SOCIALIST REPUBLIC OF VIETNAM
MINISTRY OF CONSTRUCTION

LOCAL WATER SUPPLY AND WASTEWATER SECTOR SURVEY

FINAL REPORT

January 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO. LTD.
SEWERAGE BUSINESS MANAGEMENT CENTRE
DOGAN, INC.
WATER AGENCY INC.
NIHON SUIDO CONSULTANTS CO., LTD.

1R
CR(5)
15-002

SOCIALIST REPUBLIC OF VIETNAM
MINISTRY OF CONSTRUCTION

LOCAL WATER SUPPLY AND WASTEWATER SECTOR SURVEY

FINAL REPORT

January 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO. LTD.
SEWERAGE BUSINESS MANAGEMENT CENTRE
DOGAN, INC.
WATER AGENCY INC.
NIHON SUIDO CONSULTANTS CO., LTD.

LOCAL WATER SUPPLY AND WASTEWATER SECTOR SURVEY FINAL REPORT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PICTURES

ABBREVIATIONS

A_2O	Anaerobic-Anoxic-Oxic
ADB	Asian Development Bank
AFD	French Agency for Development
AP	Anaerobic Pond
AS	Activated Sludge
BIWASE	Binh Duong Water Supply Sewerage Environment Co., LTD
BOD	Biochemical Oxygen Demand
BOT	Build–operate–transfer
BTO	Business Transformation Outsourcing / Build Transfer Operate
CA	Coordinating Agency
CAS	Conventional Activated Sludge
CEPT	Septic Tank
CIDA	Canadian International Development Agency
COC2	College of Construction No.2
COD	Chemical Oxygen Demand
CPI	Consumer Price Index
CPMU	Central Project Management Unit
CSO	Combined Sewer Overflows
CSS	Combined Sewer Systems
CUWC	College of Urban Works Construction
CW	Constructed Wetland
DARD	Department of Agriculture and Rural Development
DDS	Drainage and Sewerage Department
DO	Dissolved Oxygen
DOC	Department of Construction
DOF	Department of Finance
DONRE	Department of Natural Resources and Environment
DOT	Department of Transport
DPC	District People's Committee
DPI	Department of Planning and Investment
DPT	Department of Public Works and Town & Country Planning
DTPW	Department of Transportation and Public Works
E/S	Engineering Service
EA	Executing Agency
EBF	Equity Back Finance
EGAT	Electricity Generating Authority of Thailand
EIA	Environmental Impact Assessment
EPF	Environmental Protection Fund
F/S	Feasibility Study
FERD	Foreign Economic Relations Department
FC	Financial Cooperation Module

FP	Facultative Pond
GAC	Granular Activated Carbon
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GNI	Gross National Income
GSO	General Statistics Office
GO	General Obligation
GOV	Government
HADUWASUCO	Hai Duong Water Supply Company
HAU	Hanoi Architectural University
HCMC	Ho Chi Minh City
HCMPC	Ho Chi Minh People's Committee
HFIC	Ho Chi Minh City Finance and Investment State-owned Company
HIFU	Ho Chi Minh City Fund for Urban Development Fund
HPWSCO	Hai Phong Water Supply One Member Co., LTD
HPWACO2	Hai Phong No.2 Water Business Joint Stock Company
HSDC	Ha Noi Sewerage and Drainage Company
IBST	Institute for Building Science and Technology
ICB	International Competitive Bidding
IDA	International Development Association
IMF	International Monetary Fund
IPM	Industrial Pollution Management
IWK	Indah Water Konsortium
IZ	Industrial Zone
JICA	Japan International Cooperation Agency
JIWET	Japan Institute of Wastewater Engineering and Technology
JSWA	Japan Sewage Works Association
JS	Japan Sewage Works Agency
JWWA	Japan Water Works Association
KfW	Kreditanstalt für Wiederaufbau
KHAWASSCO	Khanh Hoa Water Supply & Sewerage One Member Co., LTD
LCB	Local Competitive Bidding
LDIF	Local Development Investment Fund
LGU	Local Government Unit
LGUGC	LGU Guarantee Corporation
LIBOR	London Interbank Offered Rate
LPD	L/person/day
M/P	Master Plan
MABUTIP	Management Board of Technical Infrastructure Development Projects
MARD	Ministry of Agriculture and Rural Development
MBR	Membrane Bio Reactor
MF	Micro Filtration
MFF	Multitranche Finance Facility

MHLW	Ministry of Health, Labour and Welfare
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOC	Ministry of Construction
MOF	Ministry of Finance
MOH	Ministry of Health
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MOSTE	Ministry of Science, Technology and Environment
MP	Maturation Pond
MPI	Ministry of Planning and Investment
NRW	Non-Revenue Water
NRWF	National Revolving Water Fund
O&M	Operation and Maintenance
OD	Oxidation Ditch
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
OEM	Original Equipment Manufacturing
PC	People's Committee
PFIs	Participating Financial Institutions
PFR	Periodic Financing Request
PI	Performance Indicator
PMB	Project Management Board
PMU	Project Management Unit
PPCs	Provincial People’s Committees
PPP	Public–Private Partnership
PSP	Private Sector Participation
PPTA	Project/Program Preparatory Technical Assistance
PS	Pumping Station
PSIF	Private Sector Investment Finance
PTF	Pre-treated Trickling Filtration
PVC	Poly Vinyl Chloride
PWRF	Philippines Water Revolving Fund
QUAWACO	Quang Ninh Clean Water One Member CO., LTD
RO	Reverse Osmosis
SADCOs	Sewerage and Drainage Companies
SAWACO	Saigon Water Corporation
SBR	Sequencing Batch Reactors
SCADA	Supervisory Control And Data Acquisition
SCFC	Steering Center of Urban Flood Control Program
SEA	Subproject Executing Agency
SMEFP	Small and Medium-Sized Enterprises Finance Project
SMEs	Small and Medium Enterprises
SNV	Dutch Overseas Supporting Group

SOEs	State-owned Enterprises
SPC	Special Purpose Company
SRF	Sanitation Revolving Fund
SSS	Separated Sewer Systems
STEP	Special Terms for Economic Partnership
SWRO	Seawater Reverse Osmosis
TCSW	Training Center for Sewerage Works
THM	TriHaloMethane
TIWACO	Tien Giang Water Supply Company LTD
TOR	Terms of Reference
TOT	Training of Trainer
TTH	Thua Thien Hue
U-BCF	Upward Flow Bio Contact Filtration
UDC	Urban Drainage Company
URENCOs	Urban Environmental Companies
USAID	United States Agency for International Development
USD	United States Dollar
VAST	Vietnam Academy of Science and Technology
VCEP	Viet Nam-Canada Environment Project
VDB	Vietnam Development Bank
VEPF	Vietnam Environmental Protection Fund
VGF	Viability Gap Funding
VND	Viet Nam Dong
VPEG	Vietnam Provincial Environmental Governance
VWSA	Vietnam Water Supply and Sewerage Association
WB	World Bank
WMA	Wastewater Management Authority
WSCs	Water Supply Companies
WSESTC	Water Supply and Environmental Sanitation Training Center
WSDCs	Water Supply and Drainage Companies
WSP	Water and Sanitation Program
WSPST	Water and Sanitation Program for Small Towns
WSRF	Water Sector Revolving Fund
WTP	Water Treatment Plant
WWMP	Waste Water Management Program
WWTP	Waste Water Treatment Plant

1. Outline of the Survey

(1) Background of the Survey

The water supply and wastewater sectors need to be developed in the Socialist Republic of Vietnam (hereinafter called "Vietnam") considering the country's rapid economic growth and urbanization. However, the budget for their development has been insufficient especially in local municipalities ofVietnam, thus causing serious deterioration of the water environment in urban areas and insufficient access to safe water.

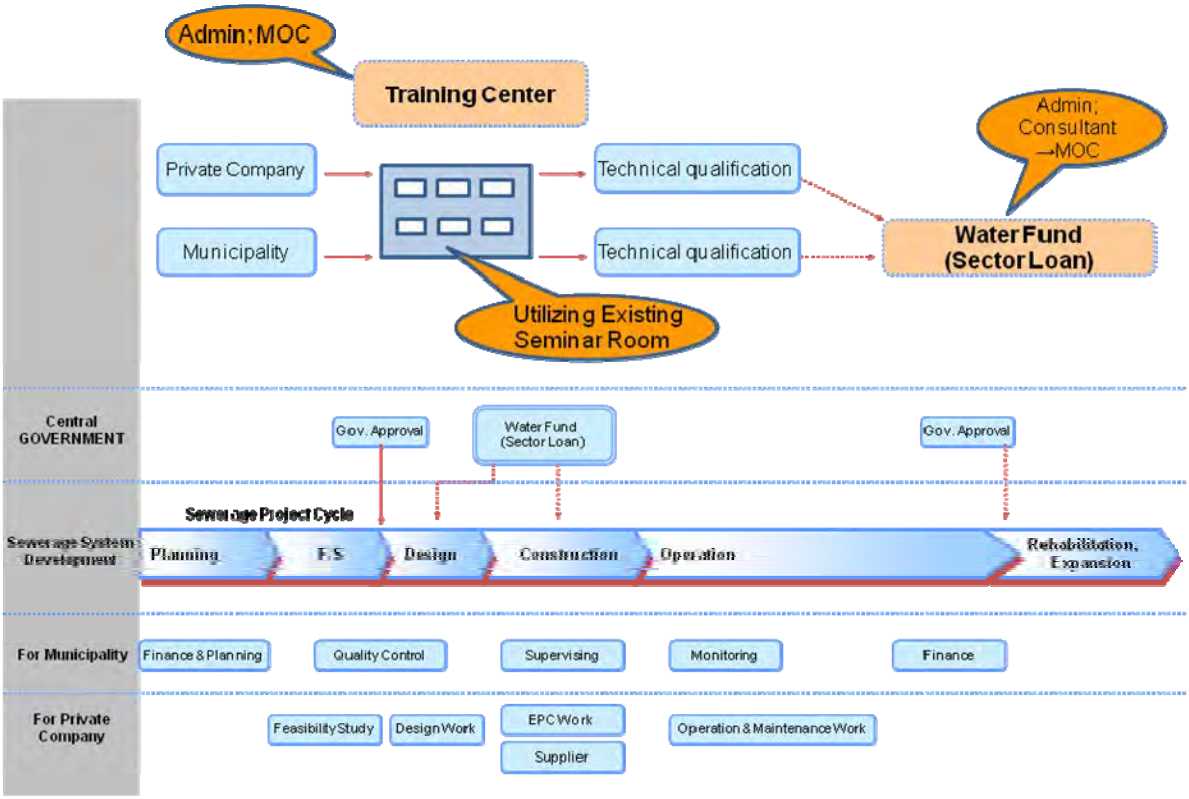
In the wastewater sector, sewerage service is now provided or implemented in Ha Noi, Ho Chi Minh City (HCMC), Ha Long, Hai Phong, Da Nang, Hue, Hoi An, Nha Tang, Bun Tau, and Bin Duong by utilizing financial and technical assistance from donors. Although, sewerage service does not cover the entire cities mentioned above, and the percentage of sewered population in Vietnam is still less than about 10%[1]. Accordingly, sewerage service should be extended in big cities and is desired to be started in local municipalities. The implementation of sewerage projects in local municipalities is the main target that needs to be materialized according to the national target, which stipulates the target coverage ratio in urban areas in 2050 as 100%.

(2) Objectives and Outline of the Survey

This survey (hereinafter called "Survey") aims to collect relevant information and investigate the strategies for sound development of the water supply and wastewater sectors in local municipalities of Vietnam.

As described in the previous section, the mobilization of public and private funds to the sector and the capacity development of relevant staff and agencies are essential for the development of the sector. The Japan International Cooperation Agency (JICA) is now considering effective solutions to solve these issues in parallel. One solution is the establishment of a new financial scheme for the water sector, and the other is the establishment of a training center for sewage works. In order to accelerate sound development of these sectors, a new financial scheme will be applied for the executing agencies (EAs) which have technical qualifications for the training center, as shown in Figure S1.1.

[1] Vietnam Urban Wastewater Review, World Bank, 2013



Source: JICA Survey Team

Figure S1.1 Practical Solution for the Sound Development of the Wastewater Sector

To materialize the above solution and accelerate sound development of the sector, relevant issues and information listed below will also be studied in the Survey.

1) Financial needs and priority projects of the sector;

2) Needs for collaboration between Vietnamese and Japanese private companies; and

3) Needs for the application of Japanese advanced technology such as upward biological contact filtration (U-BCF) and sludge recycling.

As a result, the Survey composed of following five fields.

1) Potential Finance Schemes with Japanese ODA Loan

2) Capacity Development and Project Implementation Support

3) Estimation of Financial Needs for Water Supply and Sewerage Development

4) Collaboration between Vietnamese and Japanese Private Companies

5) Matching of Vietnamese Needs and Japanese Technologies

2. Financial Needs for Urban Water Supply and Sewerage Development

(1) Population

According to the latest population census implemented in 2009, the total population of Vietnam was 86.02 million in 2009, where the urban population was 25.59 million and the rural population was 60.40 million.

According to the General Statistics Office (GSO), the total population increased to 89.71 million in 2013. Men accounted for 49.5% of the country's total population with a growth of 1.1% and women accounted for 50.5% with a growth of 1.0%. The total birth rate in 2013 reached 2.10 babies per woman, more than the level of 2.05 babies per woman in 2012. Sex ratio reached 97.91 men to 100 women, more than the level of 97.86 men to 100 women in 2012.

The total population in 2013 increased by 4.3% as compared with that of 2009, and also increased by 1.1% as compared with that of 2012. From 2009, the total population of Vietnam has increased by approximately 1.1% per year.

The urban population was 29.03 million and rural population was 60.68 million in 2013. The urban and rural population increased by 13.5% and 0.5%, respectively, as compared with that of 2009, also they increased by 2.4% and 0.4%, respectively, as compared with that of 2012.

The "Population Projection for Vietnam 2009-2049" forecasts the population of the whole country by area categories (rural/urban) and population trend by areal categories (whole, urban, and rural) are summarized in Table S2.1 and Figure S2.1.

The population will increase every year until 2049, whereas the growth rate will slow down from 2040 or so. Estimated population in 2049 is 108.71 million, where urban and rural populations are 63.92 million and 44.79 million, respectively.

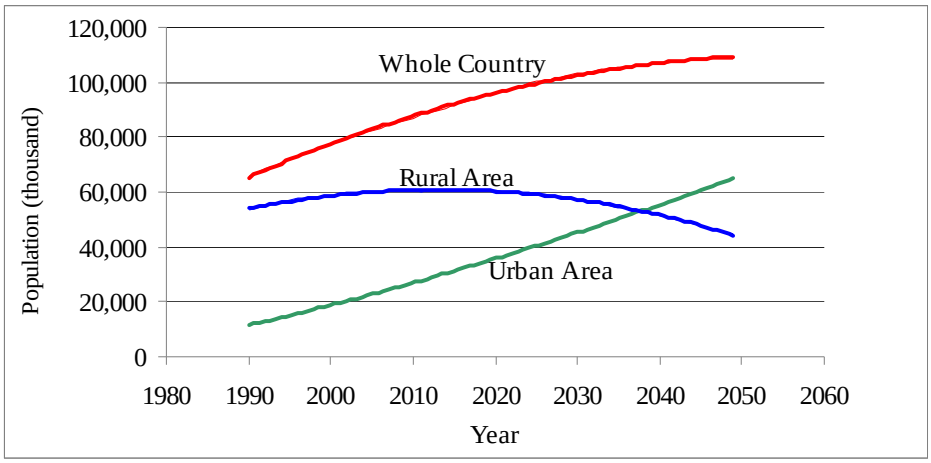
Urban population is forecasted to increase linearly at 2%-3% growth rate every year until 2040. On the other hand, rural population is estimated to increase slightly until 2015 and decrease after that.

Table S2.1 Estimated Populations for Whole, Urban and Rural Area in Vietnam

Year	1995	2000	2005	2009	2010	2013	2015
Whole (1,000 persons)	71,996	77,631	82,392	86,025	86,933	89,709	91,583
Urban (1,000 persons)	14,938	18,725	22,332	25,585	26,516	29,030	30,763
Share(%)	20.7	24.1	27.1	29.7	30.5	32.4	33.6
Rural (1,000 persons)	57,057	58,906	60,060	60,440	60,417	60,679	60,820
Share(%)	79.3	75.9	72.9	70.3	69.5	67.6	66.4

Year	2020	2025	2030	2035	2040	2045	2049
Whole (1,000 persons)	96,179	100,131	103,117	105,388	107,004	108,165	108,700
Urban (1,000 persons)	35,654	40,743	45,804	50,818	55,674	60,378	63,920
Share(%)	37.1	40.7	44.4	48.2	52.0	55.8	58.8
Rural (1,000 persons)	60,525	59,388	57,312	54,570	51,330	47,787	44,780
Share(%)	62.9	59.3	55.6	51.8	48.0	44.2	41.2

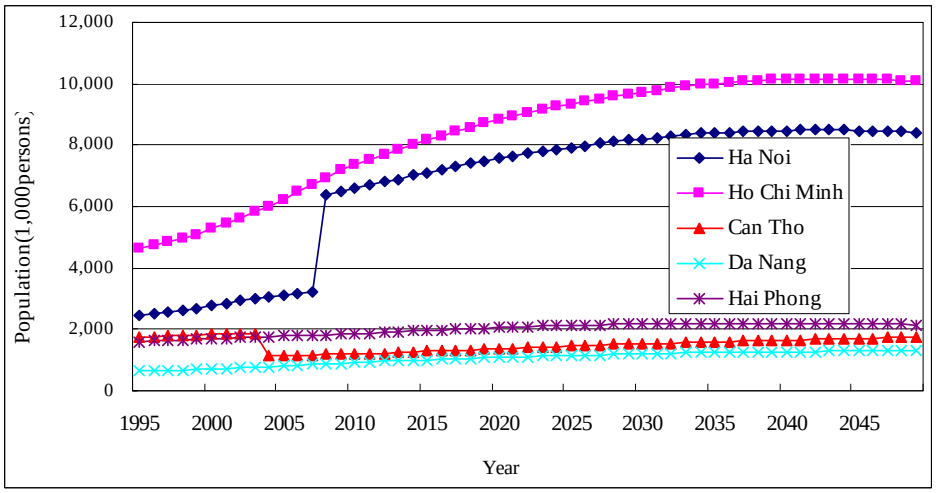
Source: Population Projection for Vietnam 2009-2049, GSO of Vietnam



Source: Population Projection for Vietnam 2009-2049, GSO of Vietnam

Figure S2.1 Population Projection in Vietnam

The population trend in the five centrally-run cities is estimated as shown in Figure S2.2. The population of Ha Noi and HCMC is forecasted to increase until 2040 and subsequently, each of them is estimated to remain flat or decline. The population of other cities is projected to slightly increase



*: A sharp population increase in Ha Noi in 2008 was caused by the merger with Ha Thai Province.

**: A sudden population drop in Can Tho in 2004 is due to the split of Can Tho Province into Can Tho City and Hau Giang Province.

Source: Population Projection for Vietnam 2009-2049, GSO of Vietnam

Figure S2.2 Population Projection of 5 Centrally-run cities

(2) Current State of Water Supply and Wastewater Sector

1) Water Supply

The number of water treatment plants (WTPs) in the urban areas of the five centrally-run cities is 55, and their total designed capacity is estimated at 3,200,000 m^3/day. It forms approximately 50% of the total capacity in Vietnam. As production and capacity utilization of each company in HCMC is over 100%, it is considered that the improvement of water supply capacity is needed immediately. Also, as production and capacity utilization of companies in the other four cities is nearly 90% or over, the improvement of water supply capacity will also be needed in the near future.

The Vietnam Urban Water Supply Database 2011 explained that the average coverage ratio was 79.4% in the urban areas of the five centrally-run cities. It is larger than the average of other provinces at 72.8%. In the case of the area above grade IV and grade V in those cities, they were 80.2% and 27.3%, respectively. Serviced population of the five cities is 11.14 million people, and above grade IV and grade V are estimated at about 11.08 million and 0.06 million people, respectively.

According to the report of the Vietnam Urban Water Supply Database in 2011 by WB and MOC, there are 83 WSCs (including joint venture companies) in the urban areas of Vietnam except small water companies which are located in small towns such as urban grade V. There are 366 WTPs in 79 WSCs surveyed and their total capacity is about 6.5 million m^3/day.

The NRW ratio is generally reported as having been reduced from 39% in 2000 to 20%-30% in 2011 except in some WSCs. According to the Vietnam Water and Sewerage Association (VWSA), NRW ratio is 30% to over 40% in some cities such as HCMC, because the insufficient upgrade of distribution networks causes high ratio of leakage. The average NRW ratio in all urban areas is 27.1% and it varies from 7.3% (in Vat Cach) to 44.9% (in HCMC). NRW ratios in 23 WSCs are smaller than 20% and those in ten WSCs are smaller than 10% including An Viet (8.93%), Vat Cach (7.26%), Binh Phuoc (8.33%), and Phu My (3.38%).

In general, water quality in WTPs meets the Vietnamese standards for drinking water which is QCVN 01:2009/BYT issued by the Ministry of Health (MOH). However, due to the insufficient quality of pipe systems and high NRW ratio, the quality of tap water does not meet the requirements for direct drinking water, but it satisfies the standards for domestic water, QCVN 02:2009/BYT. According to the report of WB and MOC, 100% of samples meet the standards of QCVN 01:2009/BYT in 56 WSCs (71% of total companies), 90% to 99% in 13 companies, and under 90% in ten companies, respectively, in 2011.

2) Current State of Sewerage

Wastewater treatment plants (WWTPs) are under operation in 21 sites in Vietnam as of September 2013. The total capacity of the existing WWTPs is approximately 460,000 m^3/day.

Binh Hung WWTP with treatment capacity of 141,000 m^3/day and Yen So WWTP with 200,000 m^3/day have started operation. They are modern and the largest WWTPs that have applied the activated sludge process. Kim Lien and Truc Bach WWTPs were the first that started the operation of activated sludge process in Vietnam and they have provided their services for about nine years since 2005

As of 2012, sewerage served population with WWTP is approximately 10% (separated sewer: 1% and combined sewer 9%), population connected to sewer without treatment is approximately 40 %, remained 40 % are not served by sewerage system.

Sewage volumes per capita of big cities, such as Ha Noi and Ho Chi Min City is 225 LPD and the average value of other cities is 121 LPD.

Sewage volume per capita is divided into the following three parts in accordance with the classification of sources:

i) Domestic sewage: 70%,
ii) Public service activities and small industries: 20%, and

iii) Inflow and Infiltration: 10%.

(3) National Master Plan of Water Supply and Wastewater Sector

In 2009, GOV updated the orientations for the development of urban water supply sector. Decision No. 1929/QD-TTg dated November 20, 2009 described the orientation for the development of water supply sector in urban areas and industrial parks in Vietnam by year 2025 and the vision of 2050. The Decision stipulates the following vision towards 2050:

1) Satisfying the water supply demand in all urban centers and industrial parks on the basis of supplying quality water with good services in a stable and efficient manner; and

2) Three-phased targets up to 2025 (as shown in Table S2.2):

   i) Accomplishment of 100% coverage with a water consumption of 120 LPD

   ii) Reduction of NRW ratio down to 15%, and

   iii) Continuous (24 hours/day) water supply service in all urban areas in Vietnam

Table S2.2 Updated Orientations for the Development of Urban Water Supply Sector

<table>
<tr><td>Year</td><td colspan="2">2015</td><td colspan="2">2020</td><td colspan="2">2025</td></tr>
<tr><td>Item
Grade</td><td>Coverage and Water Consumption</td><td>Non Revenue Water</td><td>Coverage and Water Consumption</td><td>Non Revenue Water</td><td>Coverage and Water Consumption</td><td>Non Revenue Water</td></tr>
<tr><td>Sp</td><td rowspan="4">90% with 120LPD</td><td rowspan="5">Below 25%</td><td rowspan="5">90% with 120LPD</td><td rowspan="5">Below 18%</td><td rowspan="6">100% with 120LPD</td><td rowspan="6">Below 15%</td></tr>
<tr><td>I</td></tr>
<tr><td>II</td></tr>
<tr><td>III</td></tr>
<tr><td>IV</td><td>70% with 100LPD</td></tr>
<tr><td>V</td><td>50%</td><td>Below 30%</td><td>70% with 100LPD</td><td>Below 25%</td></tr>
</table>

Source: Decision No.1929/QD-TTg

The national goal of service coverage of wastewater collection and treatment system in 2025 according to Decision No. 1930/QD-TTg is shown in Table S2.3. The coverage ratio is set between 70% and 80% in category IV or higher urban areas and 50% in category V urban areas and craft villages. The overall coverage ratio is assumed at 65% with a median of 50% to 80% of the target value of the national goal in 2025. The total amount of the project needs is assumed to 100% of service coverage of the collection and treatment system.

Table S2.3 Objectives for the Development of Urban Drainage and Wastewater Treatment

Items		2015	2020	2025	2050
Drainage (rain water discharge)	Flood	To be solved in category II or higher urban areas	To be solved in category IV or higher urban areas	To be solved in all urban areas	Will be solved in all urban areas
	Service coverage	70-80%	>80%	90-95%,100% in category IV or higher urban areas	
Wastewater discharge	Service coverage of collection and treatment system	40-50% in category III or higher urban areas	60% in category III or higher urban areas	**70-80% in category IV or higher urban areas**	**Will be solved in all urban areas**
		-	40% in categories IV, V urban areas and craft villages	**50% in category V urban areas and craft villages**	
		-	-	Wastewater treatment plants at different levels of management are located in craft villages	
	Industrial and hospital wastewater	The whole wastewater is treated	-	-	-
		All industrial parks have their own discharge system	-	-	-
	Other items	Public toilets are installed in categories IV or higher urban areas	Pipes, sewers, channels will be upgraded to prevent pollution at concentrated residential areas	20-30% treated wastewater will be reused.	-

Source: JICA2011, Research Report on Vietnam Urban Environment Management

(4) Summary of the Water Sector Needs

Project needs of the water supply and wastewater sector are shown in Table S2.4 and Figure S2.3.

Water supply has less project needs than sewerage due to the high service rate of 70% at present, however, replacement of WTP and NRW mitigation projects as well as expansion of service areas are required.

The wastewater sector requires huge amount of financial source exceeding MPI survey (USD 8.25 billion for 2011-2020) due to urgent sewerage system development in the whole country. This survey applies existing construction database which includes large-scale project in Ha Noi, HCMC, and others. Mitigating financial expenditure is indispensable through applying low-cost technology and focusing on priority projects.

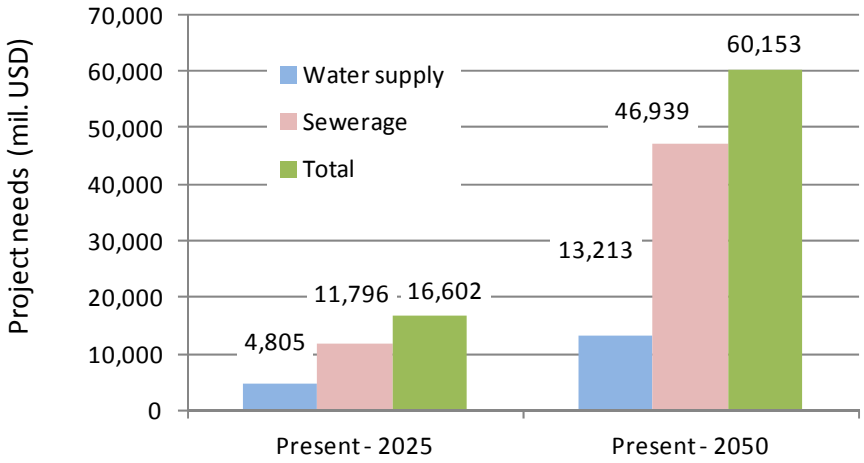
Public fund investment mechanism is urgently required considering low interest rate and long repayment period in accordance with the huge amount of financial needs.

Table S2.4 Project Needs of the Water Supply and Wastewater Sectors

(Unit: USD on millions)

Year	Present – 2025	Present – 2050
Water supply	4,805	13,213
Sewerage	11,796	46,939
Total	16,602	60,153

Source: JICA Survey Team



Source: JICA Survey Team

Figure S2.3 Project Needs of the Water Supply and Wastewater sector

(5) Priority Projects

Priority projects are selected in accordance with implementing provision such as completion of feasibility study, and Japanese ODA and PPP projects. These projects require financial source urgently in accordance with benefit to recipients as well as contributing Japanese companies.

Projects of first and second tranches are selected among projects which PPP FS and JICA TA have completed and will be implemented. The projects for which local consultants implement the F/S studied can be nominated to third tranche since JICA appraisal takes time.

Table S2.5 Priority Projects for Water Sector Loan

Phase	Project	Category		Estimated Cost
		WS or WW	PPP	
First Tranche (Project Cost: Approx. USD 300 mil.)	Binh Duong	WS	PPP	118.3-169.8 mil. USD
	Phu Quoc, Kien Giang	WS	PPP	36.7 mil. USD
	Ha Long City, Quang Ninh	WW		60 mil. USD
	Da Nang City	WW		97.31 mil. USD
Second Tranche	Ha Nam	WS + WW	PPP	-
	Long An (transfer pipe, Ben Luc)	WS	PPP	10 mil USD
	Binh Duong (Phase-3)	WW		-
	Phu Quoc, Kien Giang	WW	PPP	58.2 mil USD
Third Tranche	Long An (Phu My Vinh WTP)	WS	PPP	-
	Thai Nguyen, Dak Lak, Lao Kai	WW		-
	Hai Phong, Quang Ninh, Khanh Hoa, Tien Giang	WS		-
	Ha Tinh	WW		-

Source: JICA Survey Team

3. Potential Finance Scheme

Future investment requirement to deliver adequate water supply and sewerage services in Vietnam, including funds that are needed to operate and maintain the infrastructure, expand the coverage, and upgrade service delivery, is significant. Although infrastructure investment in the urban water supply and wastewater sectors has been, and still is, heavily dependent on official development assistance (ODA) funding, this will not be sustainable in the long run. The continued growth of the Vietnamese economy is likely to result in a decrease in the amount of ODA fund available to the country in the future, as the support will become less concessional and the cost of ODA funding will be closer to commercial terms.

Meeting future investment plans with an increased level of investment, and preparing for the transition away from concessional donor financing, both suggest a need to mobilize new sources of finance, including public or private sources at the national and international level as well as tariffs and taxes. Diversification of financing sources, notably with greater reliance on private financing, would help decentralize financing decisions reducing the burden on central planning organizations and potentially improving the efficiency of investment.

Governments in some developing countries are gradually embracing the idea of subnational entities accessing private finance for investments in public infrastructure and services. In Vietnam, however, the credit and capital market is neither efficient nor deep enough in intermediating savings from institutional and individual savers to fund projects. Moreover, establishing sustainable markets to enable municipal finance requires policies to foster sustainable markets that are supported by a robust regulatory framework that ensures prudent borrowing, accountability, and financial discipline.

Future ODA project design should cover, not only technical definition of the project, but also a comprehensive, long-term corporate development plan including in-depth institutional reforms, development and financial objectives, and project components, with the assistance from implementing agencies and key decision makers. Existing gaps in institutional and regulatory framework in the urban water supply and wastewater sectors, including the lack of robust framework for PPP and municipal finance and the financial sustainability, will require further improvement through on-going policy dialogue between the Government of Vietnam and the development partners. Close donor coordination is necessary in order to avoid geographical duplication and to foster synergy for effective ODA management in the sector.

Moreover, public sector participation for water supply and sewerage infrastructure in Vietnam represents a key opportunity for investors and financers in the long run. Further progress in institutional and regulatory arrangements as well as various risk mitigation measures would be prerequisite to provide comfort to foreign investors and financiers.

4. Training and Consultation Centers for Vietnamese Wastewater Sector's Development

4.1 Sewerage Training Center

(1) Objectives

The establishment of a training center is proposed. The training center is aimed at capacity development of sewerage engineers in order for them to develop and operate the sewerage system and its organization in Vietnam.

In Vietnam, the lack of sewerage engineers prevents the construction and operation of the sewerage system required for a sustainable environment of Vietnam. Although some sewerage projects will be financed by the sector loan proposed in the previous section, the problem affects the sound implementation of the project.

The training center will contribute to develop the sewerage sector by providing the required number and quality of engineers in the central and municipal governments, and private companies.

(2) Concept

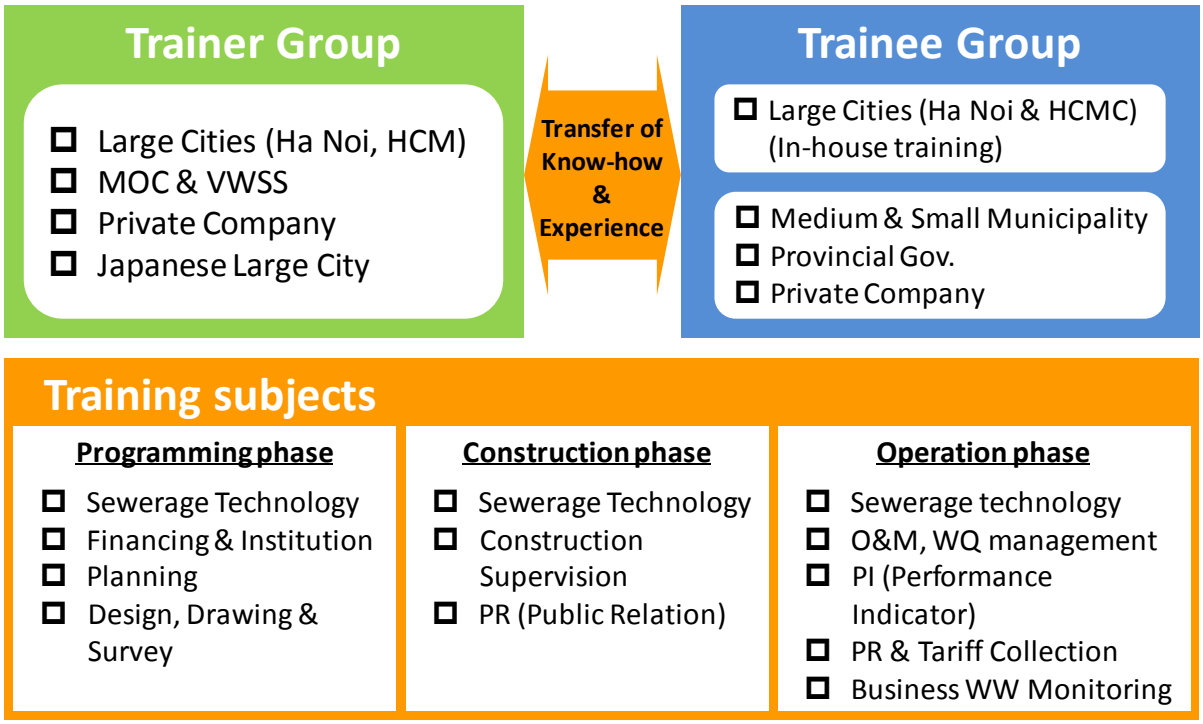
The expected roles of the training center are as follows:

1) Provision of a standardized training program for the staff in charge of sewerage project to be of highly qualified engineer;

2) Evaluation and support of new technologies to be applied to the subprojects, which can accelerate utilization of the public; and

3) Training certification to guarantee the quality of the engineer.

A diagram of the relationship among the trainer, trainee, and subjects of the training program to achieve the concept is presented in Figure S 4.1.



Source: JICA Survey Team

Figure S4.1 Relationship among Trainee, Trainer, and Subjects of Training

4.2 Scheme of the Training Center

The scheme is set based on the results of the questionnaire and interview surveys carried out in Ha Noi City, and HCMC, and answered by MOC.

(1) Framework of the Training Center

1) Trainees

The expected trainees are technical staff who have limited experience in sewerage projects in the metropolis, provinces, cities, and towns where the sewerage project has been /will be implemented. In addition, employees of private companies will be accepted as trainees because the capacity development of the person in charge of the planning, detailed design, construction, and O&M phases is essential.

2) Trainers

The expected trainers are mainly engineers working in the sewerage sector of Vietnam for many years. During the establishment of the training system, Japanese trainers shall be invited from related organizations such as the Ministry of Land, Infrastructure, Transportation and Tourism of Japan, big Japanese cities, JS, and Japan Sewage Works Association. In training of advanced technology such as microtunneling method, inviting the engineer of a private company developing the technology as trainer is effective.

Since the trainers are invited from other organizations, the period of training program shall be approximately three weeks at the maximum. In addition, some permanent trainers will be required to maintain the quality of training.

3) Program of Training

The program of training is composed of courses on planning, construction, and O&M depending on the progress of the project.

In the planning course, essential technology, organization and finance, survey and plan, and design of sewerage system are the subjects.

In the construction course, supervision of construction works, and promotion of sewerage system and its necessity to the resident are the subjects.

In the O&M course, subjects are on methods for O&M of pipelines and WWTPs, PIs for the monitoring of the project, tariff setting, and public awareness.

(2) Counterpart for Establishment of the Training Center

Regarding the counterpart organization for the establishment of the training center, VWSA, Ha Noi City, HCMC, Ha Noi Sewerage and Drainage Limited Company, and universities in Vietnam are assumed to be candidates. As a result of the Survey, the Administration of Technical Infrastructure of MOC (ATI) was recognized as the most appropriate counterpart for the establishment of the training center, as the organization comprehensively controls the project and technology of sewerage system.

In addition, CUWC, HUA, and VWSA are in charge of existing training courses on sewerage technology. These organizations are options to request their cooperation for practical training on the establishment of the training center.

(3) Authorization of Training Program and Certification under Vietnamese Regulation

Authorization of training program and its certification under Vietnamese regulation is recommended to guarantee the quality of engineers who graduated from the training program. This is the same scheme applied in Japan. The qualified engineers are indispensable for appropriate development of the sewerage system therefore a comprehensive index for the qualification of the engineer to assign sewerage projects shall be prepared in Vietnam. The university or organization where training program will be provided and which is authorized by Vietnamese regulation is expected to issue the certification.

To accelerate getting the certification, the precedence for the provision of the Water Sector Loan for the subproject needs to be discussed. Therefore, the local municipality which has the graduates of the designated training program will be preferentially provided with the Water Sector Loan.

In the initial stage of the establishing the training center, the training program for the Vietnamese trainers (TOT) need to be carried out. In the program, the foreign engineer invited from Japan and the trainees study the training program and skills through preparing technological texts and attending the existing program of technological training in Japan.

(4) Location of Training Center

Ha Noi is the recommended location for the establishment of the training center since sewerage projects have been launched in the city, and the trainees can learn practical technology and operation method on site.

According to raising the necessity of sewerage projects in major urban areas all over Vietnam, the

establishment of a second training center, or the assignment of trainer groups to provide periodical local training program shall be discussed in the future.

(5) Utilization of the Existing Facilities for the Training Center

The first priority in the establishment of the training center is to materialize it as early as possible. Thus, utilization of existing facilities for the training center will be essential to avoid wasting time for the construction of facilities. Accordingly, the recommended candidates of the training center, i.e., VWSA, CUWC, and HAU, are preliminary investigated in consideration of the following points:

1) Relationship between MOC and organization responsible for the existing facilities,

2) Physical distance between the location of MOC and the organization,

3) Current capacity of lecture and practical rooms, and

4) Possibility of constructing WTTP, or utilizing the existing facilities for practical training.

As a result of the study, CUWC is **tentatively** proposed as the most recommendable location and organization to establish the training center among the candidates shown in Table S4.1. The location of the training center is needed to have further discussions in Vietnam.

Table S4.1 Evaluation of the Locations for Establishment of the Training Center

Items for Evaluation	VWSA	CUWC	HAU
Relationship with MOC	Administration officer assigned from MOC	Under MOC	Under MOC
Physical Distance from MOC	Close	One hour by car	Forty minutes by car
Rooms for lectures or practical work	Need to be arrange in other place	Available	Available
WWTP for practical work	None	Space for the construction of plant available	Close to the site for construction project of Yen Xa WWTP
Result of evaluation	Limited activity such as arrangement of trainers	The best option in the table	Acceptable

Source: JICA Survey Team

4.3 Consultation Center

(1) Objectives and Main Role of Consultation Center

The training center mainly performs for long-term measures for the development and operation of the sewerage system through the training of engineers to manage the sewerage project. An organization managing the medium-term and short-term measurements for the ongoing sewerage project is also necessary.

The JICA Survey Team proposed the necessity of a consultation center, which is mainly in charge of short-term or medium-term measurements directly to support PMU of the subproject in finding project, project programming, design and construction of facilities, establishment of an organization and regulation. The main roles of the consultation center are presented in the Table S4.2.

Table S4.2 Main Roles of a Consultation Center

Items	Short Turm	Middle and Long Term
(1) Primary assessment of the subproject	-	O
(2) Fund administration of the Water Sector Loan	-	O
(3) Technical assistance for the subproject	O	O

Source: JICA Survey Team

(2) Primary Assessment of Sub-project

1) Primary Assessment of Subproject

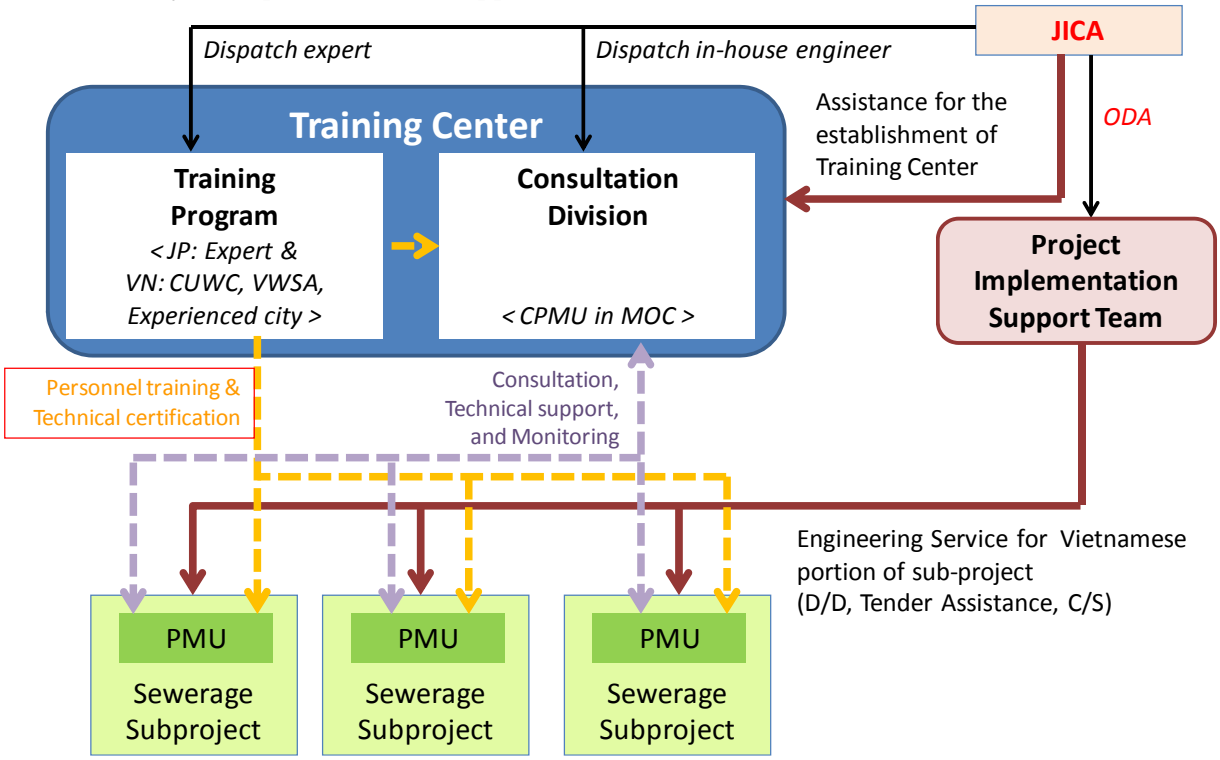
The evaluation of a project at the initial phase in terms of project schedule and disbursement schedule is indispensable for sound management of the subproject financed by the Water Sector Loan. In most cases, PMU, however, is not familiar with the necessary procedures for projects financed by the Water Sector Loan due to lack of experience. This causes delay of the project.

In the short term, JICA is directly in charge of evaluation of assignment of foreign experts. In parallel, the assigned engineers, in collaboration with the local engineers, support and instruct the staff of PMU for project implementation agreement between MOC and the province. Pursuant to the agreement, the fund of the subproject is financed by MOF.

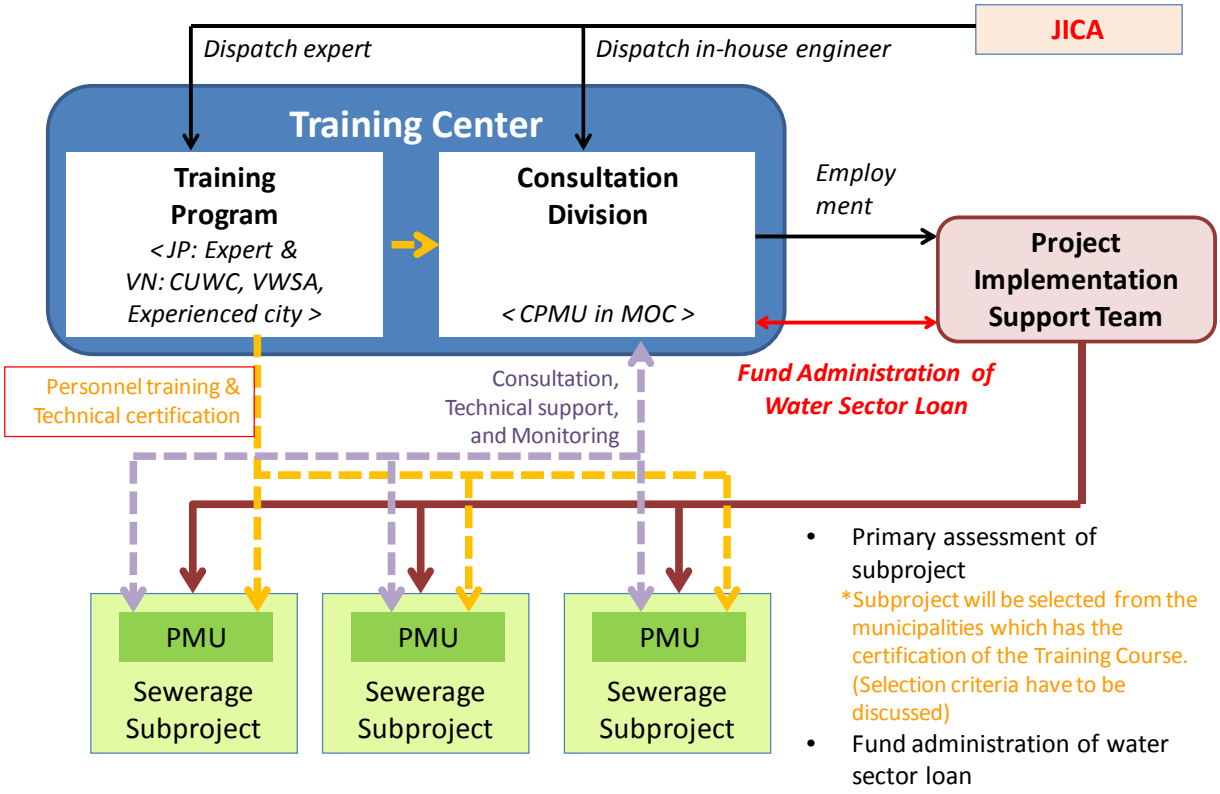
2) Engineering Service for Sub-project

Training Center issues certification to PMU through training engineers who is engaged to sewerage subproject. As the training center has not been established yet at the initial phase of the sector loan, the consultants procured by the JICA are necessary for implementation of the engineering services of sub-project. The outline of the technological assistance is presented in Figure S4.2.

Scheme of Project Implementation Support (Short Term)



Scheme of Project Implementation Support (Middle and Long Term)



Source: JICA Survey Team

Figure S4.2 Outline of Technological Support

(3) Technical Assistance for Subproject

1) Consultation

Consultation of technical issues asked by PMU during the implementation of subproject is one of the functions carried out by the consultation center.

2) Support for Establishing Regulations on Sewerage System

In the technology of the design and construction works, the new or advanced technology are New or advanced technologies for design and construction works are being developed every day. In many cases, utilization of advanced technology accelerates the progress of the project and enhances the quality of service.

From this situation, the establishment of standards for new or advanced technology is necessary as soon as possible. The consultation center performs the main role in the preparation of the standards. Technological support for the preparation of standards is presented in Table S4.3.

Table S4.3 Technological Support for the Preparation of Standards

Items	JICA (Consulting Service)	MOC
1) Project evaluation manual - Project area and population projection - Quality and quantity of water - Facility planning - Implementation plan - Tariff setting	-	Prepared during project evaluation in advance to 1st Tranche
2) Cost Estimation Standard for engineering services	-	Prepared by first tranche
3) Cost Estimation Standard for construction works	-	Prepared by first tranche
4) Standard drawing of WWTP and sewer design and planning	Prepared by second tranche	-
5) Guideline setting of - Plan and Design - Operation and management plan - Project cost programming - Public relation - Institutional design for sewerage works operation - Tariff setting - Business waste monitoring - Urban development approval	Prepared by third tranche	*Upgrade after third tranche

Source: JICA Survey Team

4.4 Financial Administration of Training Center

In the beginning of training center, JICA ODA project and Vietnam Government can not help financing an administration cost of Training Center. However, in mid- and long- term, the administration cost shall maintain a financial sustainability by obtaining an income from a provided service, for example. Therefore, a plan of training center shall be considered a prospected income in the future. The prospected income for the training center should be considered in next project.

4.5 Implement Schedule of Technological Support

The implementation schedule of technological support is proposed in Table 4.4, which is based on the loan agreement of the Water Sector Loan in 2014. The establishment of the training center will start in 2014 to support its urgent operation.

Table S4.4 Preliminary Implement Schedule of Technological Support

	2014	2015	2016	2017	2018	2019	2020
1) Water Sector Loan							
First Tranche	●	―	―	―	―	―	―
Second Tranche			●	―	―	―	―
Third Tranche					●	―	―
Forth Tranche							● ―
2) Training Center		Technical Certification	↑		↑		↑
Submission of Application Form	★						
Preparation	―	―					
Training Program		●	―	―	―	―	―
3) Project Implementation Support	●	―	―	―	―	―	―

Source: JICA Survey Team

5. Collaboration of the Vietnamese and Japanese Private Companies

5.1 Summary of the Analysis of Private Companies

(1) Vietnamese Companies

Vietnamese companies that work for treatment plant construction and operation, are relatively small except for a few large companies. Many contractors obtain projects from not only the Vietnamese large contractors such as Petrol Vietnam, Vinaconex but also from foreign companies. In fact, there are those who support this industry. Overall, the Vietnamese companies regard the Japanese companies as one of the most important companies and are seeking collaboration with them. On the other hand, they struggle in collecting information about the companies and equipment from Japan. They often try to attain the information through the internet but there are barriers that prevent actual communication because the first contact through e-mail or telephone leaves anxiety for the companies received. Thus, Vietnam does not optimize the potential and efficient development opportunities by adopting the Japanese technology.

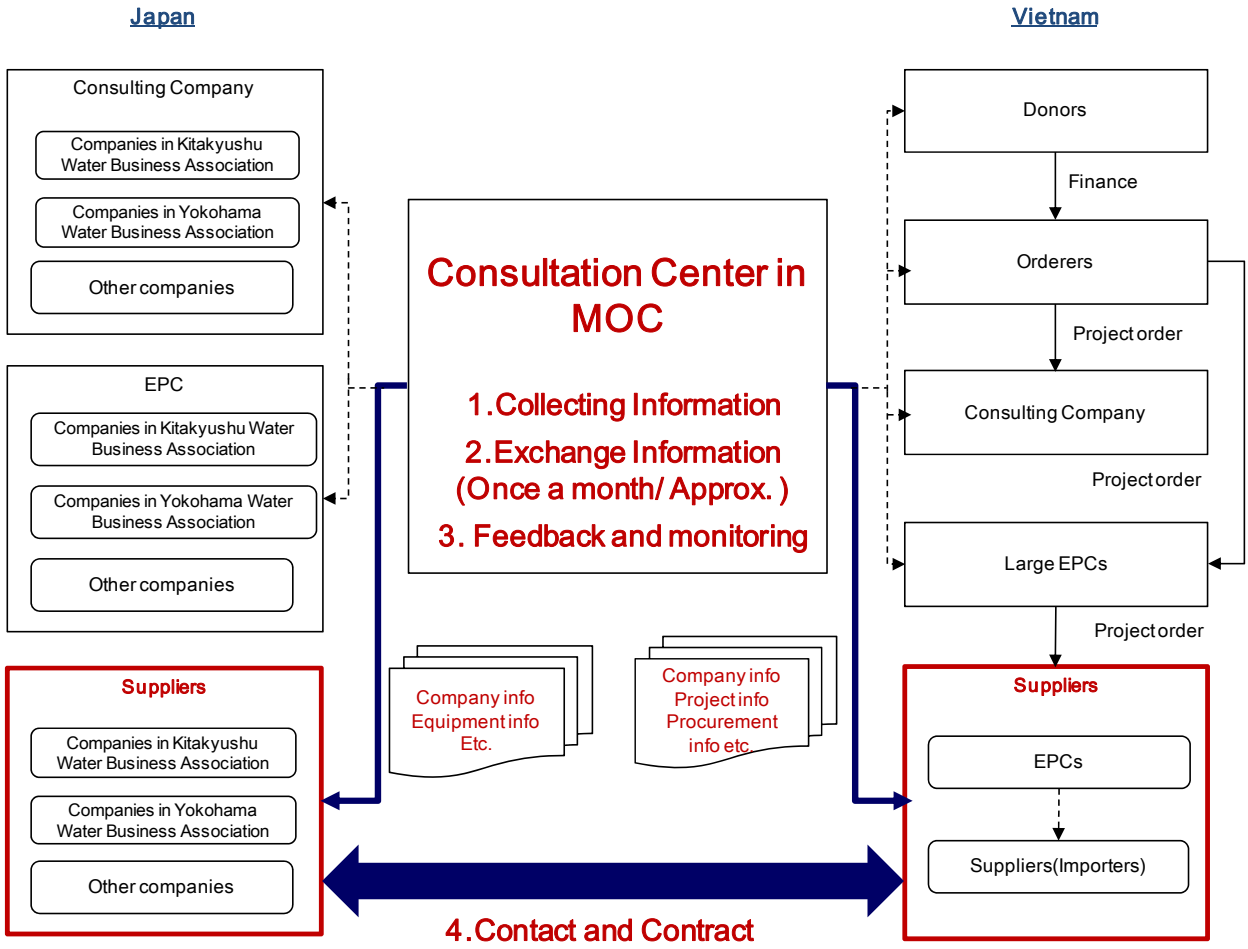
(2) Japanese Companies

Many Japanese companies would like to advance into the Vietnamese market. Especially, the Japanese suppliers investigate the business chances via exporting. On the other hand, capturing the business chances, especially meeting good partners in Vietnam is the prime issue. The Japanese companies should try to reach the Vietnamese local contractors or importers since they are the actual players who supply equipment to the main contractors and this could foster the development of the water supply and wastewater treatment facilities in Vietnam.

5.2 Scheme of Business Matching between the Vietnamese and Japanese Companies

The scheme proposed in Figure S5.1 focuses on the Vietnamese and Japanese suppliers. These are the companies which support the development of water supply and sewerage facilities. In this scheme, a business matching specialist, such as a business consultant, selected from the organization which is not directly related to any organization in the water business plays an important role. The specialist should be put both on the Vietnamese and Japanese side under the control of the training center or consultation center since they treat prudential information and also could lead to the optimization of the benefit of both Vietnam and Japan, as compared to the specialist governed by a particular private company or organization.

The tasks of the specialist should consist of collecting information by interviewing and creating a record sheet about each company's information, exchanging information between specialists in Vietnam and Japan, and providing feedback information to the companies. This scheme can resolve the issues faced by both the Vietnamese and Japanese companies and encourage them to have a business relationship with each other shown in a thick blue line of 'contact and contract'. Hence, it helps to encourage the Japanese small and medium companies to advance into the Vietnamese market, which can accelerate the development of the Vietnamese water supply and wastewater sector. On the other hand, it should be taken into account that the speed of communication is the key factor of success, therefore the scheme should only focus on the first contact between companies and leave it to themselves for further communication. In addition, the demand of the equipment being made in Vietnam will be varying from project to project, the continuity of this scheme will be another successful factor. This scheme should surely bring benefit not only to both companies in Vietnam and Japan, but to both of the countries as it leads to a better relationship.



Source: JICA Survey Team

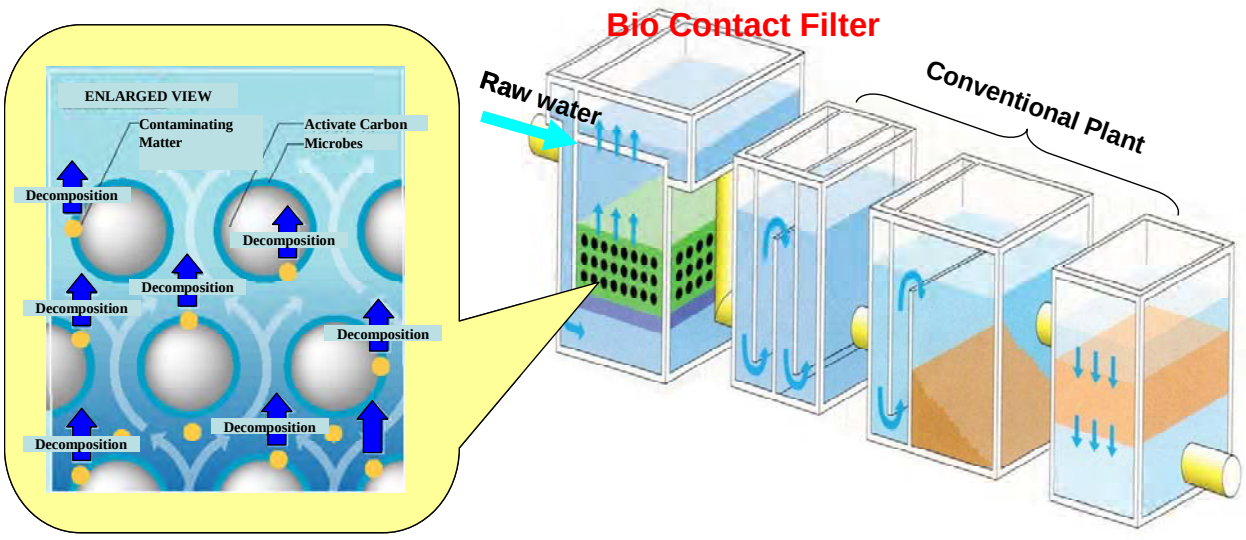
Figure S5.1 Flowchart of Potential Business Matching Scheme

6. Matching of the Vietnamese Needs and Japanese Technologies

6.1 Technology of Advanced Water Treatment (Biological Filtration Process)

Many cities in Vietnam are rich in water resources such as rivers, and they exploit river water as supply to their customers. However, these cities, which are undergoing urbanization and industrialization, are facing issues on water pollution as caused by discharged wastewater without any treatment.

In April 2009, the City of Kitakyushu and the City of Hai Phong signed the "Agreement on Friendship and Cooperation". Upward Biological Contact Filtration (U-BCF) shown in Figure S6.1 is examined at An Duong Water Treatment Plant (WTP) (100,000 m^3/day).



Source: JICA Survey Team

Figure S6.1 Diagram of U-BCF

The Survey examined raw water quality in 7 cities in North, Middle and South Vietnam, and detected high concentration of organic substances among them. Test result of raw water using water quality tester and examined at the Vietnam Academy of Science and Technology are shown in Table S6.1 and S6.2. Almost all water sources excluding Ha Noi are contaminated due to wastewater discharged without treatment. U-BCF would be most suitable method with low cost and low energy consumption for advanced water treatment.

Table S6.1 Results of Water Quality Analysis of Raw Water (Using Water Quality Tester)

Item	North Area					South Area		
	Ha Noi	Hai Phong No2	Quang Ninh	Nam Dinh	Hai Duong	Khanh Hoa	Binh Duong	Tien Giang
Date	Jan. 13	Jan. 9	Jan. 11	Jan. 14	Jan. 15	Jan. 20	Jan. 22	Jan. 22
Time	11:00	15:20	11:05	11:30	16:50	16:15	9:45	16:00
Temp. (^oC)	19.0	20.2	18	18	-	24	-	-
EC (µS/m)	170	230	20	230	180	40	240	260
Turb. (DEG)	4.1	13	4.3	20	20	13	14	20
Color (DEG)	13	27	41	31	37	50	50	50
pH	7.2	7.5	6.2	7.4	7.6	6.6	6.2	6.8
DO (mg/L)	8	4	9	9	6	4	4	3
COD (mg/L)	3	5	5	7	4	5	11	11
NO_2-N (mg/L)	<0.005	0.005	<0.005	0.03	<0.005	0.02	0.03	0.03
NO_3-N (mg/L)	0.5	0.5	<0.2	1	0.6	0.2	0.8	0.8
NH_4-N (mg/L)	<0.2	0.2	0.3	0.3	<0.2	0.2	0.5	0.6
PO_4-P (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Fe^{2+} (mg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fe^{3+} (mg/L)	<2	<2	<2	<2	<2	<2	<2	<2
Anionic Surfactant (mg/L)	0.07	<0.05	0.07	0.08	0.08	0.08	0.08	0.1
Cationic Surfactant (mg/L)	<5	<5	<5	<5	<5	<5	<5	<5

Source: JICA Survey Team

Table S6.2 Results of Water Quality Analysis of Raw Water (IET-VAST)

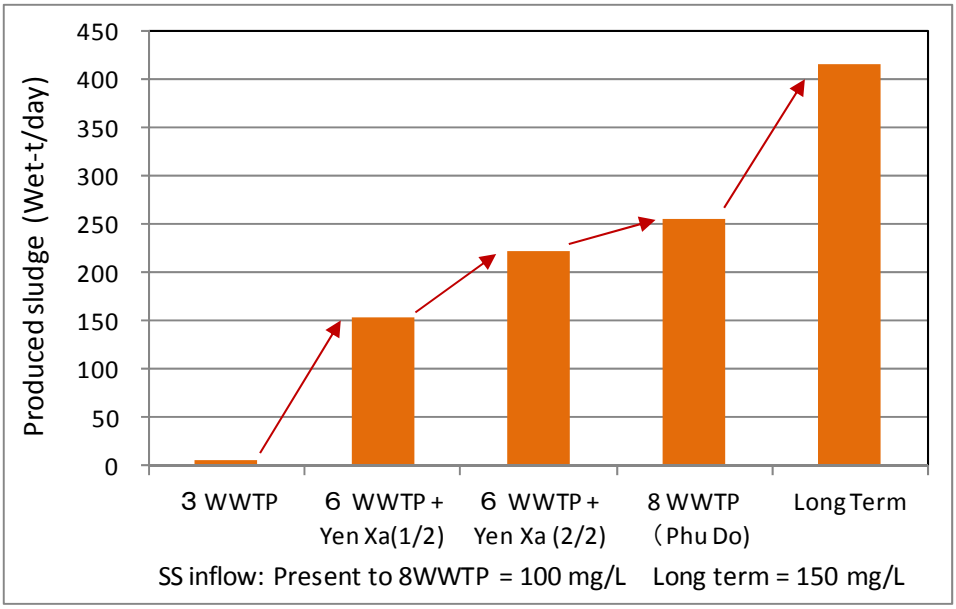
unit: mg/L

Item		North Area					South Area		
		Ha Noi	Hai Phong No2	Quang Ninh	Nam Dinh	Hai Duong	Khanh Hoa	Binh Duong	Tien Giang
Sampling Date		12-Jan	12-Jan	12-Jan	16-Jan	16-Jan	27-Jan	27-Jan	27-Jan
NH_4-N		<0.01	0.09	0.25	0.29	0.12	0.17	0.07	0.44
d-Mn		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
d-Fe		0.03	0.12	0.39	0.79	1.0	0.17	0.20	0.04
THMFP	$CHCl_3$	0.008	0.008	0.006	0.022	0.083	0.16	0.40	0.42
	$CHBrCl_2$	0.002	0.003	0.001	<0.0002	0.005	0.004	0.036	0.016
	$CHBr_2Cl$	0.0001	0.0004	0.0002	0.0001	0.001	0.0003	0.009	0.0009
	$CHBr_3$	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Total	0.010	0.011	0.007	0.022	0.089	0.16	0.44	0.44

Source: JICA Survey Team

6.2 Technology for Sludge Recycling

In the JICA study in 2012, i.e., Preparatory Study on Construction Project for Yen Xa WWTP, the amount of sewage sludge was projected, as shown in Figure S 6.2.



Source: Ha Noi Yen Xa PPP F/S

Figure S6.2 Sludge Generation Forecast (Ha Noi City)

(1) Present Situation in Ha Noi City

i) The Project Management Board (PMB) recognized the issues on sewage sludge management through the Ha Noi Yen Xa WWTP Public–Private Partnership (PPP) Study. Land reclamation is becoming restricted in accordance with produced sludge due to sewerage system development. The management bureau of Ha Noi People's Committee is also concerned with sludge management; however, internal coordination has not been concluded.

ii) Septic tanks are still utilized since the sewerage system applies interceptor sewer. Therefore, maintenance and disposal of septage are issues of sewerage management. Moreover, sludge disposal from septic tanks is also a problem since such sludge is unacceptable in composting factories managed by urban environmental companies.

iii) The present sewerage master plan does not include sewage sludge management. PMB requests to include sewage sludge reuse in the Sewage Master Plan 2030-50.

iv) Ha Noi City hopes to be the leading city in Vietnam in terms of sewage sludge recycling.

v) Economic affordability is an issue on sewage sludge reuse..

(2) Present Situation in HCMC

i) Produced sludge at present is almost 35 m3/day by centrifugal dewatering.

ii) Rice husk is dosed for moisture conditioning (40% of water content of composted sludge). Accordingly, composting proceeds to be satisfactory.

iii) Offensive odor issue was raised by adjacent residents due to operation cost saving by not dosing rice husk.

iv) Composted sludge is landfilled due to restricted product users.

v) The present composting facility is used for the existing wastewater treatment facility (treatment capacity of 141,000 m3/day). Phase 2 project on WWTP expansion considers applying land reclamation.

(3) Sludge Recycling and utilization technology

There are about three categories for sludge utilization, as shown in Table S 6.3.

Table S6.3 Sludge Utilization

Utilization categories	Sludge Form	Usage	Technology
Agricultural and land utilization	Fertilized sludge Dried sludge	Fertilizer Soil improvement agent	Compost Drying
Energy utilization	Dried sludge Carbonized sludge	Fuel	Drying Carbonization
Construction material utilization	Incinerated ash Melting slag	Road material Cement resource Block and tile resource	Incineration Melting

Source: JICA Survey Team

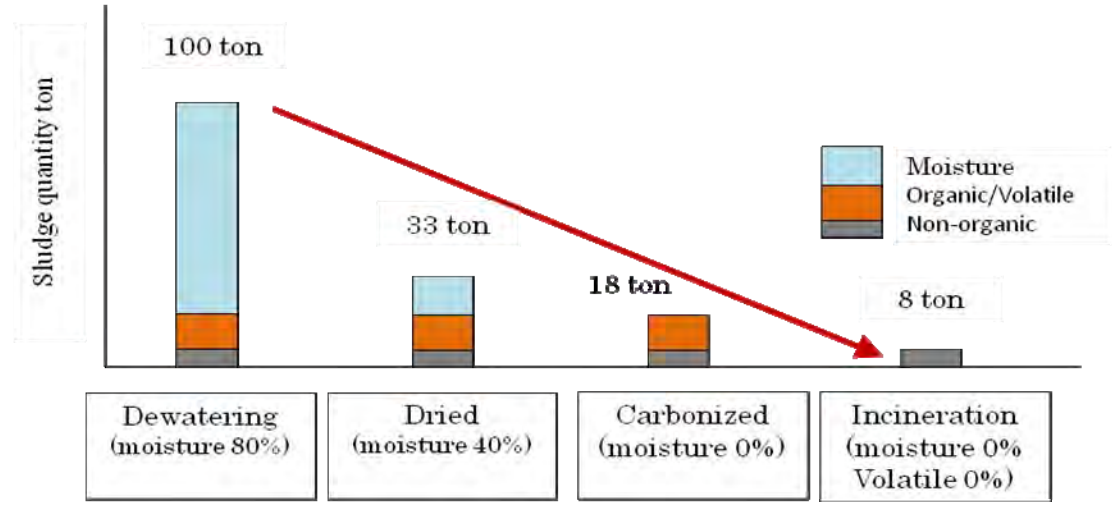
(4) Recommendable Technology

In Vietnam, the populations of huge cities, such as HCMC and Ha Noi, have been increasing year by year. With the population increase, sewage and sludge quantities have been also increasing. On the other hand, since urbanization is gradually expanding to suburban areas, it has become too difficult to find more sludge final disposal areas.

Therefore, sludge volume reduction, and sludge recycling and utilization shall be strongly required.

Sludge compost technology can be easily and economically utilized. However, the demand of fertilizer depends on the season and field conditions. And in the case of hazardous substances in industrial/business wastewater, it might be subject to sustain due to soil contamination.

1) Sludge Volume Reduction



Source: JICA Survey Team

Figure S6.3 Comparison of Sludge Volume According to Sludge Treatment

7. Conclusion

Water supply and wastewater sector in Vietnam faces seriously deteriorated environmental sanitation and water environment due to rapid economic growth, population increase and urbanization. Project needs of water supply and wastewater sector are enormously required on development project due to service area expansion, water pollution control of water supply source, rehabilitation of water supply treatment plant, NRW mitigation, upgrading service level such as 24 hour supply and supplied water quality.

Engineers and administrators, who acquire technology and know-how as well as basic knowledge, are indispensable in order to develop water supply and sewerage system, and also to operate finance effectively. However, 40 institutions such as university, college and training center work for water and environmental related engineering, among them only 4 universities and 3 training centers water supply and wastewater. There is no institution of practicable training and consultation on wastewater sector in spite that sewerage works require various fields of educational background and practical experience.

MOC summarizes followings through workshop on which National Governments, municipal governments, sewerage and drainage companies, academic and institutions and oversea donors participate.

(1) Lack of human resources and know-how as well as financial sources is serious issues to be solved, and MOC has discussed with JICA HQ during these one through two years. Technology and know-how of public and private sectors in Japan is indispensable for development of water supply and wastewater sector in Vietnam.

(2) Training Center contributes significantly on human resource development on public and private sectors as well as supporting sewerage project implementation.

(3) Sewerage Law is not enacted at now, and comprehensive regulation system consisting of law, decree, circular and guidelines/manuals as well as accumulating know-how and experiences on planning, design, construction and operation are urgently important. Accordingly, training center can disperse them into whole Vietnam.

(4) Public fund investment mechanism applying Japanese ODA, which is beneficial in term of long repayment period, low interesting rate and appropriate amount, copes with requirement of water supply and wastewater sector as a result contributes water and sanitation environment improvement as well as sound urban development.

(5) Vietnam Government requires Prime Minister’s approval through scrutinizing in detail project scheme of training program, training needs, training facilities and invested resources in order to implement technical assistance project. Present Survey result is initial information, and far from requirement of project information in order to exploit Government source.

(6) MOC requests JICA of executing supplemental detail design voluntarily, which provides requirement of Vietnam Government, in order to implement the surveyed result into practice.

Accordingly, detail design, which the Survey proposes, scrutinizes training program, needs of trainee, and training facilities and invested resources in accordant with providing requirement for MOU, Minutes of Understanding, among MOC and JICA. The Survey Team sincerely wishes road map of training center to be established as well as project implementation support in accordance with project development of water supply and sewerage system.

Chapter 1 Introduction

1.1 Background of the Survey

The water supply and wastewater sectors need to be developed in the Socialist Republic of Vietnam (hereinafter called "Vietnam") considering the country's rapid economic growth and urbanization. However, the budget for their development has been insufficient especially in local municipalities ofVietnam, thus causing serious deterioration of the water environment in urban areas and insufficient access to safe water.

In the wastewater sector, sewerage service is now provided or implemented in Ha Noi, Ho Chi Minh City (HCMC), Ha Long, Hai Phong, Da Nang, Hue, Hoi An, Nha Tang, Bun Tau, and Bin Duong by utilizing financial and technical assistance from donors. Although, sewerage service does not cover the entire cities mentioned above, and the percentage of sewered population in Vietnam is still less than about 10%[1]. Accordingly, sewerage service should be extended in big cities and is desired to be started in local municipalities. The implementation of sewerage projects in local municipalities is the main target that needs to be materialized according to the national target, which stipulates the target coverage ratio in urban areas in 2050 as 100%.

Regarding the water supply sector, water supply service has been more developed as compared to wastewater service. However, water supply service must be expanded, and the service quality parameters such as sustainability and amount of served water, have to be improved. The coverage of water supply service is 70%[2] in urban areas, and 30% in rural areas. Such coverage is planned to be increased up to 100% and 80% by 2025, respectively. In terms of operations and management of water supply systems, the government stipulated its target for the improvement of non-revenue water (NRW) ratio up to less than 15%, to have 24 hours of continuous water supply, to conduct technical resource development for operators, and to have full cost recovery through tariff revenue.

In order to develop and improve water supply and sewerage services, a huge amount of funding is required. Considering the limited national and municipal budget, the Government of Vietnam is planning to promote private financing for the sectors; however, a few projects have been materialized because of the lack of legal and regulatory framework for public–private partnership (PPP), and low profitability. Therefore, in order to accelerate the development and improvement of water supply and sewerage facilities especially in local municipalities, further mobilization of public and private funds are indispensable. In consideration of the difficulty of full cost recovery, sustainable mobilization of public funds is essential in the wastewater sector.

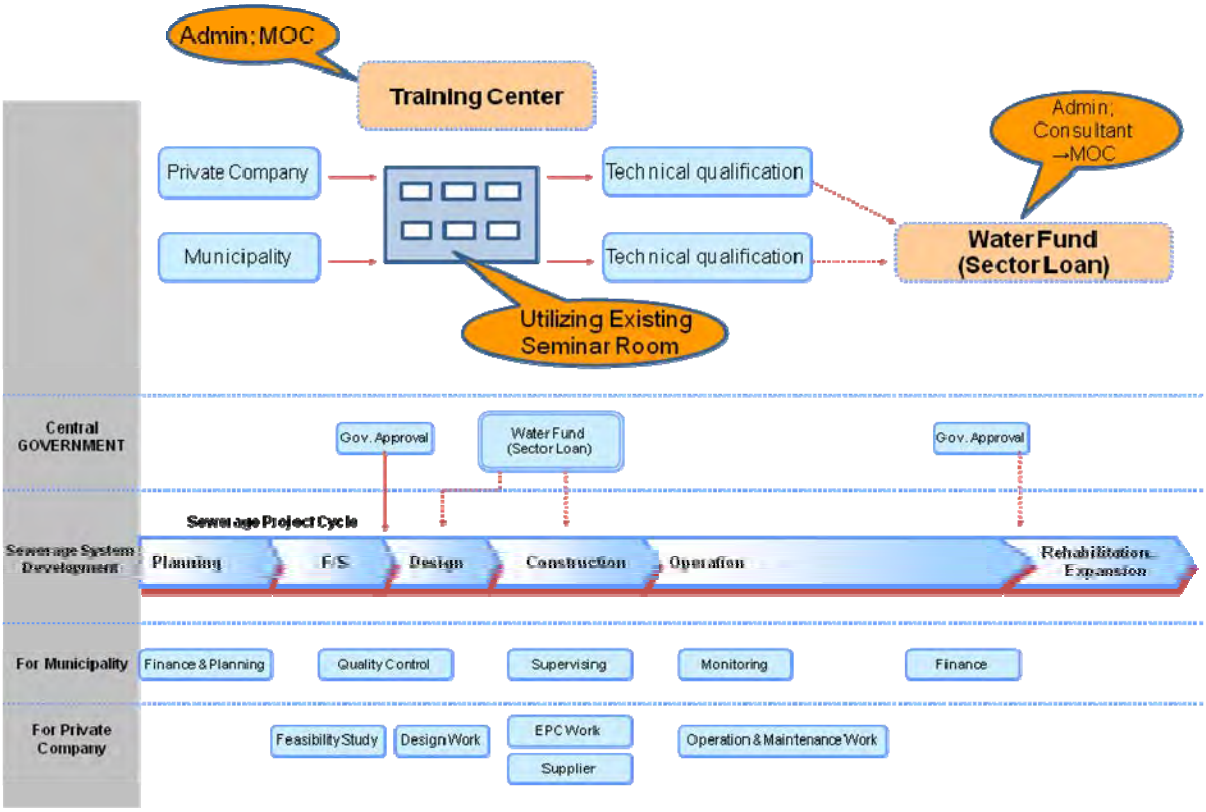
On the other hand, the number of skilled staff in the wastewater sector is quite limited in Vietnam due to limited experience on implementation and management of sewerage projects especially in local municipalities. Even in major cities which have public sewerage systems, the capacity of operators (water supply companies (WSCs) in local municipalities) is still insufficient, thus making it difficult to control and improve the quality of service. Therefore, financial support as well as technical support are needed for the development and improvement of the wastewater sector in order to materialize and sustain sound development. Regarding the water supply sector, because many donors have provided various technical assistance to the regulator, i.e., the Ministry of Construction (MOC), and operators, their technical capacity has been gradually developing.

[1] Vietnam Urban Wastewater Review, World Bank, 2013
[2] Vietnam Water and Sanitation Sector Assessment Report, World Health Organization (WHO), 2011

1.2 Objectives and Outline of the Survey

This survey (hereinafter called "Survey") aims to collect relevant information and investigate the strategies for sound development of the water supply and wastewater sectors in local municipalities of Vietnam.

As described in the previous section, the mobilization of public and private funds to the sector and the capacity development of relevant staff and agencies are essential for the development of the sector. The Japan International Cooperation Agency (JICA) is now considering effective solutions to solve these issues in parallel. One solution is the establishment of a new financial scheme for the water sector, and the other is the establishment of a training center for sewage works. In order to accelerate sound development of these sectors, a new financial scheme will be applied for the executing agencies (EAs) which have technical qualifications for the training center, as shown in Figure 1.2.1.



Source: JICA Survey Team

Figure 1.2.1 Practical Solution for Sound Development of the Wastewater Sector

To materialize the above solution and accelerate sound development of the sector, relevant issues and information listed below will also be studied in the Survey.

- Financial needs and priority projects of the sector;
- Needs for collaboration between Vietnamese and Japanese private companies; and
- Needs for the application of Japanese advanced technology such as upward biological contact filtration (U-BCF) and sludge recycling.

The Survey is composed of the following five fields:

(1) Potential Finance Schemes with Japanese ODA Loan

One of the solutions to this issue is the utilization of a Japanese concessional financial source. The establishment of the Water Sector Loan through the Japanese official development assistance (ODA) loan will be investigated as the first step of the public funding scheme considering the difficulties to establish funding from public-private investment in the short term.

In addition, public-private collaborated funds, such as "Water Fund", may be needed to fill the financing gap, and to accelerate investments to water supply and sewerage projects. However, it is difficult to establish such funds due to the current financial feasibility of the sector in Vietnam. Therefore, the possibility of developing the Water Sector Loan will be primarily investigated in the Survey for future development.

(2) Capacity Development and Project Implementation Support

Another key issue for the enhancement of the sector is capacity development of relevant staff and agencies in the sector. An effective solution to this issue is to utilize Japanese know-how and technologies through the entire phase of a project. In order to optimize technical transfer, JICA is considering the establishment of a training center, which will greatly help in enhancing the quality of service in the short term.

The functions of the training center are to provide training on comprehensive sewage works, provide technical support to executing agencies (EAs) of subprojects, facilitate business matching between Vietnamese and Japanese private companies, and introduce Japanese technologies. To establish the training center, the training needs, and the outline and road-map of the training center are studied in the Survey.

(3) Estimation of Financial Needs for Water Supply and Sewerage Development

A huge number of water supply and sewerage projects will be implemented in the near future, but the required financial source for such projects is unclear up to now. To investigate the required funding volume of the new financial scheme, the financial needs for the development of the water supply and wastewater sectors in both municipalities and industrial zones (IZs) will be studied in the provincial basis in the Survey. Furthermore, a priority project under the new financial scheme will be proposed according to the above investigation.

(4) Collaboration between Vietnamese and Japanese Private Companies

Water supply and sewerage projects in local municipalities will be implemented by local Vietnamese companies because the procurement of consultant, contractor, and supplier will be executed through a local competitive bidding (LCB) considering the scale of the projects. Although a huge number of projects will be implemented in the near future, local Vietnamese companies have limited experience, especially in the wastewater sector. To enhance the quality of water supply and sewerage projects, the collaboration between local Vietnamese private companies and Japanese companies will be needed. The possibility of business matching between Vietnamese and Japanese private companies will be investigated.

(5) Matching Vietnamese Needs with Japanese Technologies

To solve the issues in water supply and sewerage projects, the introduction of Japanese technologies, such as advanced water treatment method and sludge recycling system, will be needed according to the

increase in public awareness. The possibility to introduce these technologies will be investigated in the Survey.

1.3 Methodology of the Survey

1.3.1 Estimation of Financial Needs for Water Supply and Sewerage Development: Chapter 2

(1) Estimation of Financial Needs

Financial needs for water supply and sewerage development, and their priority projects will be proposed. Financial needs are fundamental data to be applied to the investigation of financial scheme. The target years of the financial needs estimation are 2025 for the medium term, and 2050 for the long term. The methodology to estimate the financial needs is shown below

i) Financial needs for water supply and sewerage projects are estimated separately.

ii) The investment amount for water supply and sewerage facilities such as water treatment plant (WTP), wastewater treatment plant (WWTP), sewers, and pipelines are estimated based on the conditions shown in Table 1.3.1.

Table 1.3.1 Methodology for Calculation of Required Volume

	Capacity and Pipeline Length	Unit Cost
WTP WWTP	The required capacities of municipal WTPs and WWTPs are estimated based on the national population projection[3], and unit water consumption stipulated in the design standards. The required capacity of WTP for industrial zone (IZ) is estimated based on the master plan (M/P) in centrally governed cities, and as 10% of domestic water in other cities.	Unit cost (USD/m^3) is derived from the existing feasibility study (F/S) report published by local municipalities, and donors such as JICA, the World Bank (WB), and the Asian Development Bank (ADB).
Network Sewer Line (pipeline)	The pipeline length is estimated based on the exiting F/S report. The unit length of pipeline (m/capita) is applied for the estimation.	Unit cost (USD/m) is derived from the existing F/S report published by donors such as JICA, WB, and ADB.

Source: JICA Survey Team

iii) The incremental amount (capacity of WTP, WWTP, and pipeline length) is estimated by the balance of required and existing facilities.

Furthermore, the annual financial plan will be proposed based on step-wise sewerage development in Japan considering the following:

i) Project type
- Expansion of service area; and
- Reconstruction, replacement and rehabilitation of existing facilities for upgrading and sustaining the service quality.

ii) Scheme for sewerage development
- Step-wise sewer development by applying an interceptor sewer system, which utilizes the

[3] The projection of urban population in each province was carried out based on the population census developed by the General Statistics Office (GSO) of Vietnam in 2009

existing drain facilities; and
- Trunk sewer and treatment plant will be developed in the first phase, and service sewers and house connections will be developed in the second phase.

iii) Life cycle of facilities
- Civil structures and pipelines: 40 to 50 years[4]
- Mechanical and electrical facilities: 10 to 20 years

Financial sources are principally allocated to the national government as supported through ODA, private fund invested in urban development projects, and local municipality budget. Needs survey of sewerage project is categorized into the database of WWTP (new construction and expansion), trunk sewer, and lateral/house connection in order to apply for financial sources such as ODA (granted to municipality), and the Water Fund (repaid by municipality).

