THE PREPARATORY SURVEY ON
THE DUONG RIVER WATER SUPPLY SYSTEM PROJECT
IN THE SOCIALIST REPUBLIC OF VIET NAM

FINAL REPORT
VOLUME II MAIN REPORT

May 2012

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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Preface

This study was conducted under the scheme of the joint preparatory study designed by JICA for the potential projects executed with the Public Private Partnership (PPP) concept (JICA PPP FS). The business plans for these projects are supposed to be prepared and proposed by private sector companies and here in this study, our goal is to complete the The Duong River Water Supply Project in Hanoi, Vietnam as the very first model under the Vietnam-Japan PPP Partnership.

The City of Hanoi has merged with the surrounding municipalities to become the Capital with over 6 million population under the plans to make Hanoi one of the most well organized and efficient cities in the country.

The water system in Hanoi has been well maintained as planned these years. With the advancement of urbanization and industrialization、however, the deterioration of quality of the underground water and land subsidence have emerged as serious problems. With the intention to provide solutions, the project aims to increase the water supply (300,000m3/day:Phase1&2) taking the water from Duong River converting the water source from ground to surface water and thereby contribute to the decrease of land subsidence and prevent health damage by arsenic contamination. The project costs over USD 300 million including the transmission pipelines extending over 46 km.

The study also plays the important role of promoting development of infrastructure business overseas encouraged aggressively by the Japanese government under the 'New Growth Strategy.' The model project is supposed to get financed under the Private Sector Investment Finance (PSIF) by JICA and is receiving considerable publicity from all quarters.

Under such circumstances, the study focuses on how to realize the project in terms of its feasibility and practicality as a real business to make it as a 'model case' for the potential projects in the future under the PPP scheme.

The actual negotiation processes for the project have not yet started and terms and conditions of JICA's finance or project contracts are to be negotiated and fixed. However, discussions among the experienced Study Team led to come out assumptions and conditions required which are practical enough to make the project feasible.

To make the project cashflow stable and avoid the foreign exchange risks, the water tariff is arranged to be paid under the capacity payment scheme which is already proven payment scheme applied in projects in Vietnam.

The official assistance by the Vietnamese Government such as the introduction of Viability Gap Funding (VGF), getting official priority over other ongoing local water projects, guarantees of execution of the off-take contract, etc. are important roles by the Public. In this project, the government support is especially important considering heavy investment in the public water facilities compared to relatively low water tariff income base.

This study is expected to be widely referred to the parties interested in the PPP Scheme and hopefully used most to promote other ongoing projects.

Executive Summary

This study aims to formulate the first Japan – Viet Nam (PPP) Project "The Duong River Water Supply System Project in The Socialist Republic of Viet Nam". Based on the proposal originally submitted in 2008 by VIWASEEN, currently FS (basic study) is being undertaken by Viet Nam side, and Japan side proceeds to the Preparatory Survey. The Japanese opinions have been shared with VIWASEEN, HAWACO, and other related parties during several meetings.
This study has mainly focused on the following points, to improve the feasibility of the Project.

- Legal frameworks for PPP projects and investment conditions in Viet Nam
- Forecast of needs and demands for the project
- Water resource quality tests and analysis
- Design conditions and design summaries
- Construction and implementation schedule
- Initial environment influence study
- Economic and financial analysis
- Management and institution analysis

Based on these studies, Study Team continues examination to improve the feasibility of this Project in terms of technical, financial, and administrative aspects through meetings with the counterparts such as VIWASEEN, HAWACO and so on.
This report is composed of the following Chapters (1-8).

１. Resume of the Vietnamese economy status, and legal frameworks for PPP projects are summarized.

２. Water quality analysis

This Chapter reports on the Duong River water quality tests. Duong River is the water source of this project, therefore tests are planned in both the rainy and dry seasons throughout the study. In this report, the results of water quality analysis, which were carried out during April, May, June, and August, 2011 (Jar-Tests were carried out about 180 times), are reported. Also, results of the water quality in Duong river basin, including the upper streams are mentioned.

３． Examination of technical aspects

To set the fundamentals of this project, demand forecasts have been researched, and water supply area have been reconsidered after consulting the counterparts.

Water supply facilities plan based on safety, security and stability, as well as sustainable management maintenance plan has been proposed to maintain a long-term, reliable project. In terms of water treatment process, design criteria based on the results of the water quality analysis has been put into practice, then design and cost estimation has been worked out.

Based on the above plans, implementation schedule and O&M organization are proposed.

４． Confirmation of environmental and social considerations

This Chapter briefly describes legal frameworks and formalities, and study results of environmental consideration are summarized.

５． Investment environment

Comprehensive analysis of risks and its countermeasures are clarified based on the investigation results of Vietnamese political, economic and water related project situations for investment environment.

Study Team structured possible project scheme on the basis of above analysis and systematically organized necessary contractual arrangement. Of which Major contracts are described with common provisions and remarks on the proposed project.

６． Economic analysis

Studies of extraction and quantification of economic costs, and potential variability in economic benefits are included in this Chapter.

７． Financial analysis

Pre-conditions for financial analysis are set and few financial case analyses calculating unit price to achieve certain level of EIRR are presented. Of which the case achieves the most preferable level of DSCR, EIRR and unit price is selected as “base case”.

Furthermore the impact by the risks mentioned as high possibility and impact in the chapter 7 on the base case from the point of view of the project profitability is quantified.

Besides above analysis, feasibility of the case in which initial investment is assumed to be financed through bank loan, is studied.

８. Issues and Proposals on Management and System

The validity that investors have financial affordability to secure the stable and long-term operation is described. Countermeasures as investors for major risks are shown based on the result of risk analysis and quantification in chapter 5 and 7. The proposals to the government of both countries as necessary measures to secure the feasibility of this project are described.

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Abbreviation

Abbreviation	
BT	Build Transfer
BOO	Build Own Operate
BOT	Build Operate Transfer
BTO	Build Transfer Operate
CIT	Corporate Income Tax
CPI	Consumers Price Index
DARD	Department of Agriculture and Rural Development
DF	Deflator
DONRE	Department of Natural Resource and Environment
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
E/N	Exchange of Notes
EPC	Engineering, Procurement, Construction
ERAH	Environmental Protection Agency Hanoi
EXR	Exchange Rate
F.C.	Foreign Currency
FIRR	Financial Internal Rate of Return
FIRR-E (EIRR)	Equity Internal Rate of Return
FIRR-E (PIRR)	Project Internal Rate of Return
FS	Feasibility Study
FTA	Free Trade Agreement
FY	Fiscal Year
GDP	Gross Domestic Product
HAIDEP	The Comprehensive Urban Development Programme in Hanoi Capital City
HAPI	Ha Noi Department of Planning and Investment
HAWACO	Ha Noi Water Business Company

Abbreviation	
HPC	Hanoi People`s Committee
IMF	International Monetary Fund
IS	Investment, Stock
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
km	Kilometer
L.C.	Local Currency
LCC	Life-Cycle Cost
lpcd	Liter per capita per day
m^3/day	Cubic Meter per Day
M/P	Master Plan
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MOH	Ministry of Health
MONRE	Ministry of Natural Resource and Environment
MOU	Memorandum of Understanding
MPI	Ministry of Planning and Investment
MOF	Ministry of Finance
MWRI	Ministry of Water Resource and Irrigation
NRW	Non-Revenue Water
NIURP	National Institute of Urban and Regional Planning
O&M	Operation and Maintenance
ODA	Official Development Assistance
PPI	Producer’s Price Index
PPP	Public Private Partnership
PPP	Purchasing Power Parity

Abbreviation	
SBV	State Bank of Vietnam
SCADA	Supervisory Control And Data Acquisition
SIBOR	Singapore Interbank Offered Rate
SOCBs	State Owned Commercial Banks
SOE	State Owned Enterprise
SPC	Special Purpose Company
UFW	Unaccounted-for Water
UNDP	United Nations Development Program
UNICEF	The United Nations Children’s Fund
USD(US$)	United States Dollers
VAT	Value Added Tax
VDB	The Vietnam Development Bank
VEA	Viet Nam Environment Administration
VGF	Viability Gap Funding
VIWASEEN	Vietnam Water Supply Sewerage and Environment Construction Investment Corporation
VINACONEX	Vietnam Construction and Import-Export Corporation
VND	Vietnamese Dong
WTO	World Trade Organization
WTP	Water Treatment Plant
WB	The World Bank

1. The Background and Necessity of the Proposed Project

1.1 Socioeconomic Situation in Viet Nam

The socioeconomic situation in “Country and Regional Situation According to the Ministry of Foreign Affairs in Japan” is shown in Table 1.1.1 below.

Table 1.1.1 Socioeconomic Situation in Country and Regional Situation

Economic indicator	Socioeconomic situation
① Main industries	Agriculture, forestry and fisheries industry, mining, and light industries
② GDP	101.6 billion USD (about 12 trillion JPY) (Nominal value: Viet Nam statistical general bureau in 2010)
③ GDP per capita	1,169 USD (Viet Nam statistical general bureau in 2010)
④ Economic growth rate	6.78％(2010) (The previous year period: 5.32%.)
⑤ Inflation rate	11.75％（Compared with the previous year) (average index of year: 9.19%)
⑥ Unemployment rate	2.88 ％ （Viet Nam statistical general bureau in 2010）（Underemployment rate 4.5%）
⑦ Trade value（2010）	(a) Export: 71.6 billion USD (25.5% decrease compared to the previous year) (b) Import: 84 billion USD (20.1% decrease compared to the previous year)
⑧ The main trade articles (2010）	(a) Export: crude oil, needlework goods, footwear, and marine products, etc. (b) Import: machine equipment and oil, steel, and cloths, etc.
⑨ Trading partners （2009）	(a) Export: The United States, Japan, China, Switzerland, and Australia *Switzerland is due to the special factor of a large amount of export of gold. (b) Import: China, Japan, South Korea, Taiwan, and Thailand
⑩ Exchange rate	About 19,500 VND = 1 USD (January, 2011)

⑪ Investment performance from foreign country (authorization amount)	18.6 billion USD (In 2010, 17.8% decrease compared to the previous year)
⑫ General economic condition	(a) The result of Doi Moi began to show in 1989, and high economic growth of 9% continued in 1995-1996. However, in 1997, with the influence of Asian economic crisis, the foreign direct investment decreased suddenly, and the growth rate in 1999 had decreased to 4.8%. (b) In the 2000's, the direct overseas investment increased well, and the average economic growth rate in 2010 achieved 7.26%. The positive finance and the monetary expansion of the government succeeded even during the world economic crisis in 2009, and in 2010 reached 6.8% - exceeded the initial goal (6.5%). However, for situations like the unstabilization and a rapid grow of prices and the national currency, the macro-economics is opaque. The government has been enumerating the stabilization of macroeconomics and counter-inflation measures as a high-priority issue for the economic management in 2011. (c) Recently, Viet Nam is promoting a further market-oriented economic reform and integration into international economy and accomplished to WTO in January, 2007. But still, matters like chronic trade deficit and immature investment environment, etc. remains a concern.
⑬ External debt balance （2010）	44.5 billion USD
⑭ Foreign-Currency reserves （2010）	12.4 billion USD

(Source: The Ministry of Foreign Affairs homepage)

The economic environment change is analyzed as follows.

1.1.1 The Change of Real GDP in Viet Nam

The GDP change of Viet Nam (the GDP of 1999 year is assumed to be 100) shows rapid growth compared to the United States of America (USA) and Japan (the currency is converted into the USD).

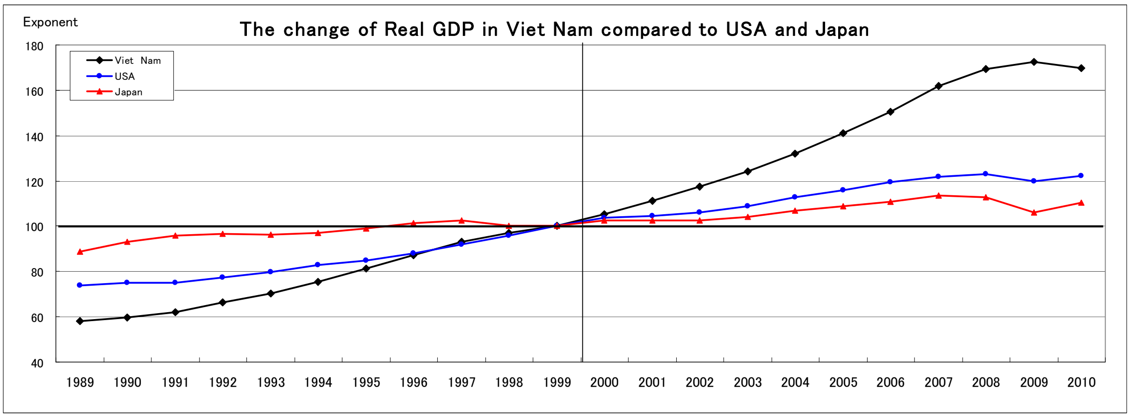

Figure 1.1.1 GDP Change of Viet Nam

The GDP real value was 74.2 billion USD in 2010(The GDP nominal value was 101.6 billion USD), and the scale is about 20 percent of Japanese GDP as shown in Figure 1.1.2 and Figure 1.1.3 below. The decreasing tendency is observed in the growth rate after attaining a peak of 8.46% in 2007.

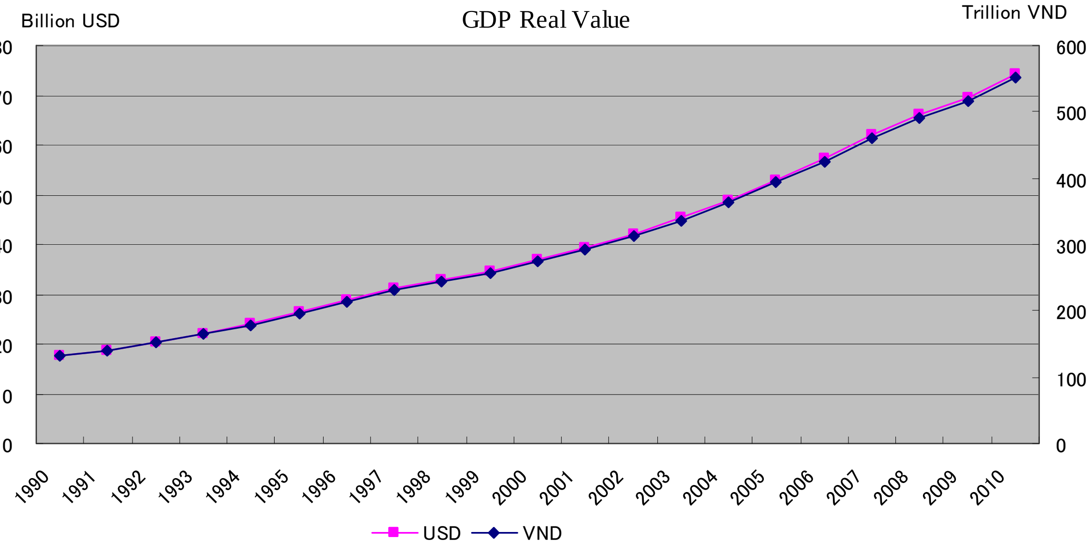

Figure 1.1.2 Transition of Real Value

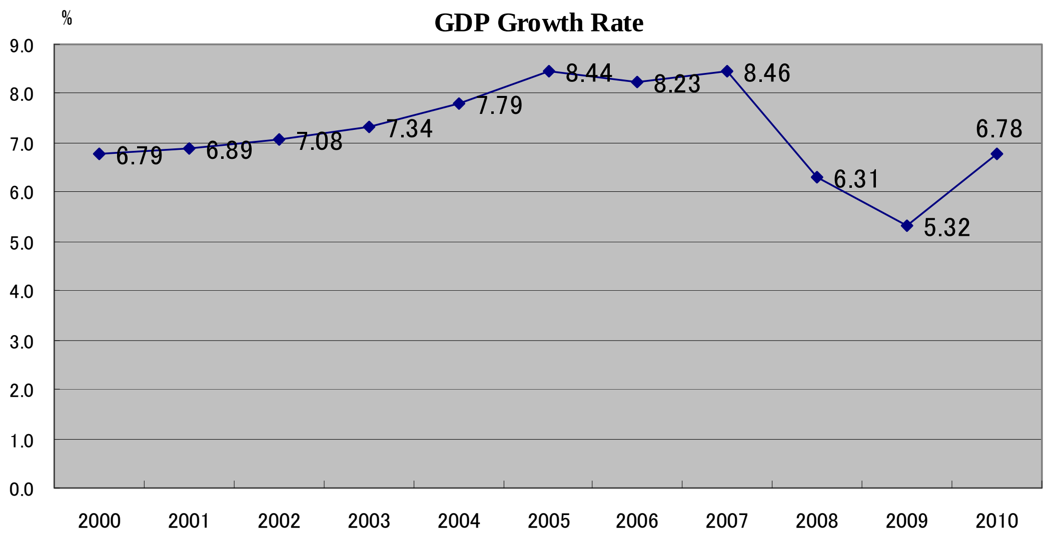

Figure 1.1.3 Growth Rate

1.1.2 Transition of Index Number of Prices of Viet Nam

In this research, three indices (the gross domestic product deflator, the producer price index, and the consumer price index) are taken up about prices of Viet Nam. The use of the analysis result of these data to the financial analysis is done according to the content.

(1) GDP deflator

The plot of the gross domestic product deflator of Viet Nam as an index that shows price changes is presented in Figure below. It is understood that the regulation in the USD base and the yen base changes comparatively stably.

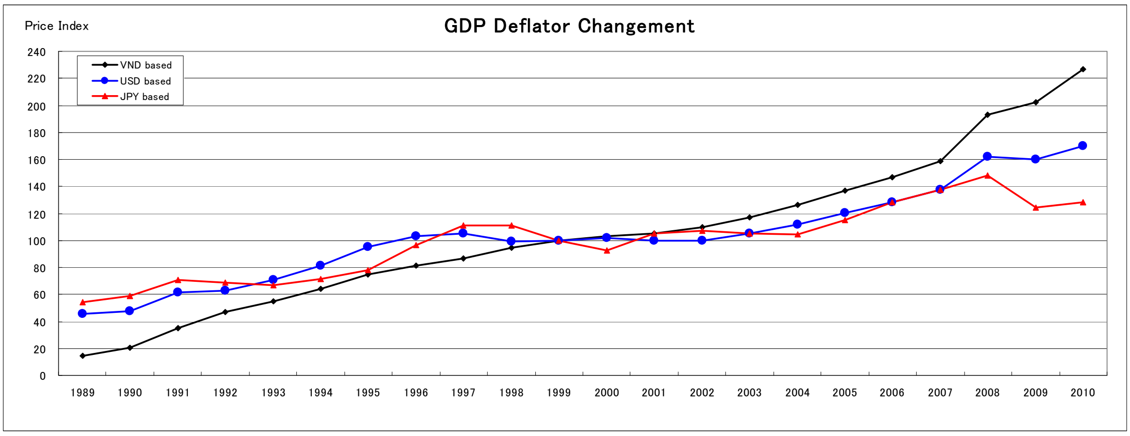

Figure 1.1.4 GDP Deflator Change

The transition of the gross domestic product deflator of referred industry and construction sector falls below the total gross domestic product deflator a little as shown in the figure.

The gross domestic product deflator is 8.32% and the GDP deflator of industry and construction sectors is 7.71% considering the average rate of growth during 11 years from 2000 to 2010.

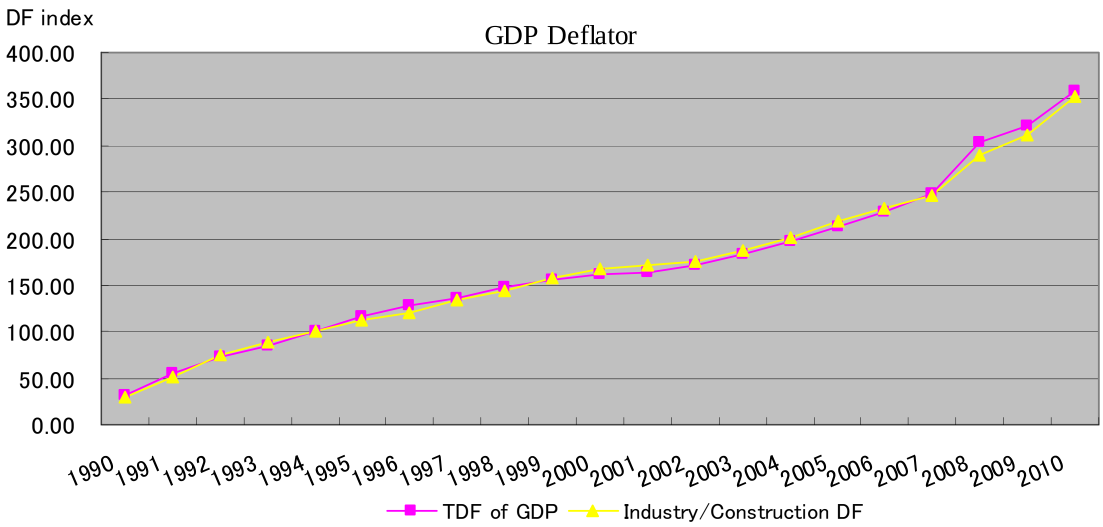

Figure 1.1.5 GDP Deflator

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(2) Producer Price Index(PPI)

The change of index number of prices concerning producer described in "Viet Nam statistical general bureau" of Vietnamese government is plotted as shown in Figure 1.1.6 below.

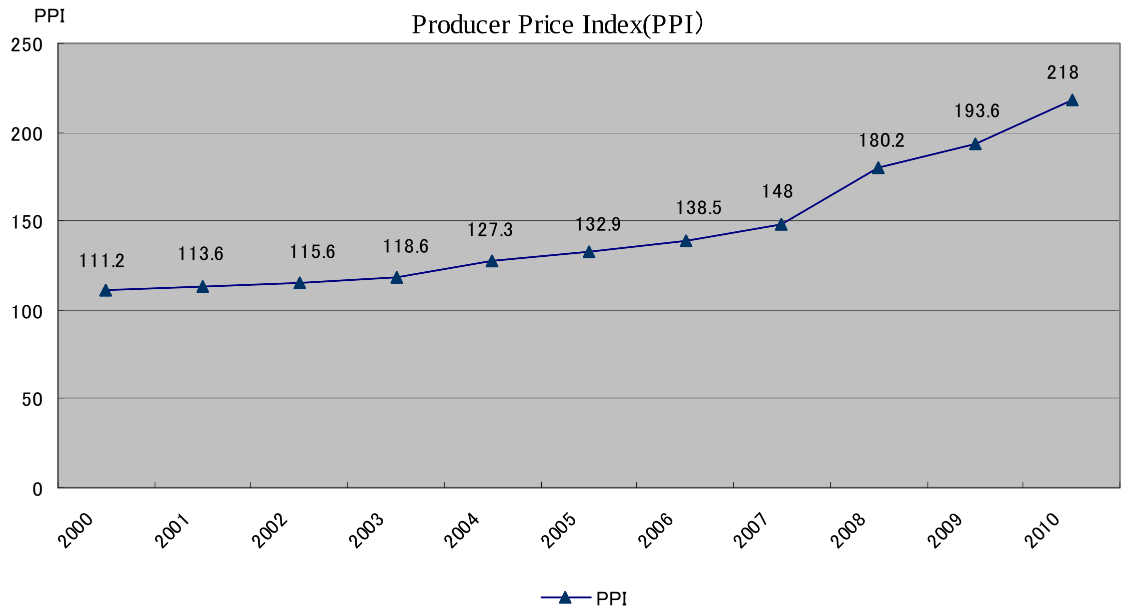


Figure 1.1.6 Producer Price Index

The average increase during 11 years from 2000 to 2010 is 6.96%/year. The average increase in the producer price index during corresponding period in case of the USA and Japan that is related to the financial analysis of this business is as follows.

- The USA : 3.84% / year
- Japan : 0.06% / year

（Data Source： Sekai no Tokei (International Statistical Compendium) in 2012）

(3) Consumer Price Index(CPI)

The changes in consumer price index according to the latest Vietnamese government "General statistics" are shown in Figure 1.1.7 below.

The average rise from 2000 to 2010 is 6.80%/year. The average rise during 6 years from 2005 to 2010 is 10.43%.

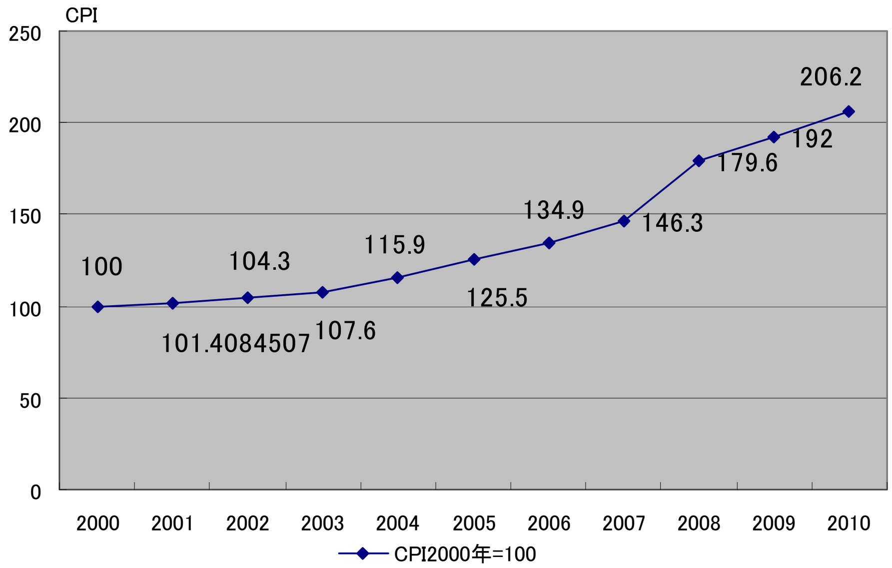


Figure 1.1.7 Consumer Price Index

1.1.3 Change of Purchasing Power Parity in Viet Nam

When the change of the purchasing power in the comparison with the USA and Japan to evaluate the value of Vietnamese currency VND is plotted as graph, the following points are observed. The value of the currency shows the tendency to decrease compared with the USA and Japan. This indicates that the cost spent to buy one unit of the product has risen more in Viet Nam (Value of money has decreased oppositely) than the USA and Japan compared to the prices rise and the exchange fluctuation in the USA and Japan.

The relation of exchange and purchasing power parity of VND to the JPY and the USD are as shown in the figures below. These figures show that the real power value of money of VND is induced by policy against JPY and USD. In this case, the risk of the possibility of inducing the exchange movement exists besides the function of the market.

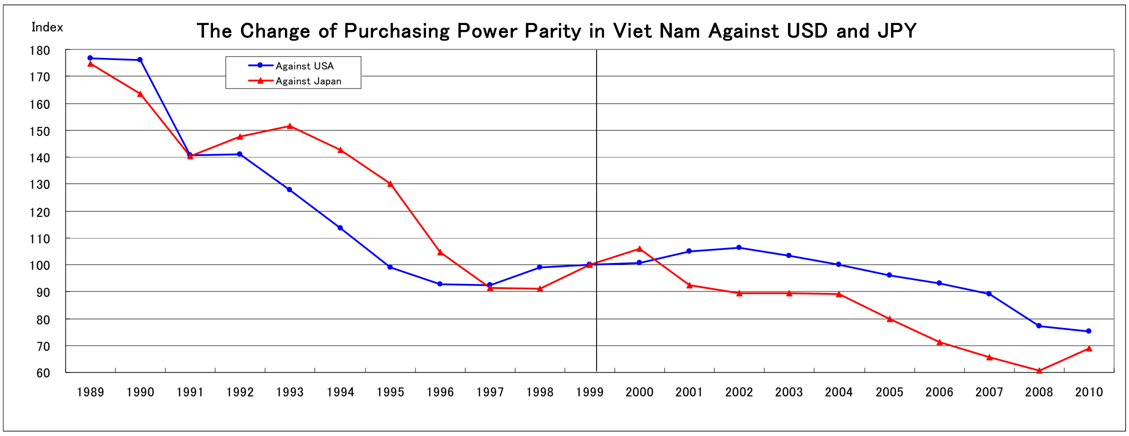


Figure 1.1.8 Purchasing Power

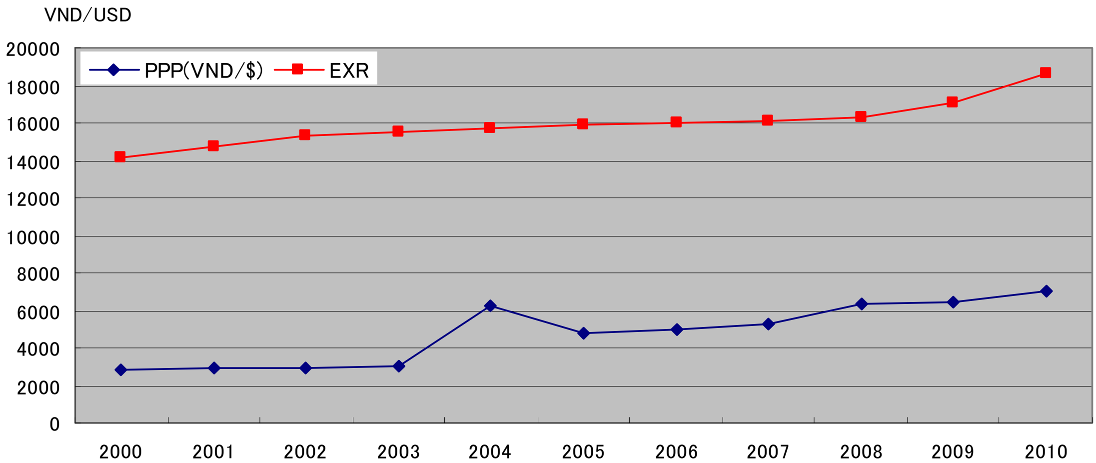


Figure 1.1.9 Relation of Exchange Rate and Purchasing Power Parity (VND/USD)

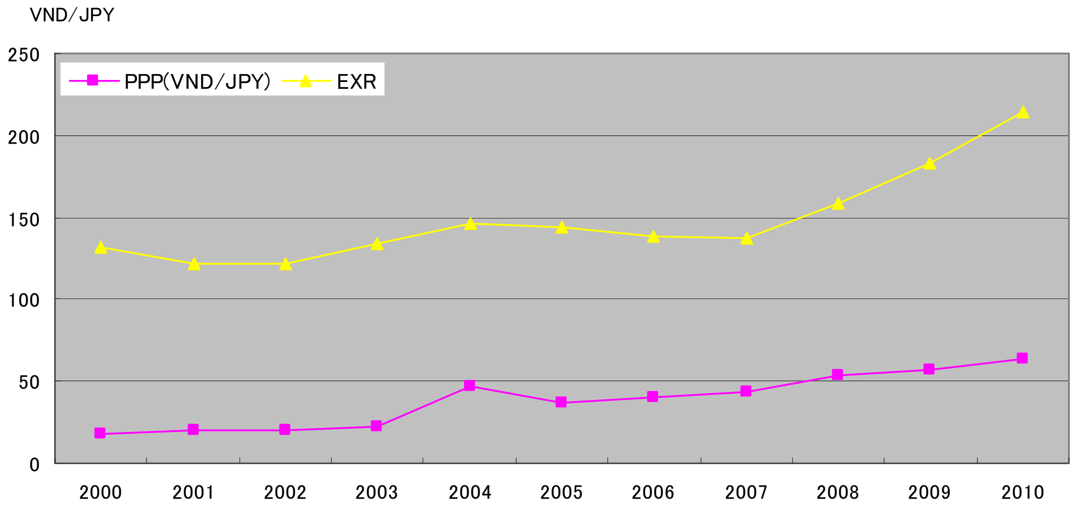


Figure 1.1.10 Relation of Exchange Rate and Purchasing Power Parity (VND/JPY)

The devaluation of VND/USD and VND/JPY from 2000 to 2010 is as follows.

- The devaluation of VND/USD : 2.76% / year
- The devaluation of VND/JPY : 4.97% / year

1.1.4 Interest Rate Change of Vietnamese Dong (VND)

The change in interest rate of Vietnamese Dong is shown in Figure 1.1.11. With a high inflation in 2008 the interest rate rose greatly too, but settled down in 2009. However, the level of 8%/year is higher compared with near zero interest rates of the USA and Japan. In the funding by the money market rate at this level, the feasibility of the water service project with high publicity is not easily expected.

Especially, the interest rate of the government bond that becomes the standard of the long-term yield for ten years has soared in recent years.

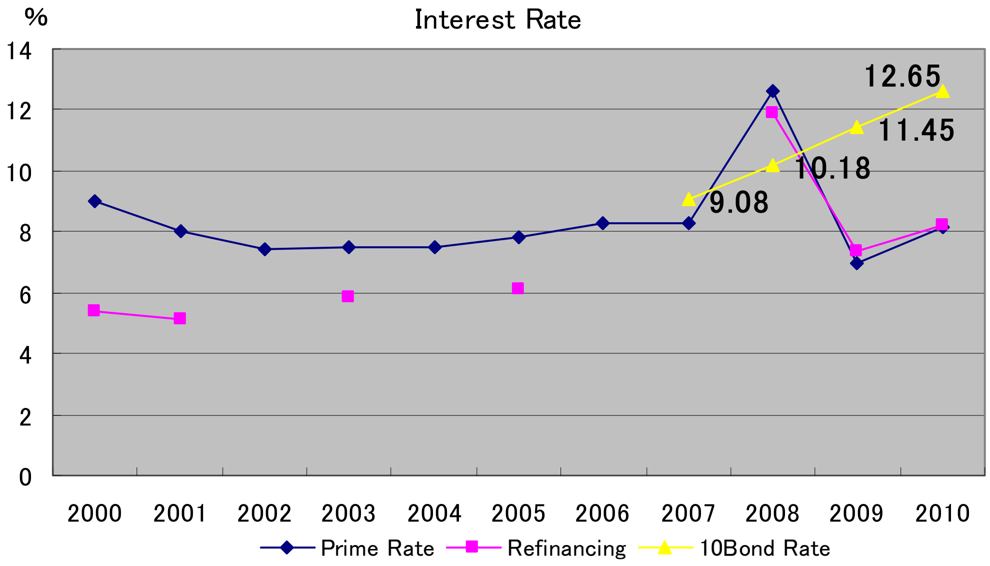
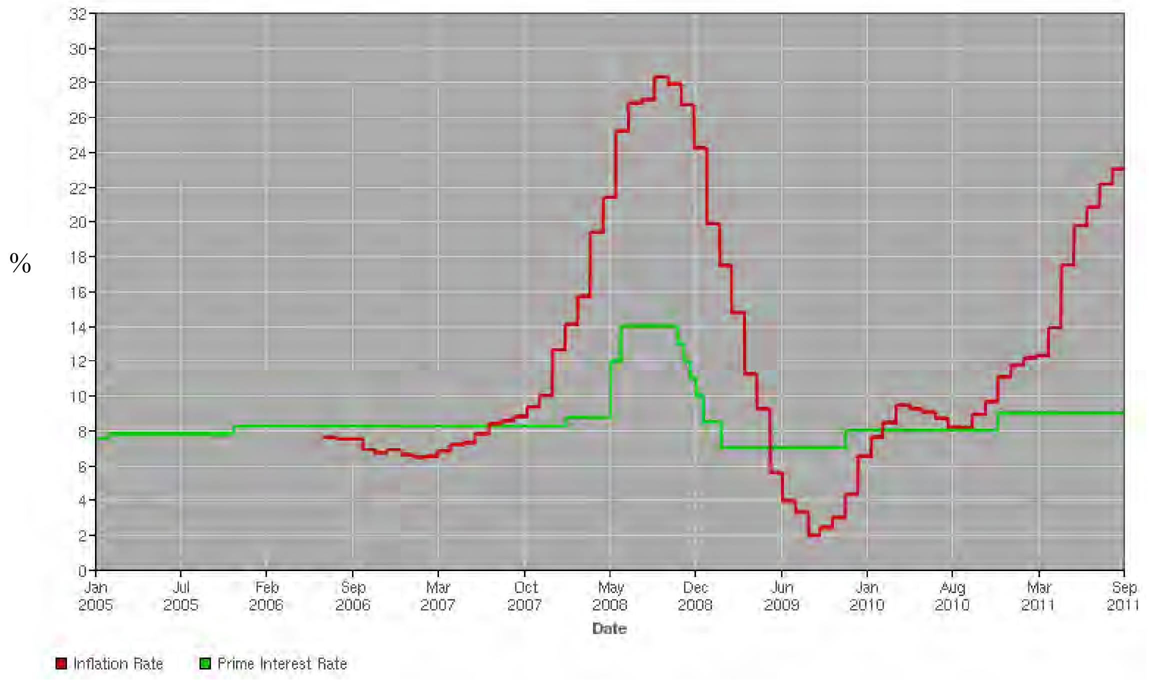


Figure 1.1.11 Interest Rate

1.1.5 Interest Rate and Inflation Rate Trend Analysis

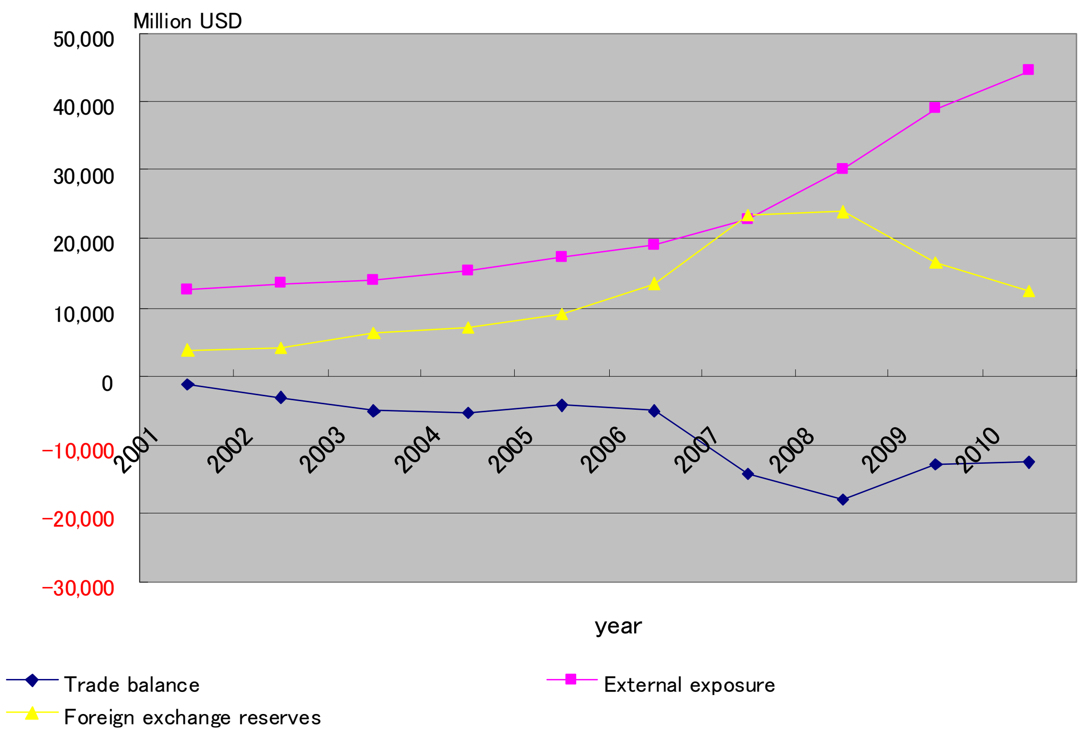
As shown in Figure 1.1.12, sharp rise of inflation rate in 2008 was once calmed down by tight-money measures controlling prime rate. After a short while of normalization, however, the inflation rate has been rising again since 2010, for which sufficient monetary policy is yet to be effected.

