	1,148,600	885
Total	**70 wards, 10 towns, 143 communes**	**1,561.8**	**1,980,800**	**1,268**

Source: Hai Phong Statistical Yearbook 2016 : Target district

(c) Results of Interview Survey

According the method mentioned above, JST conducted the interview survey from 10t December 2017 to 9 January 2018.

Source: JST

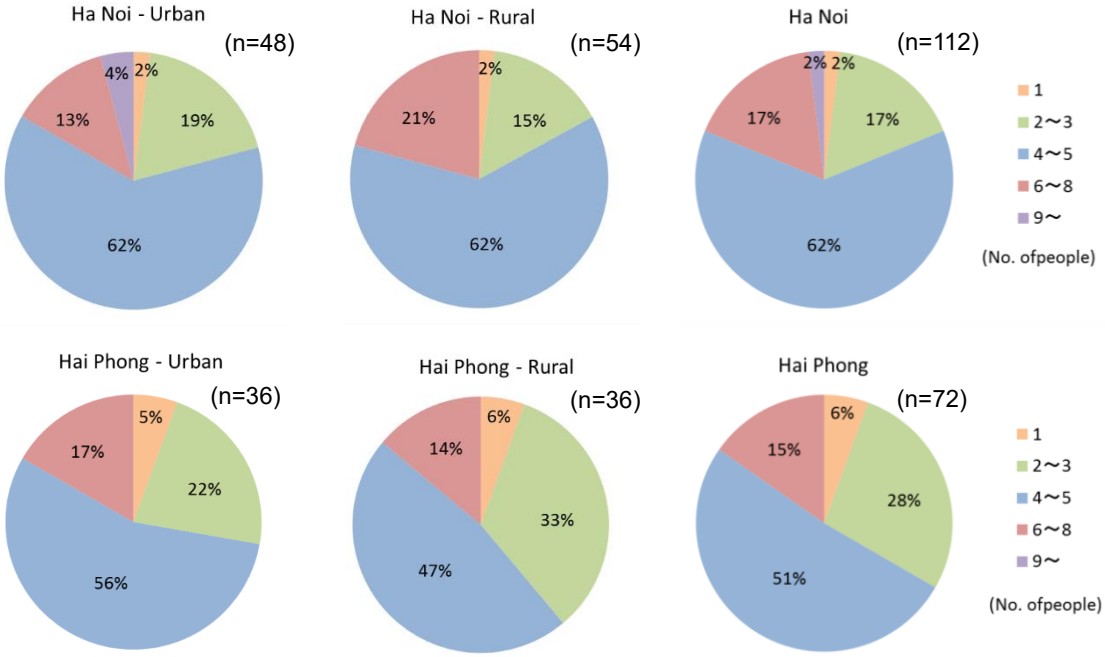
Photo 2-1 Examples of Conducting Interview Survey in Ha Noi

c.1) Basic Information of Statistical Data

<u>Number of People in each Household</u>

The results of arranging the number of the families in each area are shown in Figure 2-12. According to these results, the households of 4 - 5 people occupies approximately 60% of the total in the both of urban area and rural area in Hanoi.

The similar tendency is recognized in Hai Phong, but the ratios for the household of 4 - 5 people are smaller than Hanoi's.

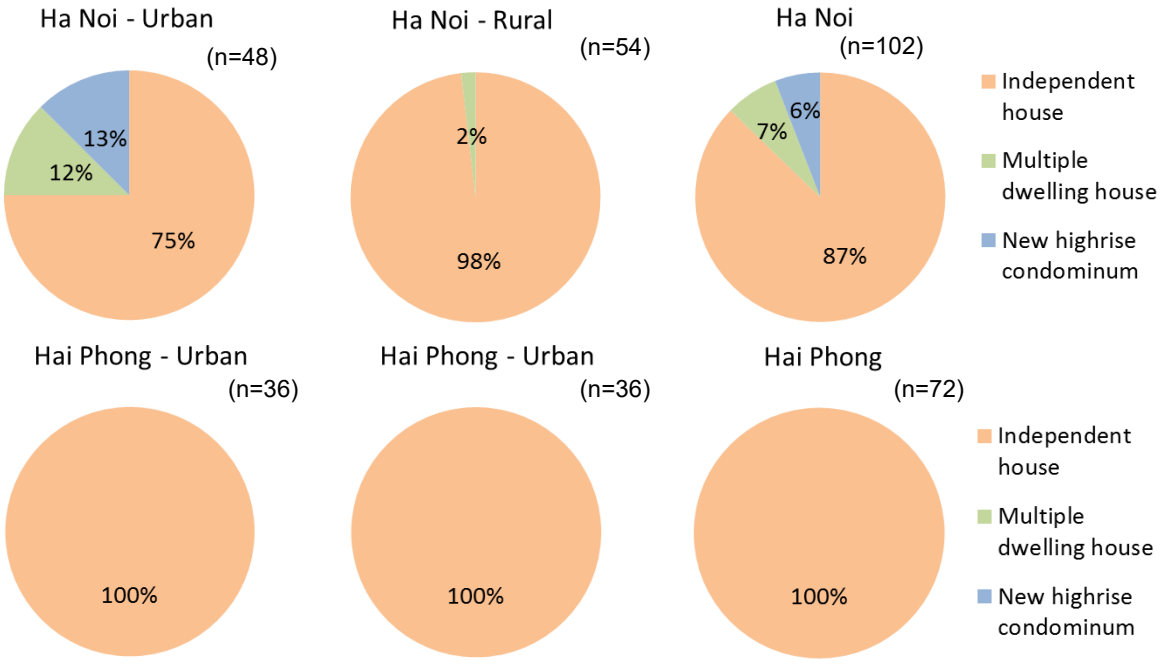


Source: JST

Figure 2-11 Ratio of Number of People per Household in Hanoi and Hai Phong

Type of House

Regarding type of house, all of houses are independent houses in Hai Phong, whereas some high-rise condominiums and multiple-dwelling houses are selected in the urban area of Ha Noi as shown in Figure 2-13.



Source: JST

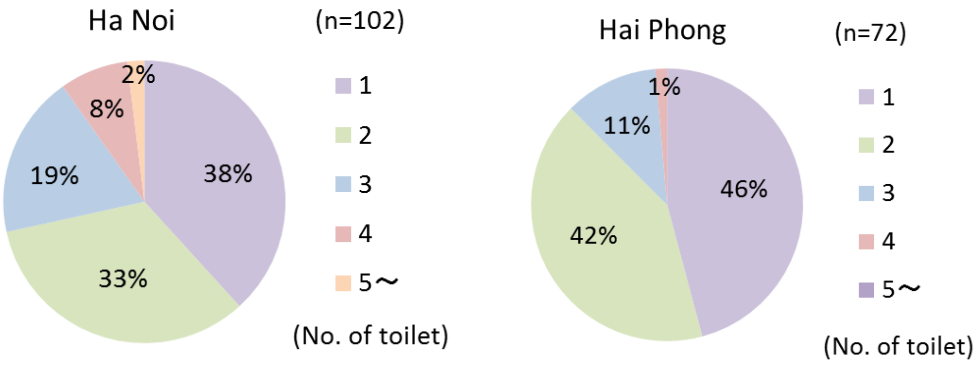
Figure 2-12 Ratio of House Type in Ha Noi and Hai Phong

c.2) Results of Interview Survey (for Households)

Number of Toilet per Household

As for the number of toilets in households, according to the result of the interview survey, around 70% of households have one or two toilets in Ha Noi. Approximately 30% of households in Ha Noi have over 3 toilets, because such houses have many floors due to narrow building space.

On the other hand, households having one or two toilets is over 80% in Hai Phong.

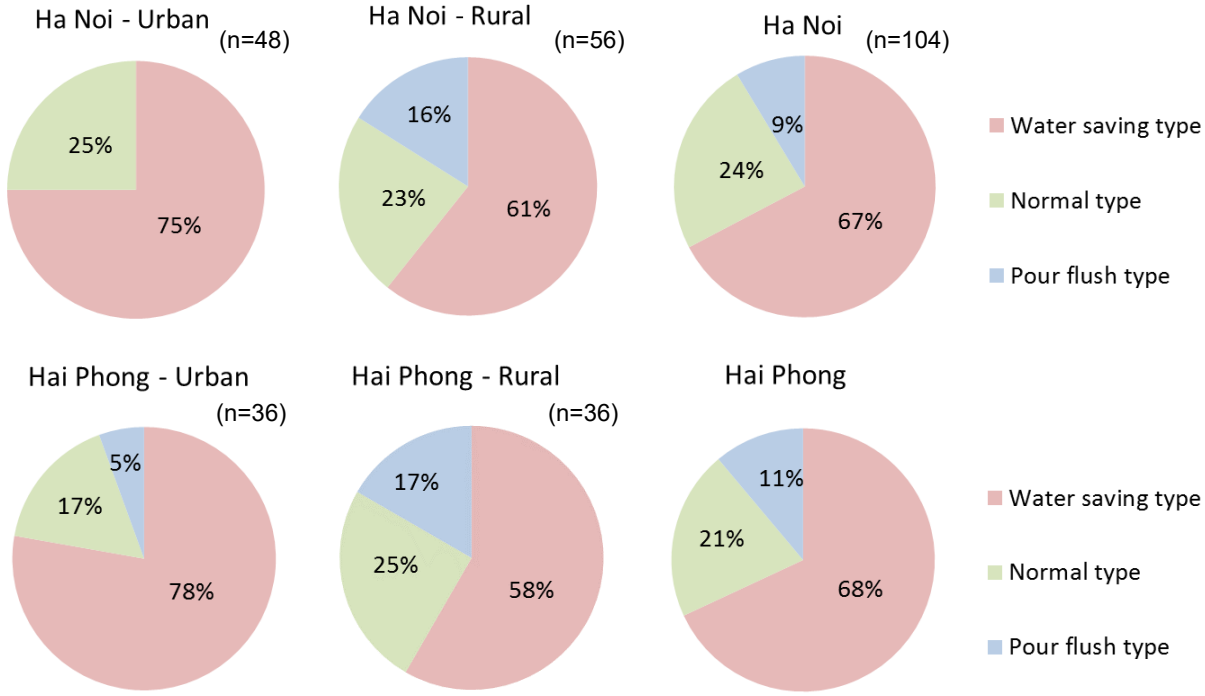


Source: JST

Figure 2-13 Number of Toilet per Households in Ha Noi and Hai Phong

Type of Toilet Facility (Multiple Answers are Existed)

Regarding the type of toilet facility, in the urban areas of both cities, over 70% of households use water-saving type of toilet. This tendency is stronger in the urban area than the rural area in both cities.



Source: JST

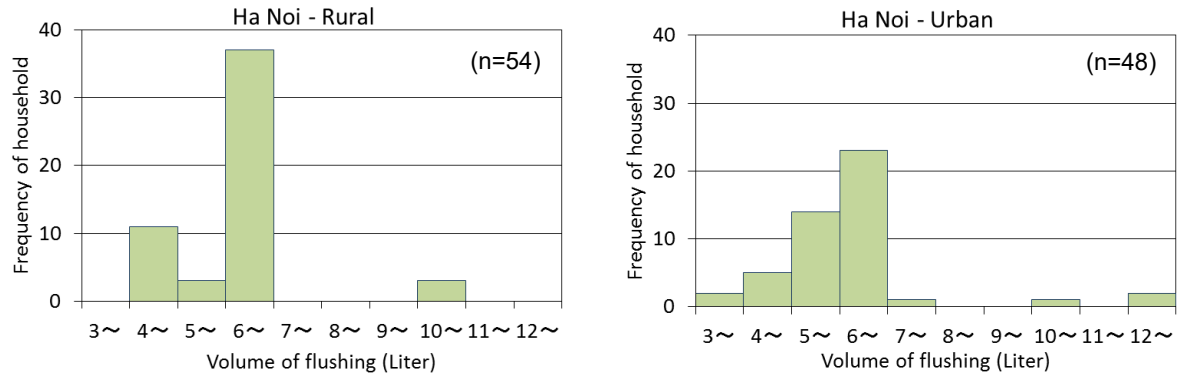
Figure 2-14 Type of Toilet Facilities for Households in Ha Noi and Hai Phong

Water Volume per Flush of Toilet

The interview result of the amount of flushing water per time for each toilet in Ha Noi is shown in Figure 2-16. In both the urban area and the rural area in Ha Noi, there are the highest value of 6 L/flush.

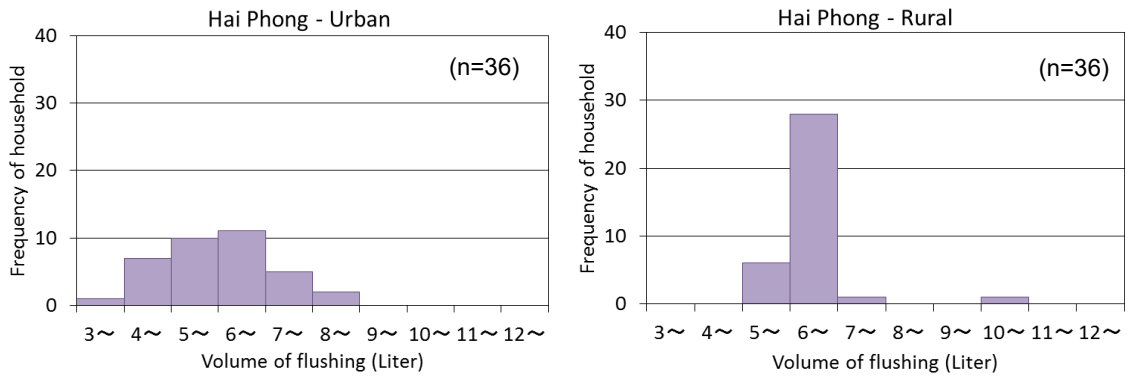
As shown in Figure 2-17, a similar result for the amount of flushing water per time for each toilet was obtained in the rural area of Hai Phong.

On the other hand, in the urban area of Hai Phong, 4 – 6 L/flush was highest.



Source: JST

Figure 2-15 Distributions of Water Volume per Flush in Toilet in Ha Noi



Source: JST

Figure 2-16 Distributions of Water Volume per Flush in Toilet in Hai Phong

As a reference, a toilet stool made by INAX with many settings and a toilet stool made by Vietnamese manufacture Viglacera used mainly in the suburbs of Hanoi and Hai Phong are shown in in the following photos.

■Product made by INAX ■Product made by Viglacera

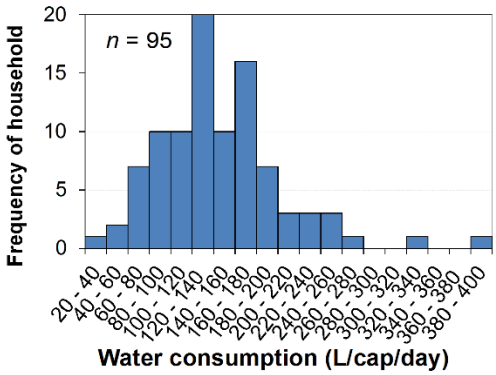
Source: JST

Photo 2-2 Example of a Toilet Stools with Many Settings (Left Side)

Water consumption

Regarding water consumption, according to the survey result conducted by Dr. Anh in Ha Noi[1)], residents mostly consumed between 100-170 L/cap/day peaking at 140 L/cap/day, then followed by 170 L/cap/day and 100 L/cap/day, respectively. The average consumption amount of this study was 146 58 L/cap/day. Median value was 133 L/cap/day.

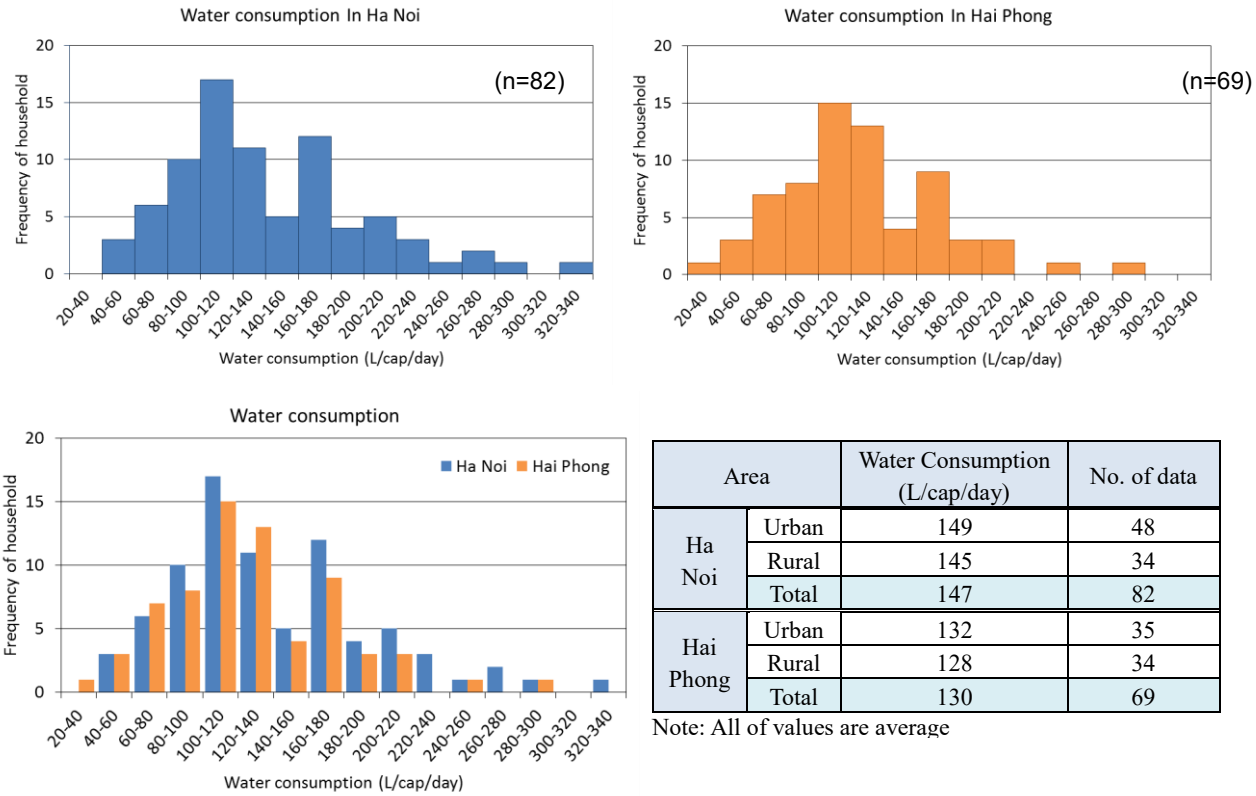
According our survey, water consumption is almost 150 L/cap/day in the urban area in Hanoi. In the urban area in Hai Phong it is around 130 L/cap/day. The difference is not



Source: Viet-Anh Nguyen, 2015. Wastewater management and technology needs in Vietnam

Figure 2-17 Survey Result of Water Consumption in Hanoi

big for water consumption between the urban area and rural area in both cities. The result of Hanoi from our survey is very similar to Dr. Anh's result.



Area		Water Consumption (L/cap/day)	No. of data
Ha Noi	Urban	149	48
	Rural	145	34
	Total	147	82
Hai Phong	Urban	132	35
	Rural	128	34
	Total	130	69

Note: All of values are average

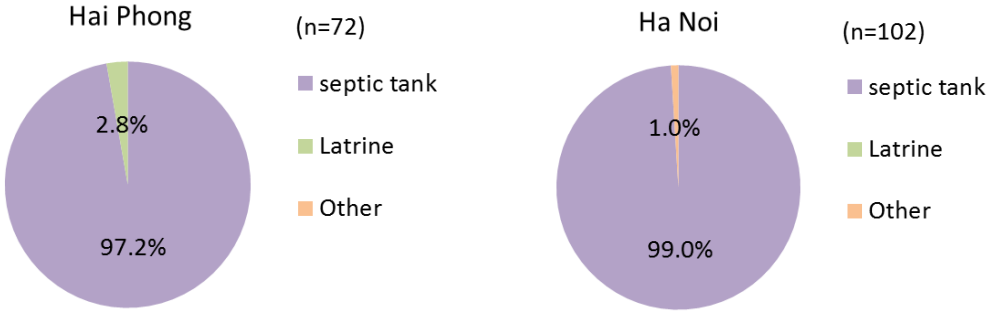
Source: JST

Figure 2-18 Distributions of water consumption in Hanoi and Hai Phong

Type of Wastewater Treatment Facility for Households

According the results of this interview survey, most households use septic tanks. Two latrine types were identified in the rural area in Hai Phong only.

Wastewater treatment facilities which added high processing facilities to the septic tank were identified in the urban area in Hanoi, for a high-rise condominium which was constructed in 2017.



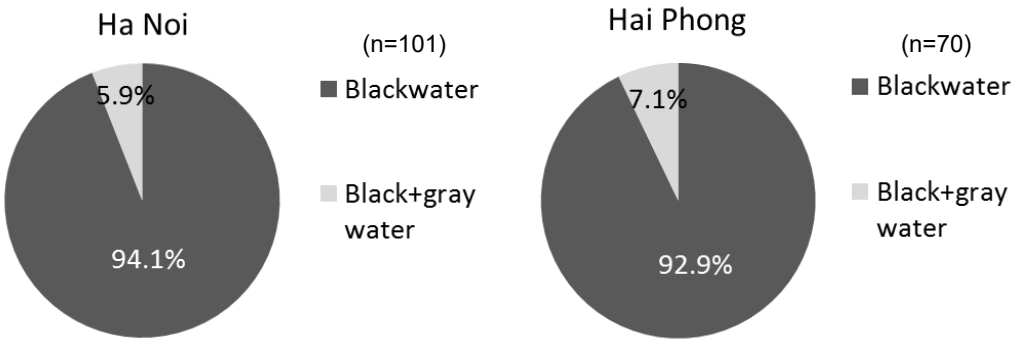
Source: JST

Figure 2-19 Type of On-site Wastewater Treatment Facility for Households in Hanoi and Hai Phong City

Type of Wastewater Treated by Septic Tank

Regarding the type of wastewater flows into the septic tank, most of septic tanks treat blackwater only as shown in Figure 2-21.

Almost 6% of septic tanks in Ha Noi and 7% of septic tanks treat black water and greywater according to our interview survey.



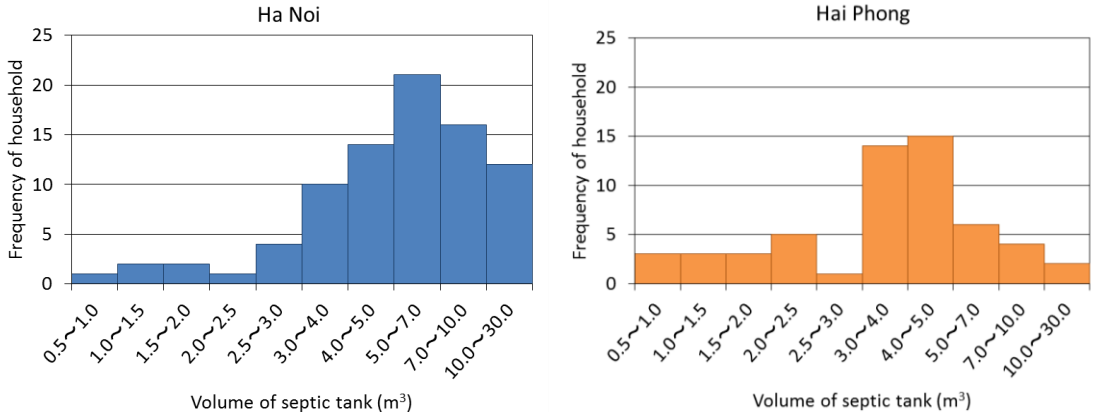
Source: JST

Figure 2-20 Type of Wastewater Treated by Septic Tank in Ha Noi and Hai Phong

Volume of Septic Tank

As for the volume of septic tank, most septic tanks are from 5 to 7 m^3 in Hanoi.

And in Hai Phong, most septic tanks are from 4 to 5m^3.



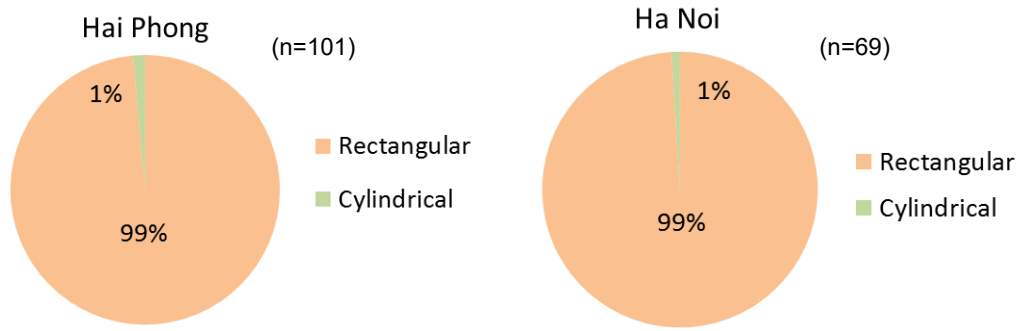
Source: JST

Figure 2-21 Distributions of Estimated Volume of Septic Tanks in Ha Noi and Hai Phong

Shape of Septic Tank and Number of Chamber

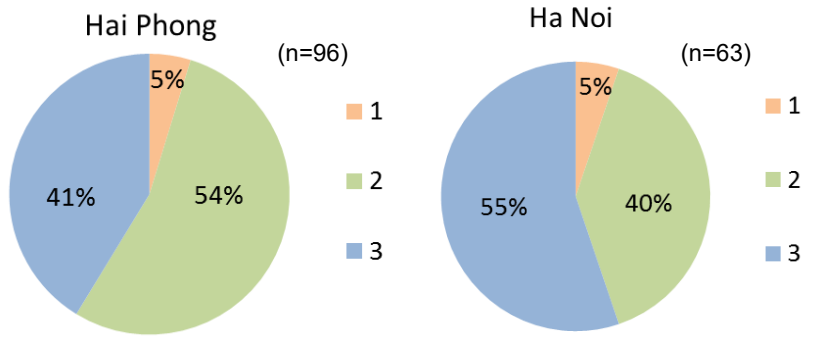
As shown in Figure 2-23, the shape of most septic tanks are rectangular in both of Ha Noi and Hai Phong.

Regarding the number of septic tank chambers, 55% consist of three chambers in Ha Noi as shown in Figure 2-24. On the other hand, two chamber type of septic tank occupies 54% of the total in Hai Phong, which is the biggest percentage of all. The single chamber type of septic tank is rare in both cities.



Source: JST

Figure 2-22 Ratio of Shape of Septic Tanks in Ha Noi and Hai Phong



Source: JST

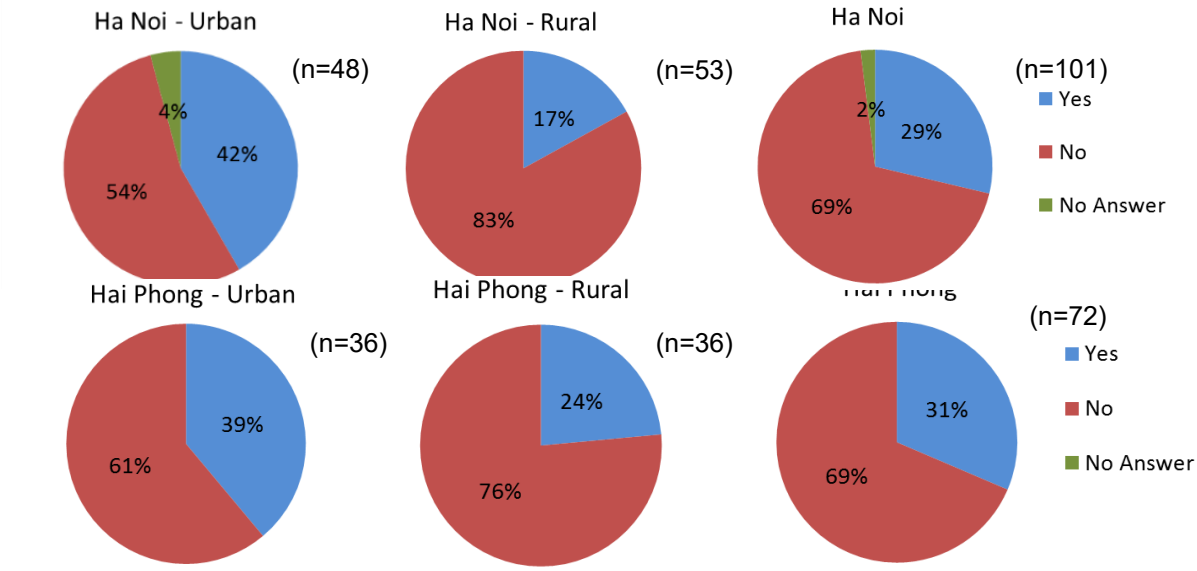
Figure 2-23 Ratio of Number of Chambers in Septic Tanks in Ha Noi and Hai Phong

Implementation Situation of Desludging

According to results of our interview survey, 43% of households in the urban area of Ha Noi have experience of desludging. On the other hand, only 15% of households in the rural area of Ha Noi have desludging, although the urban area is better than the rural area about desludging.

The situation of desludging in the urban area of Hai Phong is similar to the urban area of Ha Noi.

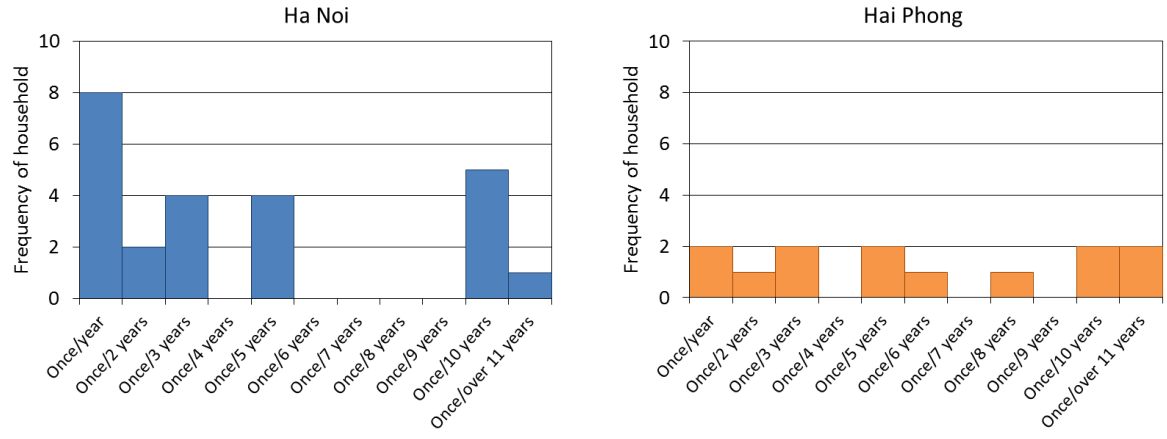
As for deluding in the rural area, Hai Phong is better than Ha Noi since 24% of households have desludging.



Source: JST

Figure 2-24 Implementation Situation of Desludging in Hanoi and Hai Phong

Regarding the desludging frequency, the highest frequency of once per year is in Ha Noi. On the other hand, there is no central tendency of the desludging frequency in Hai Phong.



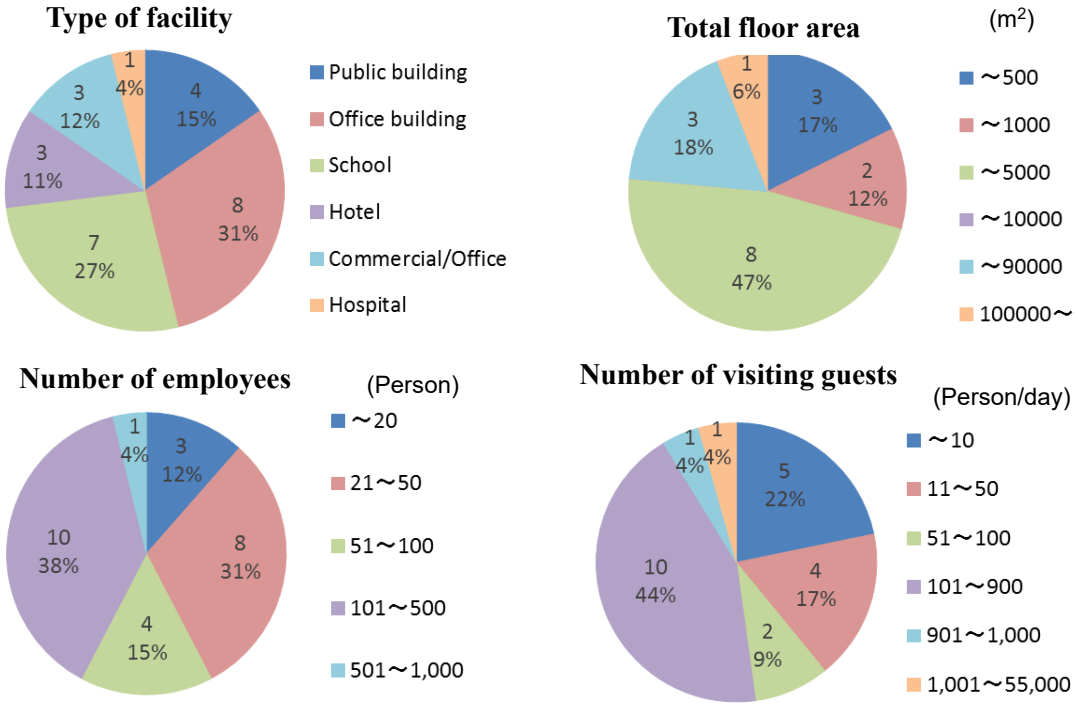
Source: JST

Figure 2-25 Distribution of Desludging frequency in Ha Noi and Hai Phong

c.3) Results of interview survey (for public facilities)

Specifications of target public facilities

JST conducted the interview survey for schools, office buildings etc., and total 26 public facilities. The specifications of each facility are shown in Figure 2-27.



Source: JST

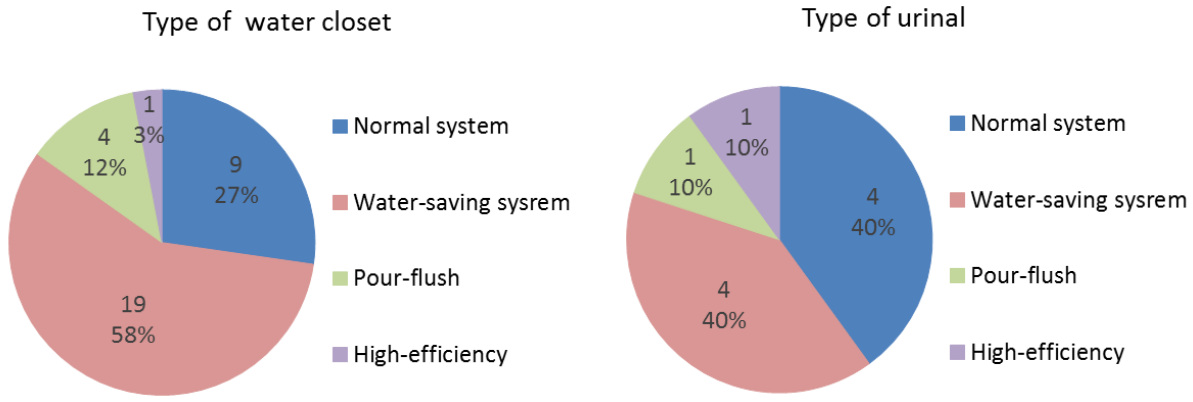
Figure 2-26 Specifications of target public facilities

Source: JST

Figure 2-27 Specifications of target public facilities

Types of toilet facilities

According to results of our interview survey, the types of water closet and urinal are shown in Figure 2-29, with 58% of water closets having water saving system. As for urinal, 40% of urinals has water saving system, and also the normal system urinal has the same percentage. As for the pour flush type, around 10% still exist.