(2) Selection of Priority Project

The priority project will be selected based on the evaluation criteria such as needs for development of water supply and sewerage facilities, technical and financial capacity of the implementation organization, and conditions of water tariff, among others. In addition, the priority project will be selected from municipal and PPP projects because the new financial scheme will be applied for PPP as mentioned in the previous section. In the process of selection of priority projects, the following will be considered:

i) Projects that will improve water quality in public water bodies as in the three major river basins of the Cau, Nhue-Day, and Dong Nai rivers will be prioritized.

ii) Supporting projects of a PPP project (municipal portion of PPP project) such as the development of distribution network will be prioritized. This will make the PPP project more efficient and sustainable.

iii) Progress of preparation of the project, such as preparation of feasibility study (F/S), and progress of environmental impact assessment (EIA), and resettlement procedure will be considered.

1.3.2 Proposal of Potential Finance Schemes with Japanese ODA Loan: Chapter 3

(1) Survey on Public Fund Investment Mechanism

The Survey will collect relevant information required to formulate potential finance schemes for the Water Sector Loan with Japanese ODA loan to finance future water and sanitation projects. In addition, for the proposal of further technical cooperation to enhance appraisal capacity of water and sewerage projects for local public financial institutions, the Survey will present case studies from previous JICA projects in Vietnam, including the Small-Scale Pro Poor Infrastructure Development Project, and the Small- and Medium-Sized Enterprises Finance Project (SMEFP), as well as other examples of water revolving fund.

(2) Water Fund Establishment and Road Map to Community Development Fund

Fund requirements for the Water Sector Loan, and the Water Fund will be estimated based on the

[4] Since sewerage system development in Vietnam has just started, fund scheme considers both expansion and replacement works as mentioned above; however, the replacement of civil structures and pipelines are not considered in consideration of their long life cycles.

overall assessment of water supply and sewerage project size, and availability of public fund from the national and local governments. (Note that the Water Sector Loan primarily refers to Japanese ODA Loan for the water supply and wastewater sectors in Vietnam, while the Water Fund refers to a fund which could potentially combine Japanese ODA (debt or equity), and other public and/or private finance sources. The Water Fund is expected to be established in the long run as the water supply and sewerage sector achieves financial sustainability and attracts both public and private investors.)

Given the difficulty of full cost recovery for small-/medium-sized sewerage infrastructure projects in local cities in developing countries, long-term financial sustainability needs to be ensured through the combination of national government subsidy, self-financing sources from local governments, and the Water Sector Loan.

In designing the detailed scheme of the Water Fund, multiple options will be considered based on different financial sources and financial conditions. Assessment of the options will be conducted through consultation with JICA and relevant counterparts. The factors to be considered in order to mitigate loan repayment risks through long-term, low-interest loans include the following:

- Fund flow for the Water Sector Loan;
- Rationale for designing the Water Fund as a revolving fund and its fund flow, operational policy, project schedule, and demarcation of relevant organizations; and
- Interest of Japanese financial institutions including private equity funds and regional banks to be part of the Water Fund, associated risks for Japanese financial institutions, and risk mitigation measures through government guarantees, trade insurance, etc.

Information sessions will be held for members of the Overseas Water Business Association in Yokohama City and Kitakyushu City to explain the current status of water and sewerage infrastructure development and to obtain feedback on issues and challenges that members are/will be facing for the members' business development in Vietnam.

The JICA Survey Team will conduct hearings with Japanese financial institutions, including regional banks with headquarters located in member cities of the Overseas Water Business Association, and with existing lending operations in Southeast Asia such as the Bank of Yokohama, Fukuoka Bank, and Nishi-Nippon City Bank. The JICA Survey Team will also conduct hearings with Japanese private equity fund operators including the Mizuho ASEAN PE Fund (operated by Mizuho Bank's affiliate company and the Japan Bank for International Cooperation as one of the fund's investors), and Japan South East Asia Growth Fund (operated by Risa Partners and the Development Bank of Japan as one of the fund's investors), for their interest in potential collaboration with the Water Fund.

1.3.3 Survey on Capacity Development and Project Implementation Support: Chapter 4

Capability of project programming and financial evaluation are urgent requirements in Vietnam. Accordingly, a sewerage training program in collaboration with the Water Sector Loan is recommended in order to secure project sustainability.

The sewerage training program aims to disseminate practical experience in Japan and know-how in Ha Noi and HCMC. The training program will utilize the existing sewerage facilities and carry out lectures to develop the required skills and knowledge for sewerage development and management, such as sewerage system planning, design and drawing, construction supervision, operation and

maintenance (O&M), and financial and institutional design. The training program shall be decided considering the needs in Vietnam through a questionnaire survey for developing an efficient training program.

The project scheme of the sewerage training program is surveyed considering existing training programs on the water supply and wastewater sectors in Vietnam and in accordance with lessons learned from Japanese ODA projects with training programs on sewage works in Thailand, and water supply and environmental sanitation training programs in Indonesia.

The survey extracts training needs from MOC, Ha Noi, and HCMC through questionnaires, such as training manner, training subjects, and training program. The outline of training and issues of the existing training center are also surveyed from relevant organizations such as the Vietnam Water Supply and Sewerage Association, the College of Urban Works Construction (CUWC) in Ha Noi, and the Ha Noi Architectural University.

(1) Scope of Training Program

The scope of the training program is discussed with MOC, particularly on legal scheme, project size, operation plan, and training program contents (project planning and implementation skill, O&M and private fund investment of municipality government, and capacity development of local private company). The training program and operation manner are also proposed considering the size of training program (training subjects and number of trainees), motivation of trainer, and training manner (practice and/or lecture). Experiences in Japan such as certification based on the Japanese Sewerage Law, are also useful in order to enhance sewerage development and operation efficiently in collaboration with the Water Fund.

Project financing usually appraises quality and executing skills of the project. The sewerage training program contributes to the project executing capacity of municipality governments and private companies on sewerage engineering, project operation, and financial and institutional design. The Japanese Sewerage Law mandates not only operational experience but certification or examination of engineers assigned to relevant works of sewerage projects such as sewerage planning, design, construction, and O&M. This regulation system assures sewerage project quality, and accordingly referred to in Vietnam. In enhancing the appraisal skills of the financing authority, know-how of sewerage operation is required. Accordingly, training program for administrators and managers is reviewed considering finance and institution, performance indicators (PIs), and collaboration and public relation among sewerage training subjects.

1.3.4 Survey for the Collaboration of Vietnamese and Japanese Private Companies: Chapter 5

To enhance the quality of subprojects under the Water Sector Loan, the collaboration of Vietnamese and Japanese companies will be needed. The needs of Vietnamese private companies from the water supply and wastewater sectors are confirmed through interview survey, while the strategy for their collaboration is investigated in the Survey.

In addition, the intention of Japanese private companies to expand their business to the Vietnamese market in collaboration with Vietnamese companies is investigated through the questionnaire and interview survey answered by the members of Yokohama City and Kitakyushu City's Overseas Water Business Association.

Furthermore, the company profile of major Vietnamese firms, and the technical specifications of equipment used in Vietnam are collected through the Survey. Such information can be utilized to

consider business matching.

1.3.5 Survey for the Matching of Vietnamese Needs and Japanese Technologies: Chapter 6

(1) Advanced Japanese Technologies

The advanced Japanese technologies related to the wastewater sector are listed in Table 1.3.2. Vietnam's needs regarding two Japanese advanced technologies, namely, sewage sludge reuse, and biological contact filtration, are investigated in the Survey in order to know the possibility and timing of dissemination of such technologies.

Table 1.3.2 Advanced Technologies Applied by Japanese Companies

Category	Advanced Technologies
Sewer Construction	Microtunneling technology, Trenchless sewer rehabilitation, High efficiency pump
Sewer O&M	Sewer inspection/cleaning/trenchless rehabilitation, Sewer ledger
Purification Works	Membrane filtration, Membrane biological reactor (MBR), Remote system
Wastewater Treatment	Membrane filtration, Combined sewer overflow (CSO) mitigation, Sludge reuse, Remote sensing system
Management/Customer Service	Customer information system

Source: JICA Survey Team

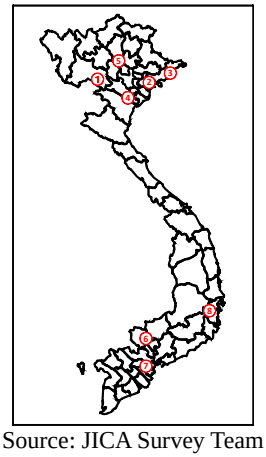
(2) Survey on Sewage Sludge Reuse

Regarding sewage sludge reuse, alternative fuel such as low calorie coal, and composting and construction materials will be examined in the Survey. Since Ha Noi and HCMC are developing large-scale wastewater treatment facilities, the produced sewage sludge will become a social concern. A sludge reuse survey scrutinizes not only the needs of both cities but also of end users.

(3) Survey on Biological Contact Filtration (U-BCF)

Biological contact filtration, which is applicable to polluted water supply sources, is examined in eight cities including three large water sheds of the Cau River, Nhue-Day, and Dong Nai rivers, as shown in Figure 1.3.1. The water quality test obtained on-site samples of river water and determined the applicability of biological contact filtration for the WTP. The examination results obtained from the river water quality test are used for the needs survey on advanced treatment of ammonia (NH_3) and sewerage development.

In case of concerns attracted by the Vietnamese side on continuous investigation and technical transfer in the future, a project implementation procedure will be arranged considering practicality of technical transfer and/or private business, road map for project implementation, and business matching opportunity.



Source: JICA Survey Team

Figure 1.3.1 Water Quality Survey

1.4 Schedule and Personnel Assignment

The Survey was carried out from December 2013 to June 2014 as shown in Table 1.4.1. At the end of

the Survey, a workshop on the establishment of the training center was carried out, in which relevant organizations from Japan and Vietnam participated, and a basic agreement was established.

The personnel arrangement of the Survey is shown in Table 1.4.2.

Table 1.4.1 Survey Plan

Items	2013	2014				
	12	1	2	3	4	5
1 Preparatory Study and Inception Report						
1-1 Collection and analysis of data and information						
(1) Estimation of project needs of water supply and sewerage in local municipalities						
(2) Study on public investment mechanism						
(3) Study on sewerage training center						
(4) Study on advantageous technologies of Japanese company						
1-2 Completion and submission of the Inception Report						
1-3 Kick-Off Seminar in Vietnam						
2 Needs Survey of Water Supply and Sewerage Projects in Local Municipalities and Data Collection of Local Companies Related to Water Sector						
2-1 Analysis of necessary funds for development of water supply and sewerage in local municipalities						
(1) Estimation of water supply and sewerage projects in local municipalities						
(2) Selection of priority projects						
2-2 Data collection of standard and specification for equipments related to water sector/Data collection of local companies related to water sector						
(1) Data collection of standard and Specification related to water sector						
(2) Data collection of local companies related to water sector						
3 Study on Public Investment Mechanism Based on International Yen Loan						
3-1 Data collection of intermediating financial institute and analysis of investment mechanism						
(1) Data collection of financial institutions in Vietnam						
(2) Study on sector loan investment mechanism to water supply and sewerage projects in local municipalities						
3-2 Study on sector loan and community development fund/Corporation of Japanese local financial institutions						
(1) Study on possibility to water fund and community development fund						
(2) Hearing of ordinance designated cities and council to compete the market of Vietnam						
(3) Hearing of local financial institutions to compete the market of Vietnam						
4 Analysis of capacity development of local government, O/M ability, utilize to private fund and education of local water companies						
4-1 Planning of the training center						
(1) Framework of the training center and training program						
(2) Study on corporation with public investment mechanism						
(3) Study on the supporting method to Japanese water industries						
5 Study on technical transfer of sludge recycling and biological filtration process						
5-1 Needs survey of sludge recycling and biological filtration technology						
(1) Needs survey of sludge recycling technology in Vietnam						
(2) Needs survey of biological filtration process in Vietnam						
5-2 Study on technical transfer of sludge recycling and biological filtration						
6 Completion and submission of the Interim Report						
6-1 Completion and submission of the Interim Report						
6-2 Discussion of the ITR in Vietnam						
7 Completion and submission of the Draft Final Report						
7-1 Completion and submission of the Draft Final Report						
7-2 Work shop in Vietnam						
8 Completion and submission of the Final Report						
8-1 Completion and submission of the Final Report						

Domestic
Re-entrustment
Local

Source: JICA Survey Team

Table 1.4.2 Personnel Arrangement

	Expertise	Name	Affiliation	Rank	2013	2014					Man/Month	
					12	1	2	3	4	5	Fiscal year 2013	
											Vietnam	Japan
Vietnam	Chief Advisor/Sewerage Plan◎	Yakuro INOUE	NIPPON KOEI Co., Ltd.	2		21		19		9	1.63	
	Sewerage Training Center◎	Takehiko KAWAI	SEWERAGE BUSINESS MANAGEMENT CENTRE	3		14		7		7	0.93	
	Financial Analysis, Local fund◎	Tadashi KOYAMA	DOGAN, Inc.	4		21		21		7	1.63	
	Sewerage, Sludge Recycling Plan (Northern Area)	Tetsuya YAMAKI	NIPPON KOEI Co., Ltd.	6		21		7			0.93	
	Sewerage, Sludge Recycling Plan (Southern Area)	Masayuki ANEZAKI	Nihon Suido Consultants Co., Ltd.	3		21					0.70	
	Water Supply (Advanced Treatment)	Masashi YAYAMA	NIPPON KOEI Co., Ltd. (Kitakyushu-City)	4		9 7		12			0.93	
	Water Supply (Project Plan)	Hyeon-Yeoul KIM	Water Agency Inc.	3		21					0.70	
	Economic and private firms analysis	Takamasa NISHIKAWA	NIPPON KOEI Co., Ltd.	3		21		7		7	1.17	
	Financial analysis, Medium-seized and Small Companies	Kazunao ITO	DOGAN, Inc.	4		11		10			0.70	
										subtotal	9.32	
Japan	Chief Advisor/Sewerage Plan◎	Yakuro INOUE	NIPPON KOEI Co., Ltd.	2	7	10	2 2		13			1.70
	Sewerage Training Center◎	Takehiko KAWAI	SEWERAGE BUSINESS MANAGEMENT CENTRE	3	5	7	14		18			2.20
	Financial Analysis, Local fund◎	Tadashi KOYAMA	DOGAN, Inc.	4	7	10	10		12			1.95
	Sewerage, Sludge Recycling Plan (Northern Area)	Tetsuya YAMAKI	NIPPON KOEI Co., Ltd.	6	5	8			1			0.70
	Sewerage, Sludge Recycling Plan (Southern Area)	Masayuki ANEZAKI	Nihon Suido Consultants Co., Ltd.	3	5	5			1			0.55
	Water Supply (Advanced Treatment)	Masashi YAYAMA	NIPPON KOEI Co., Ltd. (Kitakyushu-City)	4	4	8		4	4			1.00
	Water Supply (Project Plan)	Hyeon-Yeoul KIM	Water Agency Inc.	3	5	5			1			0.55
	Economic and private firms analysis	Takamasa NISHIKAWA	NIPPON KOEI Co., Ltd.	3	5	9	1		3			0.90
	Financial analysis, Medium-seized and Small Companies	Kazunao ITO	DOGAN, Inc.	4	5	5		1	4			0.75
										subtotal		10.30
Subm					IC/R		IT/R		DF/R	F/R	9.32	10.30
					Needs survey in Japan (ordinance-designated city, council, bank)		Needs survey in Japan (ordinance-designated city, council, bank)			Work Shop	19.62	

Legend ■ Vietnam
□ Japan

Source: JICA Survey Team

Chapter 2 Estimation of Financial Needs for Urban Water Supply and Sewerage Development

In this Survey, financial needs for urban water supply and sewerage development are estimated with the following conditions:

a. Target year designed with 100% coverage ratio and designed ground
   Water Supply : 2025, Decision No.1929/QD-TTg
   Sewerage : 2050, Decision No.1930/QD-TTg

b. Target area
   Water Supply and Sewerage : All urban areas

c. Target year for estimation of financial needs
   Water Supply and Sewerage : 2025 and 2050

d. Indicators for estimation of financial needs
   Water Supply : Projected population: 2025 and 2050
   : Water consumption per capita to be decided by the JICA Survey Team
   : Unit construction cost estimated by the JICA Survey Team

   Sewerage : Projected population in 2025 and 2050
   : Sewage volume per capita estimated by the JICA Survey Team
   : Unit construction cost estimated by the JICA Survey Team

Mid- and long-term development plans authorized by National and provincial governments require review carefully on features of individual province such as population, urban area, other infrastructure development and service qualities of water supply and sewerage. Accordingly, the survey result expects to be integrated into National Development Plan through interactive coordination among National and municipal governments.

2.1 Current Socioeconomic and Water Supply/Sewerage Situation

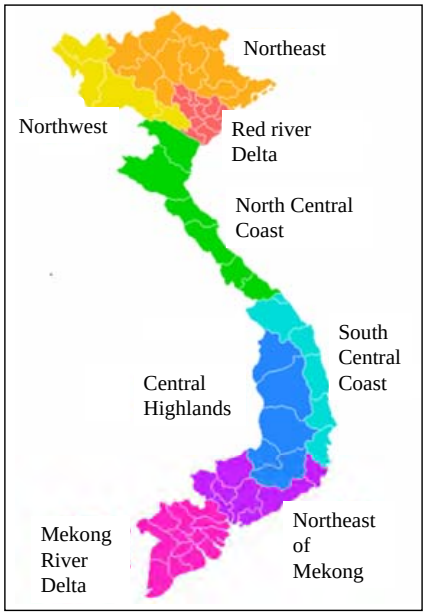
2.1.1 Socioeconomic Situation

(1) Social Situation

1) Administration Divisions and Urban Centers

Vietnam consists of five centrally-run cities and 58 provinces. The five centrally-run cities, namely, Ha Noi, Ho Chi Minh City (HCMC), Hai Phong, Da Nang, and Can Tho, are under the authority of the central government, including satellite urban area. Vietnam is classified into eight areas as shown in Figure 2.1.1. However, this is not a formal classification by the Vietnamese government.

There are some administrative divisions such as urban



Source: JICA Survey Team

Figure 2.1.1 Area Classification of Vietnam

district, town, and district under the centrally-run city. Moreover, there are some administrative divisions such as capital city, city, and district under the province.

The Government of Vietnam graded urban centers in accordance with Decree No. 42/2009/ND-CP in 2009. The purposes of grading the urban centers are as follows:

- To organize, arrange, and develop the national system of urban centers;
- To formulate and approve urban construction plans;
- To raise the quality of urban centers and develop urban centers in a sustainable manner; and
- To formulate policies and mechanisms for urban management and development.

Urban centers are classified into six grades, namely, special grade, grade I, grade II, grade III, grade IV, and grade V. Special-grade urban centers include centrally-run cities with urban districts, rural districts, and satellite urban centers. Grades I and II include centrally-run cities with urban districts and rural districts and possibly attached urban centers; and provincial cities with wards and communes. Grade III urban centers include provincial cities or towns with wards and communes. Grade IV urban centers include provincial towns with wards and communes. Urban centers of grades IV and V include district townships with consolidated street quarters and possibly rural residential spots. The population of urban centers is about 29.03 million, and it is estimated at 32.4% of the total population in 2013.

According to the decree, population of an urban center shall be more than 4,000 people. The population density suits the size, nature, and characteristics of each urban center grade and is calculated for the inner area or township's consolidated street quarter. The non-agricultural labor within the inner area or consolidated street quarter should account for at least 65% of the total labor.

The criteria for grading urban centers are described in Table 2.1.1 and the number of urban centers belonging to each grade is shown in Table 2.1.2.

Table 2.1.1 Criteria for Grading Urban Centers

Grade / Criteria	Special	I	II	III	IV	V
Population (persons)	Over 5,000,000	Over 500,000	Over 300,000	Over 150,000	Over 50,000	Over 4,000
Inner area population density (persons/km^2)	Over 15,000	Over 12,000* Over 10,000**	Over 10,000* Over 8,000**	Over 6,000	Over 4,000	Over 2,000
Non-agriculture labor /Total labor (%)	Over 90	Over 85	Over 80	Over 75	Over 70	Over 65

*: For centrally-run urban centers
**: For provincially-run urban centers
Source: Decree No. 42/2009/ND-CP

Table 2.1.2 Number of Urban Centers by Grade (As of December 2010)

Grade of Urban Centers	Number of Urban Centers	Remarks
Special	2	2 cities under the authority of the central government, including satellite urban centers (mostly Grade V)
I	10	3 cities under the authority of the central government, including satellite urban centers (mostly Grade V) 7 provincial cities
II	12	12 provincial cities
III	47	36 provincial cities 11 provincial towns Son Tay Town is a satellite urban center belonging to Ha Noi City.
IV	50	29 provincial towns 11 district towns
V	634	Mostly corresponding to district towns under rural districts. Some of the district towns are satellite urban centers belonging to the cities under the authority of the central government.
Total	755	

Source: Website of the Ministry of Construction, 2013

2) Population

According to the latest population census implemented in 2009, the total population of Vietnam was 86.02 million in 2009, where the urban population was 25.59 million and the rural population was 60.40 million.

According to the General Statistics Office (GSO), the total population increased to 89.71 million in 2013. Men accounted for 49.5% of the country's total population with a growth of 1.1% and women accounted for 50.5% with a growth of 1.0%. The total birth rate in 2013 reached 2.10 babies per woman, more than the level of 2.05 babies per woman in 2012. Sex ratio reached 97.91 men to 100 women, more than the level of 97.86 men to 100 women in 2012.

The total population in 2013 increased by 4.3% as compared with that of 2009, and also increased by 1.1% as compared with that of 2012. From 2009, the total population of Vietnam has increased by approximately 1.1% per year.

Also, according to GSO, the urban population was 29.03 million and rural population was 60.68 million in 2013. The urban and rural population increased by 13.5% and 0.5%, respectively, as compared with that of 2009, also they increased by 2.4% and 0.4%, respectively, as compared with that of 2012.

The "Population Projection for Vietnam 2009-2049" forecasts the population of the whole country by area categories (rural/urban) and population of each province (Appendix 1-1).

Projected population trend by area categories (whole, urban, and rural) are summarized in Table 2.1.3 and Figure 2.1.2.

The population will increase every year until 2049, whereas the growth rate will slow down from 2040 or so. Estimated population in 2049 is 108.71 million, where urban and rural populations are 63.92 million and 44.79 million, respectively.

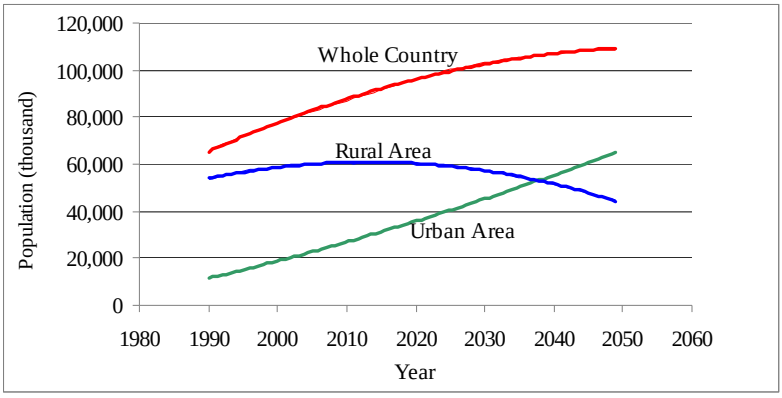
Urban population is forecasted to increase linearly at 2%-3% growth rate every year until 2040. On the other hand, rural population is estimated to increase slightly until 2015 and decrease after that.

Table 2.1.3 Estimated Populations for Whole, Urban, and Rural Areas in Vietnam until 2049

Year	1995	2000	2005	2009	2010	2013	2015
Whole (1,000 persons)	71,996	77,631	82,392	86,025	86,933	89,709	91,583
Urban (1,000 persons)	14,938	18,725	22,332	25,585	26,516	29,030	30,763
Share(%)	20.7	24.1	27.1	29.7	30.5	32.4	33.6
Rural (1,000 persons)	57,057	58,906	60,060	60,440	60,417	60,679	60,820
Share(%)	79.3	75.9	72.9	70.3	69.5	67.6	66.4

Year	2020	2025	2030	2035	2040	2045	2049
Whole (1,000 persons)	96,179	100,131	103,117	105,388	107,004	108,165	108,700
Urban (1,000 persons)	35,654	40,743	45,804	50,818	55,674	60,378	63,920
Share(%)	37.1	40.7	44.4	48.2	52.0	55.8	58.8
Rural (1,000 persons)	60,525	59,388	57,312	54,570	51,330	47,787	44,780
Share(%)	62.9	59.3	55.6	51.8	48.0	44.2	41.2

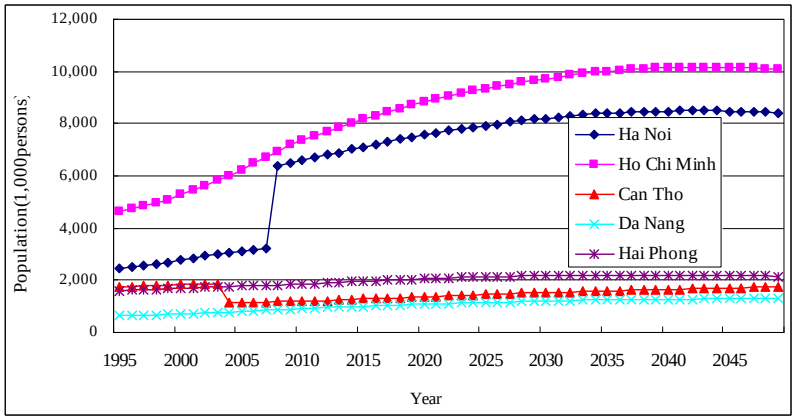
Source: Population Projection for Vietnam 2009-2049, GSO of Vietnam



Source: Population Projection for Vietnam 2009-2049, GSO of Vietnam

Figure 2.1.2 Population Projection in Vietnam

The population trend in the five centrally-run cities is estimated as shown in Figure 2.1.3. The population of Ha Noi and HCMC is forecasted to increase until 2040 and subsequently, each of them is estimated to remain flat or decline. The population of other cities is projected to slightly increase.



*: A sharp population increase in Ha Noi in 2008 was caused by the merger with Ha Thai Province.
**: A sudden population drop in Can Tho in 2004 is due to the split of Can Tho Province into Can Tho City and Hau Giang Province.
Source: Population Projection for Vietnam 2009-2049, GSO of Vietnam

Figure 2.1.3 Population Projection of the Five Centrally-run Cities

The population of each province in 2025 and 2050 projected by GSO is divided into urban area and rural area by the JICA Survey Team as shown in Table 2.1.4.

Table 2.1.4 Population Projection for Each Province and its Capital

(Unit: 1,000 persons)

No.	Province	Capital	2009				2025				2050			
			Province			Capital	Province			Capital	Province			Capital
			Urban	Rural	Total		Urban	Rural	Total		Urban	Rural	Total	
1	Phu Tho	Viet Tri	209	1,108	1,317	185	347	1,107	1454	299	627	873	1500	477
2	Vinh Phuc	Vinh Yen	225	776	1,000	94	374	770	1144	152	675	575	1250	243
3	Thai Nguyen	Thai Nguyen	288	838	1,125	278	480	811	1291	449	866	484	1350	717
4	Ha Noi		2,653	3,819	6,472		4,420	3,513	7933		7,544	856	8400	
5	Bac Ninh	Bac Ninh	242	785	1,027	164	402	803	1205	266	726	574	1300	424
6	Bac Giang	Bac Giang	146	1,411	1,557	101	243	1,467	1710	164	439	1,311	1750	261
7	Hai Duong	Hai Duong	324	1,383	1,707	213	539	1,320	1859	345	973	927	1900	550
8	Hai Phong		849	991	1,840		1,414	713	2127		1,926	224	2150	
9	Thai Binh	Thai Binh	173	1,610	1,783	183	289	1,554	1843	296	521	1,279	1800	472
10	Hung Yen	Hung Yen	136	992	1,129	83	227	1,032	1259	134	410	890	1300	213
11	Ha Nam	Phu Ly	75	711	786	82	125	703	828	132	225	625	850	211
12	Nam Dinh	Nam Dinh	322	1,507	1,828	243	536	1,445	1981	393	967	1,083	2050	628
13	Ninh Binh	Ninh Binh	161	739	900	111	268	685	953	179	484	466	950	285
14	Lai Chau	Lai Chau	53	318	371	27	89	378	467	43	160	440	600	69
15	Lao Cai	Lao Cai	130	485	616	98	217	547	764	159	392	558	950	254
16	Ha Giang	Ha Giang	92	634	725	45	153	746	899	73	275	825	1100	117
17	Cao Bang	Cao Bang	86	425	511	54	144	428	572	88	260	340	600	140
18	Dien Bien	Dien Bien Phu	74	417	491	48	122	486	608	78	221	529	750	124
19	Son La	Son La	149	931	1,079	92	248	1,108	1356	148	447	1,153	1600	237
20	Yen Bai	Yen Bai	144	598	742	91	240	608	848	147	434	516	950	234
21	Tuyen Quang	Tuyen Quang	94	631	725	89	157	656	813	144	284	566	850	230
22	Bac Kan	Bac Kan	47	247	295	37	79	256	335	60	142	208	350	96
23	Lang Son	Lang Son	141	593	733	87	234	591	825	141	423	427	850	225
24	Quang Ninh	Ha Long	594	552	1,146	219	990	343	1333	354	1,255	145	1400	565
25	Hoa Binh	Hoa Binh	118	669	786	83	196	696	892	134	354	596	950	214
26	Thanh Hoa	Thanh Hoa	355	3,049	3,404	208	592	3,010	3602	336	1,069	2,581	3650	536
27	Nghe An	Vinh	375	2,539	2,915	304	625	2,681	3306	491	1,128	2,372	3500	784
28	Ha Tinh	Ha Tinh	184	1,044	1,228	89	306	991	1297	144	552	848	1400	230
29	Quang Binh	Dong Hoi	128	717	845	111	213	721	934	180	384	616	1000	287
30	Quang Tri	Dong Ha	168	431	599	82	279	391	670	133	504	296	800	212
31	Thua Thien Hu	Hue	391	696	1,088	336	652	576	1228	543	1,176	224	1400	866
32	Da Nang		777	118	895		1,033	115	1148		1,160	140	1300	
33	Quang Nam	Tam Ky	264	1,159	1,423	108	440	1,092	1532	175	794	856	1650	279
34	Kon Tum	Kon Tum	145	287	432	143	241	357	598	231	435	415	850	369
35	Quang Ngai	Quang Ngai	178	1,039	1,217	112	297	1,002	1299	182	535	865	1400	290
36	Gia Lai	Pleiku	366	915	1,281	209	610	997	1607	337	1,101	899	2000	538
37	Binh Dinh	Qui Nhon	413	1,075	1,487	281	687	943	1630	454	1,241	559	1800	724
38	PhuYen	Tuy Hoa	199	664	862	152	331	624	955	246	598	452	1050	393
39	Dak Lak	Buon Ma Thuot	416	1,319	1,736	326	694	1,425	2119	527	1,252	1,298	2550	842
40	Khanh Hoa	Nha Trang	461	697	1,158	392	768	568	1336	634	1,318	182	1500	1,012
41	Lam Dong	Da Lat	450	739	1,189	205	751	716	1467	332	1,355	395	1750	530
42	Ninh Thuan	Phan Rang-Thap Cham	204	362	566	162	340	306	646	262	614	136	750	417
43	Binh Thuan	Phan Thiet	460	710	1,169	216	766	563	1329	350	1,339	161	1500	558
44	Dak Nong	Gia Nghia	72	419	491	42	121	521	642	68	218	582	800	108
45	Binh Phuoc	Dong Xoai	147	728	875	80	245	803	1048	130	441	709	1150	207
46	Dong Nai	Bien Hoa	829	1,670	2,500	701	1,382	1,825	3207	1,134	2,494	1,156	3650	1,810
47	Ba Ria Vung Ta	Vung Tau	498	501	999	296	829	378	1207	479	1,202	148	1350	765
48	Tay Ninh	Tay Ninh	166	901	1,067	126	277	937	1214	203	500	800	1300	324
49	Binh Duong	Thu Dau Mot	453	1,060	1,513	223	755	1,703	2458	360	1,362	1,588	2950	575
50	Ho Chi Minh		6,021	1,175	7,196		8,400	933	9333		9,046	1,004	10050	
51	Long An	Tan An	251	1,185	1,436	133	419	1,179	1598	214	756	944	1700	342
52	Tien Giang	My Tho	229	1,444	1,673	181	382	1,415	1797	293	689	1,161	1850	468
53	Ben Tre	Ben Tre	126	1,130	1,256	116	209	1,106	1315	188	378	972	1350	300
54	Dong Thap	Cao Lanh	296	1,371	1,667	161	493	1,322	1815	261	890	1,010	1900	416
55	Vinh Long	Vinh Long	157	868	1,025	137	261	838	1099	221	472	628	1100	353
56	Tra Vinh	Tra Vinh	154	850	1,003	99	256	839	1095	160	462	638	1100	255
57	An Giang	Long Xuyen	610	1,538	2,148	279	1,016	1,346	2362	451	1,834	616	2450	719
58	Can Tho		783	406	1,189		1,310	146	1456		1,570	180	1750	
59	Hau Giang	Vi Thanh	150	608	758	71	249	596	845	115	450	450	900	184
60	Soc Trang	Soc Trang	251	1,043	1,293	136	418	1,000	1418	220	754	746	1500	351
61	Kien Giang	Rach Gia	454	1,235	1,689	226	757	1,155	1912	366	1,365	735	2100	584
62	Bac Lieu	Bac Lieu	226	631	857	148	376	589	965	239	678	322	1000	382
63	Ca Mau	Ca Mau	257	950	1,207	216	429	914	1343	350	774	626	1400	558
Total			25,585	60,440	86,025	9,513	40,743	59,388	100,131	15,383	63,920	44,780	108,700	24,555

1) The whole data of 2009 is census data surveyed by GSO
2) Total population of each province in 2025 and 2050 is projected data cited from the "Population Projection for Vietnam 2009-2049, GSO"
3) The population of each urban, rural, and capital in 2025 and 2050 are estimated by the JICA Survey Team.

Source: Population Projection for Vietnam 2009-2049, GSO of Vietnam, modified by the JICA Survey Team

3) Labor and Employment

The number of labor in each category is shown in Table 2.1.5. In the employment structure, agriculture, forestry, and fishery sectors comprise about 50% continuously every year, which is different with industrial production. The manufacturing and service industry follows.

Persons aged 15 and above in all economic activities in 2013 reached to an estimated 52.40 million, which grew by 1.36% as compared with 2012. Persons aged 15 and above in the sectors of agriculture, forestry, and fishery accounted for 46.9% of the total laborers, which decreased by 0.5% as compared with the previous year; workers in the sectors of industry and construction accounted for 21.1%, which reduced by 0.1%; and workers in the service sector accounted for 32.0%, which increased by 0.6%.

In 2013, the proportion of informal workers in the total labor force aged 15 and above was estimated at 34.2% (urban area: 47.4% and rural area: 28.6%). The unemployment rate of laborers of the working age group in the same year was estimated at 2.2% (urban area: 3.58% and rural area: 1.58%).

The estimated unemployment rate for youths aged 15-24 in 2013 was 6.36% (urban area: 11.11% and rural area: 4.87%), whereas, for adults aged 25 and above it was 1.21% (urban area: 2.29% and rural area: 0.72%).

Table 2.1.5 Number of Laborers Above 15 Years Old, as of 1 July Each Year

(Unit: Thousand people)

	2006	2007	2008	2009	2010	2011	2012
TOTAL	***42,774.9***	***45,208.0***	***46,460.8***	***47,743.6***	***49,048.5***	***50,352.0***	***51,699.0***
Agriculture, forestry and fishery	**23,563.2**	**23,931.5**	**24,303.4**	**24,606.0**	**24,279.0**	**24,362.9**	**24,488.2**
Mining	256.5	298.8	291.4	291.5	275.6	279.1	286.9
Industrial processing and manufacturing	5,031.2	5,665.0	5,998.8	6,449.0	6,645.8	6,972.6	7,140.4
Production and distribution of electricity , gas , hot water , steam and air conditioning	135.4	121.3	132.7	131.6	130.2	139.7	130.2
Water supply; management activities and waste treatment , waste water	121.0	108.2	94.2	95.4	117.4	106.3	108.4
Construction	1,979.9	2,371.9	2,468.4	2,594.1	3,108.0	3,221.1	3,289.1
Wholesale and retail , repair of automobiles, motorcycles, motorcycles and other motor vehicles	4,593.1	4,929.5	5,100.4	5,150.7	5,549.7	5,827.6	6,347.8
Transportation , warehousing	1,290.4	1,341.6	1,433.3	1,426.1	1,416.7	1,414.4	1,506.4
Accommodation services and meals	824.5	1,096.4	1,307.4	1,573.7	1,711.0	1,995.3	2,148.9
Information and communication	151.4	180.5	204.8	228.0	257.4	269.0	285.2
Financial activities , banking and insurance	185.9	191.6	204.3	230.3	254.5	301.1	314.2
Operation of real estate business	19.0	53.9	51.5	65.2	101.3	119.0	148.9
Professional activities , science and technology	157.5	158.3	183.1	218.5	217.5	220.2	250.1
Administrative and operational support	119.5	147.7	158.1	171.8	185.5	197.9	230.5
Activity of the Communist Party , political organizations - social , state management , security and defense , compulsory social	1,679.9	1,665.9	1,650.6	1,596.9	1,569.6	1,542.2	1,591.3
Education and training	1,258.0	1,513.5	1,492.7	1,583.9	1,673.4	1,731.8	1,776.6
Health and social assistance activities	349.9	384.6	365.6	364.7	437.0	480.8	485.0
Arts , entertainment and recreation	82.1	129.7	180.4	210.8	232.4	250.1	257.4
Other service activities	781.8	737.9	673.8	569.0	687.3	734.9	735.8
Activity wage jobs in the household , producing physical products and services from household consumer	189.8	175.6	163.4	183.3	196.7	183.1	174.9
Activities of the institutions and international agencies	4.7	4.5	2.5	3.2	2.5	2.8	2.9

Source: GSO of Vietnam

(2) Economic Situation

The changes of major macroeconomic indicators are shown in Tables 2.1.6 and 2.1.7. According to the data released by GSO of Vietnam, the gross domestic product (GDP) growth rate in 2013 was expected at 5.42%. Of the growth rate of 5.42% for the whole economy, agriculture, forestry, and fishery sectors grew by 2.67%, which is approximate to the rate in 2012; the industry and construction sectors grew by 5.43%, which is lower than the rate of 5.75% in 2012; while the service sector grew by 6.56%, which is higher than 2012's growth rate of 5.9%.

While GDP growth rate in 2013 did not reach the government's target of 5.5%, it exceeded the 2012 target of 5.25%, and grew consistently by 4.76%, 5.0%, 5.5%, and 6.04% in each quarter of 2013. This upward trend has been seen as a sign of economic recovery.

The economic situation of Vietnam is rated to have passed the lowest point of economic slump. Owing it to the increase in foreign direct investment, the current economic situation of Vietnam shows steady recovery. In 2014, the economic growth rate is forecasted to be 5.6%, and nominal GDP is expected to attain USD 200 billion.

In 2009, GDP per capita attained USD 1,000, and it reached USD 1,896 in 2013. It is forecasted to attain USD 2,000 in 2014.

The GSO of Vietnam estimates the consumer price index (CPI) escalation rate for 2013 at 6.6%, which is the lowest value in the last ten years. Since high inflation rate of more than 18% was recorded in 2011, the rate has declined. Even CPI escalation rate for 2014 is forecasted to go up slightly by 7.1%, it is estimated to fluctuate due to the risk of a hike in import price and high debt increasing rate in the medium and long term.

Table 2.1.6 Changes of Major Macroeconomic Indicators

Item		2005	2007	2009	2010	2011	2012	2013*
Nominal GDP	(VND billion)	914,001	1,246,769	1,809,149	2,157,828	2,779,880	3,245,419	3,561,995
	(USD billion)	57.8	77.3	106.7	116.5	136.6	155.8	170.3
GDP per capita (USD)		700	843	1,160	1,273	1,517	1,755	1,896*
Economic growth rate (%)		7.6	8.5	5.4	6.4	6.2	5.3	5.4
CPI escalation rate (%)		8.4	12.6	6.5	11.8	18.1	6.8	6.5
Exchange rate (VND/USD)**		15,802	16,123	16,950	18,528	20,353	20,827	20,916

*: Data from the International Monetary Fund (IMF)
**: Data from the Ministry of Finance (MOF) of Vietnam
Source: GSO of Vietnam

Table 2.1.7 Prospect of Major Macroeconomic Indicators of Vietnam in 2014-2015

Item		2014	2015
Economic growth rate	(%)	5.6	6.3
Nominal GDP	(USD billion)	194.0	220.4
GDP per capita	(USD)	2,096	2,360
CPI escalation rate	(%)	7.1	7.2
Exchange rate	(VND/USD)	21,368	22,029

Source: IHS Global Insight, GSO of Vietnam

In the structure of economic scale in 2013 as shown in Table 2.1.8, the agriculture, forestry, and fishery sectors accounted for 18.4%; the industry and construction sectors accounted for 38.3%; and the service sector accounted for 43.3%.

The overall industrial production index decreased by 4.8% in 2008, whereas, in 2013, it increased by 5.9%. In the manufacturing industry, the index growth rate for 2013 was 7.4% which is higher than the rate in 2012 at 5.5%. Among the manufacturing industry, the textile and clothing industry showed the highest growth rate at 21.8% in 2013.

Table 2.1.8 Industrial Structure (GDP) Transition

Year	Total	Item		
		Agriculture, Forestry and Fishery	Industry and Construction	Service
		Structure (%)		
1990	100.00	38.7	22.7	38.6
1995	100.00	27.2	28.8	44.1
2000	100.00	24.5	36.7	38.7
2005	100.00	19.3	38.1	42.6
2006	100.00	18.7	38.6	42.7
2007	100.00	18.7	38.5	42.8
2008	100.00	20.4	37.1	42.5
2009	100.00	19.2	37.4	43.4
2010	100.00	18.9	38.2	42.9
2011	100.00	20.1	37.9	42.0
2012	100.00	19.7	38.6	41.7
2013	100.00	18.4	38.3	43.3

Source: GSO of Vietnam

Table 2.1.9 shows the export and import values and trade balance. Trade balance is in the red from 2001 to 2011, but it went into black since 2012. In 2013, export and import values both grew by 15.4% amounting to USD 132,175 million and USD 131,312 million, respectively. Vietnam stole out of a chronic trade deficit from 2012, and trade surplus continued in 2013. It was estimated by complex factors such as the increase in export value of foreign investment companies and decrease in import value caused by domestic depression. Since the foreign investment companies invest in higher value-added business continually, the trade surplus is estimated to continue owing to an enhanced export structure.

Table 2.1.9 Export and Import Values and Trade Balance

Item	2009	2010	2011	2012	2013
Export Value (USD million)	57,096	72,237	96,906	114,529	132,175
Increasing Rate (%)	-	26.5	34.2	18.2	15.4
Import Value (USD million)	69,949	84,839	106,750	113,780	131,312
Increasing Rate (%)	-	21.3	25.8	6.6	15.4
Trade Balance (USD million)	▲12,853	▲12,375	▲9,884	749	863

Source: GSO of Vietnam

2.1.2 Condition and Issues of Water Environment

(1) Water Resources

1) Precipitation

As shown in Table 2.1.10, according to the data released by GSO of Vietnam, annual precipitation of Vietnam was 1,200-2,600 mm in 2012, the average was about 1,890 mm at 15 points. The average annual precipitation which was measured at 15 points during the past seven years was about 1,900-2,200 mm.

However, there is serious seasonal and regional imbalance in Vietnam as shown in Table 2.1.11. There is little rainfall during the dry season (December to April) and majority of rainfall is during the rainy season (May to November) in Vietnam. In terms of regional imbalance, Bach Ma, which is located near Hue City, recorded the maximum annual precipitation of 8,000 mm, and Bac Quang located in Ha Giang Province recorded the maximum of 5,000 mm. On the other hand, Phan Rang located in Ninh Thuan Province and Phan Ri located in Binh Thuan Province have only about 700 mm and 400 mm, respectively.

Although about 1,000 mm of precipitation is lost by evaporation, actual enabled water resources are estimated at 310 billion m^3/year which is equivalent to 9.5 m^3/person/day based on the population of 2013. Considering that it is about 7.4 m^3 in other industrialized countries, Vietnam is categorized as a nation which has abundant water resources.

Table 2.1.10 Annual Precipitation Measured at 15 Points during the Past 7 Years

(Unit:mm)

	2006	2007	2008	2009	2010	2011	2012
Lai Chau	1727.0	2476.0	2628.0	1975.9	1857.8	2017.7	2618.7
Son La	1212.0	1353.0	2083.0	1002.4	1209.8	1093.4	1480.0
Tuyen Quang	1596.0	1294.0	1721.0	1284.3	1284.3	1449.5	1995.3
Ha Noi	1240.0	1659.0	2268.0	1612.1	1239.2	1795.2	1801.2
Bai Chay	1697.0	1432.0	1971.0	1567.3	1842.0	1823.8	2142.0
Nam Đinh	1114.0	1087.0	1800.0	1643.6	1461.4	1767.2	1772.8
Vinh	1951.0	1962.0	2120.0	1409.2	2716.5	2258.6	1892.5
Hue	2479.0	4393.0	3850.0	3809.1	2854.0	4481.0	2370.0
Da Nang	2233.0	3063.0	2528.0	3017.8	2236.8	3647.8	1696.1
Qui Nhon	1291.0	2241.0	2337.0	2273.6	2684.9	1524.9	1483.0
Playku	2178.0	2314.0	1645.0	2725.4	2725.4	2567.2	2207.5
Da Lat	1698.0	2156.0	1577.0	1849.1	1849.1	1650.0	1859.5
Nha Trang	819.0	1565.0	2301.0	1392.5	2657.9	1327.6	1681.7
Vung Tau	1514.0	1522.0	1390.0	1162.7	1162.7	1382.9	1215.6
Ca Mau	2387.0	2606.0	2679.0	2244.4	2244.4	2445.9	2153.9
Average	1675.7	2074.9	2193.2	1931.3	2001.7	2082.2	1891.3

Source: GSO of Vietnam

Table 2.1.11 Monthly Precipitation Measured at 15 Points in 2012

(Unit:mm)

	Months												
	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Lai Chau	99.7	5.5	31.9	142.9	282.9	481.8	668.3	165.8	323.0	243.2	146.5	27.2	2618.7
Son La	90.5	6.0	48.7	114.0	180.6	122.3	299.9	344.9	153.3	48.7	44.9	26.2	1480.0
Tuyen Quang	51.1	18.7	36.6	104.7	256.5	162.5	687.2	367.8	184.9	27.1	73.0	25.2	1995.3
Ha Noi	20.3	16.5	16.9	31.8	387.7	268.9	388.3	478.1	54.7	77.5	34.8	25.7	1801.2
Bai Chay	41.7	15.0	34.0	98.2	434.9	121.9	425.9	348.0	162.7	397.8	58.0	3.9	2142.0
Nam Đinh	40.7	22.7	22.9	102.4	177.0	208.5	263.5	328.4	320.2	173.7	77.5	35.3	1772.8
Vinh	57.9	30.7	37.5	19.0	289.2	125.1	84.9	140.4	721.5	60.7	230.0	95.6	1892.5
Hue	155.9	76.1	17.4	51.1	216.1	20.4	25.4	168.9	436.1	409.2	489.1	304.3	2370.0
Da Nang	56.8	37.4	0.0	21.3	10.9	46.1	32.0	180.5	581.7	367.5	302.4	59.5	1696.1
Qui Nhon	104.4	40.1	17.4	170.8	9.7	51.2	114.2	103.2	378.4	177.3	229.2	87.1	1483.0
Playku	6.2	15.5	5.7	91.1	173.0	526.1	454.2	392.4	397.9	126.3	19.1		2207.5
Da Lat	19.2	88.7	49.0	280.6	314.8	127.1	215.3	129.4	406.0	155.7	68.9	4.8	1859.5
Nha Trang	98.8	28.3	118.7	148.8	92.4	24.3	151.1	29.6	444.6	140.2	370.3	34.6	1681.7
Vung Tau	0.2	35.9	31.6	261.8	70.7	141.3	198.0	156.7	189.8	97.7	11.1	20.8	1215.6
Ca Mau	7.3	24.4	233.7	136.7	249.7	166.3	288.5	218.4	533.3	192.4	91.4	11.8	2153.9
Average	56.7	30.8	46.8	118.3	209.7	172.9	286.4	236.8	352.5	179.7	149.7	50.8	1891.3

Source: GSO of Vietnam

2) Available Water

Water resources consist of surface water and groundwater. According to the Vietnam Environment Monitor 2003, Water by the World Bank (WB), the total runoff in Vietnam is estimated at 835 billion m^3 and groundwater is 60 billion m^3 per year.

Despite the abundant water resources, the dependency on upstream countries (as shown in Table 2.1.12) and uneven distribution have made Vietnam's annual water availability per capita low at 4,170 m^3/person as compared with Southeast Asia average of 4,900 m^3/person.

In addition to precipitation, there are a great number of rivers in neighboring countries which rise and flow into Vietnam. About 63% of total surface water is inflow from the neighboring countries, such as China, Myanmar, Laos, and Cambodia. Water demand in these countries is inclined to increase because they also have some issues such as industrialization and urbanization. Hence, available water resources in Vietnam may not satisfy domestic water demand. In the dry season, lack of water resources in the Mekong Delta Region was often reported.

Table 2.1.12 Water Resources Index for Main Riversides in Vietnam

River Basin	Catchment Area		Total Volume		
	Total Area in VN (km^2)	% in VN	Total (billion m^3)	Total Generated in VN (billion m^3)	% Generated in VN
Ky Cung-Bang Giang	11,200	94	8.9	7.3	82
Red River-Thai Binh	155,000	55	137	80.3	59
Ma-Chu	28,400	62	20.2	16.5	82
Ca	27,200	65	27.5	24.5	89
Thu Bon	10,350	100	17.9	17.9	100
Ba	13,900	100	13.8	13.8	100
Dong Nai	44,100	85	36.6	32.6	89
Mekong	795,000	8	508	55	11

Source: Environment Monitor 2003, World Bank

As shown in Table 2.1.13, the Central Region has little water resources.

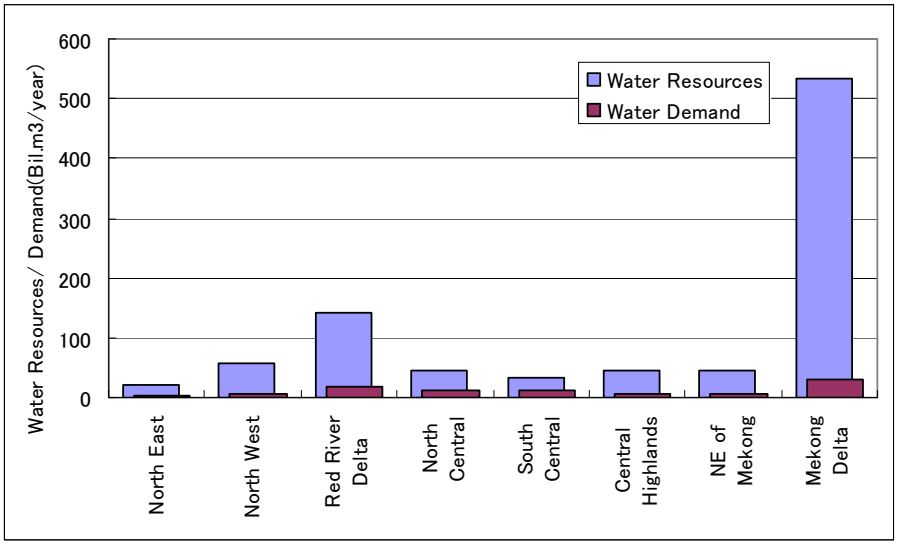
Table 2.1.13 Available Water Resources in the Regions of Vietnam

Region	Surface Water	Groundwater
Northwest Region	+++++	+++
Northeast Region	++++	+++
Red River Delta	+++++	+++++
North Central Coast	+++	+++
South Central Coast	++	+++
Central Highlands	++++	++++
Northeast of Mekong	++++	+++++
Mekong River Delta	+++++	+++++

+++++: means water resource is abundant
+: means water resource is scarce.
Source: Environmental Monitor 2003, World Bank

3) Water Demand

According to the Vietnam Environment Monitor 2003, Water by WB, eight regions of Vietnam are characterized by their available water resources and water demands as shown in Figure 2.1.4.



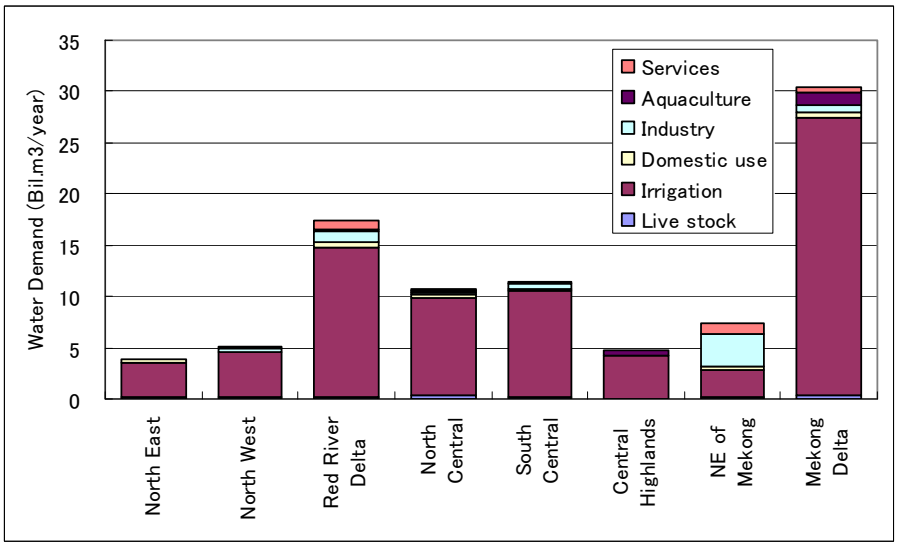
Source: Environment Monitor 2003, World Bank

Figure 2.1.4 Available Water Resources and Water Demands by Region

The total of water demand in Vietnam is 91.20 billion m^3/year, which is 10% of the total available water resources of 921.3 billion m^3/year.

4) Water Consumption by Sector

Detailed water demand per sector for each region is shown in Figure 2.1.5. The largest demand on water resources in Vietnam is irrigation, which accounts for 84% of the total demand, followed by industry (7%), and services (4%). Domestic use of water by comparison is very small, accounting only for 2% of the total demand in 1990 but is expected to increase to 3.088 billion m^3 in 2010 with population growth.



Source: Environment Monitor 2003, World Bank

Figure 2.1.5 Water Demand per Sector by Region

(2) Current State of Water Supply

According to the Southeast Asia Department Working Paper, Vietnam Water and Sanitation Sector Assessment, Strategy and Roadmap, June 2010 reported by the Asian Development Bank (ADB), water supply coverage ratio in the urban areas of Vietnam,grew during the past two decades. No more than 15% of investment has been allocated to improve distribution facilities because increasing productivity (intake, treatment, and transmission) has been hastened. The development focus is now shifting to improving coverage in small towns and suburban areas of larger cities.

The WB and Ministry of Construction (MOC) surveyed the current state of water supply for the whole Vietnam and reported it in the Vietnam Urban Water Supply Database 2011 in 2013. According to the survey, questionnaires were sent to 83 water supply companies, but they were not able to survey four companies because either there was no response on the questionnaire or responses were uncertain. Therefore, they were able to only survey the current state of water supply works of 79 water supply companies (WSCs) in 63 provinces/cities in Vietnam. But, it was not the data of all areas across the country, especially in the urban grade V (towns), as many water companies in towns did not participate in the survey. The survey data is shown in Table 2.1.14.

Table 2.1.14 Information of Water Sector by Provinces (1/2)

Type		Province	Water Supply Company	Population			Population Served			Coverage Ratio			Number of WTP	Designed Capacity	Production Utilization of Capacity	Unit Water Consumption	Non Revenue Water	Continuing Service Hour	Pipe Breaks	Operating Cost	Water Supply Revenue	Operating Cost /Revenue	Revenue Collection Efficiency	Training Cost /Revenue
				Total (Pers.)	Above Grade IV (Pers.)	Grade V (Pers.)	Total (Pers.)	Above Grade IV (Pers.)	Grade V (Pers.)	Total (%)	Above Grade IV (%)	Grade V (%)	(-)	(m^3/day)	(%)	(L/pers./day)	(%)	(hrs/day)	(brks./km/yr.)	(VND/m^3)	(VND/m^3)	(%)	(%)	(%)
Five Centrally-run Cities	1	Ha Noi	Viwaco-Water Supply Jsc.	600,000	600,000	0	572,194	572,194	0	95.4	95.4	0.0	0	8,000	0.0	130.2	21.3	24.0	0.31	489.7	4182.0	11.7	93.6	0.03
			Hawaco-Ha noi Water Company	3,470,000	3,470,000	0	2,436,404	2,436,404	0	70.2	70.2	0.0	20	656,000	91.6	115.9	30.7	24.0	0.12	3301.6	4990.2	66.2	99.7	0.03
			Ha Dong Water Company	274,266	274,266	0	260,664	260,664	0	95.0	95.0	0.0	3	44,000	99.6	119.3	32.6	24.0	1.52	4051.4	5244.4	77.3	98.7	0.10
			Son Tay Water Company	195,000	195,000	0	114,540	114,540	0	58.7	58.7	0.0	2	20,000	99.6	78.4	20.7	24.0	0.26	1570.1	4375.1	35.9	100.0	0.29
			Subtotal/Mean	469,266	469,266	0	375,204	375,204	0	80.0	80.0	0.0	25	728,000	91.3	117.3	29.0	24.0	0.53	2781.3	4840.2	57.5	98.7	0.04
	2	Ho Chi Minh	Sai Gon Water Supply General Company	6,670,046	6,670,046	0	5,615,560	5,615,560	0	84.2	84.2	0.0	5	1,545,100	104.9	103.9	44.9	24.0	0.37	3885.1	7456.3	52.1	101.2	0.09
			Binh An Water Supply ltd., Co.	0	0	0	0	0	0	0.0	0.0	0.0	1	100,000	104.1	-	-	-	-	-	-	36.1	99.2	0.08
			Thu Duc BOO Water Jsc.	0	0	0	0	0	0	0.0	0.0	0.0	1	315,000	110.4	-	-	-	-	646.9	2563.9	25.2	91.6	0.00
			Subtotal/Mean	6,670,046	6,670,046	0	5,615,560	5,615,560	0	84.2	84.2	0.0	7	1,960,100	105.7	103.9	44.9	24.0	0.36	2955.0	6050.9	48.1	100.0	0.08
	3	Hai Phong	Hai Phong Water Supply Co. Ltd.	1,149,382	950,000	199,382	946,357	919,833	26,524	82.3	96.8	13.3	5	190,500	87.0	105.2	15.6	24.0	1.62	4100.5	5465.1	75.0	101.7	0.60
			Vat Cach Water Supply Jsc.	60,226	45,170	15,056	54,252	41,724	12,528	90.1	92.4	83.2	1	11,000	136.9	117.0	7.3	24.0	0.96	2287.9	6829.8	33.5	99.4	0.02
			Tien Lang Construction Jsc.	13,822	13,822	0	12,480	12,480	0	90.3	90.3	0.0	1	1,400	89.6	56.2	30.8	18.0	5.11	3287.1	4032.3	81.5	100.0	0.00
			Subtotal/Mean	1,223,430	1,008,992	214,438	1,013,089	974,037	39,052	82.8	96.5	18.2	7	202,900	89.7	105.3	15.1	23.9	1.63	3934.1	5578.6	70.5	101.4	0.53
	4	Da Nang	Da Nang Water Supply Co. Ltd.	819,332	819,332	0	671,480	671,480	0	82.0	82.0	0.0	3	155,000	97.5	123.4	23.1	24.0	0.04	3698.1	5018.2	73.7	98.6	0.06
	5	Can Tho	Can Tho Water Supply Co. Ltd.	783,104	731,434	51,670	454,995	438,495	16,500	58.1	60.0	31.9	13	154,000	95.0	115.3	39.6	24.0	4.80	1733.2	4503.9	38.5	97.7	0.02
	SubTotal / Mean			14,035,178	13,769,070	266,108	11,138,926	11,083,374	55,552	79.4	80.5	20.9	55	3,200,000	100.5	109.7	32.1	23.4	1.51	2641	4969	50.6	98.4	0.11
Other Provinces	6	Phu Tho	Phu Tho Water Supply Jsc.	667,000	290,000	377,000	331,350	204,720	126,630	49.7	70.6	33.6	4	80,000	61.6	65.2	22.9	22.0	0.22	3120.3	6159.8	50.7	91.9	0.50
	7	Vinh Phuc	Vinh Phuc Water Supply Jsc.	112,182	95,940	16,242	58,256	52,218	6,037	51.9	54.4	37.2	2	24,000	74.8	108.4	30.3	19.0	0.63	4456.5	6235.7	71.5	93.0	0.00
			Vinh Phuc Water Supply & Drainage No.1 Jsc.	132,064	95,236	36,828	65,436	56,354	9,083	49.5	59.2	24.7	5	29,600	68.9	121.4	21.1	19.4	8.38	4511.4	6488.7	69.5	100.0	0.02
			Subtotal/Mean	244,246	191,176	53,070	123,692	108,572	15,120	50.6	56.8	28.5	7	53,600	71.6	115.3	25.3	19.2	4.66	4487.7	6379.7	70.3	97.1	0.01
	8	Thai Nguyen	Thai Nguyen Water Supply Jsc.	397,518	285,167	112,351	205,704	191,232	14,472	51.7	67.1	12.9	5	60,600	69.6	106.9	22.9	20.6	3.76	4468.6	6546.3	68.3	98.7	0.01
	9	Bac Ninh	Bac Ninh Water Supply Jsc.	212,805	174,505	38,300	147,148	118,996	28,152	69.1	68.2	73.5	4	25,200	93.5	107.4	16.0	21.2	1.61	2556.4	4454.1	57.4	92.4	0.16
			An Viet Development Investment Jsc.	15,985	15,985	0	15,985	15,985	0	100.0	100.0	0.0	1	5,000	47.9	96.2	8.9	24.0	1.94	2460.7	4638.1	53.1	93.7	0.00
			Subtotal/Mean	228,790	190,490	38,300	163,133	134,981	28,152	71.3	70.9	73.5	5	30,200	86.0	106.3	15.4	21.4	1.65	2547.4	4471.2	57.0	92.5	0.15
	10	Bac Giang	Bac Giang Water Supply and Drainage Jsc.	161,720	152,920	8,800	122,660	117,332	5,328	75.8	76.7	60.5	1	25,000	95.1	105.4	22.5	23.0	0.45	1238.9	3868.3	32.0	99.8	0.17
	11	Hai Duong	Hai Duong Water Supply Co. Ltd.	410,081	268,859	141,222	339,840	222,768	117,072	82.9	82.9	82.9	13	81,980	66.1	91.2	16.4	22.6	1.10	3768.1	6870.2	54.8	97.0	0.06
	12	Thai Binh	Thai Binh Water Supply Co. Ltd.	244,076	124,492	119,584	203,764	124,976	78,788	83.5	100.4	65.9	9	66,500	65.9	86.4	27.8	20.1	3.89	2433.2	5042.8	48.3	100.0	0.11
	13	Hung Yen	Hung Yen Water Supply Co. Ltd.	107,751	87,963	19,788	34,242	28,044	6,198	31.8	31.9	31.3	1	5,000	91.7	54.9	28.0	21.8	1.12	7557.5	9387.5	80.5	95.2	0.12
	14	Ha Nam	Ha Nam Water Supply Jsc.	70,000	60,000	10,000	68,800	60,200	8,600	98.3	100.3	86.0	2	25,000	60.8	96.5	26.0	14.6	3.39	3910.4	7077.0	55.3	103.2	0.10
	15	Nam Dinh	Nam Dinh Water Supply Co. Ltd.	434,692	285,000	149,692	407,925	281,980	125,945	93.8	98.9	84.1	4	85,000	65.5	73.9	27.0	19.3	0.88	2064.6	5500.0	37.5	99.9	0.39
	16	Ninh Binh	Ninh Binh Water Supply Co. Ltd.	208,460	208,460	0	180,315	180,315	0	86.5	86.5	0.0	8	44,900	68.4	66.3	44.6	12.0	0.70	2859.7	6231.6	45.9	89.3	0.06
	17	Lai Chau	Lai Chau Water Supply and Construction Jsc.	50,456	30,823	19,633	42,507	29,093	13,415	84.2	94.4	68.3	7	13,732	73.1	118.0	14.5	23.0	1.26	2776.0	2219.8	125.1	99.5	0.87
	18	Lao Cai	Lao Cai Water Supply Co. Ltd.	166,166	85,429	80,737	114,844	71,260	43,584	69.1	83.4	54.0	0	47,000	64.7	112.8	22.7	24.0	0.58	2962.5	5988.7	49.5	92.3	0.06
	19	Ha Giang	Ha Giang Water Supply Co. Ltd.	41,925	41,925	0	30,576	30,576	0	72.9	72.9	0.0	2	7,500	97.8	127.8	31.1	19.0	0.37	1991.9	5275.5	37.8	100.0	0.00
	20	Cao Bang	Cao Bang Water Supply Co. Ltd.	90,000	67,700	22,300	73,788	52,223	21,565	82.0	77.1	96.7	1	14,590	85.2	85.9	28.7	24.0	4.90	2507.5	5817.5	43.1	89.0	0.16
	21	Dien Bien	Dien Bien Water Supply Company	0	0	0	0	0	0	0.0	0.0	0.0	N.A											
	22	Son La	Son La Water Supply Jsc.	152,600	58,500	94,100	156,465	61,875	94,590	102.5	105.8	100.5	2	47,400	70.5	108.0	25.3	16.8	0.95	3004.3	4465.0	67.3	100.0	0.37
	23	Yen Bai	Yen Bai Water Supply and Drainage Co. Ltd.	97,000	97,000	0	44,000	44,000	0	45.4	45.4	0.0	1	11,500	80.5	102.3	21.2	20.0	0.34	1140.8	5307.1	21.5	95.2	0.00
			Nghia Lo Water Supply and Drainage Co. Ltd.	28,062	28,062	0	16,060	16,060	0	57.2	57.2	0.0	1	3,500	64.5	79.2	22.6	24.0	0.21	3360.9	5008.3	67.1	99.8	1.03
			Subtotal/Mean	125,062	125,062	0	60,060	60,060	0	48.0	48.0	0.0	2	15,000	76.7	96.1	21.5	20.9	0.26	1567.4	5249.7	29.9	96.1	0.19
	24	Tuyen Quang	Tuyen Quang Water Supply Co. Ltd.	206,247	163,447	42,800	108,944	83,160	25,784	52.8	50.9	60.2	5	24,900	71.2	93.9	17.4	20.4	2.04	3186.7	4470.4	71.3	100.0	0.03
	25	Bac Kan	Bac Kan Water Supply Co. Ltd.	43,888	24,260	19,628	33,924	17,000	16,924	77.3	70.1	86.2	5	7,100	81.7	83.9	27.9	24.0	8.98	2195.1	3095.3	70.9	92.1	0.08
	26	Lang Son	Lang Son Water Supply Company	0	0	0	0	0	0	0.0	0.0	0.0	N.A											
	27	Quang Ninh	Quang Ninh Water Supply Co. Ltd.	635,750	528,532	107,218	584,522	527,382	57,140	91.9	99.8	53.3	12	149,539	82.6	98.9	18.2	24.0	0.74	4216.6	5799.7	72.7	100.2	0.03
	28	Hoa Binh	Hoa Binh Water Supply Jsc.	137,588	137,588	0	125,256	125,256	0	91.0	91.0	0.0	10	30,800	61.1	70.8	22.8	19.0	0.16	5005.5	4815.0	104.0	100.0	0.00
	29	Thanh Hoa	Thanh Hoa Water Supply Co. Ltd.	345,100	319,800	25,300	324,362	302,858	21,504	94.0	94.7	85.0	6	63,150	94.6	89.8	31.4	19.6	0.16	3069.1	5521.4	55.6	95.8	0.15
	30	Nghe An	Nghe An Water Supply Co. Ltd.	421,800	308,868	112,932	319,765	249,805	69,960	75.8	80.9	61.9	9	69,500	75.1	86.6	27.1	16.7	0.01	2895.1	4786.9	60.5	99.1	0.48
	31	Ha Tinh	Ha Tinh Water Supply Co. Ltd.	186,604	123,794	62,810	170,078	115,593	54,485	91.1	93.4	86.7	9	38,600	70.6	87.2	24.7	18.7	0.09	3188.7	4201.9	75.9	90.9	0.79

Source: JICA Survey Team

Table 2.1.14 Information of Water Sector by Provinces (2/2)

Type		Province	Water Supply Company	Population			Population Served			Coverage Ratio			Number of WTP	Designed Capacity	Production Utilization of Capacity	Unit Water Consumption	Non Revenue Water	Continuing Service Hour	Pipe Breaks	Operating Cost	Water Supply Revenue	Operating Cost /Revenue	Revenue Collection Efficiency	Training Cost /Revenue
				Total (Pers.)	Above Grade IV (Pers.)	Grade V (Pers.)	Total (Pers.)	Above Grade IV (Pers.)	Grade V (Pers.)	Total (%)	Above Grade IV (%)	Grade V (%)	(-)	(m^3/day)	(%)	(L/pers./day)	(%)	(hrs/day)	(brks./km/yr.)	(VND/m^3)	(VND/m^3)	(%)	(%)	(%)
Other Provinces	32	Quang Binh	Quang Binh Water Supply Co. Ltd.	152,347	123,359	28,988	144,533	111,232	33,301	94.9	90.2	114.9	7	29,700	52.2	68.6	13.2	24.0	0.12	1917.8	5350.8	35.8	95.2	0.33
	33	Quang Tri	Quang Tri Water Supply Co. Ltd.	271,598	173,455	98,143	185,144	133,646	51,498	68.2	77.0	52.5	10	49,500	60.9	86.5	28.4	23.7	0.96	2050.0	5129.3	40.0	99.8	0.16
	34	Thua Thien Hue	Thua Thien Hue Construction and Water Supply Co. Ltd.	1,123,704	459,149	664,555	813,591	446,224	367,367	72.4	97.2	55.3	2	170,575	62.4	86.7	12.1	24.0	0.49	2411.4	4438.8	54.3	91.0	0.67
	35	Quang Nam	Quang Nam Water Supply Jsc.	302,956	302,956	0	122,123	122,123	0	40.3	40.3	0.0	7	37,500	69.2	85.5	28.2	24.0	0.46	2893.5	4988.5	58.0	86.6	0.00
	36	Kon Tum	Kon Tum Water Supply Co. Ltd.	142,632	142,632	0	41,800	41,800	0	29.3	29.3	0.0	1	12,000	70.2	120.6	23.0	24.0	0.78	2352.4	4488.9	52.4	95.2	0.50
	37	Quang Ngai	Quang Ngai Water Supply Jsc.	183,000	140,000	43,000	69,510	57,550	11,960	38.0	41.1	27.8	2	25,000	79.3	139.9	16.4	24.0	-	1454.5	3650.7	39.8	100.0	0.00
	38	Gia Lai	Gia Lai Water Supply Co. Ltd.	272,445	272,445	0	88,420	88,420	0	32.5	32.5	0.0	2	24,500	66.7	119.3	21.6	12.0	2.24	2831.2	4018.8	70.5	101.0	0.56
	39	Binh Dinh	Binh Dinh Sewerage and Drainage Co. Ltd.	347,977	216,633	131,344	282,722	206,375	76,347	81.2	95.3	58.1	8	64,950	63.9	87.2	22.4	24.0	3.15	2201.2	4918.4	44.8	92.4	0.17
	40	Phu Yen	Phu Yen Sewerage and Drainage Co. Ltd.	206,577	123,757	82,820	156,193	101,724	54,469	75.6	82.2	65.8	9	44,100	69.5	87.3	22.7	24.0	1.09	3889.1	5314.9	73.2	95.2	0.41
	41	Dak Lak	Dak Lak Water Supply and Construction Investment Co. Ltd.	377,549	299,317	78,232	266,795	244,455	22,340	70.7	81.7	28.6	6	61,000	75.8	113.7	16.0	24.0	9.20	1712.6	3392.0	50.5	99.7	0.12
			DakMil Water Company	54,000	0	54,000	7,236	0	7,236	13.4	0.0	13.4	0	1,000	88.8	55.7	22.6	12.0	3.51	3288.1	5345.7	61.5	100.0	0.40
			Subtotal/Mean	431,549	299,317	132,232	274,031	244,455	29,576	63.5	81.7	22.4	6	62,000	76.0	112.1	16.1	22.5	8.42	1739.2	3424.9	50.8	99.7	0.13
	42	Khanh Hoa	Khanh Hoa Water Supply Co. Ltd.	455,268	455,268	0	451,828	451,828	0	99.2	99.2	0.0	2	75,000	111.1	112.1	13.0	24.0	0.56	3368.8	4580.4	73.5	99.5	0.13
			Cam Ranh Urban Jsc.	121,354	121,354	0	59,755	59,755	0	49.2	49.2	0.0	1	16,000	61.2	85.5	25.0	24.0	0.87	3409.5	5343.0	63.8	99.9	0.00
			Ninh Hoa Urban Jsc.	34,743	21,942	12,801	21,446	13,728	7,718	61.7	62.6	60.3	1	6,000	75.4	127.9	21.9	24.0	2.79	2337.3	3681.9	63.5	99.4	0.00
			Van Ninh Urban Works Jsc.	56,200	19,406	36,794	19,294	10,901	8,393	34.3	56.2	22.8	1	3,000	96.9	107.4	20.2	24.0	0.22	1831.4	4609.1	39.7	95.2	0.00
			Subtotal/Mean	667,565	617,970	49,595	552,323	536,211	16,111	82.7	86.8	32.5	5	100,000	100.5	109.7	14.7	24.0	0.76	3287.2	4608.4	71.3	99.4	0.11
	43	Lam Dong	Lam Dong Water Supply Co. Ltd.	270,408	206,105	64,303	205,970	173,025	32,945	76.2	83.9	51.2	8	90,000	48.6	104.7	20.9	24.0	1.41	5568.1	6814.4	81.7	99.2	0.07
			Bao Loc Construction and Water Supply & Drainage Jsc.	94,687	94,687	0	48,417	48,417	0	51.1	51.1	0.0	0	11,200	62.3	86.6	21.3	20.0	4.55	4136.9	5978.6	69.2	100.0	0.26
			Di Linh Construction and Water Supply Jsc.	25,620	25,620	0	25,620	25,620	0	100.0	100.0	0.0	5	5,160	56.4	71.2	20.0	24.0	4.26	5360.2	5755.9	93.1	99.5	0.22
			Subtotal/Mean	390,715	326,412	64,303	280,007	247,062	32,945	71.7	75.7	51.2	13	106,360	50.4	98.5	20.9	23.0	2.54	5376.2	6648.7	80.9	99.3	0.10
	44	Ninh Thuan	Ninh Thuan Water Supply Jsc.	300,861	146,500	154,361	216,958	177,905	39,053	72.1	121.4	25.3	2	54,500	55.2	79.2	23.0	24.0	0.46	3091.4	5382.3	57.4	95.2	0.04
			Dong My Hai Water Supply Enterprise	36,584	36,584	0	26,114	26,114	0	71.4	71.4	0.0	1	2,500	54.7	33.4	1.2	24.0	8.71	6734.8	5553.1	121.3	100.0	0.18
			Subtotal/Mean	337,445	183,084	154,361	243,072	204,019	39,053	72.0	111.4	25.3	3	57,000	55.1	74.3	22.0	24.0	1.18	3294.5	5391.8	61.1	95.5	0.05
	45	Binh Thuan	Binh Thuan Water Supply Jsc.	285,673	235,319	50,354	265,793	227,745	38,048	93.0	96.8	75.6	4	35,200	93.0	94.5	24.7	24.0	0.16	4853.3	5845.2	83.0	100.1	0.06
	46	Dak Nong	Dak Nong Water Supply Jsc.	39,400	39,400	0	8,338	8,338	0	21.2	21.2	0.0	1	2,120	108.4	135.4	20.7	24.0	3.83	4903.0	6449.9	76.0	96.8	0.35
	47	Binh Phuoc	Binh Phuoc Sewerage and Drainage Co. Ltd.	205,766	205,766	0	46,730	46,730	0	22.7	22.7	0.0	4	15,200	85.9	185.7	8.3	24.0	0.09	1450.2	4721.7	30.7	99.9	0.00
	48	Dong Nai	Dong Nai Water Supply Co. Ltd.	897,591	897,591	0	671,676	671,676	0	74.8	74.8	0.0	12	234,900	107.9	95.4	25.7	24.0	1.29	2191.2	7292.7	30.0	92.6	0.09
	49	Vung Tau - Ba Ria	Ba Ria - Vung Tau Water Supply Co. Ltd.	708,930	492,635	216,295	561,645	409,235	152,411	79.2	83.1	70.5	6	180,000	79.2	161.0	10.6	24.0	0.37	2783.8	7012.1	39.7	89.4	0.35
			Phu My Water Jsc.	58,000	0	58,000	45,640	0	45,640	78.7	0.0	78.7	1	20,000	95.2	157.9	3.4	24.0	0.37	3822.6	6329.8	60.4	96.9	0.08
			Subtotal/Mean	766,930	492,635	274,295	607,285	409,235	198,051	79.2	83.1	72.2	7	200,000	80.8	160.7	9.1	24.0	0.37	3002.5	6868.4	43.7	90.9	0.30
	50	Tay Ninh	Tay Ninh Water Supply Co. Ltd.	200,970	156,750	44,220	85,050	46,050	39,000	42.3	29.4	88.2	6	26,500	66.7	101.1	24.5	24.0	0.05	2528.2	4947.6	51.1	99.8	0.23
	51	Binh Duong	Binh Duong Water Supply and Envoriment Co. Ltd.	579,585	542,335	37,250	549,266	518,294	30,972	94.8	95.6	83.1	6	234,000	64.2	83.3	10.0	24.0	0.60	2213.9	6270.8	35.3	99.3	0.02
	52	Long An	Long An Water Supply Co. Ltd.	373,049	133,509	239,540	53,892	52,799	1,094	14.4	39.5	0.5	3	40,000	84.3	212.8	22.3	20.0	2.08	1470.0	6120.7	24.0	95.2	0.00
	53	Tien Giang	Tien Giang Water Supply and Envoriment Co. Ltd.	559,891	150,596	409,295	364,870	222,915	141,955	65.2	148.0	34.7	4	137,860	60.3	104.9	30.8	18.5	5.59	2898.5	5017.0	57.8	99.9	0.21
	54	Ben Tre	Ben Tre Sewerage and Drainage Co. Ltd.	220,000	150,000	70,000	184,356	128,718	55,638	83.8	85.8	79.5	4	34,100	105.4	100.3	25.3	23.0	10.46	3836.7	6552.6	58.6	95.0	0.04
	55	Dong Thap	Dong Thap Water Supply, Sanitation & Urban Envir. Co. Ltd.	392,410	313,436	78,974	346,415	261,576	84,839	88.3	83.5	107.4	13	80,500	69.1	95.1	18.3	23.2	0.40	3674.9	4848.2	75.8	99.0	1.47
	56	Vinh Long	Vinh Long Sewerage and Drainage Co. Ltd.	222,390	166,680	55,710	203,835	159,640	44,195	91.7	95.8	79.3	11	42,100	101.3	105.9	23.7	23.7	0.30	3380.9	5509.9	61.4	92.6	0.13
	57	Tra vinh	Tra Vinh Sewerage and Drainage Co. Ltd.	170,405	115,590	54,815	152,385	111,620	40,765	89.4	96.6	74.4	0	25,760	83.3	77.7	23.5	24.0	2.17	2915.8	5713.9	51.0	91.9	0.00
	58	An Giang	An Giang Electrical and Water Jsc.	1,724,374	470,874	1,253,500	1,410,145	408,115	1,002,030	81.8	86.7	79.9	1	115,610	128.2	62.5	26.1	19.6	0.28	1505.8	4539.8	33.2	99.9	0.01
	59	Hau Giang	Hau Giang Water Supply and Construction Co. Ltd.	165,012	97,921	67,091	76,208	57,352	18,856	46.2	58.6	28.1	2	22,500	80.8	91.7	25.5	24.0	2.63	2586.6	5121.2	50.5	95.2	0.22
	60	Soc Trang	Soc Trang Water Supply Co. Ltd.	346,372	223,470	122,902	251,379	157,140	94,239	72.6	70.3	76.7	17	53,800	80.2	117.8	12.5	24.0	0.14	2668.7	4430.3	60.2	89.8	0.29
	61	Kien Giang	Kien Giang Water Supply Co. Ltd.	380,196	193,116	187,080	279,560	186,135	93,425	73.5	96.4	49.9	10	57,100	128.6	130.7	26.7	22.0	0.16	3115.4	5575.2	55.9	99.6	0.20
	62	Bac Lieu	Bac Lieu Water Supply Co. Ltd.	151,436	151,436	0	131,229	131,229	0	86.7	86.7	0.0	2	22,000	72.1	84.0	12.3	24.0	0.10	1178.2	4658.6	25.3	99.8	0.26
	63	Ca Mau	Ca Mau Water Supply Co. Ltd.	261,788	157,073	104,715	229,125	150,955	78,170	87.5	96.1	74.7	0	48,200	109.5	99.8	29.2	24.0	2.16	1347.9	3848.3	35.0	100.0	0.17
			Subtotal / Mean	18,551,268	12,434,921	6,116,347	13,497,518	9,878,360	3,619,158	72.8	79.4	59.2	311	3,297,226	78.1	94.7	21.1	21.9	1.94	3,061	5,296	58.0	96.8	0.21
			Total / Mean of Whole Vietnam	32,586,446	26,203,991	6,382,455	24,636,444	20,961,734	3,674,710	75.6	80.0	57.6	366	6,497,226	89.2	101.2	27.8	22.1	1.89	3,002	5,242	56.9	97.0	0.20

Source: JICA Survey Team

1) Current State of the Five Centrally-run Cities

The Vietnam Urban Water Supply Database 2011 explained that the average coverage ratio was 79.4% in the urban areas of the five centrally-run cities. It is larger than the average of other provinces at 72.8%. In the case of the area above grade IV and grade V in those cities, they were 80.2% and 27.3%, respectively. Serviced population of the five cities is 11.14 million people, and above grade IV and grade V are estimated at about 11.08 million and 0.06 million people, respectively.

The number of water treatment plants (WTPs) in the urban areas of the five centrally-run cities is 55, and their total designed capacity is estimated at 3,200,000 m^3/day. It forms approximately 50% of the total capacity in Vietnam. As production and capacity utilization of each company in HCMC is over 100%, it is considered that the improvement of water supply capacity is needed immediately. Also, as production and capacity utilization of companies in the other four cities is nearly 90% or over, the improvement of water supply capacity will also be needed in the near future.

The water consumption of the residents of each water company ranges from 56.2 to 130.2 liter/person/day (LPD). The Vat Cach Water Supply Jsc. of Hai Phong is very low with 56.2 LPD and the Viwaco-Water Supply Jsc. of Ha Noi is at the highest with 130.2 LPD. The average water consumption of the residents in the five cities is 109.7 LPD. Nonrevenue water (NRW) ratio ranges from 7.3% to 44.9% in each water company. The average NRW ratio is relatively high at 32.1% in the five cities. Especially, Sawaco of HCMC and Can Tho show high rates of NRW ratio at 44.9% and 39.6%, respectively. However, according to the report of the Department of Transport (DOT) of HCMC in 2013, the rate of HCMC was reduced to 36.5%. This high rate of NRW ratio will be the cause to pressure the management of the company, this has to be improved for the expansion of coverage ratio and sound management of water supply companies. There are 12 WSCs in the five centrally-run cities; four in Ha Noi; and three in Hai Phong.