Current high inflation is reportedly due to the increasing trade deficit, the increasing foreign debt and the decreasing foreign currency reserve as shown in Figure 1.1.13. These economic factors caused frequent VND devaluation and increased imported goods price level. It is therefore that some effective measures for export promotion and leveling down of the import amount should be urged.



(Data Source：ADB Asis Bond Outline)

Figure 1.1.12 Transition of Interest Rate and Inflation Rate



(Data Source：JETRO Basic Economic Indices)

Figure 1.1.13 Transition of Trade Balance, Foreign Debt and Foreign Currency Reserve

1.1.6 The Transition of Ha Noi City Water Rate

Water rate revisions have been carried out nine times in last 20 years in Ha Noi City. The change of the water rate compared to the price rise is shown in Figure 1.1.14. The charge in 2009 is same as it is applied now. The water rate was left untouched because prices changed comparatively stably around 2000. After 2005, the water rate has been left untouched although the prices have gone up rapidly. If the new water tariff application is approved by HPC, the water tariff will meet the price growth.

The water rate is expected to synchronize with the price hike and is expected to be revised frequently in the future.

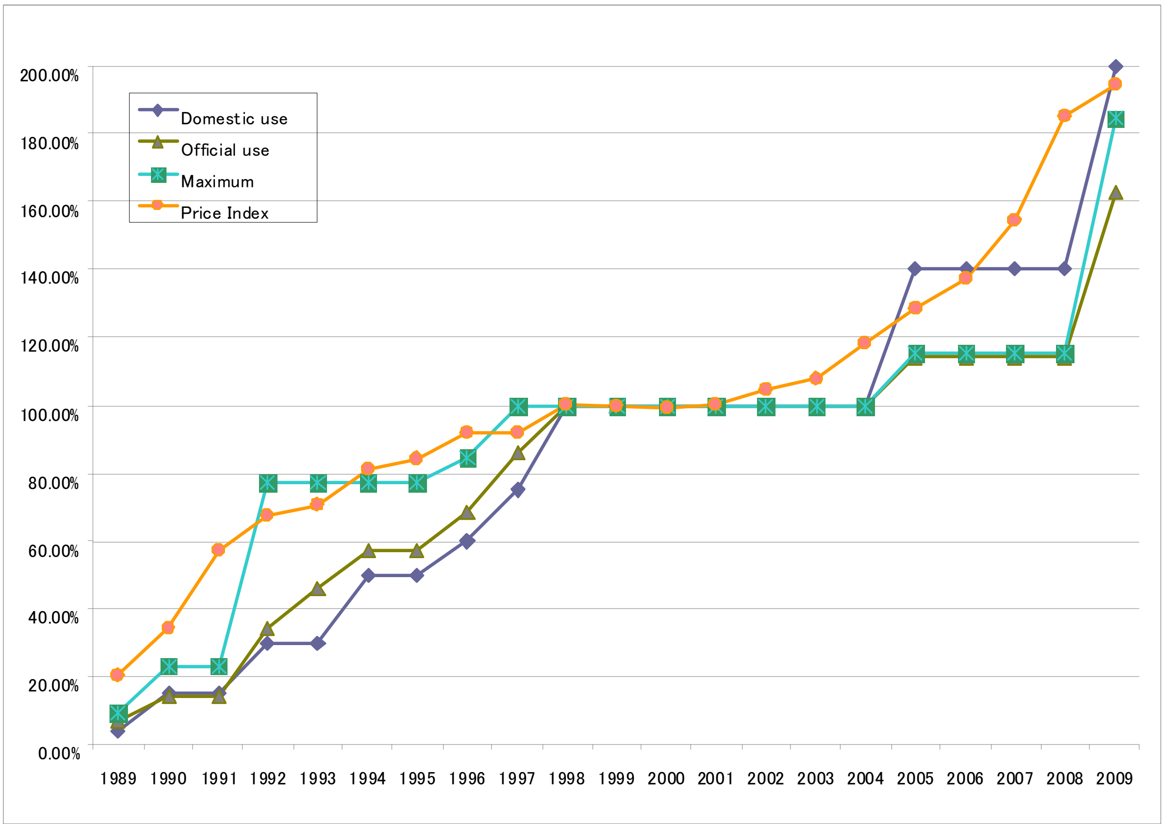


Figure 1.1.14 Water Rate Change in Hanoi

Latest water tariff in Ha Noi City is shown below. (January 1, 2010).

Table 1.1.2 Latest Water Tariff in Ha Noi City (January, 2010)

Purpose of use	Using water volume			
	$0\ m^3 – 16m^3$	$16\ m^3 – 20m^3$	$20\ m^3 – 35m^3$	$35\ m^3$ –
Domestic use (VND/m^3)	4,000	4,700	5,700	9,400
Public office use (VND/m^3)	5,700			
Public use (VND/m^3)	4,700			
Industrial use (VND/m^3)	7,000			
Private office use (VND/m^3)	12,000			

Ref) 119/2009/QD-UBND and 120/2009/QD-UBND

1.2 Outline of the Water Sector in Viet Nam

1.2.1 Government Agencies Related to Water Supply Sector

The Government of Viet Nam is managing the water resources in the country. For the use of river water as a source of water supply, permission should be obtained from the Ministry of Agriculture and Rural Development or People's Committee. In the Water Resources Law, regulations and laws related to river basin management, management of surface and groundwater, and their quality and quantity related laws have been defined.

Ministries involved in water sector are listed in Table 1.2.1.

The relationship among these agencies is summarized below. All the strategy and the policy concerning the water supply services in the urban and rural areas require approval from the Prime Minister. Ministries concerned possess power concerning the policy, and submit major project to obtain the approval of the Prime Minister. At present, in case of the special urban water supply projects with capacity of 30,000 m^3/day or more and water supply projects for smaller cities with capacity of 10,000 m^3/day or more needs mutual agreement in the form of the document from the Ministry of Construction.

On the other hand, People's Committee in each prefecture takes the responsibility for investment projects of 200 billion VND or less. Projects which cost 200 billion VND or more needs approval from the office of the Prime Minister. In all the cases, City Water Supply Corporation is responsible for the water supply services, the operation, and management of the water treatment plant and water distribution networks.

Table 1.2.1 Government Agencies in Viet Nam Related to Water Supply Projects

Organization	Functions
Prime Minister (PM)	Policy decisions related to the national strategy on water projects, final approval of major investment projects, the approval of water supply planning projects and investment plans
Ministry of Planning and Investment (MPI)	State budget allocations, approval of major investment projects in MPI: domestic and foreign investment to improve water supply services in accordance with the priorities of the Government approval of the ODA and implementation
Ministry of Finance (MOF)	Distribution of state funds, setting the annual target areas,

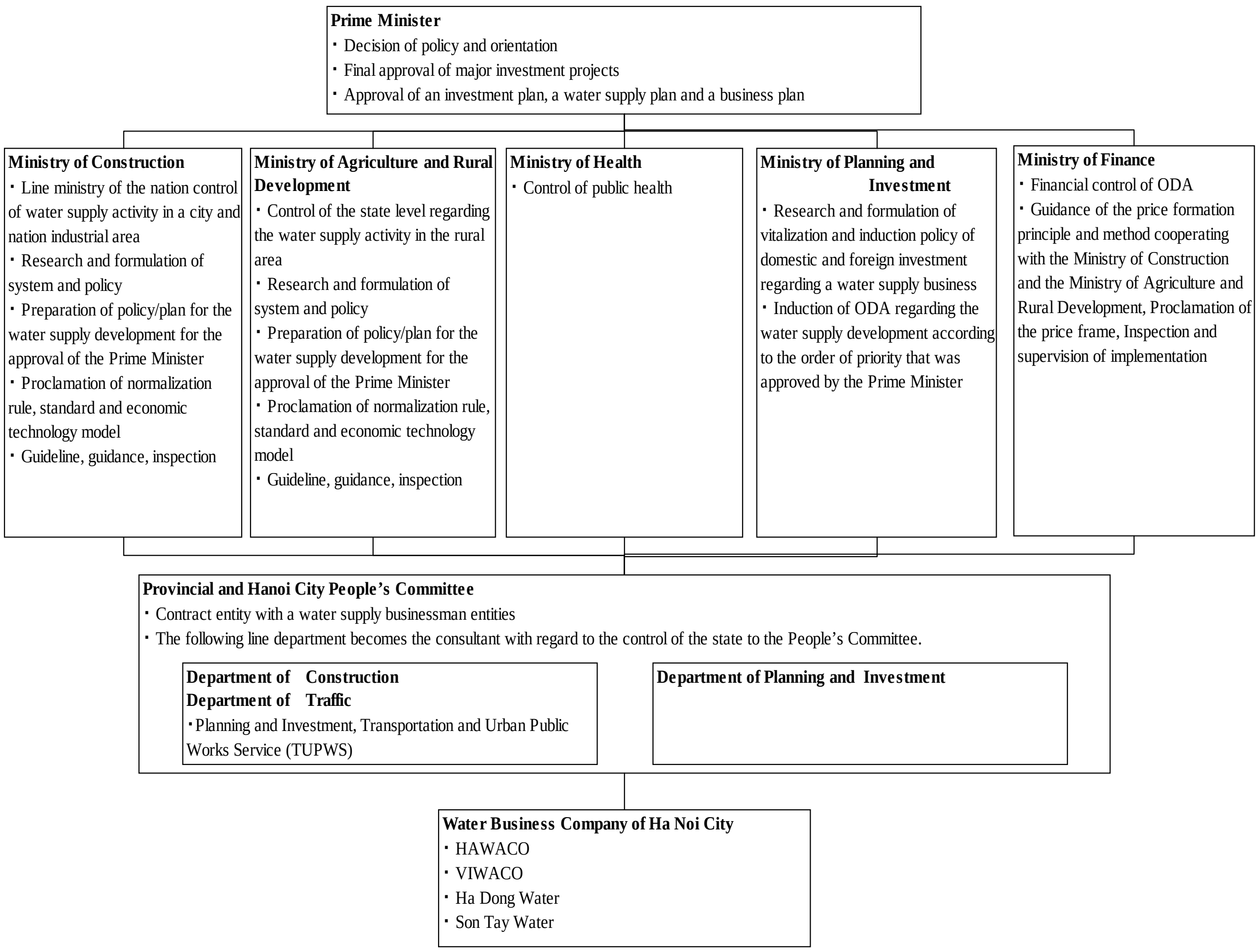
Organization	Functions
	regulation of the accounting: financial management of ODA related to water, the promulgation of the water tariff frame, inspection, and supervision of the implementation
Ministry of Health (MOH)	Management of public health (drinking water quality management)
Ministry of Natural Resources and Environment (MONRE)	Water resources, water use, pollution control
Ministry of Science and Technology (MOST)	Standards and technical management of the water sector
Ministry of Construction (MOC)	State Administration of specialized areas of water supply activities and national industrial city: Submission of the Government's policy research, preparation of plans for approval of the Government policies, guidance and inspection
Ministry of Agriculture and Rural Development (MARD)	Specialized ministry for rural water supply
Hanoi People’s Committees (HPC)	Entity responsible for execution of water projects, Ha Noi City.
Department of Natural Resources and Environment (DONRE)	Specialized agencies on the registration for land use for construction of the water treatment plant and the permission for discharge to water body
Hanoi Authority for Planning and Investment (HAPI)	Specialized agencies on the investment in the water supply business activity of the People's Committee
Hanoi Transportation and Urban Public Works Service (TUPWS)	Ha Noi City water project planning, water management corporation
Hanoi Water Limited Company (HAWACO)	Water services enterprise of central area of Ha Noi City
Fresh Water Business and Construction Investment JSC (VIWACO)	Water services enterprise of southwestern area of Ha Noi City
Ha Dong Water One Member Limited Liability Company (Ha Dong Water)	Water services enterprise of Ha Dong District and southwestern area of Ha Noi City
Son Tay Water supply Company (Son Tay Water)	Water services enterprise of western area of Ha Noi City

1.2.2 Relationship Chart for the Ministries Related to Water Supply Services

Since this project is private financing public service project, it is necessary to be approved by MOC, MPI and PM for final approval.

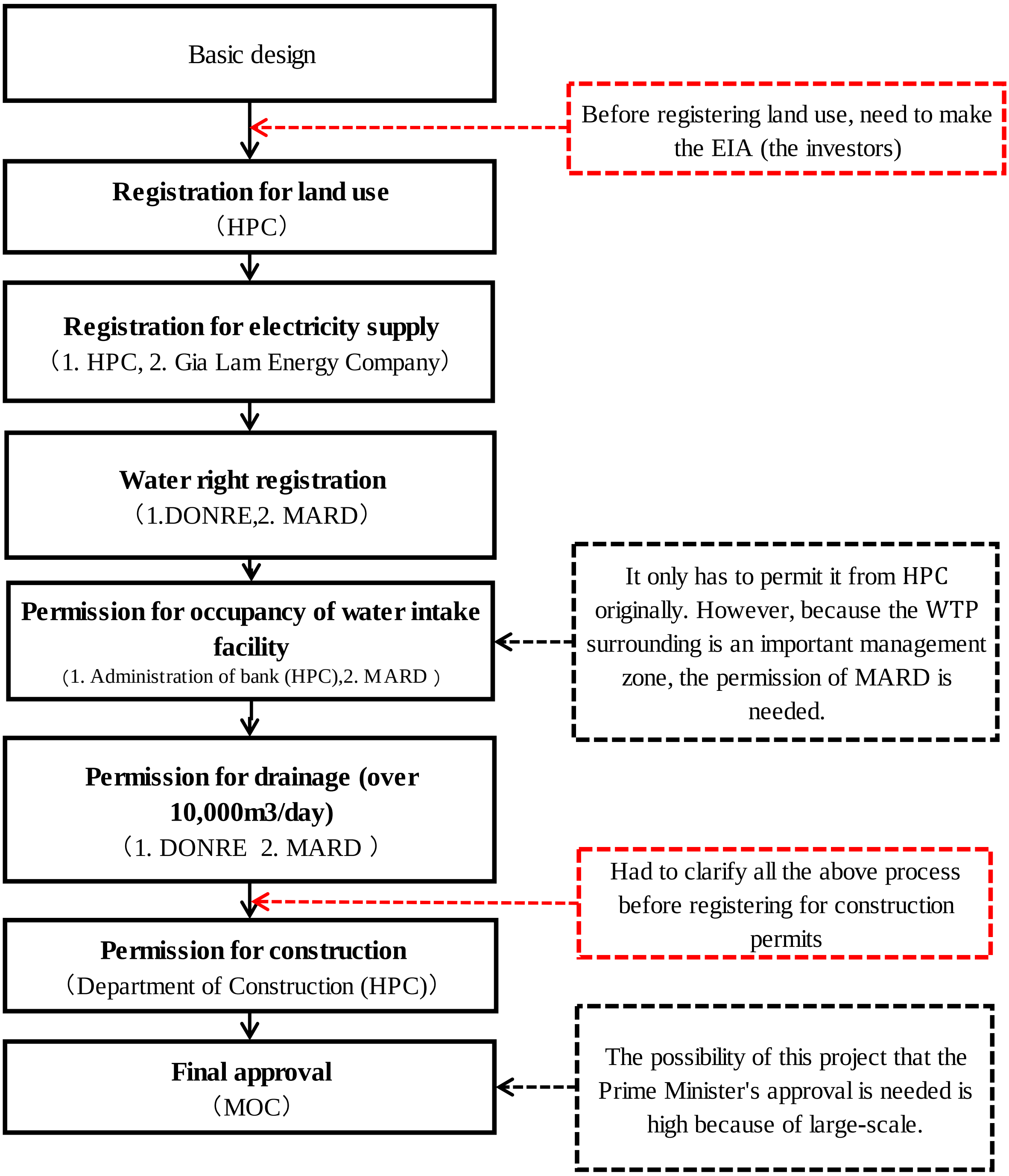
Figure 1.2.1 shows the relationship chart for the Ministries related to Water supply Services.

Figure 1.2.2 shows the procedure for project approval.



(Source: Compiled based on information through discussion with several local Agencies)

Figure 1.2.1 Relationship Chart for the Ministries Related to Water Supply Services



(Source: Compiled based on information through discussion with several local Agencies)

Figure 1.2.2 Procedure for Project Approval

1.3 Legal Frameworks Related to Water Supply Business Under Public-Private Partnership

1.3.1 Legal Frameworks Related to Water Supply Project

(1) Legal Frameworks

The legislative frameworks of Viet Nam related to water supply projects are listed in Table 1.3.1

Table 1.3.1 Legal Frameworks Related to Water Supply

No.	Legal System and Number	Promulgating Agency	Overview
1	Law No.08/1998	Prime Minister	Water resources law: Main purpose setting policy on the use of water resources management, rights and duties to be abided by the government offices concerned and users
2	Decree No.179/1999	Prime Minister	Law related to policy and implementation of water resources law
3	Decision No.63	Prime Minister	Plans for the development of urban water supply for the year 2020
4	Directive No.04	Prime Minister	Clean water production, supply and consumption management
5	Decree No.117	Ministry of Construction	Decree on clean water production, supply and consumption of clean water
6	Circular No.01/2008	Ministry of Construction	Guidelines to implement Decree No.117
7	Decree No.149/2004	Prime Minister	Regulations on the licensing of exploration, exploitation and use of water resources and regulation of discharge of waste water into water sources
8	Circular No.2/2005	Prime Minister	Guideline to implement Decree No.149
9	Inter-Circular No.95/2009	Ministry of Finance	Pricing Principles, method for determination and authority to decide clean water consumption price
10	Circular No.100/2009	Ministry of Finance	Regulation of domestic use water tariff

11	Law No.59/2005	National Assembly	Investment Law
12	Decree No.108/2006	Ministry of Planning and Investment	Guidance for the implementation of investment law
13	Decision N0.1088/2006	Ministry of Planning and Investment	Document forms for implementing investment procedure
14	Law No.60/2005	National Assembly	Enterprise Law
15	Decree No.102/2010	Prime Minister	Enforcement regulation of Enterprise Law
16	Decree No.43/2010	Prime Minister	Business regulation
17	Law N0.13/2003	National Assembly	Land Law
18	Decree No.23/2003	Prime Minister	Regulation of transaction and distribution of foreign invested enterprises in Viet Nam
19	Circular No.09/2007	Ministry of Commerce and Industry	Guidance for Decree No.23
20	Circular No.05/2008	Ministry of Commerce and Industry	Amendment of Circular No.09
21	Decision No.10/2007	Ministry of Commerce and Industry	Roadmap of goods trading and activities directly involving goods trading
22	Law on Natural Resources Royalties No.45/2009	National Assembly	Law on royalties for natural resources utilization
23	Law on Corporate Income Tax No.14/2008	National Assembly	CIT Law
24	Decree No.124/2008	Prime Minister	Enforcement regulation of laws on corporate income tax
25	Circular No.130/2008	Ministry of Finance	Guidelines on/for implementing Decree No.124
26	Circular No.18/2011	Ministry of Finance	Amending and supplementing Circular No.130
27	Circular No.201/2009	Ministry of Finance	Guiding management of exchange rate difference in enterprises
28	Decree No.34/2008	Prime Minister	Regulations on recruitment and management of

			foreigners working in Viet Nam
29	Law No.04/2007	National Assembly	PIT Law
30	Decree No.50/2010	Prime Minister	Guidance to Law on natural resources royalties
31	Circular No.105/2010	Ministry of Finance	Guidance to Decree No.50
32	Circular No.134/2008	Ministry of Finance	Tax obligations imposed on foreign organizations/individuals doing business or having income in Viet Nam
33	Circular No.197/2009	Ministry of Finance	Supplement to Circular No.134
34	Circular No.203/2009	Ministry of Finance	Regulation on management, use and depreciation of fixed assets
35	Decree No.108/2009	Prime Minister	Decree on investment in the form of BOT, BTO or BT contract
36	Decree N0.24/2011	Prime Minister	Amendment of Decree No.108
37	Circular No.03/2011	Ministry of Planning and Investment	Guidance to Decree No.108
38	Decision No.71/2010	Prime Minister	Regulation on pilot investment in the Public-Private Partnership form
39	Decision No.134/2005	Prime Minister	Regulations on control of foreign loans and loan repayments
40	Decision No.272/2006	Prime Minister	Regulations on issuance and management of the Government guarantees for foreign loans
41	Circular No.04/2001		Guidelines on foreign exchange management with foreign invested enterprise and foreign parties participating in business cooperation contracts
42	Decision No.181/2007	Ministry of Finance	Decision on re-lending of the Government's foreign loan and assistance capital
43	WTO Commitment/2007		WTO Commitments
44	Law No.52/2005	National Assembly	Laws on environment protection
45	Law No.61/2005	National Assembly	Tendering Law
46	Circular No.186/2010	Ministry of Finance	Guidance on offshore remittance of profits earned by foreign organizations and individuals

			from their direct investment in Viet Nam
47	Circular No.108/2007	Ministry of Finance	Guidance on financial management mechanism applicable to Official Development Assistance projects and programs
48	Decree No.15/2011	Prime Minister	Regulations on provision and management of government guarantees

Source: Overview of the discussions and collected information during field visit in Viet Nam

(2) Laws Related to Water Tariff

1) City categories and water tariff price frames

For urban area water supply projects, cities are categorized as given in Table 1.3.2, and all laws follow this categorization.

Table 1.3.2 City Categories

Category	Type	Population	Numbers
Special Class	Largest Cities	Over 1,500,000	Ha Noi, Ho Chi Minh
Category I	National Cities	500,000～1,500,000	3 Cities
Category II	Regional Cities	250,000～500,000	12 Cities
Category III	Provincial Cities	100,000～250,000	16 Cities
Category IV	District Towns	50,000～100,000	58 Towns
Category V	Townlets	4,000～50,000	612 Townlets

Source：Decision No.38/2005 “Water supply and Sanitation Strategy”
The World Bank in Viet Nam, 2006

According to the above categories, the water tariff price frame is set as presented in Table 1.3.3. The cities decide their tariffs following this frame. Table 1.3.4 shows the current water tariff practiced in Ha Noi City.

Table 1.3.3 Water Tariff Price Frame

Category	Minimum tariff(VND/m3)	Maximum tariff（VND/m3)
Special Class, Category I	3,000	12,000
Category II, III, IV, V	2,000	10,000
Agriculture	1,000	8,000

Source：Decision No.100/2009 ;”On the consumption price frame of clean water for daily life”
MOC, July 2009

Table 1.3.4 Water Tariff Applied in Ha Noi City (2009)

Consumed Amount	Without tax (VDB)	VAT(5%)	EPF(10%)*	Include tax（VDB）
Up to 16m3	3,478	173	347	4,000
16m3 - 20m3	4,086	204	408	4,700
20m3 - 35m3	4,956	247	495	5,700
Over 35m3	8,173	408	817	9,400

*: Environment Protection Fee (EPF) is regulated by Law on Environment Protection, 2005

Source: Decree No.119/2009(Clean water tariffs inside Hanoi district), field study

2) Tariff formula

Water suppliers hold the right to propose water tariffs to the provincial-level of People’s Committee, based on the fare issued by the Ministry of Finance on both retail and wholesale prices. The following formulas are prescribed by the Ministry of Finance.

【Water supply tariff formula】

Average water tariff = (Profit + Total consumption price (VND)) / Commercial consumption amount

Average consumption price = Production cost + Enterprise managing cost + Selling cost

Production cost = Direct material cost + Direct labor cost + General production cost

【Direct material cost】

Raw water, electricity, aluminum sulfate and other materials

【Direct labor cost】

Wages and rewards + Expenses

【General production cost】

Depreciation cost, repairing cost, material cost and equipment cost for plants, plant laborer wages, rewards, treatment cost, insurance cost, labor union cost, etc.

【Commercial consumption tariff】

Water production amount －leakage water

【Profit】

Minimum profit: 3% of equity

3) Royalties of water rights

Royalties of water rights follow the below formula according to the Royalties for Natural Resources Law, revised in 2010.

Royalties of surface water = Take off price x Product price x 1% (in accordance with Resolution No 928/2010)

① Investment incentives and supports (Article 38)

- Enterprises are entitled to enterprise income tax incentives under the law on enterprise income tax (Circular No.103)
    - No tax period (Tax free period) 4 years and 50% reduction for the following 9 years.
    - Including the above, 10% taxation for 15 years. (Possible extension up to 30 years)
    - Loss transfer for 5 years (continuous)
- Goods imported for implementing projects of contract enterprises and contractors are eligible for incentives under the law on import duty and export duty.

② Land incentives and supports (Article 38)

Enterprises are exempt from land use levy for the land area allocated by the State or from land use rent throughout the project implementation duration.

③ Guarantee for obligations of investors, project enterprises and other enterprises (Article 40)

When necessary and depending on the characteristics of a project, the Government shall designate a competent agency to guarantee loans, supply materials, sell products and fulfill other contractual obligations for the investor, the project enterprise or other enterprises participating in project implementation.

④ Right to mortgage assets (Article 41)

- Project enterprises may pledge or mortgage its assets and land use rights in accordance with law.
- The pledge or mortgage of assets of project enterprises is subject to approval of a competent state agency, must not affect projects' objectives, progress and operation indicated in project contracts, and must comply with law.

⑤ Right to buy foreign currencies (Article 42)

In the course of building and operating a work, the investor or the project enterprise may buy foreign currencies under the law on foreign exchange management, covering:

- Payment of rent of equipment and machinery hired from overseas;
- Import of machinery, equipment and other products and services for the project implementation;
- Payment of foreign debts;
- Payment of bank loans in foreign currencies;
- Transfer abroad of capital, profits, investment liquidation amounts and payments.

⑥ Assurance for provision of public services (Article 43)

⑦ Settlement of disputes (Article 44)

⑧ Capital and asset assurance (Article 45)

1.3.2 Approval Process for Privatization of Water Supply Project

On the basis of collected information through discussion with related agencies, the approval process for privatization of water supply projects is presented as flow diagram in Figure 1.3.1

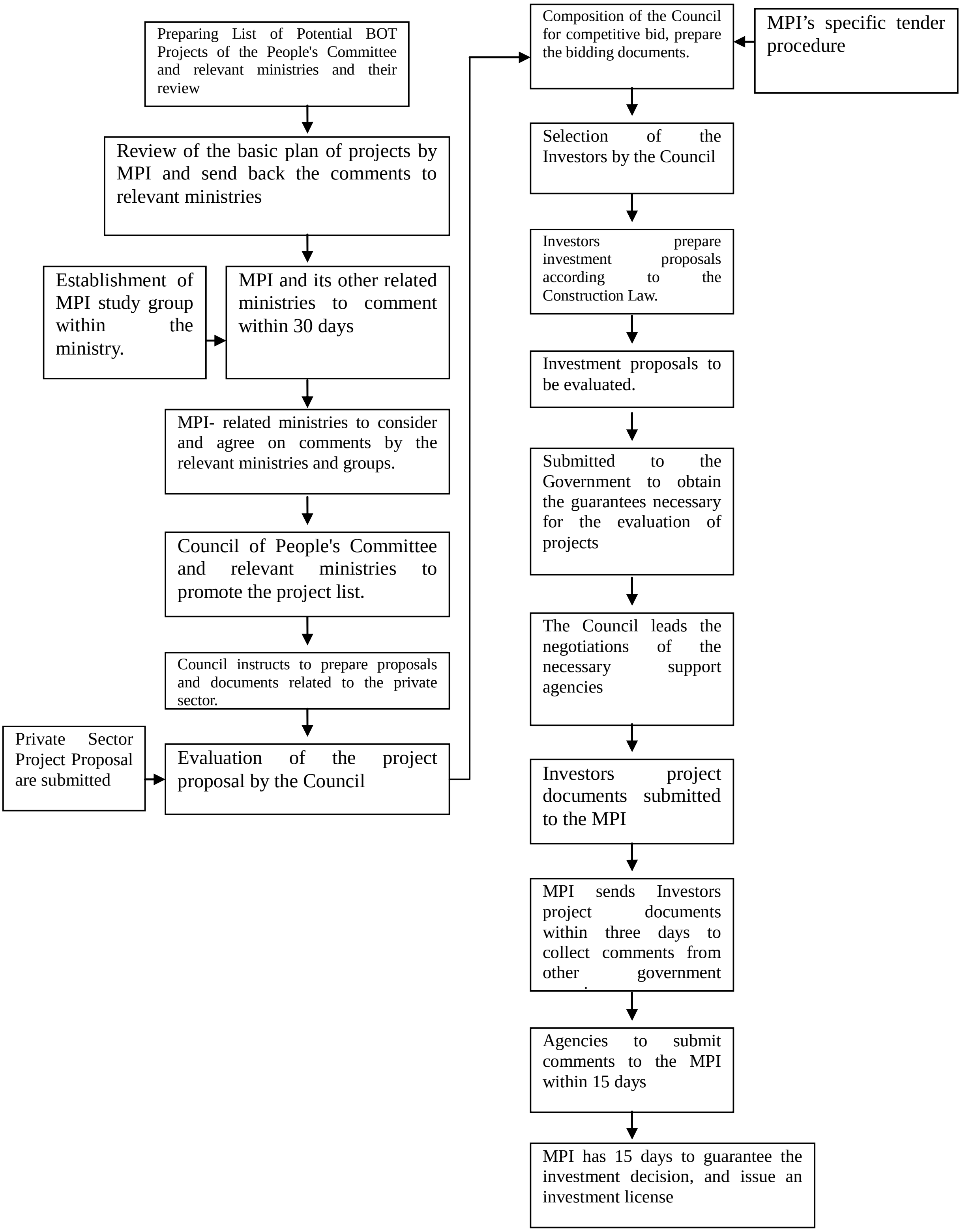


Figure 1.3.1 Flow Diagram of Approval Process for Privatization of Water Supply Projects as Per Government Ordinance No.37

1.3.3 JICA PSIF (Private Sector Investment Finance)

(1) JICA PSIF (Private Sector Investment Finance)

In cabinet decision “New growth strategy” on June 18, 2010, “After researching and evaluating both success and failure examples of the past, and reconstructing risk examination and management system, Japan International Cooperation Agency (JICA) shall restart overseas investment and accommodation (PSIF) to correspond to matters with high development effect” ,was declared.

The outlines are as follows.

1) Finance technique

Direct financing and investment

2) Loan and finance subjects

Corporations in our country or the developing world (individual firm, SPC, and fund)

3) Object field

- MDG, poverty reduction (BOP business, microfinance, etc.)
- Infrastructure and growth acceleration (PPP infrastructure business etc.)
- Climate change measures

(Projects, which are covered by existing financial institutions, are excluded.)

4) Loan terms (Yet to be decided, the following are opened).

- Loan condition :Basically, Loan and deeds
- Loan ratio: Basically 70 % of total investment cost, maximum is 80 %, if it is approved (depends on the project characteristics)
- The redemption term : Basically, 20 years, maximum 25 years.
- Period of deferment : Basically, 5 years
- Annual interest rate : based on 1.7 % (fiscal loan fund condition), the interest rate is decided so as to achieve more than 25 % of grant element.
- Security (mortgage), Guarantee : JICA will request.
- Loan currency was yen in the past. September, 1972, foreign currency loan was introduced. This was due to the rapid increase of the foreign currency reserve of Japan, and the policy to reduce the exchange risk by promoting foreign direct investment.

5) Investment

- Method: Direct investment to local companies. Invest rate is to be under 25%, thus lower than the main stockholder.

1.4 Outline of Natural Condition in Greater Hanoi

This region experiences temperate zone climate, and from May to October rainy season occurs. It is hot and humid in summer, whereas the winter is dry and cold.

In Hanoi, the average temperature is 16℃ in January and 29℃ in July, the average humidity is 84 - 86%, and the annual average precipitation is 1,704mm. Comparatively, the distinction at the dry season and the rainy season is remarkable, and the amount of mean monthly rainfall in the rainy season is 238mm, about twice of Japan. Especially, influence on the construction is feared because there is precipitation of 250mm or more from July to September. As for the number of rainy days, it rains about 15 days a month during March to September.

Moreover, it is necessary to avoid the construction that relates to the water intake facilities and the river crossing parts of transmission pipeline in the rainy season because the river water level of Red River and Duong River may increase greatly.

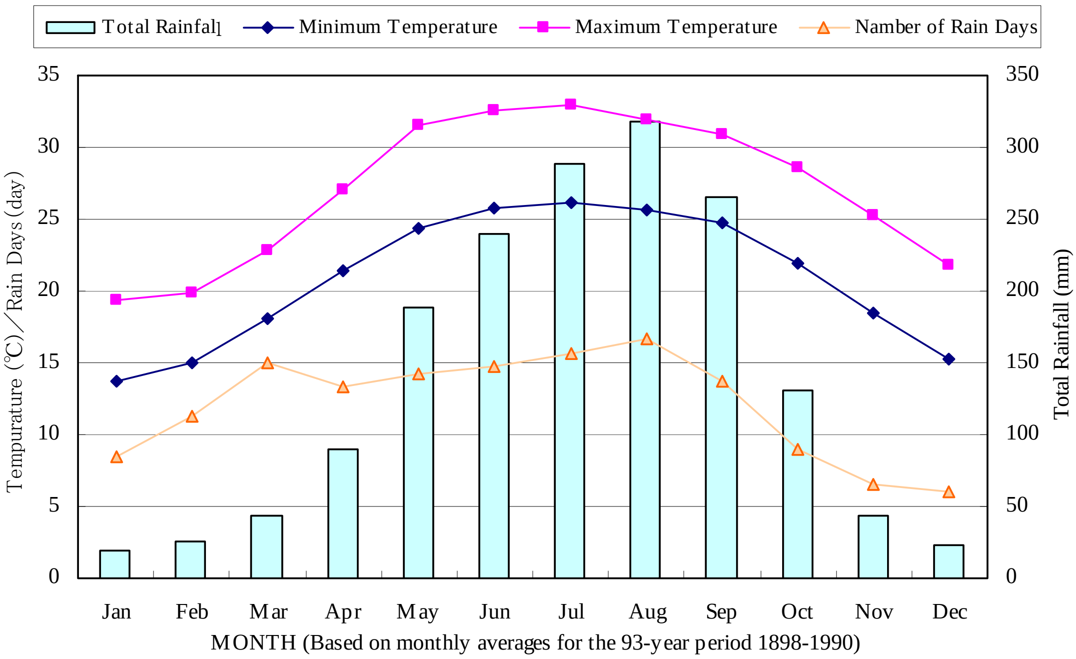


Figure 1.4.1 Monthly Mean Temperature and Rainfall in Ha Noi City

1.5 Needs of the Project

The existing WTP in Ha Noi City is mainly of small capacity and uses groundwater source, which is rather simple in terms of water treatment process (less expensive) in comparison to the water supply system using surface water source with high turbidity and of larger scale. Recently, because of too much use of groundwater for both drinking and industrial purposes, the subsidence (reported as 41mm/year), and water quality deterioration are severe in this area. For this, the Government of Viet Nam has shifted the policy from use of groundwater source to surface water source for these purposes.