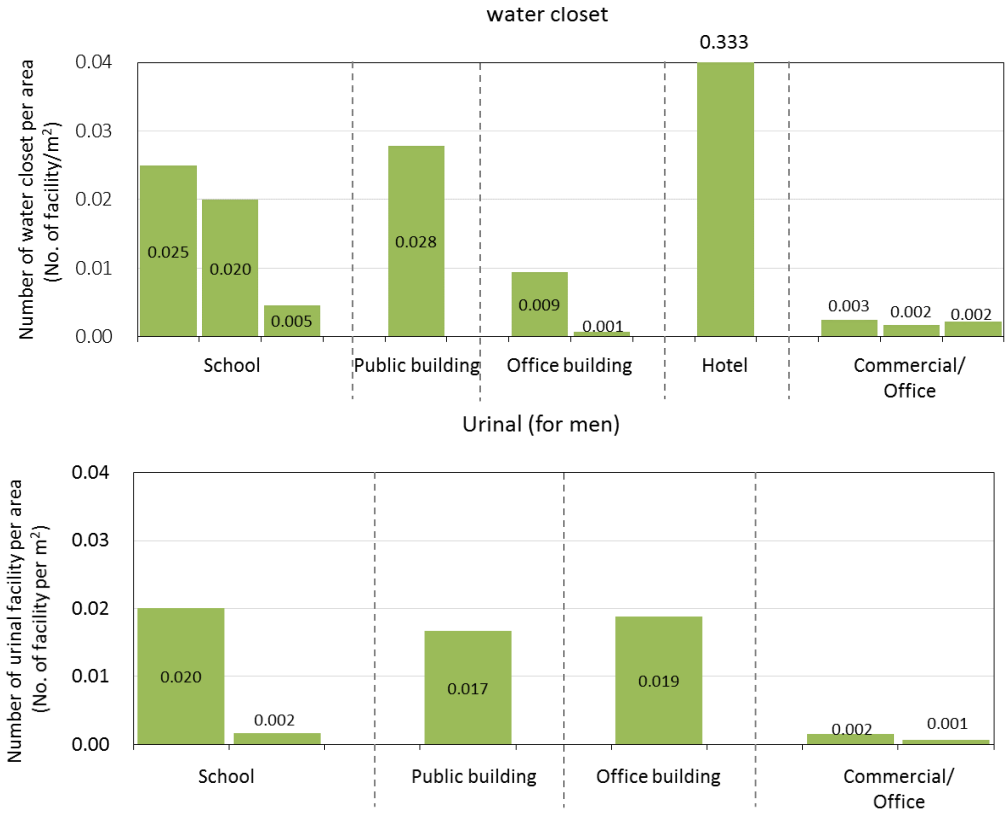


Source: JST

Figure 2-28 Ratio on type of toilet facility

Number of toilet facilities per floor area

Regarding the number of toilet facilities per floor area, the results obtained are shown in Figure 2-30.

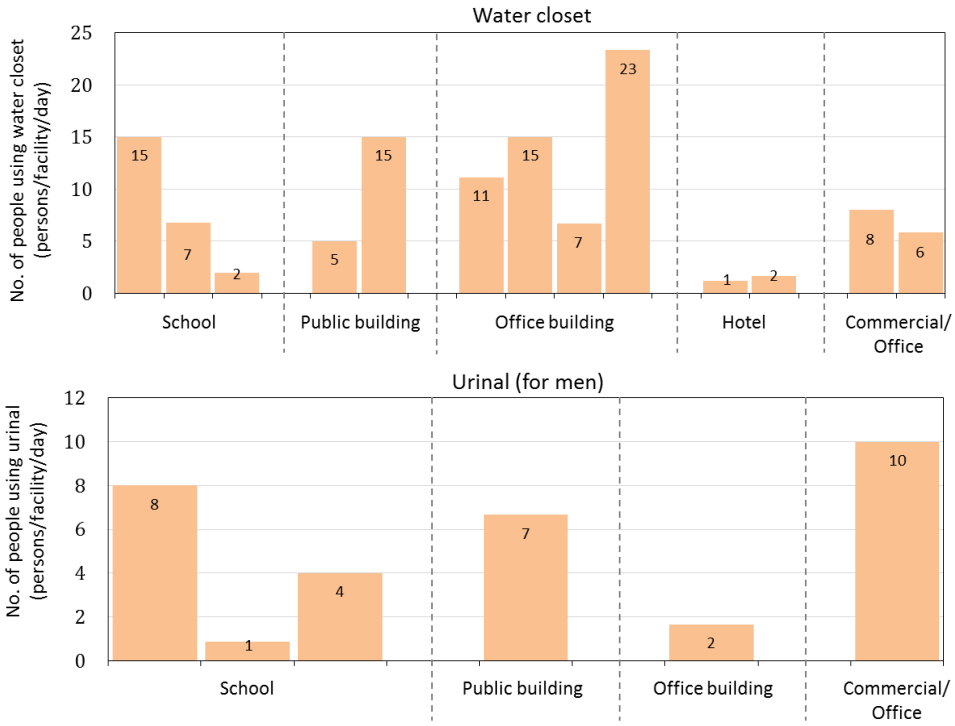


Source: JST

Figure 2-29 Number of toilet facilities per area by type of building

Number of people using toilet facilities

As for the number of people using toilets, the results are shown in Figure 2-31. The value depends on the type of facility.

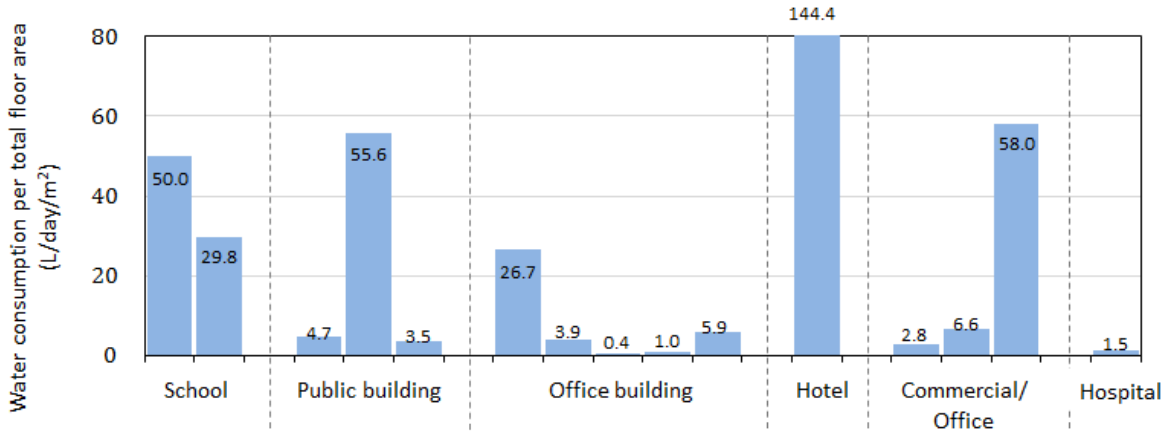


Source: JST

Figure 2-30 Number of people using toilet facilities

(d) Water Consumption

Regarding water consumption by type of public facility, water consumption per day per total floor area was calculated as shown in Figure 2-32.



Source: JST

Figure 2-31 Water consumption by tupe of public facility

(e) Sampling and Analysis of Discharged Wastewater

e.1) Selecting target sites

Among 49 sites (43 households + 6 public facilities) which are allowed to discharge wastewater sampled in the interview surveys, 20 septic tanks were collected for discharged wastewater sampling and analyzing discharged wastewater quality. Both types of tanks treating (i) black water only and (ii) black and grey water were targeted. Also in order to sellect 20 septic tanks, type of house and frequency of desludging were considered.

The results of the selected 20 septic tanks are shown in from Table 2-26 to 2-28. In the result, two households living in the multiple-dwelling houses were selected in Ha Noi. Also two households living in high-rise condominiums were selected in Ha Noi. In Hai Phong, 6 households living in their own indendent houses were selected.

As for type of wastewater, 4 households that treat black water and grey water by septic tank were selected. Of them, 3 househplds are locatied in Ha Noi, and consist of one high-rise condominium, one multiple dwelling house nad one independent house. Another is an independent house located in Hai Phong. Regarding public facilities, 3 facilities were selected as shown in Table 2-28.

The locations of the selected sites are shown in Figure 2-33 (Ha Noi) and Figure 2-34 (Hai Phong).

Table 2-26 List of Selected Households in Hanoi for Discharged Wastewater Sampling

No.	Ref. No.	area	House type	Wastewater	Desludging	Frequency of desludging
1	HN1BD5	urban	Own built/Independent housing	Black water	Yes	Every 3 years (2015)
2	HN1DD6	ditto	Multiple dwelling house	Black water	Yes	Once a year (2016)
3	HN1HM1	ditto	Own built Independent housing	Black water	No	-
4	HN1HM5	ditto	Own built; Independent housing	Black water	Yes	1 time/3 years (2015)
5	HN1HM6	ditto	New high-rise condominium	Black water	Yes	Once a year (2017, Jan)
6	HN1TX1	ditto	Own built; Independent housing	Black water	Yes	1 time/10 years (2005)
7	HN1TX5	ditto	New high-rise condominium	Black water/Grey	No	-
8	HN2DA7	rural	Own built, Independent housing	Black water	No	-
9	HN2TT1	ditto	Own built, Independent housing	Black/Grey water	No	-
10	HN2TR4	ditto	Own built; Independent housing	Black water	Yes	1 time/5 years (2013)
11	HN2TR5	ditto	Multiple dwelling house	Black/Grey water	Yes	1 time/1-2 years (2016)

Source: JST ( ): latest year of desludging

Table 2-27 List of Selected Households in Hai Phong for Discharged Wastewater Sampling

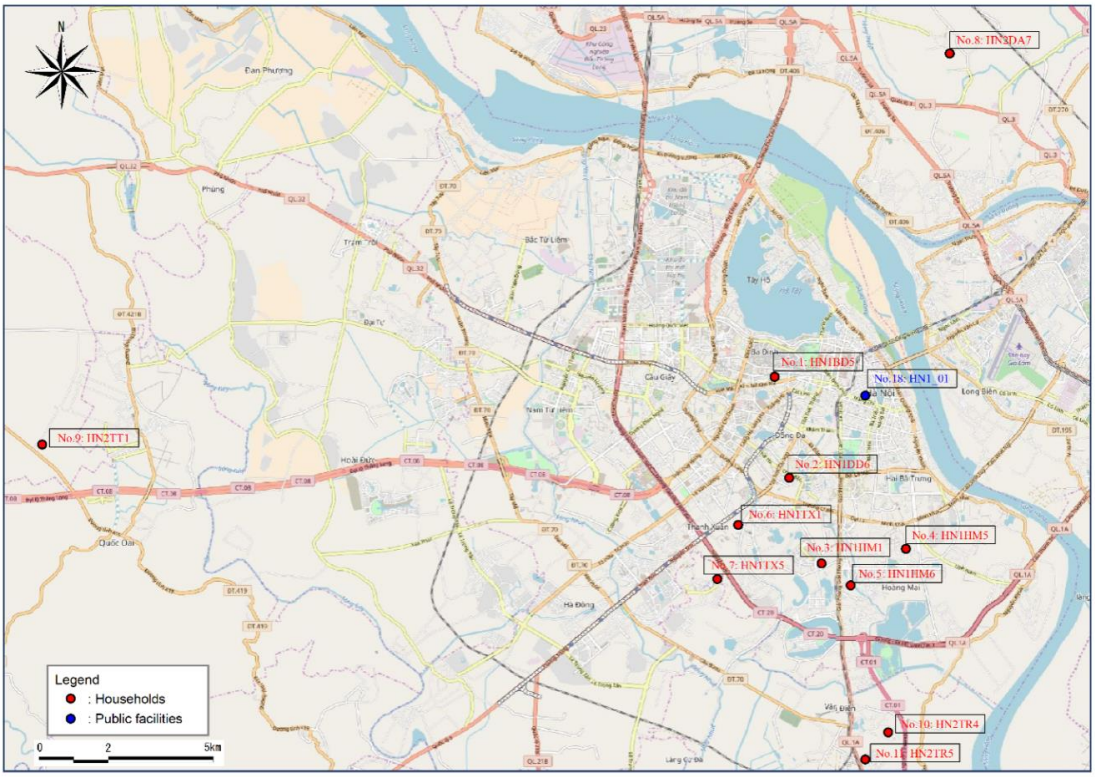
No.	Ref. No.	area	House type	Wastewater	Desludging	Frequency of desludging
12	HP1KA5	urban	Own built, Independent housing	Black water+ grey water	No	-
13	HP1NQ8	ditto	Rent, Independent housing	Black water	No	-
14	HP1LC2	ditto	Own built, Independent housing	Black water	Yes	Every 8 years (2011)
15	HP2AD4	rural	Own built; Independent housing	Black water	No	-
16	HP2VB5	ditto	Own built; Independent housing	Black water	Yes	1 time/3 years (2015)
17	HP2TN3	ditto	Own built; Independent housing	Black water	No	-

Source: JST ( ): latest year of desludging

Table 2-28 List of Selected Public Facilities in Ha Noi and Hai Phong for Discharged Wastewater Sampling

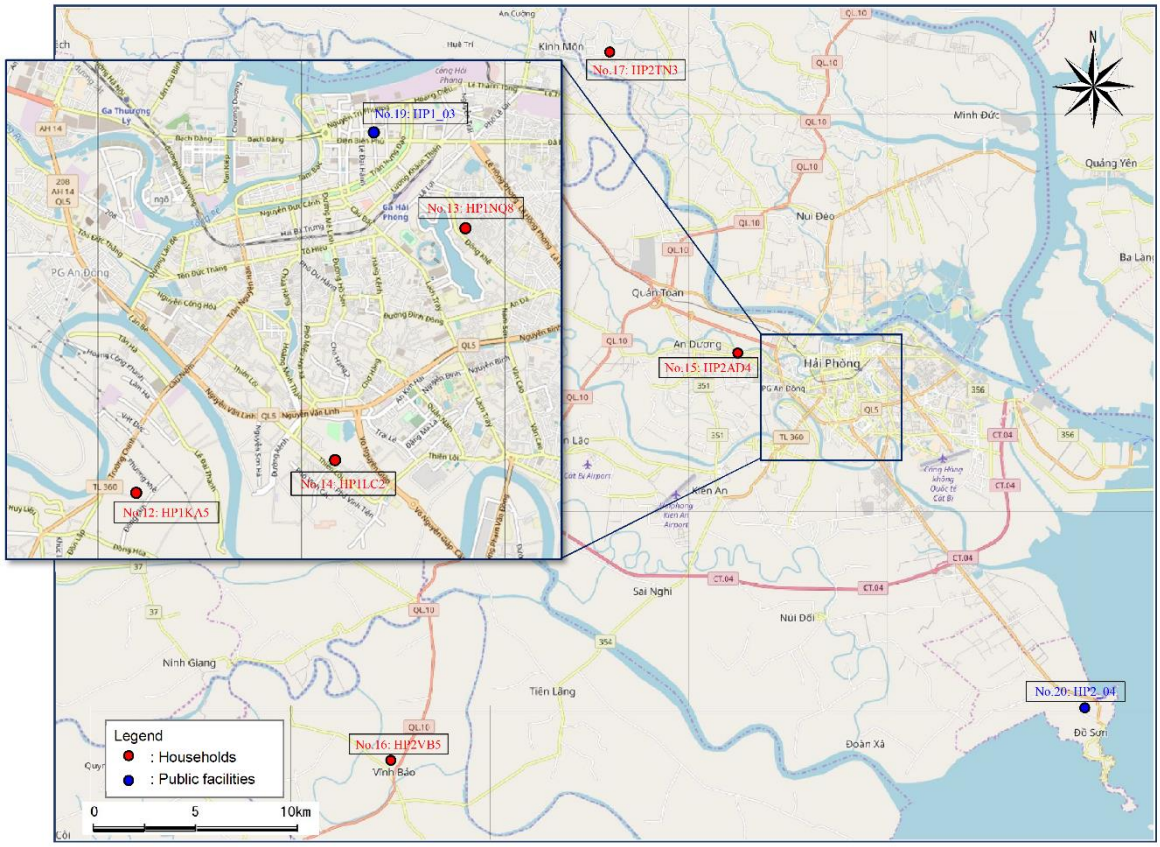
No.	Ref. No.	City	Facility type	wastewater	Desludging	Frequency of desludging
18	HN1_01	Hanoi	National library	Black water	Yes	Every 5 years (2014)
19	HP1_03	Haiphong	Cát bi Plaza (commercial)	Black water	Yes	Every 3 years (2016)
20	HP2_04	ditto	Hotel	Black water	Yes	Every year (2017, Jan)

Source: JST ( ): latest year of desludging



Source: JST

Figure 2-32 Locations of the selected sampling sites in Ha Noi



Source: JST

Figure 2-33 Locations of the selected sampling sites in Hai Phong

e.2) Methodology of sampling

The wastewater sample are collected as composit samples by mixing 4 of discharged wastewater samples during a day. The number of composit samples to be analyzed will be 20.

Analyzied parameters

The parameters to be analyzed are as follows:

a) Water temparature, b) pH, c) BOD, d) CODcr, e) T-SS, f) T-P, g) T-N, h) NH_4-N,i) Total E. coliform.

Protocol for sampling the discharged wasterwater

- Sampling point: Outlet point of pipe from septic tank, making sure not to make mistake between black water pipe and grey water pipe.
- Sample type: Within 24 hours combining from **4 grab samples** at **4 sampling times** as shown in Table 2-29.

Table 2-29 Sampling Time

6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h
1st grab sample					2nd grab sample					3rd grab sample			4th grab sample		

Source: JST

- Sampling Protocol

Step 1: Collecting black water from outlet pipe into the bucket
Step 2: Measure temperature and pH of the sample
Step3: Pouring 300 mL of sample from the bucket to the 500 mL cylinder
Step 4: Transfer 300 mL of sample from the cylinder to 1.5 L bottle, close the cap and store in refrigerator. × **4** times
Step 5: Pouring 70 mL of sample from the bucket to the 100 mL cylinder
Step6: Transfer 70 mL of sample from the cylinder to Pasteurized bottle, close the cap and store in refrigerator

Repeat **from step 2 to step 6, 4 times** corresponding to 4 grab samples of 4 sampling time within a day. After collecting 4 grab samples and combining into 1.5 L bottle and Pasteurized bottle, labeling the Pasteurized bottle, and taking 2 sub samples from the combined sample of 1.5 L bottle as follows:

Step 7: Transfer sample from 1.5 L bottle to 0.5 L bottle until full, close the cap and label the bottle.

Step 8: Transfer sample from 1.5 L bottle to 2/3 level of the 0.5 L bottle, adding 5 mL of condensed H_2SO_4, continuing filling sample until full , close the cap, and label the bottle.

Step 9: Store 3 sample bottles: 1 Pasteurized bottle (for coliform determination), 1 bottle without chemical preservation (for determination of TSS, BOD5, NH_4^+), and 1 bottle with H_2SO_4 conservation (for determination the remained parameter).

- Finish the sampling.

After finishing the sampling, clean the device, tightly close the bottle of condensed H_2SO_4, and arrange everything for transportation to the Lab.

e.3) Conducting sampling the discharged wasterwater from septic tank

According to the methodology and conditions mentioned above, the sampling survey of effluent from septic was conducted from 16 to 23 January 2018. Analyzing water quality of each sample is ongoing.

Source: JST

Photo 2-3 Photo Example of sampling of effluent from septic tank in Ha Noi(Independent house: 2018/1/16)


Source: JST

Photo 2-4 Photo Example of sampling of effluent from septic tank in Hai Phong (Independent house: 2018/1/20, treated water flows into wetland)

e.4) Results of analyzing effluent water quality of septic tank

The results of analyzing effluent water quality of septic tanks in each facility are shown in Table 2-30. In order to show the situation of analysis, relationships between each water quality were arranged, and the results are shown in Figure 2-35.

According to these results, good relationships exist between water quality related organic matter (e.g. BOD, COD and SS). Also the parameters related nutrients have relatively good relationships.

As for the relationship between BOD and Total Coliform, the tendency to raise the concentration of Total E. coliform is recognized when the concentration of BOD is high.

Situation of meeting standard (QCVN 14/2008/BTNMT: Class B)

- As shown in Table 2-30, all pH values meet the standard.
- In 7 of 20 septic tanks, SS concentration of effluent meets the standard
- As for BOD, none of the septic tanks meet the standard, and highest of all, BOD concentration is over 1,000 mg/L in the septic tanks of the households located in the urban area in Hai Phong and the National Library in Ha Noi. In both areas, septic tanks have not been desludged for a long time.
- According to this survey results, none of septic tanks meet the standard for Total E. Coliform.

Relationship between desludging and effluent water quality of septic tank

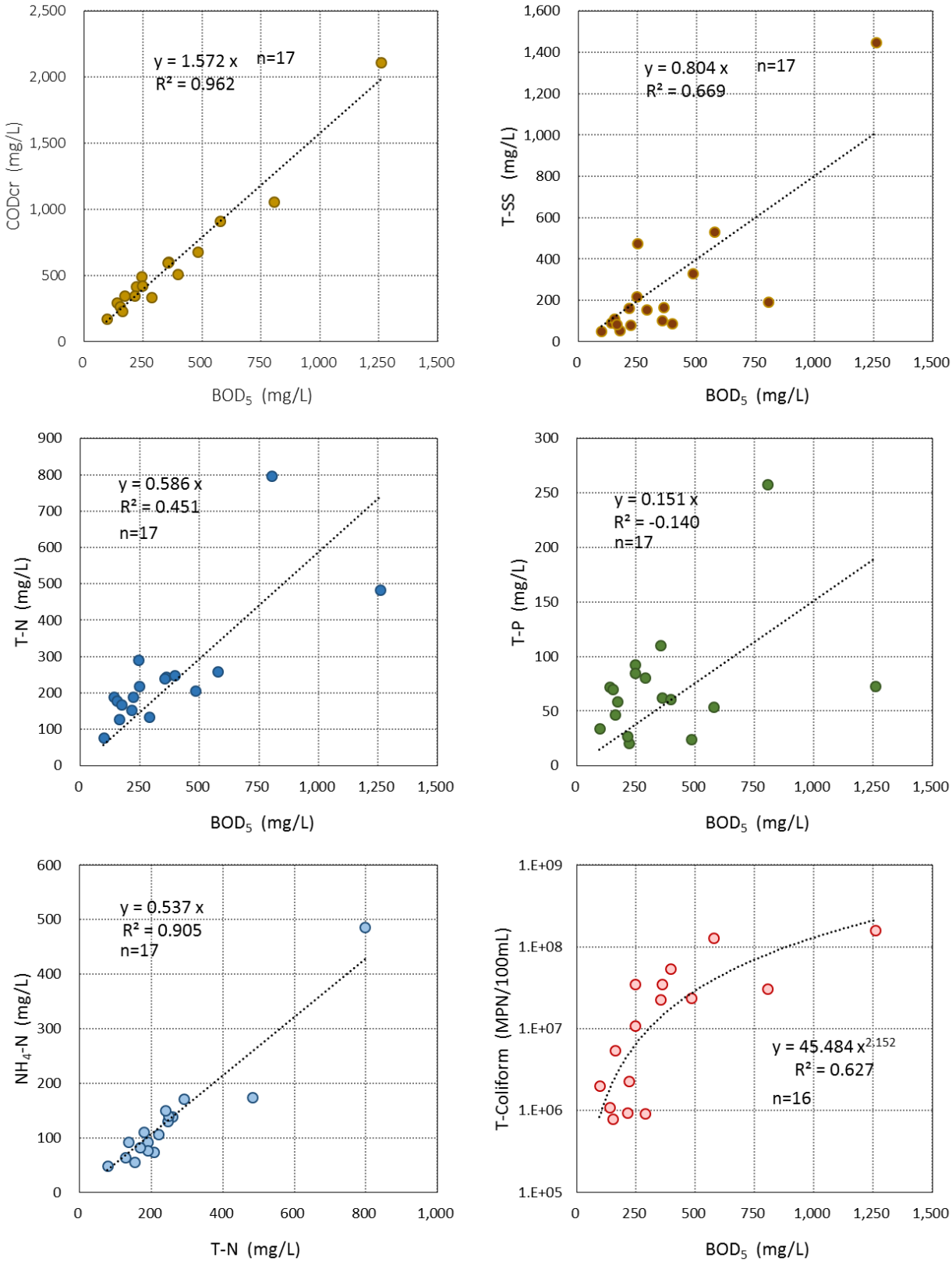
- The relationships between desludging interval and BOD and COD concentration are shown in Figure 2-36. In independent houses treating only black water by septic tank, good relationships between them are recognized relatively.
- That is to say, the effluent BOD concentration of septic tank shows a tendency to be lower when desludging interval is shorter. Also as for COD, the same tendency is recognized.
- In addition, JST studied the relationship between frequencies of desludging and the effluent BOD and COD concentration, and their results are shown in Figure 2-37.

Table 2-30 Analyzing results of effluent water quality for 20 selected facilities

No	Ref. No.	Date of sampling (y/m/d)	Water temparature, ^{O}C	pH	Parameters analyzed						
					BOD_5 ($20^{O}C$)	COD	TSS	NH_4^+ - N	Total P	Total N	Total E. Coliform
					mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MPN/100mL
					TCVN 6001-1:2008	SMEWW 5220C:2012	TCVN 6625:2000	SMEWW 4500NH_3F:2012	TCVN 6202:2008	TCVN 6638:2000	TCVN 6187-2:1996
1	HN1BD5	18/01/18	17 - 20	7 - 8	244	494	219	171	93	290	1.1×10^{7}
2	HN1DD6	18/01/16	15 - 19	7	576	912	533	139	54	259	1.3×10^{8}
3	HN1HM1	18/01/16	14 - 18	6 - 7	359	607	168	131	62	245	3.5×10^{7}
4	HN1HM5	18/01/20	16 - 21	7 - 8	138	298	92	92	72	189	1.1×10^{6}
5	HN1HM6	18/01/18	18 - 22	7	96	173	53	49	34	77	2.0×10^{6}
6	HN1TX1	18/01/16	15 - 19	7	483	680	332	74	24	207	2.4×10^{7}
7	HN1TX5	18/01/16	15 - 18	7	219	417	83	77	21	190	2.3×10^{6}
8	HN2DA7	18/01/23	18 - 21	7 - 8	152	269	110	111	70	178	7.9×10^{5}
9	HN2TT1	18/01/18	17 - 21	7	172	346	54	83	59	167	4.6×10^{8}
10	HN2TR4	18/01/16	18 - 21	7 - 8	396	510	90	140	61	248	5.4×10^{7}
11	HN2TR5	18/01/23	16 - 22	7 - 8	804	1,056	194	487	258	797	3.1×10^{7}
12	HP1KA5	18/01/21	17 - 22	7 - 8	287	336	155	92	81	135	9.2×10^{5}
13	HP1NQ8	18/01/20	17 - 22	7 - 8	1,259	2,112	1,447	174	73	483	1.6×10^{8}
14	HP1LC2	18/01/21	17 - 22	7 - 8	353	600	103	150	110	239	2.3×10^{7}
15	HP2AD4	18/01/20	17 - 23	7	213	346	162	56	27	154	9.4×10^{5}
16	HP2VB5	18/01/20	16 - 20	7 - 8	161	234	85	64	47	128	5.4×10^{6}
17	HP2TN3	18/01/20	16 - 21	7 - 8	247	422	477	106	85	219	3.5×10^{7}
18	HN1_01	18/01/23	17 - 22	7	1,906	3,960	5,110	559	298	1,542	7.0×10^{7}
19	HP1_03	18/01/21	17 - 20	7 - 8	112	194	74	57	35	78	6.3×10^{6}
20	HP2_04	18/01/20	16 - 19	7 - 8	81	240	66	47	31	135	2.2×10^{6}
QCVN14/2008/BTNMT (Class B)				5 - 9	50	—	100	10	—	—	5.0×10^{3}

Source: JST

Notice: values in green letters meet the standard.



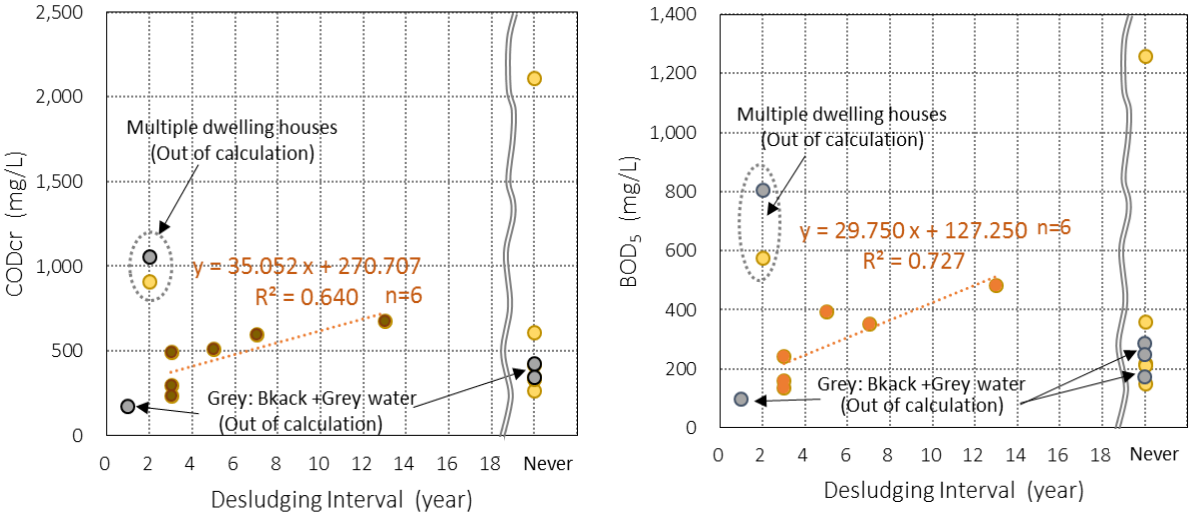
Source: JST

Figure 2-34 Relationships between effluent water quality from each septic tank

- By using frequency of desludging as an index of desludging condition, relationship between desludging and effluent water quality became clearer.

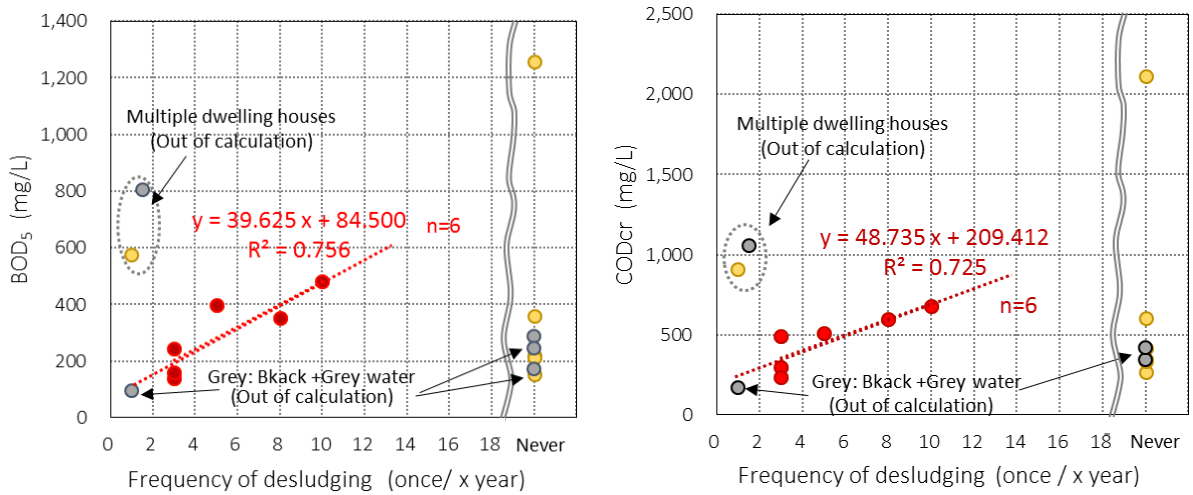
Summary of analyzing effluent water quality of septic tank at on-site treatment facility

- According to this survey results, the septic tank is not able to meet the BOD and Total E. Coliform standards (QCVN14/2008/BTNMT). Thus, septic tank is not good enough to treat domestic wastewater safely.
- On the other hand, desludging is very important to improve effluent water quality of septic tanks.



Source: JST

Figure 2-35 Relationship between desludging interval and effluent water quality from septic tank



Source: JST

Figure 2-36 Relationship between frequency of desludging and effluent water qualityfrom septic tank

- Although not sufficient as wastewater treatment systems, septic tanks are very important to improve or conserve public waters.
- From this point of view, it is important to promote desludging of septic tank strongly at the household level, and to develop concrete countermeasure that support citizens for desludging at the political level and financial level.

(f) Analyzing influent and effluent qualities of septic tank

f.1) Analysis case

Among the septic tanks identified by the interview survey, 3 septic tanks were selected for collecting inflowed/discharged wastewater samples, and analyzing inflowed and discharged wastewater quality. For the septic tanks to be selected, the following conditions tanks will be examined.

Table 2-31 Septic Tanks to be targeted for Inflowed and Dischaged Wastewater Analysis

Case	Grey water	Black water	Desludging
Septic tank No.1	-	Treat	Never
Septic tank No.2	-	Treat	Desludging oftenly
Septic tank No.3	Treat	Treat	Desludging oftenly

Source: JST

f.2) Implementation Methodology

Analyzed parameters

The parameters to be analyzed are as follows:

1. Flow rate, 2. Water temperature, 3. pH, 4. BOD_5, 5. COD_{cr}, 6. T-SS, 7. T-P, 8. T-N, 9. NH_4-N, 10. Total E. coliform.

Sampling period and frequency

For this survey, sampling will be conducted during 4 days as shown in Table 2-32. During the sampling period, the following sampling and analysis will be conducted.

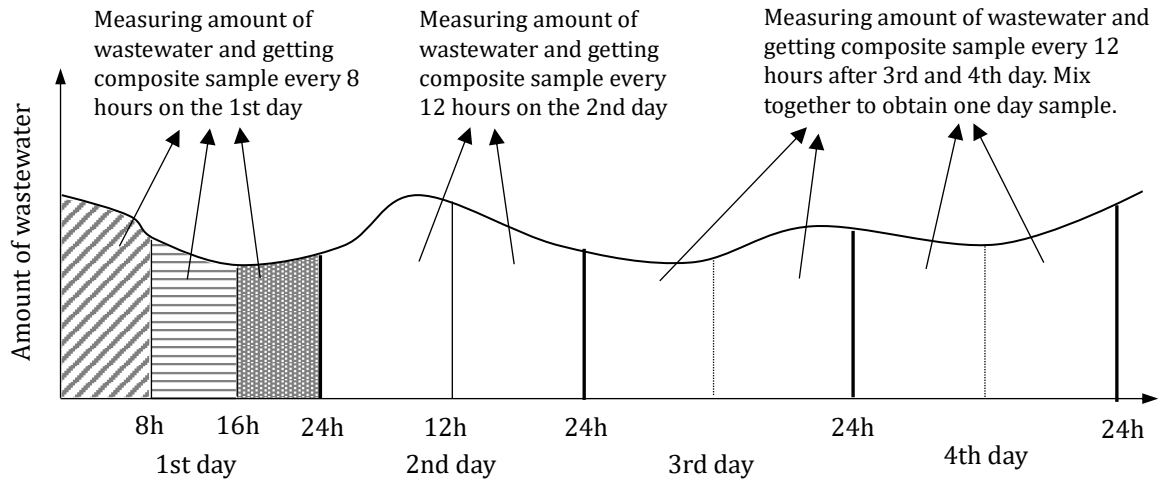
Table 2-32 Number of Samples to be analyzed for Inflowed and Dischaged Wastewater Analysis

Period	Sampling frequency	Number of Samples to be Analyzed (for 1 septic tank)								
		W.T.	pH	BOD	COD	T-SS	T-N	T-P	NH_4-N	T-E. Colif.
1st day	3 times per day	6	6	6	6	6	6	6	6	6
2nd day	2 times per day	4	4	4	4	4	4	4	4	4
From 3rd day to 4th day	1time per day	-	-	-	4	4	4	4	4	4
Total		10	10	10	14	14	14	14	14	14

Source: JST

Note: The flow rates of influent and effluent are measured continuously during survey.

The measuring of wastewater amount of inflow and outflow of septic tank and getting composite samples are shown in Figure 2-38.



Source: JST

Figure 2-37 Measuring Wastewater Amount of Inflow and Outflow of Septic Tank and Getting Composite Samples

Sampling System (for only black water)

Regarding the sampling method, JST are studying the application of a sampling system with temporary toilet as shown in Figure 2-39 in order to measure amount of wastewater from toilet exactly.

i. First day (Survey interval: 8 hours)

- By using a temporary toilet, amount of wastewater from a temporary toilet for 8 hours is stored in the temporary tank located in the bottom of a temporary toilet.
- Wastewater is discharged from the temporary tank while measuring the volume of wastewater and a composite sampling is taken from mixed wastewater.
- While returning wastewater to septic tank gradually, all of effluent from septic tank is stored in the measuring tank. After measuring amount of wastewater, composite sample of effluent is taken from mixed wastewater.
- These operations are repeated three times in 24 hours, and three composite samples are obtained for each influent and effluent.