In these five cities, water supply service is provided for 24 hours a day except for a part of Hai Phong. A part of Hai Phong is serviced by the Tien Lang Construction Jsc. but supplies water only for 18 hours per day.

2) Current State of the Whole Vietnam

According to the report of the Vietnam Urban Water Supply Database in 2011 by WB and MOC, there are 83 WSCs (including joint venture companies) in the urban areas of Vietnam except small water companies which are located in small towns such as urban grade V. There are 366 WTPs in 79 WSCs surveyed and their total capacity is about 6.5 million m^3/day as shown in Table 2.1.14.

a. Served Ratio in Urban Areas

In all the urban areas of Vietnam (except Lang Son and Dien Bien provinces), there are about 32.6 million people in the service areas of WSCs in 2011 (above grade IV: 26.2 million people and grade V: 6.4 million people).

The urban population served ratio in each province is estimated from 14.4% to 100%. Average urban population served ratio in the whole country reaches to 75.6%, in which the ratio of urban grade IV and higher is 80.0% and of urban grade V and others is 57.6%. Some companies have this ratio to nearly 100% such as Khanh Hoa, Ha Nam, An Viet of Bach Ninh Province, and Di Linh of Lam Dong Province. However, the service coverage of 14 companies is lower than 50% and the lowest is 13.4%.

b. Production Ratio at WTP

The average production ratio of all provinces is 89.2%, in which the lowest is 47.9% and the highest is 136.9%. Some WSCs have to overload its design capacity such as Vat Cach, An Giang, Kien Giang, Dong Nai, and Khanh Hoa. Only 10% of all the companies in Vietnam have fully operated or have operated more than their designed capacity. Furthermore, almost all companies have not operated at their full design capacity at all. Some has very low utilization such as An Viet (47.9%), Quang Binh (52.2%), and so on. About 10% of all companies have really low utilization from 47.9% to 64.5%. According to the Vietnam Urban Water Supply Database in 2011, the reasons for the low utilization in WTPs are described below:

- Planned unit water consumption per capita sometimes exceeds the actual water consumption in the service area;
- Users who connect to public water supply system still continue to use groundwater from their own wells considering the water tariff; and
- The extension of networks and connections cannot catch up with the high speed of urbanization in Vietnam.

c. Domestic Water Consumption

Domestic water consumption was low at a range of 80-120 LPD in 2011 compared to the national target of 120 LPD. The lowest is 33.4 LPD and the highest is 212.8 LPD. Some WCSs have high amount of domestic water consumption, namely, Vung Tau (160 LPD) and Can Tho (115 LPD). Others have low amount of domestic water consumption, namely, Dong My (33.37 LPD), Hung Yen (55 LPD), and Ninh Binh (66 LPD). These fluctuations come from the fact that in some localities people use other water resources for bathing, washing, and hygienic purposes, where the served water provided by WSCs is used only for eating and cooking.

d. NRW Ratio

The NRW ratio is generally reported as having been reduced from 39% in 2000 to 20%-30% in 2011 except in some WSCs. According to the Vietnam Water and Sewerage Association (VWSA), NRW ratio is 30% to over 40% in some cities such as HCMC, because the insufficient upgrade of distribution networks causes high ratio of leakage. The average NRW ratio in all urban areas is 27.1% and it varies from 7.3% (in Vat Cach) to 44.9% (in HCMC). NRW ratios in 23 WSCs are smaller than 20% and those in ten WSCs are smaller than 10% including An Viet (8.93%), Vat Cach (7.26%), Binh Phuoc (8.33%), and Phu My (3.38%).

e. Continuity of Service

Service provision across these companies averages to 22.1 hours per day, with 70 companies supplying 18 hours per day or more. Especially, there is low continuity of service hours at 14.6 hours per day in Ha Nam and at 12 hours per day in a part of Dak Mil Province serviced by Dak Mil WSC. Due to the rapid decrease of pressure in the distribution network, served water could be provided only into underground tanks in households, but could not flow up to higher water tanks by itself.

As many as 96% of connections are metered but low water tariffs and lack of accountability have provided little incentive for WSCs to maintain the distribution network. According to MOC, upgrading and expanding the water distribution network is said to be a priority of urban WSCs in

Vietnam. In the coming period, investment of WCSs concerned will be focused on works such as culverts to extract raw water, transmission line systems, WTP, transferring and distribution pipe systems. The water supply sector will have to correct the delay, going out of phase in the progress of the above construction works to ensure exploitation of efficiency of the system is at the highest.

f. Pipe Breaks

According to the survey carried out by WB and MOC, the average value of all WSCs is 1.89 breaks/km/year, the lowest is 0.01 and the highest is 10.46. More than 2 breaks/km/year was reported at 20 water companies, including Ben Tre (10.46 breaks/km/year), Dak Lak (9.2 breaks/km/year), Tien Giang (5.59 breaks/km/year), and Tien Lang (5.11 breaks/km/year). On the other hand, 14 WSCs have less than 0.2 breaks/km/year, in which the lowest ratios are: Bac Can, Dong My, Nghe An (0.01 breaks/km/year), Da Nang (0.04 breaks/km/year), Tay Ninh (0.05 breaks/km/year), Ha Tinh (0.09 breaks/km/year), Bac Lieu (0.10 breaks/km/year), Ha Noi and Quang Binh (0.12 breaks/km/year), Kien Giang and Soc Trang (0.14 breaks/km/year), and Hoa Binh (0.16 breaks/km/year). The others have a ratio of 0.2‐2 breaks/km/year.

g. Quality of Served Water

In general, water quality in WTPs meets the Vietnamese standards for drinking water which is QCVN 01:2009/BYT issued by the Ministry of Health (MOH). However, due to the insufficient quality of pipe systems and high NRW ratio, the quality of tap water does not meet the requirements for direct drinking water, but it satisfies the standards for domestic water, QCVN 02:2009/BYT. According to the report of WB and MOC, 100% of samples meet the standards of QCVN 01:2009/BYT in 56 WSCs (71% of total companies), 90% to 99% in 13 companies, and under 90% in ten companies, respectively, in 2011.

(3) Current State of Sewerage

1) Current State of WWTP

Table 2.1.15 shows 21 sites of wastewater treatment plants (WWTPs) that are under operation in 21 sites in Vietnam, as of September 2013. The total capacity of the existing WWTPs is approximately 460,000 m^3/day.

Binh Hung WWTP with treatment capacity of 141,000 m^3/day and Yen So WWTP with 200,000 m^3/day have started operation. They are modern and the largest WWTPs that have applied the activated sludge process. Kim Lien and Truc Bach WWTPs were the first that started the operation of activated sludge process in Vietnam and they have provided their services for about nine years since 2005.

Table 2.1.15 Existing WWTPs in Vietnam

No.	Province Name	City Name	WasteWater Treatment Plants (Existence)					Sewer Type
			Plant Name (Location)	Year (Start Up)	Capacity (m^3/day)		Treatment Method	
					Designing	Function		
1	-	Ha Noi	Kim Lien	2005	3,700	3,700	A2O(AS)	CSS
2	-	Ha Noi	Truc Bach	2005	2,500	2,500	A2O(AS)	CSS
3	-	Ha Noi	North Thang Long	2009	42,000	7,000	AO with nitrification	CSS
4	-	Ha Noi	Yen So	2012	200,000	120,000	SBR	CSS
5	-	Ha Noi	Westlake	2013	22,800	N/A	SBR	CSS
Subtotal					271,000	133,200		
6	-	HCM City	Binh Hung Plant	2009	141,000	141,000	CAS	CSS
7	-	HCM City	Binh Hung Hoa	2008	30,000	30,000	Aer.Pond + Mat Pond	CSS
8	-	HCM City	Cahn Doi (Phu My Hung)	2007	10,000	10,000	OD	SSS
9	-	HCM City	Nam Vien (Phu My Hung)	2009	15,000	15,000	A2O(AS)	SSS
Subtotal					196,000	196,000		
10	-	Da Nang	Son Tra	2006	15,900	15,900	Ana.Pond w/ float cover	CSS
11	-	Da Nang	Hoa Cuong	2006	36,418	36,418	Ana.Pond w/ float cover	CSS
12	-	Da Nang	Pho Loc	2006	36,430	36,430	Ana.Pond w/ float cover	CSS
13	-	Da Nang	Ngu Hanh Son	2006	11,629	11,629	Ana.Pond w/ float cover	CSS
Subtotal					100,377	100,377		
14	-	Ha Long	Bai Chay	2007	3,500	3,500	SBR	CSS
15	-	Ha Long	Ha Khanh	2009	7,500	7,500	SBR	CSS
Subtotal					11,000	11,000		
16	-	Da Lat	Da Lat	2006	7,400	6,000	imhoff tank + Trick.Filt.	SSS
17	-	Buon Ma Thuot	Buon Ma Thuot	2006	8,125	5,700	Stab. Ponds(AP,FP,MP)	SSS
18	-	Bac Giang	Bac Giang	2010	10,000	8,000	OD	CSS
19	-	Bac Ninh	Bac Ninh	2013	17,500	N/A	SBR	CSS
20	-	Vinh	Vinh	2012	25,000	N/A	SBR	CSS
21	-	Thu Dau Mot	Binh Duong/Thu Dau Mot	2013	17,650	N/A	SBR	SSS
Total					664,052	460,277	⇒460,000m^3/day	

*: As of the end of September 2013
Source: Vietnam Urban Wastewater Review, WB, 2014

2) Current State of Service Coverage Ratio of the Collection and Treatment System

As of 2012, sewerage served population with WWTP is approximately 10% (separated sewer: 1% and combined sewer 9%), population connected to sewer without treatment is approximately 40 %, remained 40 % are not served by sewerage system.

3) Sewage Volume per Capita

Sewage volumes per capita introduced in the existing plans are shown in Table 2.1.16. The average value of big cities such as Ha Noi and Ho Chi Min City, is 225 LPD and the average value of other cities is 121 LPD.

According to the Research Report on Vietnam Urban Environment Management (2011, JICA), the Vietnamese government is aiming at 100% coverage of the water supply system in 2025.

Consequently, sewage volume per person in 2050 is set at the same value as that of 2025.

Sewage volume per capita is divided into the following three parts in accordance with the classification of sources:

- Domestic sewage: 70%,
- Public service activities and small industries: 20%, and
- Inflow and Infiltration: 10%.

Table 2.1.16 Sewage Volume per Capita

No.	Province Name	City Name	Category	Project			
				Project Name	Project Area (ha)	Planned Population (pers.)	Sewage Volume per capita (ℓ/pers./day)
1	-	Hanoi	Special	Feasibility Study for the Construction Project of Central Large-scaled Wastewater treatment Plants for Hanoi Environmental Improvement	4,936	882,000	245
2	-	HCMC	Special	Water Environment Project	2,720	1,411,740	250
3	-	Da Nang	Ⅰ	STUDY ON WATER ENVIRONMENT IMPROVEMENT PROJECT FOR DA NANG CITY(Phase-Ⅰ)	762	264,700	180
						Average (Special city and Category Ⅰ)	225
4	HAI DUONG	Hai Duong	Ⅱ	HAI DUONG CITY DRAINAGE AND WASTEWATER TREATMENT PROJECT	1,800	50,000	150
5	THAI BINH	Thai Binh	Ⅱ	THAI BINH CITY DRAINAGE, SEWERAGE AND SANITATION IMPROVEMENT PROJECT	1,167	135,000	96
6	LAO CAI	Sa Pa	Ⅱ	PROGAME OF RURAL INFRASTRUCTURE IMPROVEMENT LAO CAI	N/A	43,600	120
7	THAI NGUYEN	Thai Nguyen	Ⅱ	THAI NGUYEN CITY DRAINAGE, SEWERAGE AND WASTEWATER TREATMENT PROJECT	1,200	100,000	150
8	THANH HOA	Thanh Hoa	Ⅱ	THANH HOA CITY COMPREHENSIVE SOCIECONOMIC DEVELOPMENT PROJECT	1,108	1,581,000	96
9	KHANH HOA	Nha Trang	Ⅱ	NHA TRANG ENVIRONMENTAL SANITATION PROJECT	42,178	300,261	150
10	VINH PHUC	Vinh Yen city	Ⅲ	Vinh Yen Drainage and Waste Water Treatment Project_Phase I	729	47,502	162
11	BAC NINH	Bac Ninh	Ⅲ	BAC NINH CITY DRAINAGE, SEWERAGE AND WASTEWATER TREATMENT PROJECT	3,000	92,800	165
12	HA NAM	Phu Ly	Ⅲ	Phu Ly City Drainage and Waste Water Treatment Project_Phase 2	150	N/A	165
13	SON LA	SON LA	Ⅲ	VIETNAM PROGRAM NORTH II-WAST WATER MANAGEMENT IN SONLA	1,406	90,263	100
14	HOA BINH	HOA BINH	Ⅲ	VIETNAM PROGRAM NORTH II-WAST WATER MANAGEMENT IN HOA BINH	470	85,575	100
15	HA GIANG	Ha Giang	Ⅲ	HA GIANG CITY DRAINAGE, SEWERAGE AND WASTE WATER TREATMENT PROJECT	13,508	94,000	80
16	CAO BANG	Cao Bang	Ⅲ	CAO BANG TOWN DRAINAGE, SEWERAGE AND WASTEWATER CONNECTION PROJECT	1,115	60,433	90
17	LANG SON	LANG SON	Ⅲ	VIETNAM PROGRAM NORTH II-WAST WATER MANAGEMENT IN LANG SON	781	80,468	100
18	QUANG NAM	Tam Ky	Ⅲ	COLLECTION, WASTEWATER TREATMENT AND DRAINAGE SYSTEM OF TAM KY CITY PROJECT	9,282	117,873	120
19	KON TUM	Kon Tum	Ⅲ	KON TUM TOWN SHIP DRAINAGE SYSTEM AND WASTEWATER TREATMENT PLANT PROJECT	2,347	52,096	96
20	BINH DUONG	Thu Dau Mot	Ⅲ	SOUTHERN BINH DUONG WATER ENVIRONMENT IMPROVEMENT PROJECT - Phase II	1,911	97,400	148
21	BINH DUONG	Thuan An	Ⅲ	SOUTHERN BINH DUONG WATER ENVIRONMENT IMPROVEMENT PROJECT - Phase II	3,163	79,700	128
22	TAY NINH	Tay Ninh	Ⅲ	Wastewater collection and treatment system project in Tay Ninh town – Tay Ninh province	2,523	104,876	70
23	DONG NAI	Bien Hoa	Ⅲ	DONG NAI WATER ENVIRONMENT IMPROVEMENT PROJECT	1,072	188,300	132
24	DONG THAP	Cao Lanh	Ⅲ	CAO LANH CITY DRAINAGE, SEWERAGE AND WASTEWATER TREATMENT PROJECT	10,719	151,027	150
25	AN GIANG	Long Xuyen	Ⅲ	LONG XUYEN DRAINAGE AND WASTEWATER COLLECTION PROJECT	14,238	128	100
26	KIEN GIANG	Phu Quoc	Ⅲ	PREPARATORY SURVEY ON WATER SUPPLY AND SEWERAGE SYSTEM PROJECT IN PHU QUOC ISLAND IN THE SOCIALIST REPUBLIC OF VIETNAM PHASE-Ⅰ	1,632	96,411	120
27	NGHE AN	Thai Hoa town	Ⅴ	THAI HOA TOWN DRAINAGE, SEWERAGE AND WASTEWATER CONNECTION PROJECT	13,500	159,529	120
						Average (Category Ⅱ,Ⅲ and Ⅴ)	121
						Average(Whole)	133

Source: JICA Survey Team

2.1.3 National Master Plan for the Improvement of Water Supply and Wastewater Sector

(1) Water Supply Sector

GOV issued Decision No. 117/2007/ND-CP dated July 11, 2007 on drinking water production, supply, and consumption in centralized water supply systems in urban areas, rural areas, industrial parks, export processing zones, high-tech zones, and economic areas (commonly called industrial zones). This decree stipulated the rights and obligations of organizations, individuals, and households taking part in activities related to production, supply, and consumption of drinking water in Vietnam.

After a short time of application, Decision No. 124/2011 ND-CP dated December 28, 2011 was issued to amend and update the previous Decision.

In 2009, GOV updated the orientations for the development of urban water supply sector. Decision No. 1929/QD-TTg dated November 20, 2009 described the orientation for the development of water supply sector in urban areas and industrial parks in Vietnam by year 2025 and the vision of 2050. The Decision stipulates the following vision towards 2050:

- ✓ Satisfying the water supply demand in all urban centers and industrial parks on the basis of supplying quality water with good services in a stable and efficient manner; and
- ✓ Three-phased targets up to 2025 (as shown in Table 2.1.17):
  - ➢ Accomplishment of 100% coverage with a water consumption of 120 LPD,
  - ➢ Reduction of NRW ratio down to 15%, and
  - ➢ Continuous (24 hours/day) water supply service in all urban areas in Vietnam.

Table 2.1.17 Updated Orientations for the Development of Urban Water Supply Sector

<table>
<tr><td>Year</td><td colspan="2">2015</td><td colspan="2">2020</td><td colspan="2">2025</td></tr>
<tr><td>Item / Grade</td><td>Coverage and Water Consumption</td><td>Non Revenue Water</td><td>Coverage and Water Consumption</td><td>Non Revenue Water</td><td>Coverage and Water Consumption</td><td>Non Revenue Water</td></tr>
<tr><td>Sp</td><td rowspan="4">90% with 120 LPD</td><td rowspan="5">Below 25%</td><td rowspan="5">90% with 120 LPD</td><td rowspan="5">Below 18%</td><td rowspan="6">100% with 120 LPD</td><td rowspan="6">Below 15%</td></tr>
<tr><td>I</td></tr>
<tr><td>II</td></tr>
<tr><td>III</td></tr>
<tr><td>IV</td><td>70% with 100 LPD</td></tr>
<tr><td>V</td><td>50%</td><td>Below 30%</td><td>70% with 100 LPD</td><td>Below 25%</td></tr>
</table>

Source: Decision No.1929/QD-TTg

(2) Wastewater Sector

The government issued Decree No. 88/2007/ND-CP dated May 28, 2007 on urban and industrial drainage, stipulating activities related to drainage in urban areas, industrial parks, export processing zones, high-tech zones, and economic zones. The decree stipulated the rights and obligations of organizations, individuals, and households to take part in drainage activities. For rural residential areas, if possible, the decree also encourages the construction of centralized drainage systems. At present, the decree has been reviewed and updated to be more appropriate to the actual situation.

In 2009, the government updated the orientation for the development of urban drainage and sewerage, issuing Decision No. 1930/QD-TTg dated November 20, 2009, in which there was a description of the development orientations of drainage sector (urban drainage and sewerage) in urban areas and industrial parks up to 2025 and a vision to 2050.

The national goal of service coverage of wastewater collection and treatment system in 2025 according to Decision No. 1930/QD-TTg is shown in Table 2.1.18. The coverage ratio is set between 70% and 80% in category IV or higher urban areas and 50% in category V urban areas and craft villages. The overall coverage ratio is assumed at 65% with a median of 50% to 80% of the target value of the national goal in 2025. The total amount of the project needs in 2050 is assumed to100% of service coverage of the collection and treatment system .

Table 2.1.18 Objectives for the Development of Urban Drainage and Wastewater Treatment

Items		2015	2020	2025	2050
Drainage (rain water discharge)	Flood	To be solved in category II or higher urban areas	To be solved in category IV or higher urban areas	To be solved in all urban areas	Will be solved in all urban areas
	Service coverage	70-80%	>80%	90-95%,100% in category IV or higher urban areas	
Wastewater discharge	Service coverage of collection and treatment system	40-50% in category III or higher urban areas	60% in category III or higher urban areas	**70-80% in category IV or higher urban areas**	**Will be solved in all urban areas**
		-	40% in categories IV, V urban areas and craft villages	**50% in category V urban areas and craft villages**	
		-	-	Wastewater treatment plants at different levels of management are located in craft villages	
	Industrial and hospital wastewater	The whole wastewater is treated	-	-	-
		All industrial parks have their own discharge system	-	-	-
	Other items	Public toilets are installed in categories IV or higher urban areas	Pipes, sewers, channels will be upgraded to prevent pollution at concentrated residential areas	20-30% treated wastewater will be reused.	-

Source: JICA 2011, Research Report on Vietnam Urban Environment Management

2.1.4 Master Plan for the Improvement of Water Supply and Wastewater Sector in the Five Centrally-run Cities

(1) Water Supply Sector

1) Ha Noi

Decision No. 499/QD-TTg, approving the water supply master plan of Ha Noi Capital through 2030, with a vision towards 2050, was issued on March 21, 2013. It aims to concretize the orientation of water supply development of Ha Noi Capital with the target period of 2030 and a vision until 2050.

The master plan (M/P), aiming to improve the access ratio to clean water, stipulates the targets by 2020 as 100% in the inner center, 90%-95% in satellite urban areas, and 85%-90% in ecological urban areas, respectively. The targets by 2030 are 100% for urban centers and satellite urban areas, and 95%-100% for ecological urban areas.

In addition, the ratio of water loss will be reduced to 22%-27% by 2020 and below 20% by 2030. Total capacity of surface WTPs will be increased from 230,000 m^3/day in 2012 to 1,140,000 m^3/day

by 2020, 2,125,000 m^3/day by 2030, and 2,750,000 m^3/day by 2050.

Water demand is estimated as shown in Table 2.1.19.

Table 2.1.19 Water Demand in Ha Noi in 2020, 2030, and 2050

No.	Demand	Average Water Demand (m^3/day)			Maximum Water Demand (m^3/day)		
		2020	2030	2050	2020	2030	2050
1	Daily-life water use demand	738,000	1,126,000	1,533,000	908,000	1,393,000	1,897,000
2	Industrial water use demand	82,000	129,000	129,000	82,000	129,000	129,000
3	Water use demand for other service forms	223,000	349,000	495,000	272,000	427,000	606,000
4	Lost water	244,000	335,000	419,000	298,000	410,000	513,000
Total Water Use Demand		1,287,000	1,939,000	2,576,000	1,560,000	2,359,000	3,145,000

Source: Decision 499/QD-TTg

2) HCMC

Decision No. 729/QD-TTg, approving the water supply planning of HCMC until 2025, was issued on June 19, 2012 in order to concretize the orientation of water supply in the general construction planning of HCMC until 2025. It is in line with urban development plan and the orientation for development of water supply in urban areas and industrial parks in Vietnam until 2025.

The plan aims to improve the percentage of population using clean water by 2015 reaching 100% for the old urban areas and 98% and reaching 100% by 2025 for the new urban and suburban areas. It also plans to reduce the rate of drain and losses of clean water reaching 32% by 2015 and reaching 25% by 2025.

With regard to the water supply in HCMC, other norms are issued such as the Approval of Adjusting General Planning of Ho Chi Minh Construction to 2025 (Decision No. 24/QD-TTg) on January 6, 2010. It sets the norms of water supply for residences at 200 li/person, for industry at 50 m^3/day night, and for public service at 38-40% of living water. The rate of water loss is aimed to be lower than 30%.

According to the above decision, water demand in 2015 and 2025 are estimated as shown in Table 2.1.20.

Table 2.1.20 Water Demand in HCMC by 2015 and 2025

No.	Water Demand	Year 2015 (m^3/day)	Year 2025 (m^3/day)
1	Demand for domestic water use	1,420,000	1,887,000
2	Demand for industrial water use	165,000	246,000
3	Demand for water use of different types of services	340,000	589,000
4	Water loss	825,000	848,000
Total		2,750,000	3,570,000

Source: Decision 729/QD-TTg

The construction of WTP is planned as shown in Table 2.1.21.

Table 2.1.21 Construction Plan of WTP in HCMC by 2015 and 2025

No.	Water Plant	Capacity (m^3 day and night)		
		2010	Stage until 2015	Stage until 2025
I	**Sources of Dong Nai River/Tri An Reservoir**			
1	Thu Duc Water Plant	750,000	750,000	750,000
2	Thu Duc Water Plant II	300,000	300,000	300,000
3	Thu Duc Water Plant III (2012)		300,000	300,000
4	Thu Duc Water Plant IV (after 2018)			300,000
5	Thu Duc Water Plant (after year 2024)			500,000
6	Binh An Water Plant	100,000	100,000	100,000
Total Capacity		1,150,000	1,450,000	2,250,000
II	**Sources of Saigon River/Dau Tieng Reservoir**			
1	Tan Hiep I Water Pplant	300,000	300,000	300,000
2	Tan Hiep II Water Plant (2015)		300,000	300,000
3	Tan Hiep III Water Plant (2020)			300,000
4	Kenh Dong I Water Plant (2012) + Urban supply + Supply to Cu Chi		200,000 150.000 50.000	200,000 150.000 50.000
5	Kenh Dong II Water Plant (2012 supply to Cu Chi and Long An)		150,000	250,000
	Total Capacity	300,000	950,000	1,350,000
III	**Sources of groundwater**			
1	Tan Binh Water Plant	65,000	75,000	75,000
2	Urban sparse wells	2,000	0	0
3	Go Vap Water Plant	10,000	10,000	10,000
4	Binh Tri Dong Water Plant	8,000	8,000	0
5	Socialization source (groundwater)	3,000	2,000	0
6	Binh Hung Water Plant		15,000	15,000
7	Industry (licensed)	350,861	190,000	0
8	Living/residential/household	256,000	140,000	0
	Total Capacity	694,861	440,000	100,000
Total Capacity of the Entire City		**2,144,861**	**2,840,000**	**3,700,000**

Source: Decision 729/QD-TTg

3) Hai Phong

Decision No. 1448/QD-TTg, approving the revision of Hai Phong City Construction Master Plan until 2025 and with a vision towards 2050, was issued on June 16, 2009. The plan estimates the water demand at 1,371,000 m^3/day and the coverage ratio at 100% in 2025.

Existing WTPs are scheduled to be upgraded to satisfy the required capacity of 389,000 m^3/day, which includes Vat Cach WTP (in An Duong District), An Duong WTP (Le Chan District), Cau Nguyet WTP (Kien An District), which includes Vat Cach WTP (in An Duong District), An Duong WTP (Le Chan District), and Cau Nguyet WTP (Kien An District).

Also, some WTPs will be built with a total capacity of 823,300 m^3/day, which includes Hung Dao (Quan Duong Kinh District), Ngu Lao (Thuy Nguyen District), Kim Sơn (An Duong District), and Dinh Vu (Hai An District).

4) Da Nang

Decision No. 2357/QD-TTg, approving the revision of the General Master Plan of Da Nang City until 2030, with a vision towards 2050 was issued on December 4, 2013. In the M/P, the total water demand of the urban areas and industrial parks of Da Nang City is estimated at 420,000 m^3/day in 2020 and 680,000 m^3/day in 2030. By 2020, total WTP capacity will be 530,000 m^3/day, which includes: Cau Do WTP (170,000 m^3/day), Airport WTP (30,000 m^3/day), and Hoa Lien WTP (360,000 m^3/day).

5) Can Tho

Decision No. 1515/QD-TTg, approving the revision of the Master Plan of Can Tho City until 2030 with a vision towards 2050 was issued on August 28, 2013. In the M/P, the total water demand of the urban areas and industrial parks of Can Tho City is estimated at 266,400 m^3/day in 2020 and 448,660 m^3/day in 2030. Total WTP capacity will be 306,220 m^3/day by 2020 and 427,500 m^3/day by 2030.

(2) Wastewater Sector

Sewerage coverage ratios in 2050 targeted in the master plans of the five big cities are summarized in Table 2.1.22. Ha Noi was targeting 100% of the coverage ratio in 2050. The other cities have not set their target ratios for 2050, although they have set the ratios greater than 70% in 2020 and 2030. Therefore, it can be assumed that 100% of coverage ratio could also be achieved by 2050 in the other big cities.

Some cities estimated future sewage volume in the M/P; however, these are estimates for limited areas or for small areas only. As the sewage volumes in the M/Ps are not valuable for the purpose of this Survey, the sewerage coverage ratios are discussed in this Survey to obtain a more comprehensive target values.

Table 2.1.22 Sewerage Coverage Ratio for the Year 2050

City Name	Name of Document	Document's ID	Issued Date	Sewerage Coverage Ratio【2050】(%)	Reference
Ha Noi	Approving the Master Plan on Hanoi capital's Drainage through 2030 with a Vision 2050	725/QD-TTG	10-May-13	100	・90% by 2030
HCM City	Approving the Drainage Master Plan of Ho Chi Minh City through 2020	752/QD-TTG	19-Jun-01	Not Decided	-
Hai Phong	Approving the General Master Plan of Da Nang City until 2030, with a vision toward 2050	2109/QD-UB	13-Sep-05	Not Decided	・For the Central Area 90% as of 2020 ・For the new Urban Area 70% as of 2020
Da Nang	Approving the Revision General Master Plan of Da Nang City until 2030, with a vision toward 2050	2357/QD-TTg	4-Dec-13	Not Decided	-
Can Tho	Approving the Revision Master Plan of Can Tho City toward 2030 with a Vision toward 2050	1515/QD-TTG	28-Aug-13	Not Decided	-

Source: Each decision in the Table

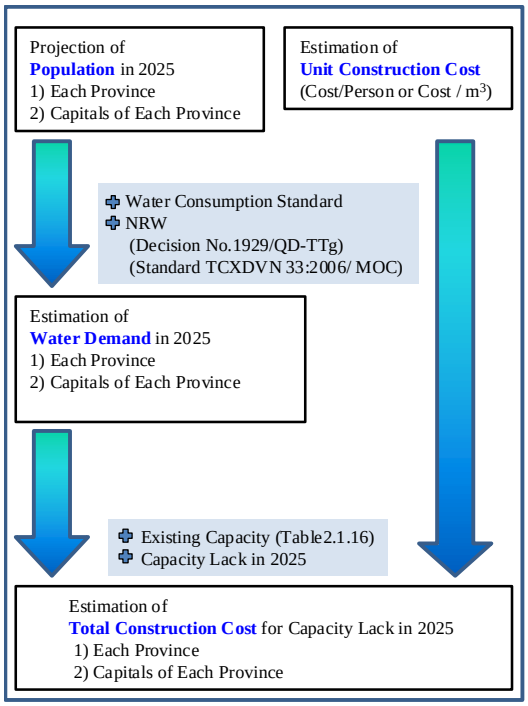
2.2 Estimation of Financial Needs Improving Water Supply Coverage Ratio in the Urban Areas of Vietnam

2.2.1 Estimation Procedure

Estimation of financial needs for improving water supply was performed in accordance with the flow shown in Figure 2.2.1.

According to Decision No.1929/QD-TTg issued on November 20, 2009, mentioned in Section 2.1.3, the Vietnamese government decided the goal of coverage ratio at 100% in the water supply sector for all urban areas (special-grade V) in 2025. Because the current coverage ratio is about 75%, in order to achieve the goal of coverage ratio, water supply improvement especially for urban areas should be conducted. But, it is assumed that water supply improvement would require huge fund. To improve the coverage ratio, it is important to make an effective financial improvement plan. In this Survey, financial needs are roughly estimated using the assumed urban population by the JICA Survey Team and some standards decided by the Vietnamese government.

This estimation was performed only for urban areas that need urgent water supply improvement. The financial needs for the whole urban area, urban area of each province, and urban area of the capital of each province were estimated.



Source: JICA Survey Team

Figure 2.2.1 Estimation Flow for Financial Needs

2.2.2 Population Projections in 2025 and 2050

The population projection is the first step to estimate the water demand and financial needs to achieve the target (100% of water supply coverage for urban area in 2025 and 2050).

(1) Population Projections of the Whole Country

The total population projection including whole urban and rural areas until 2049 was quoted from the Population Projections for Vietnam 2009-2049 (February 2012) reported by GSO of MPI. The population in 2050 was estimated by the JICA Survey Team since it was not reported in the said report. Considering the accuracy of the population projection shown in the Population Projections for Vietnam 2009-2049, the population in 2050 was estimated to be same as the population in 2049 in the Survey.

(2) Urban Population Projection of Each Province

To estimate the water demand and financial needs to achieve the goal of coverage ratio in the urban area, the population projection of each province and its urban area in 2025 was estimated in this Survey. Regarding the total population in each province, the changes of population from 1995 is reported as shown in Figure 2.1.3, but the inclination of population growth is not clear in some

provinces because of their municipal integration and division. Because of these reasons, it is difficult to catch a tendency of change in urban population in each province through previous data.

Therefore, in this Survey, based on the ratio of urban population in each province against the urban population in the whole country in 2009, it is assumed that the same ratio continues until 2025. That is to say, the urban population in each province was estimated based on the ratio in 2009 and the projections of urban population in the whole country from 2010 to 2025 shown in the Population Projections for Vietnam 2009-2049. On the other hand, the highest ratio of urban population against provincial population in each province was about 90% in Da Nang City. Considering this percentage, the maximum ratio of urban population is set at 90% in all provinces in this Survey. The rural population was calculated by subtracting the urban population from the provincial population.

(3) Population Projection of each Capital City

The total, urban, and rural populations of each capital city from 2010 to 2025 were projected in this Survey. The growth rates of the total and urban populations were set at the same number of that in whole country as shown in the Population Projections for Vietnam 2009–2049 for this Survey.

2.2.3 Estimation of Water Demand in the Urban Areas of Vietnam in 2025

As the five centrally-run cities have made the M/Ps and decisions as mentioned in Section 2.1.4, the JICA Survey Team considered the estimated water demands in the M/Ps and decisions as the water demands in 2025 in each city for this Survey.

But, as the JICA Survey Team could not find the M/Ps and decisions of other provinces other than the five centrally-run cities, their water demands were estimated according to the procedure written in Section 2.2.1.

(1) Estimation of Water Demands in the Five Centrally-run Cities in 2025

Water demands in 2025 in the five centrally-run cities were estimated according to each M/P and decision mentioned in Section 2.1.4. But, the M/Ps in Ha Noi, Da Nang, and Can Tho forecasted only water demands in 2030, therefore, that of 2030 was used in this report. Furthermore, water demands of Hai Phong, Da Nang, and Can Tho are not specified in detail; therefore, they are only available in total.

The total water use demand in 2025 in the five centrally-run cities is estimated at 8,428,660 m^3/day as shown in Table 2.2.1. It includes domestic, industrial, other use demand such as business and public works, and water losses in the lines of distribution.

Table 2.2.1 Water Demand in the Five Centrally-run Cities (Ha Noi, Da Nang, and Can Tho in 2030) in 2025

(Unit: m^3/day)

No.	City / Water Demand	Ha Noi(1)	HCMC	Hai Phong	Da Nang(2)	Can Tho(3)	Total
1	Daily-life water use demand	1,393,000	1,887,000	N/A	N/A	N/A	-
2	Industrial water use demand	129,000	246,000	N/A	N/A	N/A	-
3	Water use demand for other service forms	427,000	589,000	N/A	N/A	N/A	-
4	Water loss	410,000	848,000	N/A	N/A	N/A	-
Total Water Use Demand		2,359,000	3,570,000	1,371,000	680,000	448,660	8,428,660

(1) Each water demand in 2030 by Decision No. 499/QD-TTg issued on March 21, 2013
(2) Total water use demand in 2030 by Decision No. 2357/QD-TTg issued on December 4, 2013
(3) Total water use demand in 2030 by Decision No. 1515/QD-TTg issued on August 28, 2013

(2) Estimation of Water Demand in all Provinces without the Five Centrally-run Cities in 2025

Water demand in 2025 was estimated according to the standards such as domestic water consumption, water consumption for public purposes, production purposes, and business purposes.

From the analysis of the M/P of Ha Noi City (Decision No. 499/QD-TTg, March 21, 2013) and HCMC (Decision No. 729/QD-TTg, June 19, 2012), the industrial water consumption of the two cities are about 9.3% in Ha Noi City in 2030 and 13.0% in HCMC in 2025 as against their domestic water consumption. In this report, the industrial water consumption in all provinces except for the five centrally-run cities was set at 10% of their domestic water consumption, which is slightly lower than the average of Ha Noi and HCMC, because their scales of economy are smaller than these two centrally-run cities.

Table 2.2.2 Standards for Estimation of Water Demand

Item	Unit	Standard	Reference for Quotation
1. Coverage Ratio in 2025	%	100	Decision No.1929/QD-TTg, Nov. 20, 2009
2. Average Water Demand			
1) Domestic Water Demand Unit (a)	Lpd	120	Decision No.1929/QD-TTg, Nov. 20, 2009
2) For Public Purposes (b)	%	10 of a	Standard TCXDVN 33:2006 / BXD
3) Water Production and Business Purposes (c)	%	10 of a	Standard TCXDVN 33:2006 / BXD
4) For Industrial Use (d)	%	10 of a	JICA Study Team assumed.
5) NRW	%	15 of (a+b+c+d)	Decision No.1929/QD-TTg, Nov. 20, 2009
3. Maximum Water Demand Coefficient (K)	-	1.2	Standard TCXDVN 33:2006 / BXD

Source: Decision No.1929/QD-TTg, November 20, 2009, Standard TCXDVN 33:2006/ BXD

According to the standards shown in Table 2.2.2, water demands (average and maximum) in 2025 of each province and its capital except for the five centrally-run cities are estimated as shown in Tables 2.2.3 and 2.2.4. Water demand in 2025 for the whole urban area is estimated at 4,435,072 m^3/day (daily average) and 5,322,118 m^3/day (daily maximum), and those for the capitals of all provinces except for the five centrally-run cities are estimated at 2,823,290 m^3/day (daily average) and 3,387,974 m^3/day (daily maximum), respectively.

Table 2.2.3 Water Demand by Urban Area of Province in 2025 (1/2)

No.	Province	Population in 2025	Domestic Water ①				For Public Purpose②		For Production and Business Purpose ③		For Industrial Purpose ④		Sub Total Water Demand ⑤ (①+②+③+④)	NRW ⑥		Total Water Demand ⑦ ⑤+⑥ (Daily Avg.)	Total Water Demand (⑦×1.2) (Daily Max.)
			Coverage Ratio	Supplied Population	Unit Domestic Water Demand	Total Domestic Water Demand	Percentage of Based Date	Total Demand for Public Purpose	Percentage of Based Date	Total Demand for Public Purpose	Percentage of Based Date	Total Demand for Public Purpose		Rate	Amount		
Unit		1,000 pers.	%	1,000 pers.	L/pers./day	m^3/day	%	m^3/day	%	m^3/day	%	m^3/day	m^3/day	%	m^3/day	m^3/day	m^3/day
1	PhuTho	347	100	347	120	41,691	10	4,169	10	4,169	10	4,169	54,198	15	9,564	63,763	76,516
2	VinhPhuc	374	100	374	120	44,910	10	4,491	10	4,491	10	4,491	58,383	15	10,303	68,686	82,424
3	ThaiNguyen	480	100	480	120	57,548	10	5,755	10	5,755	10	5,755	74,812	15	13,202	88,014	105,617
4	BacNinh	402	100	402	120	48,290	10	4,829	10	4,829	10	4,829	62,776	15	11,078	73,855	88,626
5	BacGiang	243	100	243	120	29,194	10	2,919	10	2,919	10	2,919	37,952	15	6,697	44,649	53,580
6	HaiDuong	539	100	539	120	64,726	10	6,473	10	6,473	10	6,473	84,144	15	14,849	98,993	118,792
7	ThaiBinh	289	100	289	120	34,653	10	3,465	10	3,465	10	3,465	45,048	15	7,950	52,998	63,598
8	HungYen	227	100	227	120	27,254	10	2,725	10	2,725	10	2,725	35,430	15	6,252	41,683	50,020
9	HaNam	125	100	125	120	14,977	10	1,498	10	1,498	10	1,498	19,470	15	3,436	22,906	27,487
10	NamDinh	536	100	536	120	64,306	10	6,431	10	6,431	10	6,431	83,598	15	14,753	98,351	118,021
11	NinhBinh	268	100	268	120	32,173	10	3,217	10	3,217	10	3,217	41,825	15	7,381	49,206	59,048
12	LaiChau	89	100	89	120	10,658	10	1,066	10	1,066	10	1,066	13,855	15	2,445	16,300	19,561
13	LaoCai	217	100	217	120	26,074	10	2,607	10	2,607	10	2,607	33,897	15	5,982	39,878	47,855
14	HaGiang	153	100	153	120	18,316	10	1,832	10	1,832	10	1,832	23,811	15	4,202	28,013	33,616
15	CaoBang	144	100	144	120	17,276	10	1,728	10	1,728	10	1,728	22,459	15	3,963	26,423	31,708
16	DienBien	122	100	122	120	14,697	10	1,470	10	1,470	10	1,470	19,106	15	3,372	22,478	26,974
17	SonLa	248	100	248	120	29,734	10	2,973	10	2,973	10	2,973	38,654	15	6,821	45,475	54,570
18	YenBai	240	100	240	120	28,834	10	2,883	10	2,883	10	2,883	37,484	15	6,615	44,099	52,919
19	TuyenQuang	157	100	157	120	18,856	10	1,886	10	1,886	10	1,886	24,513	15	4,326	28,838	34,607
20	BacKan	79	100	79	120	9,458	10	946	10	946	10	946	12,295	15	2,170	14,465	17,359
21	LangSon	234	100	234	120	28,114	10	2,811	10	2,811	10	2,811	36,548	15	6,450	42,998	51,598
22	QuangNinh	990	100	990	120	118,834	10	11,883	10	11,883	10	11,883	154,485	15	27,262	181,747	218,097
23	HoaBinh	196	100	196	120	23,555	10	2,355	10	2,355	10	2,355	30,621	15	5,404	36,025	43,231
24	ThanhHoa	592	100	592	120	71,045	10	7,104	10	7,104	10	7,104	92,358	15	16,298	108,657	130,388
25	NgheAn	625	100	625	120	75,004	10	7,500	10	7,500	10	7,500	97,505	15	17,207	114,712	137,655
26	HaTinh	306	100	306	120	36,692	10	3,669	10	3,669	10	3,669	47,700	15	8,418	56,117	67,341
27	QuangBinh	213	100	213	120	25,515	10	2,551	10	2,551	10	2,551	33,169	15	5,853	39,022	46,827
28	QuangTri	279	100	279	120	33,513	10	3,351	10	3,351	10	3,351	43,567	15	7,688	51,255	61,506
29	ThuaThienHue	652	100	652	120	78,223	10	7,822	10	7,822	10	7,822	101,690	15	17,945	119,635	143,563

Source: JICA Survey Team

Table 2.2.3 Water Demand by Urban Area of Province in 2025 (2/2)

No.	Province	Population in 2025	Domestic Water ①				For Public Purpose②		For Production and Business Purpose ③		For Industrial Purpose ④		Sub Total Water Demand ⑤ (①+②+③+④)	NRW ⑥		Total Water Demand ⑦ ⑤+⑥ (Daily Avg.)	Total Water Demand (⑦×1.2) (Daily Max.)
			Coverage Ratio	Supplied Population	Unit Domestic Water Demand	Total Domestic Water Demand	Percentage of Based Date	Total Demand for Public Purpose	Percentage of Based Date	Total Demand for Public Purpose	Percentage of Based Date	Total Demand for Public Purpose		Rate	Amount		
Unit		1,000 pers.	%	1,000 pers.	L/pers./day	m^3/day	%	m^3/day	%	m^3/day	%	m^3/day	m^3/day	%	m^3/day	m^3/day	m^3/day
30	QuangNam	440	100	440	120	52,789	10	5,279	10	5,279	10	5,279	68,625	15	12,110	80,736	96,883
31	KonTum	241	100	241	120	28,934	10	2,893	10	2,893	10	2,893	37,614	15	6,638	44,252	53,102
32	QuangNgai	297	100	297	120	35,592	10	3,559	10	3,559	10	3,559	46,270	15	8,165	54,435	65,323
33	GiaLai	610	100	610	120	73,184	10	7,318	10	7,318	10	7,318	95,139	15	16,789	111,929	134,315
34	BinhDinh	687	100	687	120	82,482	10	8,248	10	8,248	10	8,248	107,227	15	18,922	126,149	151,380
35	PhuYen	331	100	331	120	39,751	10	3,975	10	3,975	10	3,975	51,677	15	9,119	60,796	72,956
36	DakLak	694	100	694	120	83,262	10	8,326	10	8,326	10	8,326	108,241	15	19,101	127,342	152,811
37	KhanhHoa	768	100	768	120	92,180	10	9,218	10	9,218	10	9,218	119,834	15	21,147	140,981	169,178
38	LamDong	751	100	751	120	90,061	10	9,006	10	9,006	10	9,006	117,079	15	20,661	137,740	165,288
39	NinhThuan	340	100	340	120	40,811	10	4,081	10	4,081	10	4,081	53,055	15	9,363	62,417	74,901
40	BinhThuan	766	100	766	120	91,880	10	9,188	10	9,188	10	9,188	119,444	15	21,078	140,523	168,628
41	DakNong	121	100	121	120	14,477	10	1,448	10	1,448	10	1,448	18,820	15	3,321	22,141	26,570
42	BinhPhuoc	245	100	245	120	29,354	10	2,935	10	2,935	10	2,935	38,160	15	6,734	44,894	53,873
43	DongNai	1,382	100	1,382	120	165,824	10	16,582	10	16,582	10	16,582	215,572	15	38,042	253,614	304,337
44	BaRiaVungTau	829	100	829	120	99,539	10	9,954	10	9,954	10	9,954	129,400	15	22,835	152,235	182,683
45	TayNinh	277	100	277	120	33,253	10	3,325	10	3,325	10	3,325	43,229	15	7,629	50,857	61,029
46	BinhDuong	755	100	755	120	90,580	10	9,058	10	9,058	10	9,058	117,755	15	20,780	138,535	166,242
47	LongAn	419	100	419	120	50,249	10	5,025	10	5,025	10	5,025	65,324	15	11,528	76,852	92,223
48	TienGiang	382	100	382	120	45,790	10	4,579	10	4,579	10	4,579	59,527	15	10,505	70,032	84,039
49	BenTre	209	100	209	120	25,135	10	2,513	10	2,513	10	2,513	32,675	15	5,766	38,441	46,130
50	DongThap	493	100	493	120	59,187	10	5,919	10	5,919	10	5,919	76,943	15	13,578	90,522	108,626
51	VinhLong	261	100	261	120	31,373	10	3,137	10	3,137	10	3,137	40,785	15	7,197	47,983	57,580
52	TraVinh	256	100	256	120	30,733	10	3,073	10	3,073	10	3,073	39,953	15	7,051	47,004	56,405
53	AnGiang	1,016	100	1,016	120	121,914	10	12,191	10	12,191	10	12,191	158,488	15	27,968	186,456	223,748
54	HauGiang	249	100	249	120	29,934	10	2,993	10	2,993	10	2,993	38,914	15	6,867	45,781	54,937
55	SocTrang	418	100	418	120	50,109	10	5,011	10	5,011	10	5,011	65,142	15	11,496	76,638	91,966
56	KienGiang	757	100	757	120	90,780	10	9,078	10	9,078	10	9,078	118,015	15	20,826	138,841	166,609
57	BacLieu	376	100	376	120	45,110	10	4,511	10	4,511	10	4,511	58,643	15	10,349	68,992	82,791
58	CaMau	429	100	429	120	51,469	10	5,147	10	5,147	10	5,147	66,910	15	11,808	78,717	94,461
Total		24,165	-	24,165	-	2,899,855	-	289,985	-	289,985	-	289,985	3,769,811	-	665,261	4,435,072	5,322,118

Source: JICA Survey Team

Table 2.2.4 Water Demand by Capital City in 2025 (1/2)

No.	Province	Capital City	Population of Capital in 2025	Domestic Water ①				For Public Purpose②		For Production and Business Purpose ③		For Industrial Purpose ④		Sub Total Water Demand ⑤ (①+②+③+④)	NRW ⑥		Total Water Demand ⑦ ⑤+⑥ (Daily Avg.)	Total Water Demand (⑦×1.2) (Daily Max.)
				Coverage Ratio	Supplied Population	Unit Domestic Water Demand	Total Domestic Water Demand	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Public Purpose		Rate	Amount		
Unit			1,000 pers.	%	1,000 pers.	L/pers./day	m^3/day	%	m^3/day	%	m^3/day	%	m^3/day	m^3/day	%	m^3/day	m^3/day	m^3/day
1	PhuTho	Viet Tri	299	100	299	120	35,836	10	3,584	10	3,584	10	3,584	46,587	15	8,221	54,808	65,771
2	VinhPhuc	Vinh Yen	152	100	152	120	18,297	10	1,830	10	1,830	10	1,830	23,786	15	4,198	27,983	33,581
3	ThaiNguyen	Thai Nguyen	449	100	449	120	53,879	10	5,388	10	5,388	10	5,388	70,043	15	12,361	82,404	98,885
4	BacNinh	Bac Ninh	266	100	266	120	31,882	10	3,188	10	3,188	10	3,188	41,447	15	7,314	48,761	58,514
5	BacGiang	Bac Giang	164	100	164	120	19,624	10	1,962	10	1,962	10	1,962	25,511	15	4,502	30,013	36,016
6	HaiDuong	Hai Duong	345	100	345	120	41,349	10	4,135	10	4,135	10	4,135	53,754	15	9,486	63,240	75,888
7	ThaiBinh	Thai Binh	296	100	296	120	35,506	10	3,551	10	3,551	10	3,551	46,158	15	8,145	54,303	65,164
8	HungYen	Hung Yen	134	100	134	120	16,035	10	1,603	10	1,603	10	1,603	20,845	15	3,679	24,524	29,429
9	HaNam	Phu Ly	132	100	132	120	15,889	10	1,589	10	1,589	10	1,589	20,656	15	3,645	24,301	29,162
10	NamDinh	Nam Dinh	393	100	393	120	47,188	10	4,719	10	4,719	10	4,719	61,344	15	10,825	72,170	86,604
11	NinhBinh	Ninh Binh	179	100	179	120	21,449	10	2,145	10	2,145	10	2,145	27,884	15	4,921	32,805	39,366
12	LaiChau	Lai Chau	43	100	43	120	5,182	10	518	10	518	10	518	6,737	15	1,189	7,925	9,511
13	LaoCai	Lao Cai	159	100	159	120	19,086	10	1,909	10	1,909	10	1,909	24,812	15	4,379	29,191	35,030
14	HaGiang	Ha Giang	73	100	73	120	8,787	10	879	10	879	10	879	11,423	15	2,016	13,439	16,128
15	CaoBang	Cao Bang	88	100	88	120	10,528	10	1,053	10	1,053	10	1,053	13,686	15	2,415	16,101	19,322
16	DienBien	Dien Bien Phu	78	100	78	120	9,318	10	932	10	932	10	932	12,113	15	2,138	14,251	17,101
17	SonLa	Son La	148	100	148	120	17,797	10	1,780	10	1,780	10	1,780	23,137	15	4,083	27,219	32,664
18	YenBai	Yen Bai	147	100	147	120	17,625	10	1,762	10	1,762	10	1,762	22,912	15	4,043	26,956	32,347
19	TuyenQuang	Tuyen Quang	144	100	144	120	17,311	10	1,731	10	1,731	10	1,731	22,504	15	3,971	26,475	31,770
20	BacKan	Bac Kan	60	100	60	120	7,214	10	721	10	721	10	721	9,379	15	1,655	11,034	13,241
21	LangSon	Lang Son	141	100	141	120	16,935	10	1,694	10	1,694	10	1,694	22,016	15	3,885	25,901	31,082
22	QuangNinh	Ha Long	354	100	354	120	42,462	10	4,246	10	4,246	10	4,246	55,200	15	9,741	64,942	77,930
23	HoaBinh	Hoa Binh	134	100	134	120	16,121	10	1,612	10	1,612	10	1,612	20,957	15	3,698	24,655	29,587
24	ThanhHoa	Thanh Hoa	336	100	336	120	40,302	10	4,030	10	4,030	10	4,030	52,392	15	9,246	61,638	73,966
25	NgheAn	Vinh	491	100	491	120	58,933	10	5,893	10	5,893	10	5,893	76,612	15	13,520	90,132	108,159
26	HaTinh	Ha Tinh	144	100	144	120	17,261	10	1,726	10	1,726	10	1,726	22,440	15	3,960	26,400	31,680
27	QuangBinh	Dong Hoi	180	100	180	120	21,566	10	2,157	10	2,157	10	2,157	28,036	15	4,947	32,983	39,580
28	QuangTri	Dong Ha	133	100	133	120	15,902	10	1,590	10	1,590	10	1,590	20,672	15	3,648	24,320	29,185
29	ThuaThienHue	Hué	543	100	543	120	65,115	10	6,511	10	6,511	10	6,511	84,649	15	14,938	99,588	119,506

Source: JICA Survey Team

Table 2.2.4 Water Demand by Capital City in 2025 (2/2)

No.	Province	Capital City	Population of Capital in 2025	Domestic Water ①				For Public Purpose②		For Production and Business Purpose ③		For Industrial Purpose ④		Sub Total Water Demand ⑤ (①+②+③+④)	NRW ⑥		Total Water Demand ⑦ ⑤+⑥ (Daily Avg.)	Total Water Demand (⑦×1.2) (Daily Max.)
				Coverage Ratio	Supplied Population	Unit Domestic Water Demand	Total Domestic Water Demand	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose		Rate	Amount		
Unit			1,000 pers.	%	1,000 pers.	L/pers./day	m^3/day	%	m^3/day	%	m^3/day	%	m^3/day	m^3/day	%	m^3/day	m^3/day	m^3/day
30	QuangNam	Tam Ky	175	100	175	120	20,942	10	2,094	10	2,094	10	2,094	27,224	15	4,804	32,028	38,434
31	KonTum	Kon Tum	231	100	231	120	27,767	10	2,777	10	2,777	10	2,777	36,097	15	6,370	42,467	50,961
32	QuangNgai	Quang Ngai	182	100	182	120	21,807	10	2,181	10	2,181	10	2,181	28,349	15	5,003	33,352	40,023
33	GiaLai	Pleiku	337	100	337	120	40,483	10	4,048	10	4,048	10	4,048	52,628	15	9,287	61,916	74,299
34	BinhDinh	Qui Nhon	454	100	454	120	54,435	10	5,444	10	5,444	10	5,444	70,766	15	12,488	83,254	99,905
35	PhuYen	Tuy Hoa	246	100	246	120	29,516	10	2,952	10	2,952	10	2,952	38,371	15	6,771	45,142	54,171
36	DakLak	Buon Ma Thuot	527	100	527	120	63,283	10	6,328	10	6,328	10	6,328	82,268	15	14,518	96,786	116,144
37	KhanhHoa	Nha Trang	634	100	634	120	76,118	10	7,612	10	7,612	10	7,612	98,953	15	17,462	116,416	139,699
38	LamDong	Da Lat	332	100	332	120	39,834	10	3,983	10	3,983	10	3,983	51,784	15	9,138	60,922	73,107
39	NinhThuan	Phan Rang-Thap Cham	262	100	262	120	31,382	10	3,138	10	3,138	10	3,138	40,797	15	7,199	47,996	57,596
40	BinhThuan	Phan Thiet	350	100	350	120	41,976	10	4,198	10	4,198	10	4,198	54,569	15	9,630	64,199	77,039
41	DakNong	Gia Nghia	68	100	68	120	8,109	10	811	10	811	10	811	10,541	15	1,860	12,401	14,882
42	BinhPhuoc	Dong Xoai	130	100	130	120	15,542	10	1,554	10	1,554	10	1,554	20,205	15	3,566	23,771	28,525
43	DongNai	Bien Hoa	1,134	100	1,134	120	136,060	10	13,606	10	13,606	10	13,606	176,878	15	31,214	208,091	249,710
44	BaRiaVungTau	Vung Tau	479	100	479	120	57,482	10	5,748	10	5,748	10	5,748	74,726	15	13,187	87,913	105,497
45	TayNinh	Tay Ninh	203	100	203	120	24,372	10	2,437	10	2,437	10	2,437	31,683	15	5,591	37,274	44,730
46	BinhDuong	Thu Dau Mot	360	100	360	120	43,241	10	4,324	10	4,324	10	4,324	56,213	15	9,920	66,133	79,360
47	LongAn	Tan An	214	100	214	120	25,724	10	2,572	10	2,572	10	2,572	33,441	15	5,901	39,342	47,211
48	TienGiang	My Tho	293	100	293	120	35,192	10	3,519	10	3,519	10	3,519	45,750	15	8,074	53,824	64,589
49	BenTre	Ben Tre	188	100	188	120	22,528	10	2,253	10	2,253	10	2,253	29,286	15	5,168	34,454	41,346
50	DongThap	Cao Lanh	261	100	261	120	31,297	10	3,130	10	3,130	10	3,130	40,686	15	7,180	47,866	57,440
51	VinhLong	Vinh Long	221	100	221	120	26,505	10	2,650	10	2,650	10	2,650	34,456	15	6,080	40,537	48,644
52	TraVinh	Tra Vinh	160	100	160	120	19,152	10	1,915	10	1,915	10	1,915	24,897	15	4,394	29,291	35,149
53	AnGiang	Long Xuyen	451	100	451	120	54,071	10	5,407	10	5,407	10	5,407	70,292	15	12,404	82,697	99,236
54	HauGiang	Vi Thanh	115	100	115	120	13,854	10	1,385	10	1,385	10	1,385	18,010	15	3,178	21,188	25,426
55	SocTrang	Soc Trang	220	100	220	120	26,393	10	2,639	10	2,639	10	2,639	34,311	15	6,055	40,366	48,439
56	KienGiang	Rach Gia	366	100	366	120	43,914	10	4,391	10	4,391	10	4,391	57,089	15	10,074	67,163	80,596
57	BacLieu	Bac Lieu	239	100	239	120	28,690	10	2,869	10	2,869	10	2,869	37,297	15	6,582	43,879	52,655
58	CaMau	Ca Mau	350	100	350	120	41,951	10	4,195	10	4,195	10	4,195	54,536	15	9,624	64,160	76,992
Total			15,383	-	15,383	-	1,845,998	-	184,600	-	184,600	-	184,600	2,399,797	-	423,494	2,823,290	3,387,974

Source: JICA Survey Team

(3) Estimation of Water Demand in All Urban Areas of Vietnam in 2025

Water demand in 2025 in the whole of Vietnam is estimated at 13,750,778 m^3/day as shown in Table 2.2.5. Water demand of the five centrally-run cities in 2025 is 8,428,660 m^3/day which accounts for 61.3% of water demand in all urban areas of Vietnam. Otherwise, water demand in the urban areas except for the five centrally-run cities in 2025 is estimated at 5,322,118 m^3/day which accounts for 38.7% of water demand in all urban areas of Vietnam. Water demand in the capital cities of each province and other urban areas in 2025 are estimated at 3,387,974 m^3/day and 1,934,144 m^3/day, respectively. They accounted for 24.6% and 14.1% of water demand in all urban areas of Vietnam, respectively.

Table 2.2.5 Water Demand in All Urban Areas of Vietnam in 2025

No.	Area \ Water Demand		Water Demand* (m^3/day)	Percentage (%)
1	Five centrally-run cities	Ha Noi City	2,359,000	17.2
		HCMC	3,570,000	26.0
		Hai Phong City	1,371,000	10.0
		Da Nang City	680,000	4.9
		Can Tho City	448,660	3.3
		Subtotal	8,428,660	61.3
2	All provincial urban areas except for the five centrally-run cities	Capital cities	3,387,974	24.6
		Urban areas except for the capital cities (Above Grade V)	1,934,144	14.1
		Subtotal	5,322,118	38.7
Total			13,750,778	100.0

*Water demand means maximum water demand.
Source: JICA Survey Team

2.2.4 Estimation of Water Demand in Urban Areas of Vietnam in 2050

According to the report World in 2050, The BRICs and Beyond: Prospects, Challenges, and Opportunities by PricewaterhouseCoopers Co., Ltd. (PWC), the GDP of Vietnam based on purchasing power parity in 2050 was forecasted to increase to USD 2,715 billion as the price of 2011. It means GDP per capita will be about USD 25,000 in 2050. Considering the GDP per capita of USD 4,000 in 2013, it will increase by about six times by that time. Also, Vietnam is projected to move into the top 20 countries by 2050 at 19th place according to PWC.

Considering the GDP growth and improvement of living standards by 2050, the JICA Survey Team assumed the unit domestic water consumption to be 250 LPD in the five centrally-run cities and 200 LPD in the urban areas of Vietnam except the five centrally-run cities. With regard to the public purpose demand, production and business purpose demand, and industrial demand were estimated at 10% of unit domestic water demand equal to those of 2025. But, NRW ratio was assumed to be 10% and will be reduced to 5% after 2025, which was based on the NRW ratio in Japan in 2013 at 10%. Also, the maximum water demand was set at 1.2 times the average water demand as that of 2025. The summary of assumptions is shown in Table 2.2.6.

Table 2.2.6 Standards for Estimation of Water Demand in 2050

Item	Unit	Standard	Reference for Quotation
1. Coverage Ratio in 2050	%	100	Decision No.1929/QD-TTg, Nov.20, 2009
2. Average Water Demand			
1) Domestic Water Demand Unit (a)	LPD	250	Five centrally-run cities assumed by the JICA Survey Team
		200	Except the five centrally-run cities assumed by the JICA Survey Team
2) Public Purposes (b)	%	10 of a	Standard TCXDVN 33:2006 / BXD
3) Production and Business Purposes (c)	%	10 of a	Standard TCXDVN 33:2006 / BXD
4) Industrial Use (d)	%	10 of a	JICA Survey Team assumed.
5) NRW	%	10 of (a+b+c+d)	Decision No.1929/QD-TTg, Nov.20, 2009
3. Maximum Water Demand Coefficient (K)	-	1.2	Standard TCXDVN 33:2006 / BXD

Source: Decision No.1929/QD-TTg, November 20, 2009, Standard TCXDVN 33:2006/BXD

(1) Estimation of Water Demand in the Five Centrally-run Cities in 2050

Ha Noi is the only centrally-run city that has an M/P for 2050. Therefore, the JICA Survey Team estimated the water demand in 2050 according to the procedure written in Section 2.2.1.

In Ha Noi City, there are some differences in the water demand projections between the M/P and the JICA Survey Team due to the differences in projected population and some other conditions such as NRW ratio. Despite some differences, total water demand in 2050 is almost the same, water demand estimated by the JICA Survey Team (3,268,968 m^3/day) was adopted in this Survey.

In Hai Phong City, water demand in 2030 (estimated as the one of 2025 in Clause 2.2.3 (1)) projected by M/P was greater than the one projected by the JICA Survey Team because of some differences such as the population projections, industrial water demand, and NRW ratio. The JICA Survey Team considered that water demand in 2030 by M/P was overestimated and the water demand of 2030 was applied as the water demand of 2050 (1,371,000 m^3/day). Also, as there is no change in water demand between 2030 and 2050, the JICA Survey Team calculated the costs for the renewal of WTP and distribution pipe system for financial needs only from 2025 to 2050.

The total water demand in 2050 in the five centrally-run cities was estimated at 10,236,906 m^3/day which accounts for 41% of water demand in all urban areas of Vietnam.

However, water demand per capita in 2050 in the five centrally-run cities was estimated at 358 LPD as shown in the calculation below.

Water demand per capita = domestic water demand + industrial water demand + water demand for other service forms + water loss

= (250 + 25 + 25 + 25) / (1-0.1)

≒ 361 LPD

Table 2.2.7 Water Demand in the Five Centrally-run Cities in 2050 (Unit: m^3/day)

No.	City / Water Demand	Ha Noi		HCMC	Hai Phong	Da Nang	Can Tho	Total
		M/P	**Survey Team**					
1	Daily-life water demand	1,533,000	**1,885,943**	2,261,468	525,000	575,000	392,534	5,639,944
2	Industrial water demand	129,000	**188,594**	226,147	52,500	57,500	39,253	920,131
3	Water demand for other service forms	495,000	**377,188**	452,294	449,596	115,000	78,507	1,070,969
4	Water loss	419,000	**272,414**	326,656	115,404	83,056	56,699	854,229
Total Water Demand (Daily Average)		2,576,000	**2,724,139**	3,266,565	1,142,500	830,556	566,993	8,530,753
Total Water Demand (Daily Maximum)		3,145,000	**3,268,968**	3,919,878	1,371,000	996,667	680,393	10,236,906

Source: JICA Survey Team

(2) Estimation of Water Demand in All Provinces other than the Five Centrally-run Cities in 2050

Water demand in 2050 was estimated with some factors written in Table 2.2.8 and Table 2.2.9. Water demand per capita was estimated at 286 L/day/capita as shown in the calculation below.

Water demand per capita = daily-life water demand + industrial water demand + water demand for other service forms + water loss

= (200 + 20 + 20 + 20) / (1- 0.1)

= 289 L/day/capita

The total water demand in 2050 except the five centrally-run cities is estimated at 14,793,925 m^3/day which accounts for 59% of water demand in all urban areas of Vietnam in 2050.

Table 2.2.8 Water Demand by Urban Area of Each Province in 2050 (1/2)

No.	Province	Population in 2050	Domestic Water ①				For Public Purpose②		For Production and Business Purpose ③		For Industrial Purpose ④		Sub Total Water Demand ⑤ (①+②+③+④)	NRW ⑥		Total Water Demand ⑦ ⑤+⑥ (Daily Avg.)	Total Water Demand (⑦×1.2) (Daily Max.)
			Coverage Ratio	Supplied Population	Unit Domestic Water Demand	Total Domestic Water Demand	Percentage of Based Date	Total Demand for Public Purpose	Percentage of Based Date	Total Demand for Public Purpose	Percentage of Based Date	Total Demand for Public Purpose		Rate	Amount		
Unit		1,000 pers.	%	1,000 pers.	L/pers./day	m^3/day	%	m^3/day	%	m^3/day	%	m^3/day	m^3/day	%	m^3/day	m^3/day	m^3/day
1	PhuTho	627	100	627	200	125,406	10	12,541	10	12,541	10	12,541	163,028	10	18,114	181,142	217,371
2	VinhPhuc	675	100	675	200	135,090	10	13,509	10	13,509	10	13,509	175,617	10	19,513	195,130	234,156
3	ThaiNguyen	866	100	866	200	173,103	10	17,310	10	17,310	10	17,310	225,034	10	25,004	250,037	300,045
4	HaNoi	7,544	100	7,544	250	1,885,943	10	188,594	10	188,594	10	188,594	2,451,726	10	272,414	2,724,139	3,268,968
5	BacNinh	726	100	726	200	145,255	10	14,525	10	14,525	10	14,525	188,831	10	20,981	209,812	251,775
6	BacGiang	439	100	439	200	87,814	10	8,781	10	8,781	10	8,781	114,159	10	12,684	126,843	152,212
7	HaiDuong	973	100	973	200	194,695	10	19,470	10	19,470	10	19,470	253,104	10	28,123	281,227	337,473
8	HaiPhong*	2,100	100	2,100	250	525,000	10	52,500	-	397,096	10	52,500	1,038,636	10	115,404	1,142,500	1,371,000
9	ThaiBinh	521	100	521	200	104,235	10	10,423	10	10,423	10	10,423	135,505	10	15,056	150,561	180,674
10	HungYen	410	100	410	200	81,980	10	8,198	10	8,198	10	8,198	106,574	10	11,842	118,416	142,100
11	HaNam	225	100	225	200	45,050	10	4,505	10	4,505	10	4,505	58,565	10	6,507	65,072	78,087
12	NamDinh	967	100	967	200	193,432	10	19,343	10	19,343	10	19,343	251,462	10	27,940	279,402	335,283
13	NinhBinh	484	100	484	200	96,776	10	9,678	10	9,678	10	9,678	125,809	10	13,979	139,788	167,746
14	LaiChau	160	100	160	200	32,058	10	3,206	10	3,206	10	3,206	41,676	10	4,631	46,306	55,568
15	LaoCai	392	100	392	200	78,432	10	7,843	10	7,843	10	7,843	101,961	10	11,329	113,290	135,948
16	HaGiang	275	100	275	200	55,095	10	5,509	10	5,509	10	5,509	71,623	10	7,958	79,581	95,498
17	CaoBang	260	100	260	200	51,967	10	5,197	10	5,197	10	5,197	67,557	10	7,506	75,063	90,076
18	DienBien	221	100	221	200	44,208	10	4,421	10	4,421	10	4,421	57,470	10	6,386	63,856	76,628
19	SonLa	447	100	447	200	89,438	10	8,944	10	8,944	10	8,944	116,270	10	12,919	129,189	155,027
20	YenBai	434	100	434	200	86,732	10	8,673	10	8,673	10	8,673	112,751	10	12,528	125,279	150,336
21	TuyenQuang	284	100	284	200	56,719	10	5,672	10	5,672	10	5,672	73,734	10	8,193	81,927	98,313
22	BacKan	142	100	142	200	28,449	10	2,845	10	2,845	10	2,845	36,984	10	4,109	41,094	49,313
23	LangSon	423	100	423	200	84,567	10	8,457	10	8,457	10	8,457	109,936	10	12,215	122,152	146,582
24	QuangNinh	1,255	100	1,255	200	251,017	10	25,102	10	25,102	10	25,102	326,322	10	36,258	362,580	435,097
25	HoaBinh	354	100	354	200	70,853	10	7,085	10	7,085	10	7,085	92,109	10	10,234	102,343	122,812
26	ThanhHoa	1,069	100	1,069	200	213,702	10	21,370	10	21,370	10	21,370	277,812	10	30,868	308,680	370,417
27	NgheAn	1,128	100	1,128	200	225,611	10	22,561	10	22,561	10	22,561	293,294	10	32,588	325,882	391,059
28	HaTinh	552	100	552	200	110,370	10	11,037	10	11,037	10	11,037	143,480	10	15,942	159,423	191,308
29	QuangBinh	384	100	384	200	76,747	10	7,675	10	7,675	10	7,675	99,772	10	11,086	110,857	133,029
30	QuangTri	504	100	504	200	100,806	10	10,081	10	10,081	10	10,081	131,048	10	14,561	145,609	174,731
31	ThuaThienHue	1,176	100	1,176	200	235,295	10	23,529	10	23,529	10	23,529	305,883	10	33,987	339,870	407,844
32	DaNang*	2,300	100	2,300	250	575,000	10	57,500	10	57,500	10	57,500	747,500	10	83,056	830,556	996,667

Source: JICA Survey Team

Table 2.2.8 Water Demand by Urban Area of Each Province in 2050 (2/2)

No.	Province	Population in 2050	Domestic Water ①				For Public Purpose②		For Production and Business Purpose ③		For Industrial Purpose ④		Sub Total Water Demand ⑤ (①+②+③+④)	NRW ⑥		Total Water Demand ⑦ ⑤+⑥ (Daily Avg.)	Total Water Demand (⑦×1.2) (Daily Max.)
			Coverage Ratio	Supplied Population	Unit Domestic Water Demand	Total Domestic Water Demand	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose		Rate	Amount		
Unit		1,000 pers.	%	1,000 pers.	L/pers./day	m^3/day	%	m^3/day	%	m^3/day	%	m^3/day	m^3/day	%	m^3/day	m^3/day	m^3/day
33	QuangNam	794	100	794	200	158,788	10	15,879	10	15,879	10	15,879	206,424	10	22,936	229,360	275,233
34	KonTum	435	100	435	200	87,033	10	8,703	10	8,703	10	8,703	113,142	10	12,571	125,714	150,857
35	QuangNgai	535	100	535	200	107,061	10	10,706	10	10,706	10	10,706	139,180	10	15,464	154,644	185,574
36	GiaLai	1,101	100	1,101	200	220,138	10	22,014	10	22,014	10	22,014	286,179	10	31,798	317,976	381,572
37	BinhDinh	1,241	100	1,241	200	248,106	10	24,811	10	24,811	10	24,811	322,538	10	35,838	358,375	430,051
38	PhuYen	598	100	598	200	119,572	10	11,957	10	11,957	10	11,957	155,444	10	17,272	172,715	207,259
39	DakLak	1,252	100	1,252	200	250,452	10	25,045	10	25,045	10	25,045	325,587	10	36,176	361,763	434,117
40	KhanhHoa	1,318	100	1,318	200	263,521	10	26,352	10	26,352	10	26,352	342,578	10	38,064	380,642	456,771
41	LamDong	1,355	100	1,355	200	270,902	10	27,090	10	27,090	10	27,090	352,172	10	39,130	391,302	469,563
42	NinhThuan	614	100	614	200	122,760	10	12,276	10	12,276	10	12,276	159,588	10	17,732	177,320	212,784
43	BinhThuan	1,339	100	1,339	200	267,802	10	26,780	10	26,780	10	26,780	348,143	10	38,683	386,826	464,191
44	DakNong	218	100	218	200	43,546	10	4,355	10	4,355	10	4,355	56,610	10	6,290	62,900	75,481
45	BinhPhuoc	441	100	441	200	88,296	10	8,830	10	8,830	10	8,830	114,784	10	12,754	127,538	153,046
46	DongNai	2,494	100	2,494	200	498,798	10	49,880	10	49,880	10	49,880	648,437	10	72,049	720,486	864,584
47	BaRiaVungTau	1,202	100	1,202	200	240,374	10	24,037	10	24,037	10	24,037	312,486	10	34,721	347,206	416,648
48	TayNinh	500	100	500	200	100,024	10	10,002	10	10,002	10	10,002	130,032	10	14,448	144,479	173,376
49	BinhDuong	1,362	100	1,362	200	272,465	10	27,247	10	27,247	10	27,247	354,205	10	39,356	393,561	472,274
50	HoChiMinhcity	9,046	100	9,046	250	2,261,468	10	226,147	10	226,147	10	226,147	2,939,908	10	326,656	3,266,565	3,919,878
51	LongAn	756	100	756	200	151,149	10	15,115	10	15,115	10	15,115	196,494	10	21,833	218,326	261,992
52	TienGiang	689	100	689	200	137,736	10	13,774	10	13,774	10	13,774	179,057	10	19,895	198,953	238,744
53	BenTre	378	100	378	200	75,605	10	7,560	10	7,560	10	7,560	98,286	10	10,921	109,207	131,049
54	DongThap	890	100	890	200	178,035	10	17,803	10	17,803	10	17,803	231,445	10	25,716	257,161	308,594
55	VinhLong	472	100	472	200	94,370	10	9,437	10	9,437	10	9,437	122,682	10	13,631	136,313	163,576
56	TraVinh	462	100	462	200	92,446	10	9,245	10	9,245	10	9,245	120,179	10	13,353	133,533	160,240
57	AnGiang	1,834	100	1,834	200	366,716	10	36,672	10	36,672	10	36,672	476,730	10	52,970	529,700	635,641
58	CanTho	1,570	100	1,570	250	392,534	10	39,253	10	39,253	10	39,253	510,294	10	56,699	566,993	680,393
59	HauGiang	450	100	450	200	90,040	10	9,004	10	9,004	10	9,004	117,052	10	13,006	130,058	156,070
60	SocTrang	754	100	754	200	150,728	10	15,073	10	15,073	10	15,073	195,947	10	21,772	217,718	261,263
61	KienGiang	1,365	100	1,365	200	273,067	10	27,307	10	27,307	10	27,307	354,987	10	39,443	394,430	473,316
62	BacLieu	678	100	678	200	135,691	10	13,569	10	13,569	10	13,569	176,399	10	19,600	195,999	235,199
63	CaMau	774	100	774	200	154,818	10	15,482	10	15,482	10	15,482	201,263	10	22,363	223,626	268,352
Total		65,234	-	65,234	-	14,174,883	-	1,417,488	-	1,762,084	-	1,417,488	18,783,485	-	2,087,054	20,858,998	25,030,831

Source: JICA Survey Team

Table 2.2.9 Water Demand by Capital City in 2050 (1/2)

No.	Province	Capital City	Population of Capital in 2050	Domestic Water ①				For Public Purpose②		For Production and Business Purpose ③		For Industrial Purpose ④		Sub Total Water Demand ⑤ (①+②+③+④)	NRW ⑥		Total Water Demand ⑦ ⑤+⑥ (Daily Avg.)	Total Water Demand (⑦×1.2) (Daily Max.)
				Coverage Ratio	Supplied Population	Unit Domestic Water Demand	Total Domestic Water Demand	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose		Rate	Amount		
Unit			1,000 pers.	%	1,000 pers.	L/pers./day	m^3/day	%	m^3/day	%	m^3/day	%	m^3/day	m^3/day	%	m^3/day	m^3/day	m^3/day
1	PhuTho	Viet Tri	477	100	477	200	95,337	10	9,534	10	9,534	10	9,534	123,938	10	13,771	137,709	165,251
2	VinhPhuc	Vinh Yen	243	100	243	200	48,676	10	4,868	10	4,868	10	4,868	63,279	10	7,031	70,309	84,372
3	ThaiNguyen	Thai Nguyen	717	100	717	200	143,337	10	14,334	10	14,334	10	14,334	186,339	10	20,704	207,043	248,452
4	BacNinh	Bac Ninh	424	100	424	200	84,817	10	8,482	10	8,482	10	8,482	110,263	10	12,251	122,514	147,017
5	BacGiang	Bac Giang	261	100	261	200	52,206	10	5,221	10	5,221	10	5,221	67,868	10	7,541	75,409	90,491
6	HaiDuong	Hai Duong	550	100	550	200	110,003	10	11,000	10	11,000	10	11,000	143,004	10	15,889	158,893	190,672
7	ThaiBinh	Thai Binh	472	100	472	200	94,458	10	9,446	10	9,446	10	9,446	122,795	10	13,644	136,439	163,727
8	HungYen	Hung Yen	213	100	213	200	42,658	10	4,266	10	4,266	10	4,266	55,456	10	6,162	61,618	73,942
9	HaNam	Phu Ly	211	100	211	200	42,271	10	4,227	10	4,227	10	4,227	54,952	10	6,106	61,058	73,270
10	NamDinh	Nam Dinh	628	100	628	200	125,536	10	12,554	10	12,554	10	12,554	163,196	10	18,133	181,329	217,596
11	NinhBinh	Ninh Binh	285	100	285	200	57,063	10	5,706	10	5,706	10	5,706	74,181	10	8,242	82,424	98,909
12	LaiChau	Lai Chau	69	100	69	200	13,786	10	1,379	10	1,379	10	1,379	17,922	10	1,991	19,913	23,896
13	LaoCai	Lao Cai	254	100	254	200	50,776	10	5,078	10	5,078	10	5,078	66,009	10	7,334	73,343	88,013
14	HaGiang	Ha Giang	117	100	117	200	23,377	10	2,338	10	2,338	10	2,338	30,390	10	3,377	33,767	40,521
15	CaoBang	Cao Bang	140	100	140	200	28,007	10	2,801	10	2,801	10	2,801	36,409	10	4,045	40,455	48,546
16	DienBien	Dien Bien Phu	124	100	124	200	24,789	10	2,479	10	2,479	10	2,479	32,225	10	3,581	35,806	42,967
17	SonLa	Son La	237	100	237	200	47,347	10	4,735	10	4,735	10	4,735	61,551	10	6,839	68,390	82,069
18	YenBai	Yen Bai	234	100	234	200	46,888	10	4,689	10	4,689	10	4,689	60,955	10	6,773	67,727	81,273
19	TuyenQuang	Tuyen Quang	230	100	230	200	46,052	10	4,605	10	4,605	10	4,605	59,867	10	6,652	66,519	79,824
20	BacKan	Bac Kan	96	100	96	200	19,193	10	1,919	10	1,919	10	1,919	24,951	10	2,772	27,723	33,268
21	LangSon	Lang Son	225	100	225	200	45,054	10	4,505	10	4,505	10	4,505	58,570	10	6,508	65,078	78,094
22	QuangNinh	Ha Long	565	100	565	200	112,963	10	11,296	10	11,296	10	11,296	146,852	10	16,317	163,169	195,803
23	HoaBinh	Hoa Binh	214	100	214	200	42,887	10	4,289	10	4,289	10	4,289	55,753	10	6,195	61,948	74,338
24	ThanhHoa	Thanh Hoa	536	100	536	200	107,216	10	10,722	10	10,722	10	10,722	139,381	10	15,487	154,868	185,842
25	NgheAn	Vinh	784	100	784	200	156,781	10	15,678	10	15,678	10	15,678	203,815	10	22,646	226,462	271,754
26	HaTinh	Ha Tinh	230	100	230	200	45,921	10	4,592	10	4,592	10	4,592	59,697	10	6,633	66,330	79,596
27	QuangBinh	Dong Hoi	287	100	287	200	57,372	10	5,737	10	5,737	10	5,737	74,584	10	8,287	82,871	99,446
28	QuangTri	Dong Ha	212	100	212	200	42,304	10	4,230	10	4,230	10	4,230	54,995	10	6,111	61,106	73,328
29	ThuaThienHue	Hué	866	100	866	200	173,228	10	17,323	10	17,323	10	17,323	225,197	10	25,022	250,218	300,263

Source: JICA Survey Team

Table 2.2.9 Water Demand by Capital City in 2050 (2/2)

No.	Province	Capital City	Population of Capital in 2050	Domestic Water ①				For Public Purpose②		For Production and Business Purpose ③		For Industrial Purpose ④		Sub Total Water Demand ⑤ (①+②+③+④)	NRW ⑥		Total Water Demand ⑦ ⑤+⑥ (Daily Avg.)	Total Water Demand (⑦×1.2) (Daily Max.)
				Coverage Ratio	Supplied Population	Unit Domestic Water Demand	Total Domestic Water Demand	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose	Percentage of Based Date	Total Demand for Puplic Purpose		Rate	Amount		
Unit			1,000 pers.	%	1,000 pers.	L/pers./day	m^3/day	%	m^3/day	%	m^3/day	%	m^3/day	m^3/day	%	m^3/day	m^3/day	m^3/day
30	QuangNam	Tam Ky	279	100	279	200	55,712	10	5,571	10	5,571	10	5,571	72,425	10	8,047	80,473	96,568
31	KonTum	Kon Tum	369	100	369	200	73,870	10	7,387	10	7,387	10	7,387	96,030	10	10,670	106,700	128,041
32	QuangNgai	Quang Ngai	290	100	290	200	58,014	10	5,801	10	5,801	10	5,801	75,418	10	8,380	83,798	100,558
33	GiaLai	Pleiku	538	100	538	200	107,700	10	10,770	10	10,770	10	10,770	140,009	10	15,557	155,566	186,680
34	BinhDinh	Qui Nhon	724	100	724	200	144,816	10	14,482	10	14,482	10	14,482	188,260	10	20,918	209,178	251,014
35	PhuYen	Tuy Hoa	393	100	393	200	78,523	10	7,852	10	7,852	10	7,852	102,079	10	11,342	113,422	136,106
36	DakLak	Buon Ma Thuot	842	100	842	200	168,355	10	16,836	10	16,836	10	16,836	218,862	10	24,318	243,180	291,816
37	KhanhHoa	Nha Trang	1,012	100	1,012	200	202,499	10	20,250	10	20,250	10	20,250	263,249	10	29,250	292,499	351,000
38	LamDong	Da Lat	530	100	530	200	105,972	10	10,597	10	10,597	10	10,597	137,763	10	15,307	153,070	183,685
39	NinhThuan	Phan Rang-Thap Cham	417	100	417	200	83,487	10	8,349	10	8,349	10	8,349	108,533	10	12,059	120,592	144,711
40	BinhThuan	Phan Thiet	558	100	558	200	111,671	10	11,167	10	11,167	10	11,167	145,172	10	16,130	161,302	193,563
41	DakNong	Gia Nghia	108	100	108	200	21,572	10	2,157	10	2,157	10	2,157	28,043	10	3,116	31,159	37,391
42	BinhPhuoc	Dong Xoai	207	100	207	200	41,348	10	4,135	10	4,135	10	4,135	53,753	10	5,973	59,725	71,671
43	DongNai	Bien Hoa	1,810	100	1,810	200	361,965	10	36,197	10	36,197	10	36,197	470,555	10	52,284	522,839	627,407
44	BaRiaVungTau	Vung Tau	765	100	765	200	152,921	10	15,292	10	15,292	10	15,292	198,798	10	22,089	220,886	265,064
45	TayNinh	Tay Ninh	324	100	324	200	64,837	10	6,484	10	6,484	10	6,484	84,288	10	9,365	93,653	112,384
46	BinhDuong	Thu Dau Mot	575	100	575	200	115,035	10	11,504	10	11,504	10	11,504	149,546	10	16,616	166,162	199,395
47	LongAn	Tan An	342	100	342	200	68,434	10	6,843	10	6,843	10	6,843	88,965	10	9,885	98,850	118,620
48	TienGiang	My Tho	468	100	468	200	93,624	10	9,362	10	9,362	10	9,362	121,711	10	13,523	135,235	162,282
49	BenTre	Ben Tre	300	100	300	200	59,932	10	5,993	10	5,993	10	5,993	77,911	10	8,657	86,568	103,882
50	DongThap	Cao Lanh	416	100	416	200	83,261	10	8,326	10	8,326	10	8,326	108,239	10	12,027	120,266	144,320
51	VinhLong	Vinh Long	353	100	353	200	70,512	10	7,051	10	7,051	10	7,051	91,665	10	10,185	101,850	122,221
52	TraVinh	Tra Vinh	255	100	255	200	50,950	10	5,095	10	5,095	10	5,095	66,235	10	7,359	73,594	88,313
53	AnGiang	Long Xuyen	719	100	719	200	143,847	10	14,385	10	14,385	10	14,385	187,001	10	20,778	207,779	249,335
54	HauGiang	Vi Thanh	184	100	184	200	36,856	10	3,686	10	3,686	10	3,686	47,913	10	5,324	53,237	63,884
55	SocTrang	Soc Trang	351	100	351	200	70,214	10	7,021	10	7,021	10	7,021	91,279	10	10,142	101,421	121,705
56	KienGiang	Rach Gia	584	100	584	200	116,827	10	11,683	10	11,683	10	11,683	151,875	10	16,875	168,750	202,501
57	BacLieu	Bac Lieu	382	100	382	200	76,325	10	7,632	10	7,632	10	7,632	99,222	10	11,025	110,247	132,297
58	CaMau	Ca Mau	558	100	558	200	111,603	10	11,160	10	11,160	10	11,160	145,084	10	16,120	161,205	193,446
Total			24,555	-	24,555	-	4,910,983	-	491,098	-	491,098	-	491,098	6,384,278	-	709,364	7,093,643	8,512,400

Source: JICA Survey Team

(3) Estimation of Water Demand in WholeUrban Areas of Vietnam in 2050

Water demand in 2050 in the whole of Vietnam is estimated at 25,030,831 m^3/day as shown in Table 2.2.10.