As already mentioned, the Greater Hanoi includes capital city of New Hanoi and the surrounding 6 provinces. The Greater Hanoi is divided into two regions, the north and the south, by Red River. In the southern region, there are 15 large WTP (over 10,000m^3/day) operated by 4 water works. There also exists Da River water treatment plant, operated and managed by VINACONEX. Since the water treatment capacity of the Da River project is planned to be increased from 300,000m^3/day to 600,000m^3/day (and finally to 1.2 million m^3/day), it is expected to be able to respond to the increasing water demand of the southern region.

On the other hand, in the northern region, there are only 3 large WTP. It is difficult to expand the capacity to cover water demands in the northern region, because all WTP uses groundwater source.

In this situation, since many industrial parks and residential parks are under construction, water-resource development is a severe issue for catering to increasing water demand of this area.

Moreover, in the existing situation only about 60 percent of the water demand is supplied in rapidly growing Ha Noi City.

A plan by the Vietnamese government aims to construct water supply systems by 2015, and to supply sufficient clean water for each city and the industrial parks. Therefore, 300,000m^3/day scale of this project is urgent and needed.

No.	Name of Province
1	Lai Chau
2	Lao Cai
3	Ha Giang
4	Cao Bang
5	Lang Son
6	Bac Can
7	Thai Nguyen
8	Tuyen Quang
9	Yen Bai
10	Son La
11	Phu Tho
12	**Vinh Phuc → partially merged with Hanoi → The greater Hanoi**
13	**Hanoi → The greater Hanoi**
14	Bac Giang
15	**Bac Ninh → The greater Hanoi**
16	Quang Ninh
17	Hai Phong
18	**Hai Duong → The greater Hanoi**
19	**Hung Yen → The greater Hanoi**
20	**Ha Tay → wholly merged with Hanoi → The greater Hanoi**
21	**Hoa Binh → partially merged with Hanoi → The greater Hanoi**
22	Thai Binh
23	**Ha Nam → The greater Hanoi**
24	Nam Dinh
25	Ninh Binh
26	Thanh Hoa

Figure 1.5.1 Old Ha Noi City and The Greater Hanoi

1.6 Confirmation and Understanding of Environmental and Social Aspects

VIWASEEN is the enterprise that is responsible for preparing the FS report (including the EIA) of this Project and FS preparation is now ongoing. Detail of the EIA will be confirmed after submission of VIWASEEN's EIA.

The outline of the content confirmed with respect to the environmental and the social aspects is described as follows.

1.6.1 Current State of Water Environment

Water supply in Ha Noi City, which is the target area under this project, depends on groundwater sources mainly. However, rapid increase of water demand is expected, and occurrence of land subsidence and groundwater contamination has become a major concern to the Government of Viet Nam. In response to these conditions and to meet the increasing water demand, the Government has designated the utilization of river surface water sources as a basic policy. Also, the government has set forth the policy of utilizing private sector in the field of urban water supply service. In regard to this policy, it is stated that the price hike of water tariff is approved by the government, as for radical price rising, it is concerned that social problems are arising. However, the existing level of water tariff does not result into full cost recovery, therefore problems exist in the management.

Through the implementation of this project, it is expected that the negative impacts of land subsidence and groundwater contamination could be avoided or mitigated. At the same time, the effective use of the abundant water resource will ensure promotion of public welfare. It is expected that the maintenance of social fairness of water tariff could be assured with the application of PPP business scheme and reform of the water supply services through privatization.

1.6.2 Land Subsidence

(1) General Description

According to the report of "Water supply Plan for Hanoi Metropolitan Area", National Institute of Urban and Rural Planning, Ministry of Construction, June 2007, land subsidence rate is reported as 15 - 23 mm/year, the area with maximum land subsidence is located in southern part of Ha Noi City. With alluvial formation, which consists of the sand and the gravel stone, etc., of the Red River bank, the investigation of subsidence is not done. According to the past records, around Thanh Cong area, the ground level subsided by 44.77 mm in year 2000, and by 40.88 mm in year 2003. Around Mai Dich, the subsidence during 1998 to 2003 varied in the range of 1.2 - 4.3mm/year. In addition, the circumstance of land subsidence monitoring is done by measurement. As for past subsidence rate, it was observed as 13 - 18mm/year from the measurement result which is obtained through leveling survey around Tay Lake and the Red River. The distribution chart indicating subsidence is shown in Figure1.6.1.

In some areas of Ha Noi City, it is a well-known fact that land subsidence has become intensified with the excessive pumping of groundwater. It is anticipated that if the groundwater is used at the same pace, the problem of land subsidence will accelerate and also result into the depletion of groundwater to significant level in near future. Water supply services for domestic non-commercial sector and water for industrial use in Ha Noi City still to a greater extent depends on groundwater. It is confirmed that, presently there are over 170,000 of large and small wells, and they are mainly concentrated on the right bank of Red River and in southern part of city. The inhabitants and organizations are digging wells and pumping the groundwater without any plans. In addition, in recent years, there have been rapid advancement in development of the road pavement and concrete, and it has made it difficult for rainwater to infiltrate underground. Furthermore, there are few cases in which the groundwater is polluted by the influx of untreated municipal sewage.

In 2007, "The Comprehensive Urban Development Programme in Hanoi Capital City of the Socialist Republic of Viet Nam" was formulated by JICA. In this programme, to cater to the increased water demand and urbanization, and also, in order to prevent the above-mentioned land subsidence and water pollution of groundwater, it was proposed that the capacity of water treatment plant should be increased and there is a necessity to shift from groundwater to surface water sources.

The results of public awareness survey of the study indicate that satisfaction rating is low for the quality of water supply services which is serving as a foundation for lifelines among various public services. Therefore, it will be required to achieve the target in terms of water demand, water quality and environmental protection through project implementation.

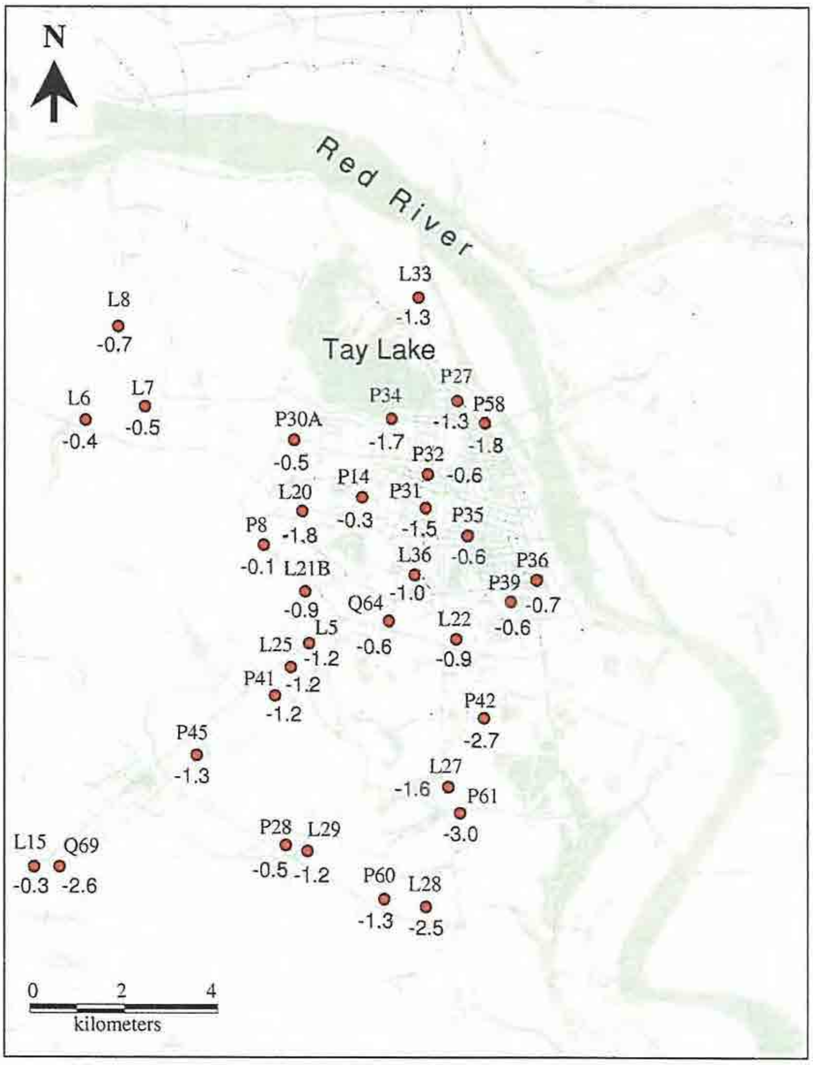


Figure 10. Locations of benchmarks listed in Table 1. Numerals represent annual rates of subsidence revealed by leveling survey in the period 1994-1995.

（Source：Spatial Distribution of Subsidence in Hanoi Detected by Jeres-1 Sar interfero & Metry）

Figure 1.6.1 Situation of Subsidence

1.6.3 Groundwater Contamination

In terms of the groundwater contamination, ammonia and arsenic are problems. As for pollution by ammonia, quantitative data was unavailable. Instead, reference has been made to the report "Arsenic pollution that extends to Asia" published by Asian Arsenic Network (AAN) for information on the arsenic pollution.

(1) Description

Arsenic contamination in Viet Nam was first reported in 2000. It was reported that arsenic had been detected in a limited region around Hanoi in groundwater. Afterwards, UNICEF carried out an investigation related to the arsenic pollution in entire Viet Nam from 2000 to 2002, and published a report in 2004. For the survey, 25 (out of the total 60) prefectures were selected nationwide and water samples were collected from 18,000 wells selected randomly. The result of this survey indicated that in more than 1 % of the wells located in 9 prefectures, the arsenic concentration exceeded 0.05mg/L, in another 1 % wells located in 10 prefectures, the concentration exceeded 0.01mg/L. Of the 9 prefectures with arsenic pollution, 7 are located in the Red River basin.

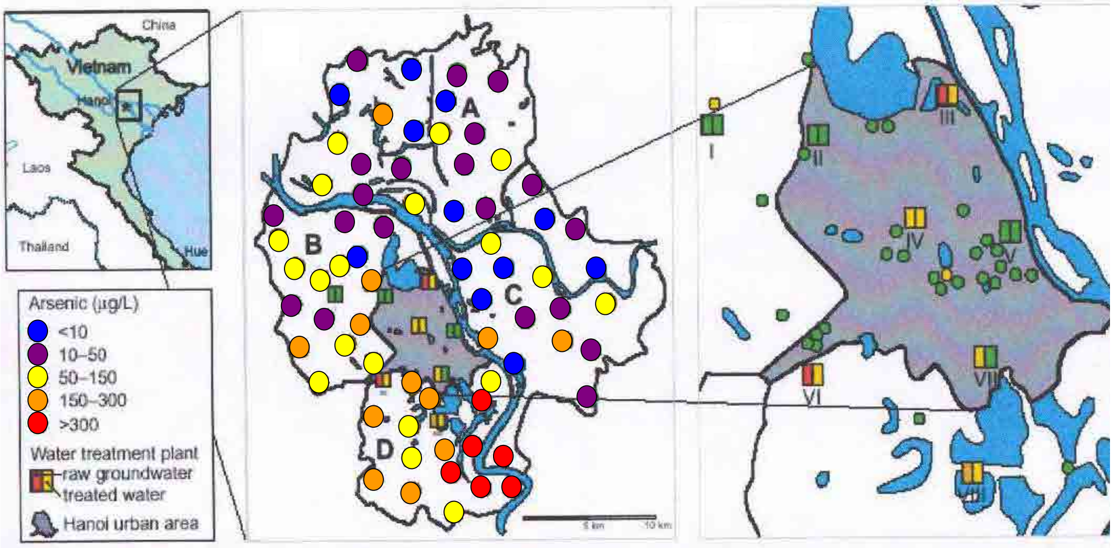
As for the cases of arsenic pollution in entire Viet Nam, neither the concentration nor the areas affected are severe compared to Bangladesh. However, there is a region located in the Ha Nam prefecture in the southern part of Hanoi where the arsenic pollution is intense. The confirmation of diseases caused by arsenic has not been investigated by the government agency yet. However, it is said that there are patients in the Ha Nam prefecture and Mekong region Duong Thap prefecture.

(2) Investigation of Hanoi University

From the reports, it is understood that groundwater contamination in this area is due to presence of ammonia, manganese, iron and arsenic. Regarding arsenic problems in the region, Hanoi University reported as described below.

According to the pollution distribution chart of the Hanoi prefecture (Figure 1.6.2), the concentration tends to be low in the left bank region of Red River, whereas it is higher in the right bank region. It is clear that the arsenic concentration is high in southern part of right bank of Red River.

The decrease in the groundwater level of Ha Noi City is thought to be one of the main factors. The total groundwater use in the Hanoi region is about 550,000 tons/day, composed of 400,000 tons/day from 8 public wells, 120,000 tons/day from the 500 privately-owned wells, and 35,000 tons/day from the suburb well installed by UNICEF. The total groundwater uses in 12 surrounding prefectures is reported as 1.15 million tons/day (Figure 1.6.2).



（Source：Pham Hung Viet and others, 2001）

Figure 1.6.2 Arsenic Pollution Situation in Hanoi

Figure 1.6.2 shows that in the Study Area, the south of Hanoi area is polluted by arsenic. Hanoi Water supply Company is gradually reducing the water supply from the water treatment plants in the south area, where the source of water is polluted. In the future, these treatment plants are expected to be abandoned.

(3) Investigation of UNICEF

UNICEF, since 2001, carried out a nationwide sample survey and published the results as report ("Arsenic Contamination in Vietnam" UNICEF 2004b) in October, 2004. The prefectures with arsenic pollution of 0.01mg/L or more are shown there. The arsenic pollution is concentrated in Red River and the Mekong River according to the pollution map. Table 1.6.1 shows the Red River pollution level based on the UNICEF report.

On the whole, arsenic contamination of well water is low in case of Viet Nam compared to other countries. However, in case of Ha Nam, the pollution level is of the same level as Bangladesh. Fortunately, the use of well water in Ha Nam has been for short duration (less than 10 years), and patients with symptoms causes by arsenic have not been reported yet. However, if immediate countermeasures are not undertaken, serious health hazards may occur.

Table 1.6.1 Arsenic Pollution Situation of Red River Basin

	Sample	0.01mg/L or more		0.05mg/L or more	
		Sample	%	Sample	%
Ha Noi	824	414	49.3	199	23.3
Ha Tay	1,368	638	46.6	338	24.7
Hung Yen	3,384	700	20.7	310	9.2
Ha Nam	7,042	4,517	73.4	3,534	62.1
Nam Dinh	605	156	21.3	104	13.8
Ninh Binh	75	26	34.7	8	10.7
Thanh Hoa	347	17	4.9	17	4.9

(Source: UNICEF 2004b)

(4) Results of Interview with Water Works

In Pre-FS, the survey was conducted by People’s Committee and the Water Works, etc. to investigate about groundwater and surface water pollution. (Table 1.6.2)

It revealed problems concerning the water quality in many regions. In this survey, many residents surrounding the project site reported worries about health hazard and groundwater pollution.

Table 1.6.2 Interview Results for Groundwater Quality

Prefecture	Results
Thong Tin (Then Ha Tay Province)	The groundwater source for WTP is contaminated by arsenic. The level of arsenic in some cases is as high as 50μg/L. River water is also contaminated by arsenic.
Pho Xuyen (Then Ha Tay Province)	Groundwater is contaminated by arsenic and others. Hospitals use contaminated groundwater. River water is also contaminated by arsenic.
Bac Ninh Province	Groundwater and surface water in the south of Duong River is contaminated with agricultural chemicals. In north part, iron and manganese concentration is high in groundwater. The water in Do River and other two rivers is also contaminated. High demand for safe and clean drinking water.

1.6.4 Social Environment

Rapid economic and industrial growth in Greater Hanoi has also resulted into accelerated increase of population in the metropolis. The population of Greater Hanoi has increased to about 6.5 million in 2009.

The water supply system of Ha Noi City has been augmented and upgraded many times in past, also including the projects under the financial assistance of Finland, Japan International Cooperation Agency (JICA), and the World Bank, depending on the needs. Even after implementation of projects for improvement of water supply services in the northern and southern part of Hong River in Hanoi, the urban water supply system is currently unable to meet the increasing demand.

There are no sensitive areas such as national parks, nationally-designated protected areas (coastal areas, wetlands, areas for ethnic minorities or indigenous people, and cultural heritage, etc.): Natural environment such as primary forests in tropical areas, habitats of important ecological values (coral reefs, mangrove wetlands, etc.), habitats of rare species, areas in danger of salt-accumulation or soil erosion, areas with remarkable tendency towards desertification, etc.; and areas with unique archaeological, historical or cultural values, etc., in and around the site of candidate proposed area for facilities to be undertaken in this project.

1.7 Cases of Private Investment Project for Water Supply by Foreign Investor

This section describes several cases of private investment projects for water supply (BOT project) as basic information for developing water supply PPP project in Vietnam.

1.7.1 Case of BOT Projects

The followings are well known BOT projects with foreign investment in Ho Ci Min city (HCMC). These BOT projects initiated because of big gap (water shortage) between demand and supply in 1989 (water supply capacity was 650,000 m^3/d, meanwhile, water demand was 1,250,000 m^3/d.)

(1) Bhin An Water Supply Project
(2) Thu Duc Water Supply Project

(1) Outline of Bhin An Water Supply Project

1) Capacity: 100,000m^3/d,
2) Investment; 38 million US$
3) Enterprise body; Bhin An Water Company (BAWC) Consortium of Malaysian enterprises (Sadec, IJM, Salcon, Malaysian South)
4) Financing; BAWC had originally tried to borrow from Malaysian private bank, but owing to the Asian financial crisis in 1989, the International Finance Corporation (IFC) loaned 25 million US$ (syndication loan;12.5 million US$ of IFC and 12.5 million US$ of private bank).
5) Type of contract; In 1995, BAWC contracted with Ho Ci Min City People's Committee (HCMCPC) and Ho Ci Min Water Supply Company (HCMWSC) for 20 years BOT.
6) Contract for water sale; Take or Pay contract between BAWC and HCMWSC. The contract price was 0.3 US$/$m^3$.

7) Scheme

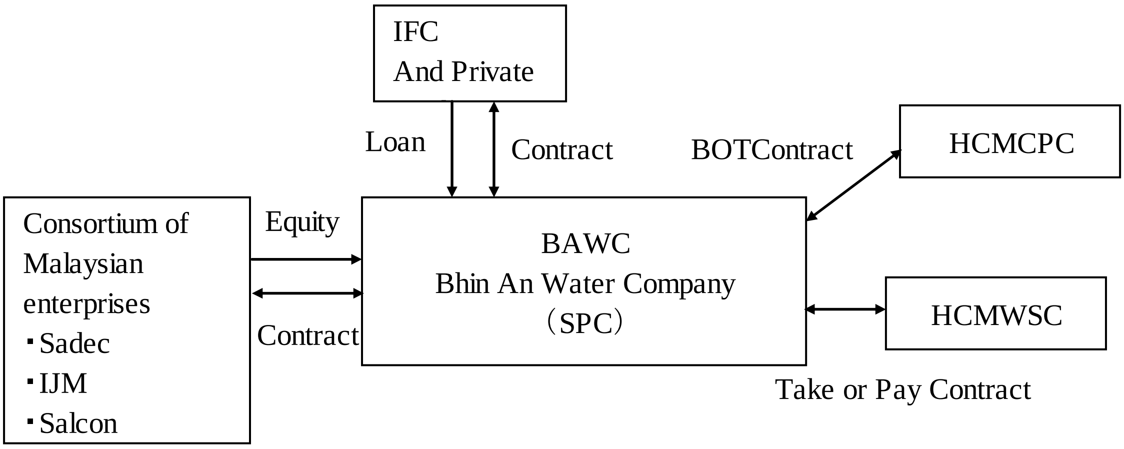


Figure 1.7.1 Bhin An Water Supply Project Scheme

(2) Outline of Thu Duc Water Supply Project

1) Capacity; 300,000m^3/d
2) Investment; 154 million US$
3) Enterprise body; Lyonnaise Vietnam Water Company (LVWC) and Consortium of France.Suez enterprises (Suez Lyonnaise, Pilecon Engineering (Malaysia), Tractebel (Belgium))
4) Financing; Loan was guaranteed in 2001.Total 106 million US$;31 million US$ by ADB (Asia Development Bank) with 15 years tenor and 75 million US$ by syndication loan with Export-Import Bank of Malaysia and private banks (Fortis Bank, ANZ Banking Group, Credit Lyonnais).
5) Type of contract; 25 years BOT contract of LVWC with HCMCPC and HCMWSC in Dec. 2000.
6) Contract for water sale; Take Or Pay Contract between LVWC and HCMWSC (off taker)

7) Scheme

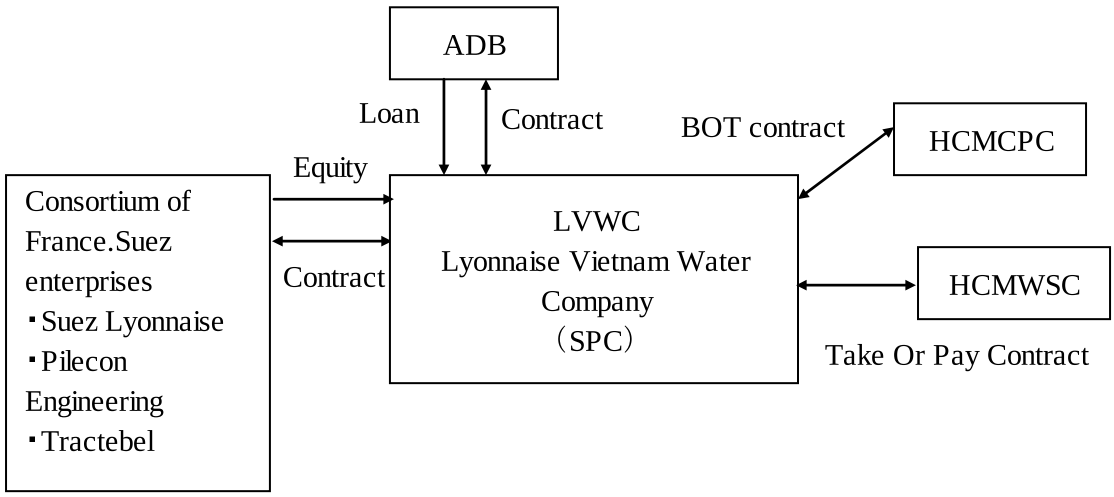


Figure 1.7.2 Thu Duc Water Supply Project Scheme

1.7.2 Progress of Both Projects

In case of Bhin An Water Supply Project, operation of the water treatment plant was started before the new distribution system (existing water leakage rate:38%) completed, which was fully responsible for HCMCPC and HCMWSC. In the result, HCMWSC had to buy the water that could not sell to the consumer and pay 8 billion VND per month instead of 3 billion VND per month (actual income) because of Take Or Pay contract.

As the result, HCMCPC had to consider raiseing the water tariff from 1,300VND/m^3 in 2000 to 9,400VND/m^3 in 2004 when Thu Duc water treatment plant would start operating.
In Binh An Project, the selling price of BAWC to HCMWSC became 3,000VND/m^3. On the other hand in Thu Duc Project, the selling price of LVWC to HCMWSC was 6,000VND/m^3.

In the end of 2002, the gape of the selling price between both projects was pointed out in the People's Committee and LVWC was required to decrease the selling price.

In April 2004, LVWC announced withdraw from the Thu Duc Project before constructing the plant. Immediately after that, HCMCPC prohibited furthermore foreign investment to a water supply project by BOT contract. In August 2004, HCMCPC and HCMWSC made a compensation for 4 million US$ and took over the Thu Duc Project. Thu Duc Water supply project have been implemented with BOO contract by domestic investor.

2. Water Quality Analysis

2.1 Purposes

Water Quality of Duong River was analyzed to determine its characteristics for process designing, especially sedimentation basin and chlorination methods. The followings survey was carried out in dry season and rainy season (April to August, 2011).

2.1.1 Water Resource Survey

The proposed Water Treatment Plant (Duong River WTP) utilizes Duong River water as water source. Duong River is tributary of Hong River, which has some tributaries, as shown in Figure 2.4.1. Some upstream tributaries of Hong River and dams are surveyed.

2.1.2 Duong River Water Quality Analysis

To analyze the characteristics of raw water quality (Duong River) is extremely important for accurate designing of the process and chemical dosing, etc. Especially, water characteristics, mainly turbidity, in the rainy season (May to October) and dry season (November to April) are important factors for the design of Water Treatment Plant.

2.1.3 Water Quality Analysis

Since the turbidity is expected to be high (past 10 years average is about 300 mg/L as SS and this value will largely influence on the construction cost for a planned water treatment plant), so coagulation and sedimentation & rapid sand filtration system is necessary. To determine the appropriate process, Jar-Test was carried out about 180 times to select coagulant type, appropriate dosing rate, and mixing condition of the coagulant. Also, chlorination is necessary to supply safe water, thus chlorine consumption demand are tested.

2.2 Survey Contents

2.2.1 Water Resource Survey

Dams and some rivers in upstream were visited and water quality was examined.

2.2.2 Duong River Water Quality Analysis

The followings show the contents of the analysis.

(1) Study on Water Quality of Duong River

Research Name	Item of Examination	Examination Method	Purpose of the Research
Daily examination of raw water	General items (pH, turbidity etc.) and particle size of raw water etc.	Daily sampling and examination of Duong River water	To collect data on Duong River water quality in rainy and dry season
24hours continuous sampling survey	General items (pH, turbidity etc.)	24 hours continuous sampling and examination of Duong River water	To collect data on hourly variation of Duong River water quality and grasp the influence of pollutant by human activity in upstream area
Consignment examination of raw water and treated water	Drinking water quality standard items pesticides, water treatment evaluation items	Consignment examination of Duong River water by Japanese examination laboratory	To collect data on micro pollutants of Duong River water, and water quality items influencing water treatment efficiency

(2) Water Treatment Process Evaluation Items

Item	Reason for Selecting the Parameter
Soluble manganese	Expected to make supplied water black in color in distribution pipe due to reaction of soluble manganese with free chlorine in water
Soluble aluminum	To collect data on the concentration of soluble aluminum in using aluminum salt as coagulant
Ammonia-nitrogen	Expected to consume free chlorine as disinfectant in water upon reacting with ammonia-nitrogen
Trihalomethane formation potential	To collect data on the concentration of trihalomethane produced by reaction of free chlorine with organics available in Duong River water

2.2.3 Raw Water Characteristics Analysis

(1) Coagulants used in the research

Coagulant Name	Reason for Selection
Polyaluminum chloride (PAC)	Widely used in Viet Nam, suitable to reduce high turbidity of raw water
Aluminum sulfate (Alum)	Widely used in Japan, plenty of research on water treatment condition
Polysilica-iron (PSI)	A kind of inorganic polymeric coagulant newly developed in Japan, having high ability of coagulation and sedimentation.

2) Contents of the research on water treatment

Research name	Content	Purpose
Jar-test	Observation of coagulation, flocculation, sedimentation, process and examination of supernatants after Jar-test	To collect data on most available kind of coagulant, dosing rate of coagulant, pH at coagulation and so on for Duong River water
Chlorine demand test	Measurement of residual free chlorine existing in sample water at elapsed time after adding free chlorine to Duong River water	To collect data on appropriate dosing rate of free chlorine for Duong River water after chlorine demand test

2.3 Survey Schedule

(1) Dry Season

1st Survey: April 12 to April 24, 2011

2nd Survey: May 22 to June 4, 2011

(2) Rainy Season

3rd Survey: June 26 to July 9, 2011

4th Survey: August 7 to August 20, 2011

2.4 Results of the Analysis

2.4.1 Water Resource Survey

(1) Situation

Figure 2.4.1 to 2.4.3 show the result of the survey. Hong River, begins in China's Yunnan province, is about 1,200 km long, and enters Viet Nam at Lao Cai Province. Then, Hong River (Thao River named before joint) joints (about 250km downstream from Lao Cai point) Da River (downstream of Hoa Bin Dam) around Co Do City, which is about 40 km in North-South from Ha Noi City and joints Lo River (downstream of Tac Ba Dam) around Viet Tri City. The length of Hong River in Viet Nam is about 500 km.

(2) Analyzed Data

The results are shown in Table 2.4.1 to 2.4.3.

Turbidity and potassium permanganate ($KMnO_4$) consumption value of Tac Ba Dam water are low, however electric conductivity is relatively high. Lo River water at Viettri Bridge, downstream of Tac Ba Dam, has higher turbidity than that of Tac Ba Dam, however, $KMnO_4$consumption value is not increased, thus it could be concluded that Lo River water is less chance of pollution by human factors.

On the other hand, water quality of Hoa Bin Dam is close to that of Tac Ba Dam. Water quality of Da River (downstream of Hoa Bin Dam) at effluent of Hoa Bin Dam is almost same quality as the junction with Hong River. Therefore, Da River is also less chance of pollution by human factors ($KMnO_4$consumption value and turbidity are low).

The turbidity of Hong River (Thao River) before joining Da River and Lo River is about 150, which is relatively higher than that of Da River or Lo River. However, the turbidity of Hong River after joining two rivers is about one forth of that before joining. Duong River water, which is tributary of Hong River, has same characteristics of Hong River after joining two rivers. Thus, pollution by human factors for Duong River is also less chance, which can be seen in the above, namely Da River and Lo River water quality.

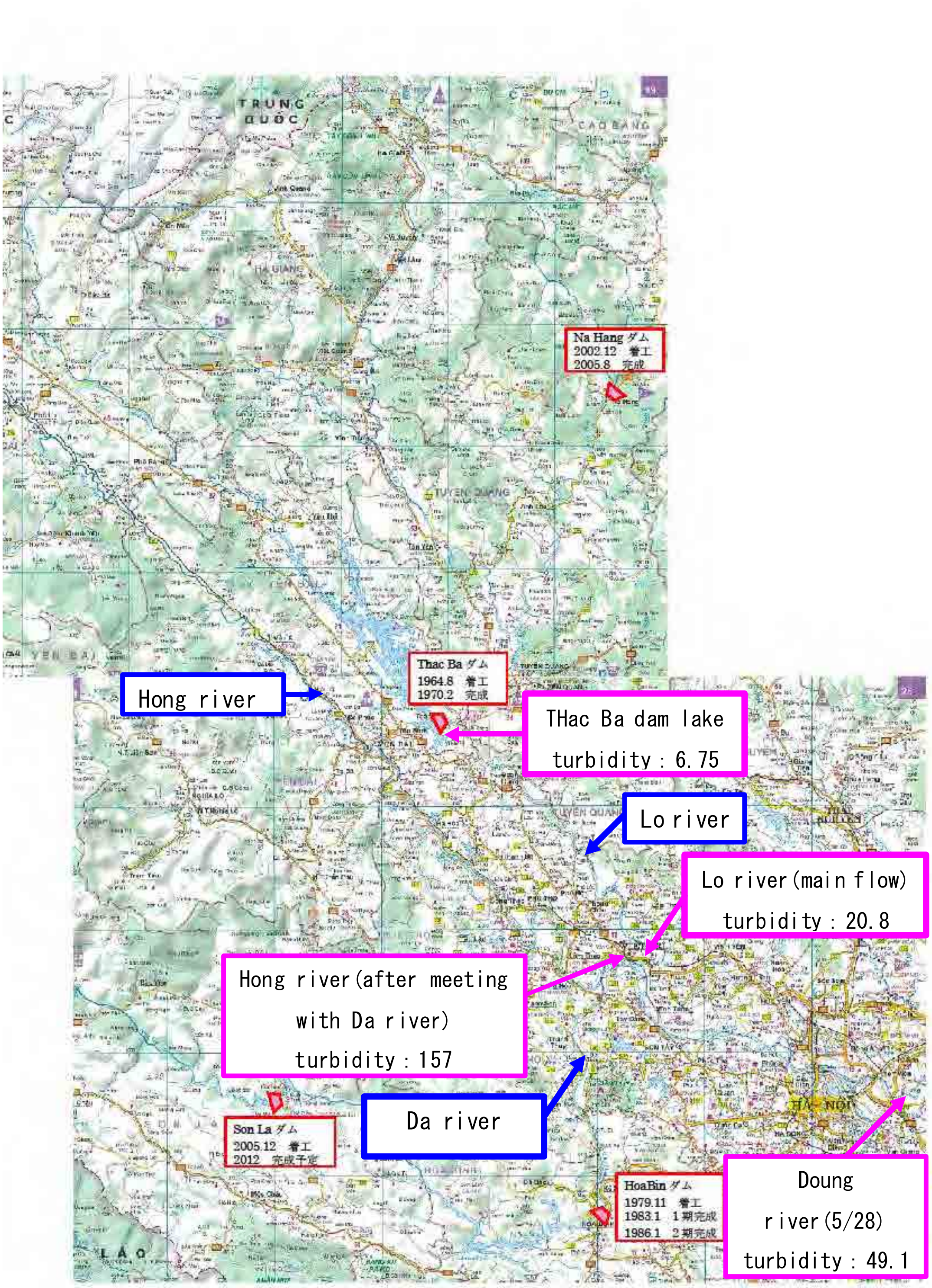


Figure 2.4.1 Location of Water Resource Survey on May 27

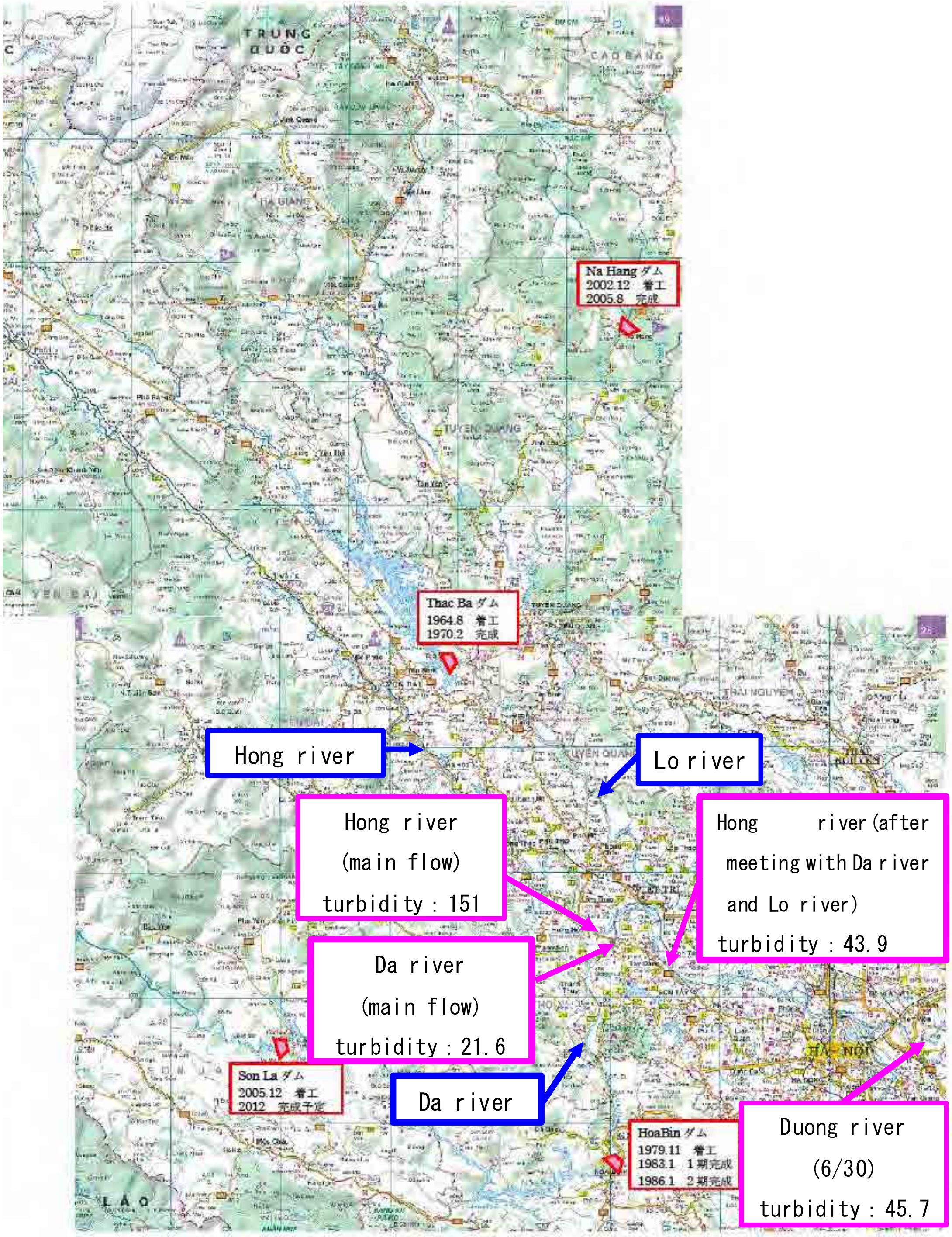


Figure 2.4.2 Location of Water Resource Survey on June 29

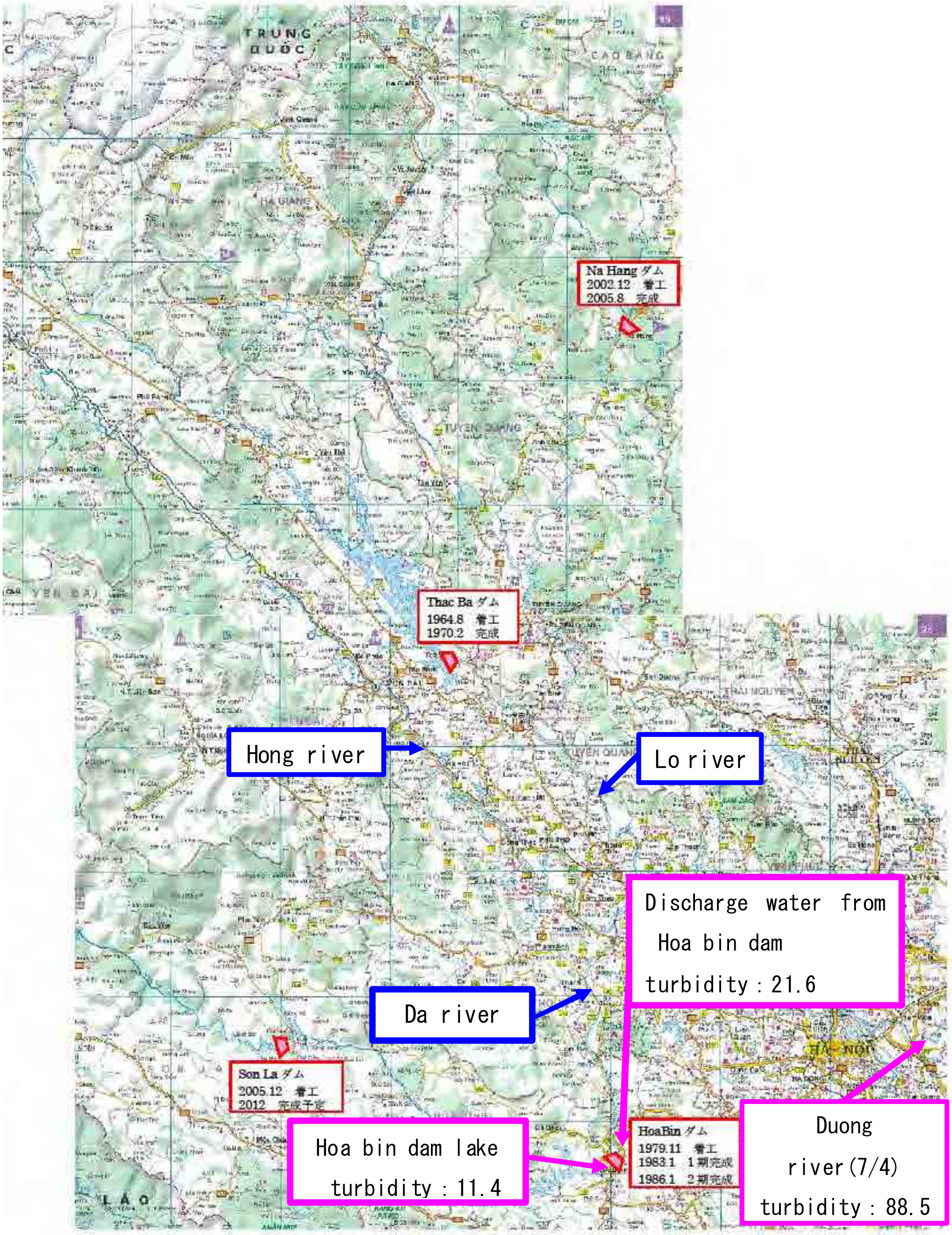


Figure 2.4.3 Location of Water Resource Survey on July 4

Table2.4.1 Result of the Water Resource Survey

(Date: 2011/05/27)