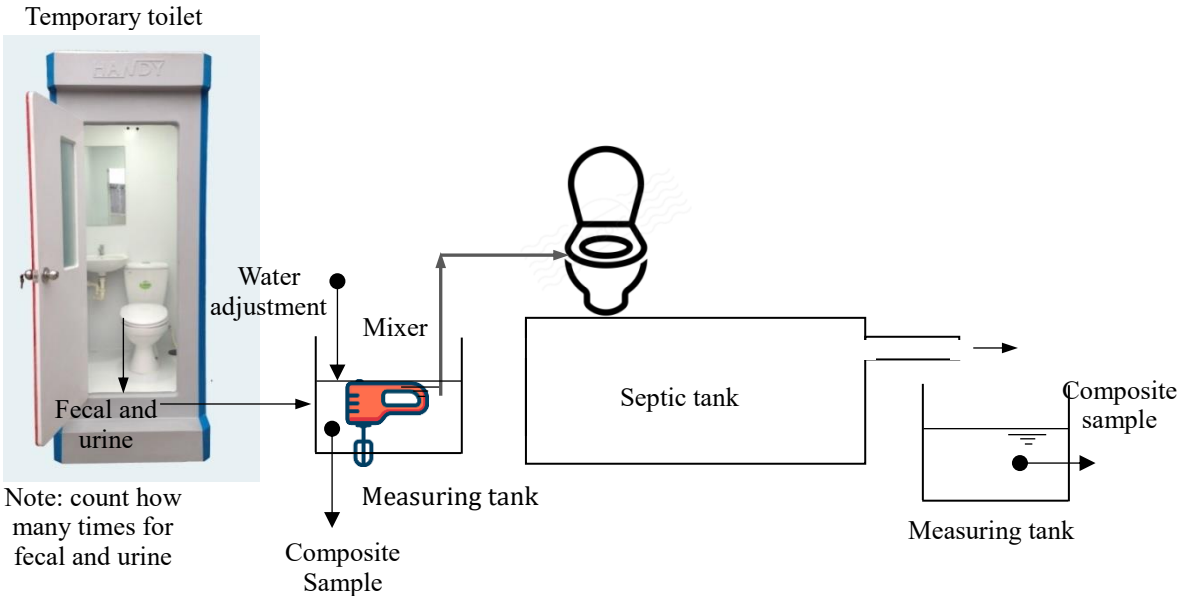
ii. Second day (survey interval: 12 hours)

- During the second day, the operation is conducted two times for each 12 hours, and two composite samples are obtained for each influent and effluent.

iii. From third day to forth day (survey interval: 12 hours, one composite sample)

- During two days, the operation is conducted two times for each 12 hours, and two samples are obtained for each influent and effluent. By using two samples per day for each influent and effluent, one composite sample is made for each influent and effluent for each day.

iv. Collect information of water use in a day, record of time of using toilet (for feces, urine) at home and outside.



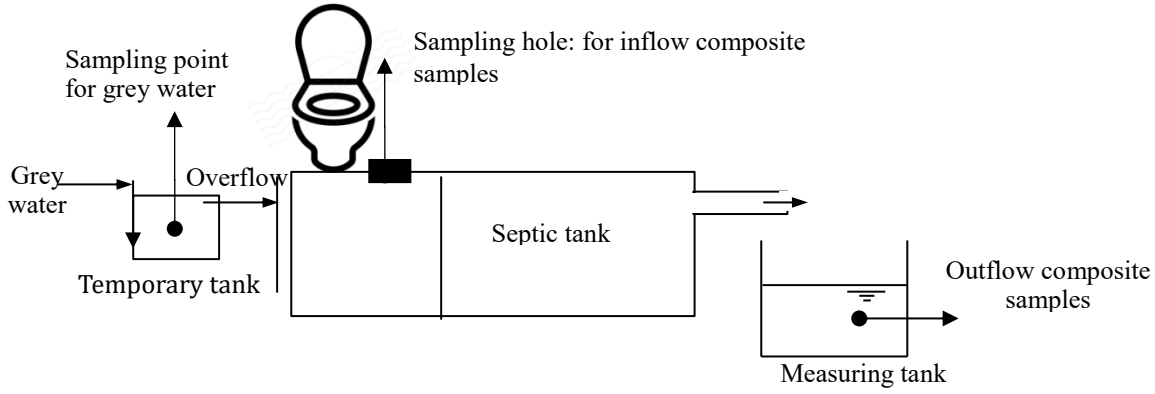
Source: JST

Figure 2-38 Method for sampling of influent and effluent of septic tank (for only black water)

Sampling System (for black water and grey water)

If black water and grey water flow into septic tank, by using the sampling method shown in Figure 2-40, JST took influent and effluent samples of septic tank. The details are as follows.

- Influent composite samples of Grey water: collected in the temporary tank
- Influent composite samples of black water & grey water: collected in the sampling hole
- Effluent composite samples are collected in the measuring tank.
- Collect information of water use in a day, record of time of using toilet (for feces, urine) at home and outside.
- Calculate amount of water used per day for toilet (for black water) and other activities (for grey water).



Source: JST

Figure 2-39 Method for sampling of influent and effluent of septic tank (for black water and grey water)

f.**3) Conducting sampling of influent and effluent of septic tank**

According to the cases as shown in Table 2-31, the three survey sites which were permitted by householders are shown in Table 2-33. As shown, the surveys were conducted from first to fourth weeks of March 2018.

Table 2-33 Specifications of target septic tanks for sampling of influent and effluent

Case	No.1 septic tank	No.2 septic tank	No.3 septic tank
Reference No. of Household	HN1HM1	HN2TR1	HP1DK1
Address	Hoang Mai Dist., Ha Noi (Urban area)	Thanh Tri Dist., Ha Noi (Rural area)	Duong Kinh Dist., Hai Phong(Urban area)
Treated wastewater	Black water	Black water	Black water+ grey water
Desludge	Never	Conducted in 2008	Conducted in 2013
Volume of ST	2.0L*1.8W*1.8H=6.48m^3 （1 chamber）	2.0L*1.2W*1.5H=3.60m^3 （2 chambers）	1.0L*1.0W*1.0H=1.0m^3 （2 chambers）
No. of people in house	8 persons	6 persons	4 persons
Water comsumption by interview survey	20-25 m^3/month	14 m^3/month	8 m^3/month
Period of sampling date ( ):No. of samples	2018.03.08-11(4days) 08Th 09Fr 10Sa 11Su (1) (1) (3) (2)	2018.03.03-06(4days) 03Sa 04Su 05M 06Tu (3) (2) (1) (1)	2018.03.22-25(4days) 22Th 23Fr 24Sa 25Su (1) (1) (3) (2)

Source: JST

Source: JST

Photo 2-5 Setting situation of a temporary toilet at the site located in Thanh Tri District in Ha Noi (HN2TR1)

Photo 2-6 Inflowing situation of wastewater into septic tank (HN2TR1)

Photo 2-7 Sampling situation of wastewater from temporary toilet (HN2TR1)

Photo 2-8 First samples of influent (left side) and effluent (right side) of septic tank (HN2TR1)

Photo 2-9 Sampling situation ofwastewater from septic tank (HN2TR1)

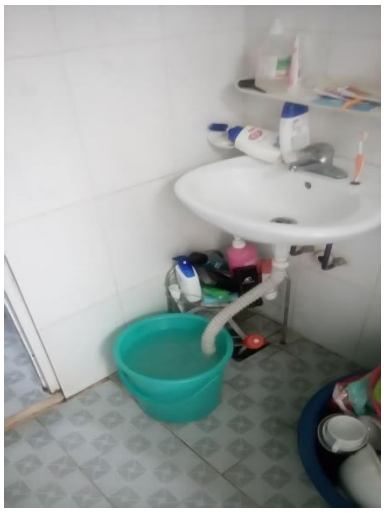
Source of all photos: JST

Photo 2-10 Setting situation of a temporary toilet at the site located in Hoang Mai District in Ha Noi (HN1HM1)

Source: JST

Photo 2-11 Sampling situation of wastewater from temporary toilet and septic tank (HN1HM1)

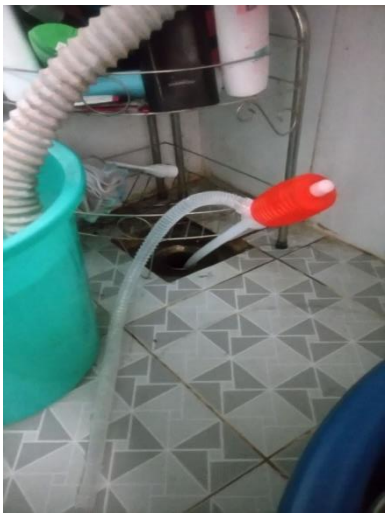
Target house in Hai Phong (HN1HM1)



Sampling greywater from washroom

Sampling greywater from kitchen

Sampling greywater from washing machine



Sampling greywater from bathroom

Sampling treated water from septic tank

Samples: Greywater (right side), Influent (Black water + greywater: center)
Effluent from septic tank (left side)

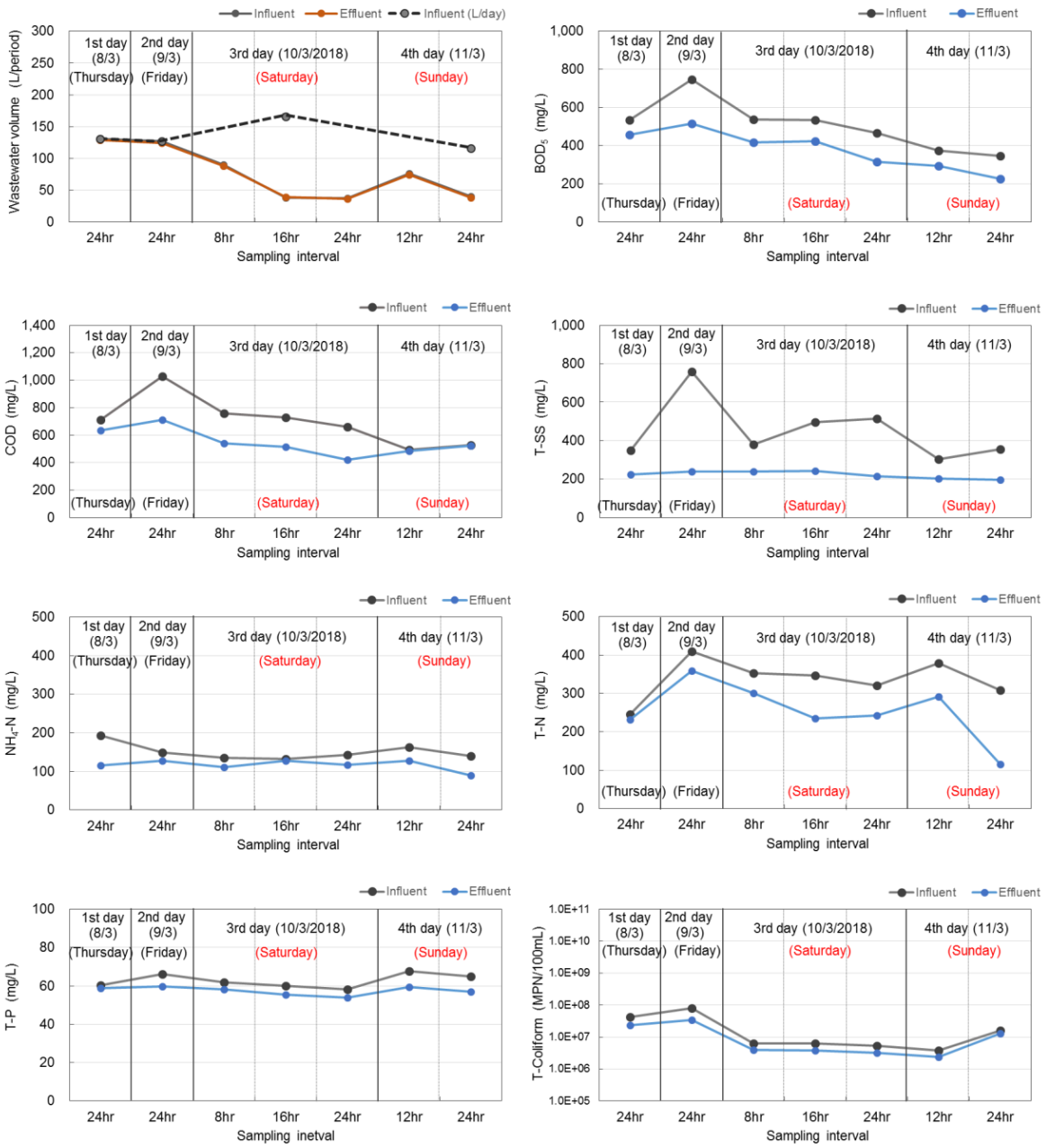
Source: JST

Photo 2-12 Sampling situation at the house in Hai Phong (HP1DK1)

f.4) Results of the survey

Analysis results of influent and effluent quality and wastewater volume are shown in Figure 2-41 (HN1HM1: black water only), Figure 2-42 (HN2TR1: black water only) and Figure 2-43 (HP1DK1: black water and grey water). Also the results on removal ratio of each septic tank are shown in Table 2-34.

- Regarding wastewater quality of a toilet, BOD_5 concentration fluctuates in the range from 350 to 750 mg/L at the house located in the urban area in Ha Noi (HN1HM1), the tendency is recognized that the concentration of BOD_5 is higher in weekday than on weekend.

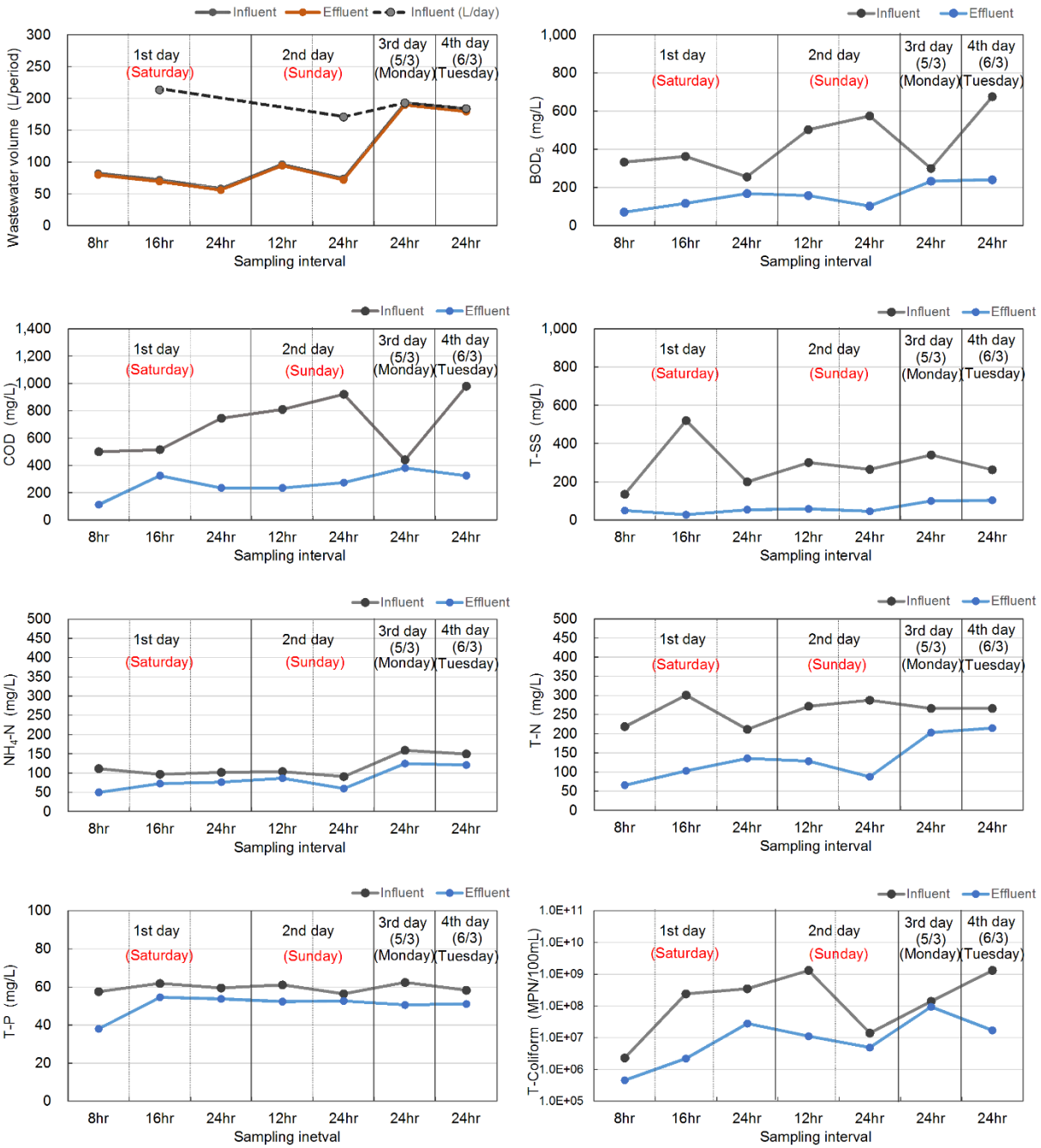


Source: JST

Figure 2-40 (Septic tank treats black water only)
Relationship between influent and effluent quality of septic Tank (HN1HM1)

- At the house located in the rural area in Ha Noi (HN2TR1), the BOD_5 concentration of wastewater from the temporary toilet fluctuated in the range from 300 to 680 mg/L, and its range is similar to HN1HM1's. Also the tendency is recognized that the concentration of BOD5 is higher in weekdays than on weekends at the rural house in Ha Noi.

As for the concentration of COD, it shows the tendency like BOD_5 at the both houses.



Source: JST

Figure 2-41 (Septic tank treats black water only)
Relationship between influent and effluent quality of septic Tank (HN2TR1)

The concentration range of COD is from 500 to 1,000 mg/L at the urban house in Ha Noi and it is around from 440 to 1,000 mg/L at the rural house in Ha Noi.

- The fluctuations of other water quality are generally small and stable except in some situations.
- As for the daily fluctuations of wastewater qualities from temporary toilets, they are not so big and there are no typical trends.
- Regarding wastewater volume from temporary toilets, the maximum wastewater volume appeared on Saturday at both target houses because all family members stayed at home on Saturday and nobody went outside.
- As shown in Figures 2-41 and 2-42, effluent volumes from septic tanks were almost same as influent volumes.
- Regarding removal effects of septic tank, they depend on water quality parameters and desludging condition.
- According to the result of this survey shown in Table 2-33, removal ratios of septic tank for each parameter are generally higher at the house that had conducted desludge than at the house never conducting desludge.
- In the example of the house which conducted desludge, the removal ratios of BOD_5 and COD were around 60%. However, the removal ratio to T-P was lower than 20%.
- On the whole, the septic tank plays an important role in treatment of black water from a toilet, and it is understood that desludging is very important to enhance the treatment function of septic tank.

Table 2-34 Results on Inflow and outflow loads of each septic tank and removal ratios

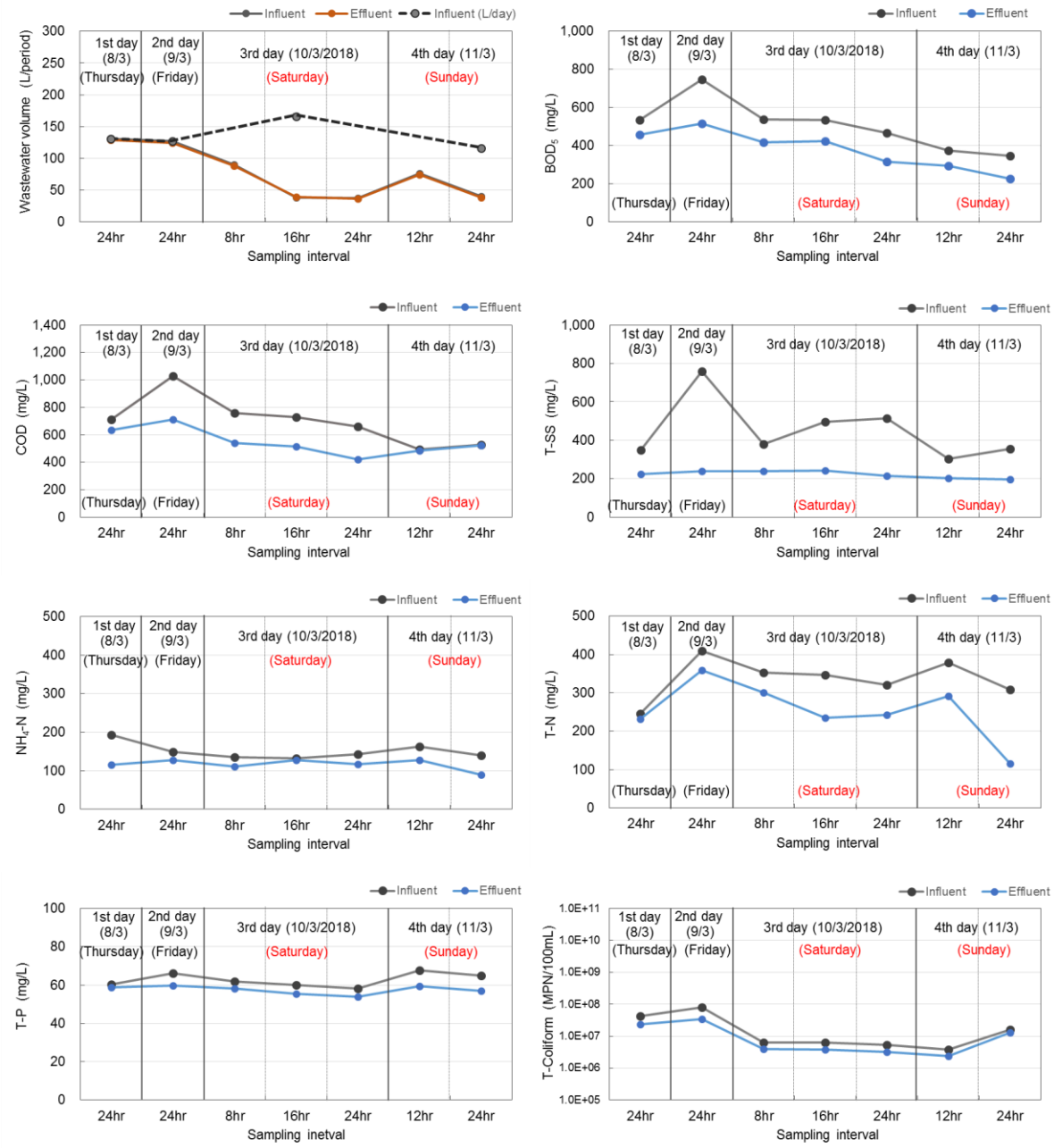
Household	Parameters	Inflow loads (Ave.) (g/day)	Outflow loads (Ave.) (g/day)	Removal ratios (%)
Ha Noi Urban HN1HM1 8 person Desludge Never	BOD_5	73.4	54.5	25.83
	COD	100.9	77.2	23.47
	SS	63.1	29.9	52.56
	NH_4-N	21.19	15.65	26.17
	T-N	45.61	36.24	20.54
	T-P	8.527	7.712	9.56
	T-E. Coli.(MPN/day)	$4.397*10^{10}$	$2.120*10^{10}$	51.78
Ha Noi Rural HN2TR1 6 person Desludge 2008	BOD_5	85.7	33.3	61.18
	COD	133.5	54.3	59.31
	SS	55.8	13.8	75.72
	NH_4-N	24.31	17.82	26.72
	T-N	50.02	28.87	42.29
	T-P	11.390	9.332	18.07
	T-E. Coli. (MPN/day)	$1.085*10^{12}$	$6.019*10^{10}$	94.45

Source: JST

The analysis results to the septic tank which treat black water and grey water are shown in Figure 2-43.

- The removal effects of the septic tank to black water and grey water are also recognized and shown in Figure 2-43.

- The influent quality concentrations of septic tank are much higher than septic tanks in Ha Noi, because the samples had to be collected from the first chamber of the septic tank due to a structural problem of the septic tank. As a result, sludge might be mixed less in the samples which were collected.



Source: JST

Figure 2-42 (Septic tank treats black water and grey water)
Relationship between influent and effluent quality of septic Tank (HP1DK1)

- On the other hand, good samples of grey water were able to be collected.
- As for the water consumption, the amount was the most on Saturday among four days, the same as other households.

f.5) Analyzing results regarding water consumption per unit, pollution load per unit etc. based on the field survey.

Water consumption per unit

Based on water consumption data measured by water meter at the three houses for sampling of influent and effluent of septic tank, JST calculated water consumption per unit, and the result is shown in Table 2-35.

- According to the results of Ha Noi, the values of water consumption per unit differ per survey. Based on the interview survey, average water consumption per unit is 149 (L/cap/day) compared to the urban area of Ha Noi. This result is almost the same as the result of Kyoto University's survey.
- On the other hand, measurement results by water meter was about 87 (L/cap/day), which is less than the result of interview survey (average).
- The water consumption per unit based on the measurement results by water meter is 101 (L/cap/day) for the rural area of Ha Noi and it is also less than the result of interview survey (average).

Table 2-35 Water consumption per unit based on each survey (Unit: L/cap/day)

Items			Ha Noi		Hai Phong	
			Urban	Rural	Urban	Rural
Interview survey [1]	Average (n: number of data)		149 (n=48)	145 (n=34)	132 (n=35)	128 (n=34)
	Result of each target house (from bill)		83-104 (HN1HM1)	78 (HN2TR1)	75 (HP1DK1)	-
Measurement results by water meter (during 4 days) [2]		Maximum	104.2 (HN1HM1)	107.8 (HN2TR1)	132.7 (HP1DK1)	-
		Average	86.8 (HN1HM1)	101.2 (HN2TR1)	112.8 (HP1DK1)	-
Kyoto University [3] (2014, reference)			146±58 (n=80)		-	-
Sybille Busser [4] (2007, reference)			170	92	-	-

Source: JST

Note; 1) Conducted by JST

2) Conducted by JST, considering toilet water consumption outside.

3) Pham Nguyet Anh, 2014. Study on household wastewater characterization and septic tanks' function in urban areas of Vietnam, doctoral dissertation in Kyoto University.

4) Sybille Busser et al, 2007. Characteristics and Quantities of Domestic Wastewater in Urban and Peri Urban households in Ha Noi, Technical University of Zurich, Switzerland.

- In the urban area of Hai Phong, the water consumption per unit based on the measurement results by water meter is about 103 (L/cap/day), and this value is relatively close to the interview survey result.

Ratio of water consumption for toilets to total

Based on the results of the field survey, the ratio of water amount for toilets and the ratio of grey water amount to total water consumption were estimated as shown in Table 2-36. The other survey results are indicated as reference.

On the whole, the ratio of water consumption for toilet is from 20% to 30%, and the ratio of grey water is from 70% to 80%.

Table 2-36 Ratios of water amount for toilets and grey water amount to total water consumption

Items	Ha Noi		Hai Phong	
	Urban	Rural	Urban	Rural

JST's Survey [1)]	Ratio of water for toilet to total (%)	19.4-27.8 Ave. 23.5 (HN1HM1)	30.3-40.2 Ave.34.9 (HN2TR1)	20.2-25.1 Ave. 23.0 (HP1DK1)	-
	Ratio of grey water to total (%)	72.7-80.6 Ave.76.5 (HN1HM1)	59.8-69.7 Ave.65.1 (HN2TR1)	74.9-79.8 Ave.77.0 (HP1DK1)	-
Busser's Survey [2)]	Ratio of water for toilet to total (%)	10- 32		-	-
	Ratio of grey water to total (%)	68- 90		-	-
Kyoto University's Survey [3)]	Ratio of water for toilet to total (%)	20			
	Ratio of grey water to total (%)[4)]	80			

Source: JST
Note: 1) Conducted by JST
2) Sybille Busser et al, 2007. Characteristics and Quantities of Domestic Wastewater in Urban and Peri Urban households in Ha Noi, Technical University of Zurich, Switzerland.
3) Pham Nguyet Anh, 2014. Study on household wastewater characterization and septic tanks' function in urban areas of Vietnam, doctoral dissertation in Kyoto University.
4) Estimated by JST based on the result of Kyoto University's survey.

Pollution load per units based on the field survey

Based on the results of the field survey, pollution load per unit was estimated as shown in Table 2-37.

- As for the pollution loads per unit to human waste (black water), they are relatively close to Japanese standard, in spite of some differences between the two.
- Regarding the pollution load per unit to grey water, they are also relatively close to Japanese standard except COD and SS.
- The COD pollution load per unit to grey water is considerably larger than Japanese standard.
- In this survey, the COD concentration of grey water is very high and the COD pollution load per unit is large. The reason of high COD concentration is not known.

Table 2-37 Results of pollution load per unit based on the field survey

Type	Households	Index	Ranges of values (g/cap/day)	Average (g/cap/day)	Other Survey[1)] (g/cap/day)	Japanese standard[3)] (g/cap/day)
Human Waste (Black water)	Ha Noi Urban (HN1HM1)	BOD_5	5.84 - 16.06	11.22	-	18.0
		COD	8.12 - 22.12	15.4	-	10.0
		T-SS	5.16 - 16.32	9.66	-	20.0
		T-N	5.24 - 8.78	6.84	6.3	9.0
		T-P	1.07 - 1.42	1.28	0.9	0.9
	Ha Noi Rural (HN2TR1)	BOD_5	11.46 - 24.11	15.92		18.0
		COD	17.23 - 34.95	24.68		10.0
		T-SS	8.69 - 13.32	10.37		20.0
		T-N	8.50 - 10.42	9.28	6.1	9.0
		T-P	1.80 -2.44	2.11	1.0	0.9
Grey Water	Hai Phong Urban (HP1DK1)	BOD_5	24.8 - 61.91	47.33	-	40.0
		COD	76.38 - 130.30	105.84	37.0 [2)]	17.0
		T-SS	10.71 - 20.64	16.35	29.9 [2)]	25.0
		T-N	2.12 - 3.31	2.87	1.0 [2)]	2.0
		T-P	0.28 - 0.43	0.35	0.6 [2)]	0.4

Source 1) Sybille Busser et al, 2007. Characteristics and Quantities of Domestic Wastewater in Urban and Peri Urban households in Ha Noi, Technical University of Zurich, Switzerland.
2) Results of the urban area in Ha Noi by the above study.
3) Japan Sewage Works Association, 2009. Japanese Sewer design guidelines

(g) Summary of field survey

The results of the field survey are summarized below.

g.1) Water consumption

- According our interview survey, the water consumption was almost 150 L/cap/day in the urban area in Hanoi. In the urban area in Hai Phong it is around 130 L/cap/day, which is smaller than in Hanoi. There was no big difference about water consumption between the urban area and rural area in both cities.
- On the other hand, the measurement result (average) by water meter was about 87 (L/cap/day) to the house located in the urban area of Ha Noi, also it was 101 (L/cap/day) to the house located in the rural area of Ha Noi.
- Water consumption (per unit) is a very important parameter to evaluate SDG6.3.1 indicator, as it depends on life style of people, urban or rural, cities (provinces) and so on.
- Therefore, in order to monitor water consumption in Vietnam, the data of water consumption should be collected in urban and rural areas of each Province, and the special and first class cities.

g.2) Treatment effects of septic tank

- According to the survey results, the effluent quality of septic tank does not meet domestic wastewater standards (QCVN14/2008/ BTNMT) for all parameters.
- For conducting desludging, the BOD and COD removal ratios of septic tank are around 60% based on the results of analyzing influent and effluent qualities of septic tank. On the other hand, their removal ratios are lower when no-desludging.

g.3) Desludging

- According to results of our interview survey, 43% of households in the urban area of Ha Noi have experience of desludging. On the other hand, only 15% of households in the rural area of Ha Noi have desludging, so the urban area is better than the rural area about desludging. The situation of desludging in the urban area of Hai Phong is similar to the urban area of Ha Noi.
- As for the reasons not to desludge, there are many as follows: there is no hole for desludging on the septic tanks, there is no action until occurrence of problems about septic tank (e.g. clogging, bad smell, full of tank, etc.), it is impossible to access to households due to narrow roads, etc.
- Regarding the desludging frequency, the highest number of once per year is in Ha Noi. On the other hand, no general tendency about the desludging frequency is not recognized in Hai Phong.
- The effluent BOD and COD concentrations of septic tank show a tendency to be lower when desludging interval is shorter.
- Although not enough to be advance wastewater treatment systems, septic tanks are very important to improve or conserve public water bodies.
- From this point of view, it is important to promote desludging of septic tanks strongly at the household level, and to develop concrete countermeasures to support citizens for desludging at the political level and financial level.

g.4) Pollution loads of household

- The pollution loads for black water and grey water are estimated based on the result of only three household surveys.
- The pollution loads for black water (BOD:11-16g/cap/day) are relatively close to Japanese standard except COD and T-SS. COD but T-SS pollution load per unit is higher than Japanese standard.
- Regarding the pollution loads of grey water, they are also similar to Japanese standard except COD and T-SS. BOD pollution load is about 47 g/cap/day. However, it is necessary to note that these results are obtained from the survey targeting only one household.

2.1.4 Field Survey on Wastewater Management: Part B. Industrial Wastewater

(a) Objectives and Scope of Field Survey

The objectives of the subcontract work are:

1) To confirm availability of data and information on industrial wastewater discharge source.
2) To review difficulty on collecting required information for SDG6.3.1 monitoring activity on industrial wastewater.

The scope of works of the survey are as follows:

1) To prepare master lists of industrial wastewater sources and to select target pollution sources in questionnaire survey.
2) To collect pollution sources information through questionnaire survey to confirm availability of data and information on industrial wastewater discharge source.
3) To review difficulty on collecting required information for SDG6.3.1 monitoring activity on industrial wastewater.

(b) Target Area

The target areas of the sub-contract work are Vinh Phuc province and Ha Nam province. Inventories shall be prepared for each province separately.

(c) Methodology

a) Preparation of master list of wastewater discharge sources and to select target pollution sources on inventory survey

JST with subcontractor prepared the master lists of target pollution sources (factory located inside and outside IZ, livestock facility, commercial facility, hospital, craft village, etc.) for each province, based on available existing information.

From the wastewater sources listed in the master lists prepared, the target wastewater sources for inventory survey were selected. When the targets are selected depending on characteristics of each province industrial structure, the subcontractor shall select number of each type of facility. For selecting each type of the target, the following facilities were included.

Table 2-38 Target Facilities on Questionnaire Survey

Type	Items to be examined for Selecting Target
Industrial zone	- All industrial zone will be selected.
Industrial cluster	- Main industrial cluster will be selected.
Factories outside industrial zone and industrial cluster	- The type of industries having specific QCVN standards will be selected, such as Textile-dyeing, Paper and paper pulp, Ethanol production, Aquatic products, Natural rubber processing and steel production - Other type of industries need to be selected depending on characteristics of industrial structure of target provinces - In case that wastewater
Livestock facility	- Main livestock facilities will be selected. - Both of newly operated and old facilities need to be included.
Commercial facility	- Large commercial facilities having restaurants will be selected. - Main markets will be selected. - Both of newly operated and old facilities need to be included.
hospital	- Main hospitals will be selected. - Both of newly operated and old facilities need to be included.
Craft village	- The craft villages conducting production activities discharging relatively large amount of wastewater will be selected.

Source: JST

After setting target facilities for questionnaire survey, the questionnaire survey sheet was finalized. The questionnaire survey has been conducted from March 2018. Currently, distributed questionnaire survey sheets are being collected with cooperation of Ha Nam and Vinh Phuc DONRE.

(d) Developing Master List of Pollution Sources

Developing the master list of pollution sources in Vinh Phuc

The master list of 278 establishments were developed that include: The centralized Domestic Wastewater Plant; The centralized Industrial Wastewater Treatment Plant of IZs and ICs; The establishments in IZ or ICs with incomplete waste water collected system and centralized wastewater treatment plant; Independent Enterprise and Services outside IZs and ICs; Store/Petroleum Station, Healthcare Facility, Large Livestock Farm as well as Craft Villages (See given master list of Vinh Phuc Province).

The master list shown that the industrial structure of Vinh Phuc Province is varied, including not only 16 major categories listed in the questionnaire but also many other types of activities. The natural rubber processing enterprise, Bio-ethanol Enterprise, Mining and Craft Villages are absent in Vinh Phuc.

Table 2-39 Master List in Ving Phuc Province

Order	Type of activities	Number of facility
1.	Centralized domestic wastewater treatment plant	1
2.	Centralized industrial wastewater treatment of IZs, ICs	4
3.	Store/Petroleum Station	43
4.	Craft Village	0
5.	Livestock facility	43
6.	Healthcare Facility	30
7.	Commercial Center	12
8.	Textile-dyeing	3
9.	Paper and paper pulp	7
10.	Ethanol production	0
11.	Food processing and Aquatic products	8
12.	Natural rubber processing	0
13.	Steel production	6
14.	Mining	0
15.	Moto bile assembly, Mechanics and Electronics	45
16.	Production of Beverages (Beer, Wine, Soft drink)	1
17.	Others (Production of building materials, supporting industries, plastic and rubber processing, production of children's toys…)	75
	Total	**278**

Source: JST

Developing the master list of pollution sources in Ha Nam

The master list of 211 establishments was developed that include: The Centralized Domestic Wastewater Plant; The centralized Industrial Wastewater Treatment Plant of IZs and ICs; The establishments in IZ or ICs with incomplete wastewater collected system and centralized wastewater treatment plant; Independent Enterprise and Services outside IZs and ICs; Store/Petroleum Station, Healthcare Facility, Large Livestock Farm as well as Craft Villages (See given master list of Ha Nam Province).