Water demand of the five centrally-run cities in 2050 is 10,236,906 m^3/day which accounts for 40.9% of water demand in all urban areas of Vietnam in 2050. It is a 21.5% increase from 2025. In spite of the increase in water demand per capita and decrease of NRW ratio in 2050 as compared with 2025, the estimated water demand of the five centrally-run cities in 2050 has very little increase than the 82.0% increase rate in all urban areas. The result is caused by a small population increase in the five centrally-run cities from 2025 to 2050 as compared with other provinces and, in addition, the overestimated water demand of each M/P of the five centrally-run cities in 2025. The population in the five centrally-run cities in 2050 is estimated at 21,246,000 people as presented in Table 2.1.4, with an increase of 4,669,000 people from 2025, and an increase rate of 28.2%. In the same period, the population in all urban areas except the five centrally-run cities is estimated to increase from 24,166,000 to 42,674,000 people with an increase rate of 76.6%.

Water demand in all urban areas except the five centrally-run cities in 2050 is estimated at 14,793,925 m^3/day which accounts for 59.1% of water demand in all urban areas of Vietnam in 2050. Water demand of the capital cities of all provinces and other urban areas in 2050 are estimated at 8,512,400 m^3/day and 6,281,525 m^3/day, respectively. They accounted for 34.0% and 25.1% of water demand in all urban areas of Vietnam, respectively. Also, they expressed the increase rate of 151.3% and 224.8%, respectively, as compared with those of 2025. The result is caused by the increase in unit water demand for daily life per capita from 120 to 200 L/day/capita and the increase in population from 24,165,000 to 42,675,000 people despite the decrease of NRW from 15% to 10%.

From this survey results, the JICA Survey Team recognized that it is necessary to invest intensively in the improvement of urban areas except for the five centrally-run cities from 2025 to 2050.

Table 2.2.10 Water Demand in All Urban Areas of Vietnam in 2050

No.	Area \ Water Demand		Water Demand*			Percentage (%)
			2025 (a) (m^3/day)	2050 (b) (m^3/day)	Increase Rate ((b-a)/a) (%)	
1	Five centrally-run cities	Ha Noi City	2,359,000	3,268,968	38.6	13.1
		HCMC	3,570,000	3,919,878	9.8	15.7
		Hai Phong City	1,371,000	1,371,000	0.0	5.5
		Da Nang City	680,000	996,667	46.6	4.0
		Can Tho City	448,660	680,393	51.7	2.7
		Subtotal	8,428,660	10,236,906	21.5	40.9
2	All provincial urban areas except for the five centrally-run cities	Capital cities	3,387,974	8,512,400	151.3	34.0
		Urban areas except for the capital cities (Above Grade V)	1,934,144	6,281,525	224.8	25.1
		Subtotal	5,322,118	14,793,925	178.0	59.1
Total			13,750,778	25,030,831	82.0	100.0

*Water demand means maximum water demand.
Source: JICA Survey Team

2.2.5 Estimation of Unit Cost for Water Supply Improvement

Unit cost for improving the water supply system is estimated through analysis of the references collected such as decisions of the government, F/S reports, design reports, and websites of WSCs. But, because of the difficulties in collecting sufficient cost information, there are not enough information collected to estimate the unit cost in detail. Based on the analyzed information, construction costs of WTP and pipe system are estimated in this Survey.

All construction costs are converted to the value as of 2013 based on the condition written in Table 2.2.11. In addition, the construction cost is composed of foreign and local portions. The ratio of foreign and local portions against the total construction cost, applied in the calculation, is 30% and 70%, respectively.

Table 2.2.11 Foreign and Local Inflation Rate Used for Estimation of Construction Cost in Each Year

Item	2010	2011	2012	2013	After 2013	Reference
Foreign inflation rate (%)	1.5	0.7	0	0.5	0.5	Hai Phong Water Supply Project, ADB
Local inflation rate (%)	10	8	6	6	6	

Source: Hai Phong Water Supply Project Final Report, 2011, ADB

(1) Construction Cost of WTP

The estimated unit construction cost for a small-capacity WTP which ranges from 10,000 to 30,000 m^3/day is about USD 274/m^3, and that of a large scale which ranges from 300,000 to 500,000 m^3/day is about USD 138/m^3 at 2013 prices as shown in Table 2.2.12.

Table 2.2.12 Unit Cost for WTP Construction at 2013 Prices

No.	Capacity (m^3/day)	Const. Cost (USD)	Unit Cost (USD/m^3)	Name of Project	Province or City	Investment Source
I. Small Capacity (10,000 - 30,000 m^3/day)						
1	25,000	8,078,808	323	Kim Son WTP	Hai Phong City	ADB, Owned
2	25,000	6,979,662	279	Cam River WTP		
3	25,000	7,022,841	281	Hung Dao WTP		
4	10,000	2,997,128	300	Thot Not WTP	Can Tho City	South Korea EDCF, Owned
5	25,000	6,209,573	248	WTP No. 2	Bac Giang City	ADB, Owned
6	30,000	7,010,033	234	Dau Mot WTP	Bing Duong Province	Danish Loan, Owned
7	25,000	6,295,366	252	Nam Nui Coc WTP	Thai Nguyen Province	ADB (MFF), Owned
Average			274			
II. Large Capacity (300,000 - 500,000 m^3/day)						
1	300,000	42,000,000	140	Thu Duc WTP Phase 3	Ho Chi Minh City	Partnership
2	300,000	32,444,053	108	Thu Duc WTP Phase 4		
3	500,000	81,110,133	162	Thu Duc WTP Phase 5		
4	300,000	50,000,000	167	Than Hiep WTP		
5	300,000	34,032,224	113	Than Hiep WTP		
Average			138			

MFF: Multi-tranche Financing Facility
EDCF: Economic Development Cooperation Fund
Source: JICA Survey Team

(2) Construction Cost of the Pipe System

For the construction cost of the pipe system, unit cost per distribution capacity is applied in this Survey.

Table 2.2.13 Unit Cost for Pipe Construction at 2013 Prices

No.	Distribution Capacity	Pipe Length*	Construction Cost	Unit Cost		Name of Project	Province or City
	(m^3/day)	(km)	(USD)	(USD/m)	(USD/Dis. Cap. m^3)		
1	25,000	21	6,257,192	298	250	Kim Sơn WTP	Hai Phong City
2	25,000	18	8,057,338	448	322	Cam River WTP	
3	25,000	5	2,923,538	585	117	Hung Dao WTP	
4	25,000	22	6,772,159	308	271	WTP No. 2	Bac Giang City
5	10,000	7	1,740,872	249	174	Thot Not WTP	Can Tho City
6	30,000	90	14,101,619	157	470	Dau Mot WTP	Bing Duong Province
7	25,000	18	6,822,396	379	273	Nam Nui Coc WTP	Thai Nguyen Province
Average				346	268		

*: Including raw water and clean water transmission pipe system, and distribution pipe system.
Source: JICA Survey Team

(3) Unit Construction Cost Including WTP and Pipe System

The unit construction cost including WTP and pipe system is set by using the data shown in Table 2.2.12 and Table 2.2.13. Estimated average unit construction cost including WTP and pipe system is USD 406/m^3 for the five centrally-run cities which consists of unit costs for WTP (USD 138/m^3) and pipe system (USD 268/m^3), and USD 542/m^3 for other cities except for the five centrally-run cities which consists of the unit costs for WTP (USD 274/m^3) and the pipe system (USD 268/m^3).

2.2.6 Estimation of Financial Needs

(1) Estimation Conditions of Financial Needs for New Construction of WTP and Pipe System

For the estimation of the construction cost of the new WTP, USD 274/m^3 estimated in Section 2.2.5 was applied for all urban areas except the five centrally-run cities, and USD 138/m^3 was applied for the five centrally-run cities. As large WTP is considered to be needed in the five centrally-run cities, USD 138/m^3 was used. Moreover, as small WTP is considered to be needed in all urban areas except the five centrally-run cities, USD 274/m^3 was applied.

But, for the estimation of pipe system, there were no valuable data in a large-scale project, the JICA Survey Team applied USD 346/m, and USD 268/m^3 estimated in Section 2.2.5 for all the estimation.

In some provinces shown in Table 2.2.15, the incremental capacities, balance of the estimated water demand in 2025, and existing capacity are calculated as “none”. This means that the existing capacity of WTP is enough to satisfy water demand in 2025, whereas distribution pipe system will be needed to improve coverage ratio toward 100%. Financial needs for the improvement of the distribution pipe system is estimated through the following methods:

Financial needs of the distribution pipe system (USD)

= Unit cost for construction of the distribution pipe system (USD/m^3)

x Existing capacity (m^3) x (100-current coverage ratio (%)) / 100

(2) Estimation Conditions of the Financial Needs for the Rehabilitation of WTP and Pipe System

Renewal of the concrete structure of WTP was not considered for estimation of financial needs for renewal in this Survey because the depreciation period is typically more than 50 years. The JICA Survey Team assumed that there will be no renewals of the concrete structure of WTPs until 2050 in all urban areas of Vietnam.

The JICA Survey Team considered the renewal of the equipment of existing WTPs only with the conditions below until 2025.

Necessary renewal capacity	: 50% of existing WTPs
Number of renewal	: 1 time/period
Range of renewal	: Equipment only
Installment cost of equipment	: 30% of construction cost of the whole New WTP

Also, the JICA Survey Team considered the renewal of the equipment of existing WTPs only with the same conditions from 2026 to 2050.

The JICA Survey Team considered the renewal of pipe system to decrease NRW ratio. According to the report of WB and MoF, the average NRW ratio in all urban areas of Vietnam was 27.8% in 2011 as shown in Table 2.1.14, on the contrary, the target NRW ratios are 15% and 10% in 2025 and 2050, respectively. The ratios of pipeline length to be renewed for NRW mitigation against the existing pipeline are set at 5% until 2025 and 10% from 2026 to 2050. However, the survey cost of pipe system conditions for efficient renewal is not included in the estimation.

(3) Financial Needs for New Construction and Renewal of Existing Facilities until 2025

Financial needs for the accomplishment of 100% coverage ratio of the water supply sector in the whole urban area of Vietnam until 2025 is estimated at about USD 3,749 million at 2013 prices. Financial needs for new WTPs and pipe system are estimated at USD 1,481 million and USD 2,267 million, respectively, as shown in Table 2.2.14. However, financial needs in Ha Noi, Da Nang, and Can Tho are estimated as the needs of 2030, because the necessary capacity of these cities is cited from the existing M/Ps. Details of all provinces are described in Table 2.2.15. .

Financial needs for the renewal of WTPs in the whole urban area of Vietnam until 2025 is estimated at about USD 201 million. Also, financial needs for the renewal of the pipe system to reduce NRW ratio is estimated at about USD 854 million.

Financial needs for the accomplishment of 100% coverage ratio and renewal of WTPs as well as pipe system in the whole urban area of Vietnam until 2025 is estimated at USD 4,805 million.

Total financial needs including new construction and renewal for the five centrally-run cities is estimated at USD 2,640 million accounting for about 55%, and that of the other provinces except the five centrally-run cities is estimated at USD 2,165 million as shown in Table 2.2.14.

Table 2.2.14 Financial Needs for New Construction and Renewal of Existing Facilities for the Five Centrally-run Cities and Other Provinces until 2025

(Unit:USD)

City/Province \ Financial needs			Financial needs For Improving Coverage ratio			Financial needs For Renewal of Existing Facilities			Total Financial needs
			For WTP	For Pipe System	For WTP + Pipe System	For WTP	For Pipe System	For WTP + Pipe System	
1	5 Centrally-run Cities	HaNoi	251,436,000	488,296,000	739,732,000	14,904,000	54,045,200	68,949,200	808,681,200
		HoChiMinhcity	221,628,000	430,408,000	652,036,000	43,988,742	78,407,060	122,395,802	774,431,802
		HaiPhong	179,538,000	348,668,000	528,206,000	4,143,105	36,589,154	40,732,259	568,938,259
		DaNang	92,046,000	178,756,000	270,802,000	1,656,000	69,390,265	71,046,265	341,848,265
		CanTho	45,264,000	87,904,000	133,168,000	3,187,800	10,258,900	13,446,700	146,614,700
		Sub Total	789,912,000	1,534,032,000	2,323,944,000	67,879,647	248,690,579	316,570,226	2,640,514,226
2	The other provinces		691,576,000	733,710,151	1,425,286,151	133,493,458	605,897,635	739,391,093	2,164,677,244
Total			1,481,488,000	2,267,742,151	3,749,230,151	201,373,105	854,588,215	1,055,961,319	4,805,191,471

Source: JICA Survey Team

Table 2.2.15 Financial Needs for New Construction and Renewal of Existing Facilities in All Urban Areas of Vietnam until 2025

No.	Province	Population in 2025	Water Demand in 2025 (Daily Max.)	Existing WTP Capacity	Existing Pipe System Length	Neccesary Capacity for Improving Coverage Ratio ①	WTP capacity for Construction ② (①/0.9)	Financial needs						Total Financial Needs
								For Improving Coverage ratio			For Renewal of Existing Facilities			
								For WTP	For Pipe System	For WTP + Pipe System	For WTP	For Pipe System	For WTP + Pipe System	
Unit		1,000 pers.	m^3/day	m^3/day	km	m^3/day	m^3/day	USD	USD	USD	USD	USD	USD	USD
1	PhuTho	347	76,516	80,000	1500.0	0	0	0	10,789,109	10,789,109	3,288,000	25,950,000	29,238,000	40,027,109
2	VinhPhuc	374	82,424	46,000	147.9	36,424	41,000	11,234,000	10,988,000	22,222,000	1,890,600	2,559,016	4,449,616	26,671,616
3	ThaiNguyen	480	105,617	60,600	578.7	45,017	51,000	13,974,000	13,668,000	27,642,000	2,490,660	10,011,510	12,502,170	40,144,170
4	HaNoi	4,420	2,359,000	720,000	3124.0	1,639,000	1,822,000	251,436,000	488,296,000	739,732,000	14,904,000	54,045,200	68,949,200	808,681,200
5	BacNinh	402	88,626	30,200	130.1	58,426	65,000	17,810,000	17,420,000	35,230,000	1,241,220	2,250,038	3,491,258	38,721,258
6	BacGiang	243	53,580	25,000	78.1	28,580	32,000	8,768,000	8,576,000	17,344,000	1,027,500	1,351,130	2,378,630	19,722,630
7	HaiDuong	539	118,792	81,980	349.0	36,812	41,000	11,234,000	10,988,000	22,222,000	3,369,378	6,037,700	9,407,078	31,629,078
8	HaiPhong	1,414	1,371,000	200,150	2115.0	1,170,850	1,301,000	179,538,000	348,668,000	528,206,000	4,143,105	36,589,154	40,732,259	568,938,259
9	ThaiBinh	289	63,598	66,500	126.0	0	0	0	2,943,511	2,943,511	2,733,150	2,179,800	4,912,950	7,856,461
10	HungYen	227	50,020	5,000	102.6	45,020	51,000	13,974,000	13,668,000	27,642,000	205,500	1,774,548	1,980,048	29,622,048
11	HaNam	125	27,487	25,000	112.0	2,487	3,000	822,000	804,000	1,626,000	1,027,500	1,937,600	2,965,100	4,591,100
12	NamDinh	536	118,021	85,000	1194.9	33,021	37,000	10,138,000	9,916,000	20,054,000	3,493,500	20,671,770	24,165,270	44,219,270
13	NinhBinh	268	59,048	44,900	426.0	14,148	16,000	4,384,000	4,288,000	8,672,000	1,845,390	7,369,800	9,215,190	17,887,190
14	LaiChau	89	19,561	13,732	139.4	5,829	7,000	1,918,000	1,876,000	3,794,000	564,385	2,411,447	2,975,832	6,769,832
15	LaoCai	217	47,855	47,000	294.2	855	1,000	274,000	3,890,429	4,164,429	1,931,700	5,089,314	7,021,014	11,185,443
16	HaGiang	153	33,616	7,500	107.1	26,116	30,000	8,220,000	8,040,000	16,260,000	308,250	1,853,072	2,161,322	18,421,322
17	CaoBang	144	31,708	14,590	130.0	17,118	20,000	5,480,000	5,360,000	10,840,000	599,649	2,249,000	2,848,649	13,688,649
18	DienBien*	122	26,974	10,000	100.0	16,974	19,000	5,206,000	5,092,000	10,298,000	411,000	1,730,000	2,141,000	12,439,000
19	SonLa	248	54,570	47,400	1050.0	7,170	8,000	2,192,000	2,144,000	4,336,000	1,948,140	18,165,000	20,113,140	24,449,140
20	YenBai	240	52,919	15,000	395.0	37,919	43,000	11,782,000	11,524,000	23,306,000	616,500	6,833,500	7,450,000	30,756,000
21	TuyenQuang	157	34,607	24,900	456.4	9,707	11,000	3,014,000	2,948,000	5,962,000	1,023,390	7,895,807	8,919,197	14,881,197
22	BacKan	79	17,359	7,100	44.5	10,259	12,000	3,288,000	3,216,000	6,504,000	291,810	770,334	1,062,144	7,566,144
23	LangSon*	234	51,598	20,000	100.0	31,598	36,000	9,864,000	9,648,000	19,512,000	822,000	1,730,000	2,552,000	22,064,000
24	QuangNinh	990	218,097	149,539	1271.4	68,558	77,000	21,098,000	20,636,000	41,734,000	6,146,053	21,995,220	28,141,273	69,875,273
25	HoaBinh	196	43,231	30,800	345.0	12,431	14,000	3,836,000	3,752,000	7,588,000	1,265,880	5,968,500	7,234,380	14,822,380
26	ThanhHoa	592	130,388	63,150	489.8	67,238	75,000	20,550,000	20,100,000	40,650,000	2,595,465	8,473,021	11,068,486	51,718,486
27	NgheAn	625	137,655	69,500	4369.0	68,155	76,000	20,824,000	20,368,000	41,192,000	2,856,450	75,583,700	78,440,150	119,632,150
28	HaTinh	306	67,341	38,600	1633.0	28,741	32,000	8,768,000	8,576,000	17,344,000	1,586,460	28,250,900	29,837,360	47,181,360
29	QuangBinh	213	46,827	29,700	206.0	17,127	20,000	5,480,000	5,360,000	10,840,000	1,220,670	3,563,800	4,784,470	15,624,470
30	QuangTri	279	61,506	49,500	443.7	12,006	14,000	3,836,000	3,752,000	7,588,000	2,034,450	7,675,751	9,710,201	17,298,201
31	ThuaThienHue	652	143,563	170,575	2212.9	0	0	0	12,615,899	12,615,899	7,010,633	38,282,305	45,292,938	57,908,837
32	DaNang	1,033	680,000	80,000	4011.0	600,000	667,000	92,046,000	178,756,000	270,802,000	1,656,000	69,390,265	71,046,265	341,848,265
33	QuangNam	440	96,883	37,500	577.0	59,383	66,000	18,084,000	17,688,000	35,772,000	1,541,250	9,982,100	11,523,350	47,295,350
34	KonTum	241	53,102	12,000	129.0	41,102	46,000	12,604,000	12,328,000	24,932,000	493,200	2,231,700	2,724,900	27,656,900
35	QuangNgai	297	65,323	49,500	100.0	15,823	18,000	4,932,000	4,824,000	9,756,000	2,034,450	1,730,000	3,764,450	13,520,450
36	GiaLai	610	134,315	24,500	100.0	109,815	123,000	33,702,000	32,964,000	66,666,000	1,006,950	1,730,000	2,736,950	69,402,950
37	BinhDinh	687	151,380	64,950	848.0	86,430	97,000	26,578,000	25,996,000	52,574,000	2,669,445	14,670,400	17,339,845	69,913,845
38	PhuYen	331	72,956	44,100	519.0	28,856	33,000	9,042,000	8,844,000	17,886,000	1,812,510	8,978,700	10,791,210	28,677,210
39	DakLak	694	152,811	62,000	267.0	90,811	101,000	27,674,000	27,068,000	54,742,000	2,548,200	4,619,100	7,167,300	61,909,300
40	KhanhHoa	768	169,178	97,000	1085.1	72,178	81,000	22,194,000	21,708,000	43,902,000	3,986,700	18,772,230	22,758,930	66,660,930
41	LamDong	751	165,288	106,360	415.2	58,928	66,000	18,084,000	17,688,000	35,772,000	4,371,396	7,182,960	11,554,356	47,326,356
42	NinhThuan	340	74,901	57,000	370.8	17,901	20,000	5,480,000	5,360,000	10,840,000	2,342,700	6,414,857	8,757,557	19,597,557
43	BinhThuan	766	168,628	35,200	370.8	133,428	149,000	40,826,000	39,932,000	80,758,000	1,446,720	6,414,857	7,861,577	88,619,577
44	DakNong	121	26,570	2,120	460.0	24,450	28,000	7,672,000	7,504,000	15,176,000	87,132	7,958,000	8,045,132	23,221,132
45	BinhPhuoc	245	53,873	15,200	14.6	38,673	43,000	11,782,000	11,524,000	23,306,000	624,720	252,753	877,473	24,183,473
46	DongNai	1,382	304,337	234,900	156.4	69,437	78,000	21,372,000	20,904,000	42,276,000	9,654,390	2,704,902	12,359,292	54,635,292
47	BaRiaVungTau	829	182,683	200,000	1034.0	0	0	0	11,157,435	11,157,435	8,220,000	17,888,200	26,108,200	37,265,635
48	TayNinh	277	61,029	26,500	332.8	34,529	39,000	10,686,000	10,452,000	21,138,000	1,089,150	5,757,890	6,847,040	27,985,040
49	BinhDuong	755	166,242	234,000	1817.4	0	0	0	3,280,585	3,280,585	9,617,400	31,441,539	41,058,939	44,339,524
50	HoChiMinhcity	8,400	3,570,000	2,125,060	4532.2	1,444,940	1,606,000	221,628,000	430,408,000	652,036,000	43,988,742	78,407,060	122,395,802	774,431,802
51	LongAn	419	92,223	40,000	170.0	52,223	59,000	16,166,000	15,812,000	31,978,000	1,644,000	2,941,000	4,585,000	36,563,000
52	TienGiang	382	84,039	137,860	337.0	0	0	0	12,869,183	12,869,183	5,666,046	5,830,100	11,496,146	24,365,329
53	BenTre	209	46,130	34,100	44.9	12,030	14,000	3,836,000	3,752,000	7,588,000	1,401,510	777,099	2,178,609	9,766,609
54	DongThap	493	108,626	80,500	937.2	28,126	32,000	8,768,000	8,576,000	17,344,000	3,308,550	16,213,387	19,521,937	36,865,937
55	VinhLong	261	57,580	42,100	682.4	15,480	18,000	4,932,000	4,824,000	9,756,000	1,730,310	11,805,901	13,536,211	23,292,211
56	TraVinh	256	56,405	25,760	316.2	30,645	35,000	9,590,000	9,380,000	18,970,000	1,058,736	5,470,260	6,528,996	25,498,996
57	AnGiang	1,016	223,748	22,500	2578.0	201,248	224,000	61,376,000	60,032,000	121,408,000	924,750	44,599,400	45,524,150	166,932,150
58	CanTho	1,310	448,660	154,000	593.0	294,660	328,000	45,264,000	87,904,000	133,168,000	3,187,800	10,258,900	13,446,700	146,614,700
59	HauGiang	249	54,937	22,500	473.0	32,437	37,000	10,138,000	9,916,000	20,054,000	924,750	8,182,900	9,107,650	29,161,650
60	SocTrang	418	91,966	53,800	584.8	38,166	43,000	11,782,000	11,524,000	23,306,000	2,211,180	10,117,230	12,328,410	35,634,410
61	KienGiang	757	166,609	57,100	1281.6	109,509	122,000	33,428,000	32,696,000	66,124,000	2,346,810	22,172,286	24,519,096	90,643,096
62	BacLieu	376	82,791	22,000	198.1	60,791	68,000	18,632,000	18,224,000	36,856,000	904,200	3,427,303	4,331,503	41,187,503
63	CaMau	429	94,461	48,200	290.0	46,261	52,000	14,248,000	13,936,000	28,184,000	1,981,020	5,017,000	6,998,020	35,182,020
Total		40,743	13,750,778	6,527,226	49398.2	7,395,846	8,248,000	1,481,488,000	2,267,742,151	3,749,230,151	201,373,105	854,588,215	1,055,961,319	4,805,191,471

* Existing capacities of Dien Bien and Lang Son are not available, thus in this estimation they are assumed 10,000 and 20,000 m3/day respectively. And also, existing pipe system length is assumed 100km in each province. Therefore the total of existing capacity and pipe system length are not equal to that shown in Table 2.1.16.
* In case of 5 centrally-run cities, necessary capacities are estimated according to their respective M/Ps.
Source: JICA Survey Team

(4) Financial Needs for New Construction and Renewal of Existing Facilities from 2026 until 2050

Financial needs for maintaining 100% coverage ratio due to population increase and unit water consumption increase in the whole urban area of Vietnam from 2026 to 2050 is estimated at about USD 6,062 million at 2013 prices. Financial needs for the new WTPs and pipe system are estimated at USD 2,963 million and USD 3,100 million, respectively, as shown in Table 2.2.16. But, in the case of Hai Phong, as the JICA Survey Team evaluated that estimated water demand in 2030 in the M/P was overestimated, therefore, construction of new WTPs and pipe system are not needed. Details of all the provinces are described in Table 2.2.17.

Financial needs for the renewal of WTPs in the whole urban area of Vietnam from 2026 to 2050 is estimated at about USD 424 million. Also, financial needs for the renewal of pipe system to reduce NRW ratio is estimated at about USD 1,925 million.

Total financial needs including new construction and renewal of WTPs as well as pipe system in the whole urban area of Vietnam from 2026 until 2050 is estimated at USD 8,411 million.

Total financial needs including new construction and renewal for the five centrally-run cities is estimated at USD 1,453 million accounting for about 17%, and that of the other provinces except the five centrally-run cities is estimated at USD 6,958 million as shown in Table 2.2.16. The low percentage of the five centrally-run cities and high percentage of the other provinces except the five centrally-run cities are caused by low increase rate of population in the five centrally-run cities and high increase rate of population in the other provinces except for the five centrally-run cities from 2026 to 2050.

Table 2.2.16 Financial Needs for New Construction and Renewal of Existing Facilities for the Five Centrally-run Cities and Other Provinces from 2026 to 2025

(Unit:USD)

City/Province \ Financial needs			Financial Needs for Improving Coverage Ratio			Financial Needs for Renewal of Existing Facilities			Total Financial needs
			For WTP	For Pipe System	For WTP + Pipe System	For WTP	For Pipe System	For WTP + Pipe System	
1	5 Centrally-run Cities	HaNoi	111,504,000	216,544,000	328,048,000	52,619,400	156,920,000	209,539,400	537,587,400
		HoChiMinhcity	28,980,000	56,280,000	85,260,000	77,232,942	199,854,920	277,087,862	362,347,862
		HaiPhong	0	0	0	31,073,805	108,045,108	139,118,913	139,118,913
		DaNang	38,364,000	74,504,000	112,868,000	15,462,900	156,656,131	172,119,031	284,987,031
		CanTho	30,498,000	59,228,000	89,726,000	9,977,400	29,308,200	39,285,600	129,011,600
		Sub Total	209,346,000	406,556,000	615,902,000	186,366,447	650,784,359	837,150,806	1,453,052,806
2	The other provinces		2,753,426,000	2,693,132,000	5,446,558,000	237,229,858	1,274,333,486	1,511,563,343	6,958,121,343
Total			2,962,772,000	3,099,688,000	6,062,460,000	423,596,305	1,925,117,845	2,348,714,149	8,411,174,149

Source: JICA Survey Team

Table 2.2.17 Financial Needs from 2026 to 2050 for New Construction and Renewal of Existing Facilities in All Urban Areas of Vietnam

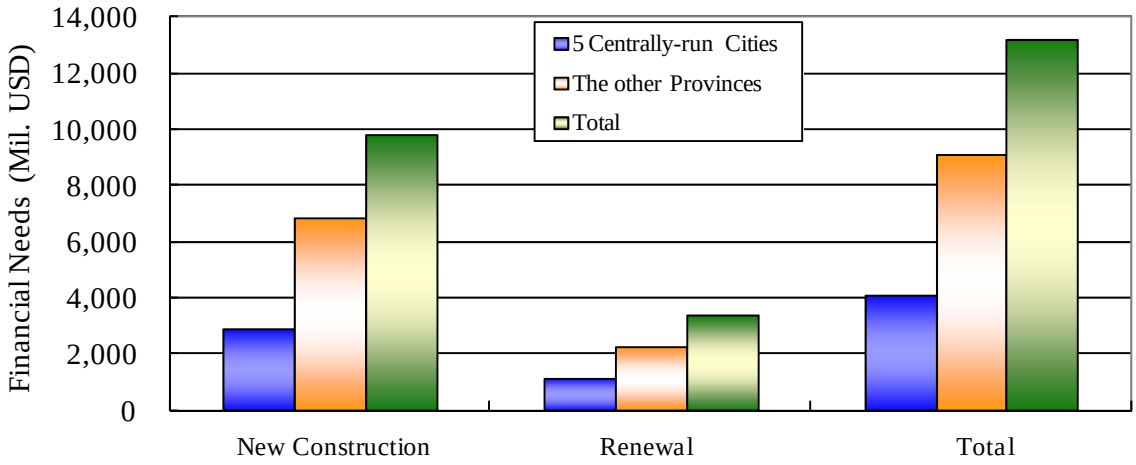
No.	Province	Population in 2050	Water Demand in 2050 (Daily Max.)	Existing WTP Capacity	Existing Pipe System Length	Neccesary Capacity for Improving Coverage Ratio ①	WTP capacity for Construction ② (①/0.9)	Financial needs						Total Financial Needs
								For Improving Coverage ratio			For Renewal of Existing Facilities			
								For WTP	For Pipe System	For WTP + Pipe System	For WTP	For Pipe System	For WTP + Pipe System	
Unit		1,000 pers.	m^3/day	m^3/day	km	m^3/day	m^3/day	USD	USD	USD	USD	USD	USD	USD
1	PhuTho	627	217,371	80,000	1531.2	137,371	153,000	41,922,000	41,004,000	82,926,000	3,288,000	52,978,911	56,266,911	139,192,911
2	VinhPhuc	675	234,156	87,000	178.1	147,156	164,000	44,936,000	43,952,000	88,888,000	3,575,700	6,163,232	9,738,932	98,626,932
3	ThaiNguyen	866	300,045	111,600	615.9	188,445	210,000	57,540,000	56,280,000	113,820,000	4,586,760	21,309,420	25,896,180	139,716,180
4	HaNoi	7,544	3,268,968	2,542,000	4535.3	726,968	808,000	111,504,000	216,544,000	328,048,000	52,619,400	156,920,000	209,539,400	537,587,400
5	BacNinh	726	251,775	95,200	178.9	156,575	174,000	47,676,000	46,632,000	94,308,000	3,912,720	6,188,476	10,101,196	104,409,196
6	BacGiang	439	152,212	57,000	102.1	95,212	106,000	29,044,000	28,408,000	57,452,000	2,342,700	3,533,060	5,875,760	63,327,760
7	HaiDuong	973	337,473	122,980	378.4	214,493	239,000	65,486,000	64,052,000	129,538,000	5,054,478	13,093,800	18,148,278	147,686,278
8	HaiPhong	1,926	1,371,000	1,501,150	3122.7	0	0	0	0	0	31,073,805	108,045,108	139,118,913	139,118,913
9	ThaiBinh	521	180,674	66,500	134.5	114,174	127,000	34,798,000	34,036,000	68,834,000	2,733,150	4,653,951	7,387,101	76,221,101
10	HungYen	410	142,100	56,000	140.5	86,100	96,000	26,304,000	25,728,000	52,032,000	2,301,600	4,862,295	7,163,895	59,195,895
11	HaNam	225	78,087	28,000	114.3	50,087	56,000	15,344,000	15,008,000	30,352,000	1,150,800	3,955,600	5,106,400	35,458,400
12	NamDinh	967	335,283	122,000	1221.2	213,283	237,000	64,938,000	63,516,000	128,454,000	5,014,200	42,254,740	47,268,940	175,722,940
13	NinhBinh	484	167,746	60,900	437.6	106,846	119,000	32,606,000	31,892,000	64,498,000	2,502,990	15,141,600	17,644,590	82,142,590
14	LaiChau	160	55,568	20,732	144.0	34,836	39,000	10,686,000	10,452,000	21,138,000	852,085	4,983,694	5,835,779	26,973,779
15	LaoCai	392	135,948	48,000	305.4	87,948	98,000	26,852,000	26,264,000	53,116,000	1,972,800	10,567,671	12,540,471	65,656,471
16	HaGiang	275	95,498	37,500	129.6	57,998	65,000	17,810,000	17,420,000	35,230,000	1,541,250	4,483,344	6,024,594	41,254,594
17	CaoBang	260	90,076	34,590	144.7	55,486	62,000	16,988,000	16,616,000	33,604,000	1,421,649	5,007,200	6,428,849	40,032,849
18	DienBien*	221	76,628	29,000	14.7	47,628	53,000	14,522,000	14,204,000	28,726,000	1,191,900	509,200	1,701,100	30,427,100
19	SonLa	447	155,027	55,400	1055.4	99,627	111,000	30,414,000	29,748,000	60,162,000	2,276,940	36,517,600	38,794,540	98,956,540
20	YenBai	434	150,336	58,000	426.8	92,336	103,000	28,222,000	27,604,000	55,826,000	2,383,800	14,765,800	17,149,600	72,975,600
21	TuyenQuang	284	98,313	35,900	464.2	62,413	70,000	19,180,000	18,760,000	37,940,000	1,475,490	16,059,613	17,535,103	55,475,103
22	BacKan	142	49,313	19,100	53.0	30,213	34,000	9,316,000	9,112,000	18,428,000	785,010	1,835,469	2,620,479	21,048,479
23	LangSon*	423	146,582	56,000	26.3	90,582	101,000	27,674,000	27,068,000	54,742,000	2,301,600	911,200	3,212,800	57,954,800
24	QuangNinh	1,255	435,097	226,539	1326.4	208,558	232,000	63,568,000	62,176,000	125,744,000	9,310,753	45,893,240	55,203,993	180,947,993
25	HoaBinh	354	122,812	44,800	355.1	78,012	87,000	23,838,000	23,316,000	47,154,000	1,841,280	12,285,400	14,126,680	61,280,680
26	ThanhHoa	1,069	370,417	138,150	545.5	232,267	259,000	70,966,000	69,412,000	140,378,000	5,677,965	18,875,642	24,553,607	164,931,607
27	NgheAn	1,128	391,059	145,500	4425.5	245,559	273,000	74,802,000	73,164,000	147,966,000	5,980,050	153,123,800	159,103,850	307,069,850
28	HaTinh	552	191,308	70,600	1657.0	120,708	135,000	36,990,000	36,180,000	73,170,000	2,901,660	57,332,600	60,234,260	133,404,260
29	QuangBinh	384	133,029	49,700	219.9	83,329	93,000	25,482,000	24,924,000	50,406,000	2,042,670	7,610,000	9,652,670	60,058,670
30	QuangTri	504	174,731	63,500	453.0	111,231	124,000	33,976,000	33,232,000	67,208,000	2,609,850	15,673,101	18,282,951	85,490,951
31	ThuaThienHue	1,176	407,844	170,575	2249.3	237,269	264,000	72,336,000	70,752,000	143,088,000	7,010,633	77,826,200	84,836,832	227,924,832
32	DaNang	1,160	996,667	747,000	4527.6	249,667	278,000	38,364,000	74,504,000	112,868,000	15,462,900	156,656,131	172,119,031	284,987,031
33	QuangNam	794	275,233	103,500	626.6	171,733	191,000	52,334,000	51,188,000	103,522,000	4,253,850	21,679,400	25,933,250	129,455,250
34	KonTum	435	150,857	58,000	163.9	92,857	104,000	28,496,000	27,872,000	56,368,000	2,383,800	5,669,400	8,053,200	64,421,200
35	QuangNgai	535	185,574	67,500	112.4	118,074	132,000	36,168,000	35,376,000	71,544,000	2,774,250	3,888,800	6,663,050	78,207,050
36	GiaLai	1,101	381,572	147,500	192.2	234,072	261,000	71,514,000	69,948,000	141,462,000	6,062,250	6,649,200	12,711,450	154,173,450
37	BinhDinh	1,241	430,051	161,950	920.0	268,101	298,000	81,652,000	79,864,000	161,516,000	6,656,145	31,833,200	38,489,345	200,005,345
38	PhuYen	598	207,259	77,100	543.0	130,159	145,000	39,730,000	38,860,000	78,590,000	3,168,810	18,788,200	21,957,010	100,547,010
39	DakLak	1,252	434,117	163,000	342.9	271,117	302,000	82,748,000	80,936,000	163,684,000	6,699,300	11,864,600	18,563,900	182,247,900
40	KhanhHoa	1,318	456,771	178,000	1144.0	278,771	310,000	84,940,000	83,080,000	168,020,000	7,315,800	39,581,260	46,897,060	214,917,060
41	LamDong	1,355	469,563	172,360	463.2	297,203	331,000	90,694,000	88,708,000	179,402,000	7,083,996	16,027,520	23,111,516	202,513,516
42	NinhThuan	614	212,784	77,000	385.5	135,784	151,000	41,374,000	40,468,000	81,842,000	3,164,700	13,338,915	16,503,615	98,345,615
43	BinhThuan	1,339	464,191	184,200	483.1	279,991	312,000	85,488,000	83,616,000	169,104,000	7,570,620	16,715,715	24,286,335	193,390,335
44	DakNong	218	75,481	30,120	480.9	45,361	51,000	13,974,000	13,668,000	27,642,000	1,237,932	16,639,600	17,877,532	45,519,532
45	BinhPhuoc	441	153,046	58,200	47.1	94,846	106,000	29,044,000	28,408,000	57,452,000	2,392,020	1,631,106	4,023,126	61,475,126
46	DongNai	2,494	864,584	312,900	210.6	551,684	613,000	167,962,000	164,284,000	332,246,000	12,860,190	7,285,803	20,145,993	352,391,993
47	BaRiaVungTau	1,202	416,648	200,000	1066.2	216,648	241,000	66,034,000	64,588,000	130,622,000	8,220,000	36,892,144	45,112,144	175,734,144
48	TayNinh	500	173,376	65,500	361.5	107,876	120,000	32,880,000	32,160,000	65,040,000	2,692,050	12,507,380	15,199,430	80,239,430
49	BinhDuong	1,362	472,274	234,000	1826.9	238,274	265,000	72,610,000	71,020,000	143,630,000	9,617,400	63,211,136	72,828,536	216,458,536
50	HoChiMinhcity	9,046	3,919,878	3,731,060	5776.2	188,818	210,000	28,980,000	56,280,000	85,260,000	77,232,942	199,854,920	277,087,862	362,347,862
51	LongAn	756	261,992	99,000	213.4	162,992	182,000	49,868,000	48,776,000	98,644,000	4,068,900	7,382,800	11,451,700	110,095,700
52	TienGiang	689	238,744	137,860	374.2	100,884	113,000	30,962,000	30,284,000	61,246,000	5,666,046	12,947,118	18,613,164	79,859,164
53	BenTre	378	131,049	48,100	55.0	82,949	93,000	25,482,000	24,924,000	50,406,000	1,976,910	1,902,597	3,879,507	54,285,507
54	DongThap	890	308,594	112,500	937.2	196,094	218,000	59,732,000	58,424,000	118,156,000	4,623,750	32,426,774	37,050,524	155,206,524
55	VinhLong	472	163,576	60,100	694.8	103,476	115,000	31,510,000	30,820,000	62,330,000	2,470,110	24,040,601	26,510,711	88,840,711
56	TraVinh	462	160,240	60,760	341.8	99,480	111,000	30,414,000	29,748,000	60,162,000	2,497,236	11,824,920	14,322,156	74,484,156
57	AnGiang	1,834	635,641	246,500	2747.6	389,141	433,000	118,642,000	116,044,000	234,686,000	10,131,150	95,068,000	105,199,150	339,885,150
58	CanTho	1,570	680,393	482,000	847.1	198,393	221,000	30,498,000	59,228,000	89,726,000	9,977,400	29,308,200	39,285,600	129,011,600
59	HauGiang	450	156,070	59,500	500.1	96,570	108,000	29,592,000	28,944,000	58,536,000	2,445,450	17,303,800	19,749,250	78,285,250
60	SocTrang	754	261,263	96,800	616.6	164,463	183,000	50,142,000	49,044,000	99,186,000	3,978,480	21,333,261	25,311,741	124,497,741
61	KienGiang	1,365	473,316	179,100	1373.0	294,216	327,000	89,598,000	87,636,000	177,234,000	7,361,010	47,506,971	54,867,981	232,101,981
62	BacLieu	678	235,199	90,000	249.2	145,199	162,000	44,388,000	43,416,000	87,804,000	3,699,000	8,623,406	12,322,406	100,126,406
63	CaMau	774	268,352	100,200	328.7	168,152	187,000	51,238,000	50,116,000	101,354,000	4,118,220	11,374,000	15,492,220	116,846,220
Total		63,920	25,030,831	14,775,226	55639.2	10,385,755	11,566,000	2,962,772,000	3,099,688,000	6,062,460,000	423,596,305	1,925,117,845	2,348,714,149	8,411,174,149

Source: JICA Survey Team

(5) Total Financial Needs for the Water Supply Sector until 2050

Total financial needs until 2050 in all urban areas of Vietnam is estimated at about USD 13,216.4 million at 2013 prices. Financial needs for the new WTPs and pipe system are estimated at USD 9,811.7 million as shown in Table 2.2.18 and Figure 2.2.2. For renewal of existing facilities, it is estimated at about USD 3,404.8 million.

Total financial needs until 2050 in the five centrally-run cities is estimated at about USD 4,093.6 million at 2013 prices accounting for 31% for all urban areas. And, that of the other provinces except for the five centrally-run cities is estimated at USD 9,122.8 million.



Source: JICA Survey Team

Figure 2.2.2 Financial Needs for the Water Supply Sector until 2050

Table 2.2.18 Total Financial Needs in All Urban Areas of Vietnam until 2050

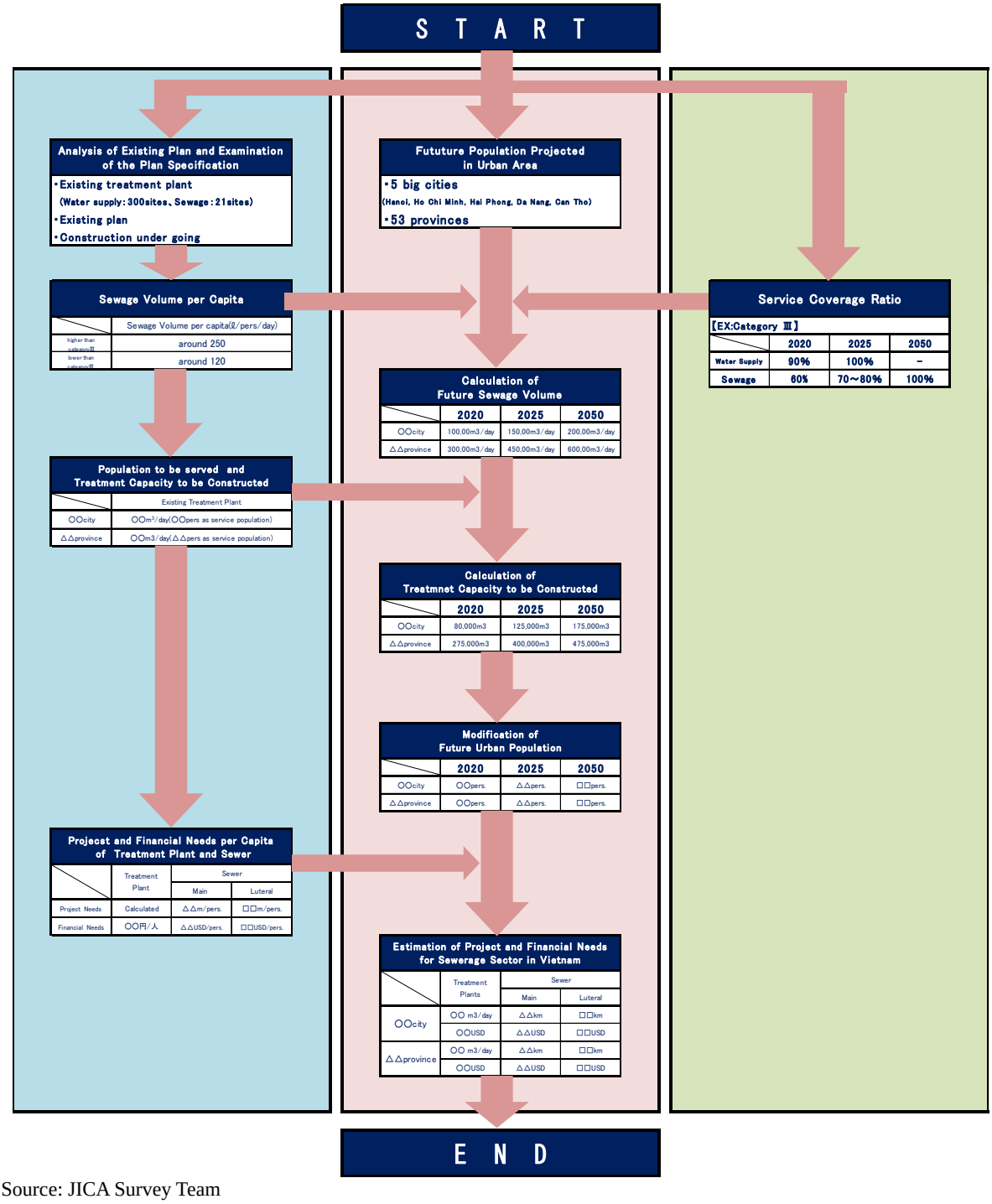
No.	Province	Financial needs														
		For Improving Coverage ratio						Sub Total Financial needs	For Renewal of Existing Facilities						Sub Total Financial needs	Total Financial needs till 2050
		～ 2025			2026 ～ 2050				～ 2025			2026 ～ 2050				
		For WTP	For Pipe System	For WTP + Pipe System	For WTP	For Pipe System	For WTP + Pipe System		For WTP	For Pipe System	For WTP + Pipe System	For WTP	For Pipe System	For WTP + Pipe System		
Unit		USD	USD	USD	USD	USD	USD	USD	USD	USD	USD	USD	USD	USD	USD	USD
1. 5 Centrally-run Cities																
1	HaNoi	251,436,000	488,296,000	739,732,000	111,504,000	216,544,000	328,048,000	1,067,780,000	14,904,000	54,045,200	68,949,200	52,619,400	156,920,000	209,539,400	278,488,600	1,346,268,600
2	HoChiMinhcity	221,628,000	430,408,000	652,036,000	28,980,000	56,280,000	85,260,000	737,296,000	43,988,742	78,407,060	122,395,802	77,232,942	199,854,920	277,087,862	399,483,664	1,136,779,664
3	HaiPhong	179,538,000	348,668,000	528,206,000	0	0	0	528,206,000	4,143,105	36,589,154	40,732,259	31,073,805	108,045,108	139,118,913	179,851,172	708,057,172
4	DaNang	92,046,000	178,756,000	270,802,000	38,364,000	74,504,000	112,868,000	383,670,000	1,656,000	69,390,265	71,046,265	15,462,900	156,656,131	172,119,031	243,165,296	626,835,296
5	CanTho	45,264,000	87,904,000	133,168,000	30,498,000	59,228,000	89,726,000	222,894,000	3,187,800	10,258,900	13,446,700	9,977,400	29,308,200	39,285,600	52,732,300	275,626,300
	Sub total	789,912,000	1,534,032,000	2,323,944,000	209,346,000	406,556,000	615,902,000	2,939,846,000	67,879,647	248,690,579	316,570,226	186,366,447	650,784,359	837,150,806	1,153,721,032	4,093,567,032
2. The Other Provinces except for 5 Centrally-run Cities																
1	PhuTho	0	10,789,109	10,789,109	41,922,000	41,004,000	82,926,000	93,715,109	3,288,000	25,950,000	29,238,000	3,288,000	52,978,911	56,266,911	85,504,911	179,220,020
2	VinhPhuc	11,234,000	10,988,000	22,222,000	44,936,000	43,952,000	88,888,000	111,110,000	1,890,600	2,559,016	4,449,616	3,575,700	6,163,232	9,738,932	14,188,548	125,298,548
3	ThaiNguyen	13,974,000	13,668,000	27,642,000	57,540,000	56,280,000	113,820,000	141,462,000	2,490,660	10,011,510	12,502,170	4,586,760	21,309,420	25,896,180	38,398,350	179,860,350
5	BacNinh	17,810,000	17,420,000	35,230,000	47,676,000	46,632,000	94,308,000	129,538,000	1,241,220	2,250,038	3,491,258	3,912,720	6,188,476	10,101,196	13,592,454	143,130,454
6	BacGiang	8,768,000	8,576,000	17,344,000	29,044,000	28,408,000	57,452,000	74,796,000	1,027,500	1,351,130	2,378,630	2,342,700	3,533,060	5,875,760	8,254,390	83,050,390
7	HaiDuong	11,234,000	10,988,000	22,222,000	65,486,000	64,052,000	129,538,000	151,760,000	3,369,378	6,037,700	9,407,078	5,054,478	13,093,800	18,148,278	27,555,356	179,315,356
9	ThaiBinh	0	2,943,511	2,943,511	34,798,000	34,036,000	68,834,000	71,777,511	2,733,150	2,179,800	4,912,950	2,733,150	4,653,951	7,387,101	12,300,051	84,077,562
10	HungYen	13,974,000	13,668,000	27,642,000	26,304,000	25,728,000	52,032,000	79,674,000	205,500	1,774,548	1,980,048	2,301,600	4,862,295	7,163,895	9,143,943	88,817,943
11	HaNam	822,000	804,000	1,626,000	15,344,000	15,008,000	30,352,000	31,978,000	1,027,500	1,937,600	2,965,100	1,150,800	3,955,600	5,106,400	8,071,500	40,049,500
12	NamDinh	10,138,000	9,916,000	20,054,000	64,938,000	63,516,000	128,454,000	148,508,000	3,493,500	20,671,770	24,165,270	5,014,200	42,254,740	47,268,940	71,434,210	219,942,210
13	NinhBinh	4,384,000	4,288,000	8,672,000	32,606,000	31,892,000	64,498,000	73,170,000	1,845,390	7,369,800	9,215,190	2,502,990	15,141,600	17,644,590	26,859,780	100,029,780
14	LaiChau	1,918,000	1,876,000	3,794,000	10,686,000	10,452,000	21,138,000	24,932,000	564,385	2,411,447	2,975,832	852,085	4,983,694	5,835,779	8,811,611	33,743,611
15	LaoCai	274,000	3,890,429	4,164,429	26,852,000	26,264,000	53,116,000	57,280,429	1,931,700	5,089,314	7,021,014	1,972,800	10,567,671	12,540,471	19,561,485	76,841,913
16	HaGiang	8,220,000	8,040,000	16,260,000	17,810,000	17,420,000	35,230,000	51,490,000	308,250	1,853,072	2,161,322	1,541,250	4,483,344	6,024,594	8,185,917	59,675,917
17	CaoBang	5,480,000	5,360,000	10,840,000	16,988,000	16,616,000	33,604,000	44,444,000	599,649	2,249,000	2,848,649	1,421,649	5,007,200	6,428,849	9,277,498	53,721,498
18	DienBien*	5,206,000	5,092,000	10,298,000	14,522,000	14,204,000	28,726,000	39,024,000	411,000	1,730,000	2,141,000	1,191,900	509,200	1,701,100	3,842,100	42,866,100
19	SonLa	2,192,000	2,144,000	4,336,000	30,414,000	29,748,000	60,162,000	64,498,000	1,948,140	18,165,000	20,113,140	2,276,940	36,517,600	38,794,540	58,907,680	123,405,680
20	YenBai	11,782,000	11,524,000	23,306,000	28,222,000	27,604,000	55,826,000	79,132,000	616,500	6,833,500	7,450,000	2,383,800	14,765,800	17,149,600	24,599,600	103,731,600
21	TuyenQuang	3,014,000	2,948,000	5,962,000	19,180,000	18,760,000	37,940,000	43,902,000	1,023,390	7,895,807	8,919,197	1,475,490	16,059,613	17,535,103	26,454,300	70,356,300
22	BacKan	3,288,000	3,216,000	6,504,000	9,316,000	9,112,000	18,428,000	24,932,000	291,810	770,334	1,062,144	785,010	1,835,469	2,620,479	3,682,623	28,614,623
23	LangSon*	9,864,000	9,648,000	19,512,000	27,674,000	27,068,000	54,742,000	74,254,000	822,000	1,730,000	2,552,000	2,301,600	911,200	3,212,800	5,764,800	80,018,800
24	QuangNinh	21,098,000	20,636,000	41,734,000	63,568,000	62,176,000	125,744,000	167,478,000	6,146,053	21,995,220	28,141,273	9,310,753	45,893,240	55,203,993	83,345,266	250,823,266
25	HoaBinh	3,836,000	3,752,000	7,588,000	23,838,000	23,316,000	47,154,000	54,742,000	1,265,880	5,968,500	7,234,380	1,841,280	12,285,400	14,126,680	21,361,060	76,103,060
26	ThanhHoa	20,550,000	20,100,000	40,650,000	70,966,000	69,412,000	140,378,000	181,028,000	2,595,465	8,473,021	11,068,486	5,677,965	18,875,642	24,553,607	35,622,093	216,650,093
27	NgheAn	20,824,000	20,368,000	41,192,000	74,802,000	73,164,000	147,966,000	189,158,000	2,856,450	75,583,700	78,440,150	5,980,050	153,123,800	159,103,850	237,544,000	426,702,000
28	HaTinh	8,768,000	8,576,000	17,344,000	36,990,000	36,180,000	73,170,000	90,514,000	1,586,460	28,250,900	29,837,360	2,901,660	57,332,600	60,234,260	90,071,620	180,585,620
29	QuangBinh	5,480,000	5,360,000	10,840,000	25,482,000	24,924,000	50,406,000	61,246,000	1,220,670	3,563,800	4,784,470	2,042,670	7,610,000	9,652,670	14,437,140	75,683,140
30	QuangTri	3,836,000	3,752,000	7,588,000	33,976,000	33,232,000	67,208,000	74,796,000	2,034,450	7,675,751	9,710,201	2,609,850	15,673,101	18,282,951	27,993,152	102,789,152
31	ThuaThienHue	0	12,615,899	12,615,899	72,336,000	70,752,000	143,088,000	155,703,899	7,010,633	38,282,305	45,292,938	7,010,633	77,826,200	84,836,832	130,129,770	285,833,669
33	QuangNam	18,084,000	17,688,000	35,772,000	52,334,000	51,188,000	103,522,000	139,294,000	1,541,250	9,982,100	11,523,350	4,253,850	21,679,400	25,933,250	37,456,600	176,750,600
34	KonTum	12,604,000	12,328,000	24,932,000	28,496,000	27,872,000	56,368,000	81,300,000	493,200	2,231,700	2,724,900	2,383,800	5,669,400	8,053,200	10,778,100	92,078,100
35	QuangNgai	4,932,000	4,824,000	9,756,000	36,168,000	35,376,000	71,544,000	81,300,000	2,034,450	1,730,000	3,764,450	2,774,250	3,888,800	6,663,050	10,427,500	91,727,500
36	GiaLai	33,702,000	32,964,000	66,666,000	71,514,000	69,948,000	141,462,000	208,128,000	1,006,950	1,730,000	2,736,950	6,062,250	6,649,200	12,711,450	15,448,400	223,576,400
37	BinhDinh	26,578,000	25,996,000	52,574,000	81,652,000	79,864,000	161,516,000	214,090,000	2,669,445	14,670,400	17,339,845	6,656,145	31,833,200	38,489,345	55,829,190	269,919,190
38	PhuYen	9,042,000	8,844,000	17,886,000	39,730,000	38,860,000	78,590,000	96,476,000	1,812,510	8,978,700	10,791,210	3,168,810	18,788,200	21,957,010	32,748,220	129,224,220
39	DakLak	27,674,000	27,068,000	54,742,000	82,748,000	80,936,000	163,684,000	218,426,000	2,548,200	4,619,100	7,167,300	6,699,300	11,864,600	18,563,900	25,731,200	244,157,200
40	KhanhHoa	22,194,000	21,708,000	43,902,000	84,940,000	83,080,000	168,020,000	211,922,000	3,986,700	18,772,230	22,758,930	7,315,800	39,581,260	46,897,060	69,655,990	281,577,990
41	LamDong	18,084,000	17,688,000	35,772,000	90,694,000	88,708,000	179,402,000	215,174,000	4,371,396	7,182,960	11,554,356	7,083,996	16,027,520	23,111,516	34,665,872	249,839,872
42	NinhThuan	5,480,000	5,360,000	10,840,000	41,374,000	40,468,000	81,842,000	92,682,000	2,342,700	6,414,857	8,757,557	3,164,700	13,338,915	16,503,615	25,261,172	117,943,172
43	BinhThuan	40,826,000	39,932,000	80,758,000	85,488,000	83,616,000	169,104,000	249,862,000	1,446,720	6,414,857	7,861,577	7,570,620	16,715,715	24,286,335	32,147,912	282,009,912
44	DakNong	7,672,000	7,504,000	15,176,000	13,974,000	13,668,000	27,642,000	42,818,000	87,132	7,958,000	8,045,132	1,237,932	16,639,600	17,877,532	25,922,664	68,740,664
45	BinhPhuoc	11,782,000	11,524,000	23,306,000	29,044,000	28,408,000	57,452,000	80,758,000	624,720	252,753	877,473	2,392,020	1,631,106	4,023,126	4,900,599	85,658,599
46	DongNai	21,372,000	20,904,000	42,276,000	167,962,000	164,284,000	332,246,000	374,522,000	9,654,390	2,704,902	12,359,292	12,860,190	7,285,803	20,145,993	32,505,285	407,027,285
47	BaRiaVungTau	0	11,157,435	11,157,435	66,034,000	64,588,000	130,622,000	141,779,435	8,220,000	17,888,200	26,108,200	8,220,000	36,892,144	45,112,144	71,220,344	212,999,779
48	TayNinh	10,686,000	10,452,000	21,138,000	32,880,000	32,160,000	65,040,000	86,178,000	1,089,150	5,757,890	6,847,040	2,692,050	12,507,380	15,199,430	22,046,469	108,224,469
49	BinhDuong	0	3,280,585	3,280,585	72,610,000	71,020,000	143,630,000	146,910,585	9,617,400	31,441,539	41,058,939	9,617,400	63,211,136	72,828,536	113,887,475	260,798,060
51	LongAn	16,166,000	15,812,000	31,978,000	49,868,000	48,776,000	98,644,000	130,622,000	1,644,000	2,941,000	4,585,000	4,068,900	7,382,800	11,451,700	16,036,700	146,658,700
52	TienGiang	0	12,869,183	12,869,183	30,962,000	30,284,000	61,246,000	74,115,183	5,666,046	5,830,100	11,496,146	5,666,046	12,947,118	18,613,164	30,109,310	104,224,493
53	BenTre	3,836,000	3,752,000	7,588,000	25,482,000	24,924,000	50,406,000	57,994,000	1,401,510	777,099	2,178,609	1,976,910	1,902,597	3,879,507	6,058,116	64,052,116
54	DongThap	8,768,000	8,576,000	17,344,000	59,732,000	58,424,000	118,156,000	135,500,000	3,308,550	16,213,387	19,521,937	4,623,750	32,426,774	37,050,524	56,572,461	192,072,461
55	VinhLong	4,932,000	4,824,000	9,756,000	31,510,000	30,820,000	62,330,000	72,086,000	1,730,310	11,805,901	13,536,211	2,470,110	24,040,601	26,510,711	40,046,922	112,132,922
56	TraVinh	9,590,000	9,380,000	18,970,000	30,414,000	29,748,000	60,162,000	79,132,000	1,058,736	5,470,260	6,528,996	2,497,236	11,824,920	14,322,156	20,851,152	99,983,152
57	AnGiang	61,376,000	60,032,000	121,408,000	118,642,000	116,044,000	234,686,000	356,094,000	924,750	44,599,400	45,524,150	10,131,150	95,068,000	105,199,150	150,723,300	506,817,300
59	HauGiang	10,138,000	9,916,000	20,054,000	29,592,000	28,944,000	58,536,000	78,590,000	924,750	8,182,900	9,107,650	2,445,450	17,303,800	19,749,250	28,856,900	107,446,900
60	SocTrang	11,782,000	11,524,000	23,306,000	50,142,000	49,044,000	99,186,000	122,492,000	2,211,180	10,117,230	12,328,410	3,978,480	21,333,261	25,311,741	37,640,151	160,132,151
61	KienGiang	33,428,000	32,696,000	66,124,000	89,598,000	87,636,000	177,234,000	243,358,000	2,346,810	22,172,286	24,519,096	7,361,010	47,506,971	54,867,981	79,387,077	322,745,077
62	BacLieu	18,632,000	18,224,000	36,856,000	44,388,000	43,416,000	87,804,000	124,660,000	904,200	3,427,303	4,331,503	3,699,000	8,623,406	12,322,406	16,653,909	141,313,909
63	CaMau	14,248,000	13,936,000	28,184,000	51,238,000	50,116,000	101,354,000	129,538,000	1,981,020	5,017,000	6,998,020	4,118,220	11,374,000	15,492,220	22,490,240	152,028,240
	Sub total	691,576,000	733,710,151	1,425,286,151	2,753,426,000	2,693,132,000	5,446,558,000	6,871,844,151	133,493,458	605,897,635	739,391,093	237,229,858	1,274,333,486	1,511,563,343	2,250,954,436	9,122,798,588
Total		1,481,488,000	2,267,742,151	3,749,230,151	2,962,772,000	3,099,688,000	6,062,460,000	9,811,690,151	201,373,105	854,588,215	1,055,961,319	423,596,305	1,925,117,845	2,348,714,149	3,404,675,468	13,216,365,620

Source: JICA Survey Team

2.3 Estimation of Project Needs for the Wastewater Sector in Vietnam

2.3.1 Survey Methods

Estimation of project needs for sewerage development is calculated in accordance with the calculation flowchart shown in Figure 2.3.1. The project needs are calculated by multiplying unit project costs per person by urban population projected. It is assumed that the centralized sewerage system will be provided to all residents in the urban areas in 2050 as the target of the project needs estimation. Therefore, the service coverage rate in 2050 is 100% and the ratio in 2025 is set according to the national target. The existing systems are excluded from the estimation of the total project needs. The unit project cost per person is estimated in reference to the present M/P and feasibility study reports.



Source: JICA Survey Team

Figure 2.3.1 Calculation Flowchart

2.3.2 Projections of Population in 2025 and 2050

To estimate the sewerage project needs in order to achieve sewerage development for the urban areas in 2025 and 2050, the population projection becomes the first step. As mentioned in Section 2.2.2, the same method was applied for population projections of the whole country, urban population in each province, and capital city in Vietnam. The results of the population projections are summarized in Table 2.3.1.

Table 2.3.1 Population of 2009 and Estimated Population in 2025 and 2050 for Each Province and Its Capital

Country	Province	Capital City	2009			2025				2050			
			Province	Urban	Capital	Province	Urban	Target 65%	Capital	Province	Urban	Target 100%	Capital
Whole country			86,025	25,585		100,129	40,743			108,700	63,920		
Province													
1	PhuTho	Viet Tri	1,317	209	185	1,454	347	226	299	1,500	627	627	477
2	VinhPhuc	Vinh Yen	1,000	225	94	1,144	374	243	152	1,250	675	675	243
3	ThaiNguyen	Thai Nguyen	1,125	288	278	1,291	480	312	449	1,350	866	866	717
4	HaNoi		6,472	2,653		7,933	4,420	2,873		8,400	7,544	7,544	0
5	BacNinh	Bac Ninh	1,027	242	164	1,205	402	262	266	1,300	726	726	424
6	BacGiang	Bac Giang	1,557	146	101	1,710	243	158	164	1,750	439	439	261
7	HaiDuong	Hai Duong	1,707	324	213	1,859	539	351	345	1,900	973	973	550
8	HaiPhong		1,840	849		2,127	1,414	919		2,150	1,926	1,926	0
9	ThaiBinh	Thai Binh	1,783	173	183	1,843	289	188	296	1,800	521	521	472
10	HungYen	Hung Yen	1,129	136	83	1,259	227	148	134	1,300	410	410	213
11	HaNam	Phu Ly	786	75	82	828	125	81	132	850	225	225	211
12	NamDinh	Nam Dinh	1,828	322	243	1,981	536	348	393	2,050	967	967	628
13	NinhBinh	Ninh Binh	900	161	111	953	268	174	179	950	484	484	285
14	LaiChau	Lai Chau	371	53	27	467	89	58	43	600	160	160	69
15	LaoCai	Lao Cai	616	130	98	764	217	141	159	950	392	392	254
16	HaGiang	Ha Giang	725	92	45	899	153	99	73	1,100	275	275	117
17	CaoBang	Cao Bang	511	86	54	572	144	94	88	600	260	260	140
18	DienBien	Dien Bien Phu	491	74	48	608	122	80	78	750	221	221	124
19	SonLa	Son La	1,079	149	92	1,356	248	161	148	1,600	447	447	237
20	YenBai	Yen Bai	742	144	91	848	240	156	147	950	434	434	234
21	TuyenQuang	Tuyen Quang	725	94	89	813	157	102	144	850	284	284	230
22	BacKan	Bac Kan	295	47	37	335	79	51	60	350	142	142	96
23	LangSon	Lang Son	733	141	87	825	234	152	141	850	423	423	225
24	QuangNinh	Ha Long	1,146	594	219	1,333	990	644	354	1,400	1,255	1,255	565
25	HoaBinh	Hoa Binh	786	118	83	892	196	128	134	950	354	354	214
26	ThanhHoa	Thanh Hoa	3,404	355	208	3,602	592	385	336	3,650	1,069	1,069	536
27	NgheAn	Vinh	2,915	375	304	3,306	625	406	491	3,500	1,128	1,128	784
28	HaTinh	Ha Tinh	1,228	184	89	1,297	306	199	144	1,400	552	552	230
29	QuangBinh	Dong Hoi	845	128	111	934	213	138	180	1,000	384	384	287
30	QuangTri	Dong Ha	599	168	82	670	279	182	133	800	504	504	212
31	ThuaThienHue	Hué	1,088	391	336	1,228	652	424	543	1,400	1,176	1,176	866
32	DaNang		895	777	0	1,148	1,033	672	0	1,300	1,160	1,160	0
33	QuangNam	Tam Ky	1,423	264	108	1,532	440	286	175	1,650	794	794	279
34	KonTum	Kon Tum	432	145	143	598	241	157	231	850	435	435	369
35	QuangNgai	Quang Ngai	1,217	178	112	1,299	297	193	182	1,400	535	535	290
36	GiaLai	Pleiku	1,281	366	209	1,607	610	396	337	2,000	1,101	1,101	538
37	BinhDinh	Qui Nhon	1,487	413	281	1,630	687	447	454	1,800	1,241	1,241	724
38	PhuYen	Tuy Hoa	862	199	152	955	331	215	246	1,050	598	598	393
39	DakLak	Buon Ma Thuo	1,736	416	326	2,119	694	451	527	2,550	1,252	1,252	842
40	KhanhHoa	Nha Trang	1,158	461	392	1,336	768	499	634	1,500	1,318	1,318	1,012
41	LamDong	Da Lat	1,189	450	205	1,467	751	488	332	1,750	1,355	1,355	530
42	NinhThuan	Phan Rang-Thap	566	204	162	646	340	221	262	750	614	614	417
43	BinhThuan	Phan Thiet	1,169	460	216	1,329	766	498	350	1,500	1,339	1,339	558
44	DakNong	Gia Nghia	491	72	42	642	121	78	68	800	218	218	108
45	BinhPhuoc	Dong Xoai	875	147	80	1,048	245	159	130	1,150	441	441	207
46	DongNai	Bien Hoa	2,500	829	701	3,207	1,382	898	1,134	3,650	2,494	2,494	1,810
47	BaRiaVungTau	Vung Tau	999	498	296	1,207	829	539	479	1,350	1,202	1,202	765
48	TayNinh	Tay Ninh	1,067	166	126	1,214	277	180	203	1,300	500	500	324
49	BinhDuong	Thu Dau Mot	1,513	453	223	2,458	755	491	360	2,950	1,362	1,362	575
50	HoChiMinhcity		7,196	6,021	0	9,333	8,400	5,460	0	10,050	9,046	9,046	0
51	LongAn	Tan An	1,436	251	133	1,598	419	272	214	1,700	756	756	342
52	TienGiang	My Tho	1,673	229	181	1,797	382	248	293	1,850	689	689	468
53	BenTre	Ben Tre	1,256	126	116	1,315	209	136	188	1,350	378	378	300
54	DongThap	Cao Lanh	1,667	296	161	1,815	493	321	261	1,900	890	890	416
55	VinhLong	Vinh Long	1,025	157	137	1,099	261	170	221	1,100	472	472	353
56	TraVinh	Tra Vinh	1,003	154	99	1,095	256	166	160	1,100	462	462	255
57	AnGiang	Long Xuyen	2,148	610	279	2,362	1,016	660	451	2,450	1,834	1,834	719
58	CanTho		1,189	783	0	1,456	1,310	852	0	1,750	1,570	1,570	0
59	HauGiang	Vi Thanh	758	150	71	845	249	162	115	900	450	450	184
60	SocTrang	Soc Trang	1,293	251	136	1,418	418	271	220	1,500	754	754	351
61	KienGiang	Rach Gia	1,689	454	226	1,912	757	492	366	2,100	1,365	1,365	584
62	BacLieu	Bac Lieu	857	226	148	965	376	244	239	1,000	678	678	382
63	CaMau	Ca Mau	1,207	257	216	1,343	429	279	350	1,400	774	774	558
	subtotal		86,025	25,585	9,513	100,131	40,743	26,483	15,383	108,700	63,920	63,920	24,555

Source: GSO, JICA Survey Team

2.3.3 Objectives for the Development of Urban Wastewater Treatment

(1) National Target

According to the Research Report on Vietnam Urban Environment Management (2011, JICA), the national goal of service coverage of wastewater collection and treatment system in 2025 is shown in Table 2.3.2. The coverage ratio is set between 70% and 80% in category IV or higher urban areas, and 50% in category V urban areas and craft villages. The overall coverage ratio is assumed at 65% with a median of 50% to 80% of the target value of the national goal in 2025. With a view to determine the total amount of the project needs, the service coverage of collection and treatment system in 2050 was set at 100%.

Table 2.3.2 Objectives for the Development of Urban Drainage and Wastewater Treatment

Items		2015	2020	2025	2050
Drainage (rain water discharge)	Flood	To be solved in category II or higher urban areas	To be solved in category IV or higher urban areas	To be solved in all urban areas	Will be solved in all urban areas
	Service coverage	70-80%	>80%	90-95%,100% in category IV or higher urban areas	
Wastewater discharge	Service coverage of collection and treatment system	40-50% in category III or higher urban areas	60% in category III or higher urban areas	**70-80% in category IV or higher urban areas**	**Will be solved in all urban areas**
		-	40% in categories IV, V urban areas and craft villages	**50% in category V urban areas and craft villages**	
		-	-	Wastewater treatment plants at different levels of management are located in craft villages	
	Industrial and hospital wastewater	The whole wastewater is treated	-	-	-
		All industrial parks have their own discharge system	-	-	-
	Other items	Public toilets are installed in categories IV or higher urban areas	Pipes, sewers, channels will be upgraded to prevent pollution at concentrated residential areas	20-30% treated wastewater will be reused.	-

Source: JICA 2011, Research Report on Vietnam Urban Environment Management

(2) Targets of the Five Big Cities

As mentioned above (Section 2.1.4), M/P reports of the five big cities, namely: Ha Noi, HCMC, Hai Phong, Da Nang, and Can Tho are collected. Since the coverage ratios for the year 2050 are not described in the M/P reports of all the big cities except Ha Noi, the coverage ratios mentioned in the

previous section are also applied to all the big cities.

2.3.4 Analysis of Existing Plan and Examination of the Plan Specifications

(1) Existing Treatment Plant

As shown in Table 2.1.15, as of September 2013, 21 sites of WWTPs run in Vietnam. The total existing treatment capacity is approximately 460,000 m^3/day.

Binh Hung Treatment Plant has the biggest capacity at 141,000 m^3/day, and its treatment method is modified aeration and conventional activated sludge. Kim Lien Treatment Plant and Truc Bach Treatment Plant began running as the fastest in the country. Both plants started service in 2005, having been running for about nine years.

(2) Current Status of the Service Coverage Ratio of Collection and Treatment System

As of 2012, total population of the urban area is 28.36 million people and the average water supply amount to 100 LPD. Therefore, the total amount of sewage generated per day is approximately 2.836 million m^3/day. Thus, current service coverage ratio based on the existing treatment capacity is approximately 16% only.

[Calculation: 460,000 / 2,836,000 = 16.2%]

(3) Sewage Volume per Capita

Sewage volumes per capita introduced in the existing plans are shown in Table 2.1.16.

The average value of big cities, such as Ha Noi and HCMC is 225 LPD and the average value of other cities except for the big cities is 121 LPD.

According to the Research Report on Vietnam Urban Environment Management (2011, JICA), the Vietnamese government is aiming at 100% coverage in the water supply system in 2025. Consequently, sewage volume per person in 2050 is set at the same value as that of 2025.

Sewage volume per capita is divided into three parts in accordance with the classification of sources.

[Domestic sewage: 70%, public service activities and small industries: 20%, infiltration, Inflow: 10%]

(4) Calculation of Future Sewage Volume

Future sewage volume which is calculated by multiplying the sewage volume per capita by future urban population is shown in Table 2.3.3. Total sewage volume in 2025 is about 6.65 million m^3/day. In 2050, it is about 15.252 million m^3/day. Total sewage volume in the five big cities in 2025 and 2050 is about 3.73 million m^3/day and 5.86 million m^3/day, respectively. This means that the sewage volume in the five big cities account for half of the amount of the entire country.

Table 2.3.3 Future Sewage Discharge

Country	Province	Capital City	2009	2025		2050	
			Urban Population (thous pers.)	Urban Population (thous pers.)	Sewage Discharge (m^3/day)	Urban Population (thous pers.)	Sewage Discharge (m^3/day)
Province							
1	PhuTho	Viet Tri	209	347	42,038	627	137,947
2	VinhPhuc	Vinh Yen	225	374	45,285	675	148,599
3	ThaiNguyen	Thai Nguyen	288	480	58,027	866	190,413
4	HaNoi		2,653	4,420	994,586	7,544	2,082,081
5	BacNinh	Bac Ninh	242	402	48,692	726	159,780
6	BacGiang	Bac Giang	146	243	29,437	439	96,596
7	HaiDuong	Hai Duong	324	539	65,265	973	214,165
8	HaiPhong		849	1,414	318,119	1,926	531,554
9	ThaiBinh	Thai Binh	173	289	34,941	521	114,658
10	HungYen	Hung Yen	136	227	27,481	410	90,178
11	HaNam	Phu Ly	75	125	15,102	225	49,555
12	NamDinh	Nam Dinh	322	536	64,842	967	212,776
13	NinhBinh	Ninh Binh	161	268	32,441	484	106,454
14	LaiChau	Lai Chau	53	89	10,747	160	35,264
15	LaoCai	Lao Cai	130	217	26,292	392	86,275
16	HaGiang	Ha Giang	92	153	18,469	275	60,604
17	CaoBang	Cao Bang	86	144	17,420	260	57,164
18	DienBien	Dien Bien Phu	74	122	14,819	221	48,629
19	SonLa	Son La	149	248	29,981	447	98,382
20	YenBai	Yen Bai	144	240	29,074	434	95,405
21	TuyenQuang	Tuyen Quang	94	157	19,013	284	62,390
22	BacKan	Bac Kan	47	79	9,537	142	31,294
23	LangSon	Lang Son	141	234	28,348	423	93,023
24	QuangNinh	Ha Long	594	990	119,825	1,255	276,119
25	HoaBinh	Hoa Binh	118	196	23,751	354	77,938
26	ThanhHoa	Thanh Hoa	355	592	71,637	1,069	235,072
27	NgheAn	Vinh	375	625	75,629	1,128	248,172
28	HaTinh	Ha Tinh	184	306	36,998	552	121,406
29	QuangBinh	Dong Hoi	128	213	25,727	384	84,422
30	QuangTri	Dong Ha	168	279	33,792	504	110,887
31	ThuaThienHue	Huế	391	652	78,875	1,176	258,824
32	DaNang		777	1,033	232,470	1,160	320,051
33	QuangNam	Tam Ky	264	440	53,229	794	174,667
34	KonTum	Kon Tum	145	241	29,175	435	95,736
35	QuangNgai	Quang Ngai	178	297	35,889	535	117,768
36	GiaLai	Pleiku	366	610	73,794	1,101	242,151
37	BinhDinh	Qui Nhon	413	687	83,170	1,241	272,916
38	PhuYen	Tuy Hoa	199	331	40,083	598	131,529
39	DakLak	Buon Ma Thuot	416	694	83,956	1,252	275,497
40	KhanhHoa	Nha Trang	461	768	92,948	1,318	289,874
41	LamDong	Da Lat	450	751	90,811	1,355	297,992
42	NinhThuan	Phan Rang-Thap C	204	340	41,151	614	135,036
43	BinhThuan	Phan Thiet	460	766	92,646	1,339	294,583
44	DakNong	Gia Nghia	72	121	14,598	218	47,901
45	BinhPhuoc	Dong Xoai	147	245	29,598	441	97,125
46	DongNai	Bien Hoa	829	1,382	167,206	2,494	548,678
47	BaRiaVungTau	Vung Tau	498	829	100,368	1,202	264,411
48	TayNinh	Tay Ninh	166	277	33,530	500	110,027
49	BinhDuong	Thu Dau Mot	453	755	91,335	1,362	299,712
50	HoChiMinhcity		6,021	8,400	1,889,933	9,046	2,496,660
51	LongAn	Tan An	251	419	50,668	756	166,264
52	TienGiang	My Tho	229	382	46,172	689	151,510
53	BenTre	Ben Tre	126	209	25,344	378	83,165
54	DongThap	Cao Lanh	296	493	59,680	890	195,838
55	VinhLong	Vinh Long	157	261	31,635	472	103,807
56	TraVinh	Tra Vinh	154	256	30,989	462	101,690
57	AnGiang	Long Xuyen	610	1,016	122,930	1,834	403,387
58	CanTho		783	1,310	294,840	1,570	433,357
59	HauGiang	Vi Thanh	150	249	30,183	450	99,044
60	SocTrang	Soc Trang	251	418	50,527	754	165,801
61	KienGiang	Rach Gia	454	757	91,537	1,365	300,374
62	BacLieu	Bac Lieu	226	376	45,486	678	149,260
63	CaMau	Ca Mau	257	429	51,898	774	170,300
		Total	25,585	40,743	6,653,967	63,920	15,252,137

Source: JICA Survey Team

(5) Future Population to be Served and Treatment Capacity to be Constructed

As mentioned above, there are 21 WWTPs providing services. The future sewage volume to be collected and treated, and population to be served are calculated by deducting the present service population and treatment capacity from the future sewage volume and population estimated in the previous section. The deducted urban population and treatment plant capacity are shown in Table 2.3.4. The urban population to be served by 2050 is approximately 61.75 million people, and the capacity of treatment plants to be constructed is about 14.79 million m^3/day. The estimated construction cost for the project needs in the wastewater sector is calculated based on both figures estimated above.