Sampling location	Turbidity (degree)	pH	Electrical Conductivity (µS/cm)	$KMnO_4$ Consumption Value (mg/L)
Thac Ba Dam Lake	6.75	8.43	188	5.1
Lo River （main flow）	20.8	7.96	204	4.3
Hong River (after meeting with Da River)	157	7.86	165	16.9
Duong River (5/28)	49.1	8.00	192	8.6

Table 2.4.2 Result of the Water Resource Survey

(Date: 2011/06/29)

Sampling location	Turbidity (degree)	pH	Electrical Conductivity (µS/cm)	$KMnO_4$ Consumption Value (mg/L)
Hong River (main flow)	151	8.03	136	21.2
Da River （main flow）	21.6	7.92	184	4.1
Hong River (after meeting with Da River and Lo River)	43.9	7.97	177	8.8
Duong River (6/30)	45.9	8.01	175	7.4

Table 2.4.3 Result of the Water Resource Survey

(Date: 2011/07/04)

Sampling location	Turbidity (degree)	pH	Electrical Conductivity (µS/cm)	$KMnO_4$ Consumption Value (mg/L)
Hoa bin Dam Lake	11.4	8.45	178	5.3
Discharge water from Hoa bin Dam	21.6	7.82	188	5.0
Duong River (7/4)	88.5	7.92	181	14.1

(3) Overall Observations

The water quality of Doung River and Hong River after joining two rivers (Da River and Lo River), which are downstream of Hoa Bin and Tac Ban Dams, is influenced by the water quality of Hong River (Thao River), Da River and Lo River. Especially, turbidity of Duong River is strongly influenced by Hong River (Thao River) at rainy season.

2.4.2 Duong River Water Quality

(1) Sampling Point

Proposed Intake point of Duong River WTP Site.

(2) Survey Period

Survey	Period	Daily Sampling	24 hours Continuous Sampling	Sampling Day for Consignment Examination in Japan
First Survey	April 14(Thr) - April 22(Fri), 2011	Every day, except April 17 (Sun)	April 19 at 10:30 am-April 20 at 10:30 am Every one hour Sampling	March 30 (Wed) Apri 22 (Fri)
Second Survey	May 23 (Mon) - June 3 (Fri), 2011	Every day, except May 27 (Fri) and May 29 (Sun)	May 31 at 10am-June 1 at 10am Every one hour sampling	June 3 (Fri)
Third Survey	June 27 (Mon) - July 8 (Fri), 2011	Every day, except June 29 (Wed) and July 3 (Sun)	Not carried out, because enough data was obtained before.	July 8 (Fri)
Forth survey	August 8 (Mon) - August 19 (Fri), 2011	Everyday	Not carried out, because enough data was obtained before.	August 19 (Fri)

(3) Water Quality Evaluation Items

Survey	Examination item
Daily Sampling	Water temperature, ambient temperature, turbidity, color, pH, electric conductivity, potassium permanganate($KMnO_4$) consumption value, bacterial number, E.coliform, suspended solid(SS)
24 hours Continuous Sampling	Water temperature, ambient temperature, turbidity, color, pH, electric conductivity, potassium permanganate($KMnO_4$) consumption value
Consignment Examination in Japan	Drinking water quality standard items in Japan (28 items), agricultural chemicals (3 items), water treatment target items(14 items)

(4) Results of Daily Sampling in Survey Period

1) Water Temperature and Ambient Temperature

Water Temperature at First Survey was steady at 23C, 24 to 27C at Second Survey, 28C at Third Survey, 29C at Forth Survey (Figure 2.4.4). There was almost no rain fall at First Survey. There was a small rain fall on May 23 during Second Survey. During Third Survey and Forth Survey, there were rain fall in the daytime and/or at the night, thus ambient temperature varied from 26 to 39C.

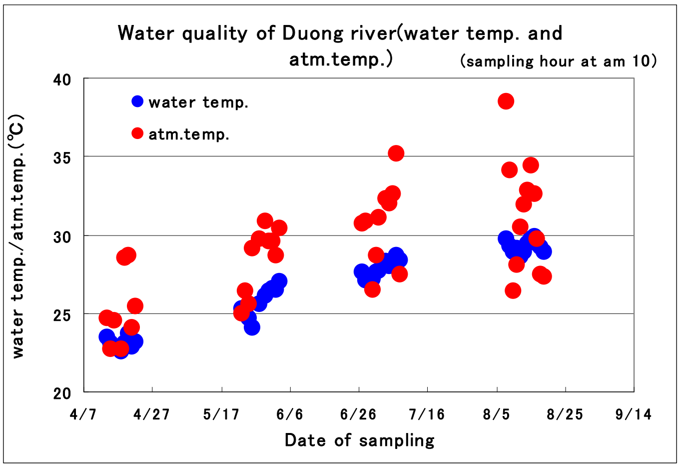


Figure 2.4.4 Water Temperature and Ambient Temperature of Duong River Water

2) Turbidity and pH

The pH value was very steady 7.8 to 8.1 during all Survey periods.

Turbidity results are shown in Figure 2.4.5, gradually increasing; 21 to 30 degree in First survey, 20 to 50 degree in Second Survey, 42 to 141 degree in Third Survey and 32 to 87 degree in Forth Survey. Also, large fluctuation was observed in Third Survey and Forth Survey. Relatively high turbidity in Third Survey and Forth Survey is due to rain fall in upstream area, however the rain fall magnitude, place and time are not known. In future, information of rain falls in the Hong River Basin and turbidity is to be examined.

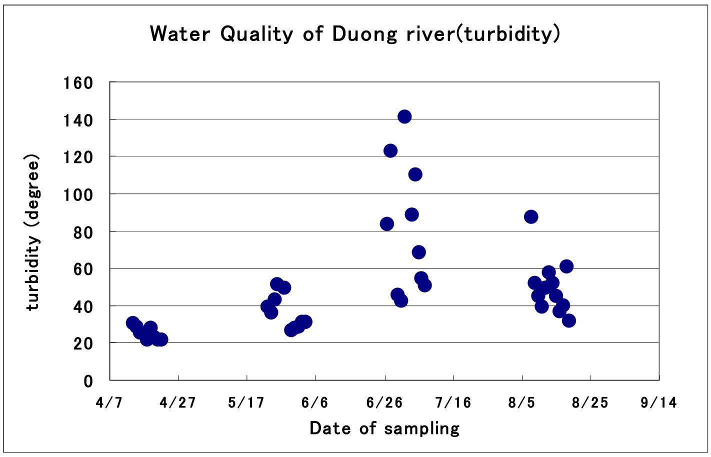


Figure 2.4.5 Turbidity of Duong River Water

3) Electrical Conductivity

Summary of Electrical Conductivity results are as follows;

First Survey : 199 - 209μS/cm

Second Survey : 192 - 202μS/cm

Third Survey : 174 - 198μS/cm

Forth Survey : 165 - 177μS/cm

When it is rainless, the electric conductivity is around 200μS/cm, When the rain comes, it is about 170μS/cm (less than 200μS/cm), which may be influenced by Hong River water quality, because electric conductivity of Hong River is lower than that of Duong River.

4) KMnO4 Consumption Value (mg/L): Potassium Permanganate Consumption Value

KMnO4 consumption value is an index for organic matter in the water, this value is important as same as turbidity, which is an index for inorganic matters. $KMnO_4$ consumption value is measured from Second Survey.

The results are as the follows (Figure 2.4.6);

Second Survey : 4.3mg/L - 8.6mg/L
Third Survey : 6.4mg/L - 12.7mg/L
Forth Survey : 5.6mg/L - 8.3mg/L

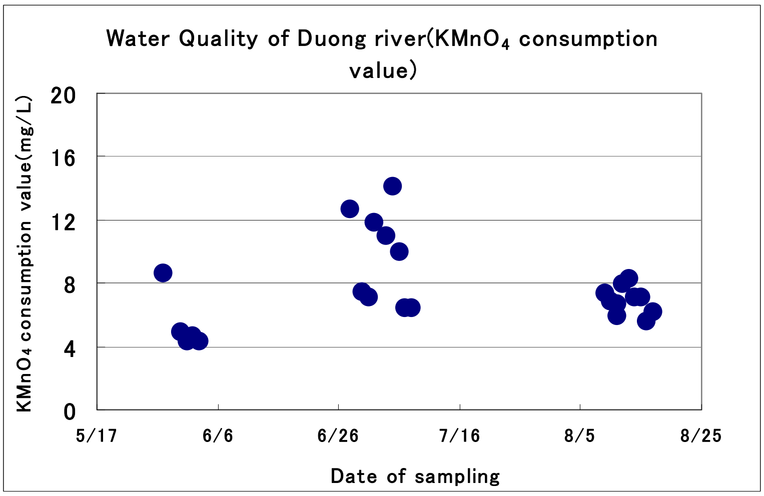


Figure 2.4.6 $KMnO_4$ Consumption Value of Duong River Water

Figure 2.4.7 shows correlation between $KMnO_4$ consumption value and turbidity. It was observed relatively high correlation (R2 value is 0.8395). Thus, it is quite reasonable to judge that most of KMnO4 consumption value comes from turbidity.

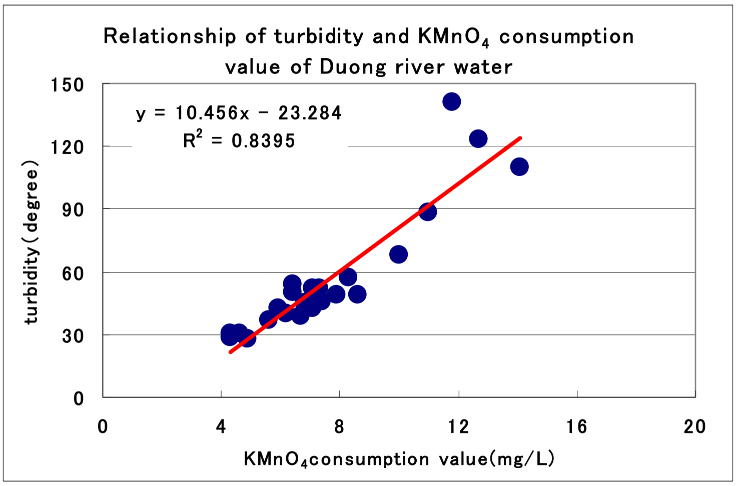


Figure 2.4.7 Relationship of Turbidity and $KMnO_4$ Consumption Value of Duong River Water

5) Suspended Solid（SS）

In Vietnamese Water Quality Standard for Surface Water (QCVN08:2008/BTNMT), SS is one of Indexes not turbidity (degree). Therefore, Study Team examined relationship between SS and turbidity (degree), which is shown in Figure 2.4.8. It can be seen that correlation is strong and SS is about 1.8 times of turbidity (degree).

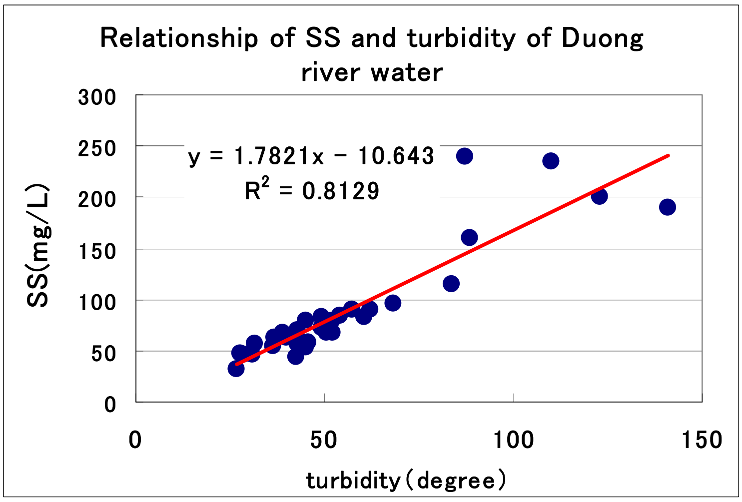


Figure 2.4.8 Relationship of Turbidity and SS (Suspended Solid) of Duong River Water

6) Comment on Daily Sampling

In the Dry Season (April, May results);

Turbidity: around 20 - 30, maximum 50 degree

$KMnO_4$ Consumption Value: around 4 mg/L organic matter is low.

pH value around 8 weak-alkaline

In the Rainy Season (June, July, August results);

Turbidity: minimum 32, maximum 141 degree (fluctuated)

$KMnO_4$ Consumption Value: around 8 mg/L (come from high turbidity)

pH: around 8 weak-alkaline (same as the Dry season)

Continuous survey for SS and turbidity, especially rainy season, is essential for accurate steady treatment process decision.

(5) 24 hours Continuous Sampling

1) Water Temperature and Ambient Temperature

Water temperature at First Survey was steady at 23C, 26C at Second Survey. Ambient temperature changed at night and daytime.

2) Turbidity and pH

The level of pH was observed to be very steady around 8 during all Survey periods.

Turbidity results for samples collected during Second Survey are shown in Figure 2.4.9. Turbidity is observed to gradually increase from 21 to 30 degree, at the same time increase in water level of Duong River is also observed.

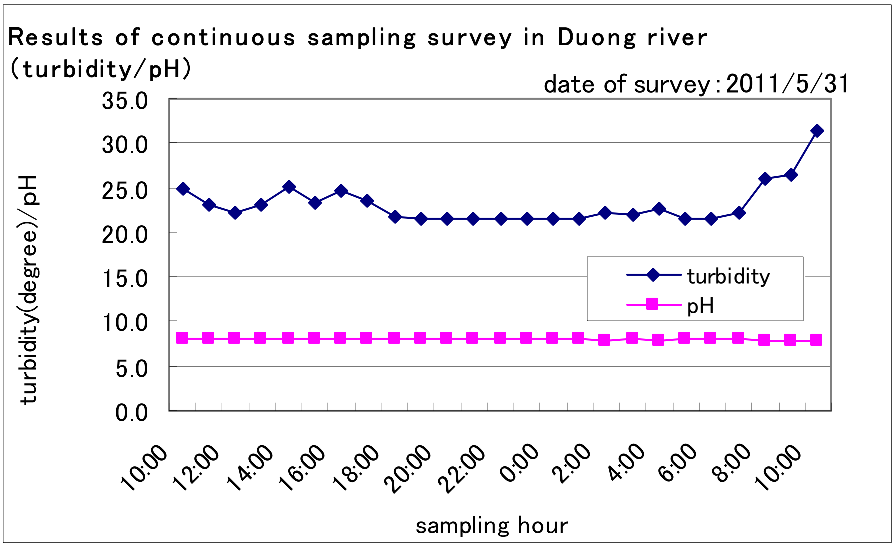


Figure 2.4.9 Turbidity and pH of Duong River Water in Case of Continuous Sampling Survey, Based on the Second Survey

3) Electrical Conductivity

Electrical Conductivity was observed to be very steady around 200µS/cm.

4) Potassium Permanganate ($KMnO_4$) Consumption Value (mg/L):

$KMnO_4$Consumption value is about 3−5 mg/L (Figure 2.4.10). $KMnO_4$Consumption value has correlation with turbidity, but not with electric conductivity.

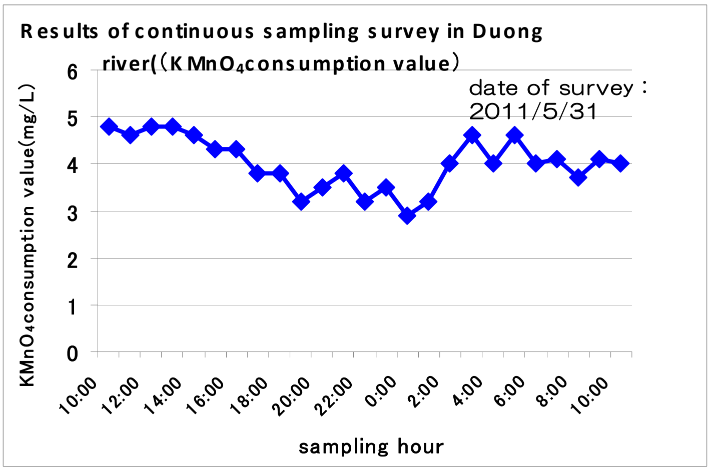


Figure 2.4.10 KMnO4 Consumption Value of Duong River Water in case of Continuous Sampling Survey, Based on the Second Survey

5) Comments on 24 hours Continuous Sampling

24 hours Continuous Sampling is carried out to collect data on daily variation of Duong River water quality and figure out the influence of pollutant by human activities at upper area. Also it was done in dry season. If there are any influences such as wastewater or industrial wastewater, electric conductivity changes in time. However, electric conductivity was steady in 24 hours. Therefore with these results, there is less chance of pollution by human factor in upstream.

(6) Consignment Examination in Japan

Sampling days for consignment examination in Japan are, March 30, April 22, June 3, July 8, and August 19 in 2011. The results are summarized below.

1) Water Quality Standard Items

Table 2.4.4 shows the results (water quality indices), which were observed to be higher than the Japanese Standards.

Table 2.4.4 Detected Item Having Level Over Japanese Standard Value

Item	Water treatment method
Bacterial number, E.Coliform	By chlorination to be reduced below standard value
Lead, aluminum, iron, manganese, turbidity, color	By coagulo-sedimentaion and sand filtration to be reduced below standard value due to the insoluble character

Comparison with Japanese Standards

Index	Japanese Standards	Results
Bacterial number	Below 100 count /ml	5400 - 190000
E. Coliform	Not detected	Detected
Lead	Below 0.01mg/L	0.003mg/L - 0.011mg/L
Aluminum	Below 0.2mg/L	0.20mg/L - 1.2mg/L
Iron	Below 0.3mg/L	0.41mg/L - 2.0mg/L
Manganese	Below 0.05mg/L	0.029mg/L - 0.12mg/L
Color	Below 5 degree	18 - 61 degree
Turbidity	Below 2 degree	16 - 59 degree

Table 2.4.5 Detected Items Having Level in Below Standard and Higher than One-tenth of Japanese Standard Value

Item	Water treatment method
Arsenic	By coagulo-sedimentaion and sand filtration to be reduced below standard value due to the insoluble character
Fluoride	The value is one-eight of the standard. It is not necessary to introduce special treatment
Total hardness, Total solid	The value is one-third of the standard. It is not necessary to introduce softening treatment
Organic matter（TOC）	The value is one-third of the standard and same level as that of Japanese drinking water treated with GAC-ozone. It is not necessary to introduce special treatment using powdered carbon and ozone.
pH value	The value is within the standard and shows a little bit alkalinity of pH8. It is not necessary to introduce pH adjusting chemical feed facility.

Table 2.4.6 Detected Items Having Level Less than One-tenth of Japanese Standard Value

Item	Character
Sodium, chloride, nitrate	Very low concentration than Japanese rivers and very low pollutant of discharge from factory and household
Metals(6 items), inorganic matters(2 items), organic matters(3 items)	The value is below one-tenth of the standard.

2) Agricultural Chemicals

Paraquat, Glyphosate-isopropyl ammonium and water soluble zinc are measured on March 30 and June 3. All values were less than detection limit value.

3) Water Treatment Target Items

The results are shown in the Table.

Table 2.4.7 Examination Results of Water Treatment Target Item

Item	Result	Water Treatment Method
Soluble manganese	<0.005mg/L (detection limt)	No need to reduce furthermore
Soluble aluminum	0.06mg/L	By coagulo-sedimentaion and sand filtration to be reduced furthermore
Ammonia-nitrogen (NH_3-N)	<0.03mg/L ~ 0.07mg/L	NH_3-N at the concentration is very easily decomposed by a little bit of free chlorine
Trihalomethane formation potential	0.016mg/L ~0.022mg/L	The value is one-fifth of the Japanese standard. It is not necessary to introduce special water treatment with powdered activated carbon

4) Comments on Consignment Examination in Japan

The items that are detected to have level over Japanese standards are possible to treat with proper treatment process, which are not so big issue. The other items are observed to be at low levels and not a problem.

Same examinations are needed to be carried out for samples collected in rainy season.

(7) Settling Characteristics

1) Particle Size Distribution

To analyze particle size distribution of the raw water, three (3) different filter papers are used, namely, pore size 2.7µm (GF/D), pore size 1µm (GF/B), and pore size 0.45µm.

Table 2.4.8 shows particle size distribution of April and May results. Table 2.4.9 is the results of June to August.

Table 2.4.8 Distribution of Particle Size of Duong River Water（April and May）

	turbidity (degree)	distribution of particle size(%)		
		>1 μm	0.45～1 μm	<0.45 μm
range	21.6～51.3	61.3～94.2	4.2～37.0	0.6～1.6
average	34.3	82.1	16.8	1.1

resluts of April and May（sample number is 9）

Table 2.4.9 Distribution of Particle Size of Duong River Water（June to August）

	turbidity (degree)	distribution of particle size(%)			
		>2.7 μm	1～2.7 μm	0.45～1 μm	<0.45 μm
range	31.7～141	40.7～75.6	2.3～43.1	2.7～35.4	0.0～1.4
average	62.8	58.4	20.0	21.1	0.5

results of June to August （sample number is 24）

It is very interesting to note that relatively large particles more than 1μm are about 80% in many cases and the water with higher turbidity has higher percentage of more than 1μm particles. Therefore, it is envisaged that particles in the raw water has high settling (sedimentation) characteristics, which is favorable considering the viewpoint of treatment. However, relationship between settling time and turbidity has to be checked.

2) Settling Time and Turbidity

Settling time and turbidities are measured using 1L of each sampling Raw Water. The results are shown in Figure 2.4.11. The settling is quite fast in one hour, then settling speed become moderate and the turbidity after 24 hours are almost same (around 20 degree) in any sample, which is also an interesting point, because no matter what initial turbidity (40 to 87 degree) is, the turbidity after 24 hours is around 20 degree.

Table 2.4.10 shows the decreasing rate of turbidity by settling. In 12 hours, the decreasing rate was almost 50%.

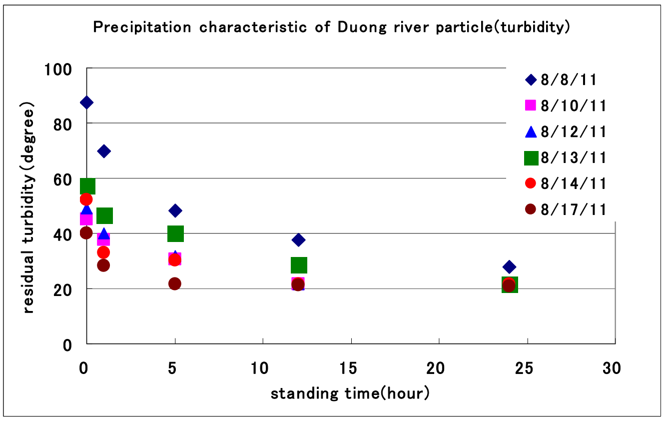


Figure 2.4.11 Settling Characteristic of Duong River Particle (Turbidity index)

Table 2.4.10 Decreasing Rate of Turbidity by Settling

	turbidity (degree)	settling time (hour)				
		0	1	5	12	24
range	39.9～87.3	0	16.2～36.7	30.0～45.9	46.9～56.9	47.9～68.0
average	55.1	0.0	23.2	38.4	53.3	57.5

results of Aug.8 to Aug.17 (sample number is 6)

value in the table shows decreasing rate(%) of turbidity on each settling time toward turbidity on 0 hour

3) Settling time and Suspended Solid (SS)

The results are shown in Figure 2.4.12.The settling in SS index was very fast as same as that of turbidity. In 12 hours the decreasing rate of SS was about 80% more than that of turbidity Table 2.4.11.

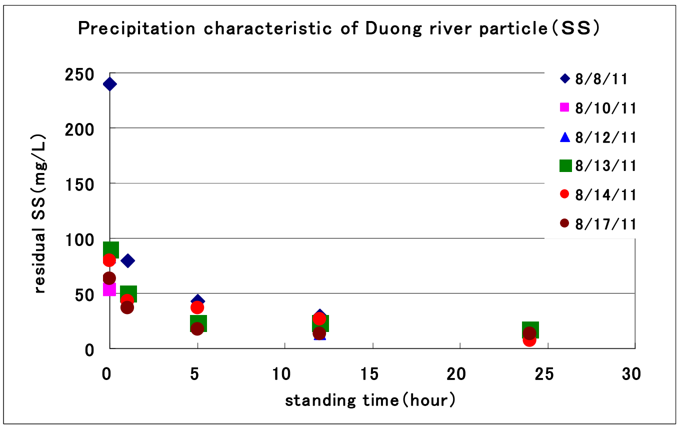


Figure 2.4.12 Settling Characteristic of Duong River Particle (SS Index)

Table 2.4.11 Decreasing Rate of Turbidity by Settling

	SS (mg/L)	settling time (hour)				
		0	1	5	12	24
range	53～240	0	11.3～66.7	53.8～82.1	62.3～87.5	67.9～92.9
average	102	0.0	41.6	68.7	75.7	82.8

results of Aug.8 to Aug.17 （sample number is 6）

value in the table shows decreasing rate(%) of turbidity on each settling time toward turbidity on 0 hour

4) Comments on Settling Characteristics

The particle more than 1μm is about 80%, and the higher turbidity is , that ratio (more that 1μm)is higher. No matter what initial turbidity is (40 to 123 degree), the turbidity becomes 20−40 degree after 24 hours. Therefore, grid chamber (sand settling basin) is very effective and relatively large size particle is expected to be removed within few hours. Detention time of sand settling basin can be guess at this stage. The particle sizes which enter into sedimentation basin are expected to be very small and light, therefore inclined plate or tube settler are recommended for effective settling in sedimentation basin. According to the results of Jar Test so far, the flocs in the sedimentation basin after sand settling basin are expected to be small and light, thus inclined plate or tube settler are also recommended.

2.4.3 Water Treatment Process Evaluation

(1) Jar Test

1) Coagulant Types

The following table shows coagulants (11 types), which were examined during survey.

According to the results of Jar-Tests, the flocs in the sedimentation basin are expected to be small and light, thus inclined plate clarifier or tube settler is also recommended.

Table 2.4.12 Kind of Coagulants Used in this Research and its Preparing Method of Dosing Solution

	chemical name	produced	product		dosing solution	
			state of product	content of Al_2O_3(%)	sol. conc. (%)	preparing method of a solution
PAC-2	polyaluminum chloride	Vietnam	powder	29	1	1g of product is disolved in H_2O up to 100ml. Prepare at using time.
PAC-4	polyaluminum chloride	Vietnam	liquid	17	2	2g of product is disolved in H_2O up to 100ml. Prepare at using time.
PAC-3	polyaluminum chloride	China	powder	31	1	1g of product is disolved in H_2O up to 100ml. Prepare at using time.
PAC-1	polyaluminum chloride	China	powder	31	1	1g of product is disolved in H_2O up to 100ml. Prepare at using time.
PAC-5	polyaluminum chloride	China	powder		1	1g of product is disolved in H_2O up to 100ml. Prepare at using time.
PACN-95	polyaluminum chloride	Vietnam	powder	28	1	1g of product is disolved in H_2O up to 100ml. Prepare at using time.
PAC-Ti	polyaluminum chloride	Japan	liquid	10	3	3g of product is disolved in H_2O up to 100ml. Prepare at using time.
PSI-025	polysilica iron	Japan	liquid	1%(as Fe)	0.2	0.2g of product is disolved in H_2O up to 100ml. Prepare at using time.
PSI-100	polysilica iron	Japan	liquid	1%(as Fe)	0.2	0.2g of product is disolved in H_2O up to 100ml. Prepare at using time.
Alum－2	aluminum sulfate	China	powder	17	2	2g of product is disolved in H_2O up to 100ml. Prepare at using time.
Alum－1	aluminum sulfate	Japan	liquid	8	4	4g of product is disolved in H_2O up to 100ml. Prepare at using time.

2) PAC (Polyaluminum Chloride)

Table 2.4.13 and Table 2.4.14 show coagulation characteristics in case of different PAC.

Table 2.4.13 Jar-Test Results of Polyaluminum Chloride (PAC) in Dry Season

(Turbidity of raw water：20 - 40degree)

Coagulant name	Result
PAC-1	Most appropriate dosing rate of PAC-1 was 15mg/L. 30mg/L of PAC-1 at excess dosing did not influence the growth and precipitation of floc. pH value at the most appropriate dosing rate of PAC-1 was 7.86.

PAC-2	Most appropriate dosing rate of PAC-2 was 15mg/L. 30mg/L of PAC-2 at excess dosing did not influence the growth and precipitation of floc. pH value at the most appropriate dosing rate of PAC-2 was 7.45.
PAC-3	Most appropriate dosing rate of PAC-3 was 10-15mg/L. 30mg/L of PAC-3 at excess dosing did not influence the growth and precipitation of floc. pH value at the most appropriate dosing rate of PAC-3 was 7.7-7.8.
PAC-4	Most appropriate dosing rate of PAC-4 was 30mg/L（15mg/L of powdered PAC）. 60mg/L（30mg/L of powdered PAC）of PAC-4 at excess dosing did not influence the growth and precipitation of floc. pH value at the most appropriate dosing rate of PAC-4 was 7.3. Decrease in pH value owing to addition of PAC-4 was larger than that of other PACs.
PAC-5	Most appropriate dosing rate of PAC-5 was 15mg/L. 30mg/L of PAC-5 at excess dosing did not influence the growth and precipitation of floc. PAC-5 was judged to be the best coagulant among PACs used in the research. pH value at the most appropriate dosing rate of PAC-5 was 7.86 and the highest among the cases of PACs used.
PAC-Ti	Most appreciate dose rate of PAC-Ti was 45mg/L.90mg/L of PAC-Ti at excess dosing did not influence on growth and precipitation of floc. pH value at most appreciate dose rate of PAC-Ti was 7.5.

Table 2.4.14 Jar-Test Results of Polyaluminum Chloride (PAC) in Dry Season

(Turbidity of raw water：20 - 40degree)

Coagulant name	Result
PAC-3	Most appreciate dose rate of PAC-3 was 10-15mg/L.pH value at most appreciate dose rate of PAC-3 was 7.8-7.9.At excess dosing, turbidity became a little higher than at most appreciate dose rate.
PAC-4	Most appreciate dose rate of PAC-4 was 30mg/L（15mg/L of powdered PAC）.60mg/L（30mg/L of powdered PAC）of PAC-4 at excess dosing did not influence on growth and precipitation of floc. pH value at most appreciate dose rate of PAC-4 was 7.5.
PACN-95	Most appreciate dose rate of PACN-95 was 10-15mg/L.25-30mg/L of PACN-95 at excess dosing did not influence on growth and precipitation of floc, but cause a little higher turbidity. pH value at most appreciate dose rate of PACN-95 was 7.9-8.0. Decreasing of pH value owing to adding PACN-95 was smallest among PACs used.

3) Dosing Rate with Different Turbidity Water

Turbidity differed from 42 to 141 degree during survey. The dosing rate of PAC-4 (Al2O3 content is 17%) is shown in Figure 2.4.13.

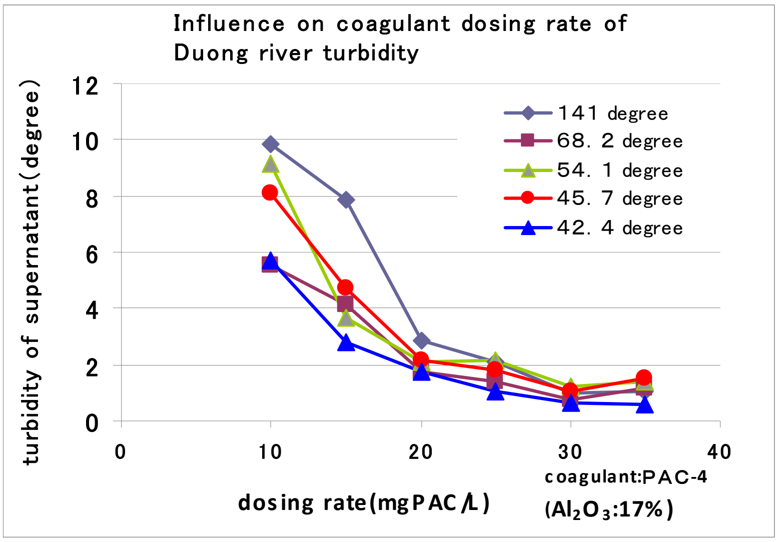


Figure 2.4.13 Influence on Coagulant Dosing Rate of Duong River Turbidity

When the dosing rate is low, turbidity of supernatant is influenced by raw water turbidity, however, when the dosing rate is around 30 mg/L, quite good coagulation effect are observed.

4) Influence by PAC Solution Concentration and PAC Solution Storage Time

Storage time influences is examined using PAC-2 (Powdered PAC made in Viet Nam). PAC solution was made on April 14, 2011. After one week, there was not much different its coagulation effect, however, after one month, the effects was much less as can be seen in Figure 2.4.14. And concentration of PAC influence is examined by Jar-Test. When the PAC concentration is 0.125% to 1%, there was not much coagulation effect, however lower concentration has less coagulation effect.