The master list shows that the industrial structure of Ha Nam Province is varied, including not only 16 major categories listed in the questionnaire but also many other types of activities. The natural rubber processing enterprise and Bio-ethanol Enterprise are absent in Vinh Phuc.

Table 2-40 Master List in Ha Nam Province

No.	Type of activities	Number of facility
1.	Centralized domestic wastewater treatment plant	1
2.	Centralized industrial wastewater treatment of IZs, ICs	4
3.	Store/Petroleum Station	9
4.	Craft Village	13
5.	Livestock facility	2
6.	Healthcare Facility	16
7.	Commercial Center	7
8.	Textile-dyeing	30
9.	Paper and paper pulp	1
10.	Ethanol production	0
11.	Food processing and Aquatic products	12
12.	Natural rubber processing	0
13.	Steel production	3
14.	Mining	19
15.	Automobile and Motorcycle Assembly, Mechanics and Electronics	19
16.	Production of Beverages (Beer, Wine, Soft drink)	2
17.	Others (Production of building materials, supporting industries, plastic and rubber processing, production of children's toys…)	73
	Total	**211**

Source: JST

Through the work preparing the master lists, the following difficulties were found.

1) The data and information of wastewater sources in both Vinh Phuc and Ha Nam were dispersed, unsystematic and not updated.
2) Data and information on the activities of wastewater have been compiled from various sources and are asynchronous (differential time, types of collected data and information etc).
3) Available information on pollution sources include only name of facility, address and type of activity. The other data and information such as telephone/fax number, production capacity, number of laborers, and revenue were absent. Data on water consumption and wastewater were available only for some facilities
4) In Vinh Phuc, the data on daily water consumption/wastewater of enterprises and service establishments is more comprehensive. However, in Ha Nam, there was little data on the amount of wastewater that is discharged from the facilities.
5) Information of facility especially information on the change of activity type was lacking.
6) In some facilities, their activity has changed but information was not updated.

(e) Collection of Data and Information of Industrial Wastewater Source (On-going)

Collection of data and information of the target facilities is being implemented by IET's experts with the support and collaboration of the Sub-Departments of Pollution Control of both Vinh Phuc and Ha Nam Province. So far, the following is the status of questionnaires.

Vinh Phuc Province

- Number of questionnaire delivered: 108
- Number of questionnaire collected: 75 (70%)

Ha Nam Province

- Number of questionnaire delivered: 114
- Number of questionnaire collected: 24 (21%)

Regarding collecting data and information, the following issues were found.

1) The task of collecting data and information on waste sources has not been included in the local yearly plan and has not yet been informed to target facilities.
2) In recent years, the state management of the environment has been strengthened, especially in the management of wastewater and flue gases emissions. Industrial facilities that discharge flue gases and wastewater in excess of the permissible standards will be severely penalized. Therefore, the facility usually refuses to perform the requirement of providing the data and information regarding the amount of wastewater discharge, wastewater analytical results as well as the status of their wastewater treatment facility. The data and information of facility especially environment data and information that can be provided as direct requirement of local environment management agency or higher level.
3) The facility's owner worry about providing data of wastewater amount and wastewater analytical results that indicate leakages to communities shall have negative effects to production and distribution of their goods to market.
4) The field survey on collection of data and information of "target facilities" shows that the support and coordination of local environmental management agencies plays an important role. Where strong support and close cooperation were given, the result is better and faster.

In Vietnam, each provincial DONRE has responsibility to check wastewater management of factories and commercial facilities through environmental check and inspection. At the same time, factories and commercial facilities have responsibility to monitor their own discharged wastewater quality and quantity. Basically, DONRE and factories/commercial facilities conduct the required actions. In this Survey, wastewater quality and quantity data and information was collected by questionnaire survey to the factories and commercial facilities with the cooperation of provincial DONRE in Vinh Phuc and Ha Nam province. The following table outlines of the collected information from the questionnaire survey. From the survey result, it can be said that the monitoring data is basically available from each facility. In addition, through the Survey, JST found it was not easy to collect monitoring information from all target facilities due to lack of systemized information collecting system of central government. It is necessary to develop such system for conducting SDG6.3.1 monitoring work.

Table 2-41 Questionnaire Survey Results on Available Monitoring Data on Factories and Commercial Facilities in Vinh Phuc Province

Categories	Number of Facility	Number of facility that provided:					Wastewater discharge standard
		Wastewater volume	BOD5	COD	Heavy Metal	Total Coliform	
Treatment of Domestic Wastewater	**1**	1	1	0	0	1	QCVN 14 : 2008/BTNMT
Bastaf – Treatment of Domestic Wastewater	**10**	10	0	0	0	0	QCVN 14 : 2008/BTNMT

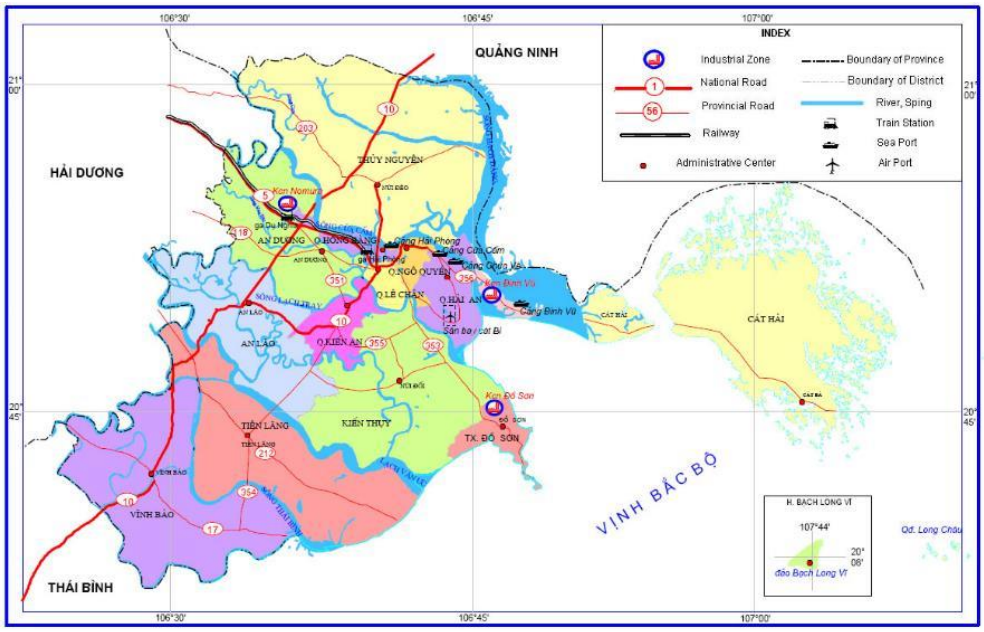
Categories	Number of Facility	Number of facility that provided:					Wastewater discharge standard
		Wastewater volume	BOD5	COD	Heavy Metal	Total Coliform	
from residential area in rural							
Treatment of Industrial Wastewater	**4**	4	4	4	4	3	QCVN 40:2011/BTNMT
Petroleum Store and Station	**5**	5	0	1	1	0	QCVN 29:2010/BTNMT
Breeding pigs	**9**	9	3	3	*0*	*3*	*QCVN 62 :2016/BTNMT*
Examination and Treatment	**11**	11	10	10	1	10	QCVN 28: 2010/BTNMT
Business, trade and services	**4**	4					**(-)**
Textile, Dyeing and Garment	**5**	5	4	3	2	2	QCVN 13 : 2008/BTNMT
Producing paper and paper products	**4**	3	4	3	1	3	QCVN 12 : 2008/BTNMT
Producing animal feeds and fertilizers	**5**	5	4	3	2	4	QCVN 40:2011/BTNMT
Producing Steel Billets	**5**	4	4	3	2	2	QCVN 52: 2013/BTNMT
Mechanics, Assembly and Electronics	**13**	13	13	11	7	12	QCVN 40:2011/BTNMT
Producing Beverages	**1**	1	1	1	1	1	QCVN 40:2011/BTNMT
Others (Production of Building Materials....)	**23**	23	20	13	9	19	QCVN 40:2011/BTNMT
Total	**100**	**98**	**68**	**55**	**31**	**60**	

Source: JST

2.2 Pilot Study in Hai Phong City

2.2.1 Objectives of Survey

Based on the results obtained and recommendation made in the Part I of the survey, from November 2018, JICA plans to conduct a case study to examine detail monitoring methodology in Hai Phong City considering the experience of septage management, construction of sewerage systems with assistance of JICA loan and technical cooperation.



Source: https://sites.google.com/a/aag.org/mycoe-servirglobal/_/rsrc/1468867471299/dieu-thuy-tran/resize_HN.png

Figure 2-43 Hai Phong City Map

Table 2-42 Districts of Hai Phong CIty

District	Number of wards (communes and towns)	Area (km²)	Population	Density (people/km²)
Dương Kinh	6 wards	46.8	55,100	1,178
Đồ Sơn	7 wards	45.9	48,500	1,056
Hải An	8 wards	103.7	114,200	1,101
Kiến An	10 wards	29.6	110,700	3,736
Hồng Bàng	11 wards	14.5	107,000	7,389
Ngô Quyền	13 wards	11.3	173,700	15,314
Lê Chân	15 wards	11.9	223,000	18,729
Sub-Total (Urban Districts)	70 wards	263.7	832,200	3,156
An Dương	1 town + 15 communes	104.2	176,000	1,689
An Lão	2 towns + 15 communes	117.7	145,200	1,233
Bạch Long Vĩ	-	3.1	1,100	346
Cát Hải	2 towns + 10 communes	325.6	32,500	100
Kiến Thụy	1 town + 17 communes	108.9	138,800	1,275
Tiên Lãng	1 town + 22 communes	193.4	152,200	787
Vĩnh Bảo	1 town + 29 communes	183.3	179,400	979
Thủy Nguyên	2 towns + 35 communes	261.9	323,400	1,235
Sub-Total (Rural Districts)	10 towns + 143 communes	1,298.1	1,148,600	885
Total	**70 wards, 10 towns, 143 communes**	**1,561.8**	**1,980,800**	**1,268**

2.2.2 Field Survey Results

(1) Water Supply Condition

Hai Phong Water Supply Company services the following area of Hai Phong City. For other areas, small water supply companies provide services.

Table 2-43 Serviced Area of Water Supply by Hai Phong Water Supply Company

No.	Name	Service area (district)	Customer	2017		2018	
				Sales (m3)	Revenue (vnd 1,000)	Sales (m3)	Revenue (vnd 1,000)
1	Central branch	Le Chan, Ngo Quyen, Hong Bang	142,653	28,920,719	347,621,641	28,579,033	349,813,379
2	Hai Phong 3	An Dong + Dong Thai Communes in An Duong District; Hung Vuong + So Dau wards in Hong Bang District	22,447	4,926,845	55,603,329	5,532,840	65,506,257
3	Hai Phong 4	An Lao, Kien Thuy	12,814	1,634,786	15,049,904	2,011,341	18,840,795
4	Hai Phong 5	Kien An, some communes in An Duong and An Lao districts	45,579	8,409,297	99,325,826	8,889,692	105,412,332
5	Hai Phong 6	Do Son	10,002	2,310,198	30,628,815	2,072,981	28,324,582
6	Hai Phong 7	Hai An, Cat Hai Town	43,202	11,707,121	147,914,936	9,988,101	127,683,924
7	Hai Phong 8	Duong Kinh	13,708	526,015	6,817,208	3,067,411	39,921,716
8	Minh Duc	Minh Duc Town in Thuy Nguyen	3,192	200,983	1,891,720	572,193	7,221,581
9	Vinh Bao	Vinh Bao Town and adjacent communes	12,458	1,663,547	19,363,953	1,901,282	22,178,807
10	Cat Ba	Cat Ba Town and adjacent communes	4,274	987,245	15,106,473	1,100,322	16,454,624
	TOTAL		**310,329**	**61,286,756**	**739,323,805**	**63,715,196**	**781,357,997**

Source: Hai Phong Water Supply Company

Main water pollution source in Hai Phong city is domestic wastewater. Water quality of water supply source is shown below.

Water supply fee is 10,000 VND/m3. Wastewater discharge fee is 20% of water supply fee. In urban area, amount of water supply is 100 m3/person.

There is an inventory of households supplied water by the company, but it is not combined with GIS. Currently there is no centralized information system of water supply network. Each district office has detail information. GIS database is under preparation.

In Hai Phong City, groundwater quality is affected by salt water intrusion, main water supply source is surface water. Water quality of intake point is shown in the table below. Water quality is affected by domestic and industrial wastewater, and the impact increases according to Hai Phong Water Supply Company and Hai Phong DONRE.

Table 2-44 Water Quality at Intake Point of Water Sppply in Hai Phong City

No.	Sampling location	Date	Analysis parameters							
			pH	SS (mg/l)	COD (mg/l)	DO (mg/l)	NO^{3-} (mg/l)	PO_4^{3-} (mg/l)	Coliforms (MPN/100ml)	E.coli (MPN/100ml)
QCVN 08-MT:2015/BTNMT			6-8.5	30	15	>=5	5	0.2	5,000	50
1	He River	23/08/2018	7.48	22	13.2	5.1	1.58	0.38	93	43
2	Quan Vinh	15/8/2018	7.17	20	12.8	5.15	1.27	0.23	930	240
3	Cau Nguyet	15/08/2018	7.4	20	12	5.45	1.3	0.2	9,300	2,400
4	Vinh Bao	23/08/2018	7.28	20	13	5.42	1.52	0.27	240	23

Source: Hai Phong Water Supply Company

(2) Wastewater Management

In Hai Phong City, under Hai Phong PC, DOC supervise control of domestic wastewater, cooperating with several companies who is in charge of implementing wastewater control activity directly, such as SADCO, and DONRE controls industrial wastewater.

Questionnaire to HPSADCO was prepared by JST which contained management of septage collection, its treatment situation, and administrative aspects operated by HPWSC. However the collected information are not so specific and still remain in general. Questionnaire and answer by HPSADCO are shown in Table 2-3.

Table 2-45 Summary of Key Findings of Questionnaire to HPSADCO

Key Questionnaire	Answer by HPSADCO	Comment by JST
Annual amount of waste water collection fee	90 billion VND in 2017 72 billion VND in 2016 68 billion VND in 2015	Total amount slightly increased which might has corresponded increase of water consumption in accordance with economic growth.
Desludging activity by SADCO	Customers' number: 300,630HHs Desludging volume: 3,610m^3 (2017) Usual desludging frequency Common HH: every 5 years Others: every 2-3 years	No regular service is demanded and regulated. Many local houses are not designed taking regular desludging into account.

Source: JST

HPSADCO does not grasp any specific administrative information of HPWSC because of different

institutional and financial structure between them. HPWSC is operated on a stand-alone basis and delegated with power for his own business. HPSADCO has not been independently privatized fully yet and he needs to obtain annual budget from HPPC state budget allocation.

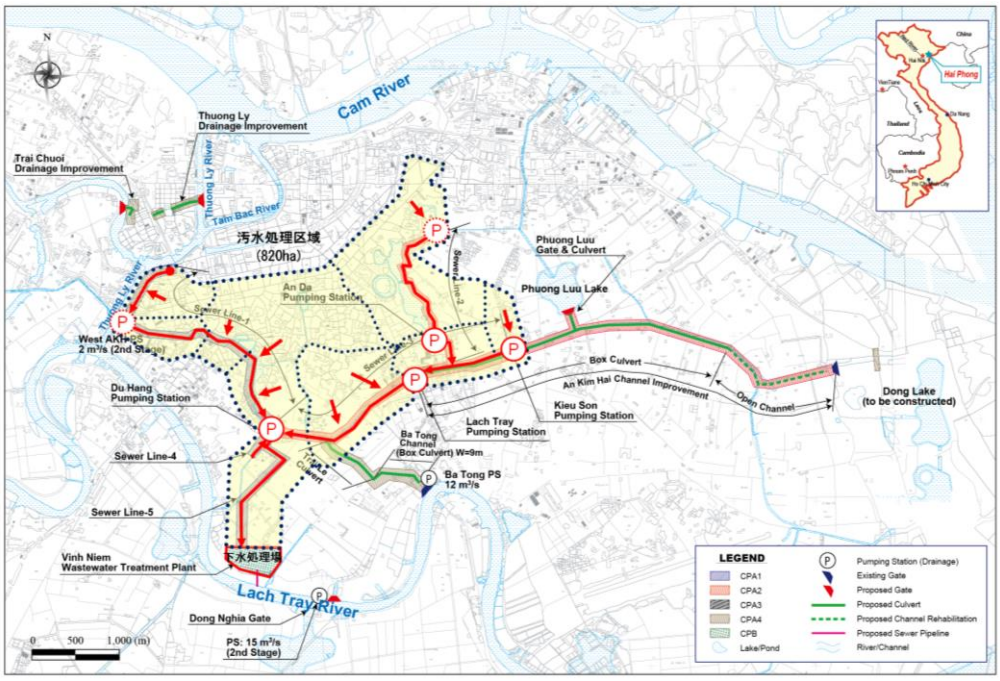
Construction of a centralized waste water treatment plant in Hai Phong City namely Vinh Niem WWTP (VNWWTP) has been implemented since 2014 under the Japanese ODA namely, The Drainage and Sewerage Components under Hai Phong Sewerage & Drainage and Solid Waste Management Project, Stage 1. Salient features of VNWWTP are shown in the table below.

Table 2-46 Salient Features of Vinh Niem WWTP

Item	Specific Features
Service Area	820 ha in Le Chan, Ngo Quynh and Hai An Districts
Service Population	209,191 persons in the year of 2010
Sewage Collection Method	Interceptor system (combined sewer system)
Treatment Process	Conventional Activated Sludge Process (Class B)
Treatment Capacity	**36,000m^3/day in Average Daily Dry Weather Flow**
Sludge Treatment	Gravity Thickening and Mechanical Dewatering (Screw-press)
Sludge Disposal	Landfill

Source: JST

The service area mainly covers western half of the central zone of Hai Phong City as shown in the figure below.



Source: JST arranged in reference to Project Introduction Paper by Nippon Koei

Figure 2-44 Service Area of Vinh Niem WWTP

Necessary information for safely treated wastewater calculation was shown in the table below.

Table 2-47 Necessary Information for Safely Treated Waste Water Calculation

Parameter	Specific Contents	Responsible Agency
Service population	- Ward/Commune-wise population in the project area	Hai Phong General Statistics Department
Service area	- Desludging service area, drainage management area	SADCO Other desludging service provider
Project related information	- Design project coverage area - Design service population - Design waste water volume - Design waste water quality (in/out)	PMU before handing-over SADCO after handing-over
Actual waste water condition	- Actual waste water quality (in/out) - Actual waste water volume (in/out)	PMU before handing-over SADCO after handing-over
Public water environment	- Water quality in public water bodies - Industrial waste water quality	DONRE
Water supply related data	- Service coverage area - Connection number per user category - Water production amount per WTP - Water consumption per user category - Water bill amount per user category - Tariff collection ratio	Water Supply Company

Source: JST

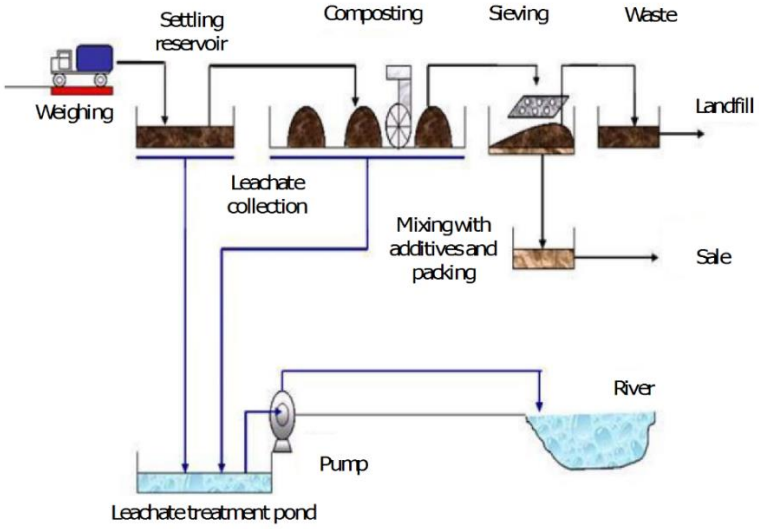
Septic Tank Treatment

SADCO covers 4disgtricts in urban area of Hai Phong city. Hai Phong SADCO is planning a desludging interval every 5 to 6 years for household septic tanks, and every 1 to 2 years for the communal houses (living apartments). However, currently, all the expenses for desludging is covered by collected wastewater fee from each household, so each household does not have intention to desludge freaquently. Therefore, desludging service provided by SADCO is limited currently, and it is difficult to update septic tank wastewater treatment status in overall serviced area. In the past, periodical desludging work was conducted, and each household desludged once in 3 to 5 years by Hai Phong city budget. The area to be desludged was selected depending on degree of wastewater pollution impact, of which information was provided from general citizens such as women's union. After enforcement of Decree 80, desludging fee should be paid by each household, so the household just requested to desludge when septic tank is stacked. Therefore, periodical and systematic desludging work has stopped. Currently, SADCO does not have enough data and information to develop systematic desludging work plan. Generally, the cost for collecting and treating septic tank sludge is 1,000,000 VND/m^3.

Fecal sludge management is implemented by Hai Phong SADCO, and operating Trang Cat sludge treatment complex constructed by the WB project. Outline of the treatment plant is as follows;

- Dry pond for open channel sludge: 6,000 m^3 (1,500 m^3 x 4 ponds)
- Dry pond for septic tank sludge: 1,500 m^3 (750 m^3 x 2 ponds)
- Amount of treated sludge is 5,000 m3/year
- Lagoon for treating supernatant liquid is equipped. After treatment, the liquid is discharged to river. Discharged liquid quality is analyzed once or twice in a year.
- Dried sludge is composted at the site.

The amount of sludge brought to Trang Cat is ranging from 10,000 to 25,000 m^3 per year. The projected amount of treated sludge will be increased when the Environmental Sanitation Project, funded by JICA will be effective.



Source: Institute of environmental science and engineering (IESE), Hanoi University of Civil Engineering, 2011. Final Report on Landscape Analysis and Business Model Assessment in Fecal Sludge Management: Extraction and Transportation Models in Vietnam

Figure 2-45 Process Line of FS treatment in Trang Cat Plant

Industrial Wastewater Management

Hai Phong DONRE control industrial wastewater in Hai Phong City. In a year, to around 50 enterprises, DONRE conduct inspection and environmental check. The environmental check and inspection is conducted based on the annual plan and complains from local people.

Hai Phon DONRE developed pollution source database by excel. However, the database is not updated currently. It is required to enhance inventory updating activity.

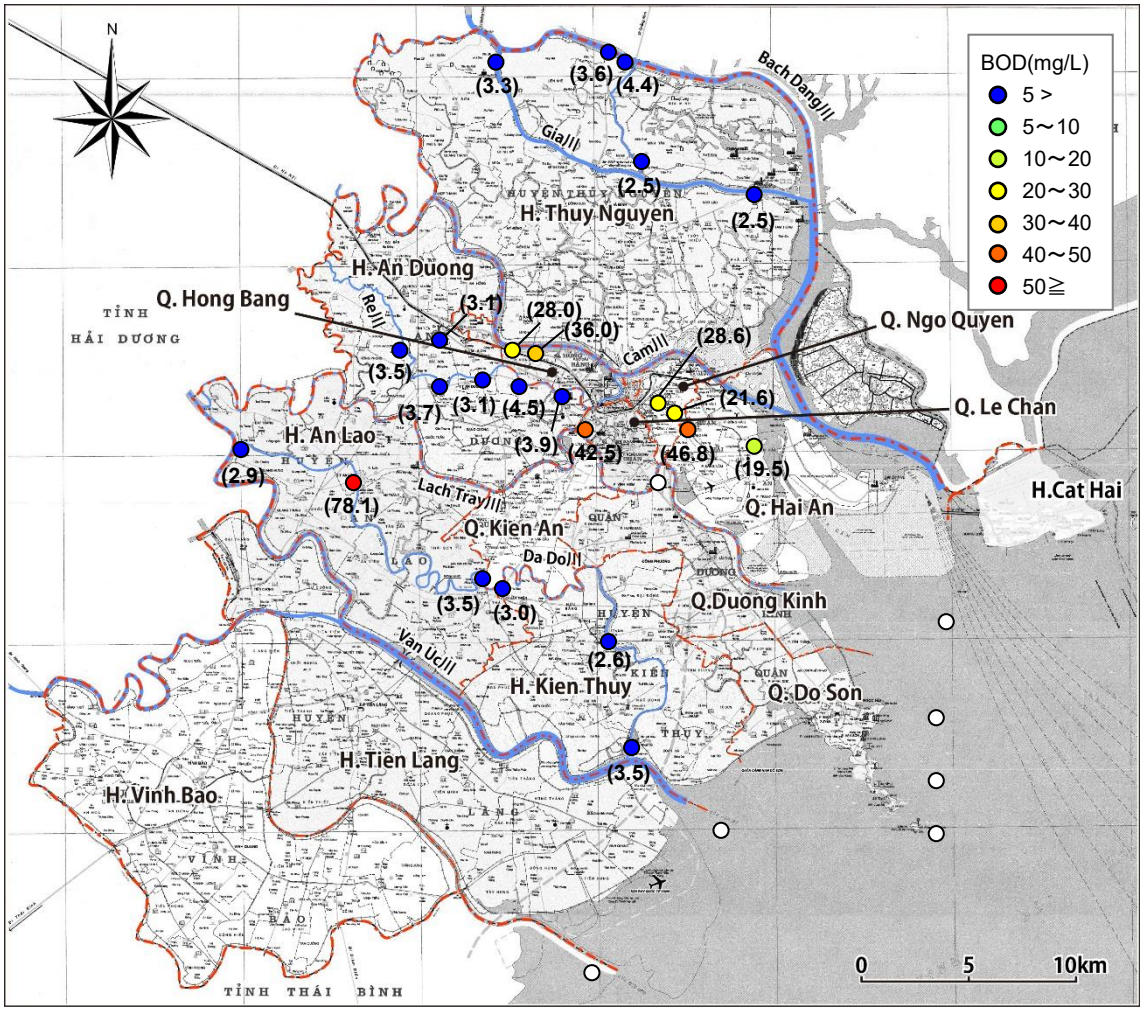
Separately from DONRE, industrial management board control wastewater discharged from industrial zone. Generally, each industrial zone has centralized wastewater system, and record discharged water quality and amount of wastewater.

(3) Water Environmental Condition

As for water quality situation of waterbodies in Haiphong City, the measured results of BOD and TSS concentration are shown in Figure-1 to 4.

These results are slightly old, based on them, rivers in the city have been polluted by discharging domestic wastewater and industrial wastewater.

Especially, canals located in the central part of Haiphong City have been heavily polluted. These polluted situations are still continued according to the interview result to Haiphong's DONRE.

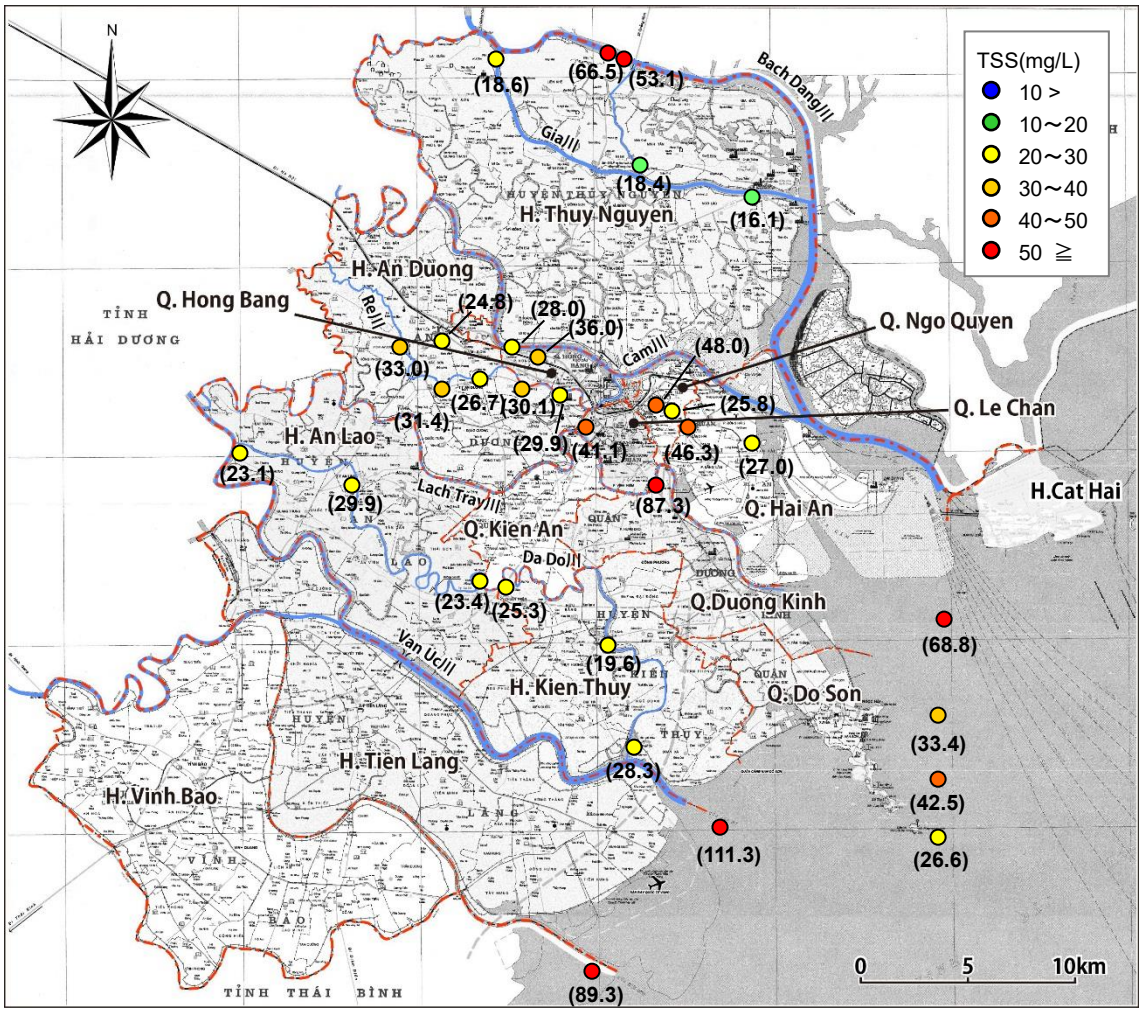


Notice; About Date of Data, Measurement Frequency etc.

Gia River	Average of four values (March, June, Sept. and Dec., 2012)
Da Do River	Ditto
Re River	Ditto
Channel in central city Area	Ditto
Cam River	Value measured on September 13, 2013
Bach Dang River	Value measured on December 20, 2013

Source: Kita-kyusyu City

Figure 2-46 BOD Concentration in Hai Phong City



Notice; About Date of Data, Measurement Frequency etc.

Gia River	Average of four values (March, June, Sept. and Dec., 2012)
Da Do River	Ditto
Re River	Ditto
Channel in central city Area	Ditto
Lach Tray River	Average of three values (April, June and August, 2012)
Cam River	Value measured on September 13, 2013
Bach Dang River	Value measured on December 20, 2013
Coastal Zone	Average of two values (August and November, 2013)

Source: Kita-kyusyu City

Figure 2-47 TSS Concentration in Hai Phong City

2.2.3 Findings on SDG Monitoring and Wastewater Management

(3) General Status of Monitoring methodology for SDG 6.3.1 (6.2.1)

In August 2018, UN Water issued "Progress on Wastewater Treatment – Piloting the monitoring methodology and initial findings for SDG indicator 6.3.1". In the report, the following findings are described. Through the Pilot Study, some recommendations and issues were found as described in the table.

Table 2-48 Monitoring Methodology summarized by UN Water and found Issues through Pilot Study

Monitoring Methodology summarized by UN Water	Findings through Pilot Study
The indicator should account for all wastewater generation, including blackwater and greywater production.	- Almost grey water is not treated.
Estimates of wastewater flows generated should be calculated as a proportion of water consumption flows for water supplies on- and off-premises.	- The method can be applied in Hai Phong City.
The indicator should assess actual treatment performance against national standards, taking into account the environmental and public health sensitivity of the receiving water and next use.	- Relevant authorities in Hai Phong City have wastewater monitoring data. It should be utilized for SDG monitoring and evaluation.
The monitoring mechanism should draw on and harmonize with existing regional monitoring mechanisms (e.g. Eurostat, African Ministers' Council on Water (AMCOW)) to avoid placing additional reporting burden on national statistical authorities that are already stretched.	- For South-eastern Asian countries, regional experiences should be summarized through international platform such as WEPA, and shared for improvement of international experiences of SDG monitoring.
There was a range of monitoring capacities among countries; as such, they requested flexibility on progressive monitoring approaches, relevant to the country's capacity level.	- Vietnam and Hai Phong City has enough capacity for implementing SDG monitoring. - For improvement of monitoring activity, Step by Step approach needs to be adopted.
Most countries measure wastewater treatment plant performance by testing effluent water quality; however, in most countries, regulatory authorities do not aggregate data at the national level.	Relevant organizations in Hai Phong City have water quality monitoring data. However, same issue pointed out by UN Water report is existed, and a mechanism for aggregating monitoring data need to be developed.
Few countries collect data on treatment performance of on-site systems (i.e. septic tanks) despite a significant proportion of the population using them in all countries and the majority of premises using them, especially in low- and middle-income countries.	In Hai Phong SADCO, updating of data and information on on-site treatment system is required.
National responsibilities for monitoring domestic and industrial wastewater treatment often fall to line ministries (i.e. public services and industry) and are reported through different reporting mechanisms. In many cases, this makes this makes combining data into a single indicator challenging.	Hai Phong PC is expected to lead combining data collected by several organizations into a single indicator
However, stakeholders also highlighted the need to promote the polluter pays principle to drive and prioritize action towards achieving target 6.3. To do this, a degree of aggregation and differentiation of pollutant load by domestic and industrial sources is needed.	Ditto

(4) Monitoring Methodology for SDG 6.3.1 (6.2.1) for Domestic Wastetwater

In "Progress on Safe Treatment and Use of Wastewater 2018 Piloting the Monitoring Methodology and Initial Findings for SDG Indicator 6.3.1" by WHO/UN Water/UN Habitat, example of calculation manner of SDG6.3.1 is summarized as the following figure.

Population [thousands]	Water supply [%]		Water use [litre/person/day]*		Sanitation [%]		Wastewater [thousand m³/day]		Sanitation service chain [%]					Safely treated wastewater [%]			
	Population with water on premises	Population with water not on premises	On-premises	Not on-premises	Type	Population using type (including shared)	Generation [G]	Collection [C]	Contained	Emptied and removed off-site	Not emptied	Delivered to treatment plant	Treated at treatment plant	Wastewater treatment	Treated in situ	Faecal sludge treatment	6.3.1a
[1]	[2]	[3]	[4]	[5]	Piped sewers	[6]	=[6]x[1] x[4]*	=[G]x1	[11]	N/A		[12]	[17]	A = [C]x[11] x[12]x[17] /G(total)x100			
					Septic tanks	[7]	=[7]x[1] x[4]*	=[G]x1	[13]	[15]	[14]	[16]	[18]		B = [C] x[13]x[14] /G(total) x100	C= [C]x[13]x[16] x[18] /G(total)x100	=A+B+C
					Other improved facilities	[8]	=[8]x[1] x[5]*	=[G]x0	0	0	0	0	0		0	0	
					Unimproved facilities	[9]	=[9] x[1]x[5]*	=[G]x0									
					Open defecation	[10]	=[10] x[1]x[5]*	=[G]x0									
TOTAL							G(total)	C(total)									

Figure 2-48 Example of Calculation Manner of SDG6.3.1

(5) Discussed Point on Monitoring Methodology for SDG 6.3.1 with Relevant Organizations in Hai Phong City

Part A: Domestic Wastewater

Currently, it is better to apply for simple calculation manner using available information.

- For centralized treatment system, currently interceptor collection system is applied, and population in the serviced area can be estimated with available information such as population density, statistical data, or existing database information. When piped sewer system is developed, database on households connected with centralized wastewater system will be necessary.
- For septic tank, data on houses, of which ST is equipped, and sludge is removed, are required.

Part B: Industrial Wastewater

Pollution source inventory

- Hai Phon DONRE developed pollution source database. It is expected to update the inventory periodically.