Table 2.3.4 Estimation of Future Population to be Served and Treatment Capacity to be Constructed

Country	Province	Capital City	2025						2050					
			Urban Population (thous pers.)	Sewege Volume (m^3/day)	Existing Treatment Capacity (m^3/day)	Present Service Population (thous	Deducted Urban Population (thos pers.)	Deducted Sewege Volume (m^3/day)	Urban Population (thous pers.)	Sewege Volume (m^3/day)	Existing Treatment Capacity (m^3/day)	Present Service Population (thous	Deducted Urban Population (thos pers.)	Deducted Sewege Volume (m^3/day)
Province														
1	PhuTho	Viet Tri	347	42,038	-	-	347	42,038	627	137,947	-	-	627	137,947
2	VinhPhuc	Vinh Yen	374	45,285	-	-	374	45,285	675	148,599	-	-	675	148,599
3	ThaiNguyen	Thai Nguyen	480	58,027	-	-	480	58,027	866	190,413	-	-	866	190,413
4	**HaNoi**		4,420	994,586	133,200	592	3,828	861,386	7,544	2,082,081	133,200	592	6,952	1,948,881
5	BacNinh	Bac Ninh	402	48,692	-	-	402	48,692	726	159,780	-	-	726	159,780
6	BacGiang	Bac Giang	243	29,437	8,000	66	177	21,437	439	96,596	8,000	66	373	88,596
7	HaiDuong	Hai Duong	539	65,265	-	-	539	65,265	973	214,165	-	-	973	214,165
8	**HaiPhong**		1,414	318,119	-	-	1,414	318,119	1,926	531,554	-	-	1,926	531,554
9	ThaiBinh	Thai Binh	289	34,941	-	-	289	34,941	521	114,658	-	-	521	114,658
10	HungYen	Hung Yen	227	27,481	-	-	227	27,481	410	90,178	-	-	410	90,178
11	HaNam	Phu Ly	125	15,102	-	-	125	15,102	225	49,555	-	-	225	49,555
12	NamDinh	Nam Dinh	536	64,842	-	-	536	64,842	967	212,776	-	-	967	212,776
13	NinhBinh	Ninh Binh	268	32,441	-	-	268	32,441	484	106,454	-	-	484	106,454
14	LaiChau	Lai Chau	89	10,747	-	-	89	10,747	160	35,264	-	-	160	35,264
15	LaoCai	Lao Cai	217	26,292	-	-	217	26,292	392	86,275	-	-	392	86,275
16	HaGiang	Ha Giang	153	18,469	-	-	153	18,469	275	60,604	-	-	275	60,604
17	CaoBang	Cao Bang	144	17,420	-	-	144	17,420	260	57,164	-	-	260	57,164
18	DienBien	Dien Bien Phu	122	14,819	-	-	122	14,819	221	48,629	-	-	221	48,629
19	SonLa	Son La	248	29,981	-	-	248	29,981	447	98,382	-	-	447	98,382
20	YenBai	Yen Bai	240	29,074	-	-	240	29,074	434	95,405	-	-	434	95,405
21	TuyenQuang	Tuyen Quang	157	19,013	-	-	157	19,013	284	62,390	-	-	284	62,390
22	BacKan	Bac Kan	79	9,537	-	-	79	9,537	142	31,294	-	-	142	31,294
23	LangSon	Lang Son	234	28,348	-	-	234	28,348	423	93,023	-	-	423	93,023
24	QuangNinh	Ha Long	990	119,825	11,000	91	899	108,825	1,255	276,119	11,000	91	1,164	265,119
25	HoaBinh	Hoa Binh	196	23,751	-	-	196	23,751	354	77,938	-	-	354	77,938
26	ThanhHoa	Thanh Hoa	592	71,637	-	-	592	71,637	1,069	235,072	-	-	1,069	235,072
27	NgheAn	Vinh	625	75,629	-	-	625	75,629	1,128	248,172	-	-	1,128	248,172
28	HaTinh	Ha Tinh	306	36,998	-	-	306	36,998	552	121,406	-	-	552	121,406
29	QuangBinh	Dong Hoi	213	25,727	-	-	213	25,727	384	84,422	-	-	384	84,422
30	QuangTri	Dong Ha	279	33,792	-	-	279	33,792	504	110,887	-	-	504	110,887
31	ThuaThienHue	Hue	652	78,875	-	-	652	78,875	1,176	258,824	-	-	1,176	258,824
32	DaNang		1,033	232,470	100,377	446	587	132,093	1,160	320,051	100,377	446	713	219,674
33	QuangNam	Tam Ky	440	53,229	-	-	440	53,229	794	174,667	-	-	794	174,667
34	KonTum	Kon Tum	241	29,175	-	-	241	29,175	435	95,736	-	-	435	95,736
35	QuangNgai	Quang Ngai	297	35,889	-	-	297	35,889	535	117,768	-	-	535	117,768
36	GiaLai	Pleiku	610	73,794	-	-	610	73,794	1,101	242,151	-	-	1,101	242,151
37	BinhDinh	Qui Nhon	687	83,170	-	-	687	83,170	1,241	272,916	-	-	1,241	272,916
38	PhuYen	Tuy Hoa	331	40,083	-	-	331	40,083	598	131,529	-	-	598	131,529
39	DakLak	Buon Ma Thuot	694	83,956	5,700	47	647	78,256	1,252	275,497	5,700	47	1,205	269,797
40	KhanhHoa	Nha Trang	768	92,948	-	-	768	92,948	1,318	289,874	-	-	1,318	289,874
41	LamDong	Da Lat	751	90,811	6,000	50	701	84,811	1,355	297,992	6,000	50	1,305	291,992
42	NinhThuan	Phan Rang-Thap Cham	340	41,151	-	-	340	41,151	614	135,036	-	-	614	135,036
43	BinhThuan	Phan Thiet	766	92,646	-	-	766	92,646	1,339	294,583	-	-	1,339	294,583
44	DakNong	Gia Nghia	121	14,598	-	-	121	14,598	218	47,901	-	-	218	47,901
45	BinhPhuoc	Dong Xoai	245	29,598	-	-	245	29,598	441	97,125	-	-	441	97,125
46	DongNai	Bien Hoa	1,382	167,206	-	-	1,382	167,206	2,494	548,678	-	-	2,494	548,678
47	BaRiaVungTau	Vung Tau	829	100,368	-	-	829	100,368	1,202	264,411	-	-	1,202	264,411
48	TayNinh	Tay Ninh	277	33,530	-	-	277	33,530	500	110,027	-	-	500	110,027
49	BinhDuong	Thu Dau Mot	755	91,335	-	-	755	91,335	1,362	299,712	-	-	1,362	299,712
50	HoChiMinhcity		8,400	1,889,933	196,000	871	7,529	1,693,933	9,046	2,496,660	196,000	871	8,175	2,300,660
51	LongAn	Tan An	419	50,668	-	-	419	50,668	756	166,264	-	-	756	166,264
52	TienGiang	My Tho	382	46,172	-	-	382	46,172	689	151,510	-	-	689	151,510
53	BenTre	Ben Tre	209	25,344	-	-	209	25,344	378	83,165	-	-	378	83,165
54	DongThap	Cao Lanh	493	59,680	-	-	493	59,680	890	195,838	-	-	890	195,838
55	VinhLong	Vinh Long	261	31,635	-	-	261	31,635	472	103,807	-	-	472	103,807
56	TraVinh	Tra Vinh	256	30,989	-	-	256	30,989	462	101,690	-	-	462	101,690
57	AnGiang	Long Xuyen	1,016	122,930	-	-	1,016	122,930	1,834	403,387	-	-	1,834	403,387
58	CanTho		1,310	294,840	-	-	1,310	294,840	1,570	433,357	-	-	1,570	433,357
59	HauGiang	Vi Thanh	249	30,183	-	-	249	30,183	450	99,044	-	-	450	99,044
60	SocTrang	Soc Trang	418	50,527	-	-	418	50,527	754	165,801	-	-	754	165,801
61	KienGiang	Rach Gia	757	91,537	-	-	757	91,537	1,365	300,374	-	-	1,365	300,374
62	BacLieu	Bac Lieu	376	45,486	-	-	376	45,486	678	149,260	-	-	678	149,260
63	CaMau	Ca Mau	429	51,898	-	-	429	51,898	774	170,300	-	-	774	170,300
		Total	40,743	6,653,967	460,277	2,163	38,580	6,193,690	63,920	15,252,137	460,277	2,163	61,757	14,791,860

Source: JICA Survey Team

2.3.5 Estimation of the Project and Financial Needs for the Wastewater Sector in Vietnam

(1) Basic Condition of Estimation

As the construction costs of the existing plans were estimated based on the various years in the past, the costs were revised using escalation results and construction costs in 2013.

The proportion of local and foreign costs for the construction is employed at 22:78 according to the present value. The project and financial needs per capita are calculated in US dollar basis.

(2) Financial Needs per Capita of the Treatment Plant

Financial needs per capita of WWTPs are calculated based on the WWTPs' construction costs estimated in the existing plans. The unit construction costs of WWTPs are set for the treatment processes to be used in the future such as sequencing batch reactors (SBR), oxidation ditch (OD), and conventional activated sludge (CAS). Treatment capacities of the referred plans range from 3,000 to 75,000 m^3/day. Unit construction cost of WWTP per sewage volume is calculated at USD 885/m^3/day as shown in Table 2.3.5.

(3) Projects and Financial Needs per Capita of Sewer

Projects and financial needs per capita of sewer are also calculated based on the plans in which sewer length and its corresponding cost were estimated. As shown in Table 2.3.6, the average length of main sewer per capita is 0.28 m/person and that of lateral sewer per capita is 0.73 m/person. Accordingly, the average unit costs per capita are set at USD 145 for main sewer and USD 167 for lateral sewer.

(4) Developing Method of Sewer

Sewage collection systems to be adopted in the future are assumed as follows:

a. In the big cities, the interceptor system will be adopted because of difficulty of construction in downtown.

b. In urban areas other than big cities, separate system will be employed following the laws and regulations.

Therefore, financial needs of main sewer are only calculated for the five big cities and financial needs for both main and lateral sewers are calculated for other cities.

Table 2.3.5 Project and Financial Needs per Capita (PS & WWTP)

No.	Province Name	City Name	Category (Ⅰ～Ⅴ)	Sewerage Plan (including construction on-going)											Project Cost (ajusted) 【defrator:2013 Basis】【exchage rate 1VND=0.0000473USD 2014】【domestic 22% Forign78%】				Project Cost per Capita (ajustted)			
				Project Name	Financial Source (Donor etc.)	Project Area (ha)	Planned Population (pers.)	Number of Pump Station	Sewage Amount to be Treated (m^3/day)	Treatment Method	Project Cost (VND) PS	Project Cost (VND) WWTP	Project Cost per Capita PS (VND/Unit)	Project Cost per Capita WWTP (VND/m^3/day)	PS (VND)	PS (USD)	WWTP (VND)	WWTP (USD)	PS (VND/Units)	PS (USD/Units)	WWTP (VND/m^3/day)	WWTP (USD/m^3/day)
1	KON TUM	Kon Tum (Town Ship)	III	KON TUM TOWN SHIP DRAINAGE SYSTEM AND WASTEWATER TREATMENT PLANT PROJECT	NORWAY	2,347	52,096	3	3,000	SBR	4,323,000,000	20,202,400,000	1,441,000,000	6,734,133	5,385,859,547	254,751	25,169,393,689	1,190,512	1,795,286,516	84,917	8,389,798	397
2	BINH DUONG	Thuan An	III	SOUTHERN BINH DUONG WATER ENVIRONMENT IMPROVEMENT PROJECT - Phase II	JICA	3,163	79,700	10	17,000	SBR	38,636,363,636	523,181,818,182	3,863,636,364	30,775,401	38,636,363,636	1,827,500	523,181,818,182	24,746,500	3,863,636,364	182,750	30,775,401	1,456
							Average	13	20,000		42,959,363,636	543,384,218,182	3,304,566,434	27,169,211	44,022,223,184	2,082,251	548,351,211,871	25,937,012	3,386,324,860	160,173	27,417,561	1,297
3	SON LA	SON LA	III	VIETNAM PROGRAM NORTH II-WAST WATER MANAGEMENT IN SONLA	German	1,406	90,263	5	10,355	OD	10,473,658,000	80,842,840,000	2,094,731,600	7,807,131	11,914,076,486	563,536	91,960,972,863	4,349,754	2,382,815,297	112,707	8,880,828	420
4	HOA BINH	HOA BINH	III	VIETNAM PROGRAM NORTH II-WAST WATER MANAGEMENT IN HOA BINH	German	470	85,575	5	5,120	OD	11,582,818,000	73,719,178,000	2,316,563,600	14,398,277	13,433,090,796	635,385	85,495,292,376	4,043,927	2,686,618,159	127,077	16,698,299	790
5	CAO BANG	Cao Bang	III	CAO BANG TOWN DRAINAGE, SEWERAGE AND WASTEWATER CONNECTION PROJECT	DANIDA	1,115	60,433	5	3,000	OD	8,872,595,000	26,110,000,000	1,774,519,000	8,703,333	10,092,822,914	477,391	29,700,849,221	1,404,850	2,018,564,583	95,478	9,900,283	468
6	LANG SON	LANG SON	III	VIETNAM PROGRAM NORTH II-WAST WATER MANAGEMENT IN LANG SON	German	781	80,468	13	5,260	OD	36,599,134,000	162,440,954,000	2,815,318,000	30,882,311	42,445,585,354	2,007,676	188,389,741,081	8,910,835	3,265,045,027	154,437	35,815,540	1,694
							Average	28	23,735		67,528,205,000	343,112,972,000	2,411,721,607	14,455,992	77,885,575,550	3,683,988	395,546,855,541	18,709,366	2,781,627,698	131,571	16,665,130	788
7	DONG NAI	Bien Hoa	Ⅲ	DONG NAI WATER ENVIRONMENT IMPROVEMENT PROJECT	JICA	1,072	188,300	2	52,000	CAS	126,553,669,725	1,353,787,155,963	63,276,834,862	26,034,368	132,006,769,876	6,243,920	1,412,120,801,765	66,793,314	66,003,384,938	3,121,960	27,156,169	1,284
8	-	Da Nang	Ⅱ	STUDY ON WATER ENVIRONMENT IMPROVEMENT PROJECT FOR DA NANG CITY(Phase-Ⅰ)	JICA	762	264,700	1	75,500	CAS	61,648,745,520	796,415,770,609	61,648,745,520	10,548,553	70,127,157,999	3,317,015	905,945,029,498	42,851,200	70,127,157,999	3,317,015	11,999,272	568
8	KIEN GIANG	Phu Quoc	Ⅲ	PREPARATORY SURVEY ON WATER SUPPLY AND SEWERAGE SYSTEM PROJECT IN PHU QUOC ISLAND IN THE SOCIALIST REPUBLIC OF VIETNAM PHASE-Ⅱ	JICA	1,280	435,000	3	22,500	CAS	50,270,270,270	355,945,945,946	16,756,756,757	15,819,820	51,133,583,959	2,418,619	362,058,763,842	17,125,380	17,044,527,986	806,206	16,091,501	761
							Average	6	150,000		238,472,685,515	2,506,148,872,519	39,745,447,586	16,707,659	253,267,511,834	11,979,553	2,680,124,595,104	126,769,893	42,211,251,972	1,996,592	17,867,497	845
							Average	47	193,735		348,960,254,151	3,392,646,062,700	7,424,686,259	17,511,787	375,175,310,568	17,745,792	3,624,022,662,517	171,416,272	7,982,453,416	377,570	18,706,081	885

Source: JICA Survey Team

Table 2.3.6 Project and Financial Needs per Capita (Main Sewer & Lateral)

No.	Province Name	City Name	Category (Ⅰ～Ⅴ)	Sewerage Plan (including construction on-going)										Project Cost (ajusted) 【defrator:2013 Basis】 【exchage rate 1VND=0.0000473USD 2014】 【domestic 22% Forign78%】				Project Cost per Capita (ajusted)				Data Source
				Project Name	Financial Source (Donor etc.)	Project Area (ha)	Planned Population (pers.)	Sewer Pipe Length (km)		Length per Area		Length per Person		Project Cost (VND)								
								Main Sewer	Lateral/ House connection.	Main Sewer (m/ha)	Lateral/H.C (m/ha)	Main Sewer (m/pers.)	Lateral/H.C (m/pers.)	Main Sewer	Lateral/H.C	Main Sewer (VND)	Main Sewer (USD)	Lateral/H.C (VND)	Lateral/H.C (USD)	Main Sewer (VND/Pers.)	Main Sewer (USD/Pers.)	Lateral/H.C (VND/pers.)	Lateral/H.C (USD/Pers.)	
1	BINH DUONG	Thuan An	Ⅲ	SOUTHERN BINH DUONG WATER ENVIRONMENT IMPROVEMENT PROJECT - Phase II	JICA	3,163	215,000	86.00	88.00	27.19	27.82	0.40	0.41	1,021,136,363,636	232,727,272,727	1,021,136,363,636	48,299,750	232,727,272,727	11,008,000	4,749,471	225	1,082,452	51	F/S 2013
2	-	Da Nang	Ⅱ	STUDY ON WATER ENVIRONMENT IMPROVEMENT PROJECT FOR DA NANG CITY(Phase- Ⅰ)	JICA	762	264,700	22.60	152.80	29.65	200.49	0.09	0.58	334,500,537,634	547,670,250,896	380,503,639,704	17,997,822	622,990,101,293	29,467,432	1,437,490	68	2,353,570	111	F/S 2009
3	DONG NAI	Bien Hoa	Ⅲ	DONG NAI WATER ENVIRONMENT IMPROVEMENT PROJECT	JICA	1,072	188,300	18.30	245.60	17.07	229.10	0.10	1.30	573,923,165,138	1,437,916,513,761	598,653,072,262	28,316,290	1,499,875,228,790	70,944,098	3,179,252	150	7,965,349	377	F/S 2011
				Average		4,997	668,000	126.90	486.40	25.39	97.34	0.19	0.73	1,929,560,066,408	2,218,314,037,385	2,000,293,075,601	94,613,862	2,355,592,602,810	111,419,530	2,994,451	142	3,526,336	167	
4	BAC NINH	Bac Ninh	III	BAC NINH CITY DRAINAGE, SEWERAGE AND WASTEWATER TREATMENT PROJECT	KfW	3,000	92,800	13.53	N/A	4.51	N/A	0.15	-	116,325,000,000	-	155,239,382,409	7,342,823	-	-	1,672,838	79	-	-	F/S 2005
5	HAI DUONG	Hai Duong	II	HAI DUONG CITY DRAINAGE AND WASTEWATER TREATMENT PROJECT	KfW	1,800	50,000	12.62	N/A	7.01	N/A	0.25	-	78,882,000,000	-	105,270,517,629	4,979,295	-	-	2,105,410	100	-	-	F/S 2005
6	KON TUM	Kon Tum (Town Ship)	III	KON TUM TOWN SHIP DRAINAGE SYSTEM AND WASTEWATER TREATMENT PLANT PROJECT	NORWAY	2,347	52,096	20.50	N/A	8.73	N/A	0.39	-	145,442,600,000	-	181,201,345,315	8,570,824	-	-	3,478,220	165	-	-	F/S 2007
7	HOA BINH	HOA BINH	III	VIETNAM PROGRAM NORTH II-WAST WATER MANAGEMENT IN HOA BINH	German	470	85,575	21.00	N/A	44.68	N/A	0.25	-	224,205,748,000	-	260,021,021,636	12,298,994	-	-	3,038,516	144	-	-	F/S 2008
8	HA GIANG	Ha Giang	III	HA GIANG CITY DRAINAGE, SEWERAGE AND WASTE WATER TREATMENT PROJECT	DANIDA	13,508	94,000	33.92	N/A	2.51	N/A	0.36	-	197,013,200,000	-	224,107,979,616	10,600,307	-	-	2,384,127	113	-	-	F/S 2009
9	CAO BANG	Cao Bang	III	CAO BANG TOWN DRAINAGE, SEWERAGE AND WASTEWATER CONNECTION PROJECT	DANIDA	1,115	60,433	41.15	N/A	36.91	N/A	0.68	-	176,190,405,000	-	200,421,472,735	9,479,936	-	-	3,316,424	157	-	-	F/S 2009
10	LANG SON	LANG SON	III	VIETNAM PROGRAM NORTH II-WAST WATER MANAGEMENT IN LANG SON	German	781	80,468	13.70	N/A	17.54	N/A	0.17	-	188,761,508,000	-	218,914,816,384	10,354,671	-	-	2,720,520	129	-	-	F/S 2008
11	TAY NINH	Tay Ninh	III	Wastewater collection and treatment system project in Tay Ninh town – Tay Ninh province	ODA-Italy	2,523	104,876	45.22	N/A	17.92	N/A	0.43	-	330,079,575,489	-	382,807,440,065	18,106,792	-	-	3,650,096	173	-	-	F/S 2008
12	QUANG NAM	Tam Ky	III	COLLECTION, WASTEWATER TREATMENT AND DRAINAGE SYSTEM OF TAM KY CITY PROJECT	WB	9,282	117,873	47.01	N/A	5.06	N/A	0.40	-	159,953,370,280	-	166,845,637,802	7,891,799	-	-	1,415,470	67	-	-	F/S 2011
13	THAI NGUYEN	Thai Nguyen	Ⅱ	THAI NGUYEN CITY DRAINAGE, SEWERAGE AND WASTEWATER TREATMENT PROJECT	FRANCE	1,200	100,000	54.30	N/A	45.25	N/A	0.54	-	395,248,795,715	-	449,606,468,263	21,266,386	-	-	4,496,065	213	-	-	F/S 2009
14	LAO CAI	Sa Pa	Ⅱ	PROGAME OF RURAL INFRASTRUCTURE IMPROVEMENT LAO CAI	AFD	N/A	43,600	13.00	N/A	N/A	N/A	0.30	-	546,702,451,500	-	634,034,279,843	29,989,821	-	-	14,542,071	688	-	-	F/S 2008
15	THAI BINH	Thai Binh	II	THAI BINH CITY DRAINAGE, SEWERAGE AND SANITATION IMPROVEMENT PROJECT	NORWAY	1,167	135,000	31.34	N/A	26.86	N/A	0.23	-	147,191,907,000	-	189,989,733,177	8,986,514	-	-	1,407,331	67	-	-	F/S 2006
				Average		37,193	1,016,721	347.29	N/A	9.34	N/A	0.34	-	2,705,996,560,984	-	3,168,460,094,876	149,868,162	-	-	3,116,352	147	-	-	
				Average(Whole)		42,190	1,684,721	474.19	N/A	11.24	N/A	0.28	0.73	1,929,560,066,408	2,218,314,037,385	5,168,753,170,477	244,482,025	2,355,592,602,810	111,419,530	3,068,017	145	3,526,336	167	

Source: JICA Survey Team

(5) Project and Financial Needs for the Wastewater Sector

Calculation results of project and financial needs for the wastewater sector in Vietnam are shown in Table 2.3.7. Total amount of financial needs by 2050 is USD 46,939 million. The breakdown is USD 19,943 million for sewer construction and USD 26,996 million for WWTP's construction, renovation, and rehabilitation.

(It is assumed that renovation and renewal costs for mechanical and electrical equipment corresponding to the plant construction cost and renovation will be required twice by 2050.)

Table 2.3.7 Project and Financial Needs for the Wastewater Sector in Vietnam

Country	Province	Capital City	2009	2025										2050									
			Urban Population (thous pers.)	Urban Population (thous pers.)	Sewage Volume (m^3/day)	Project Needs for Sewer (km)		Financial Needs for Sewer (Million USD)		Subtotal (3)=(1)+(2)	Financial Needs for Treatment Plant	Financial Needs for Renovation and Renewal	Subtotal (6)=(4)+(5)	Total (7)=(3)+(5)	Urban Population (thous pers.)	Sewage Volume (m^3/day)	Project Needs for Sewer (km)		Financial Needs for Sewer (Million USD)		Subtotal (3)=(1)+(2)	Financial Needs for Treatment Plant	Financial Needs for Renovation and Renewal	Subtotal (6)=(4)+(5)	Total (6)=(3)+(5)
						Main Sewer	Lateral/H.C	Main Sewer (1)	Lateral/H.C (2)	(Million USD)	(4) (Million USD)	(5) (Million USD)	(Million USD)	(Million USD)			Main Sewer	Lateral/H.C	Main Sewer (1)	Lateral/H.C (2)	(Million USD)	(4) (Million USD)	(5) (Million USD)	(Million USD)	(Million USD)
Province																								
1	PhuTho	Viet Tri	209	347	42,038	97	0	50	0	50	37	0	37	88	627	137,947	176	458	91	105	196	122	122	244	440
2	VinhPhuc	Vinh Yen	225	374	45,285	105	0	54	0	54	40	0	40	94	675	148,599	189	493	98	113	211	132	132	263	474
3	ThaiNguyen	Thai Nguyen	288	480	58,027	134	0	70	0	70	51	0	51	121	866	190,413	242	632	125	145	270	169	169	337	607
4	HaNoi		2,653	4,420	994,586	1,238	0	641	0	641	880	0	880	1,521	7,544	2,082,081	2,112	5,507	1,094	1,260	2,354	1,843	1,843	3,685	6,039
5	BacNinh	Bac Ninh	242	402	48,692	113	0	58	0	58	43	0	43	101	726	159,780	203	530	105	121	227	141	141	283	509
6	BacGiang	Bac Giang	146	243	29,437	68	0	35	0	35	26	0	26	61	439	96,596	123	321	64	73	137	85	85	171	308
7	HaiDuong	Hai Duong	324	539	65,265	151	0	78	0	78	58	0	58	136	973	214,165	273	711	141	163	304	190	190	379	683
8	HaiPhong		849	1,414	318,119	396	0	205	0	205	282	0	282	487	1,926	531,554	539	1,406	279	322	601	470	470	941	1,542
9	ThaiBinh	Thai Binh	173	289	34,941	81	0	42	0	42	31	0	31	73	521	114,658	146	380	76	87	163	101	101	203	366
10	HungYen	Hung Yen	136	227	27,481	64	0	33	0	33	24	0	24	57	410	90,178	115	299	59	68	128	80	80	160	288
11	HaNam	Phu Ly	75	125	15,102	35	0	18	0	18	13	0	13	31	225	49,555	63	164	33	38	70	44	44	88	158
12	NamDinh	Nam Dinh	322	536	64,842	150	0	78	0	78	57	0	57	135	967	212,776	271	706	140	162	302	188	188	377	678
13	NinhBinh	Ninh Binh	161	268	32,441	75	0	39	0	39	29	0	29	68	484	106,454	135	353	70	81	151	94	94	188	339
14	LaiChau	Lai Chau	53	89	10,747	25	0	13	0	13	10	0	10	22	160	35,264	45	117	23	27	50	31	31	62	112
15	LaoCai	Lao Cai	130	217	26,292	61	0	32	0	32	23	0	23	55	392	86,275	110	286	57	65	122	76	76	153	275
16	HaGiang	Ha Giang	92	153	18,469	43	0	22	0	22	16	0	16	38	275	60,604	77	201	40	46	86	54	54	107	193
17	CaoBang	Cao Bang	86	144	17,420	40	0	21	0	21	15	0	15	36	260	57,164	73	190	38	43	81	51	51	101	182
18	DienBien	Dien Bien Phu	74	122	14,819	34	0	18	0	18	13	0	13	31	221	48,629	62	161	32	37	69	43	43	86	155
19	SonLa	Son La	149	248	29,981	69	0	36	0	36	27	0	27	62	447	98,382	125	326	65	75	140	87	87	174	314
20	YenBai	Yen Bai	144	240	29,074	67	0	35	0	35	26	0	26	61	434	95,405	121	317	63	72	135	84	84	169	304
21	TuyenQuang	Tuyen Quang	94	157	19,013	44	0	23	0	23	17	0	17	40	284	62,390	79	207	41	47	88	55	55	110	199
22	BacKan	Bac Kan	47	79	9,537	22	0	11	0	11	8	0	8	20	142	31,294	40	104	21	24	44	28	28	55	100
23	LangSon	Lang Son	141	234	28,348	66	0	34	0	34	25	0	25	59	423	93,023	118	309	61	71	132	82	82	165	297
24	QuangNinh	Ha Long	594	990	119,825	277	0	144	0	144	106	0	106	250	1,255	276,119	351	916	182	210	392	244	244	489	880
25	HoaBinh	Hoa Binh	118	196	23,751	55	0	28	0	28	21	0	21	49	354	77,938	99	259	51	59	111	69	69	138	248
26	ThanhHoa	Thanh Hoa	355	592	71,637	166	0	86	0	86	63	0	63	149	1,069	235,072	299	780	155	178	333	208	208	416	749
27	NgheAn	Vinh	375	625	75,629	175	0	91	0	91	67	0	67	158	1,128	248,172	316	823	164	188	352	220	220	439	791
28	HaTinh	Ha Tinh	184	306	36,998	86	0	44	0	44	33	0	33	77	552	121,406	155	403	80	92	172	107	107	215	387
29	QuangBinh	Dong Hoi	128	213	25,727	60	0	31	0	31	23	0	23	54	384	84,422	107	280	56	64	120	75	75	149	269
30	QuangTri	Dong Ha	168	279	33,792	78	0	40	0	40	30	0	30	70	504	110,887	141	368	73	84	157	98	98	196	354
31	ThuaThienHue	Hué	391	652	78,875	183	0	95	0	95	70	0	70	164	1,176	258,824	329	859	171	196	367	229	229	458	825
32	DaNang		777	1,033	232,470	289	0	150	0	150	206	0	206	356	1,160	320,051	325	847	168	194	362	283	283	566	928
33	QuangNam	Tam Ky	264	440	53,229	123	0	64	0	64	47	0	47	111	794	174,667	222	580	115	133	248	155	155	309	557
34	KonTum	Kon Tum	145	241	29,175	68	0	35	0	35	26	0	26	61	435	95,736	122	318	63	73	136	85	85	169	305
35	QuangNgai	Quang Ngai	178	297	35,889	83	0	43	0	43	32	0	32	75	535	117,768	150	391	78	89	167	104	104	208	375
36	GiaLai	Pleiku	366	610	73,794	171	0	88	0	88	65	0	65	154	1,101	242,151	308	804	160	184	343	214	214	429	772
37	BinhDinh	Qui Nhon	413	687	83,170	192	0	100	0	100	74	0	74	173	1,241	272,916	347	906	180	207	387	242	242	483	870
38	PhuYen	Tuy Hoa	199	331	40,083	93	0	48	0	48	35	0	35	84	598	131,529	167	436	87	100	187	116	116	233	419
39	DakLak	Buon Ma Thuot	416	694	83,956	194	0	101	0	101	74	0	74	175	1,252	275,497	351	914	182	209	391	244	244	488	878
40	KhanhHoa	Nha Trang	461	768	92,948	215	0	111	0	111	82	0	82	194	1,318	289,874	369	962	191	220	411	257	257	513	924
41	LamDong	Da Lat	450	751	90,811	210	0	109	0	109	80	0	80	189	1,355	297,992	379	989	196	226	423	264	264	527	950
42	NinhThuan	Phan Rang-Thap C	204	340	41,151	95	0	49	0	49	36	0	36	86	614	135,036	172	448	89	103	192	120	120	239	431
43	BinhThuan	Phan Thiet	460	766	92,646	214	0	111	0	111	82	0	82	193	1,339	294,583	375	977	194	224	418	261	261	521	939
44	DakNong	Gia Nghia	72	121	14,598	34	0	17	0	17	13	0	13	30	218	47,901	61	159	32	36	68	42	42	85	153
45	BinhPhuoc	Dong Xoai	147	245	29,598	68	0	35	0	35	26	0	26	62	441	97,125	124	322	64	74	138	86	86	172	310
46	DongNai	Bien Hoa	829	1,382	167,206	387	0	200	0	200	148	0	148	348	2,494	548,678	698	1,821	362	416	778	486	486	971	1,749
47	BaRiaVungTau	Vung Tau	498	829	100,368	232	0	120	0	120	89	0	89	209	1,202	264,411	337	877	174	201	375	234	234	468	843
48	TayNinh	Tay Ninh	166	277	33,530	78	0	40	0	40	30	0	30	70	500	110,027	140	365	73	84	156	97	97	195	351
49	BinhDuong	Thu Dau Mot	453	755	91,335	211	0	109	0	109	81	0	81	190	1,362	299,712	381	994	198	228	425	265	265	530	956
50	HoChiMinhcity		6,021	8,400	1,889,933	2,352	0	1,218	0	1,218	1,673	0	1,673	2,891	9,046	2,496,660	2,533	6,603	1,312	1,511	2,822	2,210	2,210	4,419	7,241
51	LongAn	Tan An	251	419	50,668	117	0	61	0	61	45	0	45	106	756	166,264	212	552	110	126	236	147	147	294	530
52	TienGiang	My Tho	229	382	46,172	107	0	55	0	55	41	0	41	96	689	151,510	193	503	100	115	215	134	134	268	483
53	BenTre	Ben Tre	126	209	25,344	59	0	30	0	30	22	0	22	53	378	83,165	106	276	55	63	118	74	74	147	265
54	DongThap	Cao Lanh	296	493	59,680	138	0	72	0	72	53	0	53	124	890	195,838	249	650	129	149	278	173	173	347	624
55	VinhLong	Vinh Long	157	261	31,635	73	0	38	0	38	28	0	28	66	472	103,807	132	344	68	79	147	92	92	184	331
56	TraVinh	Tra Vinh	154	256	30,989	72	0	37	0	37	27	0	27	65	462	101,690	129	337	67	77	144	90	90	180	324
57	AnGiang	Long Xuyen	610	1,016	122,930	284	0	147	0	147	109	0	109	256	1,834	403,387	513	1,339	266	306	572	357	357	714	1,286
58	CanTho		783	1,310	294,840	367	0	190	0	190	261	0	261	451	1,570	433,357	440	1,146	228	262	490	384	384	767	1,257
59	HauGiang	Vi Thanh	150	249	30,183	70	0	36	0	36	27	0	27	63	450	99,044	126	329	65	75	140	88	88	175	316
60	SocTrang	Soc Trang	251	418	50,527	117	0	61	0	61	45	0	45	105	754	165,801	211	550	109	126	235	147	147	293	529
61	KienGiang	Rach Gia	454	757	91,537	212	0	110	0	110	81	0	81	191	1,365	300,374	382	997	198	228	426	266	266	532	958
62	BacLieu	Bac Lieu	226	376	45,486	105	0	55	0	55	40	0	40	95	678	149,260	190	495	98	113	212	132	132	264	476
63	CaMau	Ca Mau	257	429	51,898	120	0	62	0	62	46	0	46	108	774	170,300	217	565	112	129	242	151	151	301	543
		Total	25,585	40,743	6,653,967	11,408	0	5,908	0	5,908	5,889	0	5,889	11,796	63,920	15,252,137	17,898	46,662	9,268	10,675	19,943	13,498	13,498	26,996	46,939

Source: JICA Survey Team

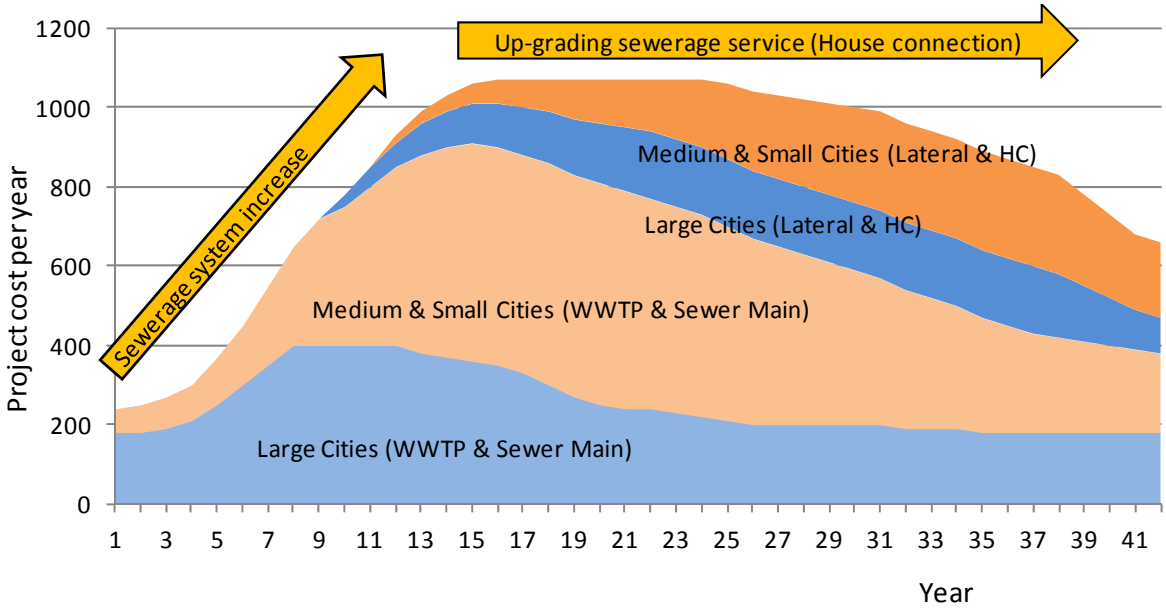
2.4 Project Needs of the Water Sector

2.4.1 Financial Model of Sewerage Development

Financial needs of the wastewater sector are estimated at a huge amount of USD 46,939 billion for 2050 vision. Individual project requires large amount of financial resources as well as long period, and full cost recovery by tariff is not realistic. Accordingly, project programming requires exploiting project result at most in accordance with saving budgetary expenditure.

Sewerage role in Vietnam prioritizes in the improvement of water environment and sanitation. Accordingly, large cities such as Ha Noi, HCMC, and other cities shall apply the interceptor sewer system, and service pipes and house connections are postponed to the latter part of the project cycle.

Financial model of the Vietnamese sewerage development is shown in Figure 2.4.1, which describes that sewerage development projects are implemented in large and tourism destinations at first, and medium and small municipalities follow. Step-wise sewerage development is practical for individual municipality which prioritizes in sewer main and WWTP postpones service sewer and house connection into the latter phase.

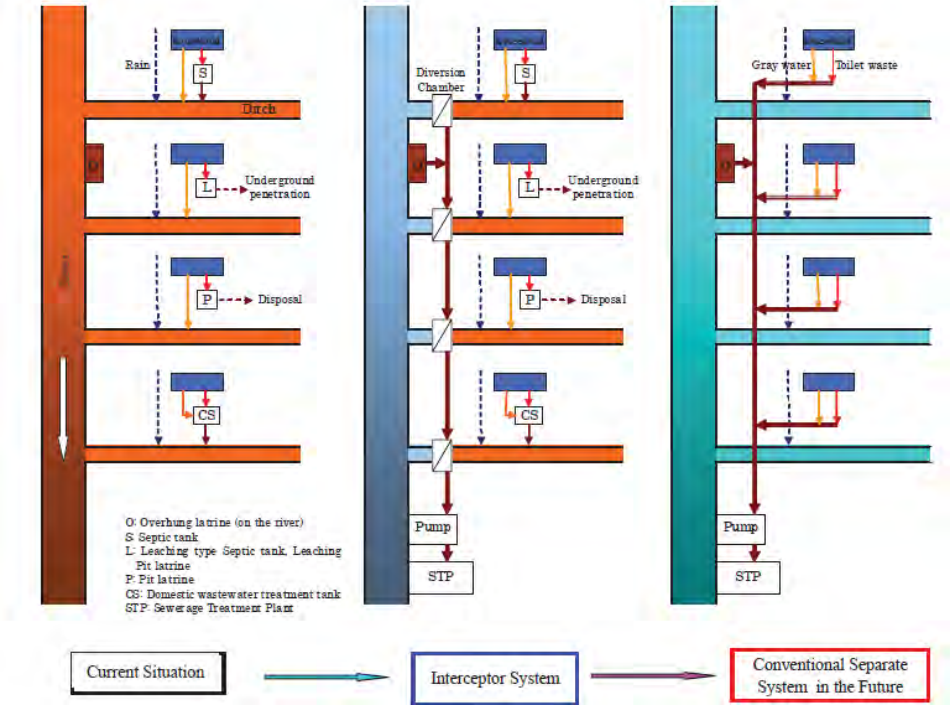


Source: JICA Survey Team

Figure 2.4.1 Step-wise Project Programming Model

2.4.2 Step-wise Project Action Plan

The image of step-wise sewerage development which applies interceptor sewer will be integrated to conventional separate sewer as shown in Figure 2.4.2.

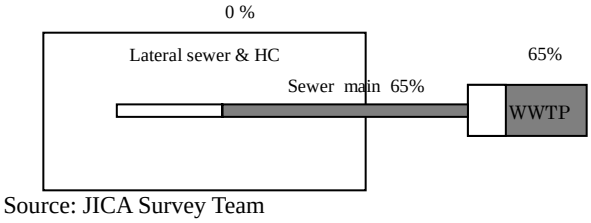


Source: Tentative Guidelines for Municipal Wastewater Management and Drainage Technology in Developing Countries, Ministry of Construction, Japan

Figure 2.4.2 Step-wise Sewerage Development

(1) Financial Needs in Year 2025

Development of the sewerage system requires long period and large amount of financial resource. Accordingly, sewerage service shall focus on the most priority role of water environment restoration through applying interceptor sewerage system, which develops WWTP and sewer main for the first step as shown in Figure 2.4.3. Most pollutants of gray water and supernatant of septic tank are collected and treated in the system. As a result, sanitation and water environment can be improved drastically. Septage can be collected by tank truck and treated through treatment plant. Financial resource for sewerage development will be saved at the first step of sewerage development by applying this system.

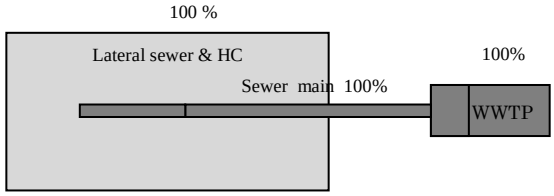


Source: JICA Survey Team

Figure 2.4.3 Model of the Sewerage System Development in 2025

(2) Financial Needs in 2050

Conventional separate sewerage system is completely developed at this stage. Accordingly, human wastes as well as gray water are treated. Sewerage system development in 2050 is shown in Figure 2.4.4.



Source: JICA Survey Team

Figure 2.4.4 Sewerage System Development in 2050

2.4.3 Summary of the Water Sector Needs

Project needs of the water supply and wastewater sectors are shown in Table 2.4.1, Table2.4.2, and Figure 2.4.5.

Water supply has less project needs than sewerage due to the high service rate of 70% at present, however, replacement of WTP and NRW mitigation projects as well as expansion of service areas are required.

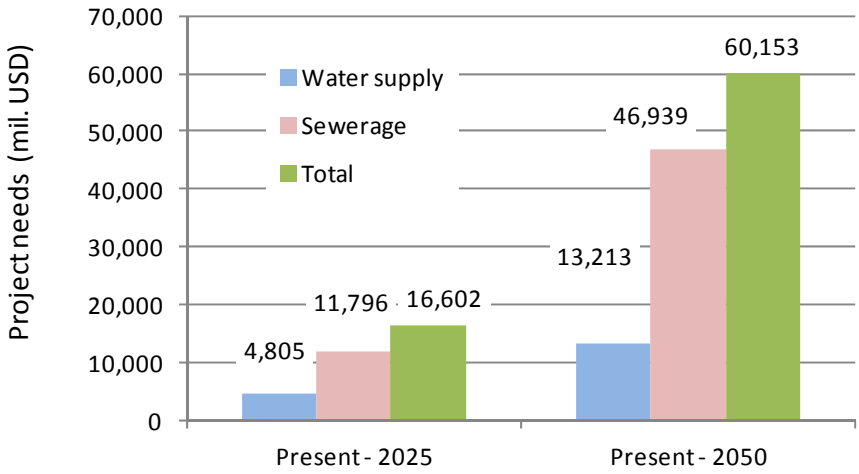
The wastewater sector requires huge amount of financial source exceeding MPI survey (USD 8.25 billion for 2011-2020) due to urgent sewerage system development in the whole country. This survey applies existing construction database which includes large-scale project in Ha Noi, HCMC, and others. Mitigating financial expenditure is indispensable through applying low-cost technology and focusing on priority projects. Public fund investment mechanism is urgently required considering low interest rate and long repayment period in accordance with the huge amount of financial needs.

Table 2.4.1 Project Needs of the Water Supply and Wastewater Sectors

(Unit: USD in millions)

Year	Present - 2025	Present - 2050
Water supply	4,805	13,213
Sewerage	11,796	46,939
Total	16,602	60,153

Source: JICA Survey Team



Source: JICA Survey Team

Figure 2.4.5 Project Needs of the Water Supply and Wastewater Sectors

Table 2.4.2 Project Needs of the Water Supply and Sewerage Sectors in 2025 / 2050 (1/2)

(Unit: million USD)

No	Province	2025							2050						
		Water Supply			Wastewater			Total	Water Supply			Wastewater			Total
		WTP (1)	Pipe System (2)	WS Total (3) =(1)+(2)	Sewer (4)	WWTP (5)	WW Total (6) =(4)+(5)	(3)+(6)	WTP (7)	Pipe System (8)	WS Total (9) =(7)+(8)	Sewer (10)	WWTP (11)	WW Total (13) =(10)+(12	(9)+(13)
1	PhuTho	3	37	40	50	37	88	128	48	130	178	196	244	440	618
2	VinhPhuc	13	13	26	54	40	94	120	61	63	124	211	263	474	598
3	ThaiNguyen	16	23	39	70	51	121	159	78	100	178	270	337	607	785
4	HaNoi	266	542	809	641	880	1,521	2,330	425	906	1,332	2,354	3,685	6,039	7,371
5	BacNinh	19	19	38	58	43	101	139	70	72	142	227	283	509	651
6	BacGiang	10	10	19	35	26	61	81	41	42	82	137	171	308	390
7	HaiDuong	14	16	30	78	58	136	166	84	93	177	304	379	683	860
8	HaiPhong	184	385	569	205	282	487	1,055	215	493	708	601	941	1,542	2,250
9	ThaiBinh	3	5	8	42	31	73	81	40	43	83	163	203	366	449
10	HungYen	14	15	29	33	24	57	86	42	46	88	128	160	288	376
11	HaNam	2	3	5	18	13	31	36	18	21	40	70	88	158	197
12	NamDinh	13	30	43	78	57	135	178	83	136	218	302	377	678	897
13	NinhBinh	6	11	17	39	29	68	85	41	58	99	151	188	339	438
14	LaiChau	2	4	6	13	10	22	29	14	20	34	50	62	112	146
15	LaoCai	2	9	11	32	23	55	66	31	46	77	122	153	275	352
16	HaGiang	8	10	18	22	16	38	56	28	32	59	86	107	193	252
17	CaoBang	6	7	13	21	15	36	49	24	29	53	81	101	182	235
18	DienBien	6	7	12	18	13	31	43	21	22	43	69	86	155	198
19	SonLa	4	20	24	36	27	62	86	37	86	123	140	174	314	436
20	YenBai	12	18	30	35	26	61	90	43	60	103	135	169	304	407
21	TuyenQuang	4	11	14	23	17	40	54	24	45	70	88	110	199	269
22	BacKan	3	4	7	11	8	20	27	14	15	29	44	55	100	128
23	LangSon	10	11	21	34	25	59	80	40	39	79	132	165	297	376
24	QuangNinh	26	41	67	144	106	250	316	99	150	248	392	489	880	1,129
25	HoaBinh	5	9	14	28	21	49	64	30	45	76	111	138	248	324
26	ThanhHoa	22	28	50	86	63	149	199	99	116	214	333	416	749	964
27	NgheAn	23	95	118	91	67	158	276	103	321	424	352	439	791	1,216
28	HaTinh	10	37	47	44	33	77	124	50	130	179	172	215	387	567
29	QuangBinh	6	8	15	31	23	54	68	34	41	75	120	149	269	344
30	QuangTri	5	11	16	40	30	70	87	42	60	102	157	196	354	455
31	ThuaThienHu	7	51	58	95	70	164	222	85	198	284	367	458	825	1,109
32	DaNang	94	248	342	150	206	356	697	146	476	622	362	566	928	1,551
33	QuangNam	19	27	46	64	47	111	157	75	100	175	248	309	557	732

Source: JICA Survey Team

Table 2.4.2 Project Needs of the Water Supply and Sewerage Sectors in 2025 / 2050 (2/2)

(Unit: million USD)

No	Province	2025							2050						
		Water Supply			Wastewater			Total	Water Supply			Wastewater			Total
		WTP (1)	Pipe System (2)	WS Total (3) =(1)+(2)	Sewer (4)	WWTP (5)	WW Total (6) =(4)+(5)	(3)+(6)	WTP (7)	Pipe System (8)	WS Total (9) =(7)+(8)	Sewer (10)	WWTP (11)	WW Total (13) =(10)+(12	(9)+(13)
34	KonTum	13	14	27	35	26	61	88	43	48	91	136	169	305	396
35	QuangNgai	6	6	12	43	32	75	87	45	45	91	167	208	375	466
36	GiaLai	34	34	67	88	65	154	221	111	110	221	343	429	772	993
37	BinhDinh	28	40	68	100	74	173	241	116	151	268	387	483	870	1,138
38	PhuYen	10	17	28	48	35	84	111	53	75	128	187	233	419	547
39	DakLak	29	31	60	101	74	175	235	118	123	241	391	488	878	1,120
40	KhanhHoa	25	39	64	111	82	194	258	117	162	279	411	513	924	1,203
41	LamDong	21	24	45	109	80	189	234	119	128	247	423	527	950	1,197
42	NinhThuan	8	12	19	49	36	86	105	52	65	117	192	239	431	547
43	BinhThuan	41	45	86	111	82	193	279	134	145	279	418	521	939	1,218
44	DakNong	7	15	23	17	13	30	53	23	46	68	68	85	153	221
45	BinhPhuoc	12	12	24	35	26	62	85	43	41	85	138	172	310	394
46	DongNai	29	21	50	200	148	348	399	209	193	402	778	971	1,749	2,152
47	BaRiaVungT	8	29	37	120	89	209	246	81	129	211	375	468	843	1,054
48	TayNinh	11	16	27	40	30	70	97	47	61	108	156	195	351	458
49	BinhDuong	10	35	44	109	81	190	235	90	168	258	425	530	956	1,214
50	HoChiMinhci	266	509	774	1,218	1,673	2,891	3,665	366	753	1,119	2,822	4,419	7,241	8,361
51	LongAn	17	18	35	61	45	106	140	71	74	145	236	294	530	675
52	TienGiang	6	19	24	55	41	96	121	41	61	103	215	268	483	586
53	BenTre	5	4	9	30	22	53	62	32	31	63	118	147	265	328
54	DongThap	11	24	35	72	53	124	160	75	115	190	278	347	624	815
55	VinhLong	6	16	22	38	28	66	88	40	71	112	147	184	331	442
56	TraVinh	10	14	24	37	27	65	89	43	56	99	144	180	324	423
57	AnGiang	61	103	164	147	109	256	420	189	314	503	572	714	1,286	1,789
58	CanTho	48	98	147	190	261	451	598	88	185	272	490	767	1,257	1,529
59	HauGiang	11	18	28	36	27	63	91	42	64	106	140	175	316	422
60	SocTrang	13	21	35	61	45	105	140	67	91	159	235	293	529	688
61	KienGiang	35	54	88	110	81	191	279	131	189	320	426	532	958	1,278
62	BacLieu	19	21	40	55	40	95	135	67	73	140	212	264	476	615
63	CaMau	16	18	34	62	46	108	142	71	80	151	242	301	543	694
	Total	1,651	3,091	4,742	5,908	5,889	11,796	16,538	5,011	8,082	13,093	19,943	26,996	46,939	60,033

Source: JICA Survey Team

2.5 Priority Projects

Based on the potential project needs survey for the water supply and wastewater sectors in Vietnam as shown in Sections 2.2 and 2.3, priority projects were selected in accordance with the following selection criteria:

1) Water supply subprojects:

- The urgency, efficiency, and feasibility of the project.
- The requirement of complementary funding source for materializing the public-private-partnership (PPP) projects (for public portion of PPP projects).

2) Sewerage subprojects:

- The urgency, efficiency, and feasibility of the project;
- The progress of the preparation of feasibility study; and
- Technical certificates, issued by the training center, for municipalities without wastewater infrastructure development experience (Note: this criteria will be considered after the establishment of the training center).

Following the above criteria, the priority projects of the water supply and wastewater sectors were selected and the list of priority projects in each tranche, namely Long List, is shown in Table 2.5.1. Projects of the first and second tranches are selected among the projects which PPP FS and JICA TA have completed and will be implemented. The projects for which local consultants implement their F/S can be nominated to third tranche considering that the JICA appraisal takes time.

Table 2.5.1 Priority Projects of Water Supply and Sewerage (Long List) (1/3)

First Tranche (2014-2015): Sector Loan Projects

Water supply

1 USD=100 JPY= 20,000VND

Province City	Project	Project scope (Sector loan)	FS status	Remarks
Bin Duong	Water Supply Project in New City and Industrial Park in Northern Part of Binh Duong Province	Transfer & Reservoir 118.3 million USD Distribution 51.5 million.USD Total 118.3-169.8 million.USD	JICA PPP FS (2013) Planed to complete in July, 2014	Water price: in consultation Land acquisition & resettlement: proceeding WTP EIA: not assessed Distribution: ADB Vietnam Water Sector Investment Program (23 May 2013)
Kien Giang	Water Supply and Sewerage System Development in Phu Quoc Island, Kien Gian Province (PPP Infra)	Reservoir, Intake & Transfer 26.3 million.USD Distribution 10.4 million USD Total 36.7 million USD	Completed (2013)	Project frame: agreed. Land acquisition & resettlement: not completed EIA: not completed

Sewerage

Province City	Project	Project scope (Sector loan)	FS status	Remarks
Quang Ninh	Halong City Environmental Protection Project	Treatment capacity East 6,500 m^3/day West 5,000 m^3/day Total 60 million USD	Completed (2008)	FS to be evaluated EI A: not studied Land acquisition: Existing WWTP applied Resettlement: not required
Da Nang	Wastewater Management Project in Da Nang City (Lien Chieu WWTP)	Served pop. 264,700 cap. Service area 5,369 ha Capacity(Total) 75,500 m^3/day Phase-1 16,400 m^3/day Project cost 97.31 million USD	JETRO FS (2010)	Phu Loc WWTP rehabilitation (BOT project completes in 2014) Land: Marsh area (location is decided) Resettlement: not required

Estimated total project cost	Approx. 300 million USD for 4 projects (two water supply projects and two sewerage projects)

Source: JICA Survey Team

Table 2.5.1 Priority Projects of Water Supply and Sewerage (Long List) (2/3)

Second Tranche (2016 –): Sector Loan Projects

Water supply

1 USD=100 JPY= 20,000VND

Province City	Project	Project scope (Sector loan)	FS status	Remarks
Ha Nam	Urban Development Project	N.A.	No	Land acquisition: not completed EIA: not studied
Long An	Bulk water supply for Ben Luc district (PPP Infra Project)	Transfer (L=10km) 10 million USD	Completed.	Land acquisition: not required SPC established 2013 Korean ODA Duc Hoa District: 2013 ground breaking Ben Luc District: only plan

Sewerage

Province City	Project	Project scope (Sector loan)	FS status	Remarks
Ha Nam	Urban Development Project	N.A.	No	Land acquisition: not completed EIA: not studied
Binh Duong	Southern Binh Duong Province Water Environment Improvement Project (Phase-3)	N.A.	N.A.	Series of Phase-2 project (2011-2018)
Kien Giang	Water Supply and Sewerage System Development in Phu Quoc Island, Kien Gian Province (PPP Infra)	Sewer in housing development and city center 58.2 million USD	Completed (2013)	Project frame: agreed. Land acquisition & resettlement: not completed EIA: not completed

Source: JICA Survey Team

Table 2.5.1 Priority Projects of Water Supply and Sewerage (Long List) (3/3)

Third Tranche

Project	Sector	PPP
Long An (Phu My Vinh WTP)	Water supply	PPP
Hai Phong Quang Ninh Khanh Hoa, Tien Giang	Water supply	
Ha Tinh	Sewerage	

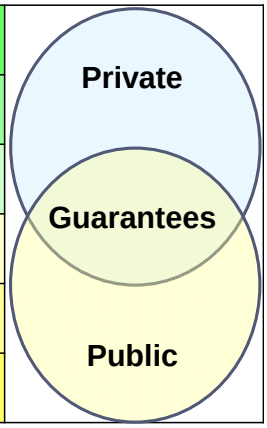
Source: JICA Survey Team

Chapter 3 Proposal of Potential Finance Scheme with the Japanese ODA

As observed in the preceding chapter, future investment requirement to deliver adequate water supply and sewerage services in Vietnam, including funds that are needed to operate and maintain the infrastructure, expand the coverage, and upgrade service delivery, is significant. Although infrastructure investment in the urban water supply and sewerage sectors has been, and still is, heavily dependent on official development assistance (ODA) funding, this will not be sustainable in the long run. The continued growth of the Vietnamese economy is likely to result in a decrease in the amount of ODA fund available to the country in the future, as the support will become less concessional and the cost of ODA funding will be closer to commercial terms.

Meeting future investment plans with an increased level of investment, and preparing for the transition away from concessional donor financing, both suggest a need to mobilize new sources of finance, including public or private sources at the national and international level as well as tariffs and taxes. Diversification of financing sources as illustrated in Figure 3.1, notably with greater reliance on private financing, would help decentralize financing decisions reducing the burden on central planning organizations and potentially improving the efficiency of investment.

Creditworthy in Tested Country Conditions	**Country Conditions and Developed Financial Markets**
Marginally Creditworthy	**Reliable Refinancing Sources & Security for Loans**
Sustainable Cost Recovery	**Anticipates Long-Term Cost Impacts (e.g. FX, asset reevaluation)**
Cost Recovery	**Profitable in Any Given Year, But Not Sustainable in Long Term**
Pay-As-You-Go Recovery of Cash	**Capital Subsidies**
Unviable Loss-Making Utilities	**Capital & Operational Subsidies**



Source: Adopted from "Financing Water Supply and Sanitation Investment: Utilizing Risk Mitigation Instruments to Bridge the Financing Gap" (January 2005), World Bank

Figure 3.1 Financing Options at Different Levels of Financial Sustainability

In order to propose a finance scheme to meet the financing gap, this chapter looks at the current situation of financing for the water supply and wastewater sectors by reviewing the recent activities of major development partners, and illustrates potential finance scheme for the Water Sector Loan and the Water Fund. (Note that "the Water Sector Loan" primarily refers to the Japanese ODA Loan for water supply and sewerage sector in Vietnam, while "the Water Fund" refers to a fund, which could potentially combine Japanese ODA (debt or equity) and other public and private financing sources. The Water Fund is expected to be established in the long run as the water supply and wastewater sectors achieve financial sustainability and attract both public and private investors.)

3.1 Background

3.1.1 Sector Background and Institutional Framework

The National Orientation Plan for Water Supply to 2020, a Government of Vietnam (GOV) policy document issued in 1998, provided the overall sectoral goals for the development of urban water supply systems taking into account national industrialization and modernization, and for investment planning for the sector. The plan emphasized that water supply companies (WSCs) will be

independent public utilities fully supported by water supply charges (both for operation and maintenance (O&M) and capital investment), with introduction of cost recovery principles and abolition of subsidies from the central government.

Besides the plan, decisions and circulars issued by GOV have reinforced and further refined sector policies. These include the following:

- Joint Ministry of Finance (MOF) and Ministry of Construction (MOC) Circular of 2004 stipulating a common tariff framework for the sector based on the principle of full cost recovery, and a reasonable profit;

- Decree 88/2007/ND-CP on urban and industrial park drainage, promoting cost recovery for basic O&M and subsidies for capital expenditure (CAPEX) (connection cost by households) – currently under revision;

- Circular 09/2009/TT-BXD on guiding of Decree 88/2007/ND-CP implementation;

- Decree 117/2007/ND-CP on clean water production, supply, and consumption, in support of full cost recovery with service contract (connection cost within tariff);

- Decree 124/2011/ND-CP with amendments of Decree 117/2007/ND-CP;

- Decision 1929/2009/QD-TTg on strategy of urban and industrial water supply to 2025 and vision to 2050 (with set targets);

- Decision 1930/2009/QD-TTg on orientation of urban and industrial drainage and sewerage to 2025 and vision to 2050 (with set targets); and

- Decree 25/2013/ND-CP on environmental protection fee.

The National Orientation Plan and later government decisions have set the basic framework for decentralization from centralized sector management to a system in which the national government retains responsibility for policy making, sector monitoring, and facilitation, and local governments assume asset ownership and responsibility for providing water supply and sewerage services.

In the urban water supply and wastewater sectors of Vietnam, a number of responsible agencies at the national, provincial and municipal levels are involved in sector planning and development.

At the national level, the demarcation among ministries involved in the urban water supply and sewerage sectors is as follows:

- **Ministry of Construction (MOC)** is the line ministry for overall urban development (including urban water supply and wastewater sectors). However, since decentralization, the role of MOC has been shifted substantially from exerting central control to setting policies, monitoring and overseeing operations, and facilitating sector development.

- **Ministry of Planning and Investment (MPI)** is responsible for allocation of state budget, approval of all major investment projects, and preparation of the country's five-year socioeconomic development plans.

- **Ministry of Finance (MOF)** is responsible for distribution of the state budget to sectors and projects, setting annual sector goals and regulating public accounting.

At the provincial level, MOC may still be an intermediary and coordinator of multicity ODA projects, but the Provincial People's Committees (PPCs) have taken over the responsibility of project implementation. The responsibility of providing water supply and sewerage services is shared between PPCs, which control the budgets and tariffs, and the public service companies, which provide services and retain equipment.

Each province has a representative body in the Provincial People's Council and in the executive body of PPCs. PPCs have departments similar to ministries in the central government at the national level. Typically, the Department of Construction (DOC), or the Department of Architecture and Planning in Hanoi and Ho Chi Minh City (HCMC) is responsible for urban infrastructure development and municipal service delivery. Typically, PPCs continue to control the funding, revenues, and tariff rates, while delegating some of other responsibilities to public service companies.

For the urban water supply subsector, state-owned WSCs were created at the provincial level to operate and maintain water supply facilities and exercise commercial functions. While WSCs are set up as legally distinct and independent entities from PPCs, WSCs' autonomy is still severely restricted by the local governments.

For the urban sewerage subsector, Decree 88/2007/ND-CP specifies that PPCs are responsible for the management of drainage and sewerage services, as the "owners" of the infrastructure. Under Decree 88/2007/ND-CP, O&M of these assets can be delegated by contract to another party through several institutional setups, which include the following:

- Combined water supply and drainage companies (WSDCs);
- PPC departments providing sanitation and other urban management services such as solid waste management, street pavement maintenance, park and public garden maintenance, streetlight maintenance, road construction, and funeral services; and
- Sewerage and drainage companies (SADCOs) and urban drainage companies (UDCs) in large cities, or urban environmental companies (URENCOs) in smaller cities, which operate as independent state-owned enterprises, and provide drainage, sanitation and in many cases other urban services.

The Study Team refers to these entities, which conduct O&M of drainage and sewerage services, collectively as "local sewerage service providers" in the rest of this chapter.

Decision 38/2007/QD-TTg on Criteria for Classification and List of Enterprises with One Hundred (100) Per Cent State Owned Capital, specifies that state-owned enterprises (SOEs) involved in water supply, drainage and sewerage in urban centers have been classified into the category to be equitized with more than 50% shareholding by the state.

3.1.2 Municipal Finance for Urban Infrastructure in Vietnam

Despite preferential government policies for privately funded infrastructure projects in Vietnam, in practice, very few foreign invested projects have been implemented. To date, the state budget and ODA have been the major financial sources to meet investment needs for delivery of urban services.

In recent years, there has been a trend towards greater autonomy for subnational governments, with the delegation of significant decision-making powers on public finances and infrastructure development. Under the present Budget Law, the financing of urban water supply and sewerage is

under the responsibility of PPCs. The legal and regulatory foundations for municipal infrastructure finance in Vietnam are governed by multiple laws and decrees, which include the following:

- Law 01/2002/QH12 on State Budget, and the ensuing Decree 60/2003/ND-CP that details and guides its implementation;
- Law 59/2005/QH11 on Investment;
- Law 29/2009/QH12 on Public Debt Management, and Decree 79/2010/ND-CP on Public Debt Management Operations;
- Decree 78/2010/ND-CP on On-lending of the Government's Foreign Loans; and
- Decree 01/2011/ND-CP on Issuance of Government Bonds, Government-guaranteed Bonds and Municipal Bonds.

Decree 79/2010/ND-CP on Public Debt Management Operations defines various aspects of public debt management including: debt management instruments; procedures for the borrowing, use, and repayment of public debt; risk management and debt restructuring; accounting, statistical review, and audit of debts; and public information on and reporting and publicity of public debts.

Decree 79/2010/ND-CP also establishes the principles for repayment of local governments' debts. For on-budget loans, repayment must come from provincial level budget funds. For loans used for programs and projects, revenues generated by these programs and projects are used to repay loans first. When such revenues are insufficient for debt repayment, provincial level budget funds must be allocated to repay the outstanding debts. PPCs must direct provincial level departments and functional sectors to closely monitor the use of proceeds from loans that fund programs and projects. According to this decree, the on-lending to local administrations must comply with the law on on-lending of the government’s foreign loans (Decree 78/2010/ND-CP).

Decree 78/2010/ND-CP on on-lending of the Government's Foreign Loans provides guidelines regarding on-lending of foreign loans (commercial, concessional, or ODA) to local governments. The decree allows the central government, specifically through MOF, to on-lend foreign loans to PPCs. Prior to the approval of the loan, MOF evaluates PPC's local budget plan for the year in which the foreign loan agreement is signed, and the loan use and payment plan are approved by PPC.

MOF borrows ODA funds with specific financial conditions and technical policies from development partners on behalf of the national government. It then either allocates grant funds to project owners through the State Treasury (for non-revenue generating projects), or relends the funds through the Vietnam Development Bank (for revenue generating projects).

Typical arrangement for past ODA financed projects in water supply and wastewater sector can be summarized as follows:

- For water supply projects, donor fund is provided to WSCs from MOF and the terms and conditions would be outlined in a subloan agreement with on-lending terms and conditions set in accordance with Decree 78/2010/ND-CP.
- For wastewater projects, donor fund is provided to PPCs on a grant basis and the terms and conditions would be outlined in the Implementation Agreement with on-granting terms and conditions set in accordance with Decree 38/2013/ND-CP on Management and Use of Official Development Assistance (ODA) and Concessional Loans of Donors, and Circular 108/2007

Guidance on Financial Management applicable to ODA projects and programs issued by MOF (Decree 38 replaced Decree 131/2006/ND-CP on Management and Utilization of Official Development Assistance in 2013.)

3.1.3 Private Sector Participation in Local Infrastructure Projects in Vietnam

The national policy of mobilizing private funds for infrastructure development was established in the Socio-Economic Development Strategy (2011-2020), which stipulates clearly the recommendation of involvement by various economic organizations, including foreign investment in infrastructure development. However, few variations of public-private partnerships (PPPs) have been successfully implemented in the water supply and wastewater sectors in Vietnam.

The legal and regulatory framework for private sector participation in infrastructure is given by a Decree Regulating Concession Contracts (Decree 108/2009/ND-CP) and a Pilot Decision on Public-Private Partnerships (Decision 71/2010/QD-TTg). For both concession and PPP framework, MPI is the coordinating ministry, gathering opinions from relevant authorities and reporting to the prime minister for approval. MPI is also expected to be an advisor for investors preparing a PPP project.

(1) Concession Framework

Decree 108/2009/ND-CP is a generic law, defining the sectors, conditions, procedures, and incentives applicable to infrastructure development investment projects develop under build-operate-transfer (BOT) contracts, build-transfer-operate (BTO) contracts, and build-transfer (BT) contracts.

Decree 108/2009/ND-CP is the third revised guideline for private participation projects after revisions in 1998 and 2007, and replaced the previous framework based on Decree 78/2007/ND-CP.

(2) PPP Framework

Decision 71/2010/QD-TTg was the first regulation in Vietnam that defines PPP schemes and covers the provision of public infrastructure services through projects implemented jointly by the public and private sectors. Although the overall goal of the pilot is to attract private capital (local and foreign) for investment in infrastructure development, there has been no project implemented under Decision 71 up to present.

(3) Issues for Further Consideration

The following issues, although not exhaustive, are raised as the shortcomings of Decree 108 and Decision 71, which have diminished investor confidence (adapted from the Infrastructure Report for Vietnam Business Forum, 2013):

- Investors complained that potential PPP projects are not tendered through a transparent and competitive process.
- It is unclear whether Decree 108 or Decision 71 would apply to a particular PPP transaction.
- Decree 108 and Decision 71 do not adequately define the scope of state contribution and fail to provide a transparent mechanism for determining the same. This leads to an ad hoc and inconsistent treatment of government guarantees in the BOT regime and difficulties determining the scope of viability gap funding under Decision 71.

- Decree 108 and Decision 71 do not provide for a single PPP unit that is empowered to act on behalf of the government and address investor concerns.

- Principles guiding risk allocation among parties are not set forth in Decree 108 and Decision 71, thereby leading to significant variations from one deal to another.

- The BOT regime under Decree 108 and its earlier regulations have been tested and proving success for the development and financing of infrastructure projects (mainly for power projects). However, the BOT regime have not been assessed and used as legal foundations and market practice for the boarder infrastructure sector.

Decision 71 is currently under review for amendment aimed at improving the conditions of private sector participation. Further improvement in legal and regulatory framework is necessary to create a workable framework for PPP infrastructure projects in Vietnam. The new decision is expected to be promulgated by mid-2014.

3.2 Overview of Assistance of Development Partners

The Japan International Cooperation Agency (JICA) is one of the major development partners for the urban water supply and wastewater sectors in Vietnam, with other development banks such as the Asian Development Bank (ADB), French Agency for Development (AFD), Kreditanstalt für Wiederaufbau (KfW), and the World Bank (WB) and bilateral agencies (Canada, Denmark, Finland, France, and Germany). Recent activities of the major development partners are summarized in this section. Close donor coordination is necessary in order to avoid geographical duplication and to foster synergy for effective ODA management in the sector.

Table 3.2.1 shows an overview of external assistance for urban development in Vietnam for the period from 1993 to the present.

Table 3.2.1 External Assistance for the Urban Development, Water, and Sanitation Sectors in Vietnam (1993 – Present)

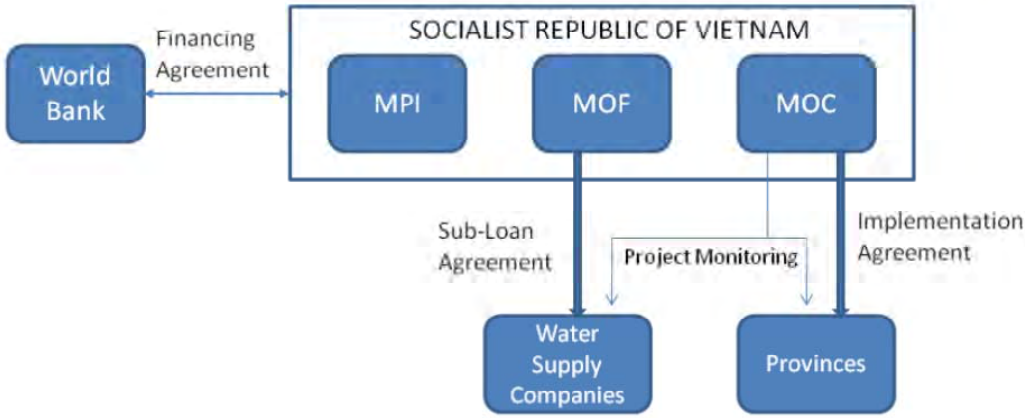
Period	Source of Funding (USD in millions)				Total
	WB	ADB	JICA / JBIC	Others	
1995-2000	330.0	278.9	588.0	209.5	**1,409.4**
Loans	317.0	270.0	588.0	143.0	
Technical Assistance	16.0	8.9	N/A	38.0	
Grants	-	-	N/A	28.5	
2001-2010	1,193.1	393.1	1,943.0	829.9	**4,359.1**
Loans	1,190.0	364.0	1,943.0	593.0	
Technical Assistance	3.1	26.0	-	27.9	
Grants	-	3.1	N/A	209.0	
2011-Pipeline	1,150.0	778.7	-	1,203.9	**3,132.6**
Loans	1,150.0	766.0	N/A	1,090.0	
Technical Assistance	-	7.6	N/A	8.9	
Grants	-	5.1	N/A	105.0	
Total	**2,676.1**	**1,450.7**	**2,531.0**	**2,243.3**	**8,901.1**

Source: Adopted from Vietnam Urban Wastewater Review (December 2013), World Bank

3.2.1 World Bank (WB)

WB has provided assistance through a number of projects in the urban water supply and sanitation sectors. Recent lending program in the sectors includes the Urban Water Supply and Wastewater Project, Medium Cities Development Project, Mekong Delta Region Urban Upgrading Project, Industrial Pollution Management Project, and Danang Sustainable City Development Project.

The **Urban Water Supply and Wastewater Project** was approved in May 2011 for USD 200 million through international development association (IDA) financing (with total project cost amounting to USD 236.3 million). The project includes investments for seven subprojects on water supply and seven subprojects on environmental sanitation (Component 1: USD 232.4 million), as well as technical assistance to MOC and MPI for capacity building (Component 2: USD 3.8 million). Project areas are municipalities with populations ranging from 58,000 to 212,000 (average population of 100,000) covering Binh Duong, Binh Phuoc, Kien Giang, Lam Dong, Nghe An, Ninh Binh, Quang Nam, Quang Ninh, Quang Tri, and Thanh Hoa. Implementation of physical infrastructure is carried out by the Project Management Unit (PMU) established at the provincial level, and the roles and responsibilities of the implementing entities are outlined in two types of agreements, namely, subloan agreements (signed between MOF and WSCs for the water subprojects), and implementation agreements (signed between MOC and provinces for the sanitation subprojects). For the water projects, WB funds would be provided to WSCs through MOF, while for the sanitation projects, the IDA funds would be provided to the provinces on a grant basis.



Source: Adopted from the Project Appraisal Document for Urban Water Supply and Wastewater Project (April 2011), World Bank

Figure 3.2.1 Project Organization Structure for Urban Water Supply and Wastewater Projects

Medium Cities Development Project was approved in December 2011 for USD 210 million through IDA financing (with total project cost amounting to USD 258.9 million). The project includes a component for the construction and rehabilitation of water and environmental sanitation infrastructure (USD 60.80 million) in three project cities (Lao Cai, Phu Ly, and Vinh) with a total population of 520,000. Each project city established a PMU, drawn from existing provincial and city agencies, which is responsible for overall coordination, quality assurance, procurement, financial management, monitoring and reporting, and supervision of project activities for its part of the project. The entire IDA credit is on-grant to the project cities, except for USD 3.8 million for the Lao Cai water supply component, which is on-lent to the city's water supply company.

Mekong Delta Region Urban Upgrading Project was approved in March 2012 for USD 292.1 million of IDA financing (of total project cost amounting to USD 398 million). The project focuses on the improvement of urban infrastructure services in low income areas of the project cities in the

Mekong Delta Region (Can Tho, Ca Mau, My Tho, Cao Lanh, Tra Vinh, and Rach Gia), including roads, water supply lines, drains and sewers, electrical power lines, river and canal embankments and social infrastructure facilities. The project cities are responsible for implementation at the local level, with respective PMUs to manage day-to-day activities. Each city would receive the investment as a grant from the central government.

The **Danang Sustainable City Development Project** was approved in April 2013 for USD 202.5 million through IDA financing (total project cost amounting to USD 272.2 million). The project aims to expand access of city residents to improved drainage, wastewater collection and treatment services, arterial road network, and public transport in selected areas of Da Nang City, and includes a component for drainage and wastewater improvement (USD 92.0 million with USD 75.1 million IDA financing).

Da Nang People's Committee (PC) will be responsible for executing and managing the project as delegated by the government, while the PMU, reporting directly to the PC, will be responsible for daily operations and coordination with concerned city agencies. At the time of the project appraisal, at least 70% of the IDA credit (USD 202.5 million) was expected to be on-grant to the city. Da Nang will provide the required counterpart funds (USD 69.7 million), and will be responsible for interest payments and principal repayment to the government for the subsidiary loan.

In addition, for rural water supply and sanitation sector, the **Results-Based Rural Water Supply and Sanitation under the National Target Program** is currently under implementation (USD 200 million approved in November 2012). Aside from the above ongoing projects, the **Ho Chi Minh City Environmental Sanitation Project (Phase 2)** is expected to be approved in 2014 (USD 450 million).

For its non-lending program, the Water and Sanitation Program (WSP), a multi-donor partnership administered by WB, provides technical assistance to support on-site sanitation improvement, as well as policy work on utility reform in the water supply and wastewater sectors. WB has also provided technical assistance for regional urban sanitation review in East Asia and the Pacific (Indonesia, the Philippines, and Vietnam) with funding from Australia.

3.2.2 Asian Development Bank (ADB)

ADB is also a major development partner in the sector with a number of ongoing and completed projects. In addition to the Water Sector Investment Program, its ongoing program for the urban water supply sector, ADB is planning to assist policy recommendation for the urban water supply and sanitation sectors, and project preparation for urban sanitation sector loan for several municipalities.

For the urban sanitation sector loan, preliminary field work to assess project needs for about ten municipalities will be conducted in 2013-14. Based on the field work, pre-feasibility study (pre-F/S) and feasibility study (F/S) (project/program preparatory technical assistance: PPTA) will be conducted for selected municipalities in 2015 and 2016, respectively.

In February 2011, ADB approved a USD 1 billion multitranche finance facility (MFF), the Water Sector Investment Program between 2010 and 2020. (An MFF is ADB’s financing modality that supports a client's medium- to long-term investment program or plan, consisting of a series of tranches to finance eligible investments. A tranche can be a loan (other than program or a sector development program loan), grant, guarantee, or ADB-administered cofinancing.)

The MFF helps WSCs in Vietnam to improve their performance through financing capital investment in water companies and co-financing the National Non-revenue Water (NRW) Program. Four pilot cities (Da Nang, Hai Phong, HCMC, and Hue) were identified for project preparation in 2008. Up to the present, two tranches have been approved: Tranche 1 (USD 138 million approved in June 2011) covers HCMC, and Tranche 2 (USD 212 million approved in December 2012) covers Hai Phong City in the north; Quang Tri Province (Dong Ha City), Da Nang City, and Thua Thien Hue (TTH) Province in the central region; and Binh Duong Province (Thu Dau Mot) in the south, and Dak Lak Province (Buon Ma Thuot, and three district towns: Ea Kar, Buon Don, and Krong Nang) in the central highlands.

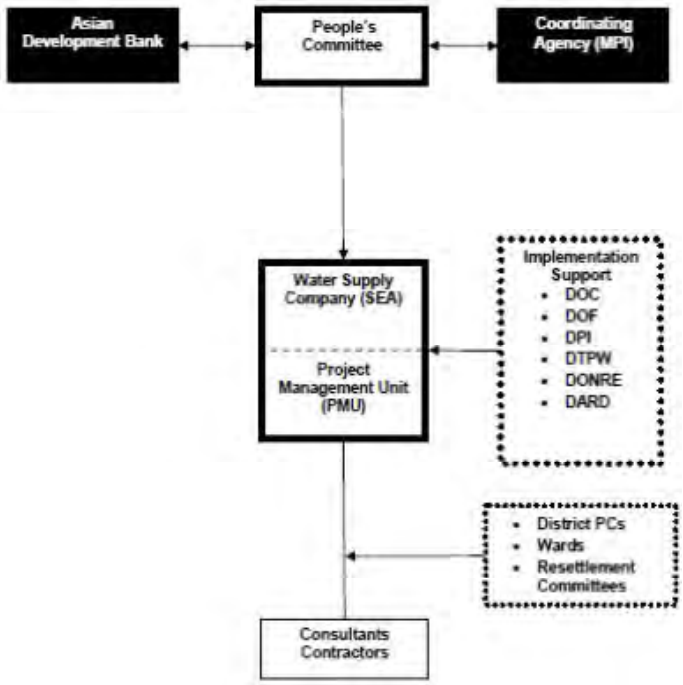
It is expected that subsequent tranches would finance part of the National NRW Program and investment subprograms for other Vietnamese water companies, following the model of the first two tranches. Indicative financing schedule of the MFF by tranche is shown in Table 3.2.2. (Note that the figures are as of January 2011 and do not match the actual financing amount for Tranche 2.)

Table 3.2.2 Indicative Financing Schedule of Water Sector Investment Program (USD in millions)

Tentative Cities	PFR1 2011	PFR2 2012	PFR3 2013	PFR4 2015	Total (USD in millions)
HCMC	138				**138**
Da Nang		47	30		**77**
Hue		40	20	20	**80**
Hai Phong		63	0	0	**63**
NRW		0	100	150	**250**
Future Cities		50	150	192	**392**
Total	**138**	**200**	**300**	**362**	**1,000**

Note: PFR = Periodic Financing Request
Source: Report and Recommendation of the President to the Board of Directors for the Proposed Water Sector Investment Program (January 2011), ADB

Implementation arrangements for the MFF are illustrated in Figure 3.2.2. At the national level, the Foreign Economic Relations Department (FERD) of MPI is the coordinating agency (CA) and selects water companies to access financing for each tranche. The selected candidates will be discussed and confirmed in consultation between ADB and the Vietnamese government. The CA is also responsible for the monitoring, evaluating, and reporting to ADB on the implementation of the MFF in accordance with the agreed project performance monitoring system for the MFF. However, procurement follows ADB guidelines and the CA has no role in procurement of consultants and contracts. ADB also provides grant assistance through its technical assistance program to assist the CA in reporting, monitoring, and evaluation, and dissemination of subproject experiences.

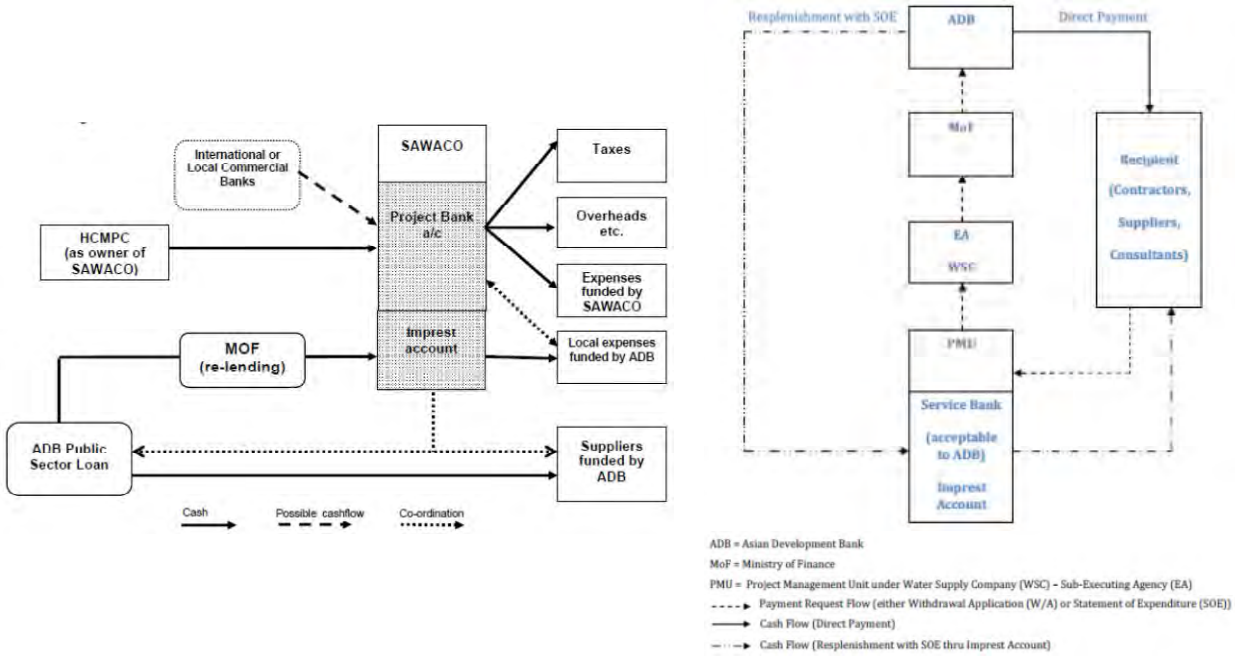


Source: Adopted from the Draft Facility Administration Manual for the Proposed Water Sector Investment Program (January 2011), ADB

Figure 3.2.2 Project Organizational Structure of the Water Sector Investment Program

For individual subprojects at the local level, a PMU, which is established under each subproject executing agency (SEA), has the responsibility for planning and implementation of the subproject. The SEA is a state-owned water company in the respective province or municipality, and the PMU has responsibility to engage and direct the work of all consultants, manage and coordinate all the aspects of the project works with all levels of the government, the central and local levels. Project management is delegated to the local authorities in accordance with Decree 131/2006/ND-CP dated November 9, 2006 (promulgating the regulation on management and use of official development assistance). (Note that Decree 131 was subsequently replaced by Decree 38/2013/ND-CP in 2013.)

Fund flow for each subprogram of the Water Sector Investment Program is illustrated in Figure 3.2.3. The loan from ADB will be on-lent from MOF to the SEAs, according to the terms and conditions set for ODA in Decree 78/2010/ND-CP dated July 14, 2010 regarding on-lending of the government's foreign loans, through subsidiary loan agreements. On-lending from MOF direct to an imprest account opened specifically for the project by SEA (e.g., SAWACO for Tranche 1) has 10% of the loan amount as the maximum ceiling for the imprest account, while the loan is a direct payment to the recipients (contractors, suppliers, and consultants), as illustrated in Figure 3.2.3 below.