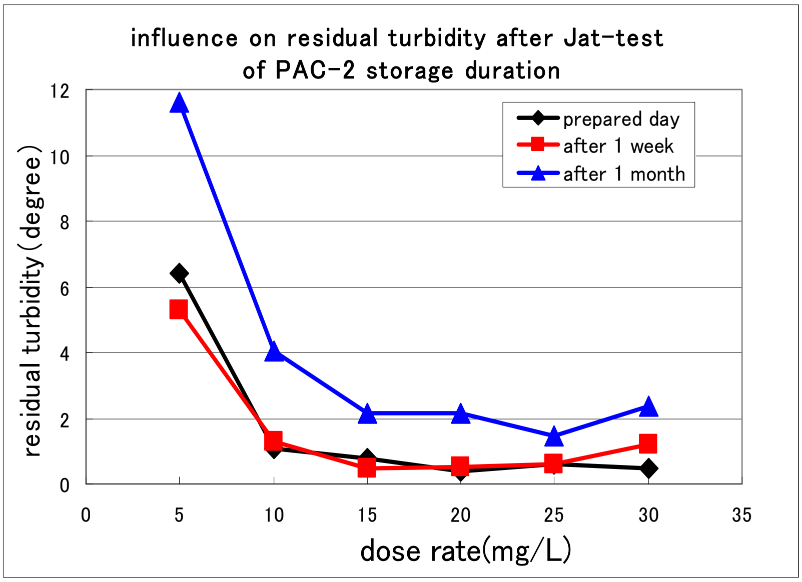


Figure 2.4.14 Influence on Residual Turbidity After Jar-test of PAC-2 Storage Duration

5) Influence by Adding Acid (different pH)

By adding sulfuric acid, Jar Tests are carried out for Alum-1 with pH7.20 - 6.25 and PAC-2 with pH7.47 - 6.37. It was not observed influences by lower pH.

6) Time before Rapid Mixing

Different Time influences between adding coagulants and starting rapid mixing are examined for PAC-2 and Alum-1. When the time is more than 30 seconds in the case of PAC, coagulation effect was influenced. In the case of Alum, the longer the time is, the influence becomes larger.

7) Slow Mixing Rates at Flocculation Basin

Jar-Tests were carried out with conditions shown in Table 2.4.15. The results are shown in Figures 2.4.15 and Figure 2.4.16.

Table 2.4.15 Condition of Slow Mixing

Run	Condition	Content
Run1	constant	Slow mixing speed is at constant during flocculation.
Run2	4step	Slow mixing speed become small step by step for 4 steps.
Run3	2step1	Slow mixing speed divide into 2 steps with same duration. First step is faster than second step.
Run4	2step2	Slow mixing speed divide into 2 steps with different duration. First step is faster and shorter than second step.
Run5	2step3	Run5 is similar to Run4.The difference is that first step of Run5 is faster than Run4, second step of Run5 is more slower than Run4.

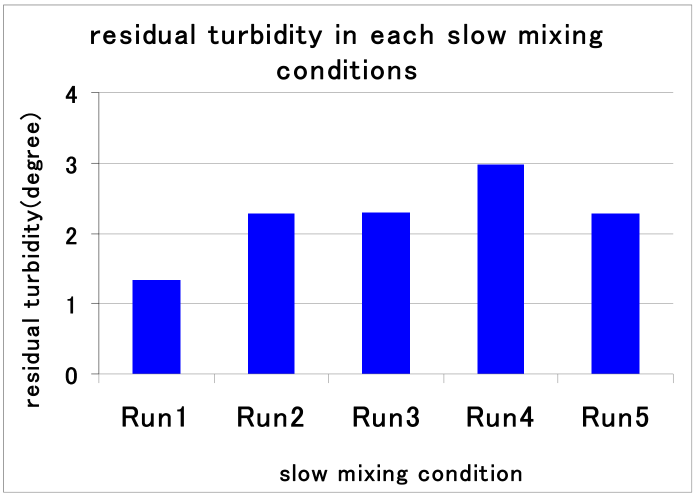


Figure 2.4.15 Comparison of Residual Turbidity in Different Slow Mixing Conditions

Run1 gives best condition as can be seen in the Figure. The best result is observed at the mixing rate of 70 RPM, as shown in Figure 2.4.16.

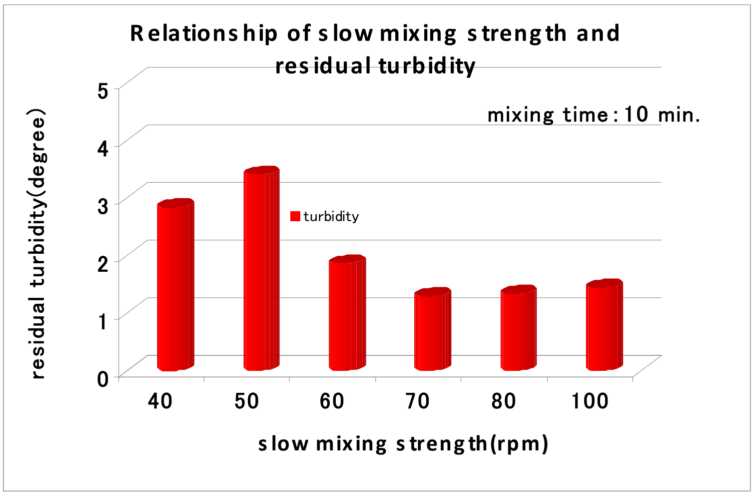


Figure 2.4.16 Influence of Changes in Slow Mixing Strength on Residual Turbidity

8) Aluminum Concentration in Jar-Test Supernatant

pH values of Jar-tested supernatant with optimum dosing rate (PAC- 4, 20mg/L) were 7.4 to 7.8. Therefore, Aluminum concentration with different pH is measured. The results are in Table 2.4.16.

The water soluble aluminum is less than 0.06 mg/L at any cases, which is lower than WHO technical level for treatment (below 0.01 mg/L). Therefore, it may not need to acid for coagulation process.

Table 2.4.16 Concentration of Aluminum in Jar-Test Supernatant

(unit:mg/L)

Dose rate of H_2SO_4(1v/v%)	ppm	0	5	10	15	20	25
Concentration of aluminum	mg/L	0.06	0.02	0.02	<0.01	0.01	<0.01
pH		7.69	7.32	7.13	6.97	6.75	6.65

9) Coagulation Effect After Standing

It was mentioned that sand settling basin is effective for Duong River Water because of high concentration of large particle (more than 1μm). Jar Tests were carried out for 0 hour and 24 hours standing water (see Figure 2.4.17).Coagulants used in the experiment are PAC-4 and PACN-95.

Initial turbidity was 45.0 degree, which became 21.6 after 24 hours. In case of PAC-4, the optimum dosing rates for 0 hours and 24 hours later were same as 25mg/L - 30mg/L(1.25ml - 1.5ml in Figure), and good coagulation results were obtained.
On the other hand, in case of PACN-95, the coagulation results were not much different from PAC-4, however, as the turbidity decrease by settling, the residual turbidity of supernatant becomes higher.

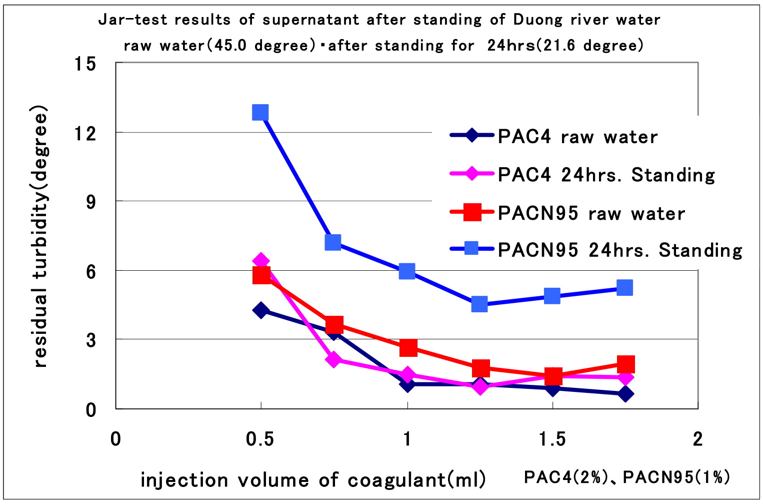


Figure 2.4.17 Influence on Jar-Test Result of Standing of Duong River Water

10) Alum (Aluminum Sulfate)

Table 2.4.17 Jar-Test Results of Aluminum Sulfate

(Turbidity of raw water：20 - 30degree)

Coagulant Name	Result
Alum-1	Most appreciate dose rate of Alum-1 was 50 - 60mg/L（10 - 15mg/L of powdered PAC） .120mg/L （30mg/L of powdered PAC） of Alum-1 made growth of floc worse. Range of most appreciate dose rate of Alum is narrow than that of PAC. pH value at most appreciate dose rate of Alum-1 is 7.17. Decreasing of pH value owing to adding Alum-1 was bigger than that of PAC.
Alum-2	Most appreciate dose rate of Alum-2 was 20 - 30mg/L（10 - 15mg/L of powdered PAC） .60mg/L （30mg/L of powdered PAC） of Alum-2 made growth of floc worse. Range of most appreciate dose rate of Alum is narrow than that of PAC. pH value at most appreciate dose rate of Alum-2 is 7.18. Decreasing of pH value owing to adding Alum-2 was bigger than that of PAC.

11) Comparison of PAC and Alum

The comparison was examined with 240rpm (15 seconds) and 80rpm (10 minutes). Figure 2.4.18 shows the results.

The size of floc using Alum is smaller than that of PAC, therefore turbidity of supernatant using Alum is higher. Also, pH value drop of Alum (0.08) is larger than that of PAC (0.06), thus adding alkali agent is required for supplied water in the case of using Alum.

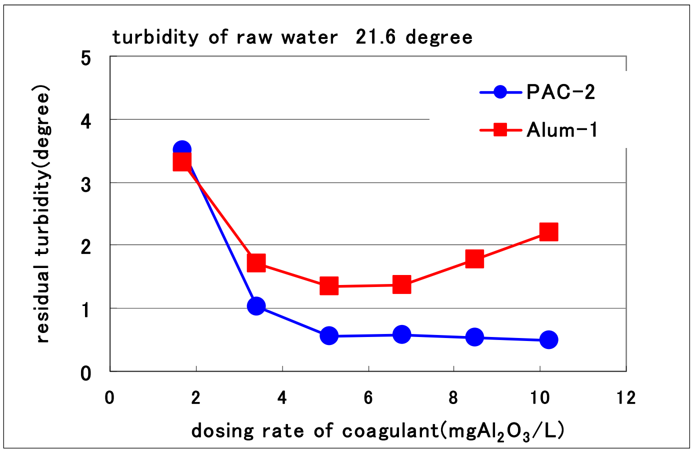


Figure 2.4.18 Comparison of PAC and Alum as Coagulant

12) PSI (Poly silicate Iron)

Table 2.4.18 shows coagulation characteristics.

Table 2.4.18 Jar-Test Results of Poly Silicate-Iron

Experimental Condition	Result
Rapid mixing strength	Turbidity of Jar-test supernatant in case of 150RPM coagulant maker recommending was higher compared to 240RPM using in this research, especially in the low dosing rate of coagulant.
pH on coagulation	In using PSI-025,as pH value of raw water by adding sulfuric acid decreasing, turbidity of the supernatant has trend to decrease and became minimum at range of 6.0-6.6.In case of PSI-100 also, turbidity of the supernatant have same trend and minimum at range of 5.5-6.6.

13) Comparison of PAC and PSI

The comparison was examined with 240rpm (15second), 150rpm (3 minutes), and 70pm (7 minutes). Figure 2.4.19 shows the results.

The size of floc using PSI is larger than that of PAC, and flocculating time in PSI is faster than PAC. However turbidity of supernatant using PSI is higher.

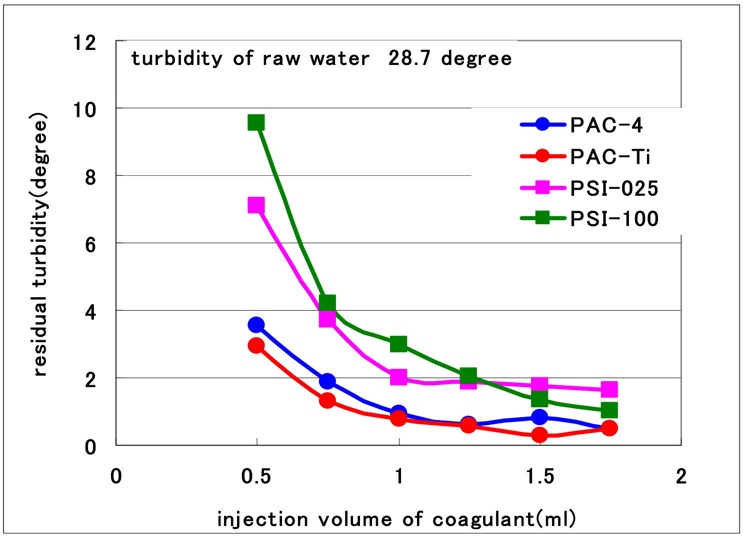


Figure 2.4.19 Comparison of PAC and PSI as Coagulant

14) Comments on Jar-Test

The most appropriate coagulant was PAC according to this time surveys. To get same results using Alum or PSI, adding acid is needed.

During low turbidity season (20 to 50 degree), optimum dosing rate of PAC-4 (solution, 17% of Al2O_3 content, made in Viet Nam) was around 30 mgPAC/L, on the other hand, when the turbidity is relatively high (42 to 141 degree, June and July), optimum dosing rate of PAC-4 was also 30 mgPAC/L.

Since coagulation effect for PAC-4 was not influenced by standing time, sand settling basin is effective for the treatment. However, as it is feared that small and light flocs produced in coagulation process after settling carry over into filtration basin, it is recommended to introduce inclined plate clarifier or tube settler into sedimentation basin Also, in coagulation process, proper rapid mixing condition and slow mixing condition can lead good coagulation-sedimentation results.

(2) Chlorine Demand

1) Results

The results are shown in Table below. Chlorine demand of raw water were about 1.1mg/L - 2.2mg/L. Chlorine demand of Jar-Test supernatant were about 0.8mg/L - 1.7mg/L. Since ammonia nitrogen concentration was less than 0.03mg/L and TOC was about 1mg/L in the raw water, lower chlorine demand of raw water were observed.

Since Chlorine demand increase with increasing of contact time, appropriate dosing rate of chlorine (intermediate chlorination and post chlorination) is to be determined by reaching time to the customers.

Table 2.4.19 Results of Chlorine Demand Test

（contact time with chlorine: 16hours - 43hours）

Date of the test	Duong River (mg/L)	Jar-Test supernatant (mg/L)
Apr.19, May 24,May 30, Jul.1,Jul.6,Aug.12, Aug.16	1.14 - 2.22	0.82 - 1.70

（Dose rate of PAC-4:20 - 30mg/L）

2) Points of Chlorine Feeding

As it is seen in the previous Table 2.4.19, Chlorine demand of supernatant is less than that of raw water by 0.3mg/L - 0.5mg/L. This means that chlorine consumed materials are removed by coagulant. Table 2.4.20 shows THMFP of raw water and Jar test supernatant. Raw water’s THMFP is 0.018 to 0.022mg/L and Jar-Test supernatant’s THMFP is 0.010 to 0.012mg/L, which is decreased by 40 %. This shows that trihalomethane precursor was removed by coagulation process, which means that intermediate chlorination is effective to reduce chlorine demand and thrihalomethane precursor.

Table 2.4.20 Comparison of Trihalomethane Formation Potential (THMFP) of Raw Water and Jar-Test Supernatant

(unit:mg/L)

		TTHMFP	$CHCl_3$ FP	$CHBr_2Cl$ FP	$CHBrCl_2$ FP	$CHBr_3$ FP
Jun.3	Raw water	0.018	0.016	<0.001	0.002	<0.001
	Jar-test supernatant	0.010	0.008	<0.001	0.002	<0.001
Aug.19	Raw water	0.022	0.019	<0.001	0.003	<0.001
	Jar-test supernatant	0.012	0.010	<0.001	0.002	<0.001

3) Overall Comments on Chlorine Demand

Chlorine demand of raw water was relatively low (1.1mg/L - 2.2mg/L). Since Chlorine demand of Jar test supernatant is less than that of raw water and THMFP is lower in case of Jar-Test supernatant, intermediate chlorination is recommended.

Water quality analysis in rainy season is recommended to confirm results.

(3) Sludge Thickening Characteristics

1) Sludge in Settling Basin

Sludge settling property and sludge concentration were examined using sludge prepared by settling of raw water. Figure 2.4.20 is the results. Sludge settling is rather fast and sludge concentration became about 30 % in half an hour from about 7% at starting point and 35% in 2.5 hours, then sedimentation became moderate and the concentration was 37% after 24 hours.

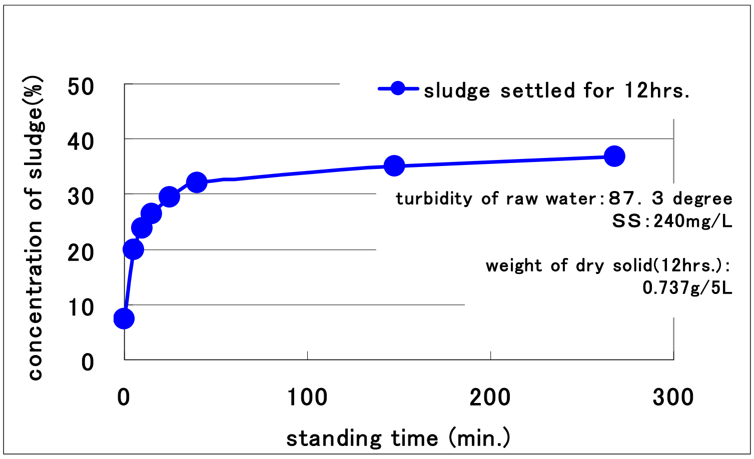


Figure 2.4.20 Concentration Curve of Sludge Produced by Settling of Raw Water

2) Sludge in Sedimentation Basin

Figure 2.4.21 shows the results using sludge settled in Jar-Test. Sludge settling is rather fast and sludge concentration became about 7 % in 1 hour from 1.3% at starting point, then sedimentation became moderate and the concentration was 9.32% after 24 hours.

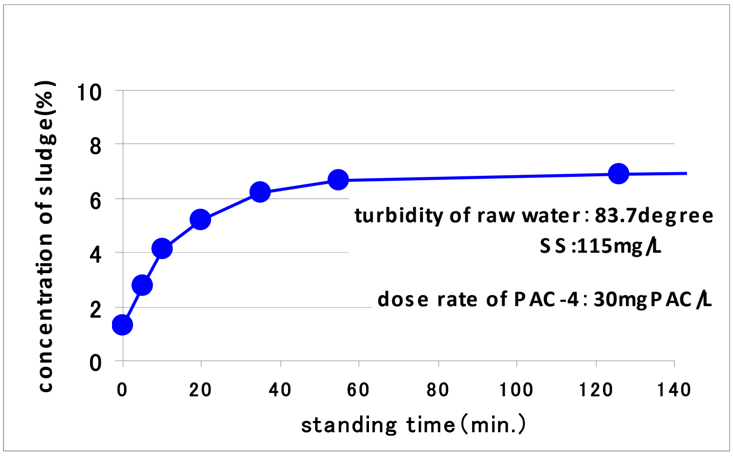


Figure 2.4.21 Concentration Curve of Sludge Produced by Jar-Test

3) Overall Comments on Sludge Thickening Characteristic

Sludge settling property and sludge concentration were examined using sludge prepared by settling of raw water and sludge settled in Jar-Test. In any sludge, sludge settling speed is rather high and the concentration was about 37% and 9% after 24 hours, respectively.

3. Examination of Technical Scale of the Proposed Project

3.1 Purpose of the Project

The main purpose of the proposed project is constructing water supply system infrastructure for the economic and social development of Hanoi urban area and contributing to the improvement of economic and social power of various provinces and prefectures in the north of Hong River (Red River) and the elimination of water shortage in the Ha Noi City center located in the south of Red River.

Another purpose of the proposed project is contributing to the capacity development of Viet Nam water supply corporations and the development of capital markets, by proposing technical transfer of Japanese maintenance, management technology and long term low interest financing.

3.2 Demand Forecast of the Project

3.2.1 Situation Around the Proposed Project

The proposed project consists of a water supply project having a policy of wholesale to Water Works, so the project will be operated with the income from the contract with Water Works receiving water from this Project. However, if the demand evaluation is not carried out appropriately, it will affect tremendously the management of Water Works and private corporations and, consequently, endanger the sustainability of the project. Therefore, it is necessary to reexamine the certainty of demand evaluations that constitute the basis of the project planning, based on the Pre-FS results and the report contents of ongoing FS survey by VIWASEEN and set Supply Area and water supply volume taking the project efficiency and the project effectiveness into consideration.

However, Study Team come to know that HPC (Ha Noi People's Committee) is preparing a master plan for Ha Noi City water supply (called "Ha Noi City water supply plan", hereafter) in parallel with this survey in Ha Noi City which is estimated to account the largest demand in the proposed project after the launch of the research. This will draw up " Ha Noi City water supply plan for 2030 and a vision up to 2050" until June, 2011, according to the decision of the Office of the Prime Minister (Decision 1655/QD-TTg) of September, 2010 and will be considered as a plan superior to the proposed project. Therefore, the present research should be carried on attentively considering the evolution of Ha Noi City water supply plan and was obliged to start the research with the possibility that the project target scope setting that constitutes the basis of the basic frame setting may change.

Based on FS survey report proceeded by VIWASEEN, the demand was estimated from data collected independently by JICA Study Team and the demand certainty was verified in order to set the basic frame.

3.2.2 Target Area

The target scope of the proposed project shall be decided in response to the contents of FS survey by VIWASEEN.

As the target scope of the proposed project covers Ha Noi City and its surrounding provinces, Bac Ninh Province and Hung Yen Province, just like last year's research, and the FS survey report by VIWASEEN, the target scope of the proposed project is decided (Figure 3.2.1).

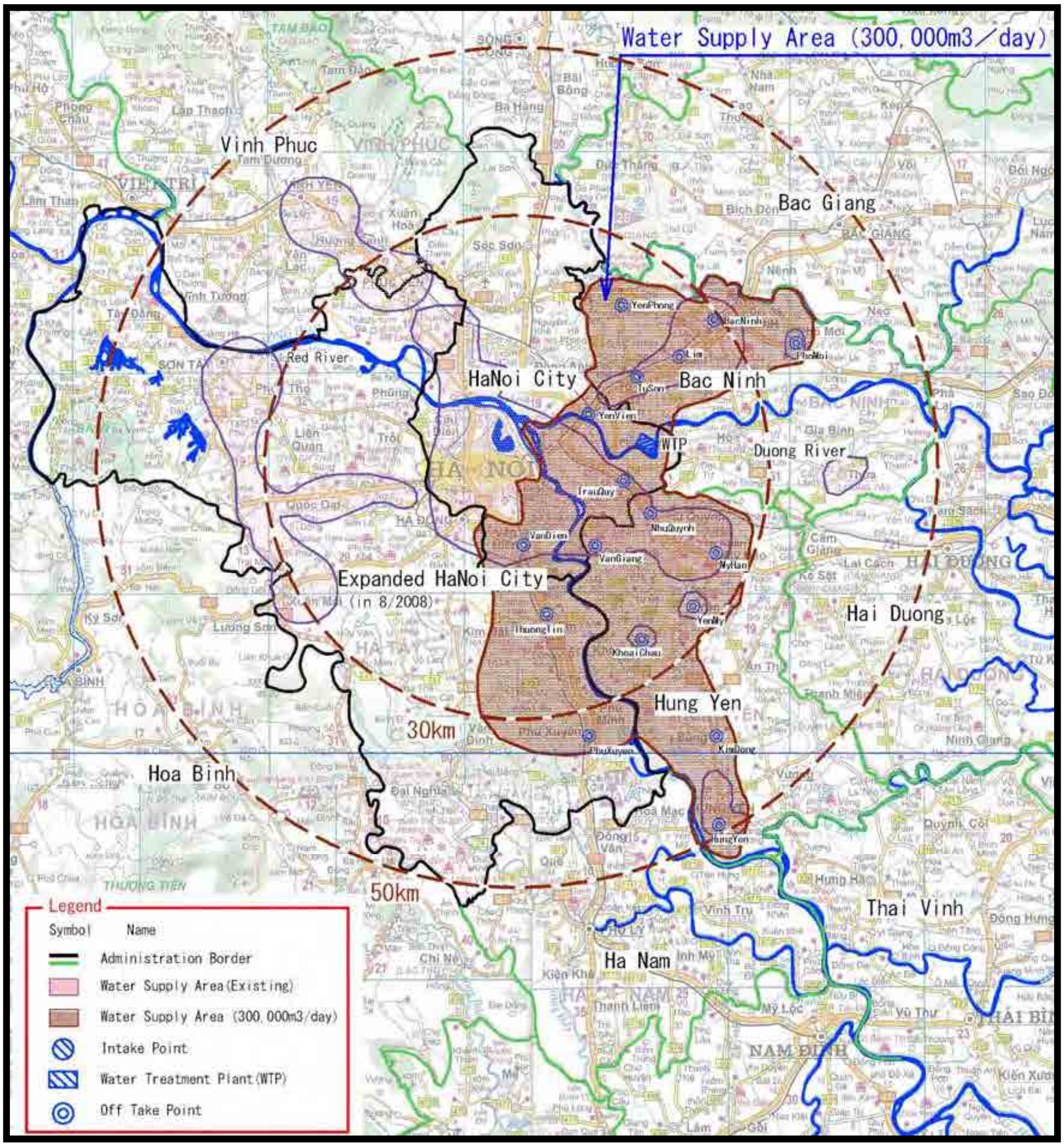


Figure 3.2.1 Target Area

3.2.3 Overall Conditions of Water Supply Business in the Research Target Area

(1) Ha Noi City

As of 2009, total area of Ha Noi City is 334,470ha and its population 6,448,837. The water supply reaches 70 to 85% penetration in urban area and 40 to 60% in rural areas, and the maximum water supply volume per day attains 683,000 m^3/day.

The water supply business is composed of four (4) business entities: HAWACO (Ha Noi Water Works) manages and operates in Old Ha Noi City, Son Tay Water Supply Corporation around Son Tay City, Old Ha Tay Province, Ha Dong Corporation in Old Ha Dong City and VIWACO Corporation (sells water from Da River Water Treatment Plan and operates transmission pipelines and distribution network) in peripheral areas of Old Ha Noi City. Particularly, HAWACO divides its management area into 6 distribution districts and each one is managed by its affiliated company.

The general outline of HAWACO, one of the business entities of the proposed project and the largest client, is described below.

- HAWACO

  The water supply of Old Ha Noi City has been divided into north and south by Red River flowing through the middle of the city; the south of Red River, corresponding to the center of Ha Noi City has been managed by Hanoi Water Business Company, predecessor of HAWACO, and the north of Red River by Hanoi Water Business Company 2. However, in June 2008, the two companies were merged to form actual HAWACO when Ha Noi City was planned to be enlarged (August 2008).

  Actually, the Old Ha Noi City is managed in a lump by HAWACO and the management area covers 8 districts in the city and surrounding 5 prefectures. As of 2009, water supply reaches 92.94% penetration in districts (Ba Dninh District, Hai Ba Trung District, Dong Da District, Hoan Kiem District, Cau Giay District, Ho Tay District, Long Bien District, Hoang Mai District) covering almost all of the area, while it reached 4 - 60% penetration in neighboring 5 prefectures (Gia Lam Prefecture, Dong Anh Prefecture, Soc Son Prefecture, Tu Liem Prefecture, Me Linh Prefecture) which is still lower than the districts (Table 3.2.1).

It controls 22 Water Treatment Plants in total (12 large scale plants and 10 small plants) offering treatment capacity of 614,000 m^3/day to provide water supply services to approx. 2,754,000 habitants.

The general outline of HAWACO water supply business is shown in Table 3.2.2.
The evolution of distribution performance and revenue rate during 2005 to 2010 is shown in Figure 3.2.2.

Table 3.2.1 Water Supply Penetration in HAWACO Managed Area (Neighboring 5 Prefectures)

Area	Coverage Ratio (%)	Remarks
Tu Liem Pref.	60	
Gia Lam Pref.	17	
Dong Anh Pref.	14	
Soc Son Pref.	4	
Me Linh Pref.	—	*Inadequate by HAWACO

*Not including small one and private well

Table 3.2.2 General Outline of HAWACO Water Supply Business

Company Name	Ha Noi Water Limited Company(HAWACO Co., Ltd)
Established	June 2008
Administrative Area	Dong Da, Ba Dinh, Hai Ba Trung, Cau Giay, Ho Tay, Long Bien, Gia Lam, Dong Anh, Soc Son, Me Linh (All of areas of above 6 districts and 4 prefectures) Hoang Mai, Thanh Xuan, Thanh Tri, Tu Liem (In some areas of above 2 districts and 2 prefectures)
Administrative WTP	【Large scale water treatment plant】 1. Yen Phu WTP (1997) 90,000m^3/day 2. Ngoc Ha WTP (1992) 32,000m^3/day 3. Ngo Si Lien WTP (1992) 47,000m^3/day 4. Mai Dich WTP (1991) 60,000m^3/day 5. Cao Dinh WTP (2005) 60,000m^3/day 6. Luong Yen WTP (1991) 50,000m^3/day 7. Tuong Mai WTP (1992) 30,000m^3/day 8. Ha Dinh WTP (1994) 30,000m^3/day 9. Phap Van WTP (1989) 30,000m^3/day 10.Nam Du WTP (2006) 60,000m^3/day

	11.Gia Lam WTP (1996) 30,000m^3/day 12.Bac Thang Long WTP (2004) 25,000m^3/day Total of above (12) WTPs : 544,000m^3/day 【Small scale water treatment plant】 1. Bach Khoa WTP 2,000m^3/day 2. Quynh Mai WTP 3,000m^3/day 3. Van Don WTP 6,000m^3/day 4. Thuy Khue WTP 4,000m^3/day 5. Don Thuy WTP 12,000m^3/day 6. Bach Mai WTP 6,000m^3/day 7. Kim Lien WTP 6,000m^3/day 8. Gia Lam Air Port WTP 9,000m^3/day 9. Dong Anh WTP 12,000m^3/day 10.Nguyen Khe WTP 10,000m^3/day Total of above (10) WTPs : 70,000m^3/day *All of above are groundwater using

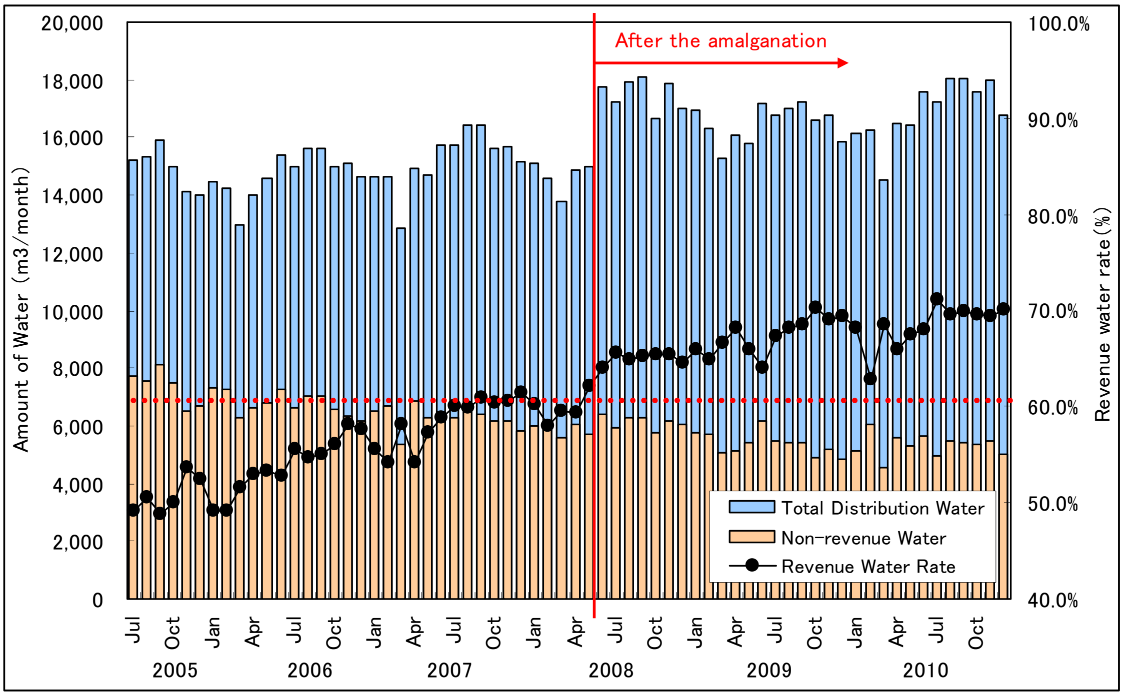


Figure 3.2.2 Evolution of HAWACO Distribution Performance and Revenue Rate 2005 to 2010

The maximum distribution amount in HAWACO jurisdiction is approx. 18,100,000 m^3 per month (≒603,000 m^3/day), where the city center distribution occupies about 91% with approx. 16,400,000 m^3 per month (≒547,000 m^3/day). The revenue rate has been about 50% in 2005, which has improved annually, realizing about 70.0% (term maximum 71%) as of December 2010. Actually, HAWACO is exerting effort to improve the revenue rate and, hereafter, it is expected that the revenue rate will be further improved. (Figure 3.2.3)

Retrench of leakage rate (increase of revenue rate) is an important factor for water supply management. In the future, it is promising to transfer Japanese technologies, both software and hardware, such as leakage survey, water distribution blocking and leakage rate cutback planning, using Japanese funds.

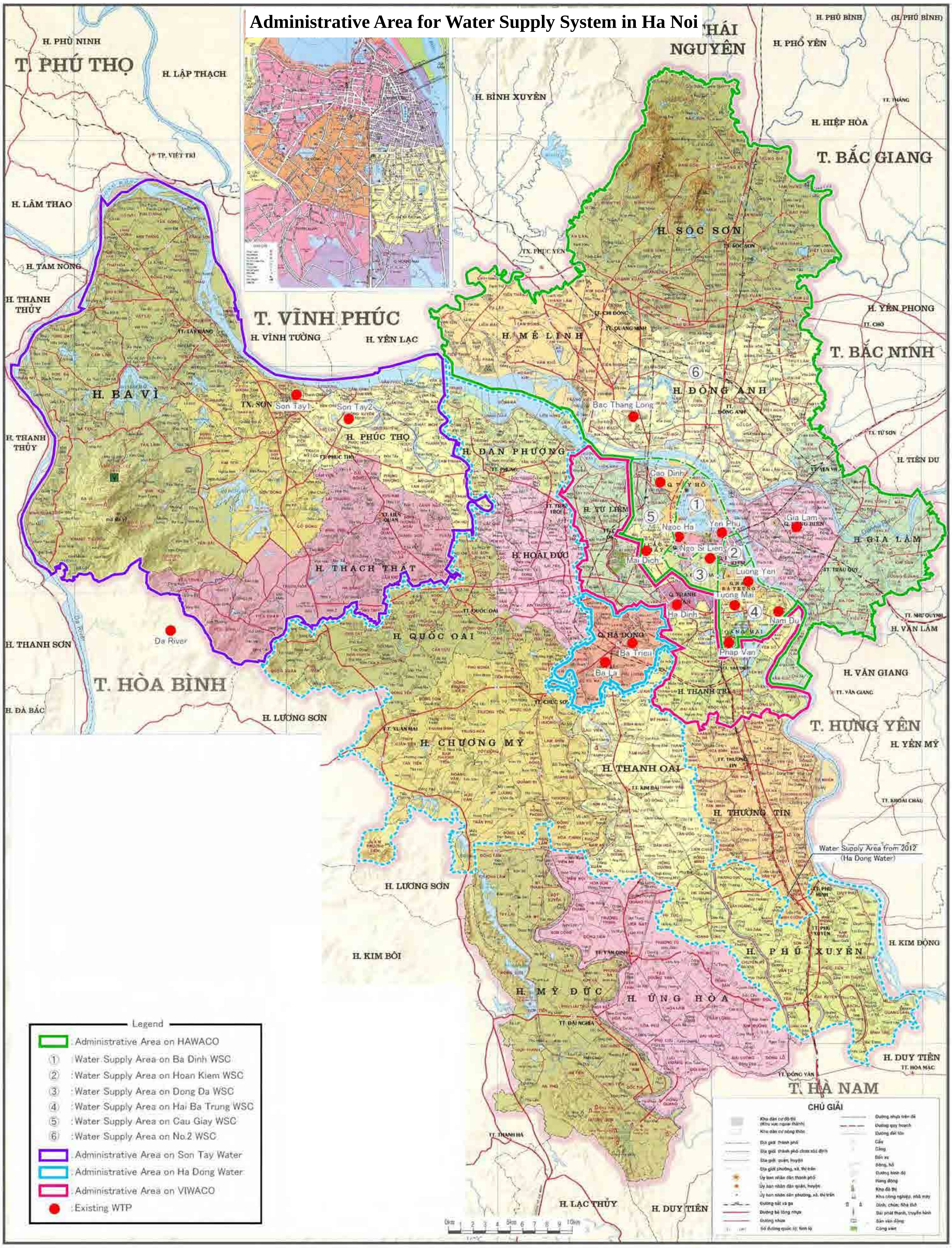


Figure 3.2.3 Ha Noi City Water Supply Area

(2) Bac Ninh Province

In Bac Ninh Province, Bac Ninh Water Supply and Sewerage LTD., Company, subsidiary organization of Bac Ninh People's Committee, manages and operates the water supply business of the entire Bac Ninh Province. Bac Ninh Water Supply and Sewerage Ltd., Company operates actually 4 underground water treatment plants. Besides the Company, private enterprises operate several water treatment plants.