Use of information collected through environmental check and inspection and EIA

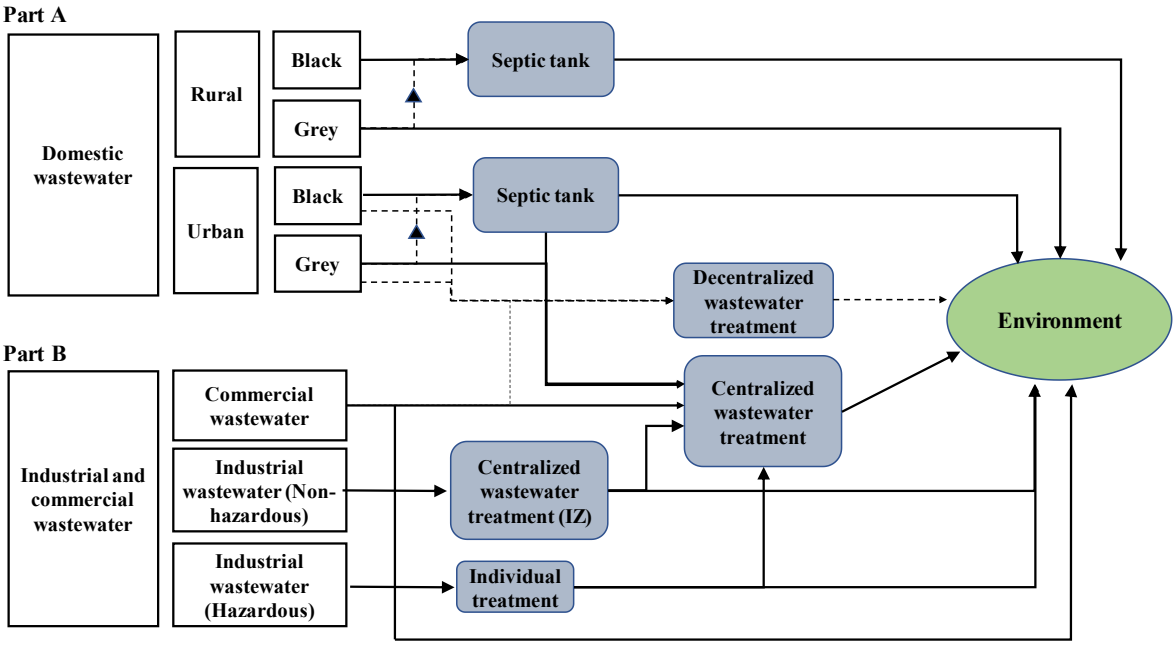
(6) Discussed Point on Achievement of SDG 6.3.1 Indicator with Relevant Organizations in Hai Phong City

- Relational Planning: Zoning of sewerage systems and on-site systems, Step wise approach for sewerage system development from transition stage to final stage
    - In March 2018, Hai Phong city designated a zoning plan of on-site and off-site treatment system by Decision no.626/QĐ-UBND on Approval of Sewerage Planning to 2025, vision towards 2050.
    - Regarding sewerage system development, realistic scenario should be adopted with final goal and target in mind.
- Technology: Improvement of septage treatment
    - Improvement of Tang Cat Sludge Treatment Plant to reduce sludge to be treated
    - Future possibility to treat not only BOD but also nutrients such as N and P
- Financial Mechanism: Way of usage of wastewater discharge charge
- Institutional Arrangement: A mechanism to integrate required data and information for SDG monitoring needs to be developed.
    - Identification of leading organization for SDG6.3.1 indicator monitoring
    - Possibility to use available existing information such as database operated by Water Supply Company in Hai Phong City
- Law and Regulation: Setting necessary level of wastewater treatment considering water quality condition at intake point and surrounding water environment and pollution load

3 Proposal on Monitoring Methodology for the Indicator of SDG 6.3.1 and Calculation Method

3.1 Proposal on Classification of Types of Wastewater and Treatment Methods

To propose calculation methods for obtaining monitoring indicator figures, the flow of wastewater treatment should be identified by type of wastewater. The wastewater handled by the Survey can be classified into three categories: (a) domestic wastewater. (b) commercial wastewater, and (c) industrial wastewater. In addition, the wastewater treatment systems applied in Vietnam are also identified as follows: (i) centralized wastewater treatment plant, (b) decentralized wastewater treatment facilities, (c) septic tank, and (d) pre-treatment facility of hazardous substances. Considering combination of the type of wastewater and treatment systems, the flow of wastewater will be summarized for calculating monitoring indicators of SDG 6.3.1. Tentative ideas of wastewater flows are described in the following figure.



Note: The lines show main flow of wastewater.
Source：JST

Figure 3-1 Tentative Wastewater Flow Diagram

3.2 Proposal on Calculating Methods for Obtaining Monitoring Indicator Figures by Types of Wastewater and Treatment Method

Considering the existing situation found through the survey, the following calculation methods are proposed for estimation of monitoring indicator SDG6.3.1.

Methodology of Estimation of SDG6.3.1 Monitoring Indicator

(1) Generated Domestic Wastewater

The amount of generated domestic wastewater was calculated by the following equation.

[Generated Wastewater] = [Population] x [Daily water consumption per capita (L/cap/day)]

Population information can be obtained by GSO's published statistical yearbook. Currently, various statistics of daily water consumption per capita were confirmed by the several literatures and fieldwork in this survey. It is desirable to set unified daily water consumption per capita in Vietnam.

	Population	Daily water consumption per capita (L/cap/day)
Availability	O	O
Expected information source	− Statistical data issued by GSO	− Proposed figure by several master plans in Vietnam − Proposed figure by WHO pilot project in Vietnam (Urban area: 150L/cap/day, Rural area: 80L/cap/day) − Results of this survey (Table 2-11)
Issue to be discussed	-	− Unified figure should be proposed.

Source: JST

(2) Safely Treated Domestic Wastewater

(a) Safely Treated Wastewater by Centralized Wastewater Treatment Plant with Satisfying Wastewater Discharge Standard

According to this survey result, effluent of centralized wastewater treatment plants operated in Vietnam generally satisfy wastewater discharge standards. The amount of the treated wastewater by centralized wastewater treatment plant satisfying wastewater discharge standard was calculated by the following equation.

Option a) [Safely Treated by Centralized Wastewater Treatment Plant] = [Actual sewered population] x [Daily water consumption per capita (L/cap/day)]

Option b) [Safely Treated by Centralized Wastewater Treatment Plant] = [Actual capacity of centralized wastewater treatment plant]

Option c) [Safely Treated by Centralized Wastewater Treatment Plant] = [Actual treated wastewater of centralized wastewater treatment plant]

Based on the result in this survey, it is not always easy to collect information to confirm existing sewered population from DOC or each WWTP operation company. In such case, designed capacity of the treatment plant or actual inflow rate to the plant can be referred and used for estimation.

Each option mentioned above would be adopted depending on available data and information. In the survey, JST collected actual treated wastewater amount from several treatment plant, but could not collect it from all target plants. Regarding actual sewered population, it was difficult to identify because service area could not be identified due to lack of information such as service area map. When SDG6.3.1 monitoring is implemented, MOC needs to collect required information, considering the selected options for calculation of safely treated wastewater.

	Actual sewered population Actual capacity of centralized wastewater treatment plant Actual treated wastewater of centralized wastewater treatment plant	**Daily water consumption per capita (L/cap/day)**
Availability	△	○
Expected information source	− MOC − DOC − Each WWTP operation company − Statistical data collected by GSO	− Proposed figure by several master plans in Vietnam − Proposed figure by WHO pilot project in Vietnam (Urban area: 150L/cap/day, Rural area: 80L/cap/day) − Results of this survey (Table 2-11)
Issue to be discussed	− Based on the survey experiences, it is not always easy to collect information for confirming existing sewered population from DOC or each WWTP operation company.	− Unified figure should be proposed.

Source: JST

(b) Safely treated Wastewater by De-Centralized Wastewater Treatment Plant with Satisfying Wastewater Discharge Standard

The de-centralized domestic wastewater treatment system, such as the facilities explained in section 2.3(1) as "Jokasho" system, also contribute to safely treated wastewater. The amount was calculated by the following equation.

[Treated by De-Centralized Wastewater Treatment Plant] = [Population treated by de-centralized wastewater system] x [Daily water consumption per capita (L/cap/day)]

For counting the treated wastewater by this kind of decentralized wastewater system, wastewater treatment performance of each facility should be checked with Vietnamese discharge standards or design criteria, and treated wastewater quality monitoring should be conducted.

(c) Safely treated Wastewater by On-site Wastewater Treatment Facilities with Satisfying Wastewater Discharge Standard

The amount of the treated wastewater by on-site wastewater treatment facilities with satisfying wastewater discharge standards was calculated by the following equation.

[Safely treated by On-site Wastewater Treatment Plant] = [Population connected on-site treatment system] x [Daily water consumption per capita (L/cap/day)]

Some local administrative bodies such as Hai Phong city has database of on-site treatment system. The information can be used for SDG6.3.1 monitoring activity. Besides, it is required to confirm updated status of existing information stored by the expected information sources.

Another issue is that effluent from on-site facilities is considered as unsuitable wastewater quality according to this survey result. To recognize treated wastewater as safety, management of on-site treatment system should be improved.

	Population connected on-site treatment system	**Daily water consumption per capita (L/cap/day)**
Availability	△	O
Expected information source	− MOH − DOC − Sanitation and drainage company of each city/province, such as Hanoi URENCO or Hai Phong SADCO	− Proposed figure by several master plans in Vietnam − Proposed figure by WHO pilot project in Vietnam (Urban area: 150L/cap/day, Rural area: 80L/cap/day) − Results of this survey (Table 2-11)
Issue to be discussed	− It is required to confirm updated status of existing information stored by the expected information sources.	− Unified figure should be proposed.

Source: JST

(3) Generated Industrial Wastewater

The amount of generated industrial wastewater was confirmed by inventory data as shown below.

[Generated Wastewater] = [Inventory of wastewater from industrial zone and industrial cluster] + [Inventory of wastewater from factories outside industrial zone and industrial cluster] + [Inventory of wastewater from commercial facilities]

Generally, information of industrial zone and industrial cluster is managed by each provincial Economic Management Board or Industrial Zone Management Board. On the other hand, the information of factories outside industrial zone and industrial cluster, and commercial facilities are managed by each provincial DONRE. For collecting required information, both organizations works are essential.

	Inventory of wastewater from industrial zone and industrial cluster	**Inventory of wastewater from factories outside industrial zone and industrial cluster**	**Inventory of wastewater from commercial facilities**
Availability	O	△	△
Expected information source	− MONRE (with list of industrial zone and industrial cluster) − To be collected from each industrial zone and industrial cluster	− MONRE − DONRE	− DONRE
Issue to be discussed	-	− Based on the experiences of former JICA study, information of wastewater discharge permission is scattered, and not integrated as database in many provinces.	ditto

Source: JST

(4) Safely Treated Industrial Wastewater

The amount of safely treated industrial wastewater was confirmed by inventory data as shown below.

[Treated Wastewater by Industrial and Commercial Wastewater Treatment Plant] = [Inventory of well-treated wastewater from industrial zone and industrial cluster] + [Inventory of well-treated wastewater from factories outside industrial zone and industrial cluster] + [Inventory of well treated wastewater from commercial facilities]

	Inventory of well-treated wastewater from industrial zone and industrial cluster	**Inventory of well-treated wastewater from factories outside industrial zone and industrial cluster**	**Inventory of well-treated wastewater from commercial facilities**
Availability	O	△	△
Expected information source	*[To be confirmed]* − MONRE (with list of industrial zone and industrial cluster) − To be collected from each industrial zone and industrial cluster	− MONRE − DONRE (Information obtained through environmental check and inspection)	− DONRE (Information obtained through environmental check and inspection)
Issue to be discussed	-	− Based on the experiences of former JICA study, information of environmental check and inspection results are not integrated as database in many provinces.	ditto

Source: JST

3.2.1 Expected data and Information collected from the Concerned Organization

The expected data and information collected from the concerned organizations are shown below.

Table 3-1 Expected data and Information collected from the Concerned Organization

Organization	**Generated Wastewater**		**Treated Wastewater**	
	Domestic Wastewater	**Industrial and Commercial Wastewater**	**Domestic Wastewater**	**Industrial and Commercial Wastewater**
MOC	- Daily water consumption per capita (L/cap/day)	-	- List of centralized and main de-centralized wastewater treatment plant - List of service company operating centralized and main de-centralized wastewater treatment plant - Collecting and summarizing data and information from DOC or Service company	-
DOC (or service company)	-	-	- Map of sewered area, serviced population, actual treated wastewater amount by centralized/de-centralized wastewater treatment plant - Treated water quality data by centralized and de-centralized wastewater treatment plant	-
MONRE	-	- List of industrial zone and industrial cluster - Collecting and summarizing data and information from DONRE and concerned organizations such as Economic Management Board	-	- Collecting and summarizing data and information from DONRE and concerned organizations such as Economic Management Board

Organization	Generated Wastewater		Treated Wastewater	
	Domestic Wastewater	Industrial and Commercial Wastewater	Domestic Wastewater	Industrial and Commercial Wastewater
DONRE and provincial Economic Management Board		- List of - Amount of generated wastewater by industrial zone and industrial cluster - Amount of generated wastewater (or wastewater discharge permission) from factories outside industrial zone and industrial cluster		- Amount of well-treated wastewater by industrial zone and industrial cluster - Amount of well-treated wastewater from factories outside industrial zone and industrial cluster
GSO	- Number of household equipping septic tank	- List of industrial zone and industrial cluster - Number of factories and commercial facilities	- Sample of treated water quality - Status of desluging condition	-

Source：JST

3.2.2 Existing Issues on Methodology on SDG6.3.1 in Vietnam

Through this survey, the following issues were identified.

(1) Issues to be discussed for Better SDG Monitoring

- Some required data and information for SDG indicator monitoring seems scattered, and are difficult to be collected. For better SDG indicator monitoring, information collecting, storing and sharing system should be developed.

Requirement to enhance wastewater monitoring data and information system

Through the survey, the following issues were identified for enhancing wastewater monitoring data and information system

Table 3-2 Expected Actions for Enhancing Wastewater Monitoring Data and Information System

Type of Wastewater	Information to be collected	Concerned Organization		Relevant Law
		National Level	Local Level	
Domestic Wastewater				
Centralized wastewater system	Amount of actual wastewater treatment and treated wastewater quality data and information should be centralized to MOC	MOC	DOC and concerned drainage and sanitation companies	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
De-centralized wastewater treatment system	Population treated by de-centralized wastewater treatment system and treated wastewater quality data and information should be centralized to MOC	MOC	DOC and companies in charge of de-centralized wastewater treatment system	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
On site treatment system	Data and information on-site treatment system should be updated and summarized.	GSO, MOH, MOC	DOC and concerned drainage and sanitation companies	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management

Type of Wastewater	Information to be collected	Concerned Organization		Relevant Law
		National Level	Local Level	
Industrial Wastewater				
Industrial Zone	Amount of actual discharged and treated wastewater treatment and treated wastewater quality data and information should be centralized to MONRE	MONRE	Industrial Zone Management Boada and DONRE	LEP Decision 140/2018/QD-Ttg
Outside industrial zone	Amount of actual discharged and treated wastewater treatment and treated wastewater quality data and information should be centralized to MONRE	MONRE	DONRE	LEP Decision 140/2018/QD-Ttg

Source：JST

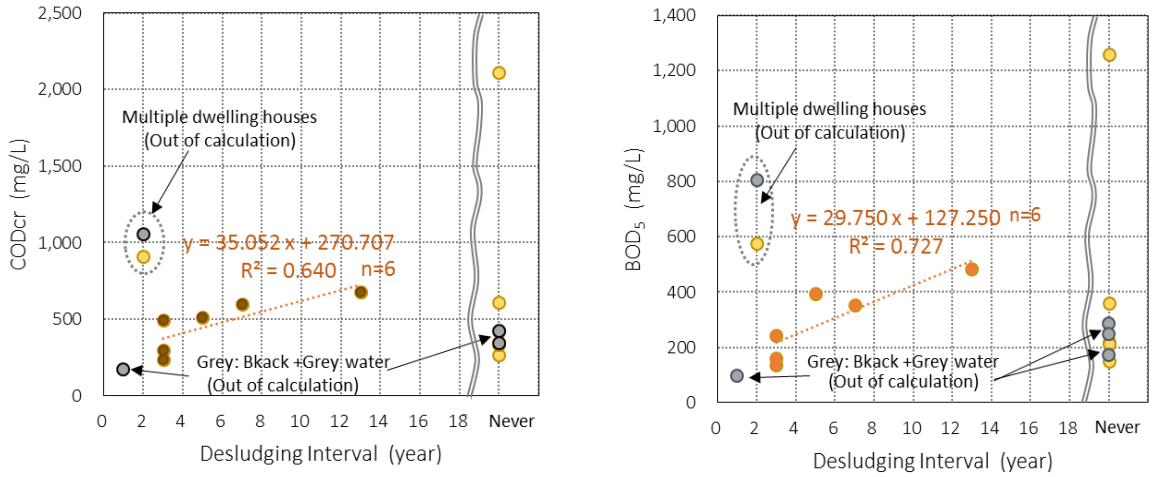
- Wastewater quality standards that can be referred for SDG indicator monitoring have been developed in Vietnam. In addition, evaluation criteria on treated domestic wastewater by on-site treatment system should be clarified.
- For developing SDG indicator monitoring, issues to be solved should be summarized, and step-by-step approach should be adopted.

(2) Issues to be discussed for Better Water Environmental Management

- Treated wastewater quality by on-site treatment system needs to be improved by enhancement of management activity, such as development of proper desludging system.

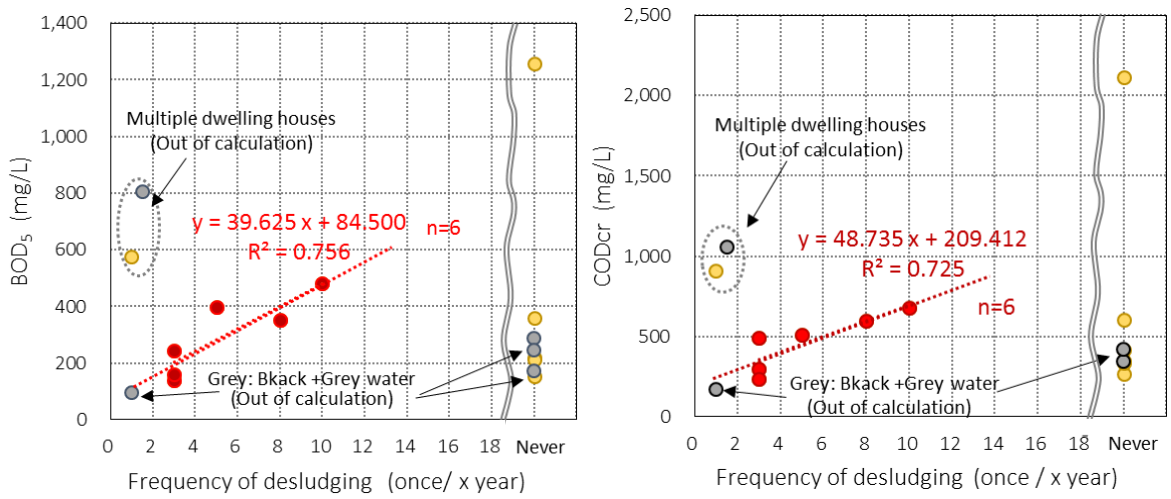
Summary on analyzing effluent water quality of septic tank as on-site treatment facility

According to this survey results, septic tank is not able to meet the BODCOD standards (Standard values of BOD are 30 mg/L for Class A, and 50 mg/L for Class B in QCVN14/2008/BTNMT). Thus, septic tank is not good enough to treat domestic wastewater safely. On the other hand, desludging is very important to improve effluent water quality of septic tanks.



Source：JST

Figure 3-2 Relationship between Desludging Interval and Effluent Water Quality from Septic Tank



Source：JST

Figure 3-3 Relationship between Frequency of Desludging and Effluent Water Qualityfrom Septic Tank

The following table shows the survey results of inflow and outflow of the wastewater from and to septic tanks treating black wastewater. Although the number of samples is limited, the removal ratios of pollutants by the septic tanks is affected by frequency of desludging. As a result of the Survey, it is recommended to conduct proper sludge treatment for improvement of domestic wastewater management.

Table 3-3 Estimated Removal Ratio by Existing On-site Treatment System

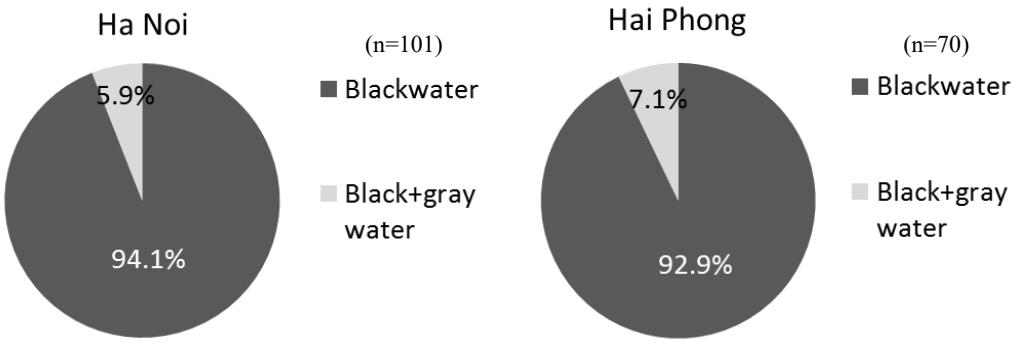
Household	Parameters	Inflow loads (Ave.) (g/day)	Outflow loads (Ave.) (g/day)	Removal ratios (%)	Condition of Desludging
Ha Noi Urban HN1HM1 8 person Desludge Never	BOD_5	73.4	54.5	25.83	Not conducted so far
	COD	100.9	77.2	23.47	
	SS	63.1	29.9	52.56	
	NH_4-N	21.19	15.65	26.17	
	T-N	45.61	36.24	20.54	
	T-P	8.527	7.712	9.56	
Ha Noi Rural HN2TR1 6 person Disludge 2008	BOD_5	85.7	33.3	61.18	Desludged in 2008 (General frequency of desluding is once in 10 years)
	COD	133.5	54.3	59.31	
	SS	55.8	13.8	75.72	
	NH_4-N	24.31	17.82	26.72	
	T-N	50.02	28.87	42.29	
	T-P	11.390	9.332	18.07	

Source：JST

Type of wastewater treated by septic tank

Regarding the type of wastewater flows into septic tank, most septic tanks treat blackwater only as shown in Figure 3-4.

Only 6% of septic tanks in Ha Noi and 7% of septic tanks in Hai Phong treat black water and greywater according to our interview survey.



Source：JST

Figure 3-4 Type of Wastewater Treated by Septic Tank in Ha Noi and Hai Phong

Based on the survey result mentioned above, almost all grey water in rural areas outside coverage area of centralized wastewater treatment plant are discharged to environment without proper treatment. The following table shows the estimated result of pollution load of black and grey domestic wastewater. It is necessary to improve grey domestic wastewater management system for better wastewater management in the future.

Table 3-4 Results of Pollution Load Estimation per units based on the Survey

Type	Households	Index	Ranges of values (g/cap/day)	Average (g/cap/day)	Other Survey 1) (g/cap/day)	Japanese standard 3) (g/cap/day)
Human Waste (Black water)	Ha Noi Urban (HN1HM1)	BOD_5	5.84 - 16.06	11.22	-	18.0
		COD	8.12 - 22.12	15.4	-	10.0
		T-SS	5.16 – 16.32	9.66	-	20.0
		T-N	5.24 - 8.78	6.84	6.3	9.0
		T-P	1.07 - 1.42	1.28	0.9	0.9
	Ha Noi Rural (HN2TR1)	BOD_5	11.46 - 24.11	15.92		18.0
		COD	17.23 - 34.95	24.68		10.0
		T-SS	8.69 - 13.32	10.37		20.0
		T-N	8.50 - 10.42	9.28	6.1	9.0
		T-P	1.80 - 2.44	2.11	1.0	0.9
Grey Water	Hai Phong Urban (HP1DK1)	BOD_5	24.8 - 61.91	47.33	-	40.0
		COD	76.38 - 130.30	105.84	37.0 2)	17.0
		T-SS	10.71 - 20.64	16.35	29.9 2)	25.0
		T-N	2.12 - 3.31	2.87	1.0 2)	2.0
		T-P	0.28 - 0.43	0.35	0.6 2)	0.4

1) Sybille Busser et al, 2007. Characteristics and Quantities of Domestic Wastewater in Urban and Peri Urban households in Ha Noi, Technical University of Zurich, Switzerland.
2) Results of the urban area in Ha Noi by the above study.
3) Japan Sewage Works Association, 2009. Japanese Sewer design guidelines

3.2.3 Trial Estimation of SDG6.3.1 in Vietnam

(1) Generated Domestic Wastewater

By the calculation methods proposed in section 3.2.1, tentatively the SDG monitoring indicator was calculated as follows.

[Generated Wastewater] = [Population] x [Daily water consumption per capita (L/cap/day)]

Table 3-5 Estimated Amount of Generated Domestic Wastewater in Vietnam

Area	Population	Daily water consumption per capita (L/cap/day)	Generated Wastewater Amount (m^3/day)
Urban area	31,067,500	150	4,660,125
Rural area	60,642,300	80	4,851,384
Total	91,709,800	-	9,511,509

Note: (1) Population was confirmed by Statistical Year Book 2015, published by GSO.
(2) Adopted daily water consumption per capita was from WHO pilot project report in Vietnam.

Table 3-6 Estimated Amount of Generated Domestic Wastewater in Hai Phong City

Area	Population	Daily water consumption per capita (L/cap/day)	Generated Wastewater Amount (m^3/day)
Urban area	832,200	150	124,830
Rural area	1148,600	80	91,888
Total	1.980,800	-	216,718

Note: (1) Population was confirmed by Statistical Department in Hai Phong City.
(2) Adopted daily water consumption per capita was from WHO pilot project report in Vietnam.

(2) Safely treated Domestic Wastewater

In this survey, effluent of centralized wastewater treatment plants operated in Vietnam generally satisfy wastewater discharge standards. The designed volume of 39 of the centralized wastewater treatment system operated in Vietnam was confirmed as 907,950 m3/day. Regarding the wastewater treated by on-site treatment system, it is considered as unsuitable wastewater quality according to this survey result. Therefore, tentatively, the amount of safely treated domestic wastewater is considered as 907,950 m3/day, if the 39 of the centralized wastewater treatment systems are fully operated. Comparing with estimated amount of generated domestic wastewater, the ratio of safe wastewater is approximately 10% of generated wastewater amount. The figure collected by this survey includes the treatment system collecting wastewater by interceptor system. In Vietnam, currently, interceptor system is the main one for collecting wastewater. The system also contributes to safe treatment of domestic wastewater.

Among the wastewater treatment systems confirmed as Canh Doi and Nam Vien WWTP in Ho Chi Minh City, many have separate systems. The amount of treated wastewater is 25,000 m3/day. Comparing with estimated amount of generated domestic wastewater, the ratio of safe wastewater is approximately 0.3% of generated wastewater amount.

In Hai Phong City, 36,000m3/day of wastewater is planned to be treated by centralized wastewater treatment plant. When the plant is operated, the amount of safely treated wastewater is estimated as shown the table below.

Table 3-7 Estimated Amount of Safely Treated Wastewater (Tentative)

Area	Amount (m^3/day)	Ratio of Safely Treated Wastewater (%)
Generated Domestic Wastewater	9,511,509	-
Treated Wastewater	907,950	10
Treated Wastewater (separate system only)	25,000	0.3

Source：JST

Table 3-8 Estimated Amount of Safely Treated Wastewater in Hai Phong City (Tentative)

Area	Amount (m^3/day)	Ratio of Safely Treated Wastewater (%)
Generated Domestic Wastewater	216,718	-
Treated Wastewater	36,000	16

Source：JST

(3) Generated Industrial Wastewater

The amount of generated industrial wastewater can be collected by inventory survey data. In this survey, JET could not collect industrial wastewater information in all provinces of Vietnam, but for 7 provinces wastewater information as shown in Table-10 were confirmed. Total amount of discharged wastewater from 7 provinces was 602,375 m^3/day, according to the information provided by MONRE.

Comparing the amount of industrial turnover of 7 provinces with the total turnover in Vietnam, the industrial turnover of 7 provinces occupies around 67% of the total in Vietnam. The generated wastewater amount is proportional to the amount of turnover. Therefore, considering the amount of industrial wastewater of 7 provinces as 602,375 m^3/day, the amount of generated industrial wastewater is around 905,000 m^3/day in total in Vietnam.

Table 3-9 Collected Inforamtion of Generated Industrial Wastewater from MONRE

Province	Wastewater Amount (m3/day)
Tp. Hồ Chí Minh	193,760
Bình Dương	136,000
Hà Nội	75,000
Bắc Ninh	65,000
Bà Rịa – Vũng Tàu	42,560
Nghệ An	26,578
Ninh Bình	13,000
Đồng Tháp	12,477
Khánh Hòa	10,000
Thanh Hóa	28,000
Total	602,375

Source：JST

(4) Safely treated Industrial Wastewater

The amount of safely treated industrial wastewater can be confirmed by the information of environmental check and inspection conducted provincial DONRE and the concerned organization. In this survey, JET could not collect the desired information from provinces. Therefore, the following rough estimation was conducted.

According to the inventory survey results conducted for 6 provinces (Thai Nguyen, Bac Giang, Bac Ninh, Bing Duong, and Dong Nai province and Ho Chi Minh city) by the JICA Project for

Strengthening Capacity of Water Environmental Management in River Basin, 90 % of the surveyed facilities have wastewater treatment plants, and around 80% of treated effluent satisfies wastewater discharge standards. From this information, the amount of safely treated industrial wastewater is around 650,000 m^3/day.

3.2.4 Findings in Vietnam and Recommendations for Other Countries

An Expert Group Meeting (EGM) to discuss on methodology for estimating SDG6.3.1 was held on 1-2 March. The discussion results were summarized as "Report of An Expert Group Meeting on Global Wastewater Monitoring for the SDGs." The discussion results of the EGM, and the proposal by this survey were compared and are summarized in the following Table.

Table 3-10 Comparison of Discussion Results by the EGM and Proposal by This Survey

Description in Report of Expert Group Meeting (EGM)	Findings and Issues in Vietnam	Recommendations for Other Countries
Methodological Issues		
It was concluded that for the indicator 6.3.1, percentage wastewater treated should be expressed in flowrates rather than populations. The update proposal proposes the use of wastewater flows estimated by applying a factor for all households with both piped and non-piped water supply. This ensures that the denominator includes estimates for both black and greywater generated by all households.	The proposal by this survey adopts same methodology proposed by the EGM. Regarding water usage amount, this survey proposes to use daily water consumption per capita, same as proposal of Annex I of the EGM. The proposed methodology can cover both black and greywater, and both piped and non-piped water supply.	The proposal by the EGM could be applied for other countries.
It was considered that, although wastewater flowrates should be measured for the indicator, the indicator should also report on the organic loads from all wastewater from domestic and industrial sources, as data becomes available. This is required to apportion responsibility for pollution, and to enable linkages to 6.3.2 to be progressively articulated.	Organic pollution load can be estimated by monitoring results in Vietnam.	For the countries which does not have monitoring system on organic pollutants, it is required to examine way of establishment of monitoring system for SDG indicator monitoring.
Greywater (wastewater produced by domestic settings excluding faucal matter) exerted a significant impact on ambient water quality and must be included in (or compensated for) in 6.3.1 calculations.	The proposed methodology of this survey covers grey water.	For each country, impact of grey water should be examined.
Urban runoff frequently includes a significant proportion of grey water.	The proposed methodology of this survey considers treated wastewater collected by interceptor system. The impact of grey water included in urban runoff should be examined.	Same condition in Vietnam could be examined where combined system on domestic wastewater treatment is applied.
The definition of 'safe treatment', and if it should be defined by technology or performance, was	In Vietnam, wastewater standards are regulated, and performance-based estimate is possible.	For the countries which does not have wastewater discharge standards, it is required to start the

Description in Report of Expert Group Meeting (EGM)	Findings and Issues in Vietnam	Recommendations for Other Countries
discussed. It was concluded that performance-based estimates are preferred where available and can follow the compliance to the national standards.	However, in case of performance base, specific treatment process (technology) to satisfy the performance is needed. (For instance, it seemed that Septic Tank treated wastewater e does not meet the standards, even if regular sludge removal is conducted). On the other hand, in case of technology base, the performance of specific treatment process (technology) should be evaluated and examined	activity to develop such standard immediately, and safely treated wastewater could be calculated by combination of performance base and technology base.
There is currently no agreed universal standard of parameter values.	Ditto	Ditto
At the present, few countries have treatment standards for treatment of fecal sludges and wastewater from onsite facilities, delivered to treatment works, by methods other than sewers. This means using the classification of "treated to national standards" will be a limiting factor in collecting this data.	In Vietnam, some concerned organizations managing treatment of fecal sludges in local administrative bodies such as SADCO in Hai Phong city, has data and information of desludging activity. Besides, the data and information needs to be updated periodically.	For other centuries who do not have proper monitoring system on fecal sludges treatment, it is requested to develop a system for monitoring on this item.
The stepwise approach for progressive wastewater monitoring was presented, with the aim of reducing the monitoring burden, particularly where resource constrained countries experienced difficulties.	Based on the Survey, necessity of enhancement of systematic data and information management system was confirmed. For enhancement management system, the stepwise approach is needed.	For other countries, the stepwise approach is needed.
Data Issues		
It was agreed that there was a significant scarcity of data for industrial wastewater production and treatment. Although many regulators and utilities (and some industries) have this data, it can be difficult to access.	Vietnam has same data issues pointed out in the EGM. It is necessary to improve for collecting and storing required information.	For other countries who have same issue, it is necessary to improve for collecting and storing required information.
Data for on-site systems is only available in a small number of countries.	In Vietnam, some concerned organizations managing treatment of fecal sludges in local administrative bodies such as SADCO in Hai Phong city, has data and information of desludging activity. Besides, the data and information needs to be updated periodically.	For other centuries who do not have proper monitoring system on fecal sludges treatment, it is requested to develop a system for monitoring on this item.
Data sharing between institutions within a country is not regularly undertaken.	Vietnam has same data issues pointed out in the EGM. It is necessary to improve existing condition on data sharing.	For other countries who have same issue, it is necessary to improve existing condition on data sharing.
Proposal for global wastewater monitoring for the SDGs		
The 6.3.1 indicator combines 2 sub-indicators:	The proposal by this survey adopts same methodology	For other countries, the proposal by this survey adopts the same

Description in Report of Expert Group Meeting (EGM)	Findings and Issues in Vietnam	Recommendations for Other Countries
6.3.1a Percentage of safely treated domestic wastewater flows *6.3.1b Percentage of safely treated industrial wastewater flows* These 2 sub-indicators do not capture all wastewater flows. They miss the wastewater flows discharged by institutions (schools, public health facilities, etc.) and by non-industrial commercial activities discharging to public sewers. However, it is likely that efforts to halve 6.3.1a and 6.3.1b in a country will also result in improving treatment of wastewater produced by these polluters. As such, if workable, they seem to fit the requirements of SDG indicators.	proposed by the EGM.	methodology proposed by the EGM.
Their combination will be possible at a later stage when data becomes available on their respective pollution loads (BOD5)	In Vietnam, generally, BOD5 is monitored at treatment facilities. Therefore, The SDGs monitoring by this indicator is available.	For other countries which does not have monitoring system on organic pollutants, it is required to examine way of establishment of monitoring system for SDG indicator monitoring.
	In case of interceptor system mostly used in Vietnam, wastewater collection area and wastewater treated population is not clear, and water quality of existing drainage channels and streams usually does not meet the standard.	Safely treated wastewater collected by Interceptor System would be estimated by the different method from that of sewer connected system (Design or actual flow rate of WWTP), and it is necessary to establish the data collection system (MOC, DOC, GSO, PC, service provider, etc.)
b) FLOWS released to an on-site system (improved septic tanks or pits) that includes treatment compliant with national and local standards (BOD removal from water before discharge) c) FLOWS released to an on-site system that is emptied regularly through pumping and septage is transferred to a treatment plant where is treated in compliance with local standards	Treatment performance of Septic Tank would be insufficient even if sludge in the tank would be emptied regularly through pumping and septage would be transferred to a treatment plant (Needs further study)	It is necessary to specify the on-site system that includes treatment compliant with national and local standards (Septic Tank?, Johkasou, Decentralized system) As the data of on-site system such as Joukasou and other type of decentralized system of which treatment performance meets the standards has not been collected by JMP, it is necessary to establish the data collection system for such kind of on-site system. (MOC, DOC, GSO, PC, Service provider, etc.)
There is not enough country data currently available on compliance with discharge permits.	Not enough data concerning total generated wastewater and safely treated wastewater	Producing of consistent industrial wastewater inventories Institutional arrangement and capacity development for monitoring of effluent water quality (Inspection) Creating the database relating to

Description in Report of Expert Group Meeting (EGM)	Findings and Issues in Vietnam	Recommendations for Other Countries
		EIA, Inventory, Monitoring (Inspection), Penal Provision, etc. It is necessary to establish the data collection system (MONRE, DONRE) In case of Industrial Wastewater connected to public WTTP (MONRE/DONRE, or MOC/, DOC, GSO, PC, WTTP O&M Service provider, etc.)