Source: Adopted from the Project Administration Manuals for the Proposed Water Sector Investment Program (January 2011(left for PFR 1) and December 2012 (right for PFR 2)), ADB

Figure 3.2.3 Fund Flow of the Water Sector Investment Program

Tranches 1 and 2 have a 25-year term including a grace period of 5-6 years with an annual interest rate determined in accordance with ADB's London interbank offered rate (LIBOR), a commitment charge of 0.15% per year, and other terms and conditions as set forth in the loan and project agreements for each tranche. The terms and conditions for the subsequent tranches are to be negotiated between the Vietnamese government and ADB.

3.2.3 Canada

The Department of Foreign Affairs, Trade and Development of the Canadian government (formerly, the Canadian International Development Agency (CIDA)) has provided assistance to the Vietnam Provincial Environmental Governance (VPEG) Project to improve the implementation capacity of the Ministry of Natural Resources and Environment (MONRE) and eight Departments of Natural Resources and Environment (DONREs) through reforms that promote transparent and accountable governance. The VPEG Project focused on capacity building of local levels to address industrial pollution issues through the adoption of industrial pollution prevention approaches and the implementation of industrial pollution management (IPM) regulations. The VPEG Project supported MONRE in improving the IPM policy and regulatory frameworks, and providing support to provinces in the implementation of IPM regulations.

The project was initiated in 2008 and completed in 2013 as a follow up to the Viet Nam-Canada Environment Project (VCEP, Phases 1 and 2) and worked in eight provinces: Hanoi, Bac Ninh, Hai Duong, Da Nang, Binh Duong, Long An, Quang Ngai, and Soc Trang.

3.2.4 Finland

Finland has provided assistance to the water and sanitation sector in Vietnam since 1983, and currently provides assistance through the Water and Sanitation Program for Small Towns in Vietnam (WSPST). After Phase 1 (August 2004–August 2009) and Phase 2 (September 2009–August 2013),

WSPST is currently in Phase 3 (December 2013–2016). WSPST has been implemented by MOC with support from a consultancy consortium made up of Finnish firms. As of December 2013, nearly 69,000 people have access to clean water and 5,000 households have been connected into wastewater collection and treatment systems. Phase 3 is the final phase of the program and is planned to complete and consolidate the program result.

WSPST has objectives of providing decent water supply and sanitation services in 25 district towns in eight northern provinces of Vietnam, with the following result areas:

- To construct clean water and sanitation systems for small towns;
- To strengthen operations, maintenance and financial management in water companies owning the systems to ensure long-term sustainability of water supply and sanitation development in their localities; and
- To activate the Sanitation Revolving Fund (SRF) to set up a national system for financing similar investments in the future.

Details of the SRF will be discussed in a case study in the next section.

3.2.5 Germany (GIZ / KfW)

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the KfW Entwicklungsbank jointly implemented a program in the following nine provincial cities for sustainable wastewater and solid waste management:

- Lang Son, Son La, Hoa Binh, Bac Ninh, and Hai Duong in the north;
- Vinh in the center; and
- Tra Vinh, Soc Trang and Can Tho in the Mekong Delta.

GIZ has been providing assistance through its Waste Water Management Program (WWMP) in Vietnam, which aims at improving conditions for sustainable wastewater and solid waste management, particularly in the supported provincial cities. WWMP includes enhancing operational capacities of supported wastewater companies (organization, management, and operations), gradual introduction of cost-covering wastewater tariffs, stakeholder participation as well as fostering of cooperation and utilization of experiences at the national, regional, and local levels via improved framework conditions.

KfW has provided assistance for the program's financial cooperation module (FC), which provides the funds for investments to enhance infrastructure for the sector.

3.3 Potential Finance Schemes with Japanese ODA

3.3.1 Overview of Japanese ODA Loan Schemes

Table 3.3.1 shows the types of Japanese ODA loans. For financing urban water supply and wastewater projects in Vietnam under a Japanese ODA framework, (i) project loan, (ii) sector loan, and (iii) combination of (i) or (ii) with JICA’s Private Sector Investment Finance (PSIF) scheme may be considered.

Table 3.3.1 Types of Japanese ODA Loan

Project-Type Loans	Non-Project Loans
Project Loans	**Program Loans** (for assisting recipient countries seeking to improve policies and implement general system reforms)
Engineering Service (E/S) Loans (for engineering services which are necessary in the survey and planning stages of the projects)	**Commodity Loans** (for providing settlement funds for urgent and essential imports of materials to the recipient country experiencing a worsening foreign currency situation)
Financial Intermediary Loans / Two-Step Loans (for the implementation of designated policies implemented through financial institutions of the recipient country)	**Sector Program Loans** (derivation of commodity loan used simultaneously to support development policies in prioritized sectors of the recipient country)
Sector Loans	

Source: JICA Survey Team

(1) Project loans finance the procurement of facilities, equipment, and services, or the conduct of civil and other related works for a specific project through the recipient government. (Project loans may be preceded by engineering service (E/S) loans.)

(2) Sector loans finance a number of subprojects for materials and equipment, services and consulting services required for the implementation of development plans in a specific sector through the recipient government. For sector loans, detailed allocation of loan proceeds to the various categories is not normally set out in the loan agreement, although a list of candidate subprojects may be reviewed during the loan appraisal process. As such, sector loans provide the borrower with flexibility of basing investment decisions on priorities and constraints defined in the sector policy and master plans.

(3) Project loan or sector loan could also be utilized to supplement private financing components of specific subprojects (e.g., public financing portion of PPP candidate projects) by using JICA's PSIF schemes (directly to private or quasi-private entities). JICA's PSIF schemes can be direct equity/loan into the project company or investment through fund. Specific type of the loan and demarcation between public and private finance sources will be considered based on the nature of each subproject.

Note that the definitions above are generic and could be different for other development partners. For the purpose of clarity, "project loan" refers to Japanese ODA loan with a predetermined target project at the time of JICA loan appraisal, while "sector loan" refers to Japanese ODA loan with target subprojects that are not finalized (a list of candidate subprojects may be required) at the time of JICA loan appraisal. Detailed arrangements for a specific ODA loan project need to be determined on a case-by-case basis through negotiations between JICA and the recipient country.

3.3.2 Case Study: Small-Scale Pro-Poor Infrastructure Development Project (III)

L/A Signed: November 2009

Loan Amount: JPY 17,952 million

Interest Rate: 1.2% (Project*) / 0.01% (Consulting Services)
* Preferred rate (0.55%) to the water supply construction portion

Executing Agency: MPI

Project Summary: Under this project, certain provinces have been selected based on poverty indices and other factors, and small-scale infrastructures consisting of rural roads, rural electrification, rural water supply system, and rural irrigation system will be upgraded and constructed. Better access to market, improved power and water services, and irrigation infrastructures are expected to increase agricultural productivity, contributing to poverty alleviation. A pilot project will be carried out to seek a community development model that benefits the rural poor by increasing capacity of agricultural production through comprehensive infrastructure development. The ODA funds will be allocated to public works, the procurement of equipment and materials, and consulting services.

This project can be categorized as a sector loan with a number of subprojects (104 subprojects at the time of JICA loan appraisal) for rural infrastructure development in multiple sectors. Target subprojects under the project had been selected based on the request by the provincial Department of Planning and Investment (DPI) prior to JICA loan appraisal. Selection of subproject was carried out in accordance with selection criteria for each subsector, and change of target subproject was granted through consultation between GOV and JICA, on the condition that a target subproject can be completed by the end of the loan disbursement period.

The District People's Committee (DPC) was primarily in charge of the implementation of subprojects as project owner, while MPI and PPC assumed the roles of Central Line Agency and Provincial Line Agency, respectively. Project implementation arrangement was decentralized, and that the District Project Management Unit (DPMU) established in DPI was empowered to manage the overall project implementation (including procurement and financial control) under the oversight of the Central Project Management Unit (CPMU) set up in the Service Sector Department of MPI.

Sector loan scheme would be suitable for financing multiple water supply and wastewater sector subprojects. Detailed implementation arrangement, including the roles and responsible entities of sector entities, will require careful consideration. For example, post evaluation of the Small-Scale Pro Poor Infrastructure Development Project (I) and (II) indicated that, quality control for rural water supply subprojects as an area for further improvement throughout project implementation (from project design to O&M). This may be attributed to the fact that there was a lack of clear definition of ownership (PPC or DPC) and management (WSCs), as WSCs, which are responsible for O&M of the water supply system, were not involved in the planning and construction phases of the project. The lack of clear definition of ownership and management is still one of the major institutional issues in the water supply and sewerage sectors, closer coordination with entities in charge of O&M (e.g., WSCs) would be desirable.

3.3.3 Case Study: Small- and Medium-Sized Enterprises Finance Project (III)

L/A Signed: November 2009

Loan Amount: JPY 17,379 million

Interest Rate: 1.2% (Project) / 0.01% (Consulting Services)

Executing Agency: State Bank of Vietnam

Project Summary: Phases I and II of the Small- and Medium-Sized Enterprises Finance Project (SMEFP) were funded with Japanese ODA loans, with loan agreements signed in March 1999 (JPY

4 billion) and 2004 (JPY 6.1 billion), respectively. This project, Phase III of the SMEFP, seeks to support the development of small and medium enterprises (SMEs) in Vietnam, by providing medium- and long-term funds through the participating financial institutions (PFIs), to strengthen the capacity of the EA and PFIs, and to contribute to the development of the financial sector of the country. The ODA loan will be allocated to fund SMEs through PFIs and consulting services for project implementation.

This project can be categorized as a financial intermediary loan (two-step loan), where PFIs are primarily responsible for the lending operations to SMEs. PFIs were selected based on the criteria including financial position, track record of SME lending, and information disclosure.

Based on the hearing with public and private financial institutions in Vietnam, the use of two-step loans for urban water supply and sewerage projects may require progress of sector reform, especially in the area of perceived financial risks inherent to the sector from financiers' perspective as well as capacity building of PFIs on loan appraisal and loan management, as two-step loans delegate responsibilities for overall lending operation to PFIs.

3.3.4 Case Study: The Philippine Water Revolving Fund (PWRF)

The passing of Executive Order No. 279 in 2004 directed creditworthy water utilities to shift from government financing to market-based financing sources. Building on this policy shift, the United States Agency for International Development (USAID) and JICA worked in partnership with the Department of Finance (DoF) to design a revolving fund for water and sewerage projects that leverages ODA and public funds with commercial bank loans.

The three core PWRF financing interventions were: (i) revolving fund mechanism; (ii) credit rating system; and (iii) training on water project appraisal. (The points in this section are summarized based on "Making Water Reform Happen: The Experience of the Philippine Water Revolving Fund", a background paper for the OECD Global Forum on Environment, October 2011.)

(1) Revolving Fund Mechanism

Mobilizing private financing for the water sector required addressing a number of obstacles which prevented PFIs from entering the water sector, including the following:

- Loan tenor limitations: PFIs lend for 7-10 years, while utilities require 15-20 year repayment terms.
- Collateral-based lending: The collateral offered by utilities is largely underground, which in the eyes of PFIs, is not a viable option. There is a need for cash flow-based lending
- Lack of business plans: Few utility managers had sound business plans that PFIs could analyze.
- Information asymmetries and perceptions of high risk: The lack of market information heightened the perceived risks of water utilities.

With these issues, USAID, JICA, and the DoF established PWRF, a co-financing arrangement that blends public and ODA funds, re-lent through the Development Bank of the Philippines (DBP), with internal funds from PFIs to achieve lending terms that are affordable to water utilities. A PFI funds 25% to 50% of a loan, but a credit enhancement mechanism limits its exposure to 85%. By blending concessional and PFI financing, the PWRF mechanism offers:

- Affordable pricing: The resulting blended rate is lower than pure commercial financing.

- Longer maturity: The loan to end borrowers has up to a 20-year tenor. This longer tenor is central to creating affordability for utilities, as annual debt service is far lower than with a traditional seven or ten-year loan.

- Alignment with PFI lending practices: The PFI loan is taken at market terms, that is, lending decision criteria and due diligence are in line with their lending practices. PFIs are not asked to compromise any of their terms to participate in the PWRF.

- Credit-enhancing guarantee: PFIs apply for a credit risk guarantee that covers up to 85% of their loan, which is provided by a private domestic guarantee corporation. The guarantee allowed the utilities to access financing on a cash flow basis without having to put up real estate as collateral.

(2) Credit Rating System

The PWRF program and the Philippines' LGU Guarantee Corporation (LGUGC) helped create a risk rating system that added a deeper political risk dimension to the PFI's traditional screening criteria, which are generally more focused on financial and managerial factors.

(3) Training on Water Project Appraisal

While many PFIs were eager to enter the market, the majority had no prior experience of lending to water service providers and thus, had no standard measure of project bankability. The PWRF program organized a series of nationwide trainings on how to evaluate water projects. The training aimed to familiarize bank officers with technical, institutional, and financial dimensions of lending to water service providers.

3.3.5 Case Study: Sanitation Revolving Fund (SRF) in Vietnam

In 2001, an SRF component was incorporated in the WB-financed Three Cities Sanitation Project in Vietnam to provide loans to low-income households for building on-site sanitation facilities. The project was carried out in the cities of Da Nang City, Haiphong City, and Quang Ninh Province. The SRF provided small loans (USD 145) at partially subsidized rates to low-income and poor households to build a septic tank, a urine diverting/composting latrine or a sewer connection. (The points in this section are summarized based on OECD "Innovative Financing Mechanisms for the Water Sector" 2010 and WSP "Financing On-Site Sanitation for the Poor" January 2010.)

To access the loans from SRF, households needed to join a savings and credit group, which brings together 12 to 20 people who must live close to each other to ensure community control. The loans covered approximately 65% of the average costs of a septic tank and enabled the household to spread these costs over two years.

The loans acted as a catalyst for household investment – households needed to find other sources of finance to cover total investment costs, such as borrowing from friends and family. In contrast to a centralized, supply-driven approach, where government institutions design a project with little community consultation and no capacity building for the community, this approach was strictly demand driven and thus required the SRF to develop awareness raising campaigns for sanitation.

The initial working capital for the revolving funds (USD 3 million) was provided as a grant by WB, Denmark, and Finland. The SRF was managed by the Women's Union, a countrywide organization

representing the rights and interests of women that has a long experience of running microfinance schemes. The initial working capital was revolved more than twice during the first phase of the project (2001 to 2004) and was then transferred for subsequent phases to be revolved further.

Combined with demand generation and hygiene promotion activities, the SRF helped around 200,000 households built sanitation facilities over the course of seven years, and improved sanitation facility coverage rates have significantly increased in all project areas. The revolving fund mechanism allowed leveraging household investment by a factor of up to 25 times the amount of public funds spent. Repayment rates are extremely high (almost 100%).

Of the 46,308 sanitation facilities built with financial support from the revolving funds, 88% were septic tanks, 9% were for sewer connections, and 3% were for composting/urine-diverting latrines. At the project design stage, it was envisaged that a higher percentage of the loans would be used to invest in sewer connections rather than septic tanks. However, the construction of the main sewers encountered some delays and did not keep up with the pace of the revolving fund component. When the main sewers eventually got built, toward the end of the Three Cities Sanitation Project, the revolving funds had to be wound down and transferred to the municipalities and households that had already invested in septic tanks, so they were reluctant to connect to the newly built sewers. This is a potential limitation of the SRF scheme, and it would have been preferable to delay it until the sewers were actually built. However, the Women's Union was keen to press on with the loan program so as to provide access where demand was high.

3.4 Proposal of Potential Implementation Arrangement for the Water Sector Loan

3.4.1 Background

In order to provide and support flexible financing in the long term, phased investment for multiple priority subprojects in the water supply and wastewater sectors as described in the preceding section, a series of stand-alone project loans may be inadequate. Therefore, sector loan (hereinafter referred to as "the Water Sector Loan") would be a more suitable financing scheme under the JICA ODA loan modalities. Implementation arrangement for the sector loan needs to be designed with a view of securing smooth implementation of subprojects and promoting institutional reform of the sector.

Before the discussion on the implementation arrangement for the Water Sector Loan, the definition of line agency, project owner, and PMU for the ODA management system in Vietnam, are provided in this section.

(1) Line Agency

Decree 131/2006/ND-CP on Issuance of Regulation on Management and Utilization of Official Development Assistance stipulates that, line agencies of ODA programs and projects (person who makes investment decision with regard to investment projects or person who gives approval to technical assistance projects) are line ministries, ministerial-level agencies, agencies directly under the government, central agencies of social and political organizations, professional organizations, agencies directly under the National Assembly, the People's Supreme Court, the People's Supreme Procuracy and PC of the provinces and centrally-run cities that have programs and projects.

(2) Project Owner

Decree 131/2006/ND-CP stipulates that, owner of ODA programs and projects (investment owner with regard to investment programs and projects; project owner with regard to technical assistance

programs and projects hereafter referred to as "project owner) is the institution that is assigned by the prime minister or line agencies to take responsibility for direct management and utilization of ODA and counterpart funds used to implement programs and projects in accordance with the contents approved by relevant competent authorities and to manage and use the resulting outputs or works after completion of programs and projects.

(3) Project Management Unit (PMU)

Circular 03/2007/TT-BKH on guiding the functions, tasks, and organizational structure of ODA program or project management units defines the principles of organization and operation, and management scope, of the PMU as follows:

- The PMU is established to assist the managing agency or project owner in implementing the program or project;
- Task assignment and authorization to the PMU shall be specified in the decision on the establishment of the PMU or in specific authorization documents issued by the agency deciding on the establishment of the PMU;
- Observing the provisions of Vietnamese law and international agreements signed with donors;
- The PMU and its head shall take responsibility for their acts in performing their assigned tasks before the law and the agency deciding on its establishment;
- Having the duty of justifying issues under their competence to the agency deciding on establishment of the PMU, ODA state management agencies, law enforcement bodies, people-elected bodies, sociopolitical organizations, and donors;
- All activities of the PMU shall be publicized and supervised according to the current law;
- Managing and using efficiently, and avoiding loss and waste of, resources of programs or projects; and
- Observing the anti-corruption law, and adopting measures to prevent and combat corruption.

The PMU functions to assist project owners to implement programs or projects with the following tasks:

1) General functions and tasks

a. Planning tasks, including elaborating an overall plan and detailed annual plans on program or project implementation (disbursement plan, spending plan, bidding plan, etc.) which specify resources used, implementation schedules, completion deadlines, quality targets, and criteria for acceptance of results of each program or project activity, to be used as the basis for monitoring and evaluation. The overall plan on project implementation shall be prepared by the PMU three months before the program or project starts and shall be approved by the agency deciding on the establishment of PMU. Detailed annual plans shall be elaborated based on the agreement with donors and submitted to the agency deciding on the establishment of PMU for approval. These annual plans must conform to the annual planning schedules of the agency deciding on establishment of the PMU and ensure timely implementation of programs or projects according to specific international agreements on ODA signed.

b. Tasks of management of preparation for program or project implementation:

- For technical assistance programs or projects: Management of preparation for technical assistance program or project implementation covers the study of documents on technical assistance programs or projects, or international agreements on ODA signed with donors, the procedures and conditions for program or project implementation (regulations on budget spending, accounting, project auditing and reporting).

- For investment programs or projects: Management of preparation for investment program or project implementation must comply with current regulations on management of work investment and construction while taking into consideration a number of requirements particularly for ODA programs and projects (evacuation and resettlement of inhabitants, ground clearance, environmental impact assessment (EIA), and social impact assessment) on the basis of international agreements signed with donors.

c. Tasks of bidding and contract management:

- Performing bidding tasks assigned by the agency deciding on the establishment of PMU in accordance with the bidding law and donor's bidding rules;

- Managing performance of obligations specified in the contracts signed between authorized persons and contractors (in terms of work progress, volume and quality, labor safety, and environmental sanitation). Monitoring, supervising, and evaluating activities and performance results of contractors. Prompt solving according to its competence problems arising in the course of contract performance;

- Organizing the takeover of works and making financial payment and settlement in accordance with the law.

d. Tasks of financial and asset management and disbursement:

- Performing financial and asset management and carrying out procedures for disbursement in accordance with the law and donors' rules.

e. Administrative and coordination tasks and responsibility of justification:

- Organizing an office for, and manage personnel of, the PMU;

- Establishing an internal information system, collecting, classifying, and archiving all information and original documents concerning programs or projects and the PMU in accordance with the law;

- Preparing the conditions for the agency deciding on the establishment of PMU to publicize contents, organization and implementation progress of programs or projects to direct beneficiaries of programs or projects (applied to technical assistance programs or projects) and to local administrations, people-elected bodies, sociopolitical and nongovernmental organizations in the project areas (applied to investment programs or projects);

- Providing an accurate and true information for law enforcement, oversight, inspection and auditing agencies, donors, mass media and concerned individuals within the scope of its assigned tasks and responsibilities, except for information restricted by law to the public;

- Being the authorized representative of the agency deciding on the establishment of the PMU in civil transactions within the powers of representative specified in the Regulation

on Organization and Operation of the PMU and in authorization documents;

- Acting as the coordinator of the agency deciding on the establishment of the PMU and agencies participating in program or project implementation in working with donors on concerned issues in the course of program or project implementation; and

- Coordinating with functional units of the agency deciding on the establishment of the PMU in program or project activities.

f. Tasks of monitoring, evaluating, and reporting program or project implementation:

- Organizing the evaluation of the PMU's activities;

- Organizing the monitoring and assessment of ODA program or project implementation according to the current law including:

- Making reports on program or project implementation according to regulations, supplying and sharing information through the national system of monitoring and assessment of ODA programs or projects;

- Hiring consultants to make initial, mid-term, and final evaluations according to the contents of the approved feasibility study (F/S) reports or program or project documents, coordinating with donors or competent management agencies in evaluating programs or projects; and

- Submitting periodical and extraordinary reports on program or project implementation according to current regulations to the agency deciding on the establishment of PMU which will send these reports to MPI, MOF and the provincial-level PC of localities where programs or projects are implemented for monitoring, supervision, and support of project implementation.

g. Tasks of takeover, handover, and financial settlement of programs or projects:

- Preparing conditions for managing agencies and project owners to take over programs or projects, and hand over completed programs or projects to recipients for operation and exploitation according to regulations.

- Making reports on completion and financial settlement of programs or projects according to the deadlines specified in Clause 3.5, Article 3, Section III of this Circular.

2) Particular tasks

a. On the basis of the content, scale and characteristics of each program or project and the PMU's capability, the agency deciding on the establishment of the PMU shall authorize the PMU to decide on or sign documents under the former's competence in the course of implementation management. The authorization may be made right at the start of programs or projects, or at each phase, and shall be defined in the Regulation on Organization and Operation of the PMU or in each specific authorization document.

b. When international agreements on ODA signed with donors define the organizational structure of project management, tasks and responsibilities of the PMU, these provisions shall be concretized and fully defined in the Regulation on Organization and Operation of the PMU.

3) Other tasks

a. The PMU shall perform other tasks within the scope of programs or projects assigned by the agency deciding on the establishment of PMU.

3.4.2 Roles and Responsibilities of Implementation Organizations

WB and ADB have projects currently under implementation with similar concept to the Water Sector Loan: the "Urban Water Supply and Wastewater Project" of WB for financing water supply and sewerage subprojects, and the "Water Sector Investment Program" of ADB for financing water supply subprojects. These projects both follow a decentralized approach, where the national government retains responsibility for policy making, sector monitoring, and facilitation, and local governments (or local service providers) assume asset ownership and responsibility for providing water supply and sewerage services, in line with the National Orientation Plan and later government decisions.

(1) Line Agency

It is recommended that MOC will take the lead as the main line agency (executing agency) for project monitoring (e.g., project monitoring and reporting to JICA, technical standard setting) for the following reasons (in comparison to other central agencies (e.g., MPI) and local governments):

- More technical capacity for project monitoring and technical standard setting;
- Previous experience in managing similar donor funded project with multiple subprojects (e.g., Urban Water Supply and Wastewater Project funded by WB); and
- As future capacity building through JICA technical assistance (JICA experts and training center) is expected, streamlined operation with one central agency in charge may be desirable.

Such arrangement may be justified as close coordination between MOC (Administration of Technical Infrastructure) and the proposed training center is expected, and the Management Board of Technical Infrastructure Development Projects (MABUTIP) under the Administration of Technical Infrastructure has sufficient experience in managing donor-funded projects of similar nature (e.g., Urban Water Supply and Wastewater Project funded by the WB).

(2) Project Owner

At the local level, each subproject may be carried out by WSCs (for water supply subprojects), or local sewerage service providers (for sewerage subprojects), as the local authorities are best placed to address the needs of the consumers. This is also in line with the Vietnamese local regulation that encourages decentralization of water and sewerage services. Accordingly, WSCs and local sewerage service providers will assume the roles of project owners.

(3) Project Management Unit

The CPMU will be set up within MABUTIP, which is under the Administration of Technical Infrastructure of MOC.

For each subproject, a PMU will be set up in a water supply company or a province. Local PMUs are expected to be in charge of all the PMU tasks described in the preceding section except for overall monitoring and reporting to JICA. Local PMUs will be responsible for the implementation of

subprojects, which includes preparing detailed design and bid documents, bidding and evaluating contracts, reviewing the contractor's designs, supervising construction, and ensuring compliance with JICA safeguards policies.

MOC (and the CPMU) will take the lead as the main line agency for project monitoring. Its role will be to monitor progress, conduct periodic site visits, and facilitate in taking corrective actions that may be necessary. MOC will also report to JICA on the progress made on all aspects of the project and will be the primary contact point for JICA. For project monitoring, each PMU will compile data and monitor the performance of its subproject, which the CPMU will consolidate at the project level. MOC, with support from the consulting services (to be financed and hired as a part of the Water Sector Loan), will be responsible for reporting to JICA on a regular basis on the progress made on the project. The consultant will work with local PMUs in other aspects of project implementation including detailed design, procurement, and construction supervision.

It is also important to note that MOC will have no procurement role, as a lengthy, multi-layer review and approval process for procurement can lead to significant delay of project implementation.

For the past ADB water supply and sewerage projects, the case was that all decisions of the national procurement committee had to be approved unanimously by all its members. The project directors of all provincial PMUs had to be present in Hanoi for that purpose, even if they had no part in the bid to be approved. In addition, documents for large international competitive bidding (ICB) bids had to be approved by the Prime Minister's Office. One layer of approval, the central CPMU and national procurement committee, has been removed and responsibility for procurement now rests with PPCs. This has reduced the review and approval requirements, but PPCs, feeling uncomfortable in their new role at first, continued to seek central advice before deciding on potentially controversial issues. Although they have become more comfortable in their decision making over time, procurement approval is still agonizingly slow. (ADB “Sector Assistance Program Evaluation on Urban Services and Water Supply and Sanitation Sector in Vietnam” August 2009)

Procurement will be carried out at the provincial level by local PMUs, and consulting services should provide assistance, where necessary.

3.4.3 Selection of Subprojects and Appraisal for the Water Sector Loan

Although feasibility studies for candidate subprojects have been completed, it is recommended that quality of the feasibility studies be confirmed by JICA through dialogue with the project implementing agencies by the time of JICA loan appraisal. Many the donor-funded projects in Vietnam in water supply and wastewater sector have experienced major delays, or in some cases, project cancellations, due to the poor quality of feasibility studies. Proper and sufficient preparation is a prerequisite for project success.

Moreover, project preparation should cover, not only technical definition of the project in feasibility studies, but also a comprehensive, long-term corporate development plan including in-depth institutional reforms, development and financial objectives, and project components, with the assistance from implementing agencies and key decision makers.

Abovementioned ADB evaluation in 2009 recommends that such corporate development plan should define objectives, detailed action plans, TA requirements, and funding needs for (i) achieving the institutional restructuring and autonomy of utilities; (ii) reinforcing the WSCs, URENCOs, and PPCs as institutions and building their capacity; (iii) increasing tariffs, with automatic adjustments for inflation; (iv) improving technical efficiency and reducing NRW in the network; and (v)

strengthening project implementation capacity.

It is, therefore, recommended that candidate subprojects to be financed under the Water Sector Loan (Tranche 1) be selected and loan appraisal will be carried out by JICA by covering technical and financial aspects as well as broader sector reform issues to be addressed through the Water Sector Loan. Note that subprojects to be financed under the Water Sector Loan may be changed during the project implementation based on project readiness and priority of GOV and JICA.

3.4.4 Procurement Issues

In Vietnam, procurement approval is now decentralized as follows:

- Decree 88/1999/ND-CP on the Bidding Regulation; and
- Decree 14/2000/ND-CP on the amendments and supplements to a number of Articles of the Bidding Regulation, which include provisions to facilitate decentralization.

Both decrees took effect on 26 May 2000 with the issuance by MPI of Circular 04/2000/TT-BKH on guiding the implementation of the Bidding Regulation.

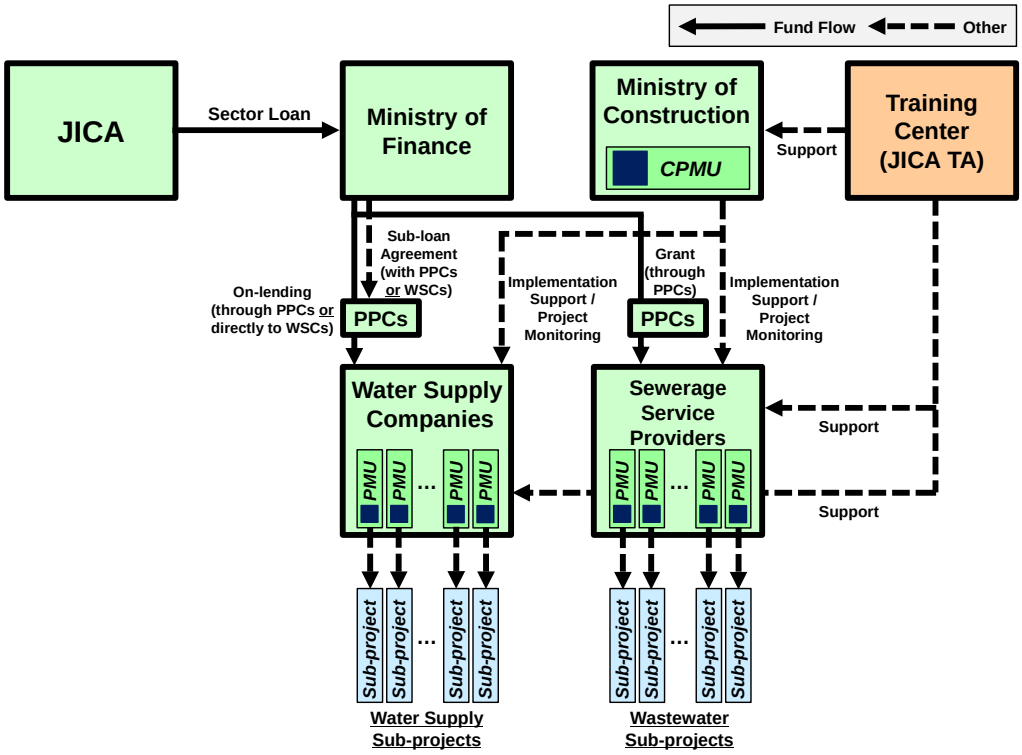
Despite the improvements, Vietnamese procurement procedures are still very cumbersome, especially in larger contracts involving ICB, and cause large delays in project implementation.

The differences between Vietnamese procurement procedures and JICA's procurement guidelines, especially in ICB, can lead to misunderstanding and extra work in order to comply with both sets of regulations.

3.5 Proposal of Potential Finance Schemes for the Water Sector Loan

3.5.1 Fund Flow

Illustrative fund flow for the Water Sector Loan is shown in Figure 3.5.1.



Source: JICA Survey Team

Figure 3.5.1 Illustrative Fund Flow for the Water Sector Loan

For water supply subprojects:

- Fund from the Water Sector Loan is provided to PPCs or WSCs from MOF, and the terms and conditions would be outlined in subloan agreements with on-lending terms and conditions set in accordance with Decree 78/2010/ND-CP. The subloan agreements are signed between MOF and PPCs or WSCs.

For sewerage subprojects:

- Fund from the Water Sector Loan is provided to PPCs on a grant basis with on-granting terms and conditions set in accordance with Decree 38/2013/ND-CP on Management and Use of Official Development Assistance (ODA) and Concessional Loans of Donors and Circular 108/2007 Guidance on Financial Management Applicable to Official Development Assistance Projects and Programs issued by MOF (Decree 38 replaced Decree 131/2006/ND-CP on Management and Utilization of Official Development Assistance in 2013.)

Note that as Decree 88/2007 specifies that PPCs are responsible for management of wastewater services, as the “owners” of the infrastructure. Under Decree 88, the O&M of these assets can be delegated by contract to another party.

In practice, local sewerage companies are usually responsible for O&M. However, formal maintenance contracts are not yet in place for every province. As such, close coordination between PPCs and local sewerage companies is strongly recommended.

3.5.2 Financial Management and Financial Sustainability

(1) Tariff Issues and Financial Sustainability of WSCs and Sewerage Service Providers

For WSCs in Vietnam, water supply tariffs are generally "subsidized" (up to approximately 40%), sufficient only to finance the cost operations and sometimes maintenance. While tariffs of special cities and Class 2 cities barely cover operating and debt services costs, in Class 3 and 4 cities, these costs are on average higher than the tariffs. Class 1 cities have generally managed to set tariffs at levels that cover those costs.

Water tariffs in Vietnam are generally very low compared with international benchmarks, including Southeast Asian averages, and in many provinces do not cover operational, capital, and debt service costs. For all city classes, the average water tariff represents only 3% to 4% of the gross national income (GNI) per capita, suggesting that there is room for increasing tariffs to cover both operational costs and support investments, while still maintaining affordability for the urban poor. It is, therefore, important to ensure cost recovery level through increased household tariffs in view of making investments in the sector viable.

For sewerage service providers in most cities, wastewater fees cover only about 10% of the operating and maintenance costs. The remainder is financed through transfers from the provincial or city governments. At the current and projected revenue bases, this arrangement is not sustainable, without clear strategy for financing the sector.

At the moment, an environmental fee set by law at 10% of the related water tariff is levied to cover wastewater, environmental sanitation, and solid waste treatment. While the law allows for the collection of additional wastewater fees to cover operating and maintenance costs and movable assets, few provinces have applied this extra fee.

In reality, however, local governments do not distinguish between the environmental charge and the wastewater fee. They all have fixed a wastewater fee, collected by the water utility, representing a small portion of the water bill, as a convenient arrangement for fee collection. Sewerage operators have not been keen to collect the sanitation charges directly, due to the added cost required to create a parallel billing system to collect the charge from all customers.

It is recommended to address the issues of financial sustainability of WSCs and sewerage service providers, and tariff setting for water supply and sewerage in the Water Sector Loan. One way of doing so would be to impose financial covenants on individual subproject on tariff increase (including past track record of tariff increase and roadmap for tariff rationalization), (O&M) cost recovery, annual working ratio, as it was the case for some past and ongoing projects funded by WB and ADB.

In order to raise the tariffs and achieve a sound cost recovery base, such covenants have to be thoroughly discussed and fully understood, and then followed up to actually comply through rigorous and persistent policy dialogues (not only during preparation but also throughout implementation), as covenants cannot make up for lack of demonstrated up-front commitment during project preparation.

(2) Issues on Government Guarantees

The "Assessment of the Financing Framework for Municipal Infrastructure" published by WB (in September 2013) has pointed the lack of a comprehensive subnational debt management mechanism, including local government borrowing limit, fiscal risk management and recourse arrangement between the national and provincial budgets as an existing regulatory gap, as follows:

- The Public Debt Management Law allows the central government to lend to provincial governments. However, the Budget Law does not stipulate how lending and repayment are managed and integrated within the budget preparation, approval and implementation process.

- Subnational debt management on borrowing limit does not reflect the repayment capacity of each local government. Local governments are currently allowed to borrow, however the borrowing limit is set based on the ratio of local government borrowing to its annual capital investments: up to 30% for all provinces, except for Hanoi and HCMC, which can borrow up to 100%. This borrowing limit mechanism also complicates the central government's structured monitoring of the local government borrowing capacity as the borrowing limit is changed every year due to the fluctuation of annual provincial capital budgets.

- There is no clear legal framework to have a recourse mechanism including its detailed procedures. The recourse mechanisms ensure that in case of local government default, the central budget can fulfill its obligations with the financiers and recover the funds from the provincial budget. The recourse mechanism would play an important role in credit enhancement for local governments by providing financiers the necessary security that is currently absent in the market in Vietnam.

- According to the Public Debt Management Law, the only relevant clause on recourse is the Government Guarantee (Chapter VI- Managing the Government Guarantees), where MOF is the guarantee provider to eligible entities and projects. The law is silent on whether the local government (PPC) can provide a guarantee. This is interpreted as formal prohibition for PPC to provide guarantees.

There are some ongoing discussions between MOF and the donor community regarding the validity of counter-guarantee for WSCs from PPCs to MOF on on-lending from MOF to WSCs for some donor-funded water supply projects. Direct on-lending to PPCs may be desirable to avoid the risk of invalid local guarantee, and it is also necessary to confirm on-lending arrangement and PPCs' debt capacity for an individual candidate water supply subproject at the time of JICA loan appraisal.

3.6 Road Map for Water Fund and Community Development Fund

As noted earlier, there is a growing recognition that public and donor finances are insufficient to meet the financing need of Vietnam for local infrastructure. Similar to other urban infrastructure, investments for the water supply and sewerage sectors require high volume of long-term financing.

Governments in some developing countries are gradually embracing the idea of subnational entities accessing private finance for investments in public infrastructure and services. In Vietnam, however, the credit and capital market is neither efficient nor deep enough in intermediating savings from institutional and individual savers to fund projects. Moreover, establishing sustainable markets to enable municipal finance requires policies to foster sustainable markets that are supported by a robust regulatory framework that ensures prudent borrowing, accountability, and financial discipline.

National governments or subnational governments in developing countries often access market through hybrid models, such as credit enhancement (e.g., PWRF) or grant-based technical assistance (e.g., Sanitation Revolving Fund in Vietnam).

Other approaches that have been adopted in developing countries to access private financing include the following:

- Borrowing from development banks and financial institutions (bank debt market);
- Direct borrowing from capital markets (municipal bond issue);
- Establishing specialized municipal intermediaries or funds to utilize private capital for municipal infrastructure (development funds); and
- Soliciting private sector investment through various forms of PPP.

This section considers some of the potential options that could be applied for the water supply and wastewater sectors of Vietnam.

3.6.1 Bank Debt Market

In many developing countries, borrowing large sums for long-term capital investment projects could be difficult due to mismatch between long-term financing required for infrastructure, and short-term deposit liabilities of private financial institutions. Typically, banking regulations limit the banks' ability to lend for long tenors, and most banks lack the expertise to evaluate the risks of a municipal finance investment. In addition, the market for other sources of long-term credit, such as mutual funds, insurance and pension funds, is still underdeveloped.

Such conditions are also present in Vietnam, and in addition, the commercial banks view the lack of assurance for tariff increase and recourse mechanism in the water supply and sewerage sectors as too risky. Only the Vietnam Development Bank (VDB) has lent to local governments, although very limited number of lending has been done in the past.

3.6.2 Municipal Bond Issue

By definition, a municipal bond is a debt obligation issued by a subnational borrower, with the undertaking to repay the bond principal with interest at a specified payment schedule. The two most common categories of municipal bond are as follows:

- Revenue bond: serviced by the revenues of a particular investment and typically do not have recourse to the municipality's revenues or assets (limited obligations); and
- General obligation (GO) bond: serviced from general revenues of the municipality.

In general, revenue bonds finance bankable projects with charging mechanism for cost recovery, while GO bonds finance investments that are non-revenue generating.

There are few examples of municipal bond issues to date in Vietnam, and it can not be a viable option especially for small municipalities with limited capacity, due to higher cost of issuance and credit enhancement than term loans from banks.

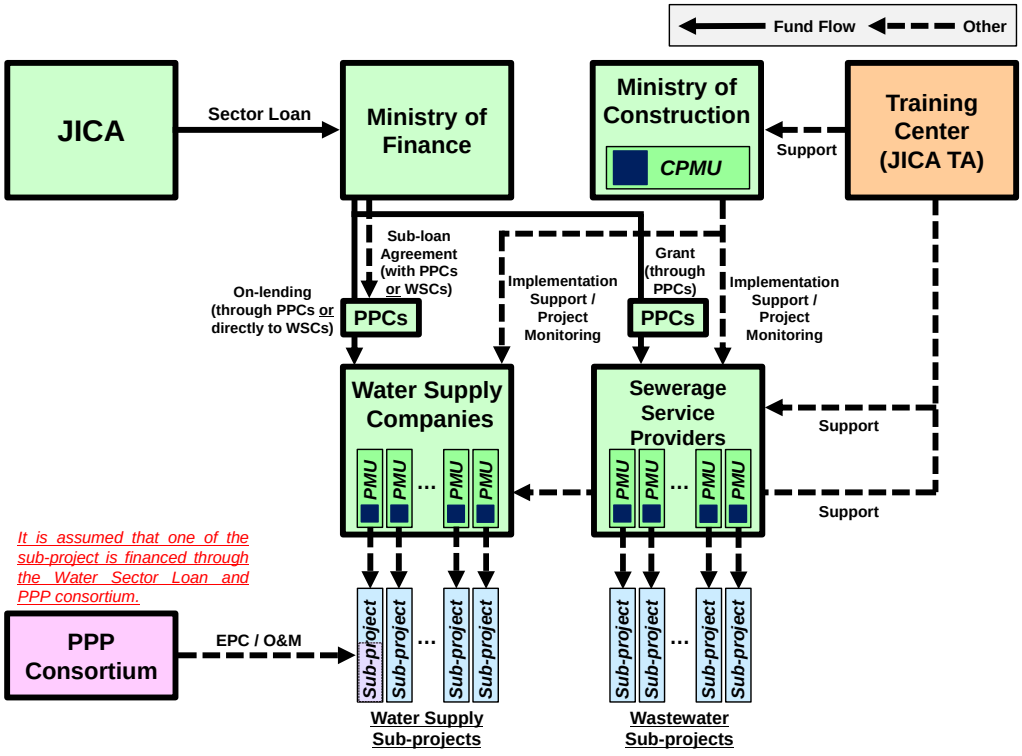
For the mobilization of bank debt or municipal bond to finance local infrastructure projects in

Vietnam, the existing conditions, including regulatory amendments, simplified review and approval procedures, credit enhancement, and transparency and disclosure requirements need further improvement.

3.6.3 Private Sector Participation in the Urban Water Supply and Sewerage Sectors

As noted in Section 3.1.3, there are a number of issues within the existing framework for concession (Decree 108/2009/ND-CP) and PPP (Decision 71/2010/QD-TTg). Clarification of these issues, as well as further improvement in legal and regulatory framework would be a necessary precondition for viable PPP project formulation.

JICA has assisted feasibility studies for potential PPP projects in Vietnam. The public sector portion of some of those projects are included in the list of candidate subprojects for the Water Sector Loan (illustrative scheme as shown in Figure 3.6.1, which assumes that one of the subprojects is financed through the Water Sector Loan and PPP consortium).



Source: JICA Survey Team

Figure 3.6.1 Fund Flow for the Water Sector Loan (with PPP)

It is recommended that the quality of feasibility studies, institutional and regulatory arrangements, and detailed demarcation of public and private components be confirmed by JICA through a dialogue with relevant stakeholders by the time of JICA loan appraisal.

3.6.4 Development Funds

The Ho Chi Minh City Fund for Urban Development Fund (HIFU) was the first Local Development Investment Fund (LDIF) established in June 1996. Following the successful model of HIFU, the 2001 Public Administration Reform Master Program (2001-2010) gave permission to all PPCs to establish their own LDIFs. Since then, 29 other PPCs have established LDIFs with the approval and

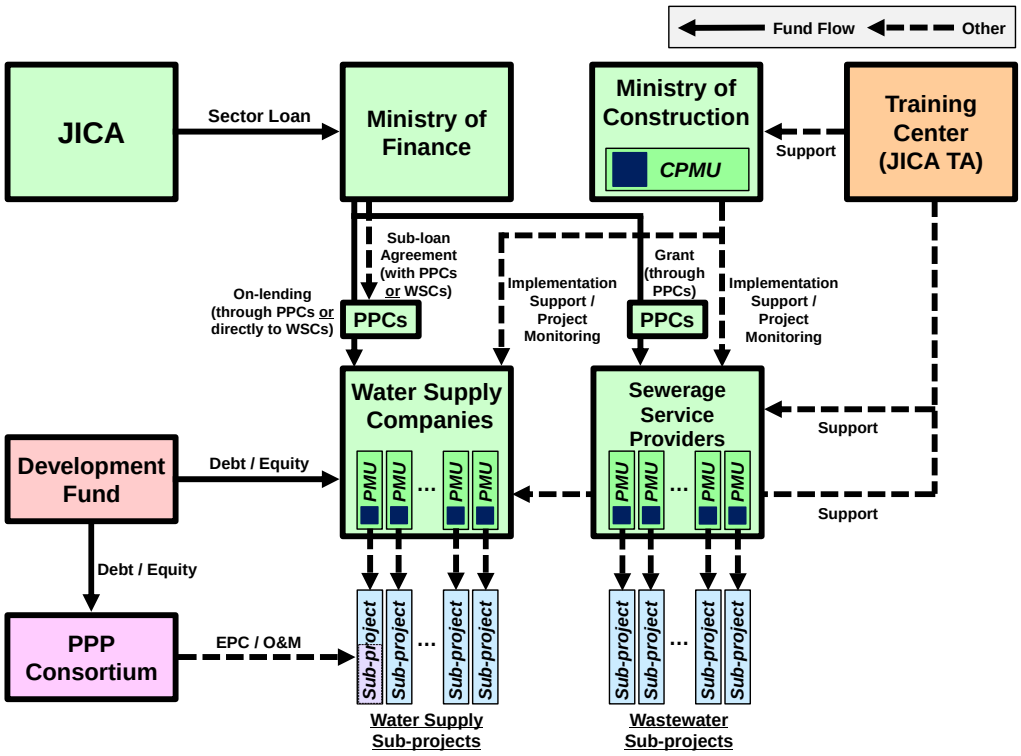
support from GOV to date.

LDIFs were established as an operational and legal structure for PPCs to invest in infrastructure and mobilize capital and enter into contracts with the private sector with the following objectives:

- Support a conducive legal and operational framework at the provincial level to develop municipal infrastructure and services;
- Attract private sources of financing, equity and debt capital for infrastructure development; and
- Enter into contracts and various forms of PPP to promote private sector participation in infrastructure development.

With the increase in the number of LDIFs, the charter capital of the LDIFs has increased by more than 100%, from USD 200 million in 2004 to approximately USD 450 million by the end of 2011. The progress of LDIFs varies greatly among different provinces but financially viable and sustainable LDIFs, such as HIFU, have contributed significantly in reducing the municipal infrastructure financing gap in economically important provinces in Vietnam.

LDIFs can also become a valuable instrument for instituting policy reforms that support decentralization and increase the efficiency of public sector management. The model of LDIF could also be replicated for financing urban water supply and sewerage projects (illustrative scheme is as shown in Figure 3.6.2).



Source: JICA Survey Team

Figure 3.6.2 Fund Flow for the Water Sector Loan (with PPP and Fund)

3.6.5 Potential Collaboration with Japanese Financial Institutions

Cross-border activities of Japanese financial institutions have risen in recent years, particularly in Southeast Asia, which include Vietnam.

Major Japanese banks have attained important global and regional presence, particularly in areas of syndicated lending and project finance. “Megabanks”, in particular, stepped up project finance and syndicated loans business, particularly in Asia, because of their strong balance sheets and long-term approach in lending.

In addition, Japanese banks, including both megabanks and regional banks, expanded their overseas network through various forms of ownership. Besides setting up local branches and subsidiaries, banks have sought the expansion of customer base and business functions through business alliances and investments in overseas financial institutions, and exploit different forms of ownership structured tailored to local markets. Table 3.6.1 shows major equity investment by Japanese megabanks in Vietnam in recent years, which demonstrates clear appetite for Japanese financial institutions to enter into the Vietnamese market.

Table 3.6.1 Recent Major Equity Investments in Vietnam by Japanese Megabanks

Date	Acquirer	Target	Stake Acquired	Amount
Nov. 2007	Sumitomo Mitsui Financial Group	Vietnam Eximbank (Vietnam Export Import Commercial Joint Stock Bank)	15.0%	JPY 25 billion
Sept. 2011	Mizuho Financial Group	Vietcombank (Joint Stock Commercial Bank for Foreign Trade of Vietnam)	15.0%	JPY 43 billion
Dec. 2012	Mitsubishi UFJ Financial Group	VietinBank (Vietnam Joint Stock Commercial Bank for Industry and Trade)	20.0%	JPY 63 billion

Source: Company disclosure

Besides megabanks, some regional banks have extended syndicated loans to finance power sector infrastructure as well as to finance their Japanese clients responding for their overseas operation in Vietnam either to the subsidiary company in Vietnam or to the parent company in Japan.

Public sector participation for water supply and sewerage infrastructure in Vietnam represents a key opportunity for investors and financers. However, as is the case for other finance schemes, further progress in institutional and regulatory arrangements as well as various risk mitigation measures would be prerequisite to provide comfort to foreign investors and financiers.

Chapter 4 Training and Consultation Center for Vietnamese Wastewater Sector's Development

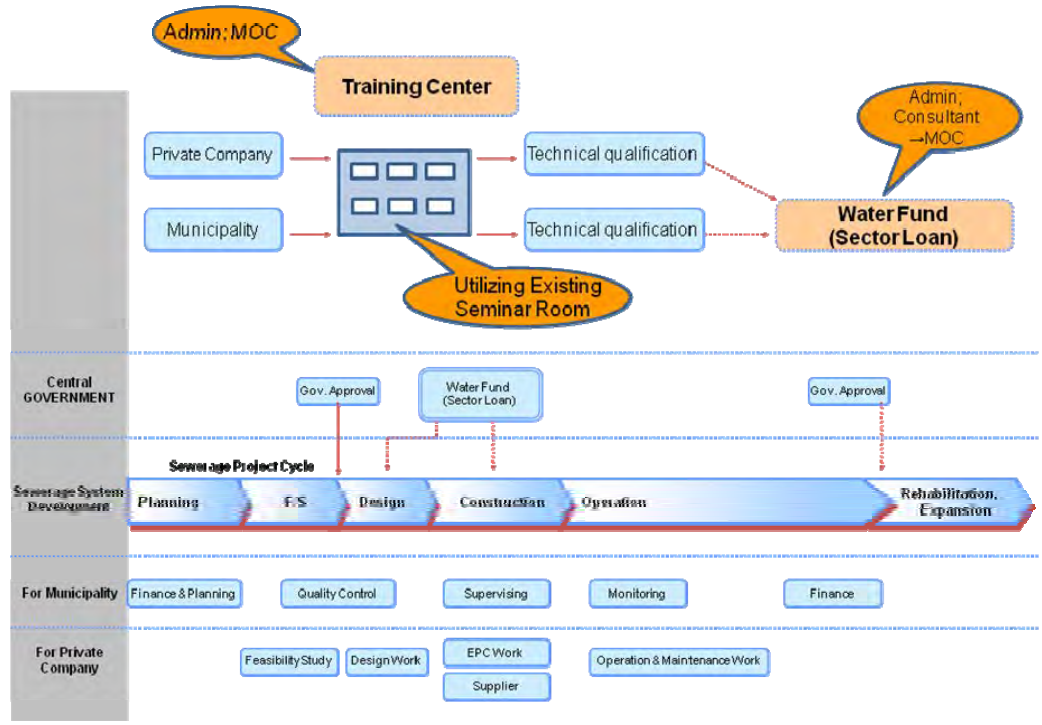
4.1 Needs for Sewerage Training

4.1.1 Basic Understanding

(1) Necessity of Capacity Building in Wastewater Sector

Sewerage development in Vietnam is planned to expand from large cities, such as Ha Noi City and Ho Chi Minh City (HCMC), to small- and medium-scale local municipalities; however, they have a limited number of staff with enough knowledge and skills for project implementation.

A sewerage project consists of a variety of stages, i.e., project programming, feasibility study (F/S), detailed design (D/D), construction supervision (C/S), operation and maintenance (O&M), and renewal. Therefore, such sewerage project requires a wide range of skills and knowledge, and capacity development of staff of the sewerage project is urgently required. The Japan International Cooperation Agency (JICA) is now considering effective solutions to solve this issue by establishing a training center for sewage works. This training center will be helpful in cultivating governmental and municipal staff by transferring Japanese accumulated know-how and technologies throughout all stages of the project.



Source: JICA Survey Team

Figure 4.1.1 Training Needs in the Project Cycle

In addition to the establishment of a training center, JICA is now considering implementation support for subprojects of the Water Sector Loan considering the required period for municipal staff to acquire sufficient know-how and skills on managing the sewerage project. A consultation division of the training center, which will provide technical support for the project management unit (PMU) of the subproject, is planned to be established.

The Vietnam Water Supply and Sewerage Association (VWSA) pointed out that human resources and technical capacity in the Vietnamese wastewater sector are insufficient in the following points, as reported in the Sewerage Solutions and Wastewater Treatment Technology Options in Urban Areas of Vietnam:

- O&M works in existing wastewater treatment plants (WWTPs) are not implemented efficiently.

- The issues on the selection of appropriate sewerage solutions and treatment technologies in consideration of typical conditions of Vietnamese urban areas, investment connections, urban development speed, operation and management of the facilities still remain.

In Japan's case, a training center was established by the Japan Sewage Works Agency (JS) at the beginning of the expansion of sewerage project in the 1970s. It was established for capacity development of staff of executing agencies (local municipalities), and has played an important role for the development of the wastewater sector of Japan. On the other hand, the capacity of private companies has been enhanced through periodical exchange of experience among experts of local municipalities and private companies. The development process of the wastewater sector in Japan must be of good practice such that it can be applied to the Vietnamese wastewater sector to attain further development.

(2) Perspective of Human Resources Development and Training Program

The Survey will propose a perspective of the sewerage training program through needs survey and analysis on the restriction of existing institutions. There are three kinds of organizations in charge of wastewater treatment operations in Vietnam, namely, water supply and sewerage companies, urban environmental companies, and sewerage and drainage companies. However, VWSA pointed out that there have not been professional agencies that have practical experiences in consulting, designing, construction, and operation and management of wastewater treatment facilities so far.

Water supply experts in Japan recognize the achievement of the College of Urban Works Construction, which provides a training program on the theory and practice in the construction sector as a post graduate education agency. However, they provide only lecture-based training because the trainer does not have practical experience in water supply operation. In addition, the training of trainers (TOT) program is insufficient so far, and the TOT program shall be provided to staff of the executing agency.

Sewerage systems in the European Union (EU) and the United States of America (USA) have separately developed the collection system and the treatment plant. The sewerage system in Vietnam shall develop the collection system and treatment plant simultaneously in a short period. While Japanese experience on sewerage development, which is well programmed for a short term, is a good practice that can be adopted in Vietnam. Therefore, a sewerage training program based on Japanese experience can transfer the required know-how for Vietnamese. In addition, the good practice of Vietnamese leading cities shall be transferred to the local municipalities, which will be of great help to acquire specified know-how for the implementation of individual subprojects.

A centralized training system in Ha Noi is insufficient so far since the entire staff cannot attend the training program due to difficulties in traffic and accommodation. Accordingly, a strategy for the development of the training center is investigated in the Survey including the number of required staff for all local municipalities who would participate in the training program.

4.1.2 Learning from Japanese Training Experience in Other Countries and Private Companies

(1) Water Supply and Environmental Sanitation Training Center (WSESTC) in Indonesia

WSESTC was established for capacity development in the water supply and sanitation sectors of Indonesia. JICA carried out a technical assistance project, and constructed this training center. In this project, 21 long-term experts and 33 short-term experts were dispatched to this center from 1991 to 1996, and equipment for the training were provided. This project contributed to the training of engineers and technical transfer of Japanese know-how to Indonesia.

However, in accordance with the termination of this JICA technical corporation project in 1997, decentralization reforms for the water supply sector proceeded, and the Indonesian Water Supply Association supported by the World Bank (WB) and EU provided satellite training courses. Accordingly, training participants of WESTC declined to 200 participants, which is equivalent to 30% of present training needs of 755 participants in 2011 and 705 participants in 2012.

At present, the training center in Surabaya provides its training program to East Indonesia as supported by the Australian Agency for International Development (AusAID) and WB. On the other hand, WSESTC provides training to West Indonesia. The training program of WSESTC is enhanced in accordance with the needs of the whole of Indonesia.

(2) Training Center for Sewerage Works (TCSW) in Thailand

The JICA post evaluation report (2003) describes TCSW as follows:

- The overall goal of the TCSW project has been achieved in improving the capability in sewerage works (SW) technology of counterparts and trainees. A total of 58 training courses have been organized for 1,928 participants, or 825 ex-trainees (as some participants attended several courses).

- Considering the number of graduates of TCSW, i.e., 489 from 72 provinces, and 336 from Bangkok, the impact of TCSW is considerable in terms of providing new SW technology. Most of the counterparts at the Drainage and Sewerage Department (DDS) remain working at their offices and perform similar tasks.

- Besides the agencies concerned, training was also provided to 228 participants from the Ministry of Science, Technology and Environment (MOSTE), the Electricity Generating Authority of Thailand (EGAT), hospitals and the private sector. These agencies appreciated the role of TCSW.

The factors promoting sustainability are as follows:

- The organizational change in the Department of Public Works and Town and Country Planning (DPT), which is not responsible for SW and related training activities, is a major factor causing considerable negative effects to the project.

- Project managers were replaced too often.

- The training curricula were not adjusted to suite the requirements of the agencies that nominated participants.

The recommendations through lessons learned are as follows:

- Further training in sewerage works at higher level with advance techniques should be conducted.

- Training should also be provided for the participants coming from vocational colleges and consulting firms as these institutions should play an important role in assisting SW tasks of the central and provincial authorities.

- Executing agency must provide the staff and budget for conducting training activities. The Wastewater Management Authority (WMA) seeks budget from the Thai government budget, through the Ministry of Natural Resources and Environment (MONRE), to conduct the training activities.

(3) Recommendations through Japanese Experience

The Sewerage Law in Japan provides a regulatory system in order to secure the quality of a sewerage project through mandated training and licensing examination of sewerage planning and design, construction supervision, building sewer, and O&M in accordance with operational experience as shown in Table 4.1.1. JS was established based on the principles of the Sewerage Law, and it provides sewerage training program.

Table 4.1.1 Qualifications of Design Engineer under Sewerage Law

Education, Training Course, Examination	Required Operational Experience in Sewerage			
	Planning and Design	Construction Supervision	Building Sewer	O/M
College: Sewerage engineering	7 years	2 years	1 year	2 years
College: Other majors	8 years	3 years	1.5 years	3 years
Junior College, Technical College	10 years	5 years	2.5 years	5 years
High School, Junior High School	12 years	7 years	3.5 years	7 years
Training mandated by the Sewerage Law (Japan Sewerage Works Agency)	Treatment Plant 5 years Pipe 2.5 years	2.5 years	-	5 years
Licensing examination (Law of JSWA)	5 years	2 years	1 year	2 years
Professional engineer (Sewerage)	-	-	-	-

Source: JICA Survey Team

In terms of capacity building of intermediate bank for project evaluation, this shall be enhanced by the following two conditions:

- Training certification is a mandated condition for the provision of loan.

- Banker acquires know-how of sewerage financial operation through training.

Project evaluation capacity of the banker such as finance and institution of sewerage works, performance indicator (PI), and public relation will be enhanced through the training program for administrator and manager classification.

(4) Training program in Private Company

Indah Water Konsortium (IWK), Malaysia's national sewerage company, has been entrusted with the task of developing and maintaining a modern and efficient sewerage system throughout Malaysians.

IWK recognizes that the sewerage sector workforce must possess relevant knowledge, skills and competencies through a structured training and development program in order to effectively plan, operate and maintain the sewerage facilities in the country. Emphasis has been placed on human capacity development throughout the years.

In 2011, 1,743 or 62% of the 2,801 average headcount attended at least one training program. This represents an 11% increase from 2010 in which 51% of the 2,726 average headcount received training. (Reference: "Sustainability Report 2011, Indah Water Konsortium Sdn. Bhd)

4.1.3 Current Situation and Needs of Capacity Development

The current situation of human resources development in the wastewater sector is determined through interview and questionnaire surveys. The current situation and proposal from each organization are summarized as follows:

(1) Interview Survey with Related Organization

1) Ministry of Construction (MOC)

At the Asian Development Bank (ADB) forum in Vung Tau in 2011, MOC suggested the requirements of both consulting center and training program. The capacities to be improved are as follows:

- Sewerage and drainage planning in line with urban planning and decrees;
- Standards and norms for wastewater discharged to sewerage system;
- Regulation for public sewerage connection;
- Centralized and decentralized wastewater treatment models;
- Wastewater quality monitoring for business wastewater;
- Regulation on violation;
- Contribution of MOC for sewerage development of category III downwards; and
- Regulations and guidelines on database, design criteria for selection of technology and treatment model, public-private partnership (PPP) investment forms, sludge treatment, etc.

Through the interview survey with MOC, they presented the needs for capacity development, and agreed to cooperate with JICA for the establishment of a training center.

2) Vietnam Water Supply and Sewerage Association (VWSA)

Training programs operated by VWSA are insufficient so far because they provide only short-term seminars sponsored by donors. VWSA is also positive in establishing a training program, and suggested its location in the northern and midland regions in Vietnam because the training program has been provided by Germans in the south regions.

3) Steering Center of the Urban Flood Control Program (SCFC) and Urban Drainage Company (UDC) in HCMC

The TOT program, prequalification of trainees, and certification of training are required. The training program is requested to be materialized urgently.

4) Project Management Board (PMB) in Ha Noi City

PMB considers the importance of a training program and positive in establishing the training center.

5) College of Urban Works Construction (CUWC)

CUWC has a water treatment plant with a capacity of 1,000 m^3/day for their training program. The training facilities were provided through French financial assistance and they provide training programs for the water supply sector, such as on water treatment, pipe fitting, inspection and maintenance of flow meter, non-revenue water, pump operation, centralized control system, centralized control, and water quality examination. As for the wastewater sector, training course on wastewater treatment for craft villages, and site study using the sewerage system in Bac Ninh financed by Germany are provided. However, trainers do not have sufficient operational experience in wastewater management and they are willing to apply Japanese experiences for the capacity development of trainers and trainees.

In addition, human waste in the college is treated by septic tank and gray water is directly discharged into marsh without treatment. They required the new WWTP which can be utilized as the training facility.

6) Ha Noi Sewerage and Drainage Company (HSDC)

The sewerage system in Ha Noi has expanded and large-scale WWTPs have commissioned. The TOT program, which aimed to enhance the capacity of HSDC, was held in 2012 as one of the components of the JICA study. Since training program is highly prioritized, HSDC requests to implement technical assistance program urgently. In the training course, HSDC's staff who have sufficient experience can be assigned as trainers. In addition, they have/ will have the sufficient facilities and site for the training course, that is, the North Thang Long WWTP with the activated sludge process and Yen Xa WWTP in the future. HSDC stressed utilizing human resources and facilities in Ha Noi to be practicable.

7) Ha Noi Architectural University (HAU)

HAU is a prominent university in water and environment sector. It is also pleased to establish professional educational course. Lectures and staff are enough to operate classroom style training program. However, facilities and professional trainer in wastewater management are required in accordance with more practical training.

8) Summary of Interview Survey

According to the interview survey, the current situation and needs of the capacity development are summarized as follows:

i) Commissioned WWTPs totaled to 20 plants in ten cities while those WWTPs under implementation totaled to 31 plants in 21 cities in the whole Vietnam. The capacity of WWTPs ranges from 2,500 m^3/day to 480,000 m^3/day with a variety of treatment processes. Applied treatment processes are conventional activated sludge, Sequencing Batch Reactor (SBR), and advanced treatment of A_2O processes etc. Required skills to manage the O&M works have not been accumulated, therefore there is a huge need of a training program for the capacity development of sewage works in Vietnam.

ii) Sewerage tariff is regulated 10% at the minimum of water supply charge but not implemented. MOC recognizes enhancing the financial capacity of executing agencies, however, tariff system is not amended so far. Therefore, the training program which transfer the practical know-how regarding financial planning and tariff setting will be required.

iii) As a short-term project, a training program can be implemented in accordance with CUWC as to vocational training and VWSA as to seminar program. Ha Noi City and HCMC can provide sufficient experts and sewerage facilities for the practical training.

iv) The TOT program has fundamental training methodology which is necessary for the provision of sustainable training program in Vietnam. Experts of large cities in Japan will be required for the TOT program to transfer Japanese experience.

Some considerations on training certification and its legal validity are required.

(2) Questionnaire Survey on Sewerage Trainings

1) Method of the Questionnaire Survey

The questionnaire survey (refer to the appendix) regarding the training needs was carried out for the Ministry of Construction (MOC), Department of Construction (DOC) in Ha Noi City, and urban drainage company (UDC) in HCMC.

2) Results of the Questionnaire Survey

The summary of questionnaire survey results about sewerage training needs is shown hereunder. (The results DOC in Ha Noi City and UDC in HCMC have been obtained.)

i) Necessities of Staff Training

Training records in the past three years are shown in Table 4.1.2. Staff mainly participated in trainings held by foreign institutions and did not seem to organize their own trainings.

Table 4.1.2 Past Training Records of PMB in Ha Noi City and HCMC

Year	Training program	Participants	Budget
Ha Noi City			
2011	- PPP training course - Advanced pipe jacking technology	4 1	Grant from MLIT Grant from MLIT
2012	- Drainage and sewerage technology	1	Grant from JICA
2013	- Water environment management - Industrial wastewater treatment	1 1	Grant from Fukuoka Grant from JICA
HCMC			
2013	- Internal training course for young engineer	35	UDC's own budget
2011 -2014	- Capacity development for O&M of WWTP and sewerage planning		Grant from JICA

Source: JICA Survey Team

ii) Presence of Trainers in the Organization

(a) Ha Noi City

The organization has no sufficient trainers so far.

(b) HCMC

UDC has the trainer for the introduction of sewage works including O&M of WWTP and sewer lines, project programming, and accounting and budget-making.

iii) Planned Training Programs for Next Year

(a) Ha Noi City

The following trainings have been planned in consideration of Yen Xa WWTP Project.

a) Pipe jacking method;
b) WWTPs planning;
c) Sewerage project management; and
d) Planning of treatment process and facilities in WWTP.

(b) HCMC

The following trainings have been planned in UDC.

a) Planning of sewerage systems
b) Emergency practice for accidents and disaster
c) Operation and maintenance of sewage facilities

iv) Priorities and Types of Training

Their priorities in relation to the types of training are shown in Table 4.1.3.

Table 4.1.3 Priorities and Types of Training

Items	DOC Hanoi	DOC HCMC
Lectures on basic knowledge of sewage works	2	5
Workshops/seminars relevant to advanced technologies	**1**	2
O&M skills for operations staff	4	3
Practices of sewerage engineering	3	4
Technical transfers of know-how for project implementation and operation	5	**1**

Note: "1" means the highest requirement and "5" means the lowest.
Source: JICA Survey Team

v) Priorities of Training Program

Priorities of training program in a sewerage project are shown in Table 4.1.4.

Table 4.1.4 Priorities of Training Program

Items	DOC Hanoi	DOC HCMC
Sewerage planning	2	**1**
Sewer design and construction	2	9
Sewer maintenance	2	4
O&M of pumping station and WWTP	5	3
Water quality management	4	6
Industrial and business discharge management	5	11
Storm water drainage and reuse	3	10
Building construction approval	5	8
Sewerage business management	**1**	5
Public relation and tariff collection	**1**	2
Project procedure and evaluation	5	7

Note: "1" means the highest requirement and "5" means the lowest.
Source: JICA Survey Team

vi) Preferred Training Program from JICA (Ha Noi City)

The following training programs are required through JICA's assistance:

(a) Pipe jacking method;
(b) Drainage and sewerage system;
(c) Wastewater treatment process technologies;
(d) Water environmental management;
(e) Wastewater treatment technologies; and
(f) Operation of WWTP.

vii) Summary of Questionnaire Survey Results

The questionnaire survey results obtained from PMB of Ha Noi City are summarized below.

(a) All training programs in the past three years were provided by foreign institutions and there is no sufficient trainer in the organization so far, which means that human resources development of staff and trainers are required.
(b) Trainings on the design and construction phase should be urgently required due to the upcoming implementation of Yen Xa Project.

The questionnaire survey results obtained from PMB of HCMC are summarized below.

(a) All training programs in the past three years were provided by foreign institutions and there is no sufficient trainer in the organization so far, which means that human resources development of staff and trainers are required.
(b) Trainings on the design and construction phase should be urgently required due to the upcoming implementation of Yen Xa Project.
(c) Training on the operation and maintenance is also required urgently.

4.2 Situations of Other Institutions

4.2.1 Sewerage Training Program of the Vietnam Water Supply and Sewerage Association (VWSA)

(1) Outline of VWSA

VWSA is a social professional organization established in June 1988. The total number of members is about 300 including individuals and organizations such as water supply, sewage, environment, and other related fields. Its activities include information exchanges among related parties and introduction of latest information such as latest scientific knowledge, new technologies, and know-how of management and O&M in order to disseminate it and improve the water works in Vietnam. The branches of VWSA have been established by region as follows:

- North Region Water Supply Branch
- Central and Highlands Region Water Supply Branch
- South Region Water Supply Branch
- North Region Sewerage Branch
- Central and Highlands Region Sewerage Branch
- South Region Sewerage Branch

This organizational structure enables members to closely contact each other to share their experience and know-how for their capacity development.

(2) Function of VWSA

The functions of VWSA are shown as follows:

- Instruction and monitoring for the dissemination of government policies to its members.
- Introduction and public relations (PR) activities of new technologies, which are evaluated and adopted in the world, and neighboring regions through workshops, seminars, and conferences.
- Research and development (R&D), and policy proposal regarding investment management in the water supply and sewerage sectors.
- Recommendations to the legal documents in related fields.
- Establishment of policies and guidelines and social monitoring of related projects by organizing and/or participating in the programs, projects, and researches in water, sewage, and sanitation fields.
- Suggestion to accomplish the industrialization and modernization of water supply, wastewater, and sanitation sector in both urban and rural areas.
- Support to establish a close relationship among supplier, beneficiary, and users in the sectors.
- Enhancement of public awareness regarding water-saving, water resources preservation, and maintenance of water supply and sewerage facilities.
- Publication of record documents and scientific/technical/managerial materials.
- Formulation of the information system specializing in water supply, sewage, and environment to provide information requested by members.

(3) Main Activities of VWSA

The main activities of VWSA are shown hereunder.

- Organize or participate in the workshops to share recommendations related to legal documents such as Decree 88/CP.
- Organize training courses relevant to drainage and sewage works.
- Select experts for the project evaluations and researches regarding the drainage and sewerage sector such as Research of Evaluations of Urban Sewage Management which was carried out by WB in 2012.
- Establish an advisory committee to consult the contents of the reports about the mechanism, policies, and finance of the projects. For example, VWSA established the Committee for the Assessment About Urban Sewage Collection and Treatment in Vietnam, which was carried out by WB in 2012.
- Select experts to carry out the assessment on the planning works of sewerage system in the Cau, Nhue-Day River basin, Ha Noi City and Thai Nguyen Province.

- Participate in the assessment of the current progress of water supply and sewerage systems for upgrading in the urban areas

The following activities are being carried out as special activities **with German organizations** as:

- Organize workshops and seminars about sewage works in association with international institutions and organizations.

- The following two workshops were held in collaboration with the German Water Association.

  - Experience sharing between Germany and Vietnam regarding the management of sewage and wastewater treatment (Ha Noi, March 2013).

  - Experience sharing about sewerage and urban flooding control (HCMC, July 2013).

The following four training programs were implemented for drainage and sewerage companies in Ha Noi, HCMC, and Vung Tau.

  - Drainage and sewerage planning
  - Drainage and sewerage system management
  - Wastewater treatment
  - Wastewater reuse

- Establishment of network of drainage and sewerage companies to improve the management qualities (GIZ).

- Establishment of Vietnam Water Energy Center (specialized in sewage and wastewater treatment) (2013-2014).

- Participation in trainings specialized in technologies about sewers and wastewater treatment (2013-2016).

The following activities are being carried out **with Japanese organization**.

- Dispatch the experts to a workshop in sewage exhibition organized by JSWA.

- Annual hosting of the VIETWATER exhibition which has Japanese booth.

(4) Interview Survey with VWSA

The JICA Survey Team visited VWSA on January 9, 2014 and interviewed Engr. Tran Quang Hung, Vice chairman–General Secretary about the outline of past trainings and directions of future trainings.

The results of trainings in the past three years are shown in Table 4.2.1. Training programs, provided by donors such as the World Health Organization (WHO), Germany and Finland, about water supply and sewerage were carried out twice to ten times per year with 14 to 60 attendees per program.

Source: JICA Survey Team

Picture 4.2.1 Situation of Hearing Survey with VWSA

Table 4.2.1 Training Records of VWSA in the Past Three Years
(Summary of Training Courses Held by VWSA)

No.	Contents of the Course	Time	Participants	Fund
2011				
1.	Train for safe water supply plan in Hai Phong		38	WHO
2.	Train for safe water supply plan in Nha Trang		47	WHO
3.	Train for safe water supply plan in Vung Tau		36	WHO
4.	Training and on-site survey in Vung Tau		27	WHO
5.	Exchange experience on safe water plan in Hue		14	WHO
6.	Train for sewerage management	October 2011		German
7.	Train for management and business development	From October to November 2011	48	Finland
8.	Training and management of human resources		48	
9.	Finance control and management		48	
10.	Assess management		48	
2012				
1.	Training for Sewerage: Challenge and solution for the future	October 2012	30	German
2.	Training for Sewerage: Direction to sustainable development for urban sewerage in Vietnam.	November 2012	35	German
2013				
1.	Training, discussion and on-site survey in companies at Phase 2	From February to March 2013	30	WHO
2.	Advanced technology training on safe water supply plan in Da Nang	July 2013	24	WHO
3.	Join training on safe water supply plan in Hue	December 2013	25	WHO
4.	Exchange experience on urban waste water management	March 2013	60	German
5.	Exchange experience on water supply and flood control	July 2013	45	German

Source: VWSA

The main results of interview survey are shown below.

- VWSA recognized the necessities of sewerage training program and will execute them in 2014 with German cooperation. The experts will be dispatched for short-period training programs which mainly introduce new technologies.

- VWSA requested the practical collaboration between German and Japan to implement the effective sewerage training programs. VWSA suggested that Japanese training programs shall be held in the north and central region because the German Water Partnership and GIZ provide their training program in the south region of Vietnam.

  The German organization provides in-house engineer training in nine provinces and wastewater sector training both in 2014. In addition, trainings for three or four days about tariff setting and public relation were provided. Note that training programs provided by GIZ will be completed in 2017 according to the hearing survey with GIZ.

- Organization of Finland provides training program about business management for the water supply sector.

- Based on the training plan prepared by the Water Competence and Training Board in VWSA, Water Competence Center (2014) will provide 14 training programs including sewerage service improvement, etc.

- The TOT program will be provided, and 20 engineers are planned to attend it.

4.2.2 Sewerage Trainings in the College of Urban Works Construction

Vocational training schools owned by MOC composed of CUWC in Ha Noi and College of Construction No. 2 in HCMC. Interview survey with CUWA was carried out in the Survey and the summary of interview is shown in this section.

(1) Outline and Requirement of CUWC

The JICA Survey Team interviewed Mr. Hue, CUWC President about the school outline.

CUWC is a vocational training school owned by MOC and has two campuses. One is located in Ha Noi with an area of 5 ha and the other is located in Hue City with an area of 3.7 ha. CUWC has 230 staff including 160 trainers (including 95 postgraduates) and 3,500 students. CUWC has departments of Architecture, Electrical, Environment (water supply and sewerage), Geology, and Construction Management. The Environmental Department actually provides water supply field only.

Source: JICA Survey Team

Picture 4.2.2 Hearing Survey in CUWC

CUWC has been supported through international cooperation with Germany, Japan, France, and Denmark. JICA provided capacity development support in the water supply sector of the Central and Highlands Region (1999 to 2006). Yokohama City supported the water sector of Hue City between 2010 and 2013. German organization will support the capacity development of trainers for the improvement of construction knowledge (2013-2016).

MOC recognizes CUWC as an important institution for human resources development and provides trainings for young engineer on water supply works. Japan also supports the insitution by the provision of training facilities. Additionally, students learn the working method and style from Japan.

There are handicraft villages with a population of 80 to 200 people and wastewater from some villages is discharged without any treatment, which results in an environmental problem. For these villages, CUWC provides lectures on small-scaled sewage system such as the legal background, technical information, and methodology of O&M about sewerage and WWTP. Even in the villages with WWTP, there are inadequate facilities which cannot function sufficiently. Therefore, most of CUWC staff visit the treatment facilities and inspect the villages.

CUWC required transfer of Japanese experience because trainers from CUWC have insufficient experience on practical operation and management of water supply and sewerage systems.

(2) Inspection of Training Room in the Water and Sewerage Training Center

The JICA Survey Team inspected the existing training facilities in CUWC such as the pilot plant of water treatment facilities, practical room for plumbing, practical room to learn the maintenance works of valves and pumps, experimental facilities for learning WTPs' operation and instrumentation, laboratory for water quality analysis, WTP with a capacity of 1,000 m^3/day, and dormitory with a capacity of 500 students. Overview of the layout of CUWC is shown in Picture 4.2.3.

Source: JICA Survey Team

Picture 4.2.3 Layout of CUWC

The names of the facilities shown in Picture 4.2.3 are listed hereunder and sufficient facilities for practical trainings are already accommodated.

A1: Storage room
A2: Headquarters zone
A3: Administration zone
A4: Lecture hall
A5: Construction laboratory no. 1
A6: Laboratory of low temperature science
A7: Hydraulic laboratory
A8: Construction laboratory no. 2
A9: Electric work laboratory
A10: Laboratories for welding work and pipe laying
A11: Multipurpose laboratory
A12: Operation office of water and environment sector training center
B1: Guesthouse
B2: Conference hall
B3: Cafeteria
B4: Transformer station
B5: Dormitory

(3) Possibilities for Implementation of Sewerage Training Program

Regarding the establishment of a sewerage training center, the Training Center for Water and Environment Sector in CUWC seems to be a qualified candidate considering the following factors:

- Lectures on water supply are practiced but the comprehensive training programs for sewage works have not been prepared.

- They have a branch in Hue and it can provide training programs to students in Vietnam's central region (only for training on water supply works).

Items to be considered are shown hereunder.

- CUWC has a septic tank but the gray water from the campus is discharged without proper treatment. It is recommended that WWTP shall be constructed for the proper treatment of the effluent from the campus and it can be utilized for the practical training program.

- The laboratory has equipment for the water quality test for water supply management in CUWC. Equipment for sewage management such as biological analytical instruments will be required.

- Practical training instruments such as sewer, manhole, pumps, and WWTPs need to be provided for practical training on sewage works. Moreover, additional lecture rooms and laboratories are required.

4.2.3 Hanoi Architectural University (HAU)

The JICA Survey Team visited the Hanoi Architectural University (HAU) and collected information to verify the possibility of establishment of sewerage training center. They received an explanation and inspected the existing facilities of HAU. The outline of the report is shown hereunder.

Source: JICA Survey Team

Picture 4.2.4 Hearing Survey with HAU

- HAU was established in 1969 and will commemorate its 45th anniversary in November 2014.

- The departments of HAU provides 'water supply', 'sewerage, drainage and wastewater disposal', 'environment engineering', 'urban infrastructure', 'transportation', 'energy development', and 'geology'.

- The number of graduates from the water sector for the past 40 years totaled to 24,000; however, this number is not sufficient to meet the demands of the water sector. HAU has 2,000 students including 160 students in the water sector, and 100 students in the environment sector under the baccalaureate degree program. In addition, HAU has 50 postgraduates in water and environment.

- HAU owns 100 lecture rooms and some laboratories. HAU's main building, which was constructed in 2013, has 50 lecture rooms, which accommodate 30 to 100 students, and its other buildings are being renovated in 2014.

- The dormitory of HAU can accommodate 200 to 300 students.

- HAU has practical rooms for concrete testing, rooms for structural experiments, equipment for jar tests, a room for pattern diagram preparation, and a room for computer-aided design (CAD) operation.

- The location of HAU is relatively close to the planned site of Yen Xa WWTP, which can be utilized as a training facility in the future.

Considering its location and potential for human resources development, HAU seems to be a good candidate for the training center, although it requires further investment on training facilities for the provision of a practical training program.

4.2.4 Sewerage Training Program Provided by Other Donors

Other donors such as WB, ADB, WHO, Germany, and Finland carry out seminars and lectures through VWSA, as mentioned in Clause 4.2.1.

In addition, Netherlands Development Organisation (SNV) organizes seminars about on-site treatment in rural areas. For example, a "SNV bio-gas workshop" was held in Hanoi on November 25 to 29, 2013, and effective use of bio-gas generated on-site was discussed.

4.3 Sewerage Training Program in Japan

Sewerage training programs in Japan are provided by several institutions. These institutions are classified into two groups by object of trainees.

1) Institutions Providing Training Programs to Public Organizations

JS, the Japan Sewage Works Association, and the Japan Construction Training Center provide sewerage training programs to public organizations.

2) Institutions Providing Training Programs to Private Companies

The Japan Sewer Collection System Maintenance Association, the Japan Microtunnelling Association, the Japan Sewage Treatment Plant Constructors Association, etc., provide sewerage training programs to private companies.

Among these agencies and associations, training programs conducted by JS have been contributing to human resources development of staff of local governments for a long time. The training programs of JS started in1972, when the Sewage Business Center, which is a precursor of JS, was established, and dispatched approximately 65,000 graduates for more than 40 years. The training programs of JS are picked up as Japanese programs and summarized below.

4.3.1 Background of Sewerage Trainings in Japan

The Sewerage Law in Japan regulates the requirement of qualification in Clause No. 23 to secure the technical level of service for the preservation of the water environment. A responsible person in charge of basic and detailed designs, supervision, and O&M works has to meet the requirements which are basically based on work experience. The training programs provided by JS can shorten the required work experience for qualification, and are used to secure the required human resources.

In pollution data in 1970, the Sewerage Law was revised and a five-year sewage development plan was established. Then, urgent securement of sufficient amount of human resources is required to implement the huge sewerage projects in Japan at that time. Therefore, a countermeasure to shorten the work experience in the sewerage field by the training program was adopted in order to transfer engineers in other sectors to the wastewater sector.

4.3.2 Sewerage Training Program

JS is the organization responsible for promoting support to sewerage projects in Japan. JS was reorganized from the Sewage Works Center, and has been established in August 1975. The Sewage Works Center was established in November 1972. The objectives of JS are described in Article 1 of the Japan Sewage Works Agency Act.

JS shall construct and carry out O&M of main facilities of sewer systems based on requests received from local governments. JS shall promote improvement of sewer systems by offering technical assistance relating to wastewater works, by training wastewater engineers, and pursuing research and technology development on water pollution control for possible practical applications. The objectives of JS are to contribute to the improvement of the living environment, and to the preservation of water

quality of public waters by means of the above activities.

The following is an outline of the training programs of JS:

(1) Characteristics of Sewerage Training by JS

A sewerage project requires extensive and specific knowledge and technologies as compared with projects of other sectors. A sewerage project requires a wide range of knowledge and know-how, such as administrative affairs, civil works, architecture, mechanical, electrical, chemical, and biology. Sewerage projects in Japan are mainly implemented by local municipalities, and the self-education of staff related with sewerage is difficult considering the limited human resources there. Therefore, JS has started the training of staffs of local municipalities.

JS prepares selective courses in accordance with the progress of sewerage project and required skills of the participant. JS prepares six courses of trainings, namely, 'planning and design', 'management', 'detailed design', 'supervision', 'O&M' and 'international expansion', and each course has specific subjects. Training programs are implemented at the JS's training center located in Toda City, Saitama Prefecture. The training center also has a dormitory.

Also, JS trainings prepare the training curricula along with practicum, and discussions and site visits are introduced to emphasize the practices.