Bac Ninh Water Supply and Sewerage LTD., Company is now preparing a master plan for the entire province with the objective of providing at least one water treatment plant in all cities and prefectures.

Though the exact water supply penetration rate and population remain unknown, it is claimed that it reached approx. 14.5% and approx. 130,000 habitants as of 2009.

Water treatment plant operation situation of Bac Ninh Province is shown in Table 3.2.3 and the overall view of Bac Ninh Province and its water treatment plants are shown in Figure 3.2.4.

Table 3.2.3 Existing Water Treatment Plant Situation in Bac Ninh Province

No.	Area	Name of WTP	Construction Year	Capacity (m3/day)	Organization
1	Bac Ninh City	Bac Ninh WTP	1995	16,000	Bac Ninh Province
2	Tu Son	Tu Son WTP	—	5,000	VIWASE
3	Tien Du	Lim WTP	2008	2,000	Bac Ninh Province
4		Tien Son WTP	—	—	VSIP
5	Que Vo	Que Vo WTP	2000	1,800	Bac Ninh Province
6	Luong Tai	Luong Tai WTP	2001	2,500	Bac Ninh Province
	Total			27,300	

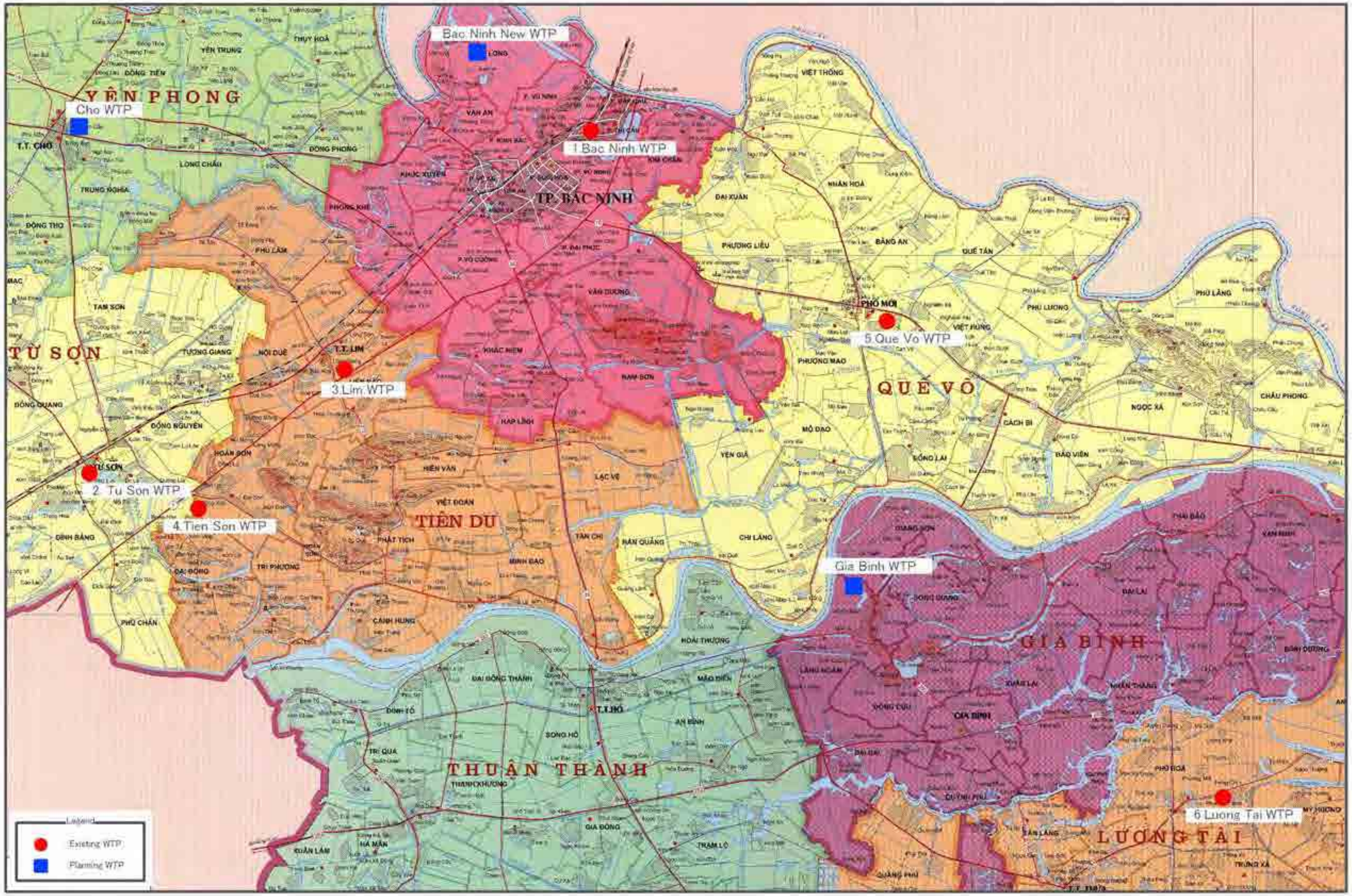


Figure 3.2.4 Existing and Planned Water Treatment Plants in Bac Ninh Province

(3) Hung Yen Province

In Hung Yen Province, Hung Yen Water Works, subsidiary organization of Hung Yen People's Committee, mainly manages and operates the water supply business of the entire Hung Yen Province. Besides, the Environmental Public Health Center of the Ministry of Agriculture and private companies exert independent water supply business in respective community (prefecture, village, etc.). Therefore, at present, water supply business is mainly operated commune by commune and there is no water supply business entity that would administrate the entire province. Consequently, in the actual situation, there is no organization for grasping exactly the actual situation of water supply business of the entire province and for preparing future water supply plan.

19 large and small water treatment plants are in operation and many small plants are now under construction.

Though the exact water supply penetration rate and population remain unknown, the hearing results tell that it reached approx. 7% and approx. 79,000 habitants as of 2006.

Water Treatment Plant operation situation of Hung Yen Province is shown in Table 3.2.4 and the overall view of Hung Yen Province and its Water Treatment Plants are shown in Figure 3.2.5.

Table 3.2.4 Existing Water Treatment Plant situation in Hung Yen Province

No.	Area	Name of WTP	Construction Year	Capacity (m3/day)	Organization
1	Hung Yen City	Hung Yen WTP	2002	5,000	Hung Yen City
2	Khoai Chau	Phung Hung WTP	2010	3,000	Environmental Health Center
3		Khoai Chau WTP	2002	980	Hop DeCo., Ltd
4		Binh Minh WTP	2008	996	Environmental Health Center
5	An Thi	An Thi WTP	2006	780	Environmental Health Center
6		Hong Quang WTP	1999	580	Environmental Health Center
7	My Hao	Pho Noi WTP	1999	3,000	Vietecco Nam Long
8		Bach Sam WTP	2007	885	Environmental Health Center
9		Di Su WTP	2005	970	Environmental Health Center
10	Van Lam	Nhu Quynh WTP	2001	1,000	VIWASE
11		Chi Dao WTP	2001	880	Environmental Health Center
12	Van Giang	Van Giang WTP	2003	980	Environmental Health Center
13	Yen My	Yen My WTP	2006	1,290	Environmental Health Center
14	Tien Lu	Thuy Loi WTP	2005	718	Local
15	Kim Dong	Luong Bang WTP	1998	560	Local
16		Tien Quan WTP	2003	300	Local
17		Ngoc Thanh WTP	2005	600	Local
18	Phu Cu	Tran Cao WTP	2004	720	Local
19		Quang Hung WTP	2002	880	Environmental Health Center
	Total			24,119	

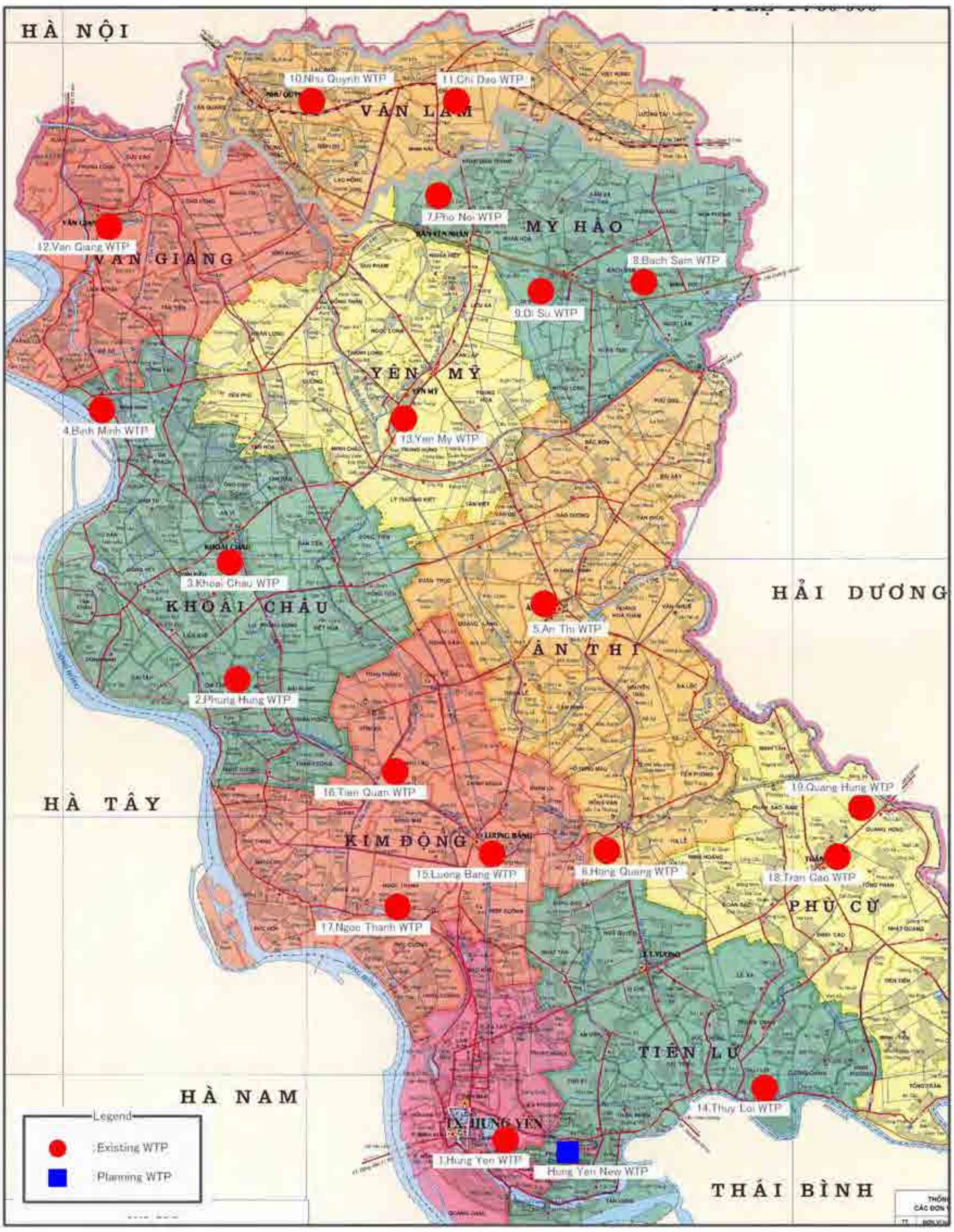


Figure 3.2.5 Existing and Planned Water Treatment Plants in Hung Yen Province

3.2.4 Demand Forecast and Basic Frame Flow

The most important matter in setting the basic frame of this research is to make it a high certainty plan all the way reflecting the demand of water receiving entities, because it concerns the water supply business.

Therefore, it is necessary to discuss about the demand with water receiving entities to which water will be distributed, and also necessary to verify whether the certainty of such demand is high, on the basis of FS survey results of VIWASEEN.

Moreover, as mentioned before, the Ha Noi City water supply plan, superior to the proposed project, is being prepared. It is necessary to review within the scope of the contents of Ha Noi City water supply plan, all the way confirming its contents.

Based on the discussion above, demand forecast and basic frame setting up on this research shall be carried out as shown in Figure 3.2.6.

Among water supply plans by other donors in the proposed project target area, including Ha Noi City water supply plan, those requiring coordination of contents are described below.

- <u>Ha Noi City water supply plan (being prepared)</u>

  As mentioned above, it was decided by the Office of Prime Minister in September 2010 to prepare a master plan of Ha Noi urban area water supply for 2030 to be executed by Ha Noi City People's Committee. It is now under examination to be authorized in June 2011.

  As Ha Noi City water supply plan is superior to the proposed project, it is necessary that the contents of this Project be in harmony with the abovementioned plan.

- <u>Gia Lam Prefecture pipeline network maintenance plan</u>

  It concerns a pipeline network maintenance plan in Gia Lam Prefecture prepared by Ha Noi City People's Committee and HAWACO in October, 2010. The contents of the pipeline network maintenance plan are considered to have a great influence on the proposed project, because Water Treatment Plants of the proposed project will be constructed in Gia Lam Prefecture.

Hence, in the present research, it is necessary to plan so that the plant maintenance becomes efficient, based on the contents of the Gia Lam Prefecture pipeline network maintenance plan.

- Various plans in other prefectures

  It is necessary to check water supply plans, water treatment plant expansion plans or other future plans in Bac Ninh Province, Hung Yen Province and so on, which will be related to the target area of this project. If there is any such plans, it is important to reflect their contents in this research.

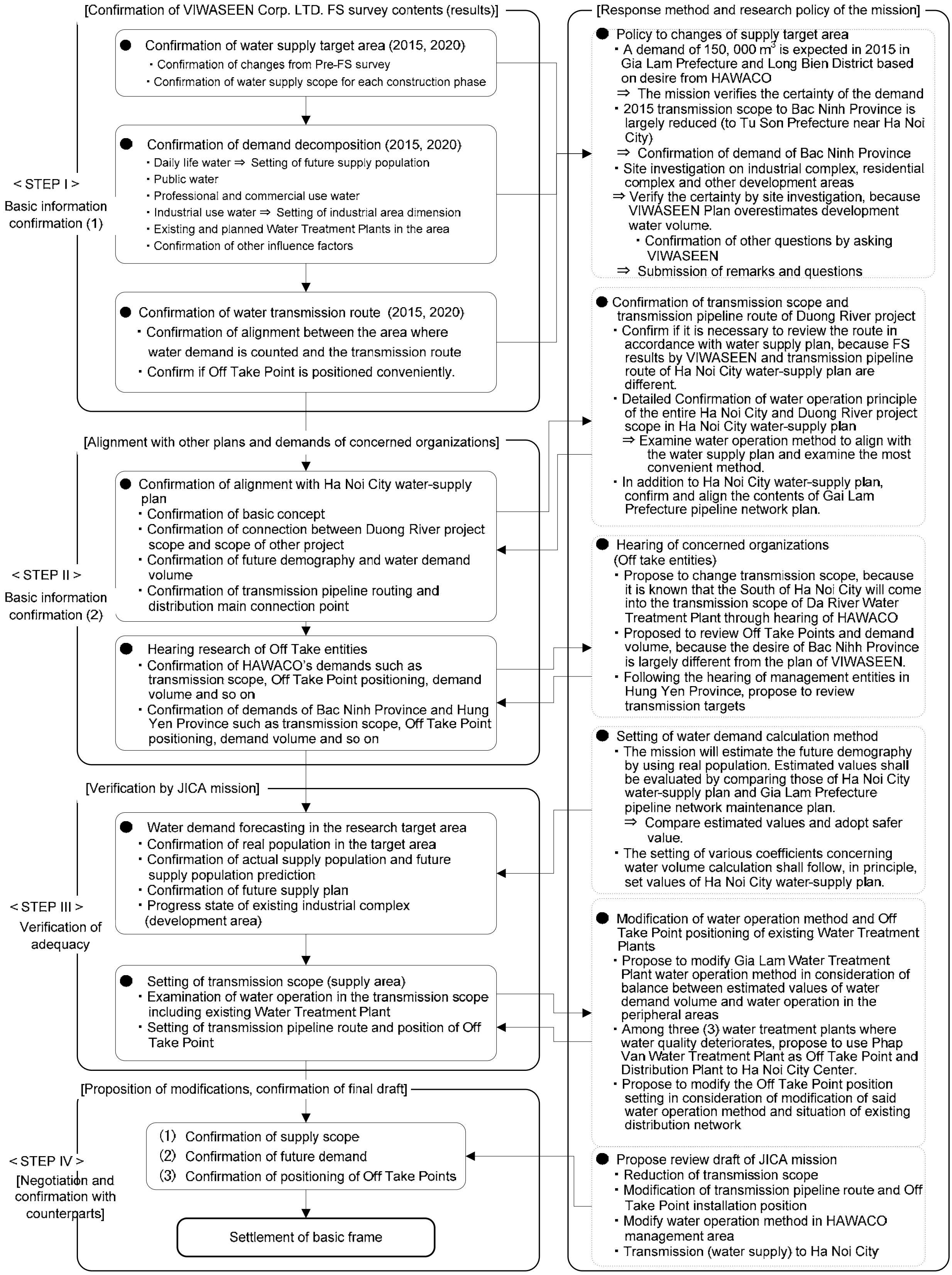


Figure 3.2.6 Flow of Demand Forecasting and Basic Frame Setting

3.2.5 Confirmation of Basic Conditions

(1) Ha Noi City Water Supply Plan (master plan)

In September 2010, according to the decision of the Office of the Prime Minister (Decision 1655/QD-TTg), Ha Noi People's Committee started to prepare Hanoi capital region global plan for the enlarged Ha Noi City (Development plan for 2030 and vision up to 2050) which is to be completed by June, 2011. This Hanoi capital region global plan including HAWACO water supply plan (called Ha Noi City water supply plan, hereafter), as major assumption, the future Ha Noi City water business shall be carried out following the Ha Noi City water supply plan, and therefore, the present proposed project should also be carried out in line with the Ha Noi City water supply plan, which is superior to the proposed project.

Ha Noi City water supply plan was submitted to the Office of the Prime Minister at the beginning of this year (2012) and waiting for the approval (JICA Study Team confirmed this situation in April, 2012). Therefore, Ha Noi City water supply plan is not opened to the public.

(2) FS Survey Report by VIWASEEN

Actually, VIWASEEN is carrying out FS survey of Duong River project in parallel to preparation of said Ha Noi City water supply plan. As for today, three workshops have been held. Besides VIWASEEN, HAWACO, METAWATER, local consultants and other key agencies have participated to discuss the contents of FS survey.

Though the research is now in the phase of preparing final report, it is difficult to say that alignment with said Ha Noi City water supply plan and accommodation of demand certainty, off take point installation point, off take method and so on are sufficient. It is considered that further examination will be required in this respect.

At present, subjects that need to be examined are as follows.

1) Coordination with concerned organizations such as HAWACO

It is considered that alignment of off take point and off take volume with HAWACO which occupies the majority of the demand in the Phase 1 is not sufficient and it will be necessary to negotiate in detail with HAWACO in respect of examination of delivery method at the off take point and ground setting of off-take volume.

2) Coordination with concerned organizations of Bac Ninh Province and Hung Yen Province

As the plan of VIWASEEN does not describe off take entities receiving water, it is unknown to what extent the alignment with off take entities is realized.

As for the alignment with Bac Ninh Province and Hung Yen Province, that are water receiving agencies other than HAWACO, it is also necessary to negotiate with these agencies to harmonize the project with the needs.

3) Clarification of grounds of demand setting

Based on negotiations with agencies mentioned above, it is necessary to clarify the grounds of demand setting, in order to harmonize the plan with the expected water demand.

3.2.6 Project Demand Forecasting and Proposal of Basic Frame

In order to resolve the aforementioned issues, JICA Study Team examines the water demand and transmission pipeline plan, based on FS survey of VIWASEEN which has entered the final phase, consideration of Pre-FS evolution, Ha Noi City water supply plan which is now being prepared, and discussion with the concerned organization. And JICA Study Team proposes the most appropriate planning.

(1) Research Principles of Water Supply Scope

1) Ha Noi City

HAWACO, most important receiving entity in the proposed project, is now waiting for the decision of contents by Ha Noi City water supply plan and its inside policies are not unified in respect of global water operation including water supply scope of Duong River project.

Consequently, JICA Study Team has set and proposed water demand and water supply area, based on results of discussion with HAWACO, existing contents of water supply plan and of Gia Lam Prefecture pipeline network maintenance plan and so on.

Research principles of Duong River Water Treatment Plant supply scope in Ha Noi City set in the present research and proposed contents are shown in Table 3.2.5 and outline of principles reviewed based on discussion results is presented in Figure 3.2.7.

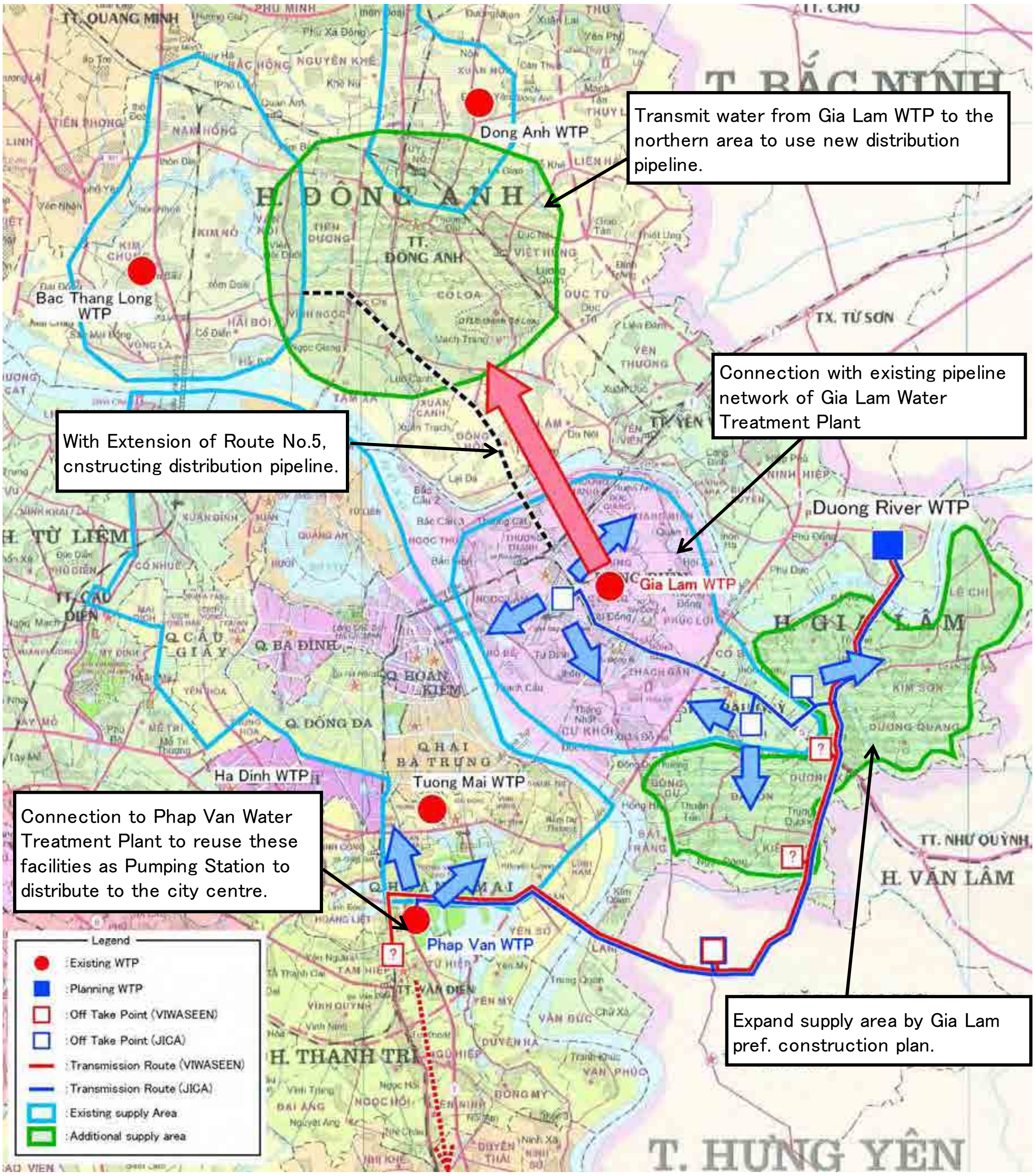


Figure 3.2.7 Water Operation Principles in Duong River Water Treatment Plant and North of Hanoi

Table 3.2.5 Principles for Setting Supply Scope in Ha Noi City

Research Item	VIWASEEN report	Hearing results	Review results of research principles
a) Transmission to the south of Ha Noi City (Thanh Tri Prefecture, Thuong Tin Prefecture, Phu Xuyen Prefecture, etc.)	• Demand is expected for Thanh Tri Prefecture in Phase 1 and further Thuong Tin Prefecture and Phu Xuyen Prefecture in Phase 2.	• Being in the transmission scope of Da River Water Treatment Plant, unnecessary to transmit from Duong River Water Treatment Plant. • The north of Red River is considered as supply scope from Duong River Water Treatment Plant. • It is necessary to maintain Red River transversal pipeline in order to secure the safety (back-up in case of emergency)	• The north of Red River is considered basically as supply scope, without expecting transmission to the south of Ha Noi City. However, transmission to the Center of Ha Noi City shall be considered according to the demand situation. • Red River intersection shall be positioned as transmission to the City Center and back-up of Da River Water Treatment Plant, without anticipating demand in the south of Red River.
b) Duong River Water Treatment Plant supply scope	• Large demand is expected around Gia Lam Prefecture and Long Bien District in Phase 1 and 2.	• Gia Lam Prefecture and Long Bien District demand to receive 150,000 m^3/day in 2015. • Actually, operation method of 150,000 m^3/day is not decided.	• The area setting will privilege Gia Lam Prefecture and Long Bien District for Phase 1 and Phase 2 supply scope. • It is highly possible that only Gia Lam Prefecture and Long Bien District cannot consume, so transmission to the Ha Noi City Center shall be considered according to the situation.
c) Connection with existing pipeline network of Gia Lam Water Treatment Plant	• It is supposed to connect to the end of distribution network of Gia Lam Water Treatment Plant • Connection of distribution area with Gia Lam Water Treatment	• The actual Water Treatment Plant uses groundwater only, so the distribution area should basically be separated from Duong River Water Treatment Plant which uses surface water. • As the actual Off take Point set position is located at the distribution	• Care should be taken not to blend with groundwater system as far as possible. • Supply to Gia Lam Water Treatment Plant distribution area with water from Duong River Water Treatment Plant, by taking benefit of existing distribution network of Gia Lam Water Treatment

	Plant is not examined.	end, connection to the existing pipeline network of Gia Lam Prefecture and Long Bien District is not desirable in terms of distribution. • Extension of Route No.5 from Long Bien District to the north of Ha Noi City and consequent main roads maintenance are scheduled. It is possible to transmit water from Gia Lam Water Treatment Plant to the north of Ha Noi City by taking benefit of it.	Plant. Off take Point shall be set at a position allowing maximum use of the existing network, in order to distribute to the existing area and additional area. • Gia Lam Water Treatment Plant shall distribute water to Ha Noi City north area (Dong Anh Prefecture, Me Linh prefecture, Soc Son prefecture), and groundwater Treatment Plants shall be concentrated to the north of Ha Noi City. • By means of said measures, the urgent demand of Ha Noi City north area shall be satisfied with three (3) Water Treatment Plants of Gia Lam, Bac Thang Long and Dong Anh.
d) Connection with Phap Van Water Treatment Plant	• Connection to Phap Van Water Treatment Plant whose operation is planned to stop is anticipated, but the consequent demand thereof is not anticipated.	• Water Treatment Plants of Phap Van, Tuong Mai and Hai Dinh are planned to stop operation because of water quality problem. It is possible to reuse these facilities as Pumping Station (Distribution Plant).	• The said Water Treatment Plants facing water quality problem should stop operation as soon as possible. Among them, by connecting with Duong River Water Treatment Plant, it is possible to stop the operation of Phap Van Water Treatment Plant earlier, which is very near to the planned transmission route. Water operation becomes more efficient by making it the distribution base of Duong River Water Treatment Plant to the city center and taking benefit of existing pipeline network.

2) Bac Ninh Province

Discussion with the Bac Ninh Province Water Works, which administrates water business of the entire province, was carried out in order to understand the situation of water demand and set water supply scope in Bac Ninh Province.

Principles proposed for Duong River Water Treatment Plant supply scope in Bac Ninh Province has been set based on the outcome of the discussion.

Following the review by the research, all off takes shall be executed at one off take point at the same position both for Phase 1 and Phase 2, thereby considerably reducing both number of off take points and length of transmission pipeline extension.

Besides receiving water from Duong River Water Treatment Plant, Bac Ninh Province plans to build four water treatment plants in the province and to prepare actually a master plan for proceeding a consolidated water supply maintenance including reception from Duong River Water Treatment Plant. (The master-plan does not mention receiving water from Duong River.)

Outline of operation principles reviewed based on said hearing results and proposal contents is shown in Figure 3.2.8.

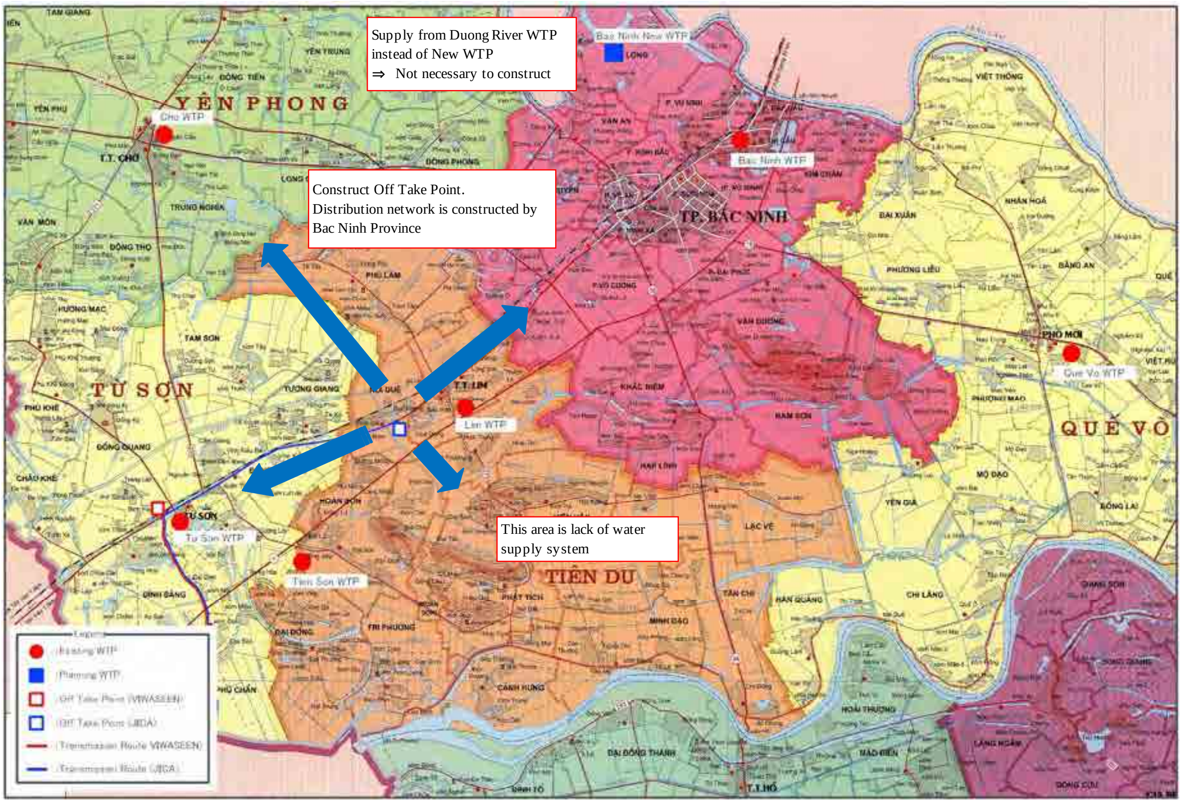


Figure 3.2.8 Water Operation Principles of Bac Ninh Province in the Proposed Project

3) Hung Yen Province

Reports of VIWASEEN expects increased water demand in future in Hung Yen Province due to industrial complex development along the Route No. 5 and, therefore, anticipates a demand of approx. 80,413 m^3/day as the main client of the Phase 2 of the proposed project.

Similar to VIWASEEN, JICA Study Team also expects increased water demand in future due to industrial complex development along the Route No. 5 and accordingly has made a research on water demand.

However, in Hung Yen Province there is no operator managing water supply business of the entire province and no enterprise preparing a master plan. Therefore, in this research, a hearing was performed mainly in Hung Yen City Water Works on supply scope and water demand.

Hearing was held in the following water supply administrations in the frame of this research:

- Hung Yen City Water Works: Hung Yen Water Treatment Plant (Hung Yen City)
- Bitecco Nam Long: Pho Noi Water Treatment Plant (My Hao Prefecture)
- VIWASE: Nhu Quynh Water Treatment Plant (Van Lam Prefecture)

Through this review proposal, transmission target up to the Phase 2 is limited to Eco Park housing complex of Van Giang Prefecture which is, at present, receiving water from Ha Noi City. However, future demand expansion is expected in the center of Van Lam Prefecture, My Hao Prefecture, Yen My Prefecture and areas along Route No.5 because of industrial complex development and, moreover, a sufficient volume may not be obtained if there is a shortage of groundwater. Therefore, it is proposed to install junction pipeline at the Route No. 5 allowing future extension to Hung Yen Province, without maintaining transmission pipeline.

Summarized operation principles reviewed based on said hearing results and proposal contents is shown in Figure 3.2.9.

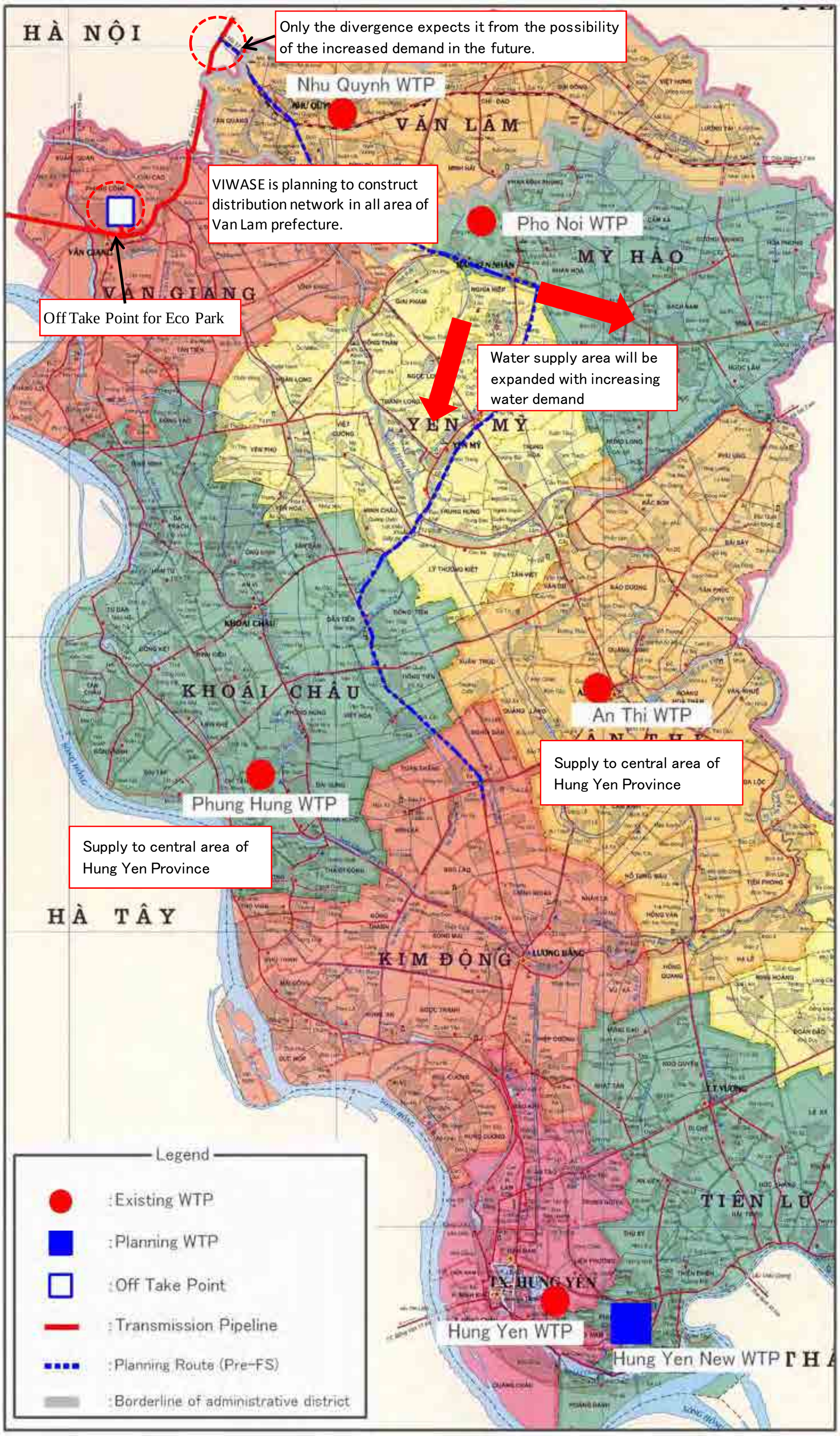


Figure 3.2.9 Water Operation Principles of Duong River Water Treatment Plant and Hung Yen Province

(2) Water Demand Forecast

Water demand is calculated as follows based on discussed basic principles and considerations earlier.