Source：JST

3.2.5 Recommendations for Proceeding SDG Indicator 6.3.1 Monitoring

To share the results of the pilot project and recommendations obtained by the Survey, a workshop was held on 30 May 2018 with several bilateral meetings to exchange opinions with key administrative organizations for proceeding SDG 6.3.1 monitoring activities in Vietnam.

(1) Workshop for Disseminating JICA Pilot Project Activities and Results

On 30 May 2018, under the charring of MOC, a workshop was held to share outcomes of the survey, and to discuss for proceeding SDG 6.1.3 monitoring. The summary of the workshop is shown in the table below.

Table 3-11 Summary of the Workshop on 30 May 2018

Items	Contents
1. Date and Time	Date: Wednesday, May 30 2018 Time: 8.30 a.m – 12.30 a.m
2. Venue	Movenpick Hotel, 83A Ly Thuong Kiet, Hoan Kiem, Hanoi
3. Participants (Person)	ATI (MOC): 5, WHO HQ Geneva: 1, WHO Vietnam: 1, JICA HQ: 2, JICA Vietnam: 2, JICA in MOC: 1, JICA Study Team: 2, JICA Expert Office in MOC: 1, Directorate of Water Resources (MARD): 2, National University of Civil Engineering: 3, JICA in MONRE: 1, Foreign Statistics and International Cooperation Dept. (GSO): 3, HEMA (MOH): 3, Hanoi DOC: 3, NCERWASS – MONRE: 1, BORDA Vietnam: 1, Hanoi Sewerage & Drainage Co.: 2, Center for Information (MOC): 1, Institute of Occupational Health & Environment (IOHE): 2, VWSA: 1 (Total: 38)
4. Main Agenda	6. Opening remarks 7. SDGs background and overview of the Pilot Study for testing methodology of wastewater monitoring for indicators of SDG 6.3.1 and WHO global perspective in wastewater monitoring. 8. Methodology and Results of pilot study and recommendations for wastewater monitoring in Vietnam 9. JICA activities on SDG Indicator 6.3.1 10. Discussion on the results of the pilot study and viewpoints of the JICA and WHO HQ 11. Brief introduction of GCF concept note and next steps of wastewater monitoring in Vietnam 12. Discussion on GCF Concept Note and next steps for Vietnam 13. Summary and conclusions
5. Discussion	・The study report states around 1,000 Johkasou units installed in Vietnam. If this figure is the number of Johkasou only, then other decentralized facilities should be also considered. (IESE) ・Cross-check with water supply amount at the local level might help to identify. JICA and WHO should consider the cross-check method. Black water normally goes to septic tanks, but a part of it still goes out directly to the environment, so the proposed wastewater diagram needs to be revised. ・Vietnam's GSO can propose the needs of water reuse indicator in the upcoming IAEG Meeting in October 2018. Final approval of this new indicator will take place only in 2020 when the full revision of the current indicator framework is completed. ・The study results are based on a really tiny number of samples, leading to illogic and

Items	Contents
	unreliability, which is though acceptable in such short implementation duration. (IOHE) ・It is necessary to choose a proper option of de-centralized treatment system to be applied. It is also necessary to consider an appropriate available technology considering required treated level in accordance with water quality of received bodies. ・Our survey is a pilot study, and further study will be required. (JICA Survey Team) ・It is recommended that GSO will modify questionnaire of annual household living standard survey to collect information related to septic tank wastewater to update required data and information for SDG6.3.1 monitoring regularly. ・It is recommended that the survey team should consider monitoring and calculating hospital wastewater separately from, industrial and commercial wastewater, and enhance the reliability of the survey results. ・The survey on decentralized systems with the volume and quality of wastewater should be implemented. This is a good chance for Vietnamese government and organizations to take act. ・In case of lack of resources for a nation-wide survey on wastewater treatment, it can be done at least at the regional level using lessons learned from other countries. ・It is recommended that the survey team considers which parameter should be used and allowable concentration level to determine safely treated wastewater. ・The toxicity of each type of wastewater should be considered and assessed in the context of Vietnam's sanitation to identify which factors affect Vietnam's environment. This should be done by not only JICA and WHO survey team, but Vietnamese ministries and sectors. ・In short, there are three priorities that need to be done, i.e. baseline setting, finalization of the SDG 6.3.1 baseline, and development and finalization of the GCF Concept Note. Instead of the 12-year timeline, WHO, JICA and Vietnam should work as a team together in one year on those three priorities to assess how much we make progress. ・With all precious comments from Vietnamese counterparts, the pilot study in Vietnam will contribute much to the global SDG monitoring methodology.

Source：JST

(2) Bilateral Meeting with GSO

A bilateral meeting was held with GSO on 31 May 2018. The summary of the bilateral meeting is shown in the table below.

Table 3-12 Summary of the Bilateral Meeting with GSO on 31 May 2018

Items	Contents
1. Date and Time	Date: 31 May 2018 (Thursday) Time: 10:15-11:45
2. Venue	Meeting room 1705 at GSO office, 54 Nguyen Chi Thanh, Lang Thuong, Dong Da, Hanoi
3. Participants (Person)	GSO: 3, WHO HQ: 1, WHO Vietnam: 1, JICA HQ: 2, JICA Vietnam Office: 2, JICA Study Team: 3 (Total: 12)
4. Main Agenda	1. Greeting and introduction 2. JICA project of SDG 6.1-6.3 in cooperation with WHO 3. Summary of the Final Workshop 4. Monitoring method and how to achieve SDG 5. Discussion
5. Discussion	Q-1: GSO has responsible for achieving SDG and should coordinate and collaborate with relevant agencies such as MOC and MONRE. Regarding this matter, do you have any idea? A-1: Recently. Decision 622 was issued by the Vietnamese government, and each ministry is responsible for each indicator. GSO plays the role of a coordinator to cover each indicator. Q-2: Do you have any future plans for SDG 6.3 on monitoring methodology and collection methods of water quality data? A-2: The future plan is to set up a monitoring process under the Decision and prepare the SDG action plan. ・The main point is "How we can modify the questions to ready for SDG monitoring". ・If you agree with the WHO proposal, it is fully possible to provide information and cooperation such as our project plan, cost estimate, water quality testing module, finance mechanism, necessary data collection etc. ・GSO should consider appropriate water quality standards while referring to the data provided by WHO. ・GSO should consider how to fill the blanks of the database matrix in collaboration with MOC

Items	Contents
	and MONRE. ・Adjust the data matrix and clarify the province responsible for each field. ・Furthermore, creating a discussion group is also effective for smooth operation. (JICA) ・GSO will carry out surveys while receiving technical assistance from WHO and finalize and provide national indicators as soon as possible. 6. ・If possible, I would like the WHO to prepare the fund for the water quality survey of domestic wastewater.

Source：JST

(3) Bilateral Meeting with HEMA

A bilateral meeting was held with HEMA on 31 May 2018. The summary of the bilateral meeting is shown in the table below.

Table 3-13 Summary of the Bilateral Meeting with GSO on 31 May 2018

Items	Contents
1. Date and Time	Date: 31 May 2018 (Thursday) Time: 13:30-14:45
2. Venue	Meeting room at HEMA office, 8 Tôn Thất Thuyết, Mỹ Đình 2, Từ Liêm, Hà Nội
3. Participants (Person)	HEMA: 5, WHO HQ: 1, WHO Vietnam: 1, JICA HQ: 2, JICA Vietnam Office: 2, JICA Study Team: 3 (Total: 14)
4. Main Agenda	1. Greeting and introduction 2. Outline of the SDG Project and GCF Project 3. Summary of the Final Workshop 4. The role of MONRE in building of wastewater database 5. Discussion
5. Discussion	・Regarding the GCF Project content, HEMA would pay more attention to drinking water, especially the drinking water quality. ・Vietnam's standards on drinking water quality are under revision and reduction in terms of the number of criteria to be tested following consultation from WHO's international experts and other countries. Then training and capacity building will be provided to central and local governmental officials to strengthen management on drinking water quality. ・HEMA will send that entire database to WHO for preparation of the application and to JICA study team for finalization of the study findings. ・13,000 medical facilities nationwide. ・40% of these facilities having wastewater safely treated that can be discharged directly to the environment ・Wastewater generation from hospitals only: 120,000m^3 per day. ・70% of wastewater from hospitals is safely treated. ・Wastewater from smaller-sized health establishments is not well treated yet, causing a big problem to Vietnam's environment.

Source：JST

(4) Bilateral Meeting with MONRE

A bilateral meeting was held with MONRE on 31 May 2018. The summary of the bilateral meeting is shown in the table below.

Table 3-14 Summary of the Bilateral Meeting with GSO on 31 May 2018

Items	Contents
1. Date and Time	**Date:** 31 May 2018 (Thursday) **Time:** 15:00-16:10
2. Venue	Meeting room at MONRE office, 10 Tôn Thất Thuyết, Mỹ Đình 2, Từ Liêm,
3. Participants (Person)	MONRE: 4, WHO HQ: 1, WHO Vietnam: 1, JICA HQ: 2, JICA Vietnam Office: 2, JICA Study Team: 3 (Total: 13)
4. Main Agenda	1. Greeting and introduction 2. Outline of the SDG Project and GCF Project 3. Summary of the Final Workshop 4. The role of MONRE in building of wastewater database 5. Discussion

Items	Contents
5. Discussion	・MONRE is the key implementer to build a database of wastewater generators nationwide, except wastewater from special establishments like those under Ministry of National Defense. ・Regarding further data on industrial and commercial wastewater, ICD will consult the new Dept of Environment Quality Management and provide the JICA study team later. ・As informed by ICD, a reporting mechanism is already developed to get wastewater data from ministries and industries, but due to poor enforcement, data collection is not so easy and inconsistent between data sources. ・Now, MONRE and other relevant ministries are working with each other to demarcate the roles of each one in wastewater management. The process is now ongoing and will take time to finish. ・About the roles of MONRE in GCF Project, MONRE will consider and respond to WHO as soon as possible. (MONRE)

Source：JST

(5) Final Seminar for Disseminating JICA Pilot Project Activities and Results

On 27 February 2019, under the charring of MOC, a final seminar was held to share outcomes of the survey, and to discuss for proceeding SDG 6.1.3 monitoring. The summary of the workshop is shown in the table below.

Table 3-15 Summary of the Final Seminar on 27 February 2018

Items	Contents
1. Date and Time	Date: Wednesday, February 27, 2019 Time: 8.30 a.m – 12.00 a.m
2. Venue	Movenpick Hotel, 83A Ly Thuong Kiet, Hoan Kiem, Hanoi
3. Participants (Person)	ATI (MOC): 5, JICA HQ: 2, JICA Vietnam: 2, JICA in MOC: 1, JICA Study Team: 2, JICA Expert Office in MOC: 1, JICA VSC; 1, National University of Civil Engineering: 2, JICA in MONRE: 1, Foreign Statistics and International Cooperation Dept. (GSO): 2, Hanoi DOC: 1, Hai Phong DOC: 1, Hai Phong SADCO: 2、Hai Phong Water Supply Company: 1, Hai Phong DONRE:1, RWSSP:2, NCERWASS – MONRE: 1, BORDA Vietnam: 1, , Institute of Occupational Health & Environment (IOHE): 2, VWSAE: 2, NGO:4 (Total: 36)
4. Main Agenda	1. Opening remarks 2. SDGs background and overview of the Pilot Study for testing methodology of wastewater monitoring for indicators of SDG 6.3.1 and WHO global perspective in wastewater monitoring. 3. Methodology and Results of pilot study and recommendations for wastewater monitoring in Vietnam 4. JICA activities on SDG Indicator 6.3.1 5. Discussion on the results of the pilot study and viewpoints of the JICA and WHO HQ 6. Brief introduction of GCF concept note and next steps of wastewater monitoring in Vietnam 7. Discussion on GCF Concept Note and next steps for Vietnam 8. Summary and conclusions
5. Discussion	・Currently, investments in WWTPs in industrial zones get much interest from private sector and that can be learned to step by step privatize the public sewerage system. This requires the macro management especially in financial policy/mechanism by both central and local governments, as well as awareness enhancement. ・To effectively privatize the wastewater sector, it is significantly important to

Items	Contents
	have concrete legislation for easy management. ・It is important to develop the financial mechanism which should be proper and transparent to get interest from private sector, and task sharing as well as good balance between water supply, wastewater management and septage management. ・It is necessary to focus on rural WW treatment, which should be paid more attention to so that the proposed monitoring methodology can be useful nationwide ・It is necessary to examine resource recovery and waste reuse towards achievement of a green economy which Vietnamese Government is committed to follow. ・For SDG6.3.1, monitoring methodology and measures to achieve the indicator should be interrelated. That means solutions should be suggested after the study on how to assess wastewater that is safely treated. ・The proposed monitoring methodology is a bit complicated and should be simplified, e.g. the ratio of treated wastewater is the total capacity of WWTP divided by the total amount of tap water supply. ・MOC should proactively participate in WEPA and AWaP for firstly partnership and secondly enhancement of knowledge and information on effective WW management. This idea is strongly recommended to be included in the final report. ・A good way to move forward in achievement of SDG 6.3.1 is setting the final goal and finding practical steps to gradually get to it, both of which are essential to make it happen.

Source：JST

4 Recommendation and Conclusion

4.1 Definition of SDG6.3

Discharged wastewater will influence the ambient water quality. Therefore, safely treated wastewater (6.3.1) is required to achieve Good ambient water quality (6.3.2) for sound ecosystems in a river basin.

(1) SDG 6.3.2 Good ambient water quality

- It is considered that "Good Ambient Water Quality" is "Environmental Water Quality Standard", which is desirable standards to protect human health and preserve the living environment
- Required "Good Ambient Water Quality" (Environmental Water Quality Standard) in terms of living environment would be different depending on the regional, social, economic condition.
- SDG 6.3.2 can be monitored by the achievement rate of environmental water quality standard in public water zones (Surface water, marine water and groundwater)

In Vietnam, environmental standards are designated for surface water, ground water, and coastal water. For surface water, "QCVN08: 2008/BTNMT is regulated. In the regulation, surface water standards are categorized by objectives of water use; "A-1" for domestic water, "A-2" for domestic water with appropriate treatment, "B-1" for irrigation water, and "B-2" for other purpose.

Currently, the categorization of environmental standards are not designated for all river sections. It is recommended to identify required water quality using the categorization of QCVN08: 2008/BTNMT.

(2) SDG 6.3.1 Safely treated wastewater (Effluent water quality regulation for achievement of SDG6.3.2)

- Safely treated" is defined as meeting national or local treatment standards for discharge of treated effluents.
- Requested effluent water quality (regulation of the effluent water quality) would be different depending on the required desirable ambient water quality.
- Necessary effluent water quality (regulation of the effluent water quality) from pollution source (Industries, WWTP, etc.) would be decided to meet Environment Standards (Desirable ambient water quality).

In Vietnam, effluent standards are designated by type of wastewater. For domestic and commercial wastewater, QCVN14:2008/BTNMT is adopted. For industrial wastewater, generally, QCVN40:2011/BTNMT is adopted, and there are several effluent standards on specific industries. These wastewater standards were regulated by type of water usage of surface water receiving wastewater; "A" for domestic water, and "B" for other purpose.

Currently, level of wastewater treatment designated by wastewater discharge standards, such as level "A" and level "B" are not always consistent with level of environmental standards of received water

bodies in Vietnam. It is recommendable to enhance the discussion on the relationship between level of wastewater discharge standards set and level of water environmental standards of receiving water bodies.

(3) Necessary treatment level of safely treated wastewater

- Technology evaluation on the wastewater treatment process (On-site/ Off-site, Aerobic/Anaerobic, Treatment Level: Primary, Secondary, Advanced, etc.) is necessary to develop the wastewater treatment plan in the river basin.

As a result of the survey, the several common design standards were confirmed as shown in Chapter 2. For septic tank, technical standard on septic tank (TCVN 10334:2014) provided by Vietnam Concrete Association was confirmed.

For proper and efficient wastewater treatment, necessary wastewater treatment level needs to be clarified to meet the regulated value. Necessary level of safely treated wastewater (regulation value) would be decided based on the condition of receiving water body, and appropriate technology is needed to meet the regulation.

To do so, technology evaluation, formulation of design and O&M manual, technology guideline, etc. are necessary.

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4.2 Monitoring Methodology

SDG indicator 6.3.1 is defined as the proportion of wastewater safely treated. The monitoring of indicator SDG 6.3.1 is useful to recognize the present situation and the progress regarding safely treated wastewater and to evaluate the effectiveness of the project and/or the policy for the achievement of SDG. The safely treated wastewater could be obtained by well-designed facilities which are managed properly with regular quality monitoring based on the appropriate planning and legal framework. To conduct the monitoring of SDG indicator effectively and to actualize proper wastewater treatment and accelerate achieving SDG 6.3.1, following factors including suggestion are important.

(1) Monitoring of SDG Indicator SDG 6.3.1

Reliable, consistent and, whenever possible, disaggregated data are essential to stimulate political commitment, inform policy-making and decision-making, and trigger well-placed investments towards health, environment and economic gains (SDG 6 Synthesis Report on Water and Sanitation).

(a) Institutional and Management Arrangements:

Clear demarcation on role of central and local government for SDG indicator monitoring

Table 4-1 Expected Actions for Enhancing Wastewater Monitoring Data and Information System

Type of Wastewater	Information to be collected	Concerned Organization		Relevant Law
		National Level	Local Level	
Domestic Wastewater				
Centralized wastewater system	Amount of actual wastewater treatment and treated wastewater quality data and information should be centralized to MOC	MOC	DOC and concerned drainage and sanitation companies	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
De-centralized wastewater treatment system	Population treated by de-centralized wastewater treatment system and treated wastewater quality data and information should be centralized to MOC	MOC	DOC and companies in charge of de-centralized wastewater treatment system	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
On site treatment system	Data and information on-site treatment system should be updated and summarized.	GSO, MOH, MOC	DOC and concerned drainage and sanitation companies	Decree 80/2014/ND-CP on Urban Drainage and Wastewater Management
Industrial Wastewater				
Industrial Zone	Amount of actual discharged and treated wastewater treatment and treated wastewater quality data and information should be centralized to MONRE	MONRE	Industrial Zone Management Boada and DONRE	LEP Decision 140/2018/QD-Ttg
Outside industrial zone	Amount of actual discharged and treated wastewater treatment and treated wastewater quality data and information should be centralized to MONRE	MONRE	DONRE	LEP Decision 140/2018/QD-Ttg

Source：JST

(b) Institutional and Management Arrangements: Clear demarcation on role of central and local government for SDG indicator monitoring (Ref p.89)

Related ministries: MOC, DOC (Urban and concentrated rural residential areas; Domestic wastewater: On-site, Off-site)

MONRE, DONRE (Industrial Wastewater)

MOC or MONRE (Industrial Wastewater connected to public WTTP)

MARD, DARD (Rural Areas; Domestic wastewater: On-site, Off-site)

GSO (SDG 6.2, JMP)

(c) Domestic Wastewater (Off-site)

Current Situation in Vietnam

- Sewer connected system: Data collection of SDG Indicator 6.2 would be applicable. (Population base)

- Interceptor system mostly used in Vietnam (Interceptor Sewers which are constructed along main river receive the wastewater from existing numerous drainage channels and streams connected to the river and convey it to a WWTP) :

  Wastewater collection area and wastewater treated population is not clear.

  Water quality of existing drainage channels and streams usually does not meet the standard, because treatment performance of Septic Tank is insufficient, and most Septic Tanks treat only human excreta. In addition, the pollution load of grey water which is not usually treated by Septic Tanks

Recommendations

- Safely treated wastewater collected by Interceptor System would be estimated by a different method from that of sewer connected system (Design or actual flow rate of WWTP)
- In case of interceptor system, it is necessary to establish the data collection system (MOC, DOC, GSO, PC, Service provider, etc.)

(d) Domestic Wastewater (On-site)

Current Situation in Vietnam

- According to the study, treatment performance of Septic Tank wasinsufficient even if sludge in the tank was emptied regularly transferred to a treatment plant (Needs further study and discussion whether Septic tank effluent water is safely treated or not, even if sludge is removed regularly)

Recommendations

- It is necessary to specify the on-site system that includes treatment compliant with national and local standards (Septic Tank, Johkasou, Decentralized system)
- Since the data of on-site system such as Joukasou and other types of decentralized system in which treatment performance meets the standards has not been collected by JMP, it is necessary to establish a data collection system for such kind of on-site system. (MOC, DOC, GSO, PC, Service provider, etc.)
- If the data of Septic Tank collected by JMP is used in SDG 6.3.1, it's necessary to evaluate and examine the treatment performance of Septic Tank whether the effluent water quality meets the standards or not.
- Safely treated wastewater should be calculated by combination of performance and technology analysis. (Specific treatment process (technology) is needed to satisfy performance, and the performance of specific treatment process (technology) should be evaluated and examined.)
- Level of safely treated wastewater should be decided based on the condition of receiving water body related with SDG 6.3.1 (Good Ambient Water Quality)

(e) Industrial Wastewater

Current Situation in Vietnam

- Not enough data concerning total generated wastewater and safely treated wastewater

Recommendations

- Producing of consistent industrial wastewater inventories
- Institutional arrangement and capacity development for monitoring of effluent water quality (Inspection)
- Creating a database relating to EIA, Inventory, Monitoring (Inspection), Penal Provision, etc.
- In addition to the monitoring and penal provision, consultation to industries (persuade industries to take countermeasures for pollution prevention) would be effective for industrial wastewater management)
  - Increasing the awareness of environment
  - Provision of the treatment process information depending on the type of industry
  - Financial support if any (Low interest loan, tax reduction, etc.)
  - Advise to formulate industrial wastewater management system
  - Designated engineer who has responsibility for wastewater management
  - Certification program for designated engineer
- It is necessary to establish the data collection system (MONRE, DONRE)
- In case of Industrial Wastewater connected to public WTTP, monitoring of effluent water quality of industrial wastewater (necessary data collection for SDG) should be by MONRE/DONRE, or MOC/, DOC, GSO, PC, WTTP O&M Service provider, etc.

(f) Database on houses of which ST sludge is removed regularly (SDG 6.2)

For monitoring SDG , it is important to develop necessary database including the following data; (a) Total num, ber of households, (b) total number of sanitation facilities for households (Number of septic tanks), (c) Desludging frequency and desludged amount from each household, and (d) annual operation days.

For developing SDG indicator monitoring, it is recommended to summarize issues and develop monitoring plan with step-by-step approach. The stepwise approach for progressive wastewater monitoring was presented, with the aim of reducing the monitoring burden, particularly where resource constrained countries experienced difficulties. Based on the Survey, necessity of enhancement of systematic data and information management system was confirmed. For enhancement management system, the stepwise approach is needed.

4.3 Achievement of SDG 6.3.1

To achieve the SDGs relating to wastewater management and sanitation, there are several issues to be solved. In many countries, emphasis for infrastructure development was put mainly on industry but not so much on living and water environment, which enabled a remarkable economic growth. The

concentration of population in cities and the development of industries accelerated the demand of water and pollution load on the environment. However, safely managed sanitation services were insufficient. Domestic and industrial wastewater was not well controlled and managed. Mainstreaming of water, sanitation and wastewater management is necessary, and for sustainable sanitation and wastewater management, in addition to the construction of the facilities, issues regarding following aspects (soft component) are needed.

1) Policy Making,
2) Rational Planning
3) Technology development, Technology evaluation, Formulation of manuals
4) Financial Mechanism,
5) Public Relation and Citizen's Participation,
6) Institutional Arrangements including Capacity Development, and
7) Establishment of Legal System, and
8) Linking and disseminating national, regional and global information and knowledge

(1) Policy making for achievement of SDG

- SDG indicators are useful to recognize present situation and progress and effective to evaluate the policy and/or project.
- It is quiet important that GSO, relating ministries and organizations monitor the SDGs indicator and deliver these results to policy makers to develop strategies, policy and national plan for the achievement SDGs.

In Vietnam, The National Action Plan to implement the 2030 Agenda for SDGs (SDG NAP) was promulgated as per Decision 633/QD-TTg dated 10 May 2017 of the Prime Minister, in which 17 SDGs of Vietnam towards 2030 have been set including 115 specific targets, in corresponding with global SDGs targets which were approved at the Summit Meeting of the UN in September 2015.

In January 2019, MPI issued a Circular 03/TTBKHTT on Sustainable Development Statistical Indicators. The Circular has (a) List of Sustainable Development Statistical Indicators of VN (15 goals with 2 roadmaps from 2019 and 2025), and (b) Content of Sustainable Development Statistical Indicators of VN (incl. definition, calculation method, deaggregation, data source, in-charge agency). In the Circular, there is no description on particular calculation manner of safely wastewater.

As a result of interview survey with GSO in March 2019, JST found that GSO is designated as secretariat of SDG monitoring by Prime Minister Office in nationwide in Vietnam.

As mentioned above, in Vietnam, policy framework and basic institutional mechanism for achievement of SDG6.3.1 and monitoring indicators is being prepared. To proceed the SDG6.3.1 monitoring and achieve the goal, it is recommended to prepare particular instructions for monitoring the indicator, developing the policy and implementing the developed policy.

(2) Planning

1) National Development Plan
   (Long-Term Program for Promotion of Wastewater Management)
   Formulation of short, middle and long term planning reflecting the indicator to achieve SDG 6.3 based on the effective strategy
2) Step wise approach
   Final stage at target year in the planned area for Sewerage systems
   Decentralized Systems (Comprehensive basin wide planning)
3) Zoning of Sewerage Systems and On-site Systems
   Cost Comparison between Off-site and On-site
4) Transition stage in the area of Sewerage Systems:
   Simplified sewerage systems: WWTP + Interceptor + Septic tank

During the survey, JST found that Haiphong city's wastewater treatment will be combination of centralized and decentralized treatment system. In March 2018, Hai Phong city designated a zoning plan of on-site and off-site treatment system by Decision no.626/QĐ-UBND on Approval of Sewerage Planning to 2025, vision towards 2050.

To achieve this kind of plan, stepwise approach needs to be adopted. It is important to formulate short, middle and long term planning reflecting the indicator to achieve SDG 6.3 based on the effective strategy and policy relating to above mentioned aspects.

When wastewater management plan is formulated, it is recommendable to achieve basin-wide planning approach. The approach can be developed by "pollution load analysis". By pollution load analysis, based on the coordination of stakeholders effective treatment systems planned for the river basin to meet the environmental water quality standards. For the analysis, the generated and discharged load (pollution load of human excreta and grey water, performance of treatment process) and the run-off ratio in the river basin is needed.

Table 4-2 Example of Stage of Sewerage System Development

<table>
<tr><th>Stage</th><th>System</th></tr>
<tr><td>Transition stage</td><td>Simplified sewerage systems: WWTP + Interceptor + Septic tank

- Existing interceptor system need to be reviewed, and improved as necessary, such as improvement of slope condition or

- It is difficult to introduce sewer pipe network immediately, so realistic schedule needs to be prepared for developing desirable final stage sewer system.

- Necessity of ST sludge removal would be decided depending on the condition of existing drainage system (flow velocity, settlement of sludge, etc.).</td></tr>
<tr><td>Final stage</td><td>Proper combination of sewerage system and decentralized system needs to be planned.

<table><tr><th>Sewerage systems</th><th>Decentralized Systems</th></tr><tr><td rowspan="3">Combine or Separate System</td><td>1.Community based sewerage system (Mostly separate system)</td></tr><tr><td>2. On-site aerobic wastewater system (Joukasou, etc.)</td></tr><tr><td>3. On-site anaerobic wastewater system(Septic tank with regular sludge removal, compost toilet)</td></tr></table></td></tr>
</table>

(3) Technology Options

1) Wastewater treatment process, Reliable facilities and equipment, O&M measures
- For safely treated wastewater, specific treatment process (technology) to meet the effluent water quality standards is requested, and the performance of specific treatment process (technology) should be evaluated and examined.
- Based on the evaluation of the treatment process (technology), formulation of design and O&M manual would be requested to treat wastewater safely and steadily.
- Innovation of technology will accelerate the efficiency of wastewater treatment and management and have an impact on existing systems

2) Septage Management
- Formulation of Database of households
- Planning on sludge removal and transportation
- Treatment process for collected sludge
- High BOD, N, P (Difficulties of biological removal of N because of low C/N)
- Effective final sludge disposal measures (Reuse of sludge)

As a result of the survey, the several common design standards were confirmed as shown in Chapter 2. For septic tank, only technical standard on septic tank (TCVN 10334:2014) provided by Vietnam Concrete Association was confirmed.

For proper and efficient wastewater treatment, necessary wastewater treatment level needs to be clarified. Necessary level of safely treated wastewater would be decided based on the condition of receiving water body. Considering water quality condition at intake point, necessary level of safely treated wastewater need to be regulated.

Currently, Hai Phong SADCO treats septage, and plans to improve Tran Cat Treatment Plant. In future, not only treatment of BOD but also nutrients such as N and P included in hydrolyzed water from septage need to be treated.

(4) Financial System and Mechanism

"The efficiency of existing financial resources and mobilizing additional and innovative forms of domestic and international finance must be increased." (SDG 6 Synthesis Report on Water and Sanitation)

- Establishment of construction and O&M cost sharing principles (3T: Tariff, Tax, Transfer)
  In Japan, Sewerage Finance Research Committee was established to study the role and responsibility of central and local government and citizens (polluter/customer/beneficiary) and a rational cost sharing for sewage works.
- The sewerage systems constructed with national and local budget should be managed in a stable and sustainable way.
  In Japan, under the Local Government Finance Act, public sewerage systems are managed by public enterprises which adopt the principle of self-support accounting system to cover costs from the income and maintain it on a self-sustaining basis.)
- Increase of the awareness and understanding of citizens as tax payers and users
- Necessity of asset management by taking the following aspects into consideration
  - Long-term basis forecast of income and expenditures considering the lifespan of the facilities and the increased numbers of users
  - Appropriate economic management based on tangible business
  - objectives, precise business analysis and future business prospects

- Accountability and disclosure of management information to the
- citizens, tax payers and users who bear user charge

➢ For Septage management, there are following two types tariff collection options

(1) Direct tariff collection from users (Depending on the willingness to pay)

If users would pay sludge removal tariff to public authority and sludge collecting company would receive it at sludge treatment site, illegal dumping would be eliminated.

(2) From water supply fee which including ST sludge tariff

➢ For sewerage systems, there are also following two types tariff collection options

(1) Direct tariff collection from users (Depending on the willingness to pay)

(2) From water supply fee which including ST sludge tariff

Through the survey, JST confirmed financial resourse for wastewater management in Hai Phong City. In Hai Phong City, wastewater discharge fee collected as 20 % of water supply fee. The amount of collected wastewater fee in Hai Phong City is around 90 billion VND in 2017. However, the wastewater fee is once combined with other revenue, and used as general account budget. To operate new centralized wastewater smoothly, it is required to clarify usage of wastewater discharge fee by each objective.

(5) Public Relation

Willingness to pay greatly depends on how citizens are aware of and evaluate the following benefits of sanitation systems (Importance of Awareness and Understanding of Sanitation Systems Benefits

1) Improvement of Surrounding Environments
   Examples of benefits;
   Hygiene status, eradication of mesquites, flies,
   People's comfort, use of flush toilet, elimination of odor problems, etc.
   Reduction of Waterborne Diseases
2) Water Quality Preservation in Public Water Bodies
   (1) Improvement of the value of water environment for citizens
   (2) Cost reduction to uptake the water for drinking, industrial use, agricultural use, etc.
   (3) Damage cost of agriculture by discharging of untreated wastewater
   (4) Damage cost of fishery by discharging of untreated wastewater
   (5) Alternative method for dredging (without sewage works, dredging is required)

Hai Phong SADCO implements awareness raising activities every year to raise awareness on effectiveness of desludging for improvement of water environment by selecting several Wards in Hai Phong City continuously.

Willingness to pay greatly depends on how citizens are aware of benefits of sanitation systems. It is necessary to continue effort on disseminating benefits of sanitation systems.

(6) Institutional Arrangement

- Role of Central Government and Municipality
- Project Implementation Organization (Project Responsible Organization)
- Private Sector Participation, Public Private Partnership (Share of Responsibilities, Risk management)
  (Service Contract, Managing Contract, Lease, Concession, Privatization, BOT. etc.)
- Human Resource Development: On-the-Job Training, Training Program
- Capacity Development (JS Training Center, Vietnam; VSC)
- Research and Technology Development (JS R&D Division, Vietnam; VSC)
- Technical Support to Middle-Small Scale Municipalities (JS: Japan Sewage Works Agency, Vietnam; VSC)

Considering current demarcation of the concerned organizations, following institutional arrangement is considered for achievement of SDG6.3.1 monitoring indicators. For achievement of SDG6.3.1 monitoring indicators, it is necessary to prepare clear instructions on actions to be conducted related to SDG6.3.1 monitoring indicators for each concerned organization.

Domestic Wastewater		Industrial Wastewater	
Developing policy and plan	Implementation of management activity	Developing policy and plan	Implementation of management activity
MOC, MOH, MARD	City / provincial DOC, DARD Wastewater management company	MONRE	City / provincial DONRE City / provincial inspection department Industrial Zone Management Board Economic Zone Management Board

(7) Laws and regulation

1) Sets up the Environmental Quality Standards
   (a) Items on Protection of Human Health
   (b) Items on Conservation of living Environment (Classified based on Water Usage)
2) Countermeasures for Pollution Control
3) Effluent Wastewater Standards from specified facilities
4) Laws regarding Sewerage Systems
   (a) Purpose of Sewerage
   (b) Comprehensive Basin-wide Sewerage Development Program
   (c) Administration of Sewage works
   (d) Procedures for Development of Sewerage Systems
   (e) Use of Sewer Systems (House Connection, Switching to Flush Toilets, Users Charge)
   (f) Formulation of project planning
   (g) Standards on Structure (technical standards, effluent water quality, examination of treated wastewater)
   (h) Financial arrangement (Construction cost, O&M cost, Financial Source)
   (i) Industrial wastewater connecting to Sewerage Systems
5) Laws regarding on-site Systems
6) Waste Management and Public Cleaning Act

As described in former sections, Vietnam has The Decree on Water Drainage and Wastewater Treatment (No.80/2014/ND-CP) stipulates provides for water drainage and wastewater treatment activities in urban areas, industrial parks, economic zones, export-processing zones and hi-tech parks, and concentrated rural residential areas as well as rights and obligations of organizations, individuals and households engaged in water drainage and wastewater treatment in the Vietnam. Based on the Decree, as necessary, it is expected to develop supporting regulation or guidelines for enhancement of commitments on items mentioned above, such as formulation of sewer planning, financial arrangement and so on.

(8) Linking and disseminating national, regional and global information and knowledge

WEPA: Water Environment Partnership in Asia

WEPA is a knowledge network programme established in 2004, with 13 countries in Asia. This program aims to improve the water environment in Asia by providing partner countries with necessary, relevant information and knowledge to strengthen water environmental governance.

AWaP: Asia Wastewater Management Partnership

AWaP was established on July 2018. This partnership will organize a regular meeting to share good practices and technologies, provide knowledge and know-how, and tackle with common issues in collaborative projects of partner countries.

The issues covered by AWAP will be above mentioned aspects (Technology Option, Institutional Arrangements including Capacity Development, Legal System, Public Relation and Financial System and Mechanism) for achieving SDG 6.3.1 except Formulation and Monitoring of Environmental Water Quality Standards which are covered by WEPA for mainly achieving SDG 6.3.2.

4.4 Future Direction for the Achievement of SDG 6.3.1 in Vietnam

Based on the results of the study, especially final recommendation and conclusion, it is important to consider detailed activities relating to the recommended issues to move forward for the achievement of SDG6.3.1.

In this case. based on the results of the study, it is considered that future activities to formulate the guideline to MOC and provincial / city PC regarding following issues is effective for the submission of the report on SDG indicator to GSO requested by newly decided prime minister's decision (Circular no.03/2019/TT-BKHĐT), development of national planning of wastewater management, and AWaP activities.

1. Definition of SDG
2. Monitoring Methodology (Part A Domestic Wastewater)
3. Achievement of SDG
    2) Planning: Stepwise approach; Final stage and Transition stage (Interceptor)

For other issues, it is effective to discuss and examine the future activities how to accomplish "National Action Plan for the Implementation of the 2030 Sustainable Development Agenda" in the newly formulated study group or task force consisting of central and local government, project implementing organization, service provider, university, research institute, private sector, etc. taking into consideration of the analysis of current situation in Vietnam and experiences in Japan described in the study and ongoing JICA project relating to VSC. watershed management, etc.

As for the study group, depending on the issues, formulation of two types study group (Technology Study Group and Policy Study Group) will be effective to discuss and examine the future activities.