(2) Curricula

The curricula of JS training programs are composed of six courses with specific subjects based on work experience. The training programs in 2014 are shown in Table 4.3.1. The period of each training program ranges from 1 to 17 days, and each training program is provided once to five times per year.

Practicum for training consists of geological and concrete tests, water analysis, biological diagnosis, pump operation, relay test, water management simulation, and odor analysis. The seminars in the training include design, cost estimation, drawing, design flow calculation, earth retaining calculation, financial modeling, etc.

Table 4.3.1 Scheme of JS Training (2014)

Courses	subject	Period (days)	Frequency (time/year)
Sewerage Planning	Introduction of sewerage project	4	1
	Sewerage project scheme (prefectures' thoughts)	5	1
	Comprehensive rainwater countermeasure	5	1
	Asset management and long-life scheme of sewage system	5	2
	Earthquake countermeasure for sewage works	4	1
	Use of unused energy for sewerage project	2	1
Finance and Management	Comprehensive dedication to private sector and manager's designation system	4	1
	Management of sewerage project	5	1
	Company counting - preparation of transfer and application-	5	1
	Consumption tax	5	1
	Sewage tariff	5	1
	Beneficiary's charge	5	1
	Countermeasure for non-payment	5	1
	Promotion of house connection and information disclosure	5	1
Detailed design	Pipe design I	12	4
	Pipe design II	17	5
	Pipe jacking method	10	2
	Pipe renewal design and supervision	5	2
	Design inspection (Counting inspection)	5	1
	Countermeasure for quick sand of pipes	4	2
	WWTP design I	4	1
	WWTP design II	12	1
	Design of mechanical facilities of WWTPs	5	1
	Design of electric facilities of WWTPs	5	1
	Long-life scheme for facilities	3	1
Construction Supervision	Construction management	11	1
Operation & maintenance	O&M for pipes	12	2
	Investigation and inspection of pipes	5	1
	WWTP management (OD method)	3	1
	WWTP management I (lecture)	3	2
	WWTP management I (lecture + practice)	10	2
	WWTP management I (practice)	5	2
	WWTP management II	10	2
	Maintenance of electric facilities	3	1
	Water quality management I	10	1
	Water quality management II	5	1
	Drainage countermeasure at site	10	1
	Fulfillment confirmation of comprehensive outsourcing to public sector	2	1
	Comprehensive water quality management (lecture)	3	1
	Comprehensive water quality management (lecture + practice)	10	1
	Comprehensive water quality management (practice)	5	1
International business	International water business and promotion	1	1

Source: Japan Sewage Works Agency

In the training scheme shown in Table 4.3.1, the contents of the sewerage project course are given hereunder as example.

- Outline of sewerage project and prefectural sewerage plan
- Outline of comprehensive basin-wide planning of sewage systems
- Basic scheme and practice of sewer line design
- Development methods for WWTP
- Explanation of combined type septic tank (Johkasou)
- Explanation of rural sewerage project
- Case study of efficient development of sludge treatment facilities
- Case study of process of authorization of project implementation
- Current situation and problem of finance in the wastewater sector
- Discussion

Table 4.3.1 shows the training program in 2014. It was flexibly amended according to the situation and needs of the participants. At first there were many training programs about planning and design, but at present, contents relevant to O&M and management are getting dominant according to the progress of sewerage projects.

(3) Management Method

JS's training center manages the training programs, and it comprises planning and trainer departments. The planning department organizes the training, and informs local municipalities on the notice of training courses. The trainer department prepares the contents and textbooks of training programs, arranges the trainer, and carries out the training programs. Both departments work together to carry out the training programs smoothly.

The trainers for the TOT programs are mainly selected from experienced staff of the sewage department of big cities, and private companies in some cases. Regarding the training program for legal systems, the staff of the Ministry of Land, Infrastructure, Transport and Tourism of Japan is requested to be the trainer.

Moreover, one- to two-week training programs in conjunction with public organizations and private companies are provided, which can accelerate their collaboration.

4.3.3 Facilities and Equipment for Sewerage Training

JS's training center is located besides the Arakawa WWTP of the regional sewerage system in Saitama Prefecture. Main structures of the training center consist of the main building and multipurpose practice building. The main building consists of training center office, lecture hall, conference room, dormitory for students, and library. The multipurpose practice building has laboratories, training rooms, libraries, exhibition room, cafeteria, and so on. The laboratories for multipurpose practice are for pumping and dewatering practices, electrical instrumentation, water quality analysis, concrete test, geology, etc. Situations of the multipurpose buildings and practices are shown in Pictures 4.3.1- 4.3.3.

Source: Japan Sewage Works Agency

Picture 4.3.1 Multipurpose Practice Building

Source: Japan Sewage Works Agency

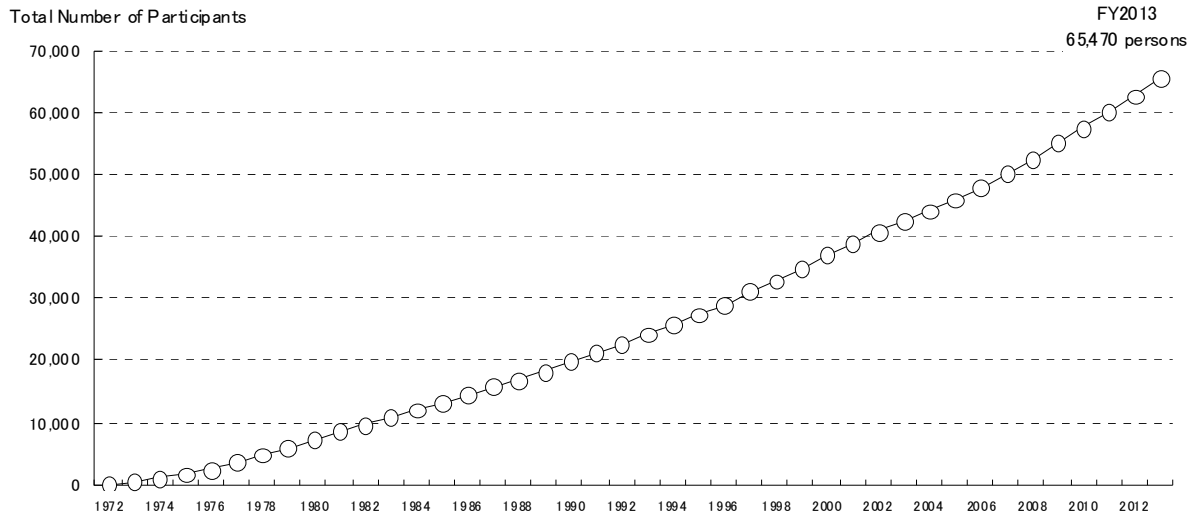
Picture 4.3.2 Situation of Drawing Practice

Source: Japan Sewage Works Agency

Picture 4.3.3 Situation of Water Quality Analysis Practice

4.3.4 Results and Effectiveness of the JS Training Center

The total number of participants that trained at the JS Training Center from fiscal year 1972 to fiscal year 2013 is shown in Figure 4.3.1. Over past 40 years, the total number of trainees at the JS Training Center is more than 60,000 persons. According to an analysis made from JS in 1991 on former trainees, the percentage of sewage works engineers engaged in local governments who are trained at the JS Training Center was 32.3% (Reference: "History of the Japan Sewage Works Agency; 20th Anniversary", 1991).



Source: Japan Sewage Works Agency

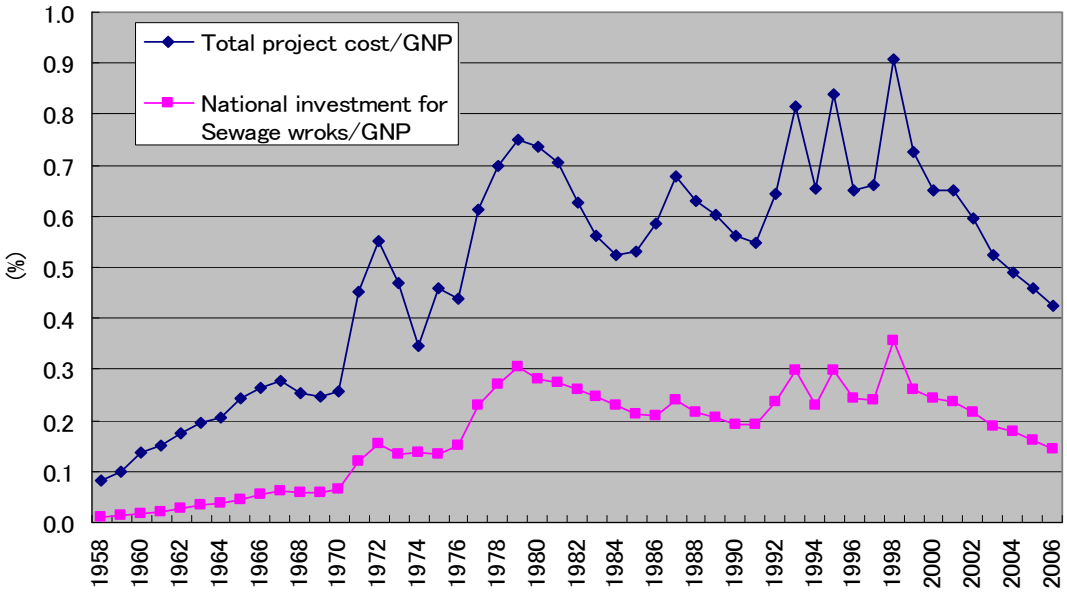
Figure 4.3.1 Total Number of the Trainees at the JS Training Center

The percentage of GNP invested for sewerage projects in Japan from 1958 to 2006 is shown in Figure 4.3.2. The blue dots show the total project costs implemented by local governments. The pink dots show the central government investment grants. Therefore, the difference between the blue and pink dots shows the investment made by local governments. From 1974 to 2004 the percentage of GNP for sewerage investment ranged between 0.5 % and 0.9 %.

The population trends for on-site and off-site sanitation systems in Japan from 1955 to 2000 is shown in Figure 4.3.3. In 1955, coverage rate of the public sewerage system, so-called off-site system, was about 10 %. In 1960s, we made a effort to reduce sever water pollution in public water bodies. In

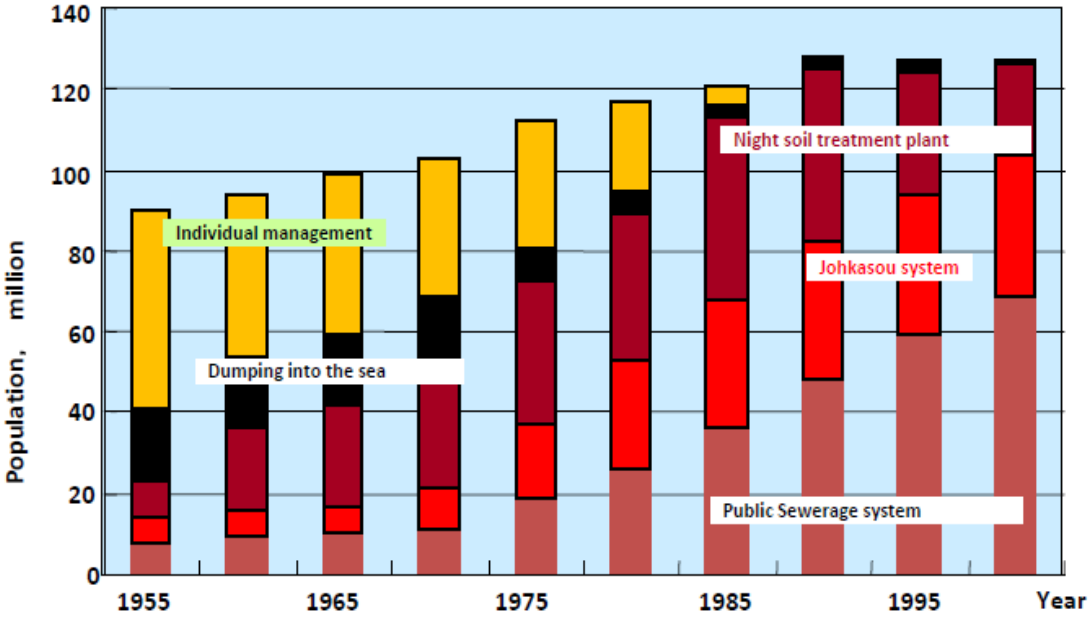
1980s, we concentrated to convert a cesspool to a flush toilet. In 2000, this coverage rate increased to almost 70 % through capacity building and the huge budget allocated to sewage works.

From what we learned through our Japanese experience, we can say that the promotion of sewerage development needs not only a huge investment budget but also human capacity building.



Source: Japan Sewage Works Agency

Figure 4.3.2 Sewerage Investment Cost/GNP in Japan (1958-2006)



Source: Presentation Material of International Year of Sanitation Follow-up Meeting, Tokyo, January 2010

Figure 4.3.3 Population Trends for On-site and Off-site Sanitation systems in Japan

4.4 Proposal for the Establishment of Sewerage Training Center

4.4.1 Objectives and Concept of the Sewerage Training Center

(1) Objectives

In this clause, the strategy for the establishment of a training center is proposed. The training center is aimed at capacity development of sewerage engineers in order for them to develop and operate the sewerage system and its organization in Vietnam.

In Vietnam, the lack of sewerage engineers prevents the construction and operation of the sewerage system required for a sustainable environment of Vietnam. Although some sewerage projects will be financed by the sector loan proposed in the previous section, the problem affects the sound implementation of the project.

The training center will contribute to develop the sewerage sector by providing the required number and quality of engineers in the central and municipal governments, and private companies.

The functions of the training center are as follows:

- To develop the required capacity for sewerage development and management.
  - For the executing agency and private company:

    => Technical capacity for planning and designing works.
  - For the central government:

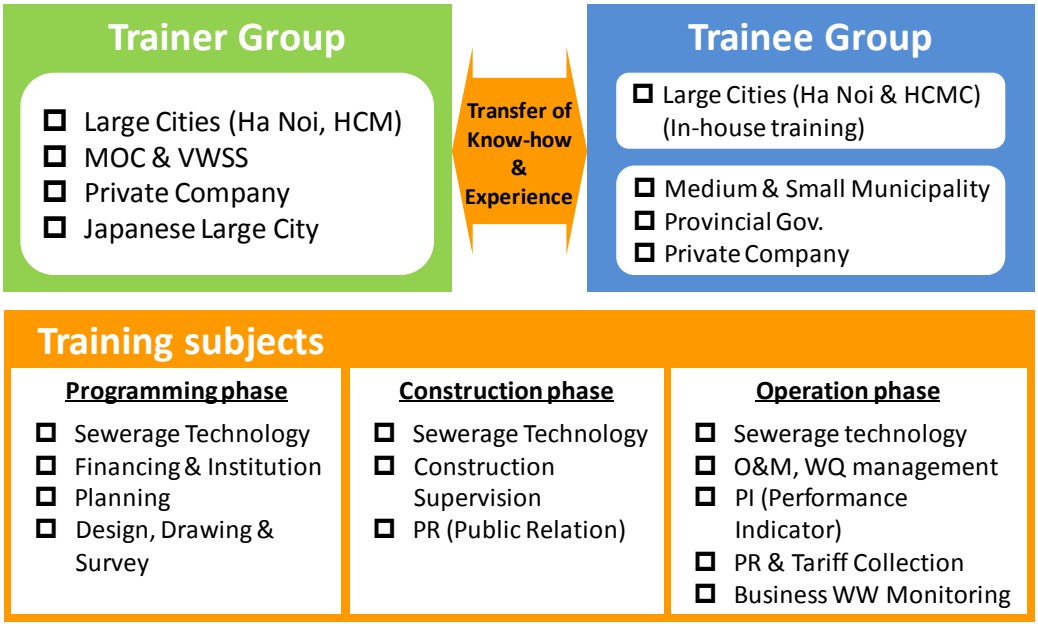
    => Programming, implementation, and management capacity of the project.
- To support the project through accumulated experience and know-how.
- To assist the Vietnamese and Japanese private companies working in project operations.

(2) Concept

The expected roles of the training center are as follows:

1) Provision of a standardized training program for the staff in charge of sewerage project to be of highly qualified engineer;
2) Evaluation and support of new technologies to be applied to the subprojects, which can accelerate utilization of the public; and
3) Training certification to guarantee the quality of engineer.

A diagram of the relationship among the trainer, trainee, and subjects of the training program to achieve the concept is presented in Figure 4.4.1.



Source: JICA Survey Team

Figure 4.4.1 Relationship among Trainee, Trainer, and Subjects of Training

4.4.2 Scheme of the Training Center

The scheme is set based on the results of the questionnaire and interview surveys carried out in Ha Noi City, and HCMC, and answered by MOC.

(1) Framework of the Training Center

1) Trainees

The expected trainees are technical staff who have limited experience in sewerage projects in the metropolis, provinces, cities, and towns where the sewerage project has been /will be implemented. In addition, employees of private companies will be accepted as trainees because the capacity development of the person in charge of the planning, detailed design, construction, and O&M phases is essential.

2) Trainers

The expected trainers are mainly engineers working in the sewerage sector of Vietnam for many years. During the establishment of the training system, Japanese trainers shall be invited from related organizations such as the Ministry of Land, Infrastructure, Transportation and Tourism of Japan, big Japanese cities, JS, and Japan Sewerage Works Association. In training of advanced technology such as microtunneling method, inviting the engineer of a private company developing the technology as trainer is effective.

Since the trainers are invited from other organizations, the period of training program shall be approximately three weeks at the maximum. In addition, some permanent trainers will be required to maintain the quality of training.

3) Program of Training

The program of training is composed of courses on planning, construction, and O&M depending on the progress of the project.

In the planning course, essential technology, organization and finance, survey and plan, and design of sewerage system are the subjects.

In the construction course, supervision of construction works, and promotion of sewerage system and its necessity to the resident are the subjects.

In the O&M course, subjects are on methods for O&M of pipelines and WWTPs, PIs for the monitoring of the project, tariff setting, and public awareness.

(2) Counterpart for the Establishment of a Training Center

Regarding the counterpart organization for the establishment of the training center, VWSA, Ha Noi City, HCMC, Ha Noi Sewerage and Drainage Limited Company, and universities in Vietnam are assumed to be candidates. As a result of the Survey, the Administration of Technical Infrastructure of MOC (ATI) was recognized as the most appropriate counterpart for the establishment of the training center, as the organization comprehensively controls the project and technology of sewerage system.

In addition, CUWC, HUA, and VWSA are in charge of existing training courses on sewerage technology. These organizations are options to request their cooperation for practical training on the establishment of the training center.

(3) Authorization of Training Program and Certification under Vietnamese Regulation

Authorization of training program and its certification under Vietnamese regulation is recommended to guarantee the quality of engineers who graduated from the training program. This is the same scheme applied in Japan. The qualified engineers are indispensable for appropriate development of the sewerage system therefore a comprehensive index for the qualification of the engineer to assign sewerage projects shall be prepared in Vietnam. The university or organization where training program will be provided and which is authorized by Vietnamese regulation is expected to issue the certification.

To accelerate getting the certification, the precedence for the provision of the Water Sector Loan for the subproject needs to be discussed. Therefore, the local municipality which has the graduates of the designated training program will be preferentially provided with the Water Sector Loan.

In the initial stage of the establishing the training center, the training program for the Vietnamese trainers (TOT) need to be carried out. In the program, the foreign engineer invited from Japan and the trainees study the training program and skills through preparing technological texts and attending the existing program of technological training in Japan.

(4) Location of Training Center

Ha Noi is the recommended location for the establishment of the training center since sewerage projects have been launched in the city, and the trainees can learn practical technology and operation method on site.

According to raising the necessity of sewerage projects in major urban areas all over Vietnam, the

establishment of a second training center, or the assignment of trainer groups to provide periodical local training program shall be discussed in the future.

(5) Utilization of Existing Facilities for the Training Center

The first priority in the establishment of the training center is to materialize it as early as possible. Thus, utilization of existing facilities for the training center will be essential to avoid wasting time for the construction of facilities. Accordingly, the recommended candidates of the training center, i.e., VWSA, CUWC, and HAU, are preliminary investigated in consideration of the following points:

1) Relationship between MOC and organization responsible for the existing facilities,
2) Physical distance between the location of MOC and the organization,
3) Current capacity of lecture and practical rooms, and
4) Possibility of constructing WTTP, or utilizing the existing facilities for practical training.

As a result of the study, CUWC is **tentatively** proposed as the most recommendable location and organization to establish the training center among the candidates shown in Table 4.4.1. The location of the training center is needed to have further discussions in Vietnam.

Table 4.4.1 Evaluation of the Locations for Establishment of the Training Center

Items for Evaluation	VWSA	CUWC	HAU
Relationship with MOC	Administration officer assigned from MOC	Under MOC	Under MOC
Physical Distance from MOC	Close	One hour by car	Forty minutes by car
Rooms for lectures or practical work	Need to be arranged in other place	Available	Available
WWTP for practical work	None	Space for the construction of plant available	Close to the site for construction project of Yen Xa WWTP
Result of evaluation	Limited activity such as arrangement of trainers	The best option among the three	Acceptable

Source: JICA Survey Team

4.4.3 Components of Training Program

(1) Training Courses

Training courses shall be prepared for covering whole phases of the sewerage project. In the courses, sufficient occasions to exchange information on new business or the latest technology among trainers and trainees will be provided. Each subject is described below.

1) Planning

The course is prepared for engineers in medium or small cities where the sewerage project will be implemented. Basic knowledge on master planning and project programming, such as procedures of project formulation and approval, knowledge of legal framework, and tariff setting and financial planning shall be provided.

2) Design, Bidding and Supervision

The trainees of the course are expected to be mainly the persons working in organizations related to sewerage projects in large cities, such as Ha Noi City. Technology, procedure and management of

design works, bidding, supervision, quality and safety control and inspection of construction works are instructed in the course.

3) O&M of Sewerage Facilities

Methodology and know-how of O&M for pipeline, pumping station and WWTP are the main subjects of the course. Regarding the O&M of sewer line, surveying functional and structural condition, cleaning, renewal method, and preparation of ledger will be provided. As for the O&M of WWTP and pumping station, know-how of daily O&M works, monitoring and recording water quality, maintenance schedule including procurement of utilities and spare parts, and preparation of ledger of facilities will be provided.

4) Regulations and Countermeasures for Accepting Wastewater to Sewerage System

Studying the necessity of administrative guidance to facilities discharging extremely polluted wastewater, such as food processing, metal plating and heavy chemical industry, is recommended. The trainees study the necessity of the pre-treatment system inside the private facility before discharging to the public sewerage system, with Japanese regulations as an example and procedure for administrative guidance.

5) Public Announcement of Sewerage System

To promote better understanding of sewerage system, public announcements such as on the necessity of sewerage and its tariff is indispensable. In the course, information to be announced, its objectives and methods are instructed.

6) Management of Organization

The course will be provided for responsible persons of organizations concerned with the sewerage project, basic knowledge of sewerage system, legal framework and regulation and management of sewerage system.

7) Training of Vietnamese Trainers (TOT)

For the establishment of the training center, training of Vietnamese trainers is also necessary. With supervision of foreign trainers, the training of trainers will carry out following items:

- Preparation of texts by trainees as coached by trainers,
- Role playing of simulated training by trainees,
- Improvement proposal and technical lectures by foreign trainers, and
- Practical training in Japan (supplemental training).

(2) Priority among the Courses in the Short Term

Assuming the location of the training center is in Ha Noi City, the schedule of establishing the training center need to be adjusted as per the progress of sewerage project in Ha Noi City. In Ha Noi City, projects for construction of new sewerage systems will be implemented soon. Based on the situation, training engineers under the course on design, bidding and supervision is the first priority. In the course, a complementary subject on design and construction technology on microtunneling is included as per the request of PMB of sewerage project in Ha Noi.

In parallel, the course for training of Vietnamese trainers should be carried out for timely provision

of courses as per the raising necessity or progress of the sewerage project in the near future.

4.4.4 Organization of the Training Center

Organization structure of the training center basically composes of division of training engineers, division of training trainers, and management unit to unify the divisions in ATI.

(1) Planning and Operation of Training Courses

Planning the training courses, management of applicants for training and trainees, assignment of trainers and arrangement of lecture room, preparation of texts and other consumables for training program are the main roles of the division. The number of initial staff is at least three.

(2) Training Vietnamese Trainers

The division is responsible for studying the contents of training and preparing the texts for the training of the Vietnamese trainers. Foreign Experts and candidates of Vietnamese trainers will be assigned to the division. Detailed information on the staff for training Vietnamese trainers is presented in Table 4.4.2.

Table 4.4.2 The Detail Information of Staffs in Training Vietnamese Trainers

Staff		Expected Number at the Establishment of the Training Center
Foreign Expert (long-term)	Planning Sewerage System and Mechanical and Electrical Equipment	2
Foreign Expert (short-term)	Sewer Design and Construction Supervision Water Quality Control Management of Sewerage System	3
Vietnamese Trainer Candidates		5

Source: JICA Survey Team

4.4.5 Facilities and Instruments and Costs Estimate

(1) Facilities and Instruments

1) General Facilities and Instruments

The necessary facilities and instruments that are expected include furniture for lecture rooms and offices of the organization, computers, photocopying machines, and stationery. The costs of these items are included in the cost estimate.

As the existing facilities and instruments, such as lecture rooms, and instruments, such as audio-visual systems, are utilized by the training center, the cost of the procurement for facilities and instruments are not included in the cost estimate.

2) Facilities and Instruments for Each Subject

(i) **Planning course, and design, bidding and supervising course**; Instruments for topographic survey, drafter, computers and software such as CAD, structural and hydraulic analysis software are required.

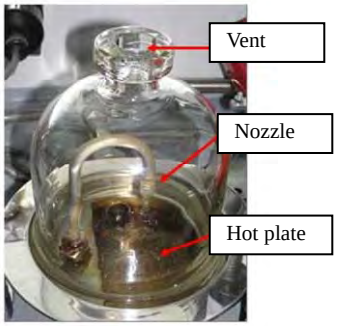
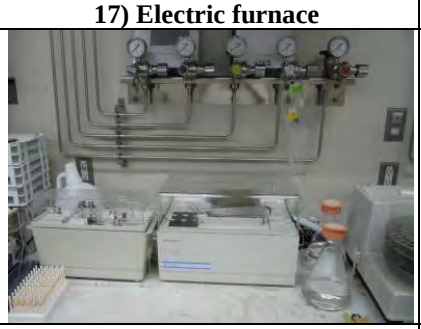
(ii) **O&M of sewerage facilities course**; Model of pumps, pipelines and valves for training of

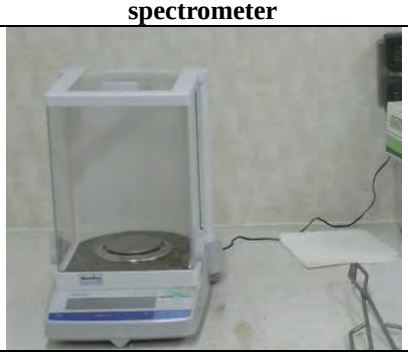
practical works, instruments (as shown in Table 4.4.3) and chemicals for water quality analysis, computers and software for simulating the activated sludge model and ledger system, and instruments and equipment for O&M of sewerage facilities are required.

(iii) WWTP for training with a capacity of about 500-1,000 m^3/day is required

Table 4.4.3 List of Instruments Procured by the Preparatory Office

Instruments in Laboratory		
		
1) Microscope and monitor	**2) Autoclaving**	**3) Hot air sterilizer**
		
4) Incubator	**5) Refrigerator for biological examination**	**6) CN distiller**
		
7) Nitrogen distiller	**8) Fluorine distiller**	**9) DO meter**
		
10) pH meter	**11) Water bath**	**12) Kjeldahl nitrogen digester**

		
13) Ultrasonic cleaner	**14) Pure water apparatus**	**15) Refrigerator-freezer for sample preservation**
		
16) Hot plate	**17) Electric furnace**	**18) Moisture meter**
		
19) Nitrogen auto analyzer	**20) Phosphorus auto analyzer**	**21) Aspirator**
		
22) BOD incubator	**23) Automatic oven**	**24) Atomic absorption photometer**

		
25) TOC meter	**26) Gas chromatography mass spectrometer**	**27) Spectrophotometer**
		
28) BOD meter	**29) Direct reading balance**	**30) Homogenizer**

Source: JICA Survey Team

(2) Initial and Operating Cost of the Training Center

The preliminary cost estimate of the training center for two years is presented in Table 4.4.4.

Table 4.4.4 Preliminary Cost Estimate of the Training Center for Two Years

Item		Cost (JPY million)	Equivalent in USD 1,000[1*)]
1) Initial Cost		**150**	**1,500**
	Procurement of Facilities and Instrument	100	1,000
	Construction of WWTP for Training	50	500
2) Assignment of Foreign Experts		**172**	**1,720**
	Long-term expert (2 persons) JPY 25 million/year x 2 persons x 2 years	100	1,000
	Short-term expert (3 persons) JPY 3 million/month x 4 times/year x 3 persons x 2 years	72	720
3) Operation Cost		**35.6**	**356**
	Cost for Trainings (16 courses, 10 persons/course) 16 times x 10 persons x JPY 0.05 million/person x 2 years	16	160
	Translation and Preparation of Text	10	100
	Translator (2 persons) JPY 0.15 million/month/person x 12 months x 2 persons x 2 years	7.2	72
	Car Rental Services JPY 0.1 million/month x 12 months x 1 car x 2 years	2.4	24
Total 1)+2)+3)		**357.6**	**3,576**
Administration Cost by Vietnamese Gov.		**Provided in due course**	

Note: Exchange Rate: JPY 100 = USD 1
Source: JICA Survey Team

4.4.6 Financial Administration of Training Center

In the beginning of training center, JICA ODA project and Vietnam Government can not help financing an administration cost of Training Center. However, in mid- and long- term, the administration cost shall maintain a financial sustainability by obtaining an income from a provided service, for example. Therefore, a plan of training center shall be considered a prospected income in the future. The prospected income for the training center should be considered in next project.

4.4.7 Roadmap of Technical Cooperation Projects

The schedule of the technical cooperation project for the establishment of the training center is **preliminarily** proposed as follows:

1) Preparatory study for the establishment of the training center from July 2014;

2) Request of the Government of Vietnam, and submission of the project implementation form to the Government of Japan;

3) Establishment of preparatory office from January 2015; and

4) Establishment of the training center form May 2015.

4.5 Proposal of Establishing a Consultation Center

4.5.1 Objectives and Main Role of a Consultation Center

The training center proposed in Section 4.4 mainly performs for long-term measures for the development and operation of the sewerage system through the training of engineers to manage the sewerage project. An organization managing the medium-term and short-term measurements for the ongoing sewerage project is also necessary.

The JICA Survey Team proposed the necessity of a consultation center, which is mainly in charge of short-term or medium-term measurements directly to support PMU of the subproject in finding project, project programming, design and construction of facilities, establishment of an organization and regulation. The main roles of the consultation center are presented in Table 4.5.1.

Table 4.5.1 Main Roles of a Consultation Center

Items	Short Term	Medium/Long Term
(1) Primary assessment of the subproject	-	O
(2) Fund administration of the Water Sector Loan	-	O
(3) Technical assistance for the subproject	O	O

Source: JICA Survey Team

(1) Primary Assessment of Subproject

The evaluation of a project at the initial phase in terms of project schedule and disbursement schedule is indispensable for sound management of the subproject financed by the Water Sector Loan. In most cases, PMU, however, is not familiar with the necessary procedures for projects financed by the Water Sector Loan due to lack of experience. This causes delay of the project.

In the short term, JICA is directly in charge of evaluation of assignment of foreign experts. In parallel, the assigned engineers, in collaboration with the local engineers, support and instruct the staff of

PMU for project implementation agreement between MOC and the province. Pursuant to the agreement, the fund of the subproject is financed by MOF.

(2) Fund Administration of the Water Sector Loan

In the medium term, the Water Sector Loan and its subprojects are managed by the Vietnamese organizations. The huge number of subprojects financed by the Water Sector Loan will be carried out in many provinces of Vietnam in parallel. From the situation described above, a unified assessment system of budget implementation and disbursement is necessary. The consultation center is in charge of the assessment of projects carried out in the provinces of Vietnam.

(3) Technical Assistance for Subproject

1) Consultation

Consultation of technical issues asked by PMU during the implementation of subproject is one of the functions carried out by the consultation center.

2) Support on Establishing Regulations on Sewerage System

New or advanced technologies for design and construction works are being developed every day. In many cases, utilization of advanced technology accelerates the progress of the project and enhances the quality of service.

From this situation, the establishment of standards for new or advanced technology is necessary as soon as possible. The consultation center performs the main role in the preparation of the standards. Technological support for the preparation of standards is presented in Table 4.5.2.

Table 4.5.2 Technological Support for the Preparation of Standards

Items	JICA (Consulting Service)	MOC
1) Project evaluation manual - Project area and population projection - Quality and quantity of water - Facility planning - Implementation plan - Tariff setting	-	Prepared under the first tranche
2) Cost estimation standards for engineering services	-	Prepared under the first tranche
3) Cost estimation standards for construction works	-	Prepared under the first tranche
4) Standard drawing of WWTP and sewer design and planning	Prepared under the second tranche	-
5) Guideline setting of - Plan and design - Operation and management plan - Project cost programming - Public relation - Institutional design for sewerage works operation - Tariff setting - Business waste monitoring - Urban development approval	Prepared under the third tranche	*Upgrade after third tranche

Source: JICA Survey Team

4.5.2 Complementary Technical Support for Subprojects

For the establishment of the Water Sector Loan and training center, some complementary support is necessary. At this time, as the consultation center has not been established yet, the consultant procured by JICA needs to carry out the support.

1) Assistance for the Establishment of Training Center

For the establishment of the training center, the following detailed design and coordination among relevant organizations are required. The terms of reference (TOR) of supporting works are proposed as follows:

(1) Project Scheme of Training Center

- Training needs and the role of consultation center
- Case study (including institution of finance and regulation in Japan)
- Collaboration with public fund investment mechanism
- Enhancing private sector on water related business
- Operation of training program and collaboration with existing institutions
- Step-wise development plan of training center

(2) Training Methodology and Certification

- Training including private company
- Training program in Japan (theory and practice) as reference
- TOT through dispatch of JICA expert(s)
- Certification

(3) Training Subjects and Training Course

Step-wise development of training program will be provided in accordance with sewerage project implementation.

- Subjects for project programming phase
- Subjects for design and construction phase
- Subjects for project operation phase
- Business wastewater monitoring and guiding urban development project
- Public relation (including tariff system)
- Subjects for finance and director class

(4) Facilities and Equipment Plan, and Administrative Organization

- Training equipment
- Laboratory and workshop for practice
- Administrative organization

(5) Resource Plan

- JICA experts
- Costs for construction and equipment
- Operation cost

(6) Supporting Methodology for Japanese Companies

- Participation in procurement for training center development
- Participation in training facility and trainer assignment

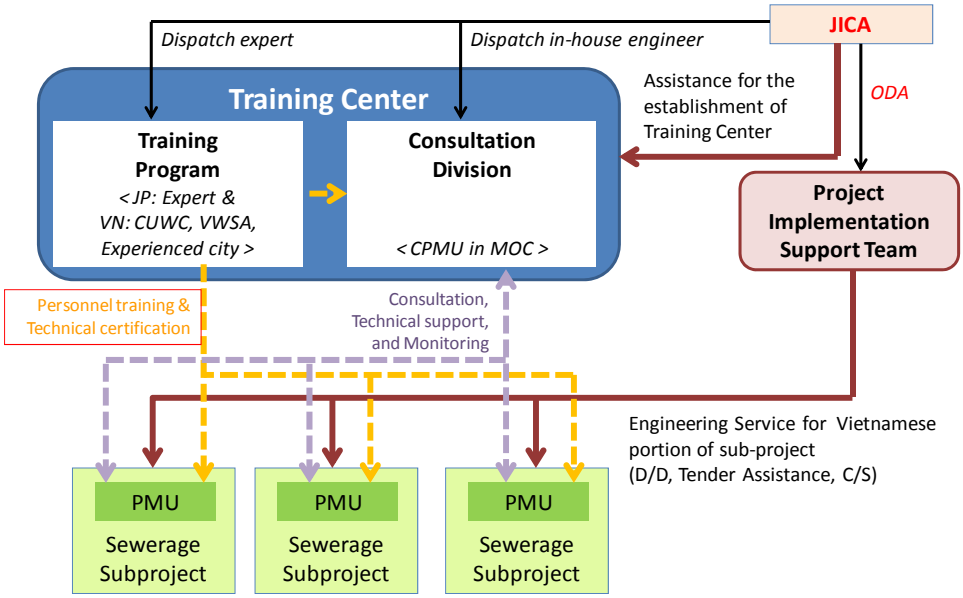
(7) Implementation Schedule

- Implementation schedule

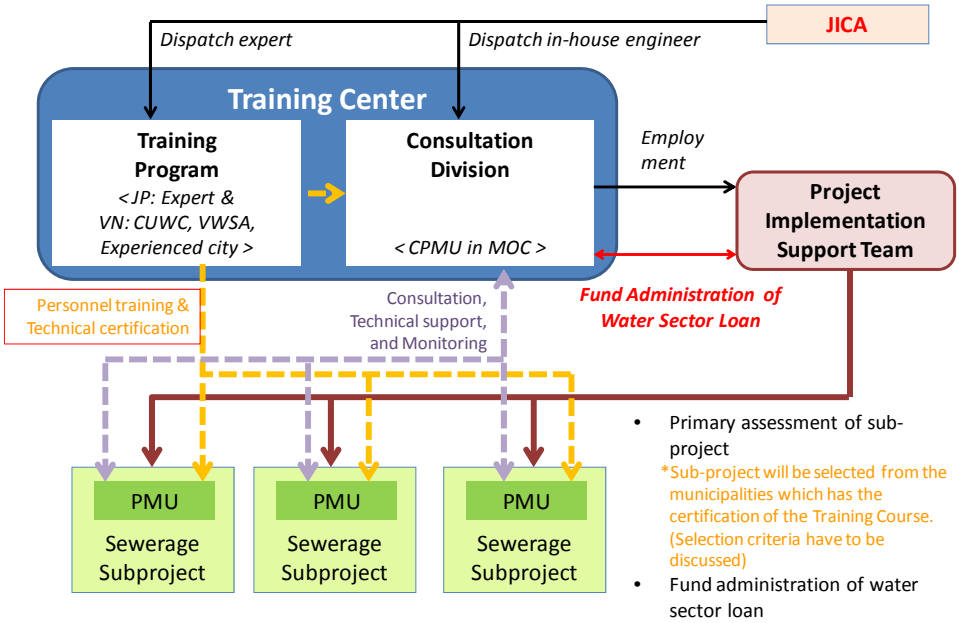
2) Engineering Service for Subproject

Due to MOC's insufficient experience and human resources for the management of the Water Sector Loan and its subproject, technical assistance for the establishment of the training center and implementation support for the subproject shall be provided with JICA's assistance. The outline of the technological assistance is presented in Figure 4.5.1.

Short Term



Medium/Long Term



Source: JICA Survey Team

Figure 4.5.1 Outline of Technological Support

For the short term, JICA shall dispatch an in-house engineer to the consultation center in MOC to support the project programming, formulation of feasibility study, and evaluation of potential subprojects. In addition, for the establishment of the training center, the JICA expert or consultant will assist coordination among relevant organizations such as MOC, VWSA, academic institutions, Vietnamese local municipalities, and JICA. The detailed conditions and training program will be investigated by the consultants. Furthermore, the project implementation support team (JICA's consultant) will support the required engineering services such as detailed design, tender assistance,

and construction supervision of the subproject for the sound implementation of the Water Sector Loan and its subproject.

For the medium/long term, the training program will be managed by MOC, and the Water Sector Loan and its subproject will be managed and implemented only by Vietnamese organizations. At that time, the project implementation support team will be procured by MOC (consultation center) by utilizing the Water Sector Loan to assist in the primary assessment of subproject and fund administration.

4.5.3 Implementation Schedule of Technological Support

The implementation schedule of technological support is proposed in Table 4.5.3, which is based on the loan agreement of the Water Sector Loan in 2014. The establishment of the training center will start in 2014 to support its urgent operation.

Table 4.5.3 Preliminary Implementation Schedule of Technological Support

	2014	2015	2016	2017	2018	2019	2020
1) Water Sector Loan							
First Tranche	●	———	———	———	———	———	———
Second Tranche			●	———	———	———	———
Third Tranche					●	———	———
Forth Tranche		Technical Certification					● ———
2) Training Center*							
Preparation	———						
Training Program		●	———	———	———	———	———
3) Project Implementation Support	●	———	———	———	———	———	———

Source: JICA Survey Team

Chapter 5 Collaboration of the Vietnamese and Japanese Private Companies

5.1 Overview of the Market Structure in the Water Supply and Wastewater Sector in Vietnam

5.1.1 Overview of the Water Supply and Wastewater Sector in Vietnam

(1) Overview of the Sector

The water supply and wastewater treatment in urban areas are managed by the Ministry of Construction (MOC) and those in rural areas are managed by the Ministry of Agriculture and Rural Development (MARD). Due to rapid urbanization and industrialization, the demand for water supply and wastewater treatment has been increasing both in urban and rural areas. However, the increase in demand for both residential and industrial uses has not been sufficiently supplied so far.

In terms of water supply services, its coverage ratio is approximately 70% and the demand was not met especially in local provinces. Moreover, even in urban locations, there are insufficient water connections because most of the water supply systems have not been expanded to the outskirts of the cities. Water supply services in special grade urban areas and urban grades I-III are provided by water supply companies (WSCs) which are state-owned companies and members of the Vietnam Water Supply and Sewerage Association (VWSA). For urban grades IV-V, it is provided mainly by state-owned water supply and sewerage companies managed by provincial governments.

Regarding wastewater treatment, the coverage is limited to urban areas and only approximately 10% of the urban wastewater is treated at municipal wastewater treatment plants (WWTPs) so far, which is because of the limited financial resources of the local government. Therefore, plenty of households in Vietnam rely on septic tanks in their housing lots, but the ratio of septage treatment is as low as 4% so far.

(2) Financial Sources of the Project

The water supply system in Vietnam was constructed during the colonial period and expanded by utilizing the government's budget and the financial assistance from donors, such as the World Bank (WB) and Asian Development Bank (ADB). Despite the rapid economic growth in Vietnam, the central and local governments still hesitate to invest in water supply development considering the low water tariff. Therefore, the government encouraged the public–private partnership (PPP) project to develop the sector, but only limited projects have materialized so far. It is because of the low water tariff and insufficient financial status of the local government and WSCs that make it difficult for the PPP project to materialize.

In the case of the wastewater sector, the development of the service has just started recently and the main financial source has still been provided by donors, such as the Japan International Cooperation Agency (JICA) and WB. According to the rapid economic growth in Vietnam, the need to develop the service will increase both in urban and rural areas but it is assumed that it will be difficult to materialize the PPP project in the sector considering the low wastewater tariff, collected as environmental tax which is 10% of the water tariff. Therefore, it is quite important for the central and local governments to acquire the sufficient budget for its implementation.

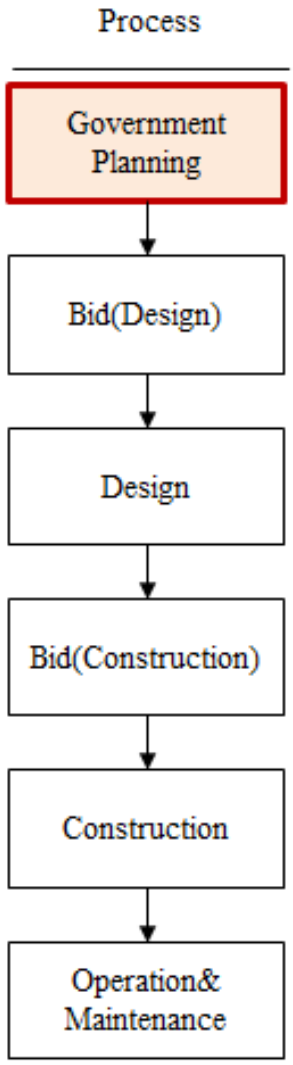
5.1.2 Business Flow

Before analyzing the private companies, the basic structure of the water supply and sewerage development should be studied since it will be the fundamental understanding when analyzing the market environment.

Figure 5.1.1 shows the basic flow of the water supply and sewerage development, which is similar to the Japanese structure. However, for the potential Japanese business players, the decision making process of the projects is unclear because of its complexity. Therefore, this chapter will focus on the basic system of decision making of development projects in governmental planning. In the process of governmental planning, the project evaluation and decision making are the two main tasks. For the state budget-funded project, there are three basic evaluation processes depending on the evaluation players.

At the ministerial level, the Ministry of Planning and Investment (MPI) evaluates projects falling under their investment-deciding competence. Actual evaluation is conducted by the management of the professional units such as the Department of Planning and Investment (DPI). At the provincial level, DPI will be mainly responsible for evaluation of the project and submission to the provincial people's committees for approval. The unit such as the Department of Construction will help DPI. At the district or commune level, the department/agency in charge of budget planning under district/commune people's committees will be responsible for the evaluation of the project.

After the evaluation, the decision maker will decide whether the project will be carried out or not. The decision maker will be the prime minister, ministers or heads of ministerial level agencies, or presidents of people's committees. It depends on the project size who decides on the project. In Vietnam, the project size is divided into three categories and Table 5.1.1 explains the group patterns of the water supply and sewerage construction.



Source: JICA Survey Team

Figure 5.1.1 Flow Chart for the Project Development

Table 5.1.1 Categories of Investment Projects on the Construction Works

Group Category	Project Size
Group A	Over VND 1 trillion
Group B	Between VND 50 billion and 1 trillion
Group C	Under VND 50 billion

Source: Government's Decree No. 12/2009/ND-CP of February 12, 2009

1) The prime minister decides on investing in projects of national importance under the National Assembly's resolutions as well as other important projects.

2) Ministers or heads of ministerial level agencies shall decide on investing in projects under groups A, B, and C and may authorize or decentralize their subordinates to decide on investing in projects under groups B and C.

3) Presidents of people's committees at all levels shall decide on investing in projects of groups A, B, and C within the limits and balancing capacity of local budgets after consulting with the people's councils of the same level. Presidents of provincial or district-level people's committees may authorize or decentralize their subordinates to decide on investing in projects of groups B and C.

4) Depending on local practical conditions, provincial-level people's committee presidents shall assign district or commune-level people's committee presidents to decide on investing in projects funded by budgets of superior levels.

Once the project is determined to be implemented by the basic rules mentioned above, the consultant will design and estimate the budget for construction after the bid for design. (The bidding work is managed by the project investor, without considering categories A, B, and C) After the design, the construction bid and the actual construction will be set forward.

5.2 Survey on Private Companies in Vietnam

5.2.1 The Objective and Method of the Survey

To cultivate a better understanding of the business situation of the Vietnamese companies, the JICA Survey Team conducted an interview on each of these Vietnamese companies in relation to the water business. The JICA Survey Team visited the companies' offices to meet the company directors. The following points were the focus in the interview:

i. Company's overview;
ii. Business relationship with foreign companies;
iii. Intention to have a business relationship with the Japanese companies; and
iv. Issues faced in terms of procurement

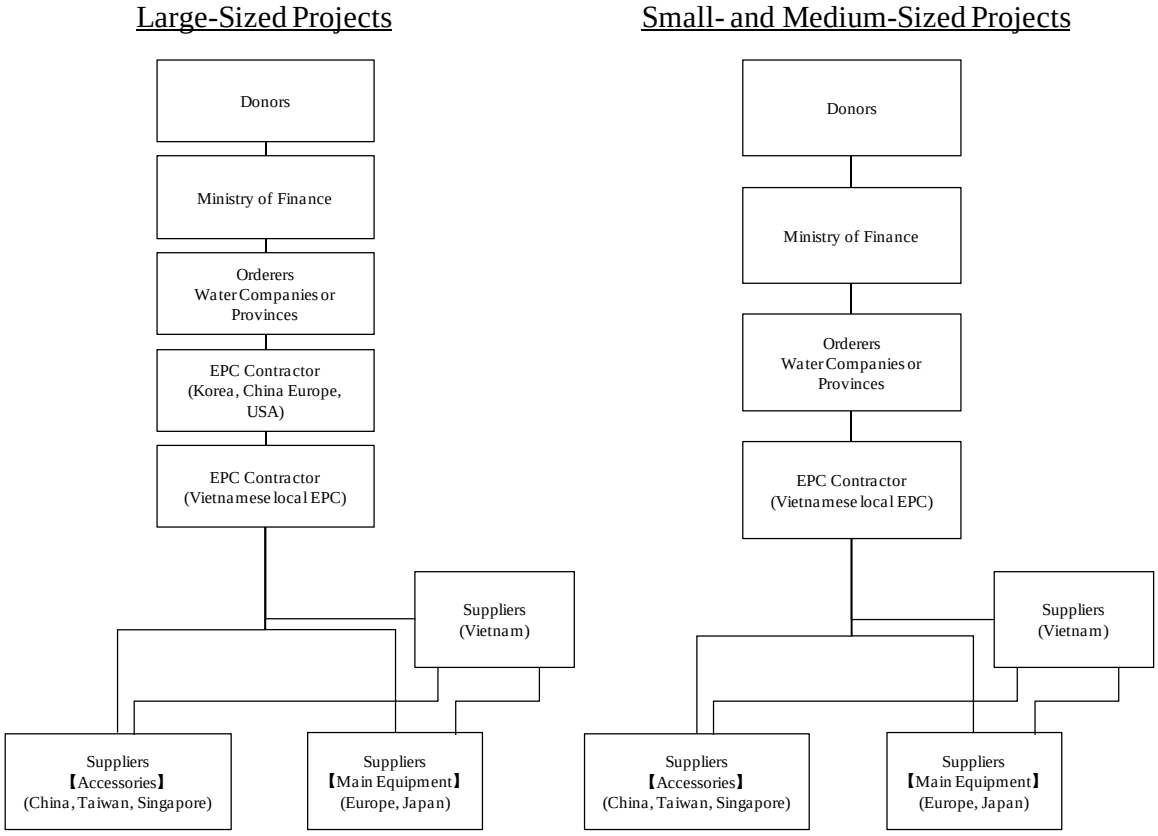
The target companies were mainly the Vietnamese contractors and suppliers (including importers). Fourteen companies were successfully interviewed.

5.2.2 Overview

In Vietnam, the market structure of the water supply and wastewater business can be described in Figure 5.2.1. As far as large size projects are concerned, the main contractor tends to be a foreign company (such as Korean, Chinese, European, or American). Once they have obtained the project, they sublet a certain portion of the project to the Vietnamese local contractors for the actual procurement. Thus, the local companies operate their businesses not only in small- or medium-sized projects but in large-sized projects as well. An industry structure can be featured such that many small-sized companies can deal with many projects. There are not many manufactures who can produce equipment for water supply and wastewater treatment facilities, thus, local companies import equipment from overseas. For the small-sized companies, the import of equipment from overseas is one of the most important businesses.

From the interview, we found that the Japanese and Europeans are the main partners of the Vietnamese companies. Moreover, the Vietnamese companies would like to expand business with the Japanese suppliers more than the Europeans since the Japanese can provide better service and shorter lead time. However, there are some issues regarding the expansion of business with the Japanese companies. The Vietnamese companies face difficulties in obtaining new equipment information or information from the Japanese companies. The main methods of obtaining the information are

through the internet, going to exhibitions or getting information from current partners. However, the Vietnamese companies feel that the current situation is not sufficient to provide the required quality by the buyers.



Source: JICA Survey Team

Figure 5.2.1 Market Structure of the Water Supply and Wastewater Business in Vietnam

5.2.3 Findings

(1) Basic Information of the Companies Interviewed by the JICA Survey Team

Apart from some exceptions, the Vietnamese local companies are relatively smaller in size, less than 200 workers and USD 20 million of annual sales volume as shown in Table 5.2.1. These companies obtain projects from various companies; from private factories to large companies for public facilities. In addition, small companies are relatively young. They have been established sometime within 15 years and the founders are independent of the large companies. Therefore, their customers could be these large companies, including foreign contractors. These companies play a very important role in the procurement of equipment for the water supply and wastewater treatment facilities.

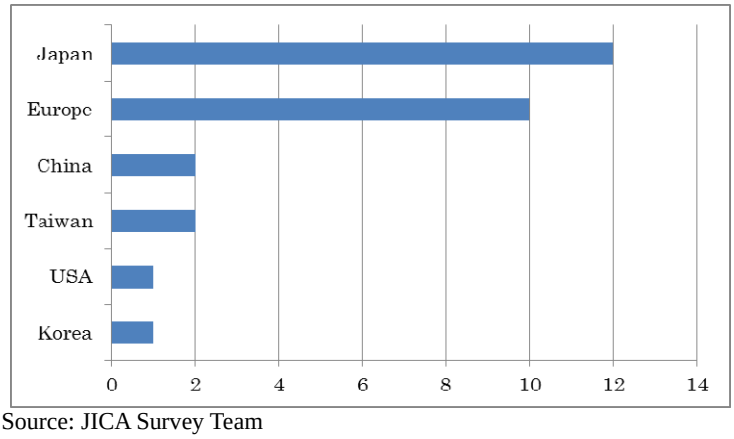
Table 5.2.1 Summary of Basic Information of the Companies Interviewed

Company	Location of Headquarter	Business Category	Year of Foundation	No. of Workers	Sales Volume (million USD)
Company A	Ha Noi	Contractor	unknown	25	1.3
Company B	HCMC	Contractor	1998	100	6.5
Company C	HCMC	Contractor	1999	1000	unknown
Company D	Ha Noi	Contractor	1991	40,000	1,000
Company E	Ha Noi	Contractor	2005	45	1
Company F	Ha Noi	Contractor	2005	170	21
Company G	Ha Noi	Importer	2012	10	unknown
Company H	HCMC	Importer	2011	25	4
Company I	HCMC	Importer	2008	35	2.5
Company J	HCMC	Contractor	1979	200	20
Company K	HCMC	Importer	2005	25	3
Company L	HCMC	Contractor	unknown	100	200
Company M	Ha Noi	Contractor	2003	100	12
Company N	Ha Noi	Contractor	1990	700	unknown

Note: Ho Chi Minh City (HCMC)
Source: JICA Survey Team

(2) Situation of the Import Area

Figure 5.2.2 shows the number of countries where the Vietnamese companies import main equipment. Asian countries such as China, Taiwan, or Korea provide inexpensive equipment. The Vietnamese companies tend to import from Europe or Japan where the equipment price is higher. The main reason why the Vietnamese companies import from Europe or Japan is that they cannot produce the main equipment themselves. There are no such factories, thus they have no other choice but to rely on imports. Another reason is that they are looking for equipment with better quality rather than the inexpensive one. Finally, they regard a long-term relationship as one of the most important factors when finding suppliers. The European or Japanese companies possess the same values as the Vietnamese companies, while the Chinese or Taiwanese tend to focus on short-term relationships. Thus, for the Vietnamese companies, the Japanese and European companies play a very important role in the water and wastewater business.



Source: JICA Survey Team

Figure 5.2.2 Number of Countries where the Vietnamese Companies Import Main Equipment

(3) Difference between the European and Japanese Equipment

From the interview, the quality and price of the equipment itself is at the same level when comparing

the European and Japanese. Although overall, the Vietnamese companies have better images for the Japanese equipment than the European equipment. There are two main reasons for this. Firstly, because Japan is closer to Vietnam compared to Europe, the lead time of procurement is shorter, with an average of 10 days. A shorter lead time improves the cash flow of the Vietnamese companies as well as their business relationship with their customers. Secondly, the engineers from Japan are regarded as very highly skilled, while European engineers are often young and unskilled. Thus, the Japanese companies can provide better services and solutions.

Table 5.2.2 Difference in Categories between the European and Japanese Equipment

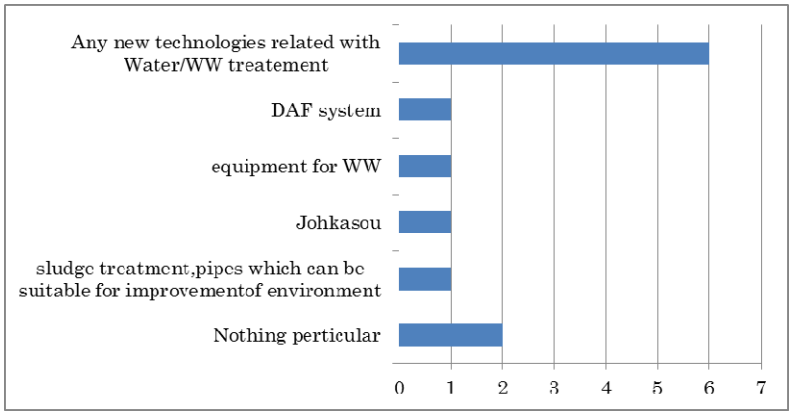
Company	Categories of Viewpoints			
	Quality	Price	After Service	Comments in other Viewpoints
Company A	Japan is better	equal	Europe is better	-
Company B	unknown	unknown	unknown	-
Company C	equal	equal	Japan is better	Japanese are better in sewerage equipment.
Company D	unknown	unknown	unknown	Mainly imported from China
Company E	equal	equal	equal	Lead time of procurement is important and Japan's is quicker.
Company F	equal	Japan is cheaper	Europe is better	We trust the Japanese brand, durability is especially good.
Company G	unknown	unknown	unknown	Unknown
Company H	equal	equal	Europe is better	European companies have established the system of providing after service, which is simple and effective.
Company I	equal	equal	equal	Japanese can provide shorter lead time in procurement, which encourages us to deal with the Japanese companies rather than European companies.
Company J	equal	equal	Japan is better	Japanese Engineers are highly qualified, thus they can solve the issues quickly, while European engineers are relatively young and not highly qualified. Short lead time of procurement is important, thus we tend to prefer the Japanese companies.
Company K	equal	equal	Japan is better	European engineers are young and not professional, while the Japanese engineers are seniors and very professional.
Company L	unknown	unknown	unknown	-
Company M	equal	equal	Japan is better	A short lead time and after service is the feature of the Japanese companies.
Company N	equal	equal	equal	It depends on customers and exchange rate that determine which companies we import from.

Source: JICA Survey Team

(4) Particular Equipment in Demand

Figure 5.2.3 shows the number of particular equipment in demand by the Vietnamese companies. Not much of the particular equipment needed is collected, however, many companies insist that they need any kind of new equipment used in water supply and wastewater treatment. As mentioned earlier, the Vietnamese companies rely on imports in terms of procurement. In this industry structure, the competitive advantage for the Vietnamese companies depend on how quickly and what equipment they can offer to the customers. Thus, searching for the new Japanese/European companies and/or technologies is one of their crucial strategies. They always look for business chances to expand their

business.

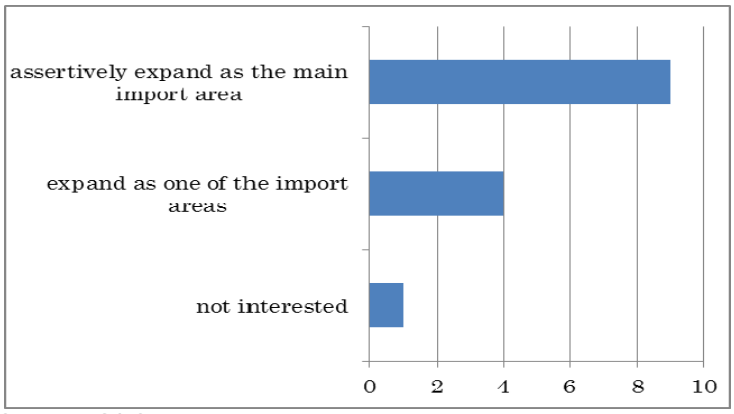


Source: JICA Survey Team

Figure 5.2.3 Number of Particular Equipment in Demand by the Vietnamese Companies

(5) Intention to Have Business Relationship with the Japanese Companies

Figure 5.2.4 shows the number of Vietnamese companies which have an intention to have a business relationship with the Japanese companies. Almost all the Vietnamese companies would like to expand their relationship with Japanese companies. In fact, they regard the Japanese companies as the most important companies in terms of new technologies and values of long-term business relationships.



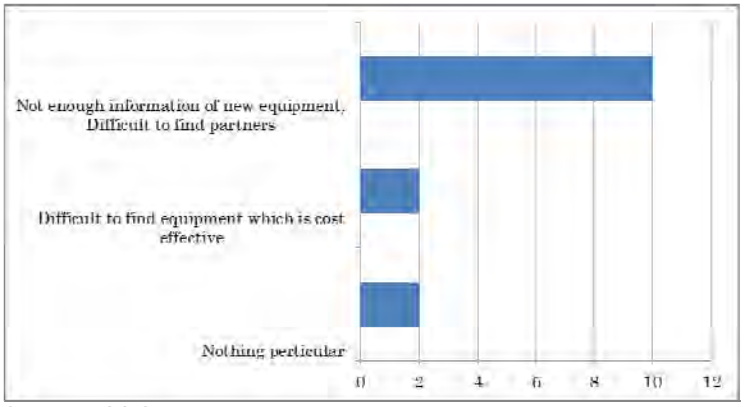
Source: JICA Survey Team

Figure 5.2.4 Intention to Have Business Relationship with the Japanese Companies

(6) Issues Faced by the Vietnamese Companies

Figure 5.2.5 shows the issues faced by the Vietnamese companies in terms of procurement. For the Vietnamese companies, there are some barriers to overcome in order to expand business relationships with the Japanese companies. Information, especially on new equipment or technology from small or medium Japanese companies is limited in Vietnam. The Vietnamese companies usually collect information through the internet or in exhibitions. But websites of the Japanese companies are often written in Japanese only making it very hard to obtain information. Even if there are English websites, it takes time to obtain a reply via e-mail or there are no replies when trying to contact them. There are exhibitions such as 'Viet Water' but it only takes place once a year; thus it is not sufficient. The Vietnamese companies obtain new projects on an average once a month and they need

information just as quick. Hence, many Vietnamese companies insist on business matching schemes which can provide information on Japanese companies and their equipment continuously.



Source: JICA Survey Team

Figure 5.2.5 Issues Faced by the Vietnamese Companies in Terms of Procurement

5.2.4 Case Study Analysis of Suppliers

(1) Analysis of European Suppliers

In Vietnam, the European suppliers have historically played an important role. In this section, we analyze the example of 'Grundfos' who have been successfully operating for more than 20 years in Vietnam and should be able to capture some hints useful for the suppliers who would like to advance into the Vietnamese market.

(2) Case Study of Grundfos

Grundfos is one of the world's largest pump manufacturers, based in Denmark. It has more than 18,000 employees globally with an annual production of more than 12 million pump units. Their business model is characterized in four aspects. Firstly, in terms of their products, the standardization of the products is fairly advanced, thus, the contractor would appreciate its cost effectiveness. Secondly, in terms of their technical assistance, Grundfos had established its subsidiary in Vietnam and had been teaching the methods of implementation and maintenance of their products to contractors. It had helped not only in the satisfaction of achieving the project needs, but they had advanced the Vietnamese contractor's skills. Therefore, the Vietnamese companies are more likely to use their products to improve the technologies. Thirdly, they have conformed to the terms and conditions of trade with the Vietnamese contractors. Grundfos provides better conditions in terms of the payment period. The Vietnamese contractors are willing to use their products as it will improve their cash flow status. Finally, Grundfos is very keen on marketing, not only towards the Vietnamese contractors but to the buyers and the consultants of project development. They have been promoting their products, teaching new skills and technologies to these people and organizations. It had helped them to be widely well known in this industry and had led to the smooth acceptance when adopting their equipment in the particular project by the buyers.

5.3 Survey on Private Companies in Japan

5.3.1 Objective and Method of the Survey

To cultivate a better understanding of the situation and the intention of advancement into the Vietnamese market by the Japanese companies, we have conducted a questionnaire survey and

interview with the member companies of Kitakyushu and Yokohama Overseas Water Business Association. The JICA Survey Team sent the questionnaires to the target companies on December 15, 2013 for Yokohama and on January 22, 2014 for Kitakyushu, and have collected them on January 22, 2014. Moreover, we have interviewed the 11 companies from December 15, 2013 to April 1, 2014 both in Japan and Vietnam to understand the situation more precisely.

The target companies are mainly private companies of the member organizations of Kitakyushu and Yokohama Overseas Water Business Association. The target for the questionnaire survey is 180 companies and the number of the companies we have interviewed is 11 companies. We have succeeded to collect the questionnaires of 56 companies (Yield: 31.1%).

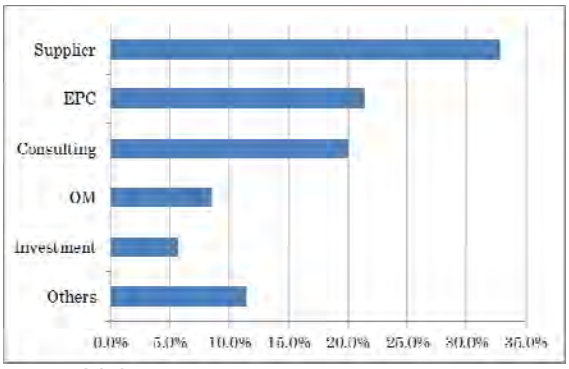
5.3.2 Overview

Approximately, 90% of the Japanese companies who have answered the questionnaire would like to or have already started business with the Vietnamese companies or in Vietnam. There is a strong business need for the Japanese companies to expand their business in Vietnam. Specifically small and medium suppliers look for business opportunities by exporting their own equipment which have succeeded in the Japanese market. On the other hand, these companies struggle to find partners or customers in Vietnam. The information about the project which the Vietnamese companies possess is not attainable for the Japanese suppliers at the moment. By analyzing this section and Section 5.2, it could be concluded that both the Vietnamese and Japanese companies might be losing potential business chances because of the information gap between them. Hence, a scheme of business matching between the Vietnamese and Japanese companies could lead to the benefit of both companies.

5.3.3 Findings

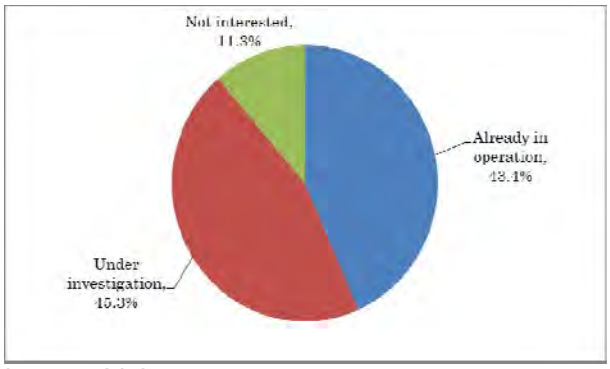
(1) Proportion of the Business Domain and Intention to Advance into Vietnam

The percentage of business domain categories of the companies which have answered the questionnaire and the percentage of the degree of the intention to advance into Vietnam are shown in Figures 5.3.1 and 5.3.2. Overseas Water Business Association in Yokohama and Kitakyushu possess companies from various kinds of industry domains but the proportion of the equipment suppliers draws the line from other domains. Among all the companies 43.4% of them have already operated their business with the Vietnamese companies or in Vietnam. Moreover, 45.3% of companies would like to advance into the Vietnamese market and are now conducting marketing research. Thus, the Vietnamese market is regarded as an attractive market for the Japanese companies. Not only because Vietnam is a growing market, but the Japanese companies possess a good image about the Vietnamese workers from Vietnamese trainees accepted in Japan. Hence, it is reasonably concluded that there is still a great need for the Japanese companies to collaborate with the Vietnamese companies hereafter.



Source: JICA Survey Team

Figure 5.3.1 Percentage of Business Domain Categories of the Companies which have Answered the Questionnaire

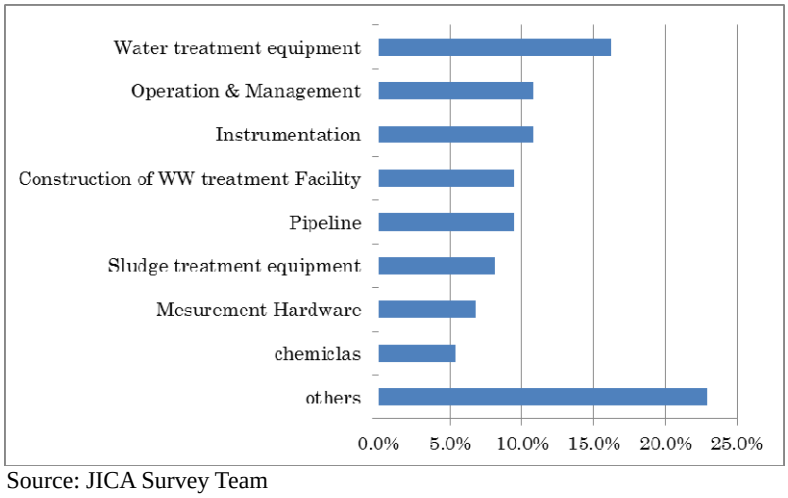


Source: JICA Survey Team

Figure 5.3.2 Percentage of Degree for an Intention to Advance into Vietnam

(2) Proportion of the Business Areas where the Japanese Companies would like to Operate in Vietnam

As shown in Figure 5.3.3, water treatment equipment in Vietnam is regarded as the service area which the Japanese companies would like to advance into. But more interestingly, it can also be regarded that service categories which the Japanese companies would like to expand in Vietnam are fairly spread. This is because each company has their own strengths in these fields originating from the history of their operations in Japan. Thus, the Japanese companies are looking for business chances for various kinds of service areas. As mentioned in (4) of Section 5.2.3, the Vietnamese companies also search for various kinds of any new or unknown technologies overseas. Taking this into account, there is a good chance for the Japanese companies and Vietnamese companies to collaborate in business.



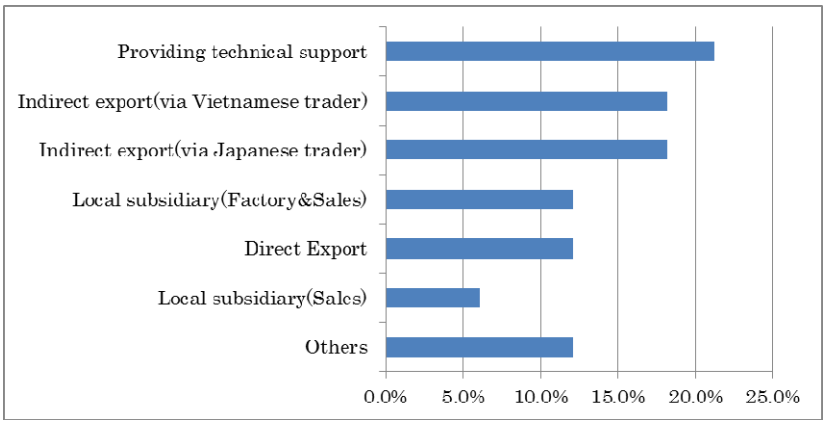
Source: JICA Survey Team

Figure 5.3.3 Percentage of Service Categories which Companies would like to Expand in Vietnam

(3) Business Models which the Japanese Companies Try to Provide in Vietnam

Although more than 40% of the companies which answered the questionnaire have already started with the Vietnamese companies or in Vietnam, an indirect export (both via the Vietnamese and Japanese traders) is the business model which many companies pursue at the moment. Also,

providing technical support to the Vietnamese companies is another easy method to be able to launch into the Vietnamese market.

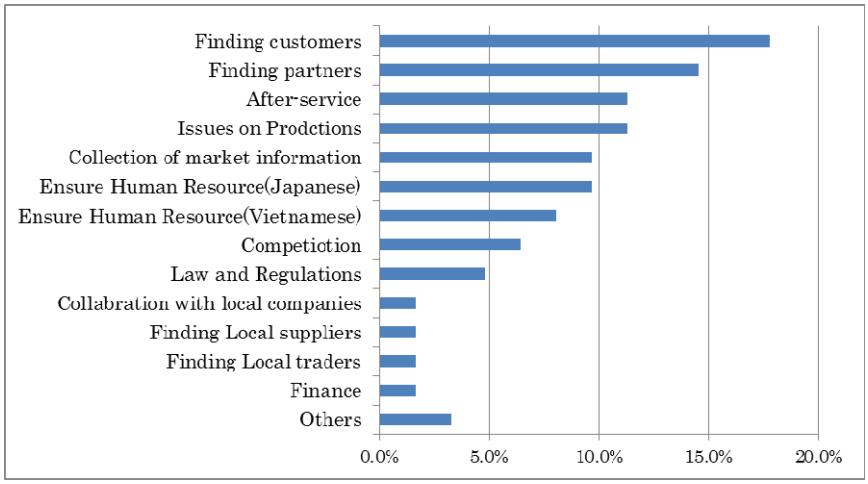


Source: JICA Survey Team

Figure 5.3.4 Percentage of Business Models which the Japanese Companies try to Pursue in Vietnam

(4) Issues Faced by the Japanese Companies who Try to Advance into the Vietnamese Market

By analyzing with Figure 5.3.5, it could be concluded that companies which would like to expand their business by export are struggling with finding new partners. In fact, from the interview of the Japanese companies, many of them seek information about the Vietnamese companies. For the companies which have not yet started business with Vietnamese companies, they do not have methods to create business relationships with the Vietnamese companies. Especially for small and medium companies, it is not affordable to invest in finding partners on their own. This is one of the main reasons why some of the Japanese companies still could not start business. Interestingly, the issues for the Vietnamese companies (see (6) of Section 5.2.3) and those faced by the Japanese companies are similar. They both look for a business chance to deal with each other but there is an information gap between them. Hence, both the Japanese and Vientamese companies currently could not optimize the potential business chances.



Source: JICA Survey Team

Figure 5.3.5 Percentage of Issues Faced by the Japanese Companies who Try to Advance into the Vietnamese Market

5.3.4 Strategy to Promote the Collaboration

From the analysis in Section 5.2 and 5.3, both the Vietnamese and Japanese companies require their further collaboration. First, there is a strong demand from the Vietnamese companies; and second the Japanese companies would like to expand their sales volume and Vietnam is regarded as one of the attractive markets. Hence, In this section the JICA Survey Team concludes by analyzing how the Japanese companies pursue to advance into the Vietnamese market.

(1) Collaboration with the Vietnamese Contractors (Targeting)

The Japanese suppliers should take into account the business environment in which the potential customers could be the Vietnamese contractors or the Vietnamese suppliers, rather than the Japanese contractors as far as the project in water supply and wastewater sector is concerned. The Vietnamese contractors have faced the difficulties in meeting the demands for some projects since the projects' needs vary from one to another. Thus, they are very keen on accepting the new equipment and seeking a chance to meet the Japanese companies. In our interview, almost all contractors have mentioned that they are willing to discuss how to implement the Japanese equipment. Collaboration with the Japanese suppliers contribute to the improvement of their competitiveness.

(2) Growing out of 'the Quality of Japanese Standard' and Developing 'the International Standard' (Marketing Mix)

The equipment marketed in Japan is generally said to be too expensive for the Vietnamese market. Since the Vietnamese buyers do not require such high quality, the Japanese companies should care only for the most fundamental or critical function and try to reduce the production costs of the other functions. The methods of cost reduction could narrow the functions, compromise the appearance, or change the overseas parts, and so on. Another important aspect is the standardization of the production process. The standard product can minimize the design cost and a simple assembly process can reduce the production cost because it will eventually enable the production process to be carried out in Vietnam where the labor cost is much lower than Japan. Therefore, when the company develops the new product, it should take into account not only the product itself but also the production process. It could be more effective if the suppliers involve their own suppliers in the product development process. Involvement of suppliers could give a wide range of business models and reduce the manpower of the development process.

5.3.5 Analysis of the Potential Business Model for the Japanese Suppliers

(1) Pattern of Business Models for Advancing into Overseas in General

In general, there are three stages when the companies advance into an overseas market.

1) Export Stage

This is the first step when the company initially advances into the overseas market. An indirect export could be the easiest way because the traders which have already operated in a particular country could sell their products instead of the company. Although traders often deal with the products of competitors, the direct export model would be preferred. To make the direct export more feasible, the company should find a salesperson to conduct the market research and find some business partners. This process will be the key factor of success for the export model.

2) Local Production Stage

After creating the local sales channel, the company would develop their manufacturing process overseas. There are three types of local production models. Original equipment manufacturing (OEM) by the supplier (manufacturer) will be the model which can lower the initial costs. The other two types are the joint venture and local subsidiary model. These models are usually considered as the second step to advance into overseas.

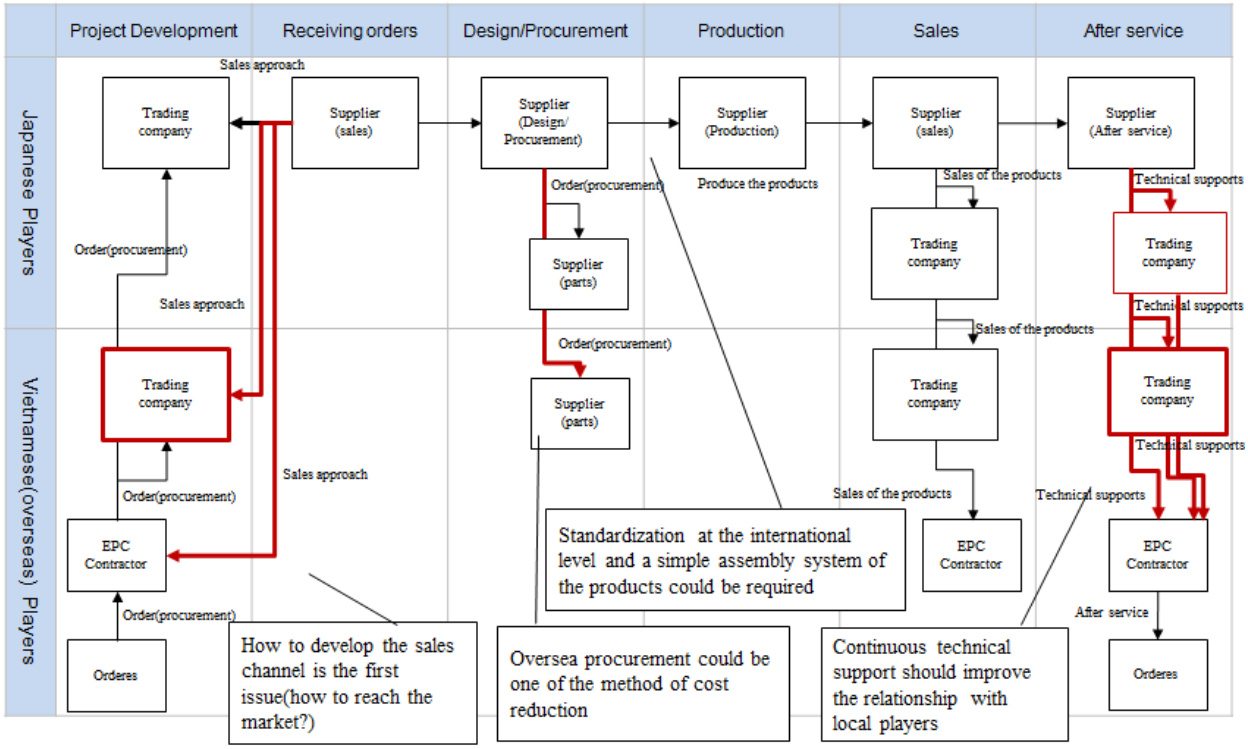
3) Global Integration Stage

This stage is the final stage to advance into overseas. The companies establish their own subsidiary and localize their business functions, including indirect functions such as human resources or general affairs.

In the next chapter, export and local production model (particularly OEM Model) will be analyzed, as these are the feasible models for the Japanese small and medium companies.

(2) Export Model

The red lines in Figure 5.3.6 are the key processes of this model. To make this model feasible, the company should develop the sales channels. Preferably, the company should seek the trading companies or even the local contractors in Vietnam on their own by placing a salesperson in charge of this. It should give the company market information, thus the company could broaden the business chances or define the specific issues that need to be solved in order to develop the market. On the other hand, the cost of production tends to be the problem in this model. The company should try to establish a worldwide standard for their products and a simple assembly production process preferably before carrying out the sales channel development. In addition, the dynamic use of parts from overseas could be one of the solutions, although it will depend on the cost structure of the products. At the same time, the company should consider the technical assistance since the requirements of this support from the local contractors are relatively high. The continuous technical assistance rather than the assistance by a temporary business trip will also improve the relationship among the customers. Overall, it should be recognized that the integration of the sales, design, procurement, and after services is the key success factor of this model.

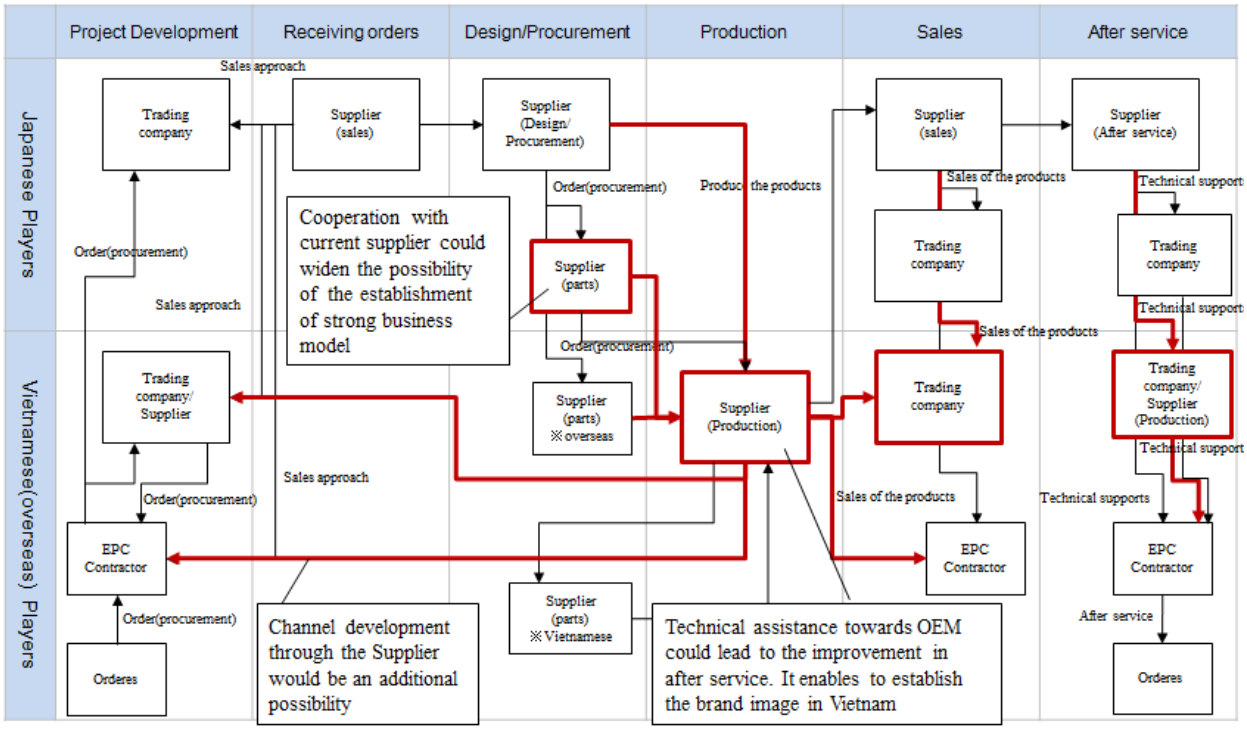


Source: JICA Survey Team

Figure 5.3.6 Potential Business Flow of the Export Model

(3) OEM Model

This model shown in Figure 5.3.7 is another feasible way of advancing into the Vietnamese market for small and medium companies. Pioneering the OEM is obviously the critical point. However, even if the supplier (manufacturer) could find the OEM, it faces some difficulties in the actual production. In Japan, the manufacturer procures various kinds of equipment, including semi-finished goods. In the actual business, they need to collaborate with such services because the manufacturer itself does not have the skills to develop these semi-finished goods. Therefore, the collaboration with the current suppliers or the potential suppliers in Japan could broaden the possibility of the quick establishment of this model. Another important aspect is that the manufacturer could use the business channel of the local OEM. It should evaluate business channels of OEM and try to negotiate other business chances. After the establishment of the production process, the supply method of the after service should be taken into account. Continuous technical support towards the OEM for the after service could establish the brand image of the products in Vietnam. On the other hand, if the manufacturer could directly provide the after service, continuously, it enables them to make a better relationship with the customers. This can provide another business chance for them. Therefore, the scheme of the after service should be carefully examined by the manufacturer. Overall, not only the manufacturers themselves but the collaboration of their suppliers could be the important aspects of establishing a stronger business model.