1) Estimation of future population

Future population shall be estimated only for Ha Noi City. In this proposed project, scope of Ha Noi City supply will cover Gia Lam Prefecture, Long Bien District east of Ha Noi City and HAWACO Supply Area in the center of Old Ha Noi City, based on the results of discussion.

Real population during 2005 to 2009 in target area is shown in Table 3.2.6.

Table 3.2.6 Real Population in Target Area

Area	District	Dimension (km2)	Item	Population (1,000 people)					Annual increasing ratio (%)
				2005	2006	2007	2008	2009	
Center of Ha Noi	Ba Dinh	9.25	Total Population	217.7	220.4	222.2	223.8	225.0	0.83%
			Served Population	202.5	205.0	206.6	208.1	209.3	
			Population Density	23.5	23.8	24.0	24.2	24.3	
	Tay Ho	24.01	Total Population	112.4	116.5	120.7	125.1	131.0	3.91%
			Served Population	104.5	108.3	112.3	116.3	121.8	
			Population Density	4.7	4.9	5.0	5.2	5.5	
	Hoan Kiem	5.29	Total Population	153.9	152.1	150.3	148.6	147.0	-1.14%
			Served Population	143.1	141.5	139.8	138.2	136.7	
			Population Density	29.1	28.8	28.4	28.1	27.8	
	Cau Giay	12.03	Total Population	190.7	195.3	206.6	215.6	227.8	4.56%
			Served Population	177.4	181.6	192.1	200.5	211.9	
			Population Density	15.9	16.2	17.2	17.9	18.9	
	Tu Liem	75.33	Total Population	289.8	298.1	331.9	355.2	394.7	8.09%
			Served Population	173.9	178.9	199.1	213.1	236.8	
			Population Density	3.8	4.0	4.4	4.7	5.2	
	Thanh Xuan	9.08	Total Population	208.8	211.4	216.4	221.7	224.9	1.88%
			Served Population	194.2	196.6	201.3	206.2	209.2	
			Population Density	23.0	23.3	23.8	24.4	24.8	
	Dong Da	9.96	Total Population	352.6	356.8	361.1	365.5	371.0	1.28%
			Served Population	327.9	331.8	335.8	339.9	345.0	
			Population Density	35.4	35.8	36.3	36.7	37.2	
	Hai Ba Trung	10.09	Total Population	290.3	310.5	311.2	310.0	292.9	0.32%
			Served Population	270.0	288.8	289.4	288.3	272.4	
			Population Density	28.8	30.8	30.8	30.7	29.0	
	Hoang Mai	39.81	Total Population	235.7	255.5	267.3	330.9	337.2	9.68%
			Served Population	219.2	237.6	248.6	307.7	313.6	
			Population Density	5.9	6.4	6.7	8.3	8.5	
East of Ha Noi	Long Bien	59.93	Total Population	186.4	195.1	204.3	220.8	227.1	5.08%
			Served Population	173.4	181.4	190.0	205.3	211.2	
			Population Density	3.1	3.3	3.4	3.7	3.8	
	Gia Lam	114.73	Total Population	207.9	213.3	218.8	224.5	232.2	2.81%
			Served Population	35.3	36.3	37.2	38.2	39.5	
			Population Density	1.8	1.9	1.9	2.0	2.0	

(Source：Ha Noi Statical Data Year Book 2009)

The future population of 2015 to 2030 is estimated using values presented in table 3.2.6, and the results are presented in Table 3.2.7.

The upper row in each case in the table indicates the estimated values in this research and the lower row gives estimated values of the water supply plan. As for Gia Lam Prefecture, population is compared within the Supply Area, because the whole prefecture is not included in the Supply Area. Moreover, the city center is defined as one Supply Area (except for Tu Liem Prefecture) in the water supply plan; consequently, future population is estimated only as global population.

Concerning the estimation method, as recent demographic evolution tends to increase linearly, it is estimated by linear approximation, supposed that the actual trend will continue for the moment. R^2 values in the approximation formula are all high as 0.96 or more.

Table 3.2.7 Estimation of Future Population

Area	Existing Population (1,000 people)	Estimated Populations (1,000 people)			R^2
	2009	2015	2020	2030	
Center of Ha Noi (8) districts	1,956.8	2,276.6	2,532.7	3,044.8	0.9694
		1,768.5	1,727.8	1,656.0	
Long Bien district	227.1	267.2	297.1	356.9	0.9943
		272.1	317.0	426.0	
Gia Lam prefecture	109.6	151.9	179.7	235.4	0.9826
(Water supply Area)		167.4	180.0	247.0	

*The upper row in each category in the table indicates estimated values by Study Team and the lower row estimated values in Ha Noi City water supply plan.

The results of Table 3.2.7 for Center of Ha Noi (8) districts indicate that the estimated values in this research exceed remarkably the estimated values of the water supply plan. This is because, in the water supply plan, it is intended to limit future population influx through development limitation area in four districts of Ba Dinh, Hoan Kiem, Dong Da and Hai Ba Trung, on account of actual sudden increase, and thereby to decrease artificially the future population. Therefore, concerning the future population, it will be reasonable to adopt relatively small estimated values of the water supply plan to avoid excessive water demand forecast.

In respect of Long Bien District, estimated values of the water supply plan came slightly exceeds the estimates in this research, by about 70 thousands habitants in 2030. The detail cannot be confirmed because the estimation method of the water supply plan is unknown, but it can be supposed that various factors such as future development population, etc. are anticipated. As the present research aims at setting a basic frame up to 2020, it will be evaluated only with estimated values up to 2020 and relatively small estimated values of JICA Study Team will be adopted.

As for Gia Lam Prefecture, a large disparity between the estimated values in this research and estimated values of the water supply plan was not marked. Therefore, the present estimated values shall be adopted, because the detail of target Supply Area is not clarified in the water supply plan.

Based on above discussion, the final future population is set as shown in Table 3.2.8.

Table 3.2.8 Set Values of Future Population

Area	Estimated Population (1,000 people)		
	2015	2020	2030 (Reference)
Center of Ha Noi 8 districts	—	1,727.8	1,656.0
Long Bien district	267.2	297.1	356.9
Gia Lam prefecture (Planning Water supply Area)	151.9	179.7	235.4

*Method of Population calculation in case of Gia Lam Prefecture

In Gia Lam Prefecture, only 6 of 22 districts in the prefecture are supplied with water. Among them, only two districts in the south of Duong River are supplied with water from Gia Lam Water Treatment Plant. However, according to the Gia Lam Prefecture pipeline network maintenance plan, Supply Area shall be enlarged to the order of 11 districts in the south of Duong River through future distribution network maintenance. On the other hand, the north of Duong River, being targeted by the other project, is not included in future distribution targets from Duong River Water Treatment Plant. Therefore, population of 11 districts in the south of Duong River which will be, in the future, supplied with water from Duong River Water Treatment Plant is calculated in Table 3.2.8.

For the calculation, future population of the whole prefecture is divided proportionally by the actual population ratio of respective district, and future populations of concerned district were accumulated.

Districts target of water supply considered for the estimation are shown in Figure 3.2.10.

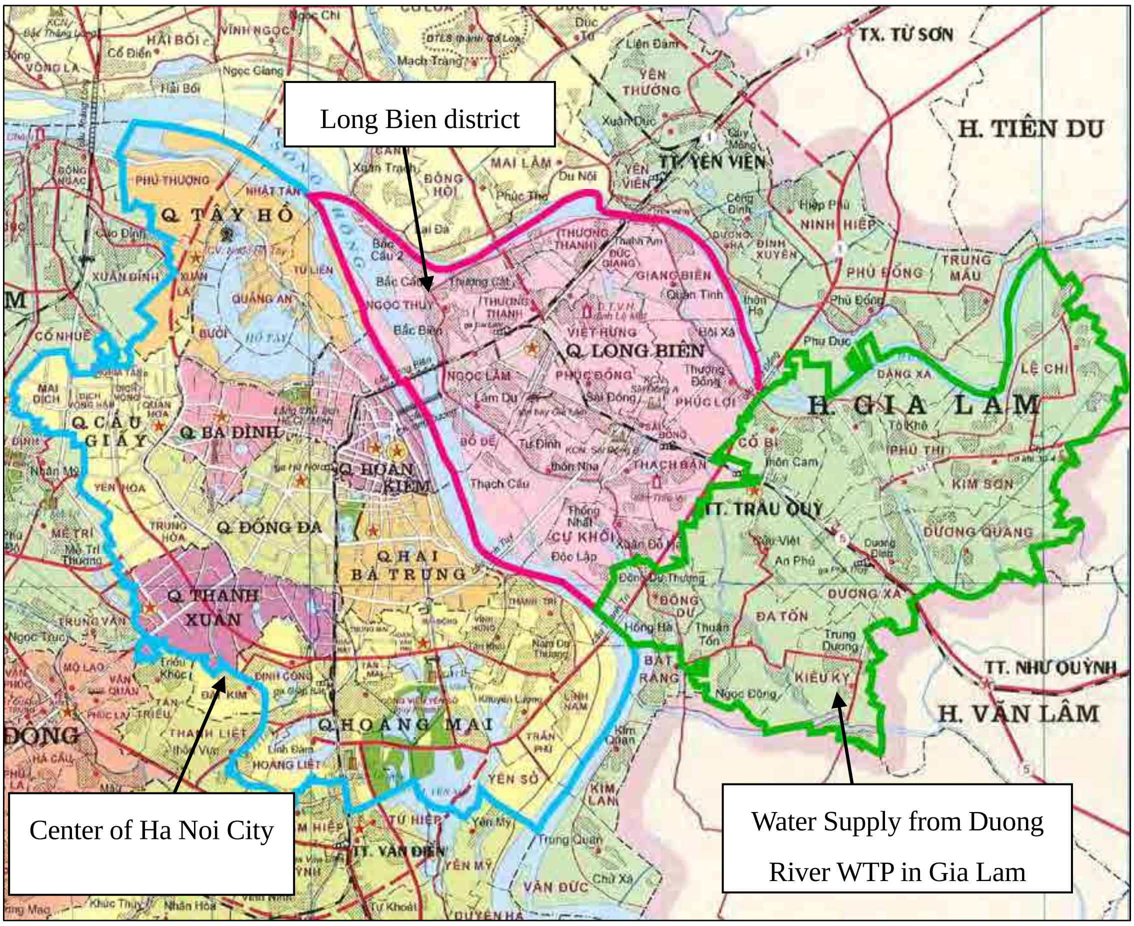


Figure 3.2.10 Target Districts of Population Estimation

2) Water Supply Service Ratio

Water supply service ratio is set based on Ha Noi City water supply plan.

At present, water supply reaches approximately 93% in average for districts, and for certain districts, it has already reached almost 100%. Ha Noi City water supply plan targets 100% coverage in 8 districts in the city center by 2020 and 95% for Long Bien District, therefore, the present estimation is also made considering these levels of service ratio.

On the other hand, the actual water supply coverage of Gia Lam Prefecture is low at approximately 17% of the total population. However, the exact water supply service ratio is unknown, because water is supplied village by village for certain districts. Moreover, at present, 9 districts are totally deprived of water supply in Duong River south area which is included in water supply target area, but these districts will be supplied with water, as mentioned above, by the future pipeline maintenance plan. Gia Lam Prefecture pipeline maintenance plan targets 90%

service ratio in 2015 and 95% in 2020 in water supply target districts, while Ha Noi City water supply plan targets 90% coverage by 2020.

Following safer targets of Ha Noi City water supply plan, this estimation aims at 90% coverage ratio in 2015 and 2020.

Table 3.2.9 Water Supply Coverage Ratio in Ha Noi City (Planned)

Area	2015	2020
Center of Ha Noi 8 districts	－	100%
Long Bien district	95%	95%
Gia Lam prefecture (Planned Water supply Area)	90%	90%

（Source：Ha Noi City water supply plan）

3) Supply Unit (daily average supply per capita)

So far, future supply unit has been set based on water supply facility construction standard of MOC (Ministry of Construction) (TCXDVN 33 2006). However, actual supply units often do not meet the mentioned construction standard, so the importance of reviewing the basic unit setting is discussed in Ha Noi City water supply plan which is now being prepared.

Units and adopted values in the present Ha Noi City is shown in Table 3.2.10. In the present estimation, basic unit setting will follow set values of Ha Noi City water supply plan and Gia Lam Prefecture pipeline maintenance plan that are set based on achieved values.

Table 3.2.10 Basic Unit Set Values (unit: Lpcd)

Area		2010		2015			2020		
		Existing	WS	GL	HN	WS	GL	HN	WS
Centre of Ha Noi (8) district		150	165	—	—	—	—	170	200
Long Bien district		130	165	145	—	—	—	160	150
Gia Lam prefecture	Urban	130	80	130	—	—	—	140	150
	Rural	60	60	100	—	—	120	120	100

* The figures in bold represents adopted values in the estimation

* Symbols in the table represent the following meaning.

GL：Gia Lam Prefecture pipeline maintenance plan

HN：Ha Noi City water supply plan,

WS：Water supply facility construction standard（TCXDVN 33 2006）

4) Setting of other coefficients

Besides abovementioned service ratios and supply unit, it is necessary to set various coefficients in order to calculate water demand. These coefficients are set as shown in the following table, according to the values adopted in the Gia Lam Prefecture pipeline maintenance plan and Ha Noi City water supply plan which have set the values based on Water supply facility construction standard (TCXDVN 33 2006).

Table 3.2.11 Setting of Various Coefficients Necessary for Water Demand Estimation

No.	Item		2015	2020
a)	Domestic use	common	Served Population × Lpcd	
b)	Public use	Central Area	—	18% of a)
		Long Bien	15% of a)	18% of a)
		Gia Lam	10% of a)	15% of a)
c)	Commercial use	common	10%of a)	
d)	Manufacturing use	Central Area	5% of a)	
		Long Bien	5% of a)	
		Gia Lam	7% of a)	
e)	Industrial use	common	22m3/ha	
f)	Water leakage	Central Area	—	30% of a) - e)
		Long Bien	25% of a) - e)	25% of a) - e)
		Gia Lam	22% of a) - e)	22% of a) - e)

g)	Loading Ratio	Central Area	20% of total above
		Long Bien	20% of total above
		Gia Lam	30% of total above

（Source：Water supply facility construction standard TCXDVN 33 2006,
Ha Noi City water supply plan, Gia Lam Prefecture pipeline maintenance plan）

5) Development water volume for industrial and housing complex

Industrial and housing complexes whose demand is anticipated in the present estimation are shown in Table3.2.12.

Development water volume for industrial and housing complex shall be calculated according to the following principles.

- Industrial complex and service center: planned area x basic unit 22 m^3/ha
- Housing complex: planned population x life basic unit *1 x various coefficients *2
- Leakage rate: Set to 10% according to Ha Noi City water supply plan, for the scale is smaller than general pipeline network and leakage is to be little.
- Loading rate: Loading rate is not anticipated for the industrial complex, because, different from general household, the variation of water consumption is small.

*1,*2… Habitants of development district are expected to have high standard of livings, therefore basic unit and various coefficients are set same to those of Long Bien District.

Table 3.2.12 Industrial and Housing Complexes Considered in the Estimation

No.	City and Province	District and Prefecture	Name	Name Year	Planned Area	Planned Population	Remarks
1	Ha Noi City	Long Bien District	Industrial complex in Long Bien District (including those planned)	2015 2020	700ha 1,000ha	—	Source: Ha Noi City water supply plan
2			Garden City housing complex	2017	18ha	6,600	Housing complex by Malaysian developer (in preparation)
3			High Tech Park	—	414ha	39,500	Complex dedicated to IT industries (not prepared at present)
4			Sai Dong new housing complex	—	70ha	10,000	Housing complex by a domestic developer (infrastructure is already prepared)
5		Gia Lam Prefecture	Hanoi-Dai Tu industrial complex	—	40ha	—	Industrial complex (existing) Housing complex is also planned to be prepared
5			Dang Xa housing complex	—	73.5ha	5,000	Housing complex by a major domestic ceramic maker (in preparation)
6			Kieu Ky Service Center	—	55ha	9,000	Redevelopment project focused on village specialty: leather items (not launched)
7			Harpo industrial complex	2012	140ha	—	Industrial complex by a domestic major food company (under preparation)
8			Harpo housing complex	2012	—	3,500	Housing complex annexed to the industrial complex (under preparation)
9	Hung Yen Province	Van Giang Prefecture	Eco Park housing complex	—	500ha	136,000	Housing complex by a domestic developer (in preparation)

6) Demand Forecast Results

Results of water demand calculation of each area for 2015 and 2020 based on settings discussed earlier are shown in Table 3.2.13 and Table 3.2.14.

Concerning water demand of Bac Ninh Province, water volume corresponding to the construction of new water treatment plant is set as follows, based on planned contents of the Decision No. 1580-QD-UBND.

- 2015 (Phase 1): 10,000 m^3/day
- 2020 (Phase 2): 30,000 m^3/day

【2015】

From Table 3.2.13, water demand in 2015 is expected to be approximately 162,000 m^3/day.

In Ha Noi City, demand only in Long Bien District and Gia Lam Prefecture required by HAWACO is approximately 110,000 m^3/day, which is far below 150,000 m^3/day. Therefore, the JICA Study Team proposed earlier to stop the operation of Phap Van Water Treatment Plant presenting water quality problems and to use it as Distribution Facility (Pumping Station), by anticipating transmission to Phap Van Water Treatment Plant to be connected after traversing Red River, as the transmission to the center of the city. As water volume for stopping the operation, 30,000 m^3/day corresponding to the existing water treatment capacity shall be anticipated as demand and thereby, approximately 140,000 m^3/day come to be anticipated only for Ha Noi City as the Phase 1 water demand.

【2020】

From Table 3.2.14, approximately 392,000 m^3/day of demand is anticipated for 2020 and, of that, approximately 340,000 m^3/day of water demand is anticipated in Ha Noi City. Demand of only Gia Lam Prefecture and Long Bien District is approximately 170,000 m^3/day, the remaining 170,000 m^3/day are all for the center of Ha Noi City.

Water demand without existing water treatment capacity is anticipated for the center of Ha Noi City; as for three (3) Water Treatment Plants where the operation will be suspended (Phap Van, Tuong Mai, Ha Dinh), the suspension is excluded from the anticipated deduction.

Moreover, in 2020, demand volume will exceed largely the planned water treatment capacity of 300,000 m^3/day, but the lack will be compensated by Red River Water Treatment Plant, because Red River Water Treatment Plant which is also a surface water system large scale water treatment plant and is expected to operate at that time. Even if Red River Water Treatment Plant operation starts late, it will be recovered without problem by three water treatment plants including Duong River Water Treatment Plant, because backup from Da River Water Treatment Plant is available.

Table 3.2.13 Water Demand in Ha Noi City in 2015 (Phase 1)

No.	Area	Population	Coverage Ratio (%)	Served Population	Domestic Use		Public Use		Commercial Use		Manufacturing Use		Industrial Use			Total (Qtt)	Leakage Water		Average Daily Supply	Loading Ratio	Maximam Daily Supply	Accounted by VIWASEEN (m3/day)
					Lpcd	Demand (m3/day)	Consumption Ratio	Demand (m3/day)	Consumption Ratio	Demand (m3/day)	Consumption Ratio	Demand (m3/day)	m3/ha	Area (ha)	Demand (m3/day)		Consumption Ratio	Demand (m3/day)				
	【Ha Noi City】																					
1	Central Area of Ha Noi																Capacity of Phap Van WTP				30,000	(0)
2	Long Bien	267,200	95%	253,840	145	36,807	15%	5,521	10%	3,681	5%	1,840				47,849	25%	11,962	59,811	1.20	71,773	(36,000)
	Garden City Residential Park	6,600	10%	660	145	96	15%	14	10%	10	5%	5				125	10%	13	138	1.20	166	(216)
	High Tech Park	39,500	5%	1,975	145	286	15%	43	10%	29	5%	14				372	10%	37	409	1.20	491	(11,519)
	Sai Dong New Residential Park	10,000	10%	1,000	145	145	15%	22	10%	15	5%	7				189	10%	19	208	1.20	250	(2,916)
	Long Bien Industrial Park												22	300	6,600	6,600	10%	660	7,260	1.00	7,260	(16,301)
3	Trau Quy	30,120	90%	27,108	130	3,524	10%	352	10%	352	7%	247				4,475	22%	985	5,460	1.30	7,098	(60,000)
	Hanoi-Dai Tu Industrial Park												22	20	440	440	10%	44	484	1.30	629	(1,267)
4	Co Bi	11,700	90%	10,530	130	1,369	10%	137	10%	137	7%	96				1,739	22%	383	2,122	1.30	2,759	including of 3
5	Da Ton	14,620	90%	13,158	100	1,316	10%	132	10%	132	7%	92				1,672	22%	368	2,040	1.30	2,652	(2,064)
6	Dang Xa	11,110	90%	9,999	100	1,000	10%	100	10%	100	7%	70				1,270	22%	279	1,549	1.30	2,014	(1,547)
	Dang Xa Residential Park	5,000	25%	1,250	145	181	10%	18	10%	18	5%	9				226	10%	23	249	1.00	249	(2,316)
7	Dong Du	5,560	90%	5,004	100	500	10%	50	10%	50	7%	35				635	22%	140	775	1.30	1,008	(607)
8	Duong Quang	13,740	90%	12,366	100	1,237	10%	124	10%	124	7%	87				1,572	22%	346	1,918	1.30	2,493	(820)
9	Duong Xa	12,570	90%	11,313	100	1,131	10%	113	10%	113	7%	79				1,436	22%	316	1,752	1.30	2,278	(2,028)
10	Kieu Ky	12,570	90%	11,313	100	1,131	10%	113	10%	113	7%	79				1,436	22%	316	1,752	1.30	2,278	(1,786)
	Kieu Ky Service Centre												22	55	1,210	1,210	10%	121	1,331	1.00	1,331	(247)
11	Kim Son	14,910	90%	13,419	100	1,342	10%	134	10%	134	7%	94				1,704	22%	375	2,079	1.30	2,703	(0)
	Hapro Industrial Park												22	60	1,320	1,320	10%	132	1,452	1.00	1,452	(2,880)
	Hapro Residential Park	3,500	90%	3,150	145	457	10%	46	10%	46	5%	23				572	10%	57	629	1.00	629	(1,021)
12	Le Chi	15,200	90%	13,680	100	1,368	10%	137	10%	137	7%	96				1,738	22%	382	2,120	1.30	2,756	(0)
13	Phu Thi	9,360	90%	8,424	100	842	10%	84	10%	84	7%	59				1,069	22%	235	1,304	1.30	1,695	(910)
	【Bac Ninh Province】																					
14	Lim																Water Demand of Bac Ninh Province				10,000	(10,080)
	【Hung Yen Province】																					
15	Eco Park Residential Park	136,000	25%	34,000	145	4,930	15%	740	10%	493						6,163	10%	616	6,779	1.20	8,135	(39,838)
	Total	619,260		432,189		57,662		7,880		5,768		2,932			9,570	83,812		17,809	101,621		162,099	(194,363)

Center of Ha Noi City	30,000	m3/day (Above 1)
Lon Bien District	79,940	m3/day (Above 2)
Gia Lam Prefecture	34,024	m3/day (Above 3-13)

Total volume of not supplyed area	21,208	m3/day
Total volume of deveroping area	10,873	m3/day

Table 3.2.14 Water Demand in Ha Noi City in 2020 (Phase 2)

No.	Area	Population	Coverage Ratio (%)	Served Population	Domestic Use		Public Use		Commercial Use		Manufacturing Use		Industrial Use			Total (Qtt)	Leakage Water		Average Daily Supply	Loading Ratio	Maximam Daily Supply	Accounted by VIWASEEN (m3/day)
					Lpcd	Demand (m3/day)	Consumption Ratio	Demand (m3/day)	Consumption Ratio	Demand (m3/day)	Consumption Ratio	Demand (m3/day)	m3/ha	Area (ha)	Demand (m3/day)		Consumption Ratio	Demand (m3/day)				
	【Ha Noi City】																					
1	Central Area of Ha Noi	1,727,800	100%	1,727,800	170	293,726	18%	52,871	10%	29,373	5%	14,686				390,656	30%	117,197	507,853	1.20	609,424	
2	Long Bien	297,100	95%	282,245	160	45,159	18%	8,129	10%	4,516	5%	2,258				60,062	25%	15,016	75,078	1.20	90,094	
	Garden City Residential Park	6,600	100%	6,600	160	1,056	18%	190	10%	106	5%	53				1,405	10%	141	1,546	1.20	1,855	
	High Tech Park	39,500	100%	39,500	160	6,320	18%	1,138	10%	632	5%	316				8,406	10%	841	9,247	1.20	11,096	
	Sai Dong New Residential Park	10,000	50%	5,000	160	800	18%	144	10%	80	5%	40				1,064	10%	106	1,170	1.20	1,404	
	Long Bien Industrial Park												22	700	15,400	15,400	10%	1,540	16,940	1.00	16,940	
3	Trau Quy	35,640	90%	32,076	140	4,491	15%	674	10%	449	7%	314				5,928	20%	1,186	7,114	1.30	9,248	
	Hanoi-Dai Tu Industrial Park												22	40	880	880	10%	88	968	1.30	1,258	
4	Co Bi	13,840	90%	12,456	120	1,495	15%	224	10%	150	7%	105				1,974	20%	395	2,369	1.30	3,080	
5	Da Ton	17,300	90%	15,570	120	1,868	15%	280	10%	187	7%	131				2,466	20%	493	2,959	1.30	3,847	
6	Dang Xa	13,150	90%	11,835	120	1,420	15%	213	10%	142	7%	99				1,874	20%	375	2,249	1.30	2,924	
	Dang Xa Residential Park	5,000	90%	4,500	160	720	18%	130	10%	72	5%	36				958	10%	96	1,054	1.20	1,265	(183,204)
7	Dong Du	6,570	90%	5,913	120	710	15%	107	10%	71	7%	50				938	20%	188	1,126	1.30	1,464	
8	Duong Quang	16,260	90%	14,634	120	1,756	15%	263	10%	176	7%	123				2,318	20%	464	2,782	1.30	3,617	
9	Duong Xa	14,880	90%	13,392	120	1,607	15%	241	10%	161	7%	112				2,121	20%	424	2,545	1.30	3,309	
10	Kieu Ky	14,880	90%	13,392	120	1,607	15%	241	10%	161	7%	112				2,121	20%	424	2,545	1.30	3,309	
	Kieu Ky Service Centre												22	55	1,210	1,210	10%	121	1,331	1.00	1,331	
11	Kim Son	17,650	90%	15,885	120	1,906	15%	286	10%	191	7%	133				2,516	20%	503	3,019	1.30	3,925	
	Hapro Industrial Park												22	140	3,080	3,080	10%	308	3,388	1.30	4,404	
	Hapro Residential Park	3,500	100%	3,500	160	560	18%	101	10%	56	5%	28				745	10%	75	820	1.30	1,066	
12	Le Chi	17,990	90%	16,191	120	1,943	15%	291	10%	194	7%	136				2,564	20%	513	3,077	1.30	4,000	
13	Phu Thi	11,070	90%	9,963	120	1,196	15%	179	10%	120	7%	84				1,579	20%	316	1,895	1.30	2,464	
	【Bac Ninh Province】																					
14	Lim																Water Demand of Bac Ninh Province				30,000	(108,104)
	【Hung Yen Province】																					
15	Eco Park Residential Park	136,000	50%	68,000	160	10,880	18%	1,958	10%	1,088						13,926	10%	1,393	15,319	1.20	18,383	(39,838)
	Total	2,404,730		2,298,452		379,220		67,660		37,925		18,816			20,570	524,191		142,203	666,394		829,707	(331,146)

【Existing WTP】

No.	Item	Capacity (m3/day)
1	Yen Phu WTP	90,000
2	Ngoc Ha WTP	32,000
3	Ngo Si Lien WTP	47,000
4	Mai Dich WTP	60,000
5	Cao Dinh WTP	60,000
6	Luong Yen WTP	50,000
7	Nam Du WTP	60,000
8	Small scale several WTPs	39,000
	Total	438,000

Center of Ha Noi City	171,424	m3/day (Different above 1 from capacity of existing WTP)
Lon Bien District	121,389	m3/day (Above 2)
Gia Lam Prefecture	50,511	m3/day (Above 3-13)

∴ Difference of total volume of demand from existing WTP capacity: 391,707 (m3/day)

(3) Off Take Points and Off Take Method

1) Ha Noi City

Four (4) off take points shown in Table 3.2.15 are set for Ha Noi City according to the aforementioned principles. As for off take method, if pipeline is connected directly, not only transmission pumping cost and pipeline cost increase due to chronicle variation of distribution volume, but also it is feared that water quality accident or pipeline rupture may affect downstream distribution network, therefore, it is recommended to deliver at off take tank.

Therefore, all of off take points shall be provided with an off take tank and, as for Phap Van Water Treatment Plant, off take shall be realized at the distribution reservoir in the plant.

It is to be noted that the off take tank shall be installed by the receiving entity (HAWACO).

Locations of respective off take point and distribution area are shown in Figure 3.2.11.

Table 3.2.15 Composition of Off Take Point Water Volume

Off take Point	Supply Area	Water Demand (m3/day) 2015	Water Demand (m3/day) 2020	Condition of Distribution Network Construction
1.Phu Thi（Sui）	Total	13,991	23,665	
	Dang Xa	2,263	4,189	Planning
	Duong Quang	2,493	3,617	Planning
	Kim Son	4,784	9,395	None
	Le Chi	2,756	4,000	None
	Phu Thi	1,695	2,464	Planning
2.Trau Quy	Total	20,033	26,846	
	Trau Quy	7,727	10,506	Existing
	Co Bi	2,759	3,080	Existing
	Da Ton	2,652	3,847	Planning
	Dong Du	1,008	1,464	Planning
	Duong Xa	2,278	3,309	Planning
	Kieu Ky	3,609	4,640	Planning
3.Sai Dong	Total	79,940	136,389	
	Long Bien	79,940	121,389	Existing
	Central area of Ha Noi	―	15,000	Existing
4.Phap Van WTP	Central area of Ha Noi	17,901	64,717	Existing

Off take Point setting location are shown in Figure 3.2.11.

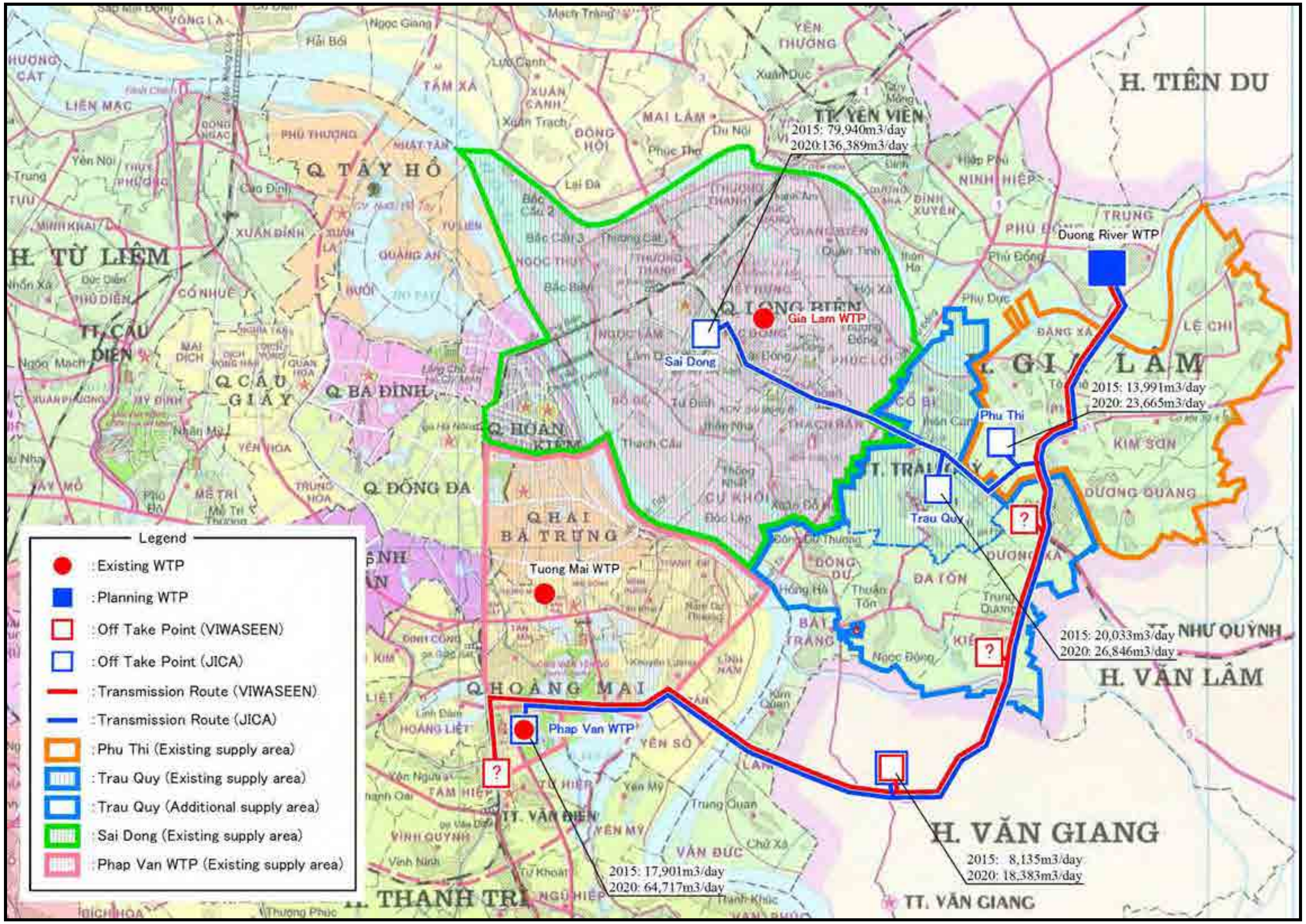


Figure 3.2.11 Off Take Point and Distribution Area

2) Bac Ninh Province

As for off take point location and off take method of Bac Ninh Province, the off take point shall be installed near Lim, Tien Du Prefecture, on negotiation with Bac Ninh Province Water Works.

Study Team received the response that both off take tank and delivery by pipeline are good as off take method, therefore off take tank shall be adopted similar to the case of Ha Noi City.

It was agreed that off take tank, distribution pump or other facilities shall be prepared by Bac Ninh Province Water Works.

3) Hung Yen Province

As for off take point location and off take method of Hung Yen Province, Study Team received the response that the client is a housing complex which will install independently its own off take tank (and possibly its own water treatment facility) through a hearing at the time of Pre-FS survey; therefore the delivery shall be performed by directly connecting pipelines.

It is necessary to negotiate with Eco Park Management Company about the delivery point, but the delivery shall be exerted in Eco Park, because the transmission pipeline will be laid in the vicinity of Eco Park.

4) Off Take Point location and off take volume

Principles set in said 1) to 3) and off take volume at the Off take Point are shown in Table 3.2.16.

Moreover, transmission pipeline route chart including final review is shown in Figure 3.2.11.

Table 3.2.16 Off Take Volume by Off Take Point

No.	Off take Point	Water Demand (m3/day)		Method of off take
		2015	2020	
①	Lim	10,000	30,000	Reservoir Tank
②	Phu Thi	13,991	23,665	〃
③	Trau Quy	20,033	26,846	〃
④	Sai Dong	79,940	136,389	〃
⑤	Eco Park	8,135	18,383	Direct Connection
⑥	Phap Van WTP	17,901	64,717	Connect to Existing Tank
	Total	150,000	300,000	

3.2.7 Basic Frame of the Proposed Project

(1) Negotiation with Counterpart

The project based on said survey results of JICA Study Team was proposed to the counterparts. Their responses, comments and wishes are compiled in Table 3.2.17 and graphically shown in Figure 3.2.12.