2. Monitoring Methodology

Part B Industrial Wastewater (Technology Study Group)

3. Achievement of SDG

1) Policy making (Policy Study Group)

2) Planning: National Wastewater Management Plan (Policy Study Group)

3) Technology Development and Evaluation (Technology Study Group)

4) Financial Mechanism (Policy Study Group)

5) Public Relation (Policy Study Group)

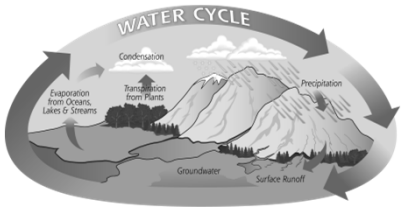
6) Institutional Arrangement: PPP (Policy Study Group), Capacity Development (Technology Study Group)

7) Legal System (Policy Study Group)

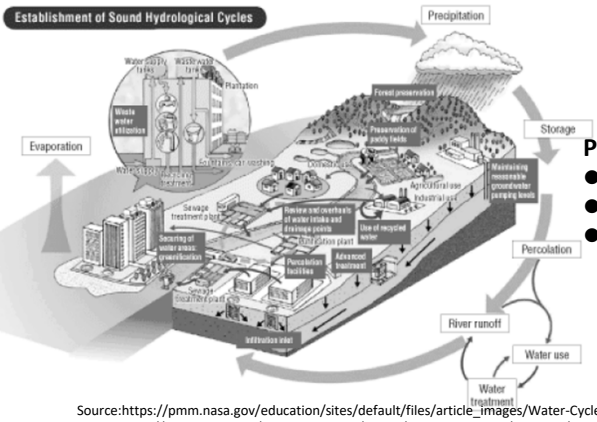
APPENDIX

1. MONITORING METHODOLOGY

Safely treated wastewater (6.3.1)
is required to achieve
<u>Good ambient water quality(6.3.2)</u>
for sound ecosystems
in a river basin.



Discharged wastewater will influence the **ambient water quality**.



Pollution Source

- Domestic Wastewater
- Industrial Wastewater
- Nonpoint Source (Fields, Run-off water from roads, etc.)

Source:https://pmm.nasa.gov/education/sites/default/files/article_images/Water-Cycle-Art2A.png
http://www.mlit.go.jp/tochimizushigen/mizsei/water_resources/contents/responding_properly.html

1

1.1 GOOD AMBIENT WATER QUALITY [EXPERIENCE IN JAPAN]

ENVIRONMENTAL PROBLEMS IN JAPAN

<u>Rapid Economic Growth →</u>

<u>Serious Environment Pollution / Destruction of Nature</u>

<u>Implementation of Several Measures</u>

Environmental Standard, Effluent Regulation,
Environmental Pollution Control Program,
Promotion of Sewage Works,
Industrial Wastewater Management, etc.

<u>New Tasks for Future</u>

Global Warming, Sustainable Development, etc.

2

Establishing Environmental Standards to improve the water environment

Environmental Standards ⇨ Good Ambient Water Quality

- **Desirable Standards**
  to protect human health and preserve the living environment;
- **Policy Objectives of the Government**

In Article 16 of the **Basic Environment Law**, setting of environmental goals is determined as follows.

- Environmental quality standards for air pollution
- Environmental quality standards for noise
- **Environmental quality standards for water pollution**
- Environmental quality standards for soil pollution

3

Environmental Quality Standard for Water Pollution

Environmental quality standards for water pollution in public water bodies were established for the first time by a Cabinet resolution on April 21, 1970.

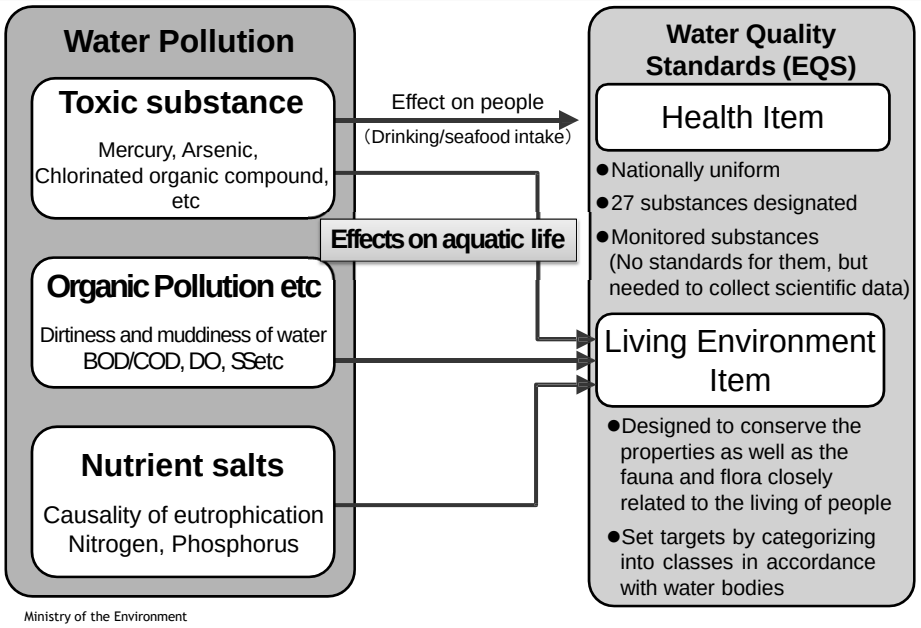
-Environment standards relating to protecting human health (Parameters related to health)
- itai-itai disease ;chronic cadmium
- Minamata disease; methyl mercury compound

Environment standards relating to preserving the living environment (Parameters related to living environment)
BOD, COD, pH, etc.

4

Water Environment Quality Standards (EQS)

Ministry of the Environment



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2

■ Environmental quality standards for human health

Standards

Item	Standard values
Cadmium	≤ 0.01 mg/L
Total cyanide	Not detectable
Lead	≤ 0.01 mg/L
Hexavalent chromium	≤ 0.05 mg/L
Arsenic	≤ 0.01 mg/L
Total mercury	≤ 0.0005 mg/L
Alkyl mercury	Not detectable
PCBs	Not detectable
Dichloromethane	≤ 0.02 mg/L
Carbon tetrachloride	≤ 0.002 mg/L
1,2- Dichloroethane	≤ 0.004 mg/L
1,1-Dichloroethylene	≤ 0.02 mg/L
Cis 1,2-Dichloroethylene	≤ 0.04 mg/L
1,1,1- Trichloroethane	≤ 1 mg/L
1,1,2- Trichloroethane	≤ 0.006 mg/L
Trichloroethylene	≤ 0.03 mg/L
Tetrachloroethylene	≤ 0.01 mg/L
1,3-Dichloropropene	≤ 0.002 mg/L
Thiram	≤ 0.006 mg/L
Simazine	≤ 0.003 mg/L
Thiobencarb	≤ 0.02 mg/L
Benzene	≤ 0.01 mg/L
Selenium	≤ 0.01 mg/L
Nitrate nitrogen and nitrite nitrogen	≤ 10 mg/L
Fluoride	≤ 0.8 mg/L
Boron	≤ 1 mg/L

Monitored substances and guideline values

Categories	Guideline values
Chloroform	≤ 0.06 mg/L
trans1,2-Dichloroethylene	≤ 0.04 mg/L
1,2- Dichlor propane	≤ 0.06mg/L
p- Dichlor benzene	≤ 0.2 mg/L
Isoxathion	≤ 0.008 mg/L
Diazinon	≤ 0.005 mg/L
Fenitrothion (MEP)	≤ 0.003 mg/L
Isoprothiolane	≤ 0.04 mg/L
Oxine copper (organocopper)	≤ 0.04 mg/L
Chlorothalonil (TPN)	≤ 0.05 mg/L
Propyzamide	≤ 0.008 mg/L
EPN	≤ 0.006 mg/L
Dichlorvos (DDVP)	≤ 0.008 mg/L
Fenobucarb (BPMC)	≤ 0.03 mg/L
Iprobenfos (IBP)	≤ 0.008 mg/L
Chlornitrofen (CNP)	–
Toluene	≤ 0.6 mg/L
Xylene	≤ 0.4 mg/L
Diethylhexyl phthalate	≤ 0.06 mg/L
Nickel	–
Molybdenum	≤ 0.07 mg/L
Antimony	≤ 0.02 mg/L
Vinyl chloride monomer	≤ 0.002 mg/L
Epichlorohydrin	≤ 0.0004 mg/L
1,4-Dioxane	≤ 0.05 mg/L
Total manganese	≤ 0.2 mg/L
Uranium	≤ 0.002 mg/L

Remarks 1. Standard values are for annual average values. However, the value for total cyanide is the maximum value.
2. "Not detectable" means that when the substance is measured by the specified method, the amount is less than the quantitative limit defined by that method.
3. The standard values for boron and fluoride are not applied to coastal waters.

6

7

Items of Environmental Quality Standard for Water Pollution

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Living environment items

	River	Lake	Sea Area
BOD	≤ 1 - 10 mg/L	-	-
COD	-	≤ 1 - 8 mg/L	≤ 2 - 8 mg/L
pH	6.0 - 8.5	6.0 - 8.5	7.0 - 8.3
SS	≤ 25 - 100 mg/L etc.	≤ 1 - 15 mg/L etc.	-
DO	2-7.5 mg/L≤	2-7.5 mg/L≤	2-7.5 mg/L≤
DO at bottom layer	-	2.0～4.0mg/L≦	2.0～4.0mg/L≦
Coliform bacteria count	≤ 50 - 5,000 MPN/100mL	≤ 50 - 1,000 MPN/100mL	≤ 1,000 MPN/100 mL
N-hexane extracts	-	-	Undetected.
Total nitrogen	-	≤ 0.1 - 1 mg/L	≤ 0.2 - 1 mg/L
Total phosphorous	-	≤ 0.005 - 0.1 mg/L	≤ 0.02 - 0.09 mg/L
All zinc	≤ 0.03 mg/L	≤ 0.03 mg/L	≤ 0.01 - 0.02 mg/L
Nonylphenol	≦0.0006～0.002mg/L	≦0.0006～0.002mg/L	≦0.0007～0.001mg/L
LAS	≦0.02～0.05mg/L	≦0.02～0.05mg/L	≦0.006～0.01mg/L

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Environmental quality standards for conservation of the living environment

Lakes (natural lakes and artificial reservoirs with 10 million m³ of water or above)

Items / Categoly	Standard values				
	pH	Chemical Oxygen Demand	Suspended Solids (SS)	Dissolved Oxygen (DO)	Number of coliform groups
AA	6.5-8.5	≦1mg/L	≦1mg/L	≧7.5mg/L	≦50MPN/100mL
A	6.5-8.5	≦3mg/L	≦5mg/L	≧7.5mg/L	≦1,000MPN/100mL
B	6.5-8.5	≦5mg/L	≦15mg/L	≧5mg/L	
C	6.0 -8.5	≦8mg/L	Floating matter such as garbage should not be observed	≧2mg/L	

Category / Purpose of water use / Items	Standard values	
	Total Nitrogen	Total Phosphorus
I Conservation of natural environment	≦0.1mg/L	≦ 0.005 mg/L
II Water supply. Fishery type 1. Bathing	≦0.2 mg/L	≦0.01mg/L
III Water supply class 3 (special types)	≦0.4 mg/L	≦0.03mg/L
IV Fishery type 2	≦0.6 mg/L	≦0.05mg/L
V Fishery type 3. Industrial water. Agricultural water. Conservation of the living environment	≦1 mg/L	≦0.1mg/L

AA: Water supply, class 1; Fishery, class 1 ; Conservation of natural environment.
A : Water supply, class 2 and 3 ; Fishery, class 2 ; Bathing.
B : Fishery, class 3 ; Industrial water, class 1 ; Agricultural water.
C : Industrial water, class 2 ; Conservation of environment.

Water Quality Standard PDF (hyper link to "WCS wp.pdf")

8

Status of ambient water quality monitoring for public water bodies in Japan

No. of Monitoring Stations	Frequency	Indicator	Responsible Institution	Year
Indicators for **human health** protection: 3,947 (rivers), 405 (lakes and reservoirs), 1,057 (sea)	Monthly	Indicators stipulated in Environmental Standards	Local government (Ministry of the Environment)	2013
Indicators for the **living environment**: 4,550 (rivers), 475 (lakes and reservoirs), 2,044 (sea)				
Indicators for **aquatic biodiversity**: 1,447 (rivers), 150 (lakes and reservoirs), 125 (sea)				
Groundwater: 3,680 (outline survey)				

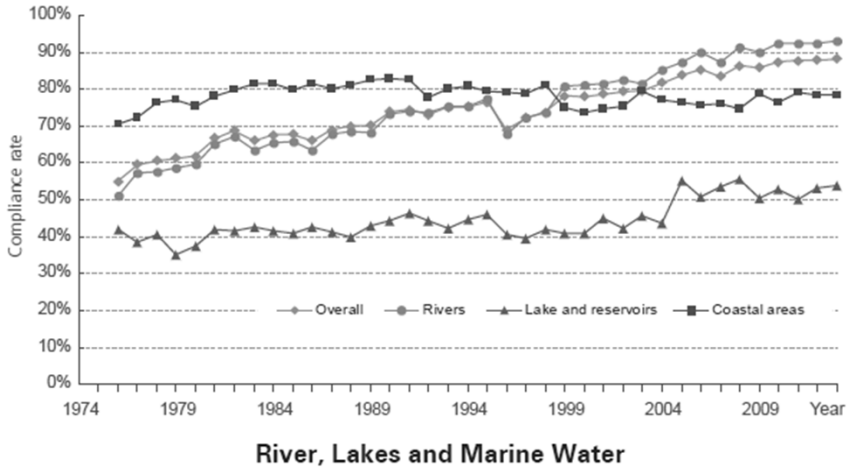
Evaluation methodology for water quality monitoring in Japan

Achievement rate of environmental standard for water in public water zones (Surface water, marine water and groundwater)

http://www.wepa-db.net/activities_201504outlook2015.htm 9

Achievement rate of environmental standard for water in public water zones

Disclosure of Ambient Water Quality Monitoring Results



River, Lakes and Marine Water

10

Water Pollution Control Law (promulgated in 1970)

to regulate the facilities generating hazardous wastewater from economic activities.

1. Specifying economic activities which may generate hazardous wastewater ⇨ Formulation of the Inventry

The Water Pollution Control Law designates as Specified facilities;
74 types of facilities with different economic activities have the potential of generating hazardous wastewater, and are subject to regulations under the Water Pollution Control Law.

The 74 types of businesses/industries are listed in a table such as, virtually all kinds of manufacturing industries,

mining industries, livestock industries, fishery industries,
photo processing businesses, hotels and inns,
medium and large restaurants, laundry business,
hospitals with 300 beds or more,
water utilities and wastewater treatment plants for 500 PE or above,
waste treatment/disposal facilities, etc.

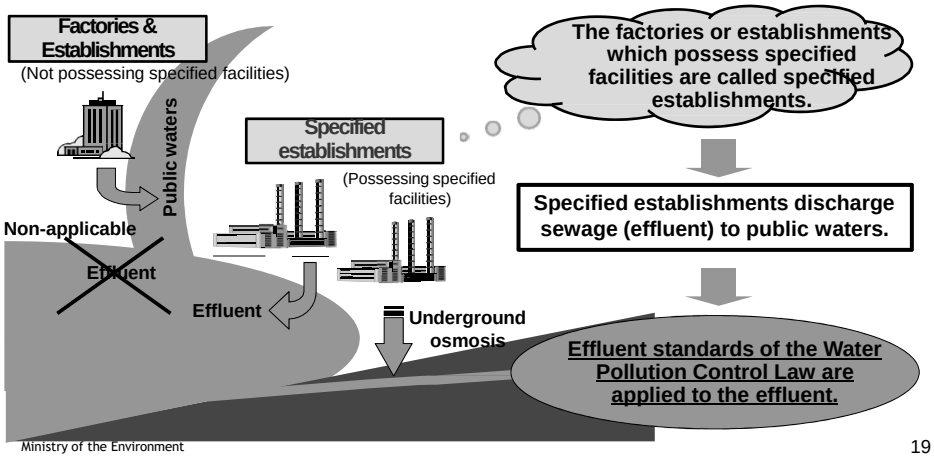
As of the end of FY2010, approx. 274,000 establishments are control subjects

11

Uniform National Effluent Standards (Concentration Regulation)

Ministry of Environment

- The effluent control of the Water Pollution Control Law stipulates effluent standards (Uniform National Effluent Standards) that are uniform across all industries for the specified establishments throughout the country.
- The control is carried out using the so-called **"direct penalty system"** by which **penalties can be applied simply because of excess concentrations**.



Ministry of the Environment

19

Wastewater standards (Regulation on effluent water quality)

Ministry of the Environment

【Health item】

Kinds of harmful substances	Tolerable limit
Cadmium and its compounds	0.1 mg/L
Cyanide compounds	1 mg/L
Organic compound (limited to parathion, methyl parathion, methyl demeton and EPN (ethyl p-nitrophenyl phenylphosphorothioate))	1 mg/L
Lead and its compounds	0.1 mg/L
Hexavalent chromium compounds	0.5 mg/L
Arsenics and its compounds	0.1 mg/L
Mercury and alkyl mercury, and other mercury compounds	0.005 mg/L
Alkyl mercury compounds	Not detected
Polychlorinated biphenyl	0.003 mg/L
Trichloroethylene	0.3 mg/L
Tetrachloroethylene	0.1 mg/L
Dichloromethane	0.2 mg/L
Carbon tetrachloride	0.02 mg/L
1,2-dicholoroethane	0.04 mg/L
1,1-dichloroethylene	0.2 mg/L
cis-1,2-dichloroethylene	0.4 mg/L
1,1,1-trichloroethane	3 mg/L
1,1,2-trichloroethane	0.06 mg/L
1,3-dichloropropene	0.02 mg/L
Thiram	0.06 mg/L
Simazine	0.03 mg/L
Thiobencarb	0.2 mg/L
Benzene	0.1 mg/L
Selenium and its compounds	0.1 mg/L
Boron and its compounds	Other than sea area: 10 mg/L Sea area: 230 mg/L
Fluorine and its compounds	Other than sea area: 8 mg/L Sea area: 1 mg/L
Ammonia, ammonium compounds, nitrite compounds and nitrate compounds	(*) 100 mg/L
1,4-dioxane	0.5mg/L

(*) Amount of ammonia nitrogen compound, and the total of nitrite nitrogen and nitrate nitrogen

【Living environment item】

Kinds of harmful substances	Tolerable limit
Hydrogen ion concentration (pH)	Other than sea area: 5.8 – 8.6 Sea area: 5.0 –9.0.
Biochemical oxygen demand (BOD)	160 mg/L (Daily mean value: 120 mg/L)
Chemical oxygen demand (COD)	160 mg/L (Daily mean value: 120 mg/L)
Suspended solids (SS)	200 mg/L (Daily mean value: 150 mg/L)
Normal-hexane extracts content (mineral oils content)	5 mg/L
Normal-hexane extracts content (animal and plant fats content)	30 mg/L
Phenols content	5 mg/L
Copper content	3 mg/L
Zinc content	2 mg/L
Soluble iron content	10 mg/L
Soluble manganese content	10 mg/L
Chromium content	2 mg/L
Coliform group number	Daily mean value: 3,000/cm³
Nitrogen content	120 mg/L (Daily mean value: 60 mg/L)
Phosphorus content	16 mg/L (Daily mean value: 8 mg/L)

Note
The effluent standard shown in this table is applicable to the effluent water discharged by a plant, factory, or business establishment which discharges 50m3/day or more of effluent water on daily average.

Ministry of the Environment

21

Uniform Effluent Standards and Stringent Standards

Ministry of the Environment

Flat wastewater standards set by the national government
(minimum control applied nationwide)

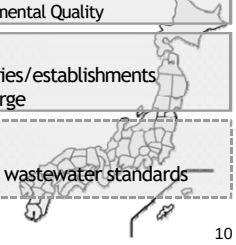
- **Health items**
  Applied to all factories/establishments
- **Living environment items**
  Applied to factories/establishments with wastewater discharge of 50 m3/day or more

Prefectural governments authorized to tighten controls, according to local conditions

More Stringent by prefecture
Prefectural ordinances to set more stringent wastewater standard values if the flat standards are not sufficient (for example, preventing the realization of Environmental Quality

"Hem down" by prefecture
Extend application of the Living Environment Items to factories/establishments with less than 50 m3/day wastewater discharge

"Side stretch" by prefecture
Introduce additional wastewater control items on top of the flat wastewater standards



Ministry of the Environment

10

■ Stringent Effluent Standards Imposed by Prefectural Governments

Achieving Environmental Quality Standards through uniform effluent standards may not be possible in some water bodies where there are many pollution producers. In such water bodies, the prefectural governments, through their municipal laws, may define stricter standards in addition to the uniform standards of the national government. Stringent effluent standards are defined according to the local situations in each of the nation's prefectures. The numbers in parentheses are daily average values.

■ Example of Stringent Effluent Standards

Water quality item	Prefecture A		Uniform Standards (mg/ℓ)
	Water Area A (mg/ℓ)	Water Area B (mg/ℓ)	
Cadmium and its compounds	Not detectable	/	0.1
Cyanide compounds	Not detectable	/	1
Organic phosphorus compounds	Not detectable	0.2	1
Lead and its compounds	0.05	/	0.1
Sexivalent chrome compounds	0.05	/	0.5
Arsenic and its compounds	0.01	/	0.1
Flouride and its compounds	0.8	/	8 (Non-Coastal Regions) 15 (Coastal Regions)
BOD	15(10)	25(20)	160(120)
COD	15(10)	25(20)	160(120)
SS	30(20)	70(40)	200(150)
Phenols	0.005	0.5	5
Copper	1	1	3
Zinc	1	1	5
Dissolved iron	0.3	3	10
Dissolved manganese	0.3	1	10
Chromium	0.1	/	2
Nickel	0.3	1	/

15

Technical Standards for Wastewater Treatment Processes (Off-site)

Planning Final Effluent Water Quality should be defined considering the condition of public water bodies in which treated effluent water is discharged (**Sewerage Law**).

Technology option for required effluent water quality and Technology evaluation

Item	Planning Final Effluent Water Quality(mg/l)			Typical Wastewater Treatment Process	Additional Treatment		
	BOD	T-N	T-P		Rapid Filtration	Addition of Caogulant	Addition of Organic Mattter
1	>10	>10	>0.5	Anaerobic-Anoxic-Oxic Process	○	○	○
2			0.5-1	Recycled Nitrification / Denitrification Process	○	○	○
3			1-3	Anaerobic-Anoxic-Oxic Process	○		○
4			—	Recycled Nitrification / Denitrification Process	○		○
5		10-20	>1	Recycled Nitrification / Denitrification Process	○	○	
6			1-3	Anaerobic-Anoxic-Oxic Process	○		
7			—	Recycled Nitrification / Denitrification Process	○		
8		—	>1	Anaerobic-Oxic Activated Sludge Process	○	○	
9		—	1-3	Anaerobic-Oxic Activated Sludge Process	○		
10		—	—	Conventional Activated Sludge Process	○		
11	10-15	>20	>3	Anaerobic-Anoxic-Oxic Process			
12			—	Recycled Nitrification / Denitrification Process			
13		—	>3	Anaerobic-Oxic Activated Sludge Process			
14		—	—	Conventional Activated Sludge Process			

Same Level of Conventional Activated Sludge Process: OD, SBR, BAF, etc

http://www.sbmc.or.jp/english/200407/Partial_amendment_of_Enforcement_Order_of_the_Sewerage_Law.htm

16

Technical Standards for Wastewater Treatment Processes (On-site: Johkasou)

Class	Type of treatment	Treatment process	Number of users for design (5 50 100 200 500 2000 5000)	BOD removal rate	Treatment performance: Effluent quality (mg/ℓ) BOD	COD	T-N	T-P
1	Combined domestic wastewater treatment	Separation-contact aeration process		90% or more	20 or less	—	—	—
		Anaerobic filter-contact aeration process					—	—
		Denitrification type anaerobic filter-contact aeration process					20 or less	—
4	Flush toilet wastewater treatment	Septic tank process		55% or more	120 or less	—	—	—
5		Land infiltration process		SS: 55% or more	SS: 250 or less	—	—	—
6	Combined domestic wastewater treatment	Rotating biological contactor process		90% or more	20 or less	30 or less	—	—
		Contact aeration process						
		Trickling filter process						
		Extended aeration process						
		Conventional activated sludge process						
7		Contact aeration and trickling filter process		—	10 or less	15 or less	—	—
		Coagulation separation process						
8		Contact aeration and activated carbon absorption process		—	10 or less	10 or less	—	—
		Coagulation separation and activated carbon absorption process						
9		Nitrified water recirculation type activated sludge process		—	10 or less	15 or less	20 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
10		Nitrified water recirculation type activated sludge process			10 or less	15 or less	15 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
11		Nitrified water recirculation type activated sludge process			10 or less	15 or less	10 or less	
		Tertiary treatment type denitrification dephosphorization process						
12	Emission standard under the Water Pollution Control Law	Class: 6 - 11 / 6 - 11 / 6 - 11 / 7 - 11 / 8 — COD (mg/ℓ): 60 / 45 / 30 / 15 / 10 — SS (mg/ℓ): 70 / 60 / 50 / 15 / 15 — n-Hex (mg/ℓ): 20 / 20 / 20 / 20 / 20 — pH: 5.8–8.6 / 5.8–8.6 / 5.8–8.6 / 5.8–8.6 / 5.8–8.6 — Total coliforms (N/mℓ): 3,000 or less / 3,000 or less / 3,000 or less / 3,000 or less / 3,000 or less							

Technology option for required effluent water quality and Technology evaluation
Technology Evaluation and Design and O&M Manual

2. Monitoring methodology (Off-site and On-site; Domestic Wastewater)

Waste Management and Public Cleaning Act in Japan

Article 6 General waste disposal planning

Municipalities shall formulate a general waste disposal planning in the administrative area.

Note: General Waste means non-industrial Waste including liquid (domestic wastewater) and solid waste.

2. In the general waste disposal planning, each of the following matters shall be defined as specified by the ministerial decree.

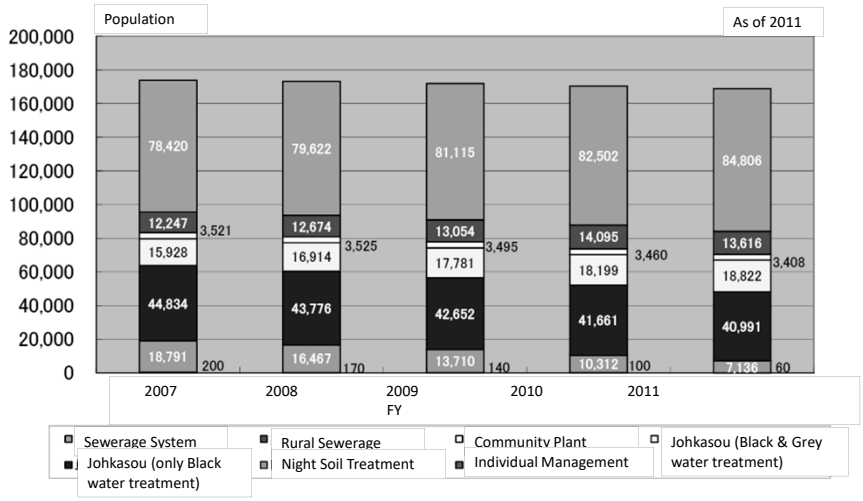
1) Prospected amount of generated and treated general waste (domestic wastewater),
2) Basic matters related to proper treatment of general waste and operators,
3) Matters related to construction of treatment facilities for general waste, etc.

Article 6-2

Municipalities shall collect, transport and dispose (including reuse and recycle) before problem in respect of conservation of the living environment occurs based on the general waste disposal planning.

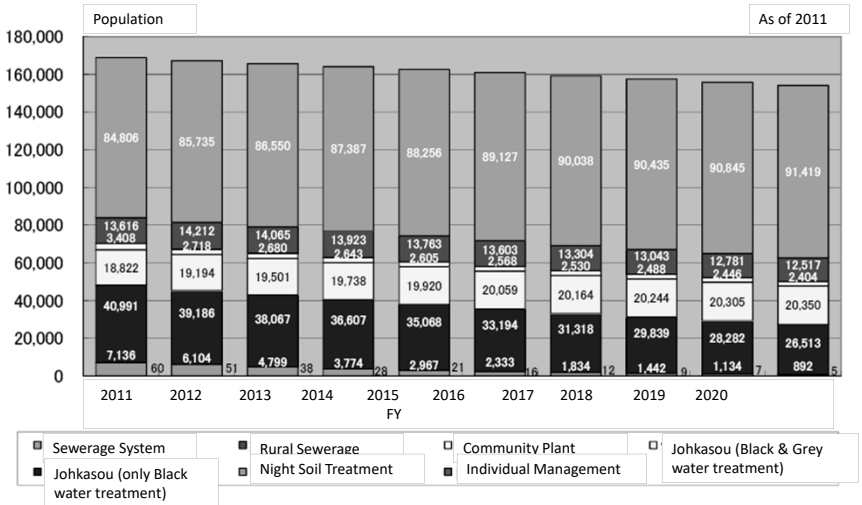
18

Population Trend Classified by Wastewater Treatment System in A city in Japan



19

Planned Population Classified by Wastewater Treatment System in A city in Japan



20

Middle and Long Term Plan of Wastewater Treated Population in A City

These data are also quite important for tariff collection and sustainable management.

			Present 2011	Middle Term Plan 2015	Long Term Plan 2020
Wastewater Treated Population Rate			71.5%	76.6%	82.2%
Total Population			168,839	162,600	154,100
	Wastewater Treated Population		120,652	124,544	126,690
		Public Sewerage System	84,806	88,256	91,419
		Rural Sewerage	13,616	13,763	12,517
		Community Plant	3,408	2,605	2,404
		Johkasou (Black & Gray water treatment)	18,822	19,920	20,350
	Wastewater not Treated Population		48,187	38,056	27,410
		Johkasou (Black water treatment)	40,991	35,068	26,513
		Night Soil Treatment	7,196	2,988	897

21

Wastewater Treated Population Rate in Japan (2016)

No.	Prefecture	Wastewater Treated Population Rate (%)	Total Population (Thousand)	Wastewater Treated Population (Thousand)	Type of Wastewater Treatment System (Thousand)			
					Sewerage Systems	Rural Sewerage System	Johkasou	Communal WTTs
1	Hokkaidou	95.20	5,346	5,089	4,857	69	163	0
2	Aomori	78.10	1,314	1,025	777	117	131	0
3	Iwate	79.80	1,270	1,013	737	109	166	2
4	Miyagi	90.60	2,310	2,092	1,861	71	154	6
5	Akita	86.10	1,022	880	654	109	118	0
*	*	*	*	*	*	*	*	*
11	Saitama	91.20	7,346	6,703	5,896	96	709	1
12	Chiba	87.50	6,285	5,498	4,622	51	817	8
13	Tokyo	99.80	13,570	13,540	13,508	2	28	2
14	Kanagawa	97.90	9,159	8,970	8,848	3	119	0
*	*	*	*	*	*	*	*	*
26	Kyoto	97.80	2,563	2,507	2,412	44	50	0
27	Osaka	97.40	8,852	8,626	8,451	1	174	0
*	*	*	*	*	*	*	*	*
46	Kagoshima	79.00	1,655	1,307	688	43	572	5
47	Okinawa	85.20	1,462	1,245	1,044	67	134	0
	Total	90.40	127,540	115,314	99,824	3,518	11,747	225

22

Middle and Long Term Plan of Wastewater Treated Population in A City in Japan

These data are also quite important for tariff collection and sustainable management.

	Present 2011	Middle Term Plan 2015	Long Term Plan 2020
Wastewater Treated Population Rate	71.5%	76.6%	82.2%
Total Population	168,839	162,600	154,100
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Importance of the Achievement of SDG 6.2 before 6.3

In Case of Vietnam

+ Intercepter Systems

Septic Tank (Treatment Performance?)

Septic Tank

Septic Tank

Effect of Grey Water

23

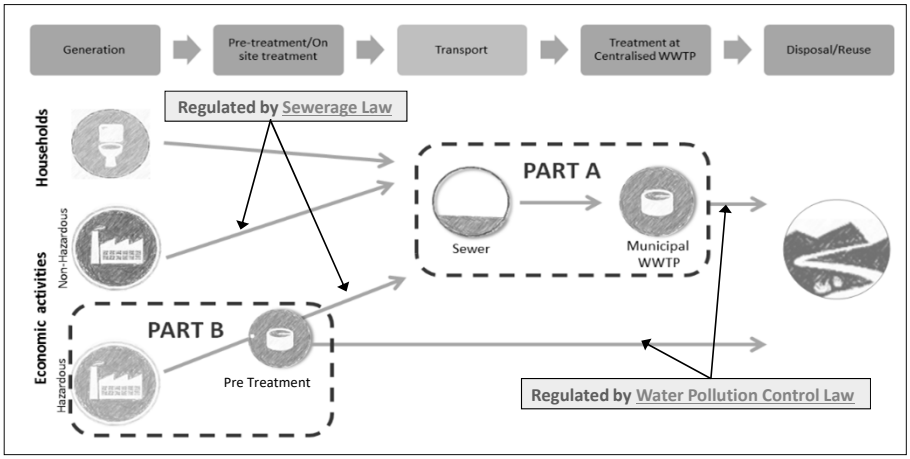
2. MONITORING METHODOLOGY

2-1 SDG 6.3.1 Part B Industrial Wastewater

- **Institutional Arrangement ;** Two type of specified facilities
  Facilities of which wastewater is directly discharged to public water bodies
  Facilities connected sewerage systems
- **Necessary action and Monitoring methodology**
  1) Environment Impact Assessment, Approval of factory construction plan
  2) Formulation of Inventory and Regular Monitoring
  3) Consultation to industries
  Persuade industries to take countermeasures for pollution prevention
  Increasing the awareness of environment
  Provision of the treatment process information
  Financial support if any (Low interest loan, tax reduction, etc.)
  Advise to formulate industrial wastewater management system
  Designated engineer who has responsibility for wastewater management
  Certification program for designated engineer
  4) Administrative direction and Imposing penalty
- **Monitoring methodology**
  Number of designated facilities
  Appropriate measures to identify the facilities, which meet the standards

24

Regulation of Wastewater from Household and Economic Activities



PART A: Municipal WWTP ; Mainly Biological Treatment for BOD, SS, N, P (Biodegradable matters)
PART B: Hazardous WWTP ; Mainly Chemical, Physical Treatment for heavy metals

25

Sewerage Law and Water Pollution Control Law in Japan

Effluent Standards for facilities connected to Sewerage Systems

Facilities connected to sewerage systems is regulated by the Sewerage Law.

Under the Sewerage Law, the specified facilities which discharge wastewater to sewerage systems shall meet the Uniform National Effluent Standards or, Stringent Effluent Standards, if any, which consist of the following two categories:

(1) Items which are difficult to treat in wastewater treatment plants (WWTPs)
The regulated value of these items is same as (1) Human health items and heavy metals listed in the (2) Living environment items of the Water Pollution Control Law.

(2) Items which can be treated in WWTPs
These items are pH, BOD, SS, N-hexane Extracts, Phenols, Nitrogen and Phosphorus. The regulated value of N-hexane Extracts and Phenols is same as the (2) Living environment items of the Water Pollution Control Law, but other values are higher than the (2) Living environment items.

26

Major difference of the effluent standards
between Water Pollution Control Law and Sewerage Law

	Effluent Standards for Hazardous Economic Activities which discharge wastewater **directly to water bodies**	**Effluent Standards** for Hazardous Economic Activities connected to **Sewerage System**
Heavy metal	same	same
BOD	160mg/l (Ave. 120mg/l)	600mg/l
SS	200mg/l (Ave. 160mg/l)	600mg/l

27

Water Pollution Control Law (Same as Sewerage Law)

Monitoring of Hazardous Wastewater Generated by Economic Activities ⇨ EIA(Environment Impact Assessment)

(1) All the factories and installations that belong to the 74 types of economic activities shall register the specified facilities that generate hazardous wastewater at the stage of construction of these facilities, and to declare to the concerned local government (prefectural government) the treatment method for all the wastewater they will generate.

(2) When a governor of a prefecture, receives the report above mentioned, and deems that the state of pollution of the effluents at the place of discharge do not satisfy the effluent standards, he may order to change the structure or the way of use of the Specified Facility or the plan for the treatment of the polluted water, etc. about the report concerned, or to abandon the plan for establishing the Specified Facility.

(3) They are required once a year to measure and record the quality and quantity of the effluent they generate, and to keep these records for three (3) years.

28

Water Pollution Control Law (Same as Sewerage Law)

Monitoring of Hazardous Wastewater Generated by Economic Activities ⇨ Monitoring

(4) Local governments conduct frequent On-Site Inspection of effluent water quality at discharge points (outside of the establishment).