Source: JICA Survey Team

Figure 5.3.7 Potential Business Flow of the OEM Model

5.4 Potential Business Chances for the Japanese Suppliers in Vietnam

5.4.1 Technical Issues in the Water Supply and the Wastewater Sector

(1) Water Supply Sector

In order to establish a sustainable water supply service by raising the tariff, the enhancement of the quality of service is one of the important factors. The insufficient technical background sometimes leads to the low quality of facilities and accordingly, the low service level for the users.

The municipal water has to meet the drinking water quality standard issued by the Ministry of Health (MOH), but the quality of supplied water to the households often do not meet the standards. The reasons for this are as follows:

- Approximately 65% of the water used for water treatment plants (WTPs) come from surface water and the remaining 35% is extracted from ground water. Both surface water and ground water have gradually deteriorated due to urbanization and the insufficient sewerage system.
- According to population increase, the capacity of WTP is not sufficient and overloaded in some cases. The expansion of WTP shall be required.
- The distribution system is old and poor, which causes low water pressure and allows treated water to be easily polluted by the groundwater.

(2) Wastewater Sector

The main issue of the wastewater sector in Vietnam is the low coverage of service. According to the economical development, the needs of the wastewater treatment has gradually increased, but the

limited financial source prevents the project from implementation. In order to accelerate the implementation, the following measures are required:

- The appropriate strategy and policy for sewerage development and the watershed management, including the roll allocation between the centralized system and communal system, shall be established.
- Capacity development for all phases of the sewerage development, such as the planning, design, construction, and operation and maintenance (O&M) phases, will be required.

5.4.2 Technology Applied for the Water Supply and Wastewater Sector in Vietnam

(1) Water Treatment

The most common process applied for both surface water and groundwater treatment in Vietnam is the rapid sand filtration system with the following procedure.

i) Flocculation
ii) Sedimentation
iii) Filtration
iv) Disinfection by chlorine

In terms of the desalination system, it has not applied for the municipal WTPs in Vietnam except for An Binh Island. Its desalination plant, with the capacity of 200 m^3/day, consists of two seawater reverse osmosis (SWRO) units, and was donated by Doosan Vina, a subsidiary of Doosan Heavy Industries and Construction, through their corporate social responsibility program.

(2) Wastewater Treatment

The effluent standard in Vietnam, QCVN 40:2011/BTNMT, stipulates that 30 mg/liter of biochemical oxygen demand (BOD) for the water bodies should be used as sources of domestic water supply and 50 mg/liter of BOD for the water bodies should be used for other water usage purposes with lower quality requirements. The effluent standard is relatively strict and the suitable treatment process shall be selected for the municipal sewerage system. The wastewater treatment process applied in Vietnam is reported in the WB report and the dominant treatment process is the activated sludge and its modified process as shown in Table 5.4.1.

Table 5.4.1 Wastewater Treatment Process Applied in Vietnam

Treatment Process		In Operation	On Going
Activated Sludge	A_2O	3	0
	AO with nitrification	1	0
	Sequencing Batch Reactor	7	9
	Conventional Activated Sludge	1	8
	Oxidation Ditch	2	8
Pond and Lagoon		6	3
Others		1	3
Total		21	31

Source: Vietnam Urban Wastewater Review (WB: 2013)

(3) Pipeline

The pipeline for the water supply and sewerage systems has been mainly installed by the conventional methodology, namely open cut method. The sewer line, especially the main sewer, is normally installed in a deeper location compared to the distribution network of the water supply system. Hence, the microtunneling (pipe jacking) technology shall be applied to the installation of sewers to prevent the influence on transportation during the construction period.

In terms of the existing distribution network, the high level of non revenue water (NRW) and the frequent breakage prevents the users from satisfaction in its services. As reported in the multiple reports, the quality of service has not been sufficient in many cities; particularly the following points:

- the coverage ratio is still not enough;
- the water quality does not satisfy the standard; and
- the water pressure of the tap is not enough.

5.4.3 Specification and Criteria for the Water Supply and Wastewater Sector in Vietnam and Japan

(1) Current Status

In the case of Japan, the related ministries, namely, the Ministry of Health, Labour and Welfare (MHLW) and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), stipulate the related laws, the enforcement ordinance, and the detailed enforcement regulations for water supply and sewage works. Moreover, the related associations, namely, Japan Water Works Association (JWWA) and Japan Sewage Works Association (JSWA), issue the design criteria and the specifications and guidelines for the sectors. In addition, the Japan Sewage Works Agency (JSWA) is the agency that will contribute to the sewerage development through technical assistance and on the capacity development from planning to O&M phase, stipulates their own criteria and specifications. These plentiful criteria and standards cover the required technology and require high quality of materials and equipment for the sectors.

In the case of Vietnam, the sewerage law has not been issued and the environmental law covers the sector. The design criteria and standards, such as QCVN 07:2010/BXD, TCXDVN 33/2006/BXD, were issued by MOC, but the specifications for the facilities are not stipulated in the said criteria and standards. They stipulate the basic requirement for the engineering works and the consultants select the facilities and equipments according to the design conditions. Vietnam Institute for Building Science and Technology (IBST) is in charge of the establishment of new technical standards. IBST formulated the draft technical standard and it will be certified after the review and approval of MOC and the Ministry of Science and Technology (MOST).

(2) Issues

In order to optimize the water supply and sewerage facilities in Vietnam, the suitable technology, such as microtunneling (pipe jacking), U-BCF, and sludge recycling technologies, shall be procured from other countries. For the application of new technology, the certification procedure mentioned in the above section shall be required and it takes time in current regulation. In order to accelerate this innovation, the procedure shall be shortened as not to be an added obstacle.

5.4.4 Advanced Technology Applied to the Water Supply and Wastewater Sector in Japan

(1) Advanced Technologies for the Sector

A variety of technologies are introduced and developed for the water supply and wastewater sector in order to sustain the quality of life and the water environment. The advanced technologies applied to the sector are shown in Table 5.4.2 and Table 5.4.3.

Table 5.4.2 Typical Advanced Technologies Applied to the Water Sector in Japan

	Treatment	Pipeline
Construction	1) Water Treatment - Upflow Biological Contact Filtration (U-BCF) - Membrane Filtration (MF) - Reverse Osmosis (RO) - Advanced Water Treatment Process - Ozone Treatment 2) Sludge Treatment and Reuse - Dewatering Facilities 3) Equipment - High Efficiency Pump - Energy Saving Equipment	1) Pipe Installation - Microtunneling (pipe jacking) Technology 2) Small-scale Hydropower
Rehabilitation and O&M	1) SCADA (remote control system) 2) Asset Management	1) NRW Management - Leakage Detection - Planning and Measure 2) Pipe Replacement without Water Stoppage 3) Water Distribution Control System 4) Ledger of Network 5) Customer Information System

Source: JICA Survey Team

Table 5.4.3 Typical Advanced Technologies Applied to the Wastewater Sector in Japan

	Treatment	Pipeline
Construction	1) Wastewater Treatment - Membrane Biological Reactor (MBR) - Pre-treated Trickling Filtration (PTF) - Advanced Oxidation Ditch 2) Water Reuse 3) Sludge Treatment and Reuse - Dewatering Facilities - Incinerator - Biomass Power Station 4) Combined Sewer Overflow (CSO) Control 5) Hydrogen Sulfide Corrosion Control 6) Equipment - High Efficiency Pump - Energy Saving Equipment - High Efficiency Air Diffuser 7) Johkasou	1) Pipe Installation - Microtunneling (pipe jacking) Technology - Hydrogen Sulfide Corrosion Control 2) Urban Flood Control (storm water management) 3) CSO Mitigation
Rehabilitation and O&M	1) SCADA (remote control system) 2) Asset Management	1)Trenchless Sewer Rehabilitation 2) Sewer Inspection (TV camera) 3) Maintenance of Sewer Line 4) Ledger of Sewer Line 5) Customer Information System

Source: JICA Survey Team

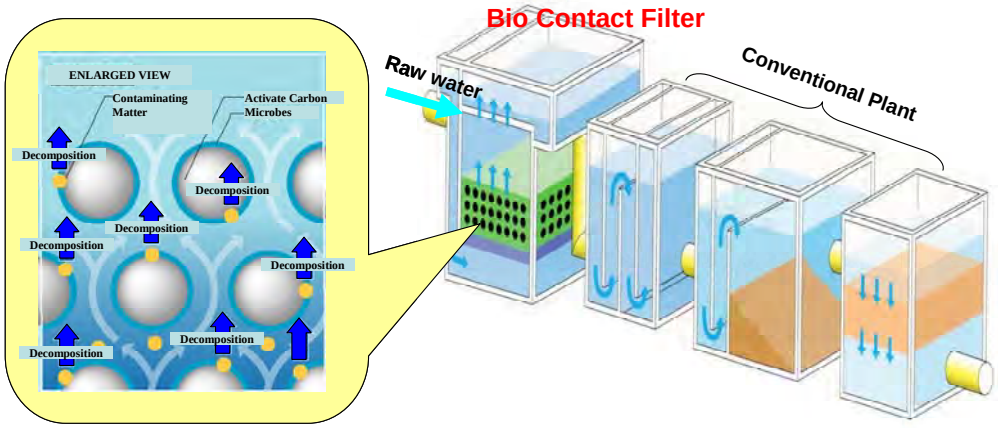
(2) Proposal of Cutting Edge Technology Desired for Vietnam

In consideration of the current status of the water supply and wastewater sector, the technology which can be applied for the rehabilitation is mainly needed in the water supply sector, and for the construction in the wastewater sector, respectively. The following technology seems to be needed in order to optimize the service in Vietnam.

1) Water Supply Sector

i) Upward Biological Contact Filtration (U-BCF)

U-BCF is the pretreatment method for WTP. The basic mechanism of U-BCF is the biological treatment through the bio contact filter as shown in Figure 5.4.1. The detail of this technology is described in Chapter 6.



Source: City of Kitakyushu

Figure 5.4.1 Diagram of U-BCF

ii) NRW Management

In general, not only in Vietnam, NRW gives a harmful impact on the financial situation of water utilities and the utilities tackled with this issue. The activities for NRW reduction, as shown in Table 5.4.4, are generally common around the world through the experiences in various water utilities. However, different situations of physical conditions in infrastructure, socio-economic conditions, financial conditions of the water authority, and availability of water resources give different priorities to the common activities and make it difficult to solve these issues. Therefore, the NRW reduction activities shall be carried out with the experienced organizations.

Table 5.4.4 Summary of NRW Reduction Activities

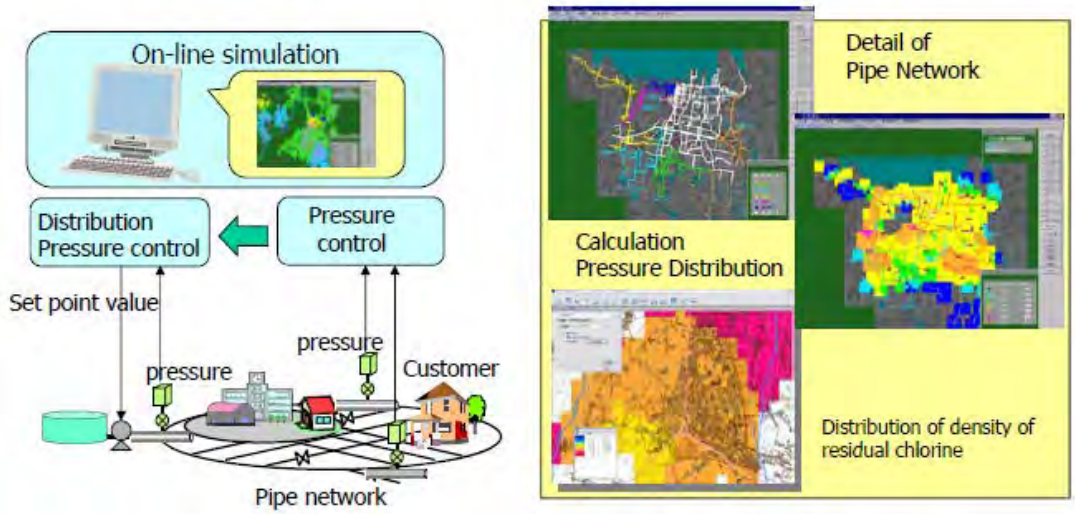
Programs	Descriptions	Examples of Activities
1) Real Loss		
Pipeline and assets management	Replacement or maintenance of water supply system to reduce existing or potential leaks	- Improvement of reported leak detection system - Improvement of leak repair skills - Improvement of pressure control system - Sectorization and sector metering - Update of asset database - Replacement of old networks
Pressure management	Control of hydraulic pressure to a predetermined desired range of pressures	
Active leakage control	Detection of unreported leaks by water leak detection equipment and repair of the detected leaks	
Speedy ad reliable repairs	Repair reported leaks by reliable method	
2) Apparent loss		
Water meter management	Installation of water meters of suitable diameters, maintenance, and periodic replacement	- Replacement or calibration of customer meters - Update of customer database - Illegal consumption control program - Introduction of advanced metering and billing system
Illegal consumption management	Activities to eliminate illegal consumption by inspection of service connections, monitoring of billed amount of the customers, etc.	
Billing system improvement	Reinforcement of metering and billing system to eliminate data handling error	

Source: JICA Survey Team

iii) Water Distribution Control System

The water distribution control system shown in Figure 5.4.2 is effective in order to optimize the treated water distribution by utilizing the ICT technologies. The system has the following functions:

- Monitoring and data management through geographical interface;
- Adaptability of demand fluctuation based on real-time analysis; and
- Saving energy and leakage reduction.



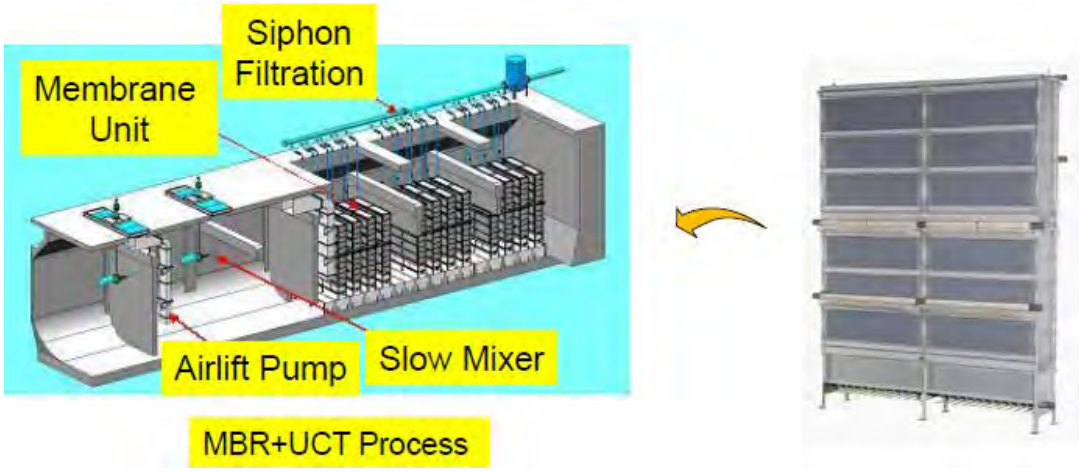
Source: HITACHI

Figure 5.4.2 Water Distribution Control System

2) Wastewater Sector

i) Membrane Bio Reactor (MBR)

The MBR needs no final sedimentation tank, which enables the production of high-quality treated water in a limited space. Therefore, it is expected that MBR will be a key technology for solving various problems in sewage treatment. The MBR system is shown in Figure 5.4.3.

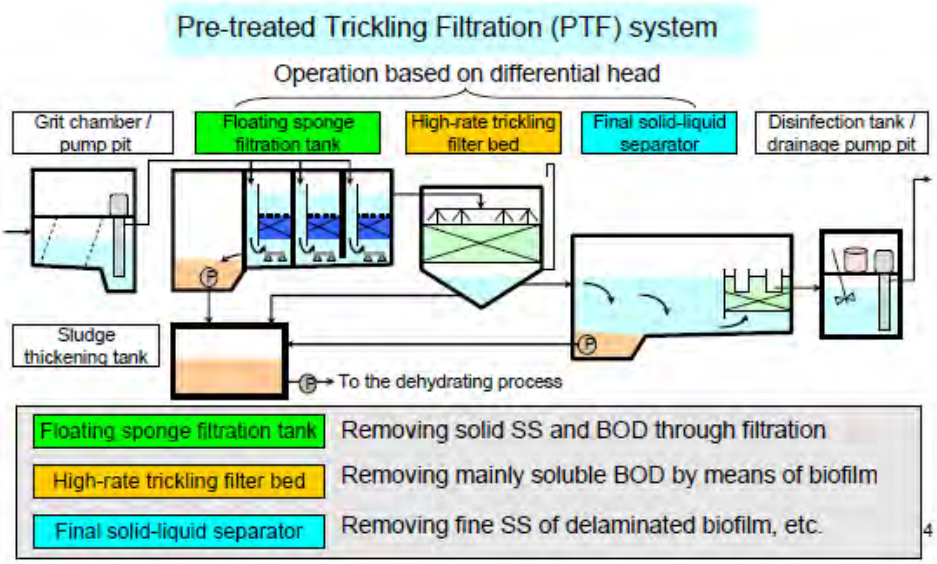


Source: Advancing Water Reuse in Japan

Figure 5.4.3 MBR System

ii) Sludge Treatment and Reuse

As shown in Figure 5.4.4, the pretreated trickling filtration system is composed of a floating sponge filtration tank, high-rate trickling filter bed, and a final solid-liquid separator. It has been developed for application in the market of developing countries, especially in the Asian region by MetaWater Co., Ltd. The features of the system are the low electricity consumption, easy-maintenance, and stable treated water quality, which were all confirmed through the demonstration experiment carried out in Da Nang City.

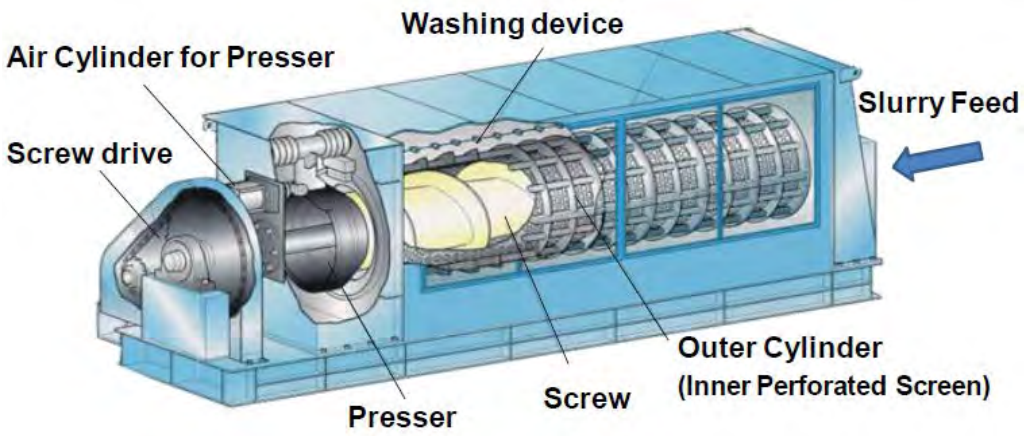


Source: METAWATER

Figure 5.4.4 Treatment Process of Pretreated Trickling Filtration (PTF) System

iii) Sludge Treatment and Reuse

For sludge dewatering, the screw press has been selling well. Polymer is added to the feed sludge. After this, rotating screens thicken the sludge. Then, the sludge is mixed with another coagulant before the screw press dewatering. The system is in an air tight casing for an odor free environment. Detail of the sludge reuse technology is described in Chapter 6.

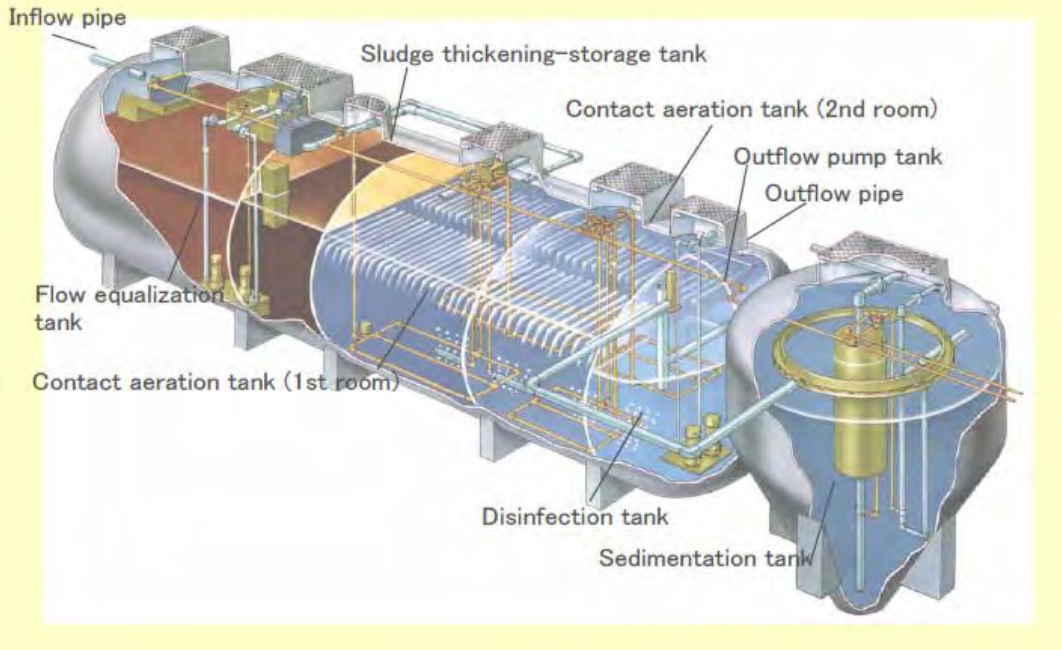


Source: Japan Institute of Wastewater Engineering and Technology (JIWET)

Figure 5.4.5 Screw Press Dewatering Machine

iv) Johkasou

Johkasou is the package type WWTP which can be applied to the household (small scale) and to the community (medium scale). The wastewater treatment process and the quality of its effluent is almost the same as that of the municipal WWTPs. In Japan, Johkasou is applied especially in rural areas where a centralized sewerage system is not economically feasible.



Source: Domestic Wastewater Treatment by Johkasou Systems in Japan

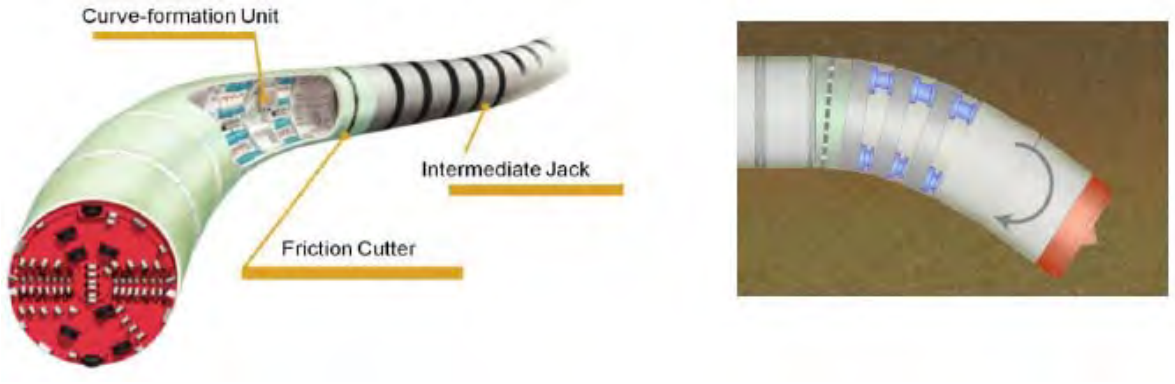
Figure 5.4.6 Johkasou (Medium Scale)

v) Pipe Installation

(i) Microtunneling (pipe jacking) Technology

Microtunneling (pipe jacking) technology is remarkably advantageous than the cut and fill construction, since limited road space during construction mitigates traffic disturbance and large construction vehicles are not applied. Accordingly, clean construction for the urban environment and public life is achieved in noise, vibration, dusts, and so on during construction.

Microtunneling (pipe jacking) technologies developed for the principal construction technology at present, and long distance and curve microtunneling (pipe jacking) is applied to winding roads (see Figure 5.4.7). Automation as well as development of measuring and control equipments contribute to infrastructure projects of sewerage construction and other utilities.

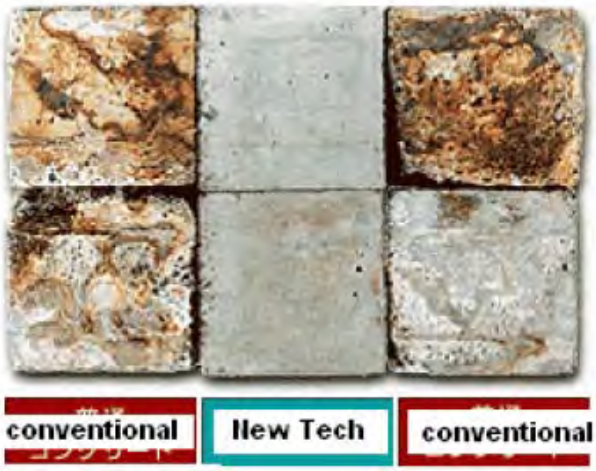


Source: MLIT

Figure 5.4.7 Long-Distance and Curve Microtunneling (Pipe Jacking)

(ii) Hydrogen Sulfide Corrosion Control

Concrete is strong, inexpensive, and with less carbon footprint compared with polyvinyl chloride (PVC). However, it is much weaker against chemical attacks of hydrogen sulfide than PVC. To deal with this problem, the innovative anti-bacterial additive is developed. Manufacturers of concrete products have started using this to make them durable.



Source: Wastewater Technology in Japan Second Edition

Figure 5.4.8 Antihydrogen-sulfide Concrete

5.5 Proposal for the Business Matching between the Japanese and Vietnamese Companies in the Water Supply and Wastewater Sector

5.5.1 Summary of the Analysis of Private Companies

(1) Vietnamese Companies

Vietnamese companies that work for treatment plant construction and operation, are relatively small except for a few large companies. Many contractors obtain projects from not only the Vietnamese large contractors such as Petrol Vietnam, Vinaconex but also from foreign companies. In fact, there are those who support this industry. Overall, the Vietnamese companies regard the Japanese companies as one of the most important companies and are seeking collaboration with them. On the other hand, they struggle in collecting information about the companies and equipment from Japan.

They often try to attain the information through the internet but there are barriers that prevent actual communication because the first contact through e-mail or telephone leaves anxiety for the companies received. Thus, Vietnam does not optimize the potential and efficient development opportunities by adopting the Japanese technology.

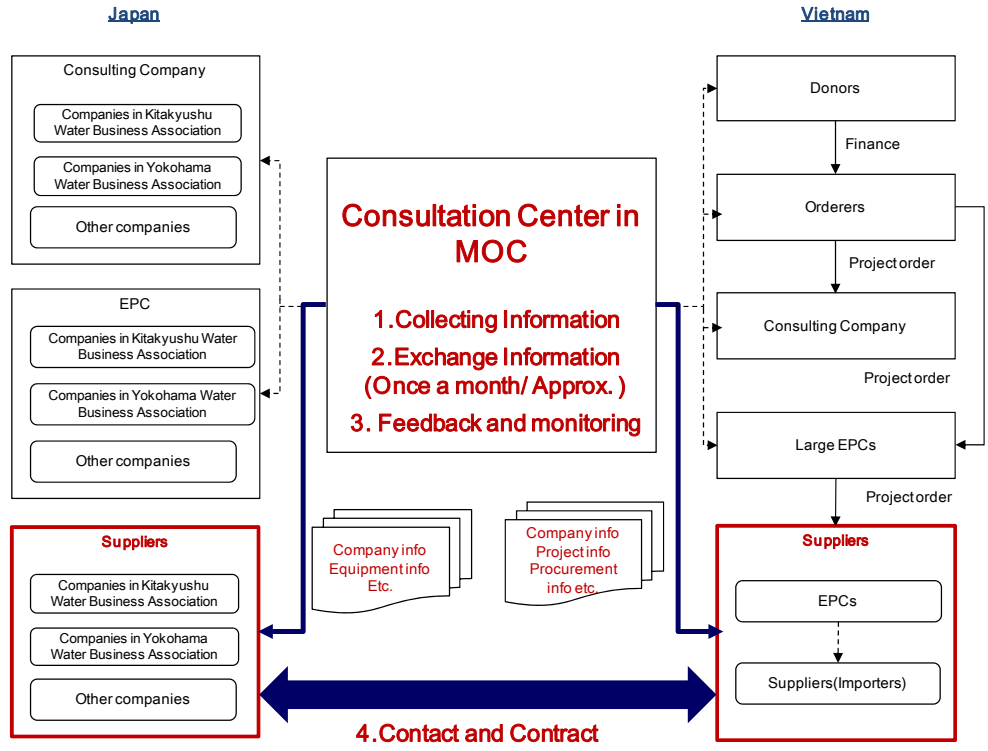
(2) Japanese Companies

Many Japanese companies would like to advance into the Vietnamese market. Especially, the Japanese suppliers investigate the business chances via exporting. On the other hand, capturing the business chances, especially meeting good partners in Vietnam is the prime issue. The Japanese companies should try to reach the Vietnamese local contractors or importers since they are the actual players who supply equipment to the main contractors and this could foster the development of the water supply and wastewater treatment facilities in Vietnam.

5.5.2 Scheme of Business Matching between the Vietnamese and Japanese Companies

The scheme proposed in Figure 5.5.1 focuses on the Vietnamese and Japanese suppliers. These are the companies which support the development of water supply and sewerage facilities. In this scheme, a business matching specialist, such as a business consultant, selected from the organization which is not directly related to any organization in the water business plays an important role. The specialist should be put both on the Vietnamese and Japanese side under the control of the training center or consultation center since they treat prudential information and also could lead to the optimization of the benefit of both Vietnam and Japan, as compared to the specialist governed by a particular private company or organization.

The tasks of the specialist should consist of collecting information by interviewing and creating a record sheet about each company's information, exchanging information between specialists in Vietnam and Japan, and providing feedback information to the companies. This scheme can resolve the issues faced by both the Vietnamese and Japanese companies and encourage them to have a business relationship with each other shown in a thick blue line of 'contact and contract'. Hence, it helps to encourage the Japanese small and medium companies to advance into the Vietnamese market, which can accelerate the development of the Vietnamese water supply and wastewater sector. On the other hand, it should be taken into account that the speed of communication is the key factor of success, therefore the scheme should only focus on the first contact between companies and leave it to themselves for further communication. In addition, the demand of the equipment being made in Vietnam will be varying from project to project, the continuity of this scheme will be another successful factor. This scheme should surely bring benefit not only to both companies in Vietnam and Japan, but to both of the countries as it leads to a better relationship.



Source: JICA Survey Team

Figure 5.5.1 Flowchart of Potential Business Matching Scheme

Chapter 6 Matching of the Vietnamese Needs and the Japanese Technologies

6.1 Technology of Advanced Water Treatment (Biological Filtration Process)

6.1.1 Current Conditions and Issues of Water Treatment

Many cities in Vietnam are rich in water resources such as rivers, and they exploit river water as supply to their customers. However, these cities, which are undergoing urbanization and industrialization, are facing issues on water pollution as caused by discharged wastewater without any treatment.

The water quality test in Hai Phong City detected high concentrations of ammonium nitrogen in the river water, as shown in Table 6.1.1. It is supposed that surface water is polluted by domestic wastewater. Some test results were higher than 1.0 mg/L, or more than ten times the 0.1 mg/L acceptable quality for water supply service.

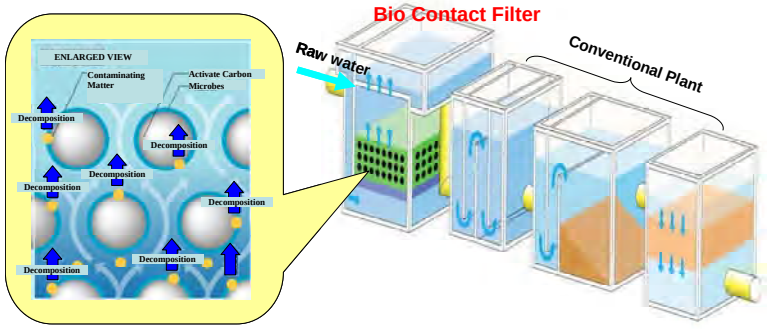
Table 6.1.1 Quality of Raw Water from Rivers in Hai Phong City

Name of WTP	Turbidity (NTU)	pH	Ammonium Nitrogen (mg/L)	Manganese (mg/L)
An Duong	30.90	7.20	0.27	0.18
Vat Cat	48.08	7.38	1.60	0.30
Do Son	29.73	7.29	1.38	0.41

Source: Hai Phong City

On the other hand, trihalomethane (THM), which is identified as a causative agent of carcinogen, is produced in the water treatment process by the chemical reaction of chlorine and organic substances brought in by raw water. The produced THM, which is identified as a chemical substance hazardous to human health, increases in accordance with the amount of organic substance in raw water, and chlorine dosing. Accordingly, ammonia in raw water is removed through chlorine dosing, and the produced THM becomes a serious issue with regard to municipal water supply.

In April 2009, the City of Kitakyushu and the City of Hai Phong signed the "Agreement on Friendship and Cooperation". Then, Hai Phong Water Supply One Member Co., Ltd. (HPWSCO) requested technical cooperation from the Water and Sewer Bureau, City of Kitakyushu (Kitakyushu Water) to solve serious problems on their raw water quality. During the periods from July 2010 to 2012, Kitakyushu Water carried out an on-site survey at An Duong Water Treatment Plant (100,000 m^3/day), the biggest plant in Hai Phong City, as part of the JICA Partnership Program. Under such circumstances, upward biological contact filtration (U-BCF), as shown in Figure 6.1.1, was proposed to be the most suitable method of countermeasure to the problem.



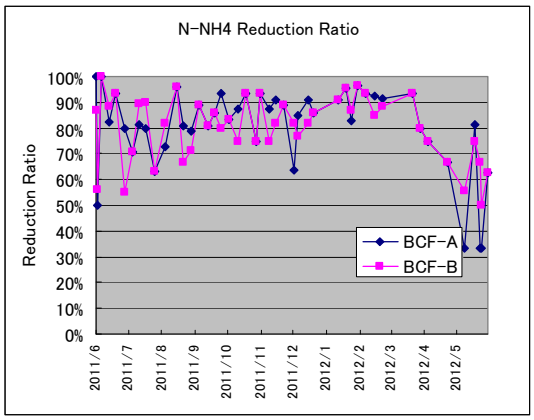
Source: City of Kitakyushu

Figure 6.1.1 Diagram of U-BCF

In Japan, several advanced treatment methods for water treatment plants (WTPs) are applied in order to supply safer and higher quality water for consumers. Such methods include ozone, activated carbon, membrane, ultraviolet, and biological treatment. On the other hand, these advanced treatment methods are rarely implemented in WTPs in developing countries because of their very expensive construction and operating costs in relation to the water tariffs of developing countries. In the meantime, construction of U-BCF is about half the price of construction of ozonation facilities. Operation cost of U-BCF is about one-twentieth the operation cost of ozonation facilities.

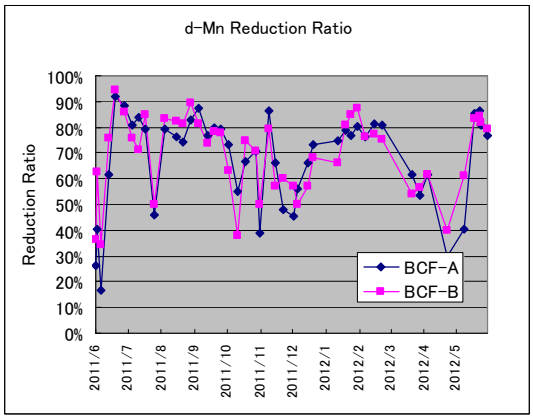
In order to confirm the effectiveness of U-BCF in Haiphong City, Kitakyushu Water placed a pilot plant of U-BCF in An Duong WTP, and collected and analyzed data for one year.

As for ammonium nitrogen, approximately an 80% reduction ratio was obtained, as shown in Figure 6.1.2. As for dissolved manganese, approximately a 70% reduction ratio was obtained, as shown in Figure 6.1.3. As for E260, which is an indicator of organic substances, approximately a 30% reduction ratio was obtained, as shown in Figure 6.1.4.



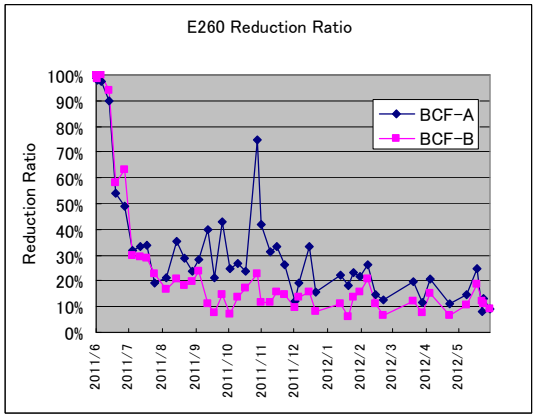
Source: City of Kitakyushu

Figure 6.1.2 N-NH_4 Reduction Ratio



Source: City of Kitakyushu

Figure 6.1.3 d-Mn Reduction Ratio



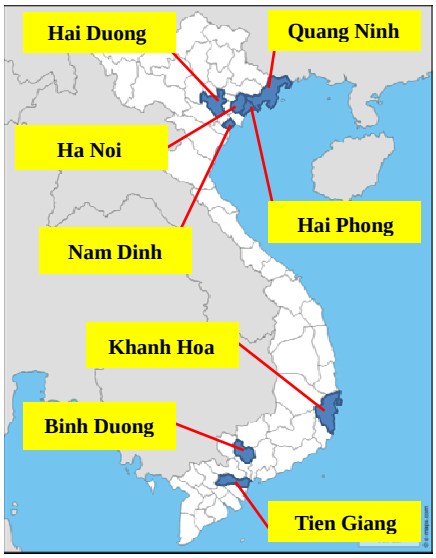
Source: City of Kitakyushu

Figure 6.1.4 E260 Reduction Ratio

As a result of the Survey, U-BCF was confirmed the most effective and advanced water treatment method for Hai Phong City, and will contribute to supply safe water for use of residents. Therefore, HPWSCO decided to apply U-BCF to remove ammonium nitrogen, manganese, and organic substances at Vinh Bao WTP (5,000 m^3/day) using its own budget.

6.1.2 Survey of Eight Cities and Provinces

Based on the selection criteria as shown in Table 6.1.2, the JICA Survey Team selected eight water supply utilities as shown in Figure 6.1.5, and introduced an outline for U-BCF using documents as shown in the appendix. The water source of the surveyed utilities, except for Ha Noi Water Supply Utilities, is surface water, such as rivers and lakes. They are facing the common problem of water source pollution by wastewater as a result of urbanization and industrialization.



Source: JICA Survey Team

Figure 6.1.5 Location of Eight Cities

Table 6.1.2 Selection Criteria

- To use surface water for raw water
- High pace of urbanization in recent years
- To accelerate water quality improvement

Source: JICA Survey Team

(1) Ha Noi

Ha Noi is the capital of Vietnam, and has a population of approximately 6.5 million people. It is the second most populous city in Vietnam. Ha Noi Water Works supplies treated water to approximately 2.60 million people. Ha Noi Water Works operates its water supply service using mainly groundwater as its water source. The current total capacity of water supply is 650,000 m^3/day. It is planned in Ha Noi to construct a new WTP (150,000 m^3/day) by 2015 with surface water (of the Duong River) as the city's water source.

(2) Hai Phong

Hai Phong is a port city in Vietnam, and has a population of approximately 1.8 million people. For main water supply utilities, HPWSCO already introduced U-BCF in Vinh Bao WTP. The Survey focuses on Hai Phong No. 2 Water Business Joint Stock Company (HPWACO2), which was a direct subordinate of HPWSCO before. It supplies treated water to approximately 68,000 people. The total capacity of water supply is 20,000 m^3/day.

(3) Quang Ninh

Quang Ninh Province is located in the northeastern part of Hai Phong City, and faces Ha Long Bay which attracts many oversea tourists. The number of population is approximately 1.1 million people. Quang Ninh Clean Water One Member Co., Ltd. (QUAWACO) supplies treated water to approximately 650,000 people. The province's water source is mainly lake water (storage volume of 10 million m^3). The total capacity of water supply is 100,000 m^3/day.

(4) Nam Dinh

Nam Dinh Province is located approximately 80 km southwest of Ha Noi City, and has a population of approximately 1.8 million people. Nam Dinh Water Supply Company supplies treated water to approximately 106,000 households. The total capacity of water supply is 130,000 m^3/day.

(5) Hai Duong

Hai Duong Province is located approximately 50 km west of Ha Noi City, and has a population of approximately 1.7 million people. It has many industrial areas. Hai Duong Water Supply Company (HADUWASUCO) supplies treated water to approximately 140,000 households. The capacity of water supply is 98,000 m^3/day.

(6) Khanh Hoa

Khanh Hoa Province is located in the south-central part of Vietnam, and has a population of approximately 1.2 million people. It gets many tourists domestically and from abroad (approximately 2.0 million people in a year). Khanh Hoa Water Supply and Sewerage One Member Co., Ltd. (KHAWASSCO) supplies treated water to approximately 98,000 households. The capacity of water supply is 100,000 m^3/day.

(7) Binh Duong

Binh Duong Province is located approximately 40 km northwest of Ho Chi Minh City (HCMC), and has a population of approximately 1.7 million people. It has a new town and many people are being concentrated there at present. Binh Duong Water Supply Sewerage Environment Co., Ltd. (BIWASE) supplies treated water to approximately 100,000 households. The capacity of water supply is 200,000 m^3/day.

(8) Tien Giang

Tien Giang Province is located approximately 80 km south of HCMC, and has a population of approximately 1.7 million people. The main industry in Tien Giang is agriculture. Tien Giang Water Supply Company Ltd. (TIWACO) supplies treated water to approximately 820,000 people. The capacity of water supply is 20,000 m^3/day.

Table 6.1.3 Eight Water Supply Utilities

Name	Basic Data				Targeted WTP	
	Resource	Capacity (m^3/day)	Num. of WTP	NRW	Name of WTP	Capacity (m^3/day)
HA NOI WATER WORKS	Well Water	650,000	12	23%	*planning* (Duong River)	150,000
HAIPHONG NUMBER TWO WATER BUSINESS JOINT STOCK COMPANY	River (Bat Cat)	20,000	1	7%	Hai Phong No2	20,000
QUANG NINH CLEAN WATER ONE MEMBER CO., LTD.	Lake (Cao Van)	100,000	10	10%	Gieng Vong	60,000
NAM DINH WATER SUPPLY COMPANY	River (Sat)	130,000	4	34%	Vu Ban	6,000
HAI DUONG WATER SUPPLY COMPANY	River (Thai Bimn)	98,000	3	12%	Tu Ky	1,500
KHANH HOA WATER SUPPLY AND SEWERAGE ONE MEMBER CO., LTD.	River (Song Cai)	100,000	2	<20%	Vo Canh	60,000
BINH DUONG WATER SUPPLY SEWERAGE ENVIRONMENT CO., LTD.	River (Saigon)	200,000	8	8%	Thu Dan Mot	20,000
TIEN GIANG WATER SUPPLY COMPANY CO., LTD.	River (Ba Ray	20,000	4	22%	Cai Lay	4,000

Source: JICA Survey Team

6.1.3 Eight Surveyed WTP

Each water supply utility operates several WTPs. The Survey selected one WTP for every water supply utility, as shown in Table 6.1.3. The most serious issue affecting WTPs is water pollution. The Survey examined water quality of the WTPs using portable water meters on site and easy method. The items of water analysis are temperature, turbidity, conductivity, color, pH, dissolved oxygen (DO), chemical oxygen demand (COD), NO_2-N, NO_3-N, NH_4-N, PO_4-P, Fe^{2+}, Fe^{3+}, anionic surfactant, and cationic detergent for raw water; and turbidity, conductivity, color, pH, COD, NH_4-N, and residual chlorine for treated water. The annual water quality and plan of WTP were obtained from each water supply utility.

At the moment, Ha Noi Water Works exploits groundwater as its water source. As groundwater in Ha Noi does not consist of ammonium nitrogen, U-BCF would not be practical. The JICA Survey Team examined the water quality of the Duong River on site. The results of water quality analysis on site are shown in Table 6.1.4 and Table 6.1.5.

Table 6.1.4 Results of Water Quality Analysis of Raw Water (Using Water Quality Tester)

Item	North Area					South Area		
	Ha Noi	Hai Phong No2	Quang Ninh	Nam Dinh	Hai Duong	Khanh Hoa	Binh Duong	Tien Giang
Date	Jan. 13	Jan. 9	Jan. 11	Jan. 14	Jan. 15	Jan. 20	Jan. 22	Jan. 22
Time	11:00	15:20	11:05	11:30	16:50	16:15	9:45	16:00
Temp. (^oC)	19.0	20.2	18	18	-	24	-	-
EC (μS/m)	170	230	20	230	180	40	240	260
Turb. (DEG)	4.1	13	4.3	20	20	13	14	20
Color (DEG)	13	27	41	31	37	50	50	50
pH	7.2	7.5	6.2	7.4	7.6	6.6	6.2	6.8
DO (mg/L)	8	4	9	9	6	4	4	3
COD (mg/L)	3	5	5	7	4	5	11	11
NO_2-N (mg/L)	<0.005	0.005	<0.005	0.03	<0.005	0.02	0.03	0.03
NO_3-N (mg/L)	0.5	0.5	<0.2	1	0.6	0.2	0.8	0.8
NH_4-N (mg/L)	<0.2	0.2	0.3	0.3	<0.2	0.2	0.5	0.6
PO_4-P (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Fe^{2+} (mg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fe^{3+} (mg/L)	<2	<2	<2	<2	<2	<2	<2	<2
Anionic Surfactant (mg/L)	0.07	<0.05	0.07	0.08	0.08	0.08	0.08	0.1
Cationic Surfactant (mg/L)	<5	<5	<5	<5	<5	<5	<5	<5

Source: JICA Survey Team

Table 6.1.5 Results of Water Quality Analysis of Treated Water (Using Water Quality Tester)

Item	North Area					South Area		
	Ha Noi	Hai Phong No2	Quang Ninh	Nam Dinh	Hai Duong	Khanh Hoa	Binh Duong	Tien Giang
Date		Jan. 9	Jan. 11	Jan. 14	Jan. 15	Jan. 20	Jan. 22	Jan. 22
Time		9:50	10:30	12:00	15:55	11:00	8:45	16:00
EC (μS/m)		-[1)]	-[1)]	260	190	50	270	290
Turb. (DEG)		0.6	1.2	0.2	0.6	0.2	0.2	0.4
Color (DEG)		4.5	10.5	5.0	9.0	10	9.3	11
pH		7.2	6.8	7.2	7.5	6.9	6.8	7.2
COD (mg/L)		3	5	4	3	3	2	7
NH_4-N (mg/L)		<0.2	0.4	<0.2	<0.2	<0.2	<0.2	<0.2
R-Cl (mg/L)		0.64	0.10	0.52	0.38	0.66	0.34	0.64

Note: no permission for sampling in Ha Noi
Source: JICA Survey Team

According to the results of water analysis on site, water treatment was conducted almost appropriately in each WTP except for color. As for color, treated water in all WTPs consisted of high color. Residual chlorine after coagulation was detected at Hai Duong and Khanh Hoa only. That is far from being satisfactory. In Quang Ninh, ammonium nitrogen was detected in treated water. It is supposed that pre-chlorine dosing could be in short supply. In Tien Giang, high COD was detected not only in raw water but also in treated water. It is supposed that the condition of coagulation is insufficient.

In addition, in order to get exact measurements of THM, ammonium nitrogen and dissolved manganese, the Institute of Environmental Technology of the Vietnam Academy of Science and Technology (IET-VAST) analyzed the raw water and treated water samples. The results of the analysis are shown in Table 6.1.6 and Table 6.1.7.

Table 6.1.6 Results of Water Quality Analysis of Raw Water (IET-VAST)

unit: mg/L

Item		North Area					South Area		
		Ha Noi	Hai Phong No2	Quang Ninh	Nam Dinh	Hai Duong	Khanh Hoa	Binh Duong	Tien Giang
Sampling Date		12-Jan	12-Jan	12-Jan	16-Jan	16-Jan	27-Jan	27-Jan	27-Jan
NH_4-N		<0.01	0.09	0.25	0.29	0.12	0.17	0.07	0.44
d-Mn		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
d-Fe		0.03	0.12	0.39	0.79	1.0	0.17	0.20	0.04
TH MFP	$CHCl_3$	0.008	0.008	0.006	0.022	0.083	0.16	0.40	0.42
	$CHBrCl_2$	0.002	0.003	0.001	<0.0002	0.005	0.004	0.036	0.016
	$CHBr_2Cl$	0.0001	0.0004	0.0002	0.0001	0.001	0.0003	0.009	0.0009
	$CHBr_3$	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Total	0.010	0.011	0.007	0.022	0.089	0.16	0.44	0.44

Source: JICA Survey Team

Table 6.1.7 Results of Water Quality Analysis of Treated Water (IET-VAST)

unit: mg/L

Item		North Area					South Area			Standard	
		Ha Noi	Hai Phong No2	Quang Ninh	Nam Dinh	Hai Duong	Khanh Hoa	Binh Duong	Tien Giang	VN	JP
Sampling Date			12-Jan	12-Jan	16-Jan	16-Jan	27-Jan	27-Jan	27-Jan		
NH_4-N			<0.01	0.04	0.04	0.03	<0.01	0.01	0.38	3	-[e]
d-Mn			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.3[a]	0.05[c]
d-Fe			0.03	0.20	0.01	<0.01	0.07	0.05	0.04	0.3[b]	0.3[d]
THM	$CHCl_3$		0.005	0.0004	0.002	0.003	0.006	0.007	0.012	0.2	0.06
	$CHBrCl_2$		0.002	<0.0002	0.002	0.001	0.002	0.010	0.005	0.06	0.03
	$CHBr_2Cl$		0.0005	<0.0001	0.0008	0.0002	<0.0002	0.006	0.001	0.1	0.1
	$CHBr_3$		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.001	<0.0005	0.1	0.09
	Total		0.008	0.0004	0.004	0.004	0.008	0.024	0.018	-	0.1

$CHCl_3$: Chloroform, $CHBrCl_2$: Bromodichloromethane, $CHBr_2Cl$: Chlorodibrimomethane, $CHBr_3$: Bromoform
a)Regulated Total Mn b)Regulated Total Fe C)Mn and Mn Compounds d)Fe and Fe compounds e)Not regulated.
Note: no permission for sampling in Ha Noi
Source: JICA Survey Team

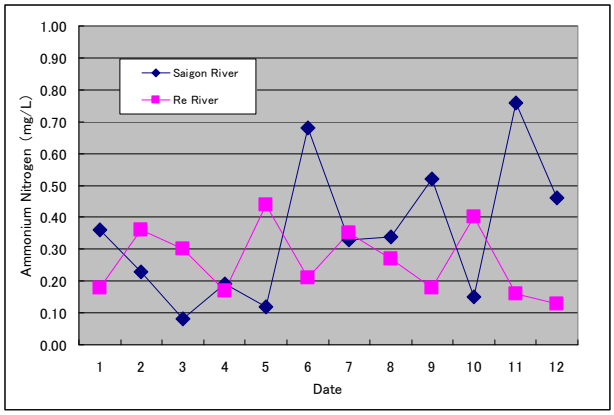
According to the results of analysis by IET-VAST, ammonium nitrogen was entirely detected in raw water. Especially, high ammonium nitrogen content was detected in Tien Giang. Dissolved manganese was not detected in raw water in all cities. THM formation potential (THMFP) was high in the south area, and low in the south area. On the other hand, in Khanh Hoa and Tien Giang, THM in treated water was low regardless of the south area. The reason might be insufficient chlorine dosing.

To comprehensively consider all the results of water quality analysis, some parameters, as shaded in

the tables above, are suspicious and questionable. It was assumed that the sample bottles were stored for a long period of time due to the Vietnamese TET holidays.

Sampling was conducted between mid-January and late January. In this season, water quality in Vietnam tends to be good as shown in **Figure 6.1.6**. Therefore, it is necessary to consider that water quality could get worse throughout the year. In fact, around 0.5 mg/L of ammonium nitrogen is shown in the annual water quality data obtained from the water supply utilities. Thus, there is a possibility to detect high THM in that season because more chlorine is needed to remove high ammonium nitrogen.

Moreover, in north area, ammonium nitrogen was detected at treated water. When the water supply utilities operate proper volume of chlorine dosing, THM become increase. Therefore, there is a high possibility of introducing U-BCF in Vietnam.



Source: annual water quality data

Figure 6.1.6 Annual data of Ammonium Nitrogen

6.1.4 Required Investment for Advanced Water Treatment

The effectiveness of U-BCF needs to be examined through pilot testing in candidate cities before its introduction. In order to conduct verification test for one year, pilot equipment cost, technical training cost, and operation and maintenance (O&M) cost will be required. Required investment for U-BCF is shown in Table 6.1.8. The pilot study cost is estimated using experimental data from Hai Phong City. The pilot project cost includes planning, designing, construction, and soft components (referred from the Japanese experimental data).

Table 6.1.8 Required Investment for U-BCF

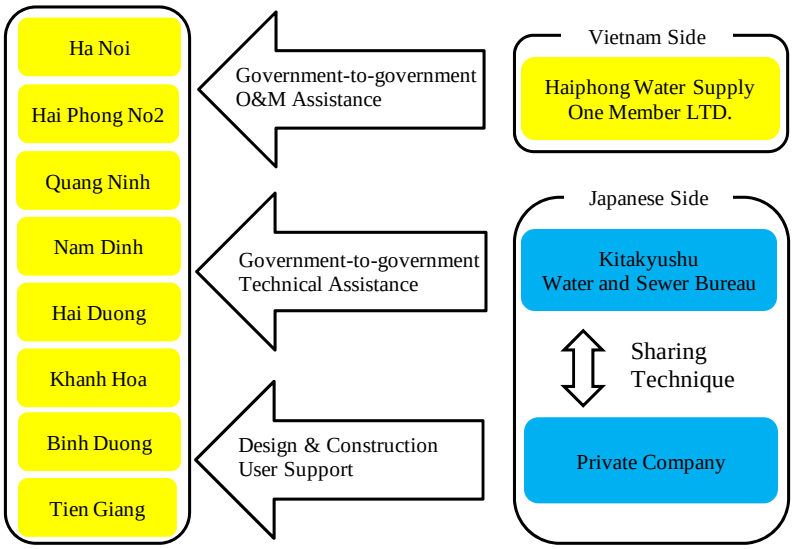
Name	Capacity (m^3/day)	Frame Material for U-BCF	Pilot Study Cost (USD)	Project Cost (USD)
Ha Noi	150,000	Concrete	120,000	11,250,000
Hai Phong No. 2	20,000	Concrete	120,000	1,500,000
Quang Ninh	60,000	Concrete	120,000	4,500,000
Nam Dinh	6,000	Steel	120,000	600,000
Hai Duong	1,500	Steel	120,000	150,000
Khanh Hoa	60,000	Concrete	120,000	4,500,000
Bin Duong	20,000	Concrete	120,000	1,500,000
Tien Giang	4,000	Steel	120,000	400,000
		Total	960,000	24,400,000

Source: JICA Survey Team

6.1.5 Load Map for Project Formulation

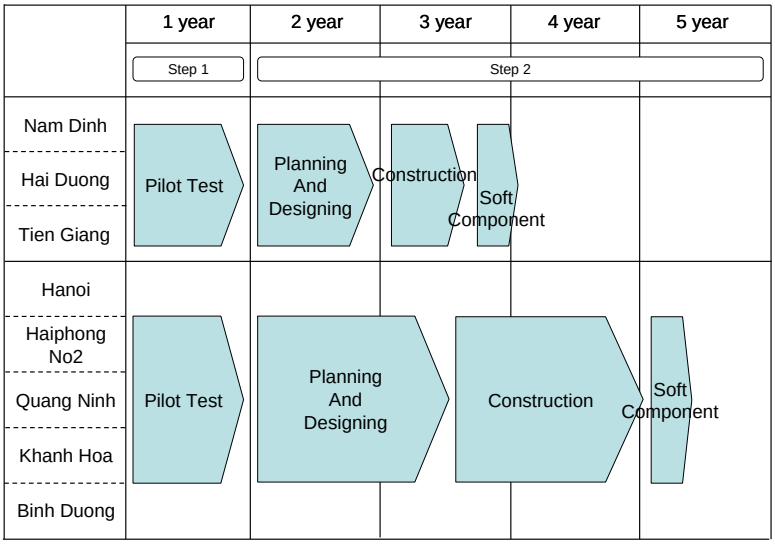
U-BCF is one of the Japanese original advanced treatment technologies developed by the Water and Sewer Bureau of Kitakyushu City through 11 years of assiduous research. HPWSCO and the Water and Sewer Bureau of Kitakyushu City engaged in mutual cooperation to encourage broad use of U-BCF in the whole of Vietnam.

It is expected that this project will be conducted under a government-to-government powerful support system, as shown in Figure 6.1.7.



Source: JICA Survey Team

Figure 6.1.7 Business Flow in Vietnam



Source: JICA Survey Team

Figure 6.1.8 Load Map of U-BCF Project in Vietnam

6.1.6 Overview of Introduction of Advanced Treatment

(1) Expansion of Water Supply Capacity

As a result of the Survey, the common issues in the water supply sector in Vietnam had been identified. Mainly, these issues are expansion of water supply capacity, and improvement of quality of supplied water.

Vietnam has a total population of 86 million, and has an estimated gross domestic product (GDP) per capita of USD 3,100. Also, it is estimated that both population and GDP will increase constantly from now on. Accordingly with this situation, water demand in Vietnam may also increase.

However, due to the lack of water supply facilities and financial situation of Vietnam, water supply has not yet met the future's water demand.

Especially, it is a serious situation in rural areas, where a lot of poor people live, that coverage of water supply service is only around 40% of the population. The other 60% of the people living in rural areas use groundwater pumped from private wells mainly, but it is reported that groundwater has arsenic level over the drinking water limit in the northern part of Vietnam, and has high salinity in the seaside area in Vietnam.

On the other hand, the water supply sector is presently undertaking the following projects with assistance from the Asian Development Bank (ADB) in order to meet the future's water demand:

Urban areas
- ✓ Expansion of distribution networks
- ✓ Improvement of capacity of existing WTPs

Rural areas
- ✓ Establishment of new water supply utilities
- ✓ Construction of water supply facilities

(2) Lessons Learned from Japanese Experience

Due to rapid economic development in Vietnam, river water has been polluted by untreated wastewater produced by domestic, industries, and agriculture activities.

The best solution against river pollution is to carry out required countermeasures to prevent untreated wastewater from being discharged into rivers. However, this is too difficult to be realized. Even in Japan, it has not been realized yet.

Therefore, water supply utilities, such as those in Japan, which use polluted river water as their water source have to introduce advanced treatment into their existing WTPs in order to be able to supply safe water.

The JICA Survey Team discussed with the lead staff of water supply utilities in Vietnam, and understood the requirements for improving the quality of water supply. Advanced Japanese water treatment technology is practical due to low operation cost and energy saving feature.

(3) Recommendation

ADB is providing technical assistance and funding for a project to expand the water supply sector of

Vietnam. However, the JICA Survey Team did not find any road map to solve the issues on water pollution in the water supply sector of Vietnam including the ADB project.

The water supply sector in Japan has a lot of technologies, know-how, and facilities to supply safe water such as ozone treatment, activate carbon treatment, biological treatment, and ultraviolet light treatment.

Therefore, it is expected that JICA and Japanese water supply utilities will assist in developing Vietnamese water supply utilities using advance treatment with enough fund (Japanese loan).

The JICA Survey Team recognizes the importance of advanced treatment. The pilot project can be recommended for enhancing capacity of water supply utilities.

6.2 Technology on Sludge Recycling

6.2.1 Current Status and Issues of Wastewater Treatment in Ha Noi and HCMC

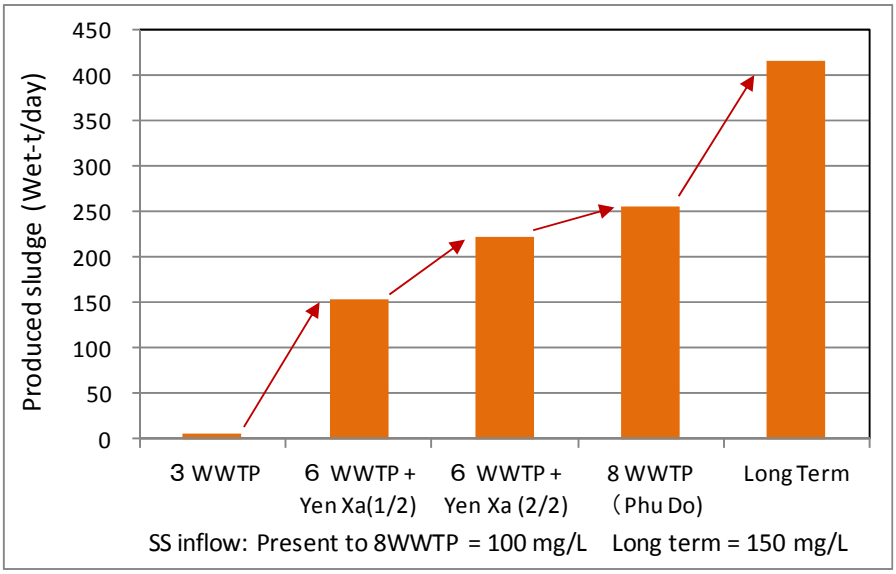
The operational wastewater treatment plants (WWTPs) in Ha Noi are Truc Bach, Kim Lien, North Thang Long, Yen So, and Ho Tay. Moreover, Bay Mau WWTP is under construction, and Yen Xa WWTP and Phu Do WWTP will start construction in the near future. Eventually, the sewerage system will cover the central area of Ha Noi. The details of each WWTP are shown in Table 6.2.1.

Table 6.2.1 Summary of WWTPs in Ha Noi

WWTP		Capacity (m^3/day)	Current Situation
1	Truc Bach	2,500	Operational
2	Kim Lien	3,700	Operational
3	North Thang Long	42,000	Operational
4	Yen So	200,000	Operational
5	Ho Tay	22,800	Operational
6	Bay Mau	13,300	Construction
7	Yen Xa	270,000	Financial Arrangement
8	Phu Do	85,000	Planned for BT
Total		**639,300**	

Source: JICA Survey Team

In the JICA study in 2012, i.e., Preparatory Study on Construction Project for Yen Xa WWTP, the amount of sewage sludge was projected, as shown in Figure 6.2.1.



Source: Ha Noi Yen Xa PPP F/S

Figure 6.2.1 Sludge Generation Forecast

The amount of sewage sludge in Kim Lien, Truc Bach, and North Thang Long WWTPs is quite small. However, it is projected that the amount of sewage sludge will increase with the operations of Yen So, Yen Xa, and Phu Do WWTPs. Since the acquisition of waste disposal sites becomes more and more restricted, sludge volume reduction and sludge recycling are suitable.

In HCMC, Binh Hung WWTP, which has a capacity of 146,000 m^3/day, is operational. However, the acquisition of waste disposal site is quite difficult, and composting has been applied. Considering this situation, sludge volume reduction and sludge recycling are needed the same as in Ha Noi.

6.2.2 Needs for Sludge Recycling

The JICA Survey Team carried out a hearing survey to know the needs for sludge recycling in Ha Noi and HCMC. Details and results are as follows:

(1) Present Situation in Ha Noi City

- The Project Management Board (PMB) recognized the issues on sewage sludge management through the Ha Noi Yen Xa WWTP Public–Private Partnership (PPP) Study. Land reclamation is becoming restricted in accordance with produced sludge due to sewerage system development. The management bureau of Ha Noi People's Committee is also concerned with sludge management; however, internal coordination has not been concluded.

- Septic tanks are still utilized since the sewerage system applies interceptor sewer. Therefore, maintenance and disposal of septage are issues of sewerage management. Moreover, sludge disposal from septic tanks is also a problem since such sludge is unacceptable in composting factories managed by urban environmental companies.

- The present sewerage master plan does not include sewage sludge management. PMB requests to include sewage sludge reuse in the Sewage Master Plan 2030-50.

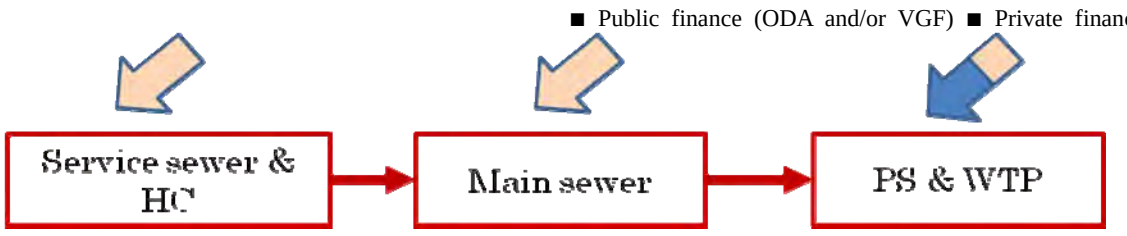
- Ha Noi City hopes to be the leading city in Vietnam in terms of sewage sludge recycling.

- Economic affordability is an issue on sewage sludge reuse.

1) Recommendations from the JICA Survey Team

- Sewage sludge fuel (sewage sludge drying) costs almost USD 70/t. Accordingly, a sludge reuse project is more expensive than land reclamation. A public fund investment mechanism such as official development assistance (ODA) or viable gap fund (VGF) is indispensable to decrease the project cost.

- A sewage sludge reuse project in Ha Noi is required to propose the service cost through a financial model for public fund investment, such as shown in Figure 6.2.2. Accordingly, discussions on financial affordability among relevant organizations should be carried out.



Source: JICA Survey Team

Figure 6.2.2 Financial Model of PPP Project

(2) Present Situation in HCMC

- Produced sludge at present is almost 35 m^3/day by centrifugal dewatering.
- Rice husk is dosed for moisture conditioning (40% of water content of composted sludge). Accordingly, composting proceeds to be satisfactory.
- Offensive odor issue was raised by adjacent residents due to operation cost saving by not dosing rice husk.
- Composted sludge is landfilled due to restricted product users.
- The present composting facility is used for the existing wastewater treatment facility (treatment capacity of 141,000 m^3/day). Phase 2 project on WWTP expansion considers applying land reclamation.

1) Recommendations from the JICA Survey Team

- Although sewage sludge increases in accordance with sewerage system development, land acquisition of reclamation site becomes restricted. Accordingly, technologies for sludge volume reduction and/or sludge reuse shall be applied.
- Technology on composting and greenery reuse is the most important; however, greenery reuse of municipal sewage sludge is not practical as it contains heavy metals and hazardous chemicals. Soil conditioning and cultivation of flowers are more practical.
- A sewerage project requires public fund investment due to restricted full cost recovery. Private sectors in Japan operate PPP projects of sludge fuel reuse by exploiting biomass energy, which is equivalent to low calorie coal. JICA is now planning to implement the technical assistant project in conjunction with ODA and VGF, accordingly, operation cost can be decreased.
- A business transformation outsourcing (BTO)/build–operate–transfer (BOT) project, a part of which is financially supported through grant aid, will be needed for HCMC.

6.2.3 Technology for Sludge Recycling

(1) Sludge Recycling and Utilization Technology

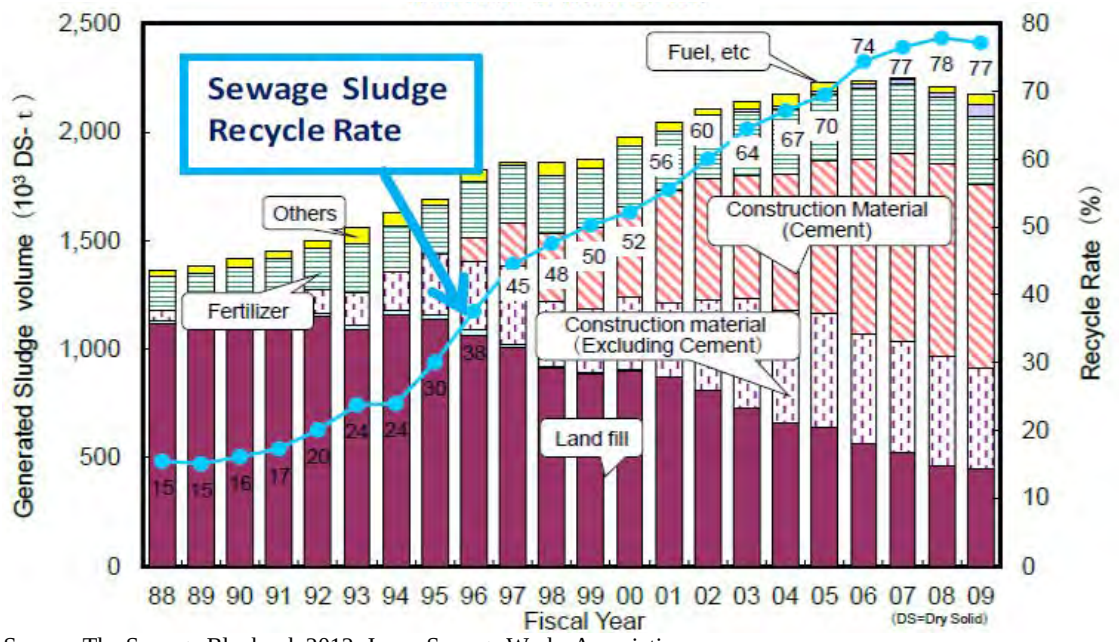
There are about three categories for sludge utilization, as shown in Table 6.2.2.

Table 6.2.2 Sludge Utilization

Utilization Categories	Sludge Form	Usage	Technology
Agricultural and land utilization	Fertilized sludge Dried sludge	Fertilizer Soil improvement agent	Compost Drying
Energy utilization	Dried sludge Carbonized sludge	Fuel	Drying Carbonization
Construction material utilization	Incinerated ash Melting slag	Road material Cement resource Block and tile resource	Incineration Melting

Source: JICA Survey Team

Sewage treatment is completed by proper treatment of sludge and sustainable recycling. Japan has made lots of efforts to recycle sludge as the reclamation site capacity is limited. Figure 6.2.3 shows how much recycling rate has increased over the past 20 years in Japan.



Source: The Sewage Bluebook 2012, Japan Sewage Works Association

Figure 6.2.3 Trend of Sewage Sludge Recycling

According to the above figure, the recycling rate in Japan reached 77% in 2010 on dry solid basis. Forty-five percent of recycled sludge was recycled into construction materials, and 30% into cement material. In the case of recycling into construction materials, only the inorganic content of sludge is used. If only organics are taken, the recycle rate is down to 24%. Energy use from organics in sludge is merely 13%.

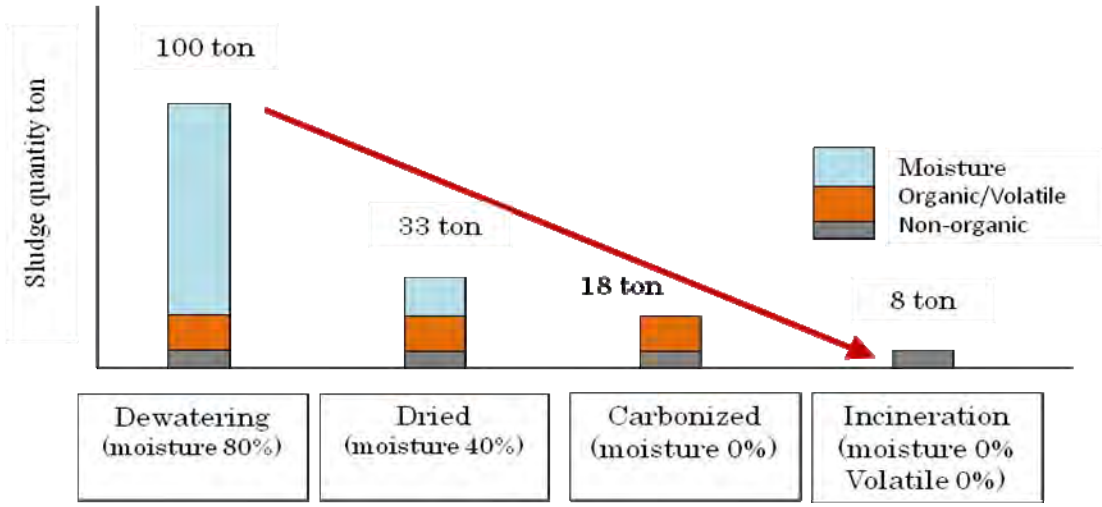
(2) Recommendable Technologies

In Vietnam, the populations of huge cities, such as HCMC and Ha Noi, have been increasing year by year. With the population increase, sewage and sludge quantities have been also increasing. On the other hand, since urbanization is gradually expanding to suburban areas, it has become too difficult to find more sludge final disposal areas.

Therefore, sludge volume reduction, and sludge recycling and utilization shall be strongly required.

Sludge compost technology can be easily and economically utilized. However, the demand of fertilizer depends on the season and field conditions. And in the case of hazardous substances in industrial/business wastewater, it might be subject to sustain due to soil contamination.

1) Sludge Volume Reduction



Source: JICA Survey Team

Figure 6.2.4 Comparison of Sludge Volume According to Sludge Treatment

2) Comparison of Recommendable Technologies

A comparison of drying, carbonization, and incineration technologies is shown in Table 6.2.3.

Table 6.2.3 Comparison of Drying, Carbonization, and Incineration

	Drying	Carbonization	Incineration
Final form	Dried sludge	Carbonized sludge	Incinerated ash
Usage	Fuel/fertilizer	Fuel fertilizer	Cement resource/load material/Block and tile resource
Initial Cost	Cheap	Expensive	Expensive
Running Cost (Utility Cost)	Expensive	Expensive	Cheap

Source: JICA Survey Team

As a method to be stable, and to treat a large quantity of sludge, sludge drying, sludge incineration (including drying and incineration) are considered to be recommendable technologies.

6.2.4 Project Implementation Plan for Sludge Recycling

(1) Waste Disposal and Disposal Cost

Table 6.2.4 shows the construction cost of waste disposal facility, and O&M cost.

It is estimated that the construction cost and O&M cost of a waste disposal site are USD 90-100/m^2, and USD 7-40 USD/wet-t, respectively. In urban areas, assuming that the O&M cost, the construction cost and transportation cost are about USD 20/wet-t, USD 20/wet-t, and USD 10-20 USD/wet-t, respectively, the total cost per wet-t becomes USD 50-60/wet-t.

Table 6.2.4 Cost for Construction and Operation of Waste Disposal Site

Project and Company	Project Outline	Cost
Thai Nguyen Province Son Cong Waste Treatment Company	Investment cost: VND 35.2 billion Land area: 2 ha Treatment volume: 50 t/day Operation cost: VND 15 billion	Construction cost: VND 35.2 billion/2 ha = VND 1,760,000/m^2 = USD 90/m^2 Operation cost: VND 15 billion/(50 t*365 day) = VND 820,000/t (USD 40/t)
	Investment cost: NA Land area: 25 ha Treatment volume: 130 t/day Operation cost: VND 27 billion	Construction cost: NA Operation cost: VND 27 billion /(130 t*365 day) = VND 569,000/t (USD 28/t)
Quang Ninh Province Cam Pha JSC (Quang Hanh Landfill)	Investment cost: VND 186 billion Land area: 9 ha Treatment volume: 170 t/day Operation cost: VND 9 billion	Construction cost: VND 186 billion/9 ha = VND 2,070,000/m^2 = USD 100/m^2 Operation cost: VND 9 billion/(170 t*365 day) = VND 145,000/t (USD 7/t)
(Ha Khau Landfill)	Investment cost: NA Land area: 2 ha Treatment volume: 30 t/day Operation cost: VND 4 billion	Construction cost: NA Operation cost: VND 4 billion/(30 t*365 day) = VND 365,000/t (USD 18/t)
(Ha Long Waste Treatment Plant)	Investment cost: NA Land area: 9 ha Treatment volume: 100 t/day Operation cost: VND 7 billion	Construction cost: NA Operation cost: VND 7 billion/(100 t*365 day) = VND 192,000/t (USD 10/t)
Kon Tum Province Kon Tum City Environment Co.	Investment cost: NA Land area: 6.23 ha Treatment volume: 35,770 t/year Operation cost: VND 12 billion	Construction cost: NA Operation cost: VND 12 billion/35,770 t = VND 335,000/t (USD 17/t)

Source: JICA Survey Team

(2) Practicability of Project Formation by Private Firms

For the BOT project for private firms, there are some conditions to be considered, such as size of business, disposal cost, service fee, and the conditions of off taker such as volume, period, and price.

1) Processing Cost and Service Fee

The cost of sludge drying and incineration is USD 70-100/wet-t. The cost of landfill is different depends on the conditions of land acquisition. In the Asian metropolitan areas, social needs of sludge volume reduction and recycling are increasing since the sewage sludge disposal becomes restricted.

In order to reduce the capital cost, the guarantee for sludge treatment fee and subsidy of VGF are beneficial. These will restrain the project cost, and therefore, the project becomes viable.

2) Size of Business

The sludge disposal process consists of dewatering, gasification, sludge drying, and carbonization. The growth of sludge disposal production contributes to the reduction of disposal cost per unit. For utilizing this economy of scale, private sector participation (PSP) project by Japanese firms requires a large amount of sewage sludge.

In a sewerage system by interceptor sewer, the water quality is lower than that of separated sewerage. It means that sludge production becomes low. However, in HCMC, 35 wet-t/day sludge is produced by WWTP, which has a capacity of 146,000 m^3/day, although the interceptor sewer is applied. In Ha Noi, it is projected that sludge production will grow due to the Yen So and Yen Xa WWTPs.

The expansion of WWTPs and establishment of new WWTPs will increase sludge production, and it is expected that private firms will receive better conditions for entering the market.

3) Off Taker

For sludge recycling, utilization of composting, and drying/carbonization is expected for sewage sludge. The receivers of sewerage sludge are horticultural agriculture, site preparation, cement factory, and pulp.

4) Possibility of Business Matching with Japanese Firms

Large Japanese cities have experienced changing their sludge disposal from landfill to recycling. In addition to construction of WWTPs, the Japanese firms also have experience in BTO projects such as on gasification, sewage sludge fuel, and cement recycling.

JICA had granted sludge drying machinery to HCMC. The Japanese private firms can enter the market through information sharing such as in seminars and pilot projects.

i) Opinions of the Japanese Private Firms

The JICA Survey Team confirmed their intention on project formation for sludge disposal and recycling project in Vietnam. The results are as follows:

- They have much concern about sewerage development in Ha Noi. At present, they assume that BOT project scheme is not suitable for sewerage development since the production of sewage sludge is small. It is indispensable to apply integrated treatment/recycling with urban disposal, agreement on sludge recycling in the sludge recycling master plan, and administration support.

- In HCMC, they are considering to compete in the pilot test of sludge dryer, which is funded by JICA. After the pilot test, they want to formulate a sludge recycling project in HCMC.

6.2.5 Load Map for Project Formulation

The project scheme and applicable technologies for sewage sludge recycling depend on the amount of sewerage sludge and social situation. Due to the operation of large-scale WWTPs, the expansion of sewerage area, and development of separated sewer system, the production of sewage sludge would increase. When large-scale WWTPs start operating, the utilization of BOT project by private firms for sewerage sludge recycling would be realistic.

The development procedure of the sludge recycling project is shown in Table 6.2.5.

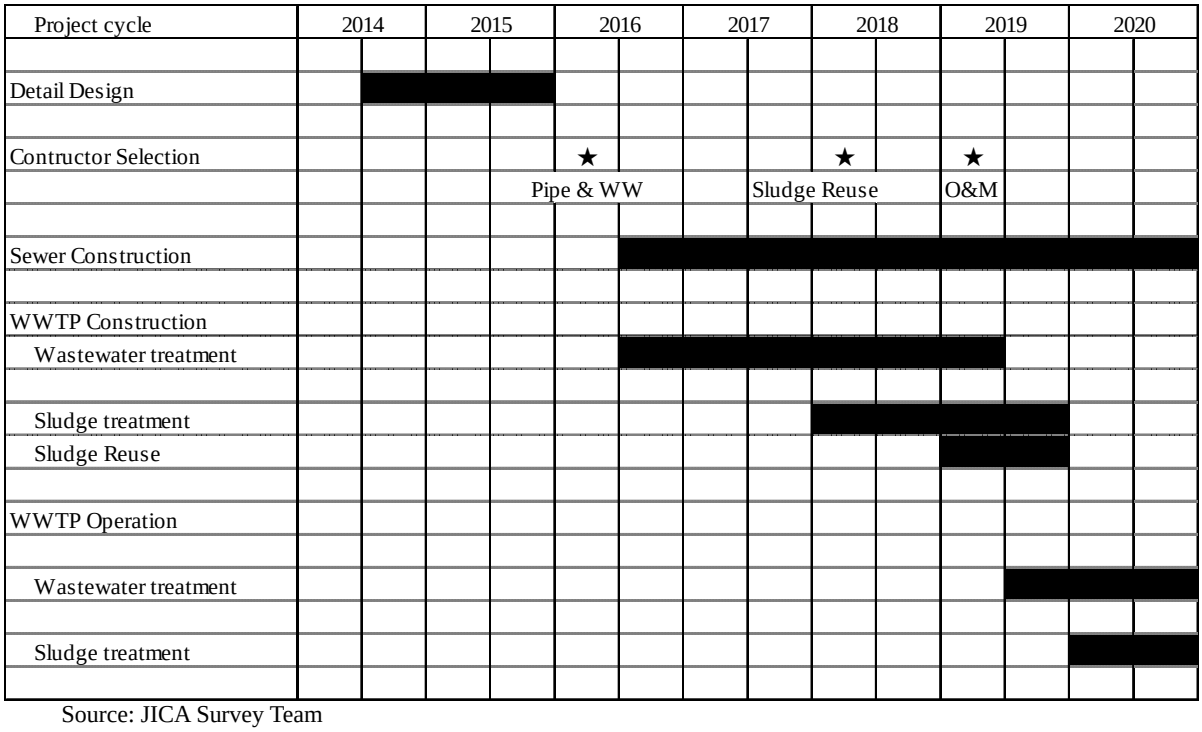
Table 6.2.5 Stepwise Development of Sludge Reuse Project

	Current Situation	On Operation of Large-Scale WWTP	Development of Sewerage System and Separated Sewerage
Ha Noi	Kim Lien Truc Bac North Thang Long Bay Mau Ho Tay Yen So	Yen Xa Phu Do	
Stage	Research	BTO Project	Diversification of off taker
HCMC	Bin Hung (Phase-1)	Bin Hung (Phase-2) District-2 WWTP	
Stage	Pilot Test	BTO Project	Diversification of off taker
Public Purchase	Amendment of PPP Law Institutional Design of VGF	PPP Operation	

Source: JICA Survey Team

Taking Yen Xa WWTP as an example, the implementation schedule of sewerage sludge recycling project is shown in Figure 6.2.5.

Assuming that the construction period of WWTP is for three years, the sewerage sludge recycling project would require the start of construction and contract agreement after the implementation of sewer and WWTP construction.



Source: JICA Survey Team

Figure 6.2.5 Yen Xa WWTP Implementation Schedule