(5) Central government and concerned Local government (prefectural government) are authorized to demand the reporting from the factory or installation, to enter and inspect the facility, if they consider that there is a danger that the factory discharges an effluent that does not meet the effluent water quality standards.

(6) The local government (prefectural government) can instruct the factory to modify the facility, can order the suspension of operations of the specified facility and/or of the discharge of the effluent to public water bodies.

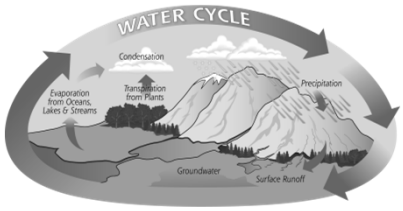
6) Penal Provisions

Any person who violates the orders shall be punishable and liable to penal servitude.

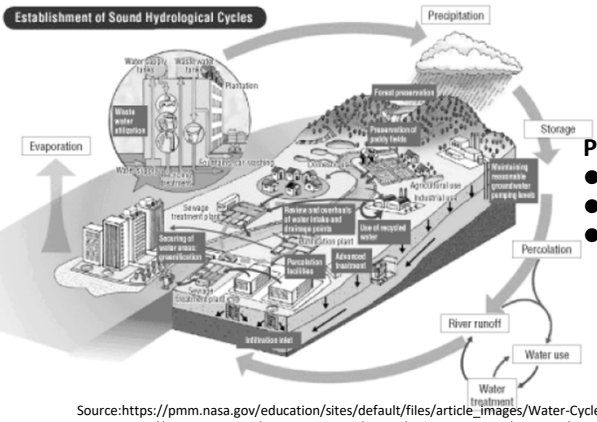
29

3. ACHIEVEMENT OF SDG 6.3.1

Safely treated wastewater (6.3.1)
is required to achieve
Good ambient water quality(6.3.2)
for sound ecosystems
in a river basin.



Discharged wastewater will influence the **ambient water quality**.



Pollution Source

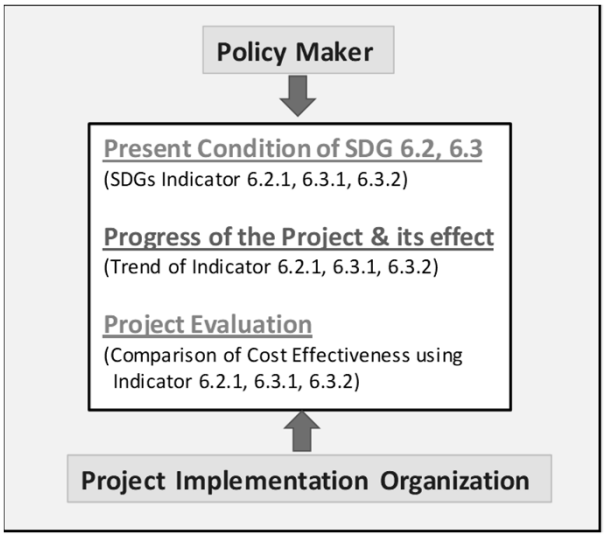
- Domestic Wastewater
- Industrial Wastewater
- Nonpoint Source (Fields, Run-off water from roads, etc.)

1

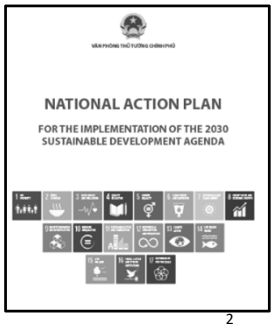
Source:https://pmm.nasa.gov/education/sites/default/files/article_images/Water-Cycle-Art2A.png
http://www.mlit.go.jp/tochimizushigen/mizsei/water_resources/contents/responding_properly.html

3-1 Policy Making:SDG indicators and planning/project implementation

Indicators for Policy Maker, Project Implementation Organization (Public and Private Sector) and Citizen



Vietnam Prime Minister
DECISION
on the issuance of the
National Action Plan
for the Implementation
of the 2030 Sustainable
Development Agenda



2

3-2 Planning

1) Long-Term Program for Promotion of Sewerage Systems

- Systematic construction of sewerage systems in Japan began with the First Five-Year Program, which started in FY 1963.
- The construction of sewerage in Japan has steadily advanced under these Long-Term Programs.
- The Program shows the planned and actual investment as well as the target and actual achievement of **sewered population rat**e.

3

Five Year Plans for Sewerage Systems Development in Japan

Planned Period	Planned and Actual Investments (Achievement ratio) [Unit: billion yen]	Objective of Construction	
		Targets	Achieved Levels
First (FY 1963 - FY 1967)	440.0 296.3 (67.3%)	Percent of area provided with drainage systems (*1)	
		16 — 27%	20%
Second (FY 1967 - FY 1971)	930.0 617.8 (66.4%)	Percent of area provided with drainage systems	
		20 — 33%	23%
Third (FY 1971 - FY 1975)	2600.0 2,624.1 (100.9%)	Percent of area served by sewerage systems (*2)	
		23 — 38%	26%
Fourth (FY 1976 - FY 1980)	7500.0 6,867.3 (91.6%)	Percent of total sewered population(*3)	
		26 — 40%	30%
Fifth (FY 1981 - FY 1985)	11,800.0 8,478.1 (71.8%)	Percent of total sewered population	
		30 — 44%	36%
Sixth (FY 1986 - FY 1990)	12,200.0 11,693.1 (95.8%)	Percent of total sewered population	
		36 — 44%	44%
		Percent of area provided with stormwater drainage systems (*4)	
		35 — 43%	43%
Seventh (FY 1991 - FY 1995)	16,500.0 16,710.5 (101.3%)	Percent of total sewered population	
		44 — 54%	54%
		Percent of area provided with stormwater drainage systems	
		40 — 49%	47%
		Percent of population served by advanced wastewater treatment (*5)	
		2.3 million — 7.5 million people	7.3 million people
Eighth (FY 1996 - FY 2002)	23.700.0	Percent of total sewered population	
		54 — 66%	58%
		Percent of area provided with stormwater drainage systems	
		46 — 55%	49%
		Percent of population served by advanced wastewater treatment	
		5.3 million — 15 million people	8 million people

National Development Plan

Formulation of short, middle and long term planning reflecting the indicator to achieve SDG 6.3 based on the effective strategy

4

3-2 PLANNING
2) FINAL STAGE AT TARGET YEAR IN THE PLANNED AREA
(Comprehensive basin wide planning)

Sewerage systems	Decentralized Systems
Combine or Separate System	1.Community based sewerage system (Mostly separate system)
	2. On-site aerobic wastewater system (Joukasou, etc.)
	3. On-site anaerobic wastewater system (Septic tank with regular sludge removal, compost toilet)

All cases satisfy SDG 6.2.1

Colored cases satisfy SDG 6.3.1

(It would be considered that all cases satisfy 6.3.1 in the specific area in rural area)

5

Comprehensive Basin-wide Planning in Japan

Project Planning

Calculation and allocation of pollution load
to meet the Environment Standards

Comprehensive Basin-wide Planning (Sewerage Law)

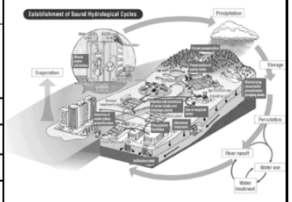
If rivers and other public water bodies or coastal areas, to which the **'environmental water quality standards'** is applied to maintain a sound living environment in relation to water pollution as provided for in the Basic Environmental Law,
each prefecture shall set forth a comprehensive basic plan for the installation or development of sewerage systems ('comprehensive basin-wide planning of sewerage system')
for the respective public water bodies or coastal areas
in order to bring the environmental conditions of the subject area to environmental water quality standards

6

Environmental quality standards for conservation of the living environment

Lakes (natural lakes and artificial reservoirs with 10 million m³ of water or above)

Items / Categoly	Standard values				
	pH	Chemical Oxygen Demand	Suspended Solids (SS)	Dissolved Oxygen (DO)	Number of coliform groups
AA	6.5-8.5	≦1mg/L	≦1mg/L	≧7.5mg/L	≦50MPN/100mL
A	6.5-8.5	≦3mg/L	≦5mg/L	≧7.5mg/L	≦1,000MPN/100mL
B	6.5-8.5	≦5mg/L	≦15mg/L	≧5mg/L	
C	6.0 -8.5	≦8mg/L	Floating matter such as garbage should not be observed	≧2mg/L	



Items / Category — Purpose of water use	Standard values	
	Total Nitrogen	Total Phosphorus
Ⅰ Conservation of natural environment	≦0.1mg/L	≦ 0.005 mg/L
Ⅱ Water supply. Fishery type 1. Bathing	≦0.2 mg/L	≦0.01mg/L
Ⅲ Water supply class 3 (special types)	≦0.4 mg/L	≦0.03mg/L
Ⅳ Fishery type 2	≦0.6 mg/L	≦0.05mg/L
Ⅴ Fishery type 3. Industrial water. Agricultural water. Conservation of the living environment	≦1 mg/L	≦0.1mg/L

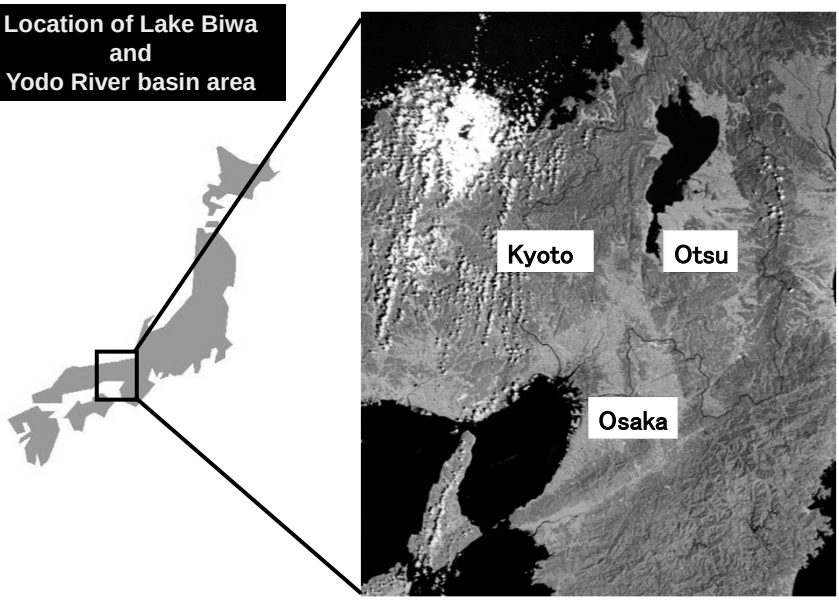
AA: Water supply, class 1; Fishery, class 1 ; Conservation of natural environment.
A : Water supply, class 2 and 3 ; Fishery, class 2 ; Bathing.
B : Fishery, class 3 ; Industrial water, class 1 ; Agricultural water.
C : Industrial water, class 2 ; Conservation of environment.

Water Quality Standard PDF (hyper link to "WCS wp.pdf")

7

Comprehensive Basin-wide Planning

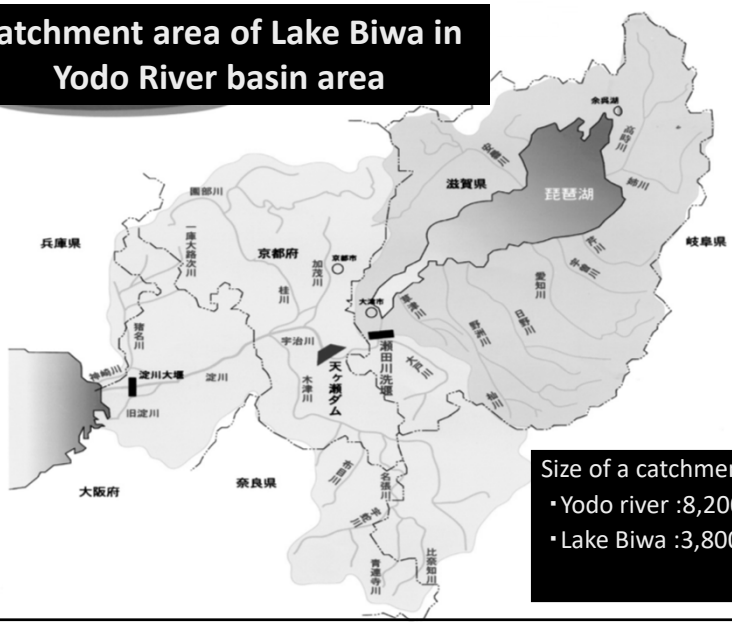
Location of Lake Biwa and Yodo River basin area



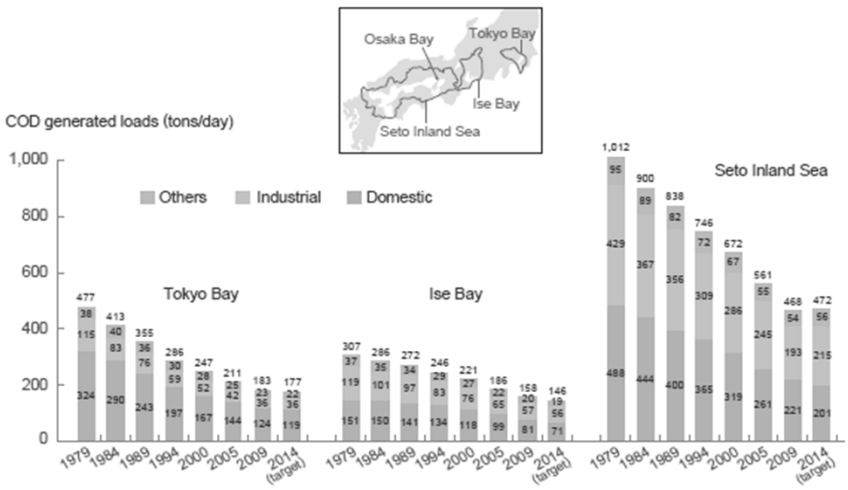
8

Comprehensive Basin-wide Planning

Catchment area of Lake Biwa in Yodo River basin area



Size of a catchment area
- Yodo river :8,200km2
- Lake Biwa :3,800km2



Note: Figures for 1979-2009 are actual. Figures for 2014 is the reduction target

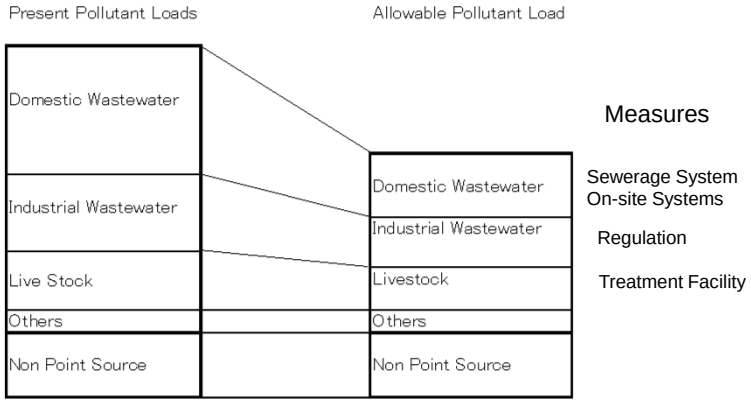
Figure 2.4.6. Challenges in pollution load and target value (in terms of COD)
(Source: provided by MoEJ)

10

Comprehensive Basin-wide Planning

To meet the Environment Standards, allocation of required pollution load reduction in accordance with Pollution Source is necessary

Calculation and Allocation of Pollution Load in the River Basin



Pollutant Load = (Number) X (Unit Pollutant Load) or Measured Value

Example of unit pollutant load: 55g-BOD/capita

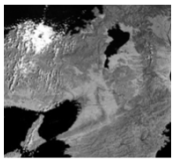
11

Comprehensive Basin-wide Planning

Planning for Drainage and Treatment of Domestic Wastewater to meet the Water Quality Standards

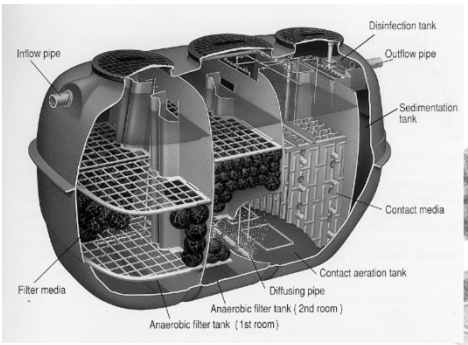
CONTENTS

- Target Area, Coverage Area
  - Area-wide Sewerage System (more than 2 cities)
  - Number and Location of WWTPs in Administrative Area
  - Main Pipe Route, Number and Location of Pumping Stations
  - On-site Treatment Area
- Wastewater Inflow Quantity and Quality
- Required Treated Water Quality and Treatment Processes



12

3) ZONING OF SEWERAGE SYSTEMS AND ON-SITE SYSTEMS



Joukasou System

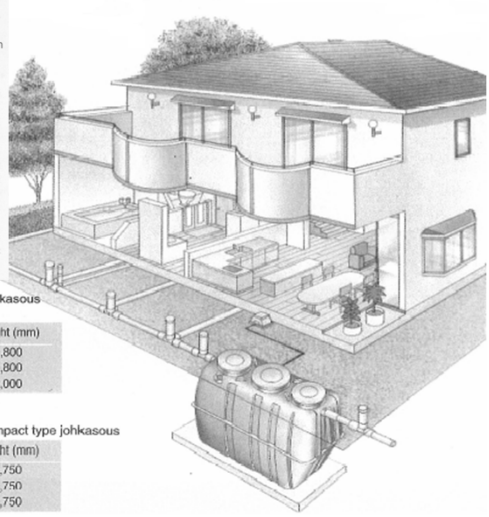


Table 5.1 Dimensions of typical small-scale johkasous (anaerobic filter - contact aeration process)

NUD	Width (mm)	Length (mm)	Height (mm)
5	1,200	2,400	1,800
7	1,500	2,700	1,800
10	1,700	3,200	2,000

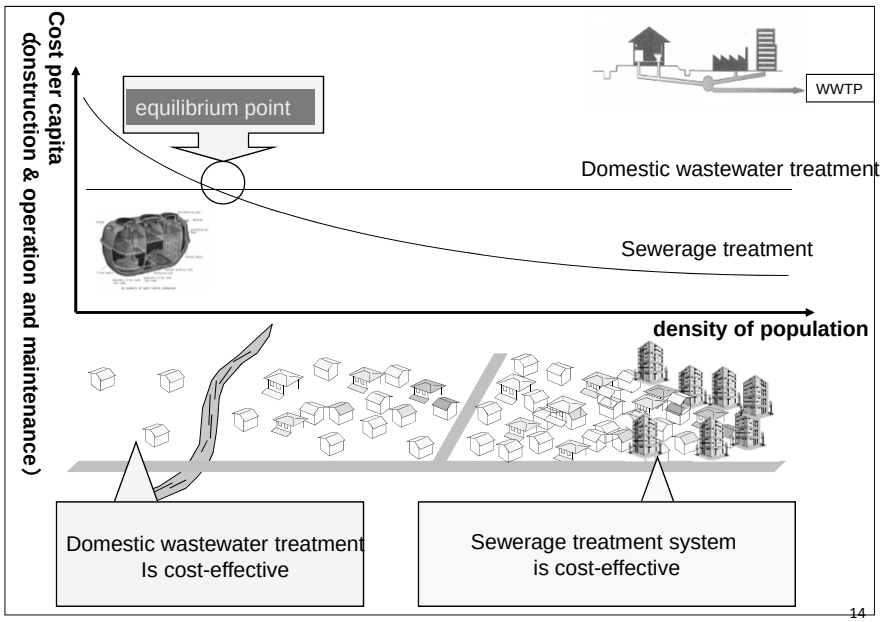
Table 5.2 Dimensions of typical small-scale compact type johkasous

NUD	Width (mm)	Length (mm)	Height (mm)
5	980	2,155	1,750
7	980	2,775	1,750
10	1,230	3,115	1,750

https://www.env.go.jp/recycle/jokaso/pamph/pdf/wts_full.pdf

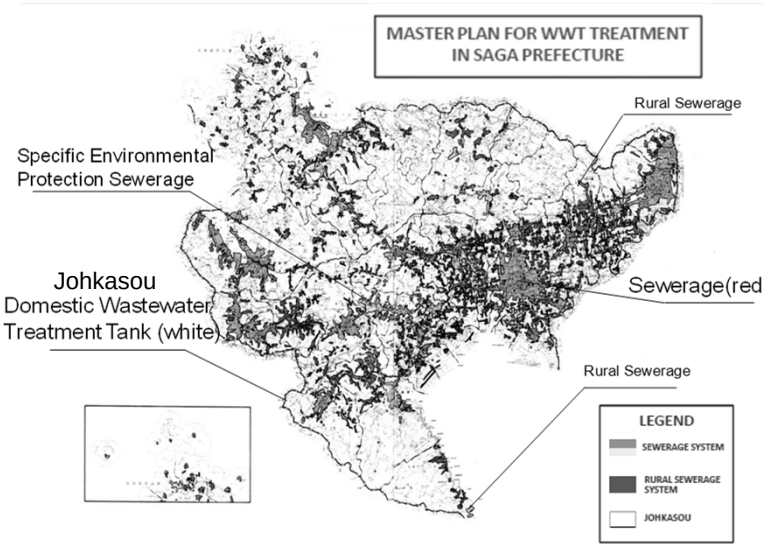
13

Concept of Cost Comparison between Off-site and On-site



14

Prefectural Plan for Appropriate Wastewater Treatment



15

4) TRANSITION STAGE IN THE AREA OF SEWERAGE

(1) Simplified sewerage systems: WWTP + Interceptor + Septic tank

Necessity of ST sludge removal would be decided depending on the condition of existing drainage system (flow velocity, settlement of sludge, etc.).

1-1 It could be considered that the following case satisfies SDG 6.3.1 and 6.2.1
- Appropriate flow velocity
- Little sludge settlement
- All of existing drainage open channel is covered

(ST sludge would be removed in case of clogging, etc.)

1-2 It could be considered that the following case satisfies 6.2.1 and partly 6.3.1
- Utilization of existing open drainage channel
- Regular ST sludge removal

1-3 It could be considered that the following case partly satisfies 6.2.1 and 6.3.1
- Utilization of existing open drainage channel

(No regular sludge removal)

(2) On-site anaerobic system

2-1 It could be considered that the following case satisfies 6.2.1
- ST with regular sludge removal

Waste Management and Public Cleaning Act in Japan

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Middle and Long Term Plan of Wastewater Treated Population in A City in Japan

These data are also quite important for tariff collection and sustainable management.

	Present 2011	Middle Term Plan 2015	Long Term Plan 2020
Wastewater Treated Population Rate	71.5%	76.6%	82.2%
Total Population	168,839	162,600	154,100
Wastewater Treated Population	120,652	124,544	126,690
Public Sewerage System	84,806	88,256	91,419
Rural Sewerage	13,616	13,763	12,517
Community Plant	3,408	2,605	2,404
Johkasou (Black & Gray water treatment)	18,822	19,920	20,350
Wastewater not Treated Population	48,187	38,056	27,410
Johkasou (Black water treatment)	40,991	35,068	26,513
Night Soil Treatment	7,196	2,988	897

Importance of the Achievement of SDG 6.2 before 6.3

In Case of Vietnam

← + Intercepter Systems

← Septic Tank (Treatment Performance?)

← Septic Tank

← Septic Tank

Effect of Grey Water

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3-3 TECHNOLOGY OPTIONS

1) Wastewater treatment process, Reliable facilities and equipment, O&M measures

- For safely treated wastewater, **specific treatment process (technology) to meet the effluent water quality standards is requested, and the performance of specific treatment process (technology) should be evaluated and examined.**
- Based on the evaluation of the treatment process (technology), formulation of design and O&M manual would be requested to treat wastewater safely and steadily.
- Innovation of technology will accelerate the efficiency of wastewater treatment and management and have an impact on existing systems

National Government develops Technology Standards in collaboration with local governments, Japan Sewage Works Association and Japan Sewage Works Agency

Technology Standards helps local governments to conduct sewage works properly.

Design guideline

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Technical Standards for Wastewater Treatment Processes (On-site: Johkasou)

Class	Type of treatment	Treatment process	Number of users for design (5 50 100 200 500 2000 5000)	BOD removal rate	Treatment performance: Effluent quality (mg/ℓ) BOD	COD	T-N	T-P
1	Combined domestic wastewater treatment	Separation-contact aeration process		90% or more	20 or less	—	—	—
		Anaerobic filter-contact aeration process					—	—
		Denitrification type anaerobic filter-contact aeration process					20 or less	—
4	Flush toilet wastewater treatment	Septic tank process		55% or more	120 or less	—	—	—
5		Land infiltration process		SS: 55% or more	SS: 250 or less	—	—	—
6	Combined domestic wastewater treatment	Rotating biological contactor process		90% or more	20 or less	30 or less	—	—
		Contact aeration process						
		Trickling filter process						
		Extended aeration process						
		Conventional activated sludge process						
7		Contact aeration and trickling filter process		—	10 or less	15 or less	—	—
		Coagulation separation process						
8		Contact aeration and activated carbon absorption process		—	10 or less	10 or less	—	—
		Coagulation separation and activated carbon absorption process						
9		Nitrified water recirculation type activated sludge process		—	10 or less	15 or less	20 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
10		Nitrified water recirculation type activated sludge process			10 or less	15 or less	15 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
11		Nitrified water recirculation type activated sludge process			10 or less	15 or less	10 or less	
		Tertiary treatment type denitrification dephosphorization process						
12	Emission standard under the Water Pollution Control Law	Class: 6・11 / 6・11 / 6・11 / 7・11 / 8	COD (mg/ℓ): 60 / 45 / 30 / 15 / 10	SS (mg/ℓ): 70 / 60 / 50 / 15 / 15	n-Hex (mg/ℓ): 20 / 20 / 20 / 20 / 20	pH: 5.8–8.6 / 5.8–8.6 / 5.8–8.6 / 5.8–8.6 / 5.8–8.6	Total coliforms (N/ml): 3,000 or less / 3,000 or less / 3,000 or less / 3,000 or less / 3,000 or less	

Technology Evaluation and Design and O&M Manual

Technical Standards for Wastewater Treatment Processes (Off-site)

Planning Final Effluent Water Quality should be defined considering the condition of public water bodies in which treated effluent water is discharged (**Sewerage Law**).

Item	Planning Final Effluent Water Quality(mg/l) BOD	T-N	T-P	Typical Wastewater Treatment Process	Additional Treatment: Rapid Filtration	Addition of Caogulant	Addition of Organic Mattter
1	>10	>10	>0.5	Anaerobic-Anoxic-Oxic Process	○	○	○
2			0.5-1	Recycled Nitrification / Denitrification Process	○	○	○
3			1-3	Anaerobic-Anoxic-Oxic Process	○		○
4			—	Recycled Nitrification / Denitrification Process	○		○
5		10-20	>1	Recycled Nitrification / Denitrification Process	○	○	
6			1-3	Anaerobic-Anoxic-Oxic Process	○		
7			—	Recycled Nitrification / Denitrification Process	○		
8		—	>1	Anaerobic-Oxic Activated Sludge Process	○	○	
9		—	1-3	Anaerobic-Oxic Activated Sludge Process	○		
10		—	—	Conventional Activated Sludge Process	○		
11	10-15	>20	>3	Anaerobic-Anoxic-Oxic Process			
12			—	Recycled Nitrification / Denitrification Process			
13		—	>3	Anaerobic-Oxic Activated Sludge Process			
14		—	—	Conventional Activated Sludge Process			
	Same Level of Conventional Activated Sludge Process: OD, SBR, BAF, etc						

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http://www.sbmc.or.jp/english/200407/Partial_amendment_of_Enforcement_Order_of_the_Sewerage_Law.htm

3-3 TECHNOLOGY OPTIONS

2) Septage Management

- Formulation of Database of households
- Planning on sludge removal and transportation
- Treatment process for collected sludge
  - High BOD, COD, N, P
  - (Difficulties of biological removal of N because of low C/N)
- Effective final sludge disposal measures (Reuse of sludge)

Table 3.2 Established wastewater treatment technologies WHO "GUIDELINES ON SANITATION AND HEALTH"

Treatment process	Level	Treatment objectives	Pathogen reduction measures	PRL*	Treatment products & pathogen level**
Low flow rate					
Waste stabilization ponds	NA	BOD reduction Nutrient management Pathogen reduction	Aerobic ponds (maturation) Ultraviolet radiation	H	Liquid sludge with low pathogens Effluent with low pathogens
Constructed wetlands	Secondary or Tertiary	BOD reduction Suspended solid removal Nutrient management Pathogen reduction	Natural decay Predation from higher organisms Sedimentation UV radiation	M	Plants – no pathogens Effluent with medium pathogens

https://www.who.int/water_sanitation_health/sanitation-waste/sanitation/sanitation-guidelines/en/ 21

Table 3.2 Established wastewater treatment technologies WHO "GUIDELINES ON SANITATION AND HEALTH"

High flow rate					
Primary sedimentation	Primary	Suspended solid reduction	Storage	L	Liquid sludge with high pathogens Effluent with high pathogens
Advanced or chemically enhanced sedimentation	Primary	Suspended solid reduction	Coagulation/flocculation Storage	M	Liquid sludge with medium pathogens Effluent with medium pathogens
Anaerobic upflow sludge blanket reactors	Primary	BOD reduction	Storage	L	Liquid sludge with high pathogens Effluent with high pathogens Biogas
Anaerobic baffled reactors	Primary/ Secondary	BOD reduction Stabilization/nutrient management	Storage	L	Liquid sludge with high pathogens Effluent with high pathogens Biogas
Activated sludge	Secondary	BOD reduction Nutrient management	Storage	M	Liquid sludge with medium pathogens Effluent with medium pathogens
Trickling filters	Secondary	Nutrient management	Storage	M	Liquid sludge with medium pathogens Effluent with pathogens
Aerated lagoon and settling pond	Secondary	BOD reduction Pathogen reduction	Aeration	M	Liquid sludge with medium pathogens Effluent with pathogens
High rate granular or slow rate sand filtration	Tertiary	Pathogen reduction	Filtration	H	Effluent with low pathogens
Dual media filtration	Tertiary	Pathogen reduction	Filtration	H	Effluent with low pathogens
Membranes	Tertiary	Pathogen reduction	Ultrafiltration	H	Effluent with low pathogens
Disinfection	Tertiary	Pathogen reduction	Chlorination (oxidation)	H	Effluent with low pathogens
Disinfection	Tertiary	Pathogen reduction	Ozonation	H	Effluent with low pathogens
Disinfection	Tertiary	Pathogen reduction	Ultraviolet radiation	H	Effluent with low pathogens

https://www.who.int/water_sanitation_health/sanitation-waste/sanitation/sanitation-guidelines/en/ 22

3-4 Financial System and Mechanism for wastewater management:

"The efficiency of existing financial resources and mobilizing additional and innovative forms of domestic and international finance must be increased."
(SDG 6 Synthesis Report on Water and Sanitation)

- Establishment of construction and O&M cost sharing principles (3T: Tariff, Tax, Transfer)
- The sewerage systems constructed with national and local budget should be managed in a stable and sustainable way.
  In Japan, under the **Local Government Finance Act**, public sewerage systems are managed by public enterprises which adopt the principle of **self-support accounting system to cover costs from the income and maintain it on a self-sustaining basis**.
- Increase of the awareness and understanding of citizens as tax payers and users
- Necessity of asset management by taking the following aspects into consideration
  - **Long-term basis forecast of income and expenditures** considering the lifespan of the facilities and the increased numbers of users
  - **Appropriate economic management** based on tangible business objectives, precise business analysis and future business prospects
  - **Accountability and disclosure of management information** to the citizens, tax payers and users who bear user charge

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3-4 FINANCING ARRANGEMENTS

Sewerage Finance Research Committee

- established to study **government's role and responsibilities** and **a rational cost sharing** for sewage works
- made an intensive research by **academics, researchers, local administration experts and sewerage engineers and officials on finances for sewerage Works**
- made **a major recommendation in its first report in 1961** and **other fundamental recommendations until the 5th Report in 1985**
- formulated **the current fundamental concept for sewage works on the principle** of

"Stormwater at public burden and Wastewater at private burden"

- the necessary expenses that should bear the central government based on the public role of sewerage systems
- the basic policy for the construction and maintenance financial sources

3-4 FINANCING ARRANGEMENTS

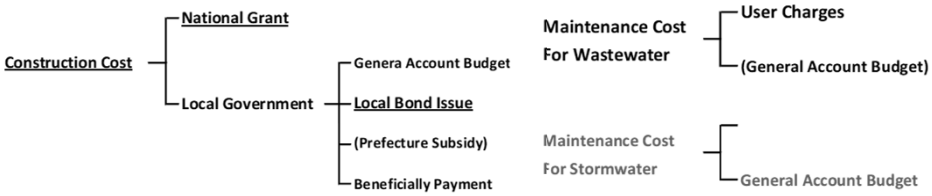
Sewerage Systems

Table : National Subsidy Ratio

Classification		Ratio of National Subsidy	Cost Sharing Ratio of Local Governments
Sewer Pipes	Granted Project	1/2	1/2
	Unsubsidized Project		10/10
Wastewater Treatment Plants	Granted Project	5.5/10	4.5/10
	Unsubsidized Project		10/10

Note : All of the costs shared by local governments are covered by local bonds

Table: Financial Sources of Sewage Works



"Stormwater at public burden and Wastewater at private burden"

Financial System for Wastewater Management

- **Establishment of Construction and O&M Cost Sharing Principles**
  Construction Cost: Subsidy, Local Bond, **User Charge**
  O&M Cost : **User Charge**, Public Sector Cost Burden

Collection of User Charge (Sustainability) greatly depends on
User's Willingness To Pay, (Affordability to pay)

In respect of
(1) The need for a water supply and sewerage system
(2) Awareness and understanding of residents for paying for the facilities
(3) A suitable payment system

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Financial System for Septage Management

•**Establishment of Construction and O&M Cost Sharing Principles**

Construction Cost: Subsidy, Local Bond, **User Charge**

O&M Cost : **User Charge**, Public Sector Cost Burden

Collection of User Charge (Sustainability) greatly depends on

User's Willingness To Pay, (Affordability to pay)

Tariff collection options

(1) Direct tariff collection

(2) From water supply fee which including ST sludge tariff

If users would pay sludge tariff to public authority and sludge collecting company would receive it at sludge treatment site, illegal dumping would be eliminated.

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3-5 Public Relation

- **Willingness to pay greatly depends on how citizens are aware of and evaluate the following benefits of sanitation systems**
  (Importance of Awareness and Understanding of Sanitation Systems Benefits)

1) Improvement of Surrounding Environments

Examples of benefits;

hygiene status, eradication of mesquites, flies,

People's comfort, use of flush toilet, elimination of odor problems, etc.

Reduction of Waterborne Diseases

2) Water Quality Preservation in Public Water Bodies

(1) Improvement of the value of water environment for citizens

(2) Cost reduction to uptake the water for drinking, industrial use, agricultural use, etc.

(3) Damage cost of agriculture by discharging of untreated wastewater

(4) Damage cost of fishery by discharging of untreated wastewater

(5) Alternative method for dredging (without sewage works, dredging is required)

Necessary Viewpoints for Public Relation, Public Education

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3-6 Institutional arrangements

- **Role of Central Government and Municipality**
- **Project Implementation Organization**(Project Responsible Organization)

- **Private Sector Participation,**
- **Public Private Partnership** (Share of Responsibilities, Risk management) (Service Contract, Managing Contract, Lease, Concession, Privatization, etc.)

- **Human Resource Development**: On-the-Job Training, Training Program
- **Capacity Development (JS Training Center)**

- **Research and Technology Development (JS R&D Division)**

- **Technical Support to Middle-Small Scale Municipalities (JS: Japan Sewage Works Agency)**

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3-7 Legal System for Sanitation Systems in Japan

1. Basic Law for Environmental Protection

(1) Sets up the Environmental Quality Standards
Items on Protection of Human Health
Items on Conservation of living Environment
(Classified based on Water Usage)

(2) Stipulates to Take Countermeasures for Pollution Control

2. Water Pollution Control Law

(1) Sets the Effluent Wastewater Standards from Specified facilities
National Standards

(2) Prefecture Government Can Set Several Effluent Standards
Wastewater Treatment plant; Specific Place of Business

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3-7 Legal System for Sanitation Systems in Japan

3. Sewerage Law

(1) Purpose of Sewerage

- Prevention of Flood
- Improving the Surrounding Environment
- Switching Flushing Toilet
- Prevention of Water Quality in Public Water Bodies

(2) Comprehensive Basin-wide Sewerage Development Program

(3) Administration of Sewage works

- **Municipalities;** in charge of **Public sewerage**
- **Prefectures ;** in charge of **Regional sewerage system (More than 2 Cities)**

(4) Procedures for Development of Sewerage Systems

(5) Use of Sewer Systems

- Obligation for house Connection
- Switching to Flush Toilets
- Users Charge

4. Johkasou Law

5. Waste Management and Public Cleaning Act

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