Table 3.2.17 Results of On Site Negotiation

Negotiation Item	Proposal of JICA Study Team	Opinion about JICA Study Team proposal	Conclusion
1. Proposal of modification of Gia Lam Water Treatment Plant distribution area	• If distribution area of Duong River Water Treatment Plant and that of Gia Lam Water Treatment Plant overlap, it is feared that sufficient water consumption cannot be expected and water quality control and distribution pressure control would become difficult. Therefore, the distribution area of Gia Lam Water Treatment Plant shall be switched to the north of Ha Noi City (Dong Anh Prefecture) which may be short of water and the actual distribution area of Gia Lam Water Treatment Plant shall entirely be covered by transmission from Duong River Water Treatment Plant.	• Support the proposal of JICA Study Team	• As proposed
2. Proposal of modification of Off take Point setting position and transmission pipeline routing	• Given the problem of pipeline caliber, the connection with existing pipeline network of Gia Lam Water Treatment Plant shall preferably be carried out in upstream of the network. • Distribution to the center of Ha Noi City may effectively be operated by making Phap Van Water Treatment Plant the base thereof.	• Support the proposal of JICA Study Team concerning Red River north area (Long Bien District, Gia Lam Prefecture). However, transmission pipeline route and Off take Point location shall be set in consideration of actual situation. (Is it possible to find a route on north side of Route No.5 in place of laying on Route No.5?) • Transmission to the center of Ha Noi City will be carried out by 400mm diameter pipeline connecting Long Bien	• Basically approval to the proposal • Though it is possible to lay transmission pipeline in the north of Route No. 5, many of sites are difficult to access and site purchase may become huge; so it is recommended to lay along Route No.5. Considering the site situation, laying location should not interfere with the traffic, and the engineering work shall be performed at the night when the traffic is small. • As for connection to Phap Van Water Treatment Plant, it shall be connected to existing 800mm

		District and Hoan Kiem District and Red River transversal pipeline to be laid according to the proposed project. After crossing Red River, it shall be connected to a newly laid 800mm diameter distribution main (near Yen So) in place of Phap Van Water Treatment Plant.	diameter distribution main and the construction to Phap Van Water Treatment Plant shall not be performed.
3. Supply Area setting	• As for Supply Area in Ha Noi City, the whole area of Long Bien District shall be set as one (1) Supply Area and, as for Gia Lam Prefecture, the south of Duong River is divided into the south and the north of Route No.5 setting two (2) Supply Areas. In addition, transmission end in the south shall be Phap Van Water Treatment Plant to serve the center of Ha Noi City. • As for the north of Duong River (Bac Ninh Province), transmission pipeline shall be laid up to the proximity of Lim town, in compliance with the wishes of Bac Ninh Province Water Works.	• Actually, JICA Study Team proposal limit Route No.181 in Ha Noi City, but it is preferable to include it in the Supply Area, because a large scale industrial complex is also under construction in Bac Ninh Province (Thuan Thanh Prefecture). • Concerning the transmission end in the south, as mentioned above, it is planned connecting to 800mm diameter distribution main near Yen So immediately after crossing Red River. • As for the north of Duong River, there will be no problem to lay up to Tu Son Prefecture as planned by VIWASEEN.	• Certainly a large scale industrial complex is under construction in Thuan Thanh Prefecture of Bac Ninh Province and the area is full of promise; however, it will be excluded for the moment from Supply Area, because future population and urbanization plan are unknown. However, transmission pipeline construction plan shall anticipate branching to said area so that to allow future transmission to the area. • Concerning the transmission end in the south, as mentioned above, it shall be connected to 800mm diameter distribution main, without connection to Phap Van Water Treatment Plant. • As for the north (Bac Ninh Province), transmission pipeline shall be laid up to the proximity of Lim town, in compliance with survey results and results of negotiation with Bac Ninh Province Water Works.

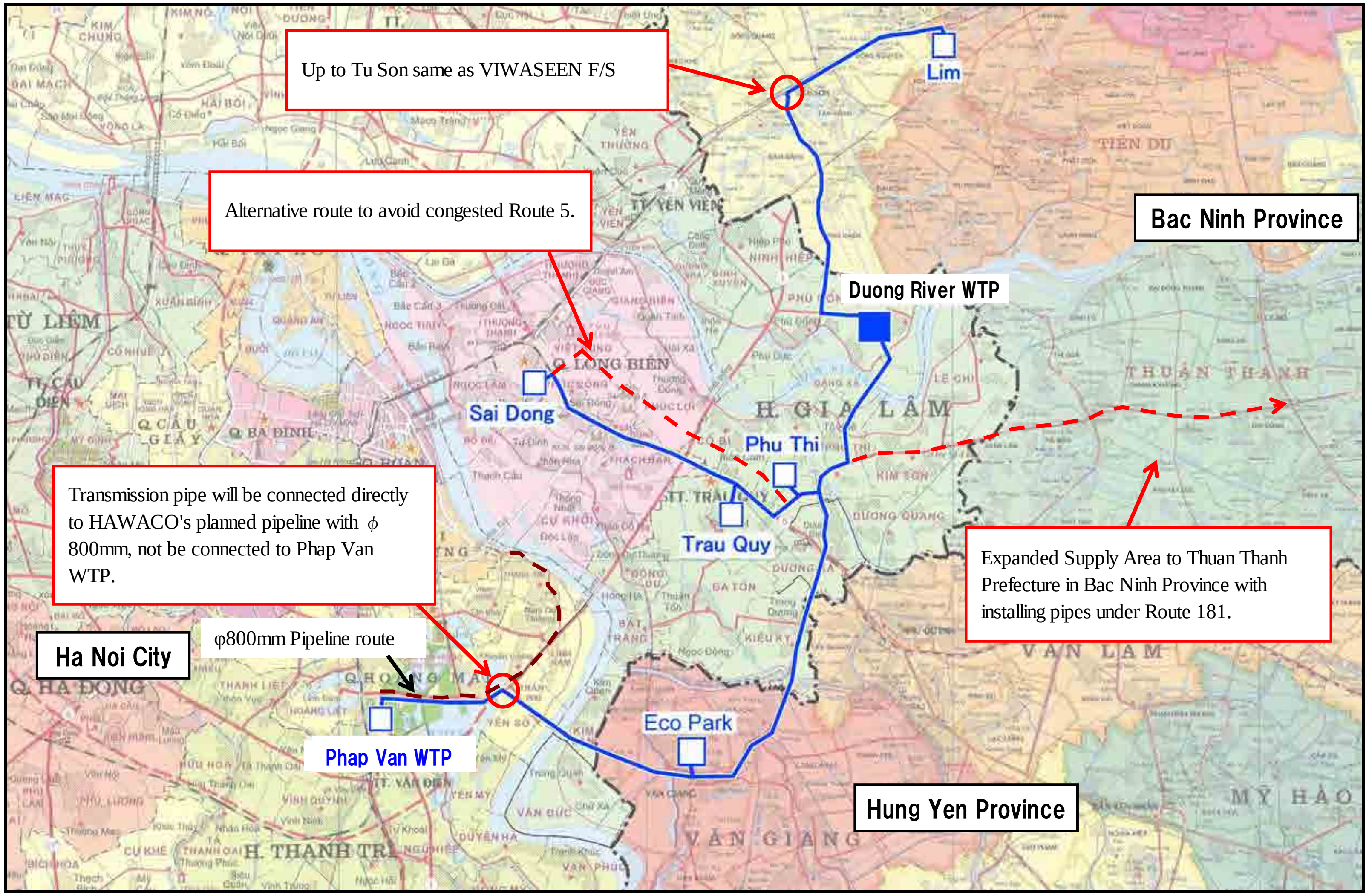


Figure 3.2.12 Results of Meeting with HAWACO

(2) Basic Frame

Based on results of surveys and examinations, the basic frame of the proposed project is set as described below.

Supply target area includes one City and two Provinces as the result of FS survey report of VIWASEEN, but the supply target area of the Phase 2 is proposed to be largely reduced. This is the result of consideration of the intention of HAWACO, communication with other Water Works (VIWACO, Ha Dong Water supply Company, and so on) and the demand certainty. Especially for Hung Yen Province, large scale water consumption cannot be expected and, for Bac Ninh Province, only one off take point will be enough corresponding to the demand. These factors have influenced the result considerably.

This means that the transmission pipeline extension would be shortened, and this shortening is considered to reduce risks concerning the transmission pipeline construction. Moreover, as the scale of transmission target area is reduced, larger becomes the proportion that the demand of Ha Noi City occupies in the proposed project, and this fact allows improving demand certainty and business profitability in the urban area of Ha Noi City where economical disparity still exists.

In the future, it is necessary to proceed to more concrete contract negotiation (adjustment of tariff, water volume and so on). Moreover, depending on the situation, it may become necessary to enlarge, reduce or otherwise review the Supply Area or modify supply water volume. Regarding Basic Frame, it will be discussed and finalized in the expected Shareholders meetings, which was started from March, 2012 occasionally. In the meeting, it was mostly agreed that Supply Area up to Phase 2 could be only Hanoi City.

❒ Scale of Water Treatment Plant
Phase 1: 150,000 m^3/day
Phase 2 : 300,000 m^3/day

❒ Target Supply Area
Phase 1: Ha Noi City (Long Bien District, Gia Lam Prefecture, the center of Ha Noi City)
Bac Ninh Province (transmission to the proximity of Lim town, Tien Du Prefecture)
Hung Yen Province (Housing complex of Van Giang Prefecture)
Phase 2: Same as in case of Phase 1

❒ Length of transmission pipeline
Phase 1: approx. 45.6km Phase 2: Same as in case of Phase 1

❒ Number of Off Take Point
Phase 1: 6 (4 in Ha Noi City, 1 in Bac Ninh Province and 1 in Hung Yen Province)
Phase 2: Same as in case of Phase 1

Note) If the Water Supply Area is only Ha Noi City, the transmission pipeline length is about 20.6 km (please see Table 3.5.33).

Final candidate target Supply Area of this research is shown in Figure 3.2.13 and target water volume of Duong River Water Treatment Plant is presented in Table 3.2.18 and Figure 3.2.14.

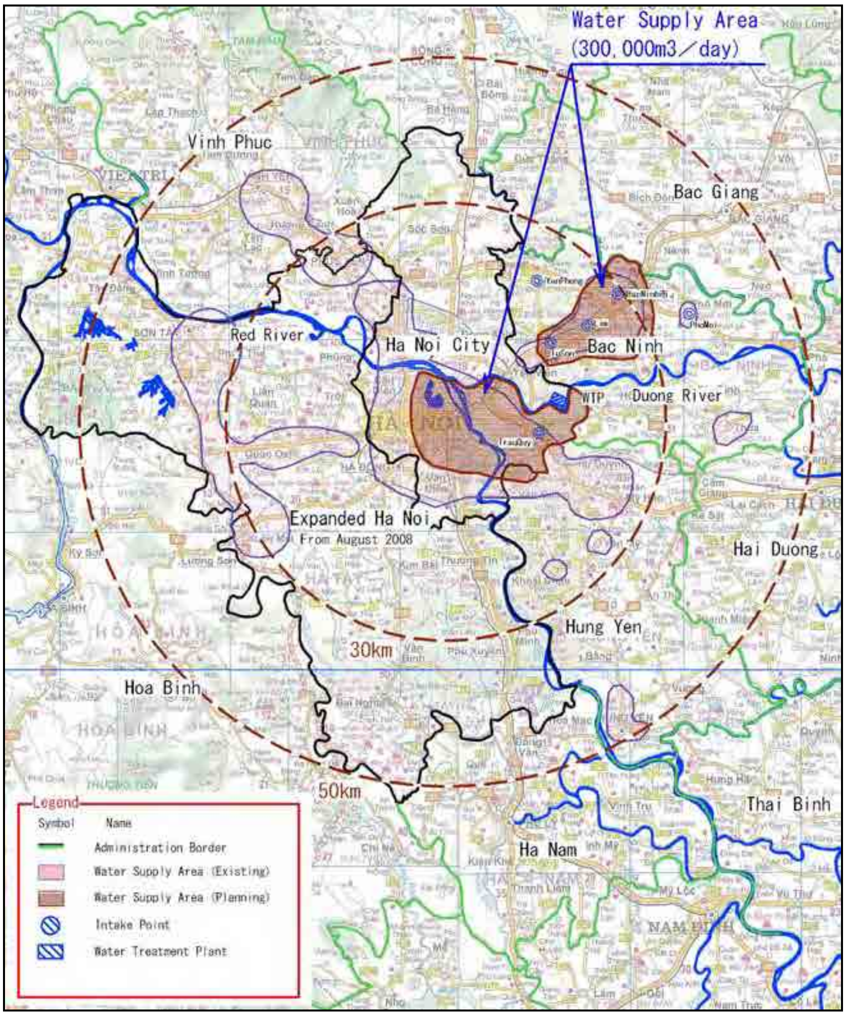


Figure 3.2.13 Supply Area of the Proposed Project (Reviewed)

Table 3.2.18 Target Water Volume of Duong River Water Treatment Plant

Item	2015	2020
Water demand (thousand m^3/day)	162.1	829.7
Capacity of Other Water Treatment Plants (existing, planned, thousand m^3/day)	0.0	438.0
Shortage in water available (thousand m^3/day)	162.1	391.7
Duong River Water Treatment Plant (thousand m^3/day) is proposed to provide	150.0	300.0
	Phase 1	Phase 2
Planned water volume (thousand m^3/day)	150.0	300.0

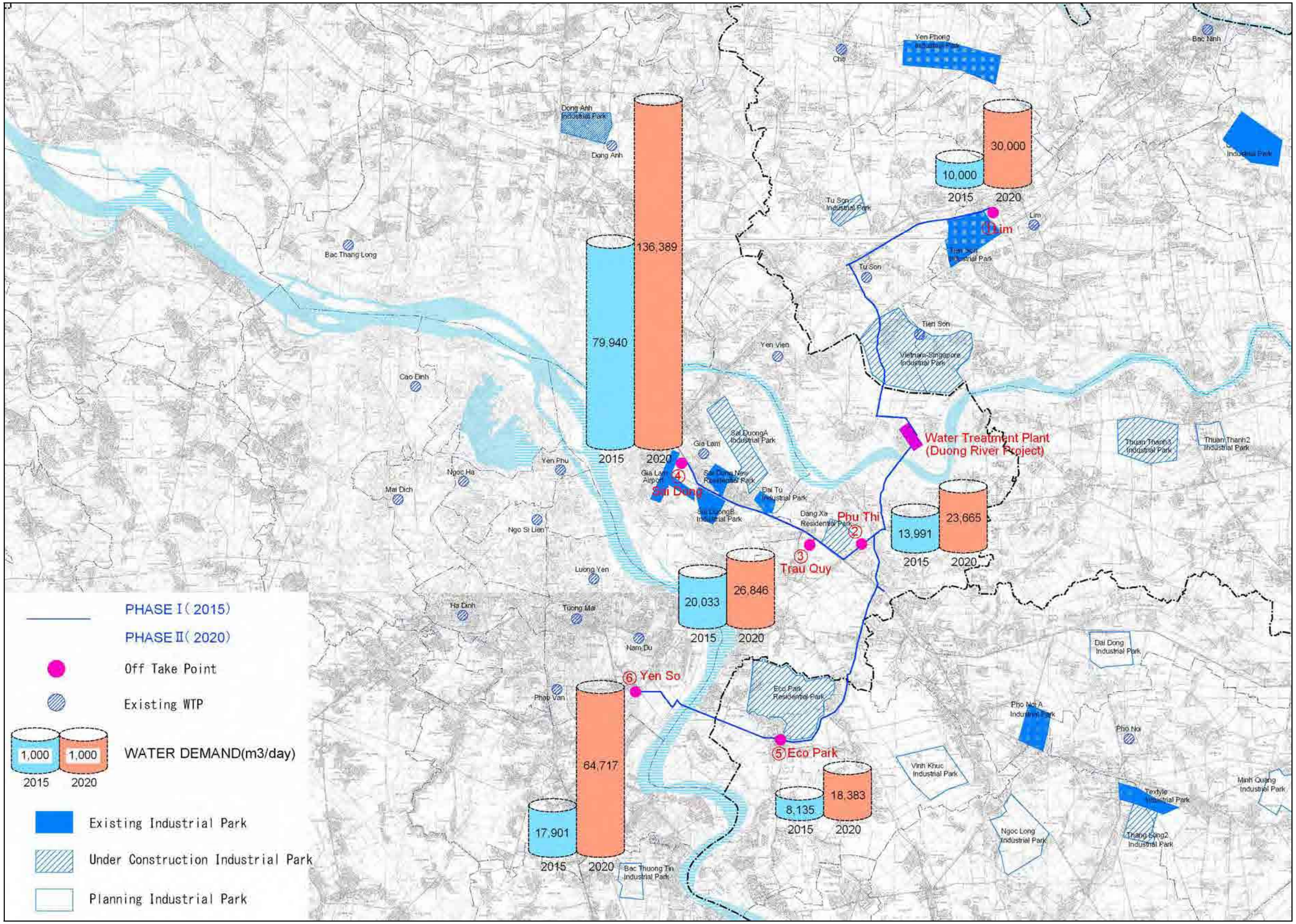


Figure 3.2.14 Target Water Volume of Duong River Water Treatment Plant

3.3 Proposal of Appropriate Scope of Project

3.3.1 Overview of Project

The proposed project is meant for supplying water to one city and two (2) provinces to meet the increasing water demand of the Hanoi metropolitan area. The construction, operation and maintenance of water treatment plant with design water treatment capacity of 300,000 m^3/day (Phase 1: 150,000; Phase 2: 150,000 m^3/day), and maintenance of transmission pipelines of overall length 46 km are to be implemented as a Japanese-Vietnamese PPP venture in this project using the surface water of the Duong River as the water source.

Besides the water supply business units of the Bac Ninh Water supply Authority and HAWACO, industrial parks and residential parks form part of the main water receiving locations.
An overview of the project is given below. (For details, see Figure 3.3.1)

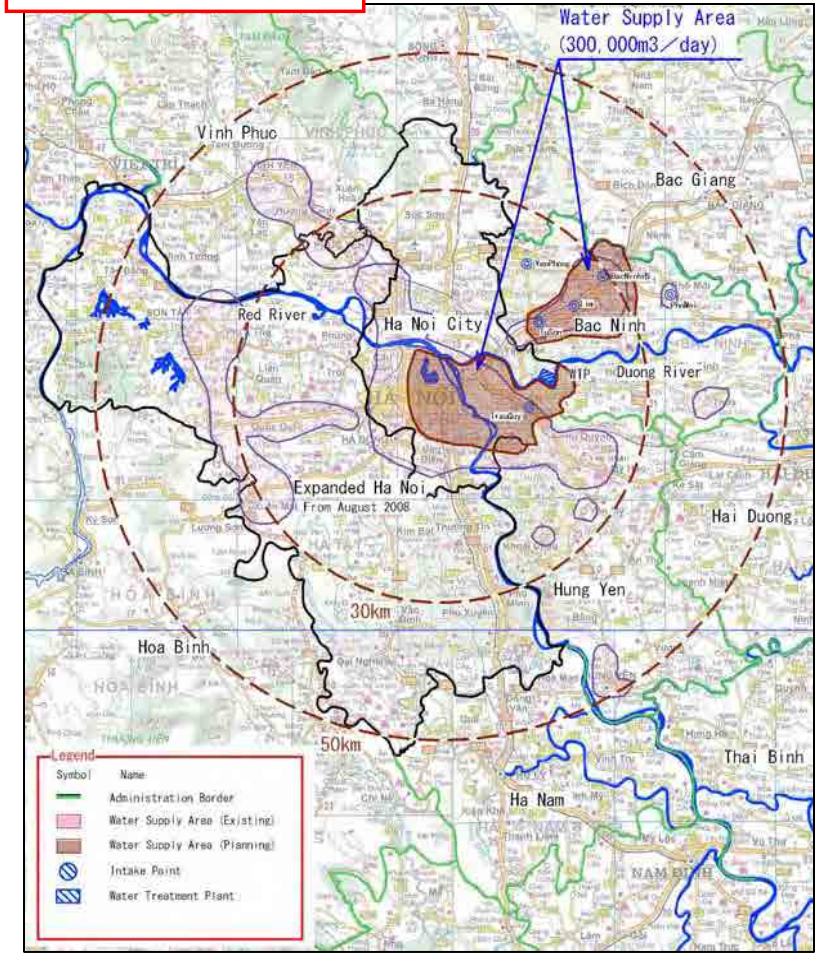
❒ Design Water Treatment Capacity
  Phase 1：150,000m^3/day
  Phase 2：300,000m^3/day

❒ Water Supply Area
  Phase 1：Ha Noi City（Long Bien and Gia Lam and Central area of city）
  Bac Ninh Province（Surrounding Lim Town in Tien Du Prefecture）
  Hung Yen Province（Residential Park in Van Giang Prefecture）
  Phase 2：Same as in case of Phase 1

❒ Length of Transmission pipeline
  Phase 1：about 45.6 km Phase 2：common with Phase 1

❒ Number of Off Take Points
  Phase 1：6 points
  Phase 2：common with Phase 1

Water supply area (300,000m3/day)



Transmission Pipeline and Off Take Point

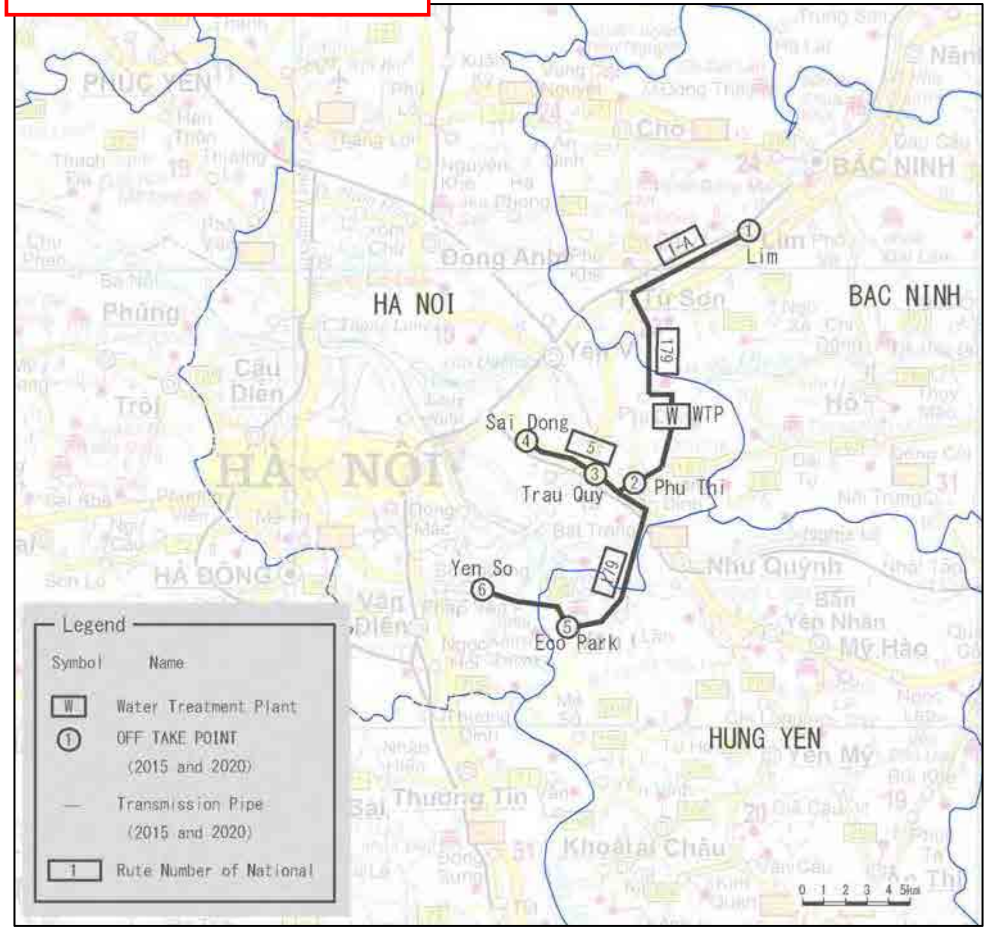


Figure 3.3.1 Outline of This Project

3.3.2 Proposed Scope of Project

As shown in Figure 3.3.2, the scope of the proposed project includes the construction, operation and maintenance of water treatment plant and transmission pipelines. The project is to be implemented after forming the SPC.

Clearly defining the sharing of public roles by the Japanese and Vietnamese sides are important from the viewpoint of the PPP project. The role of the Japanese industry is to propose treatment technologies for treating river water of high turbidity, construction of facilities, and responsibility of operation and maintenance. The assumption for capital procurement is that public funds (with the cooperation of authorities) and private funds will be effectively utilized, and new finances will be procured to ensure long-term viability of the project.

The proposal for these water treatment technologies and finances will contribute to the growth of water supply works and development of capital markets in Viet Nam.

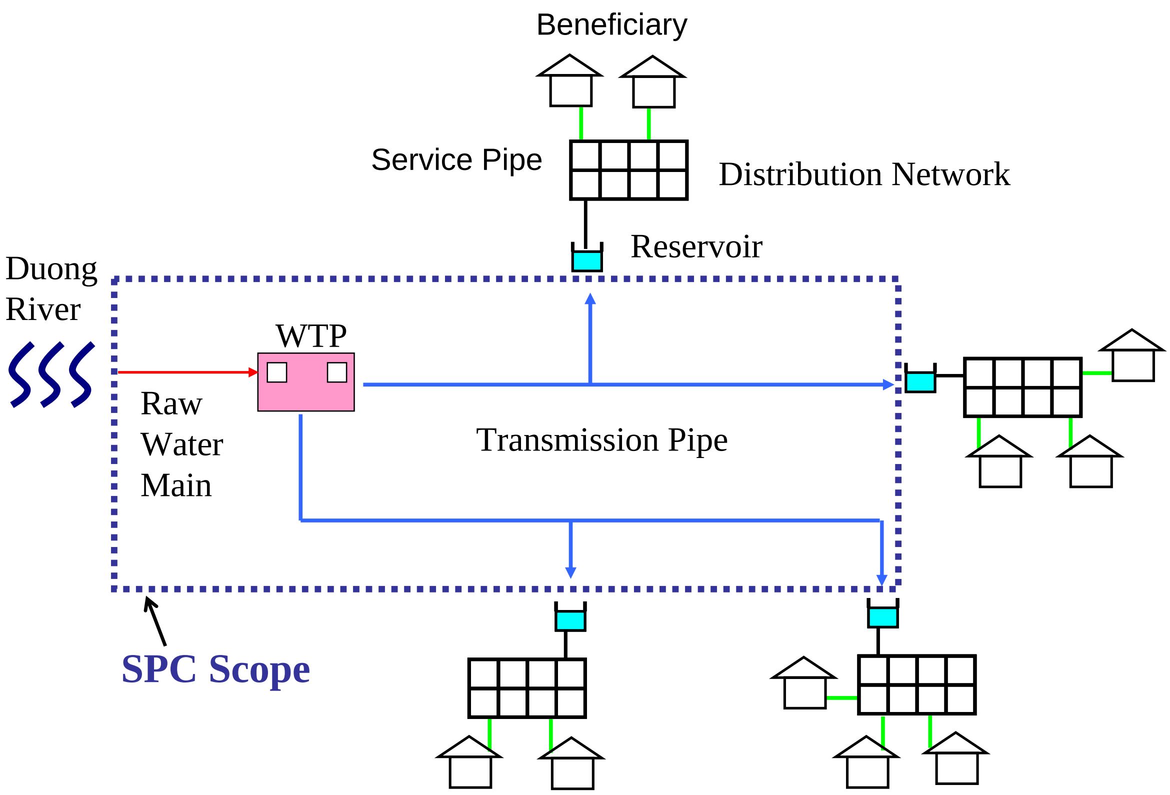


Figure 3.3.2 Concept of the Proposed Project

3.3.3 Selection of Construction Site for Water Treatment Plant

From the results of field survey during the pre-feasibility study, the land to be used for water treatment plant (WTP) construction was selected as shown in Figure 3.3.3. However, according to the plan by VIWASEEN, the main implementing agency in this study, and based on the outcome of confirmation on site, the proposed site for construction of WTP was changed because there was a possibility of several houses to be affected and decided as shown in Figure 3.3.3 .

The main considerations for the selection are as given below.

- Proposed site is to be such that relocation of residents does not occur.
- Proposed site is to be such that routine operation and maintenance, and installation of facilities are easy and the facilities can be extended in the future.
- Land acquisition inclusive of site for expansion of WTP in the future (600,000 m^3/day) is necessary.

Considering the points mentioned above and studying the installation of facilities mentioned later, the land use of proposed site for WTP construction appears to be ideal and is shown in Figure 3.3.3. It is necessary for the layout to be optimaized further in terms of economical design.

Site photographs and details of environmental impact studies are given in Chapter 4. Details of facilities plan, site area and so on, are described in Section “3.5 Design.”

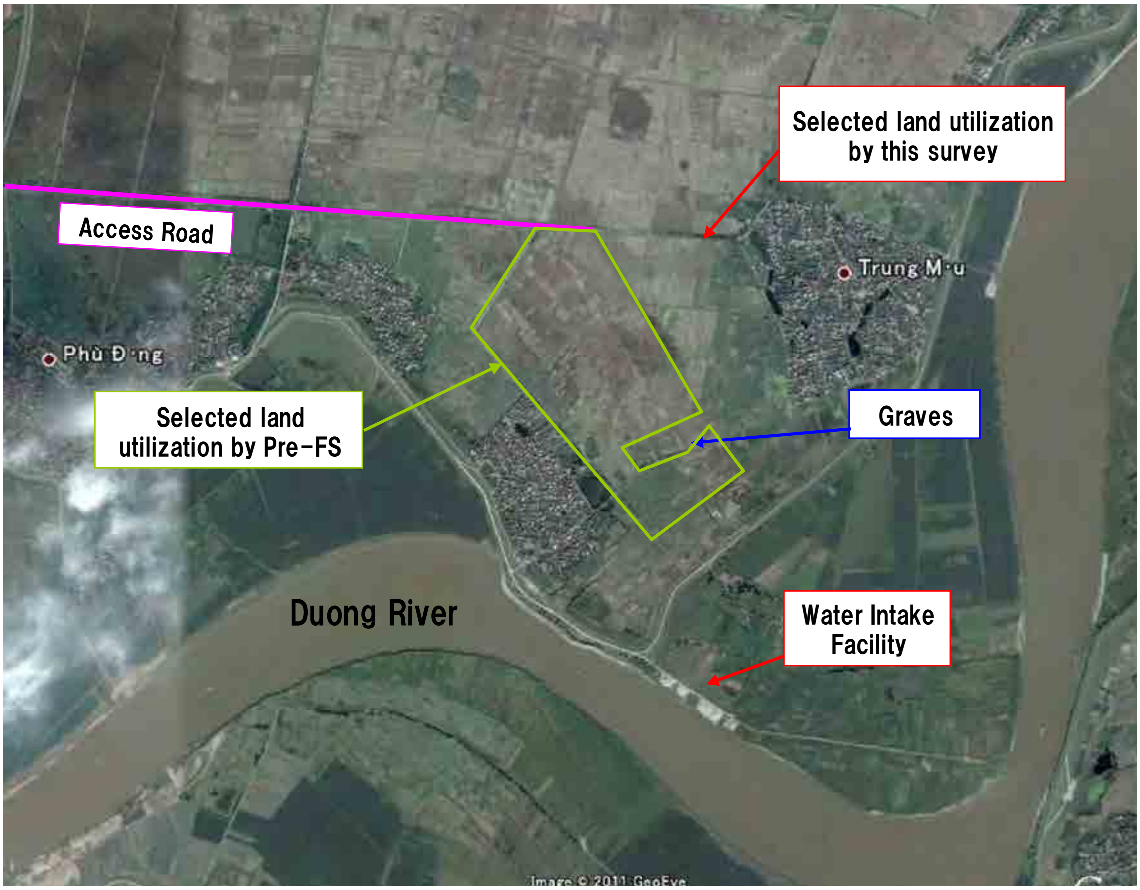


Figure 3.3.3 Proposed Construction Sites for Water Treatment Plant and Intake Facilities

3.3.4 Selection of Transmission Pipeline Route and Setting the Off Take Point

(1) Plans for Transmission Pipelines and Setting the Off Take Point

The proposed project is meant for supplying water mainly to one city and two provinces in the Hanoi metropolitan area. The extended transmission pipelines are to be provided for about 46 km before 2015. In the pre-feasibility study, water supply to the southern part of Ha Noi City, the entire northern part of Bac Ninh Province and the southern part of Hung Yen Province is to be included by the year 2020. The total length of the transmission pipelines planned in the study was about 130 km, but in the present study, as a result of discussions held with various agencies responsible for water supply and the struggles with other businesses starting with the Da River business, the quantity to be provided could be reduced by about 60%. Similarly, the total of 19 locations of the installation of off take points proposed initially has been revised to 6 locations. However, in the joint meetings between Japanese and Vietnamese sides, which was started from March, 2012, it was almost agreed that Supply Area up to Phase 2 was only Hanoi City.

As indicated in "3.3.2 Proposed Scope of Project," the scope of the project is limited to provision of transmission pipelines. Flow meter will be installed at the boundary of responsibility (off take points) of each customer, and the point up to the flow meter will be considered as the scope of this project.

Figure 3.3.4 shows proposed alignment of the transmission pipeline routes.

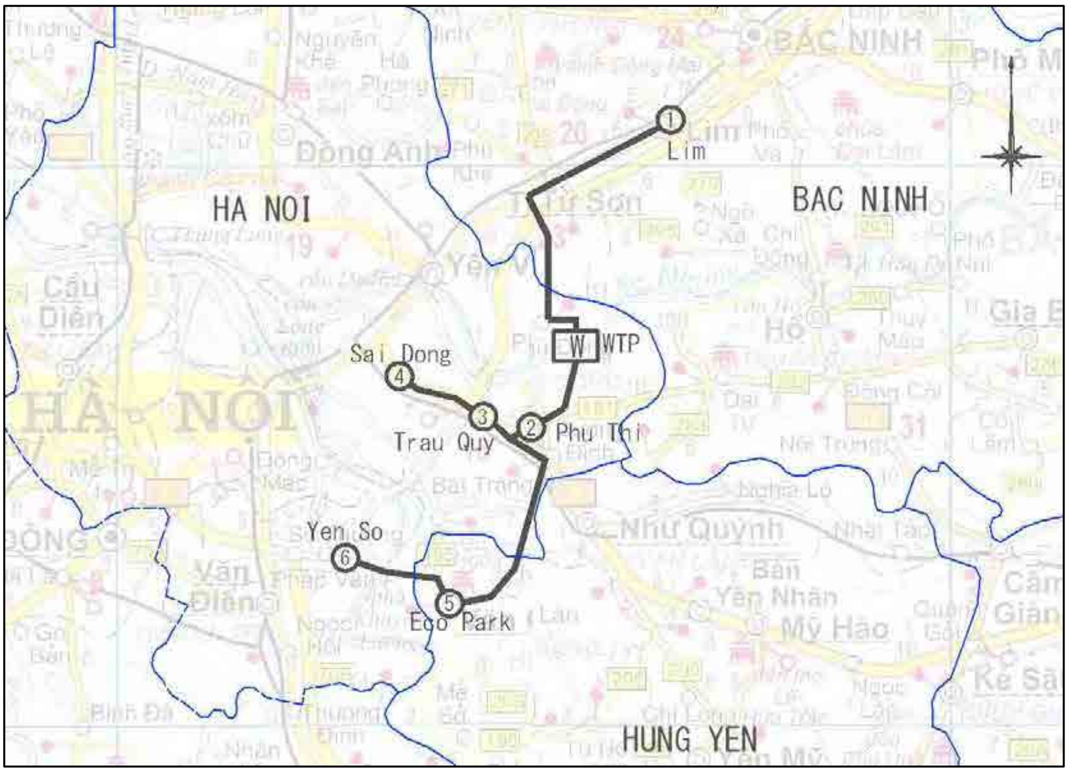


Figure 3.3.4 Proposed Transmission Pipeline Routes in this Project

(2) Selection of Transmission Pipeline Route

The status of roads including those that cannot be constructed and the surrounding environment are summarized in Table 3.3.1 for the transmission pipeline routes selected based on the conditions of existing distribution pipelines and the conditions of distribution of water demand in "3.2 Demand Forecast of the Project".

Table 3.3.1 Status of Transmission Pipeline Routes and Roads

NO.	Type of road (Road No.)	Diameter (mm)	Status of route	Remarks
(1)	National highway (No. 1A)	700	The traffic volume on the old trunk road connecting Ha Noi City and Bac Ninh Province is rather high, with large vehicles accounting only for a small proportion of the traffic volume.	
(2)	National highway (No. 179A) * Northern part of Duong River	700	This is a road linking National Highway 1A, National Highway 1B and the Duong River embankment road; the traffic volume is low. Since an industrial park is being constructed nearby, the volume of construction vehicles is high.	
(3)	Within the Duong River embankment	1,600	This is a route that passes through fields and farm roads. Breakdowns are unlikely to occur.	
(4)	Duong River crossing	1,600	Not a large change from the pre-FS; location where the channel is most stable is selected.	
(5)	National Highway (No. 1A)	1,600	This is bypass road to the No. 5 and No. 38 roads; the traffic volume is low. With the development along the lines, construction for widening of roads is in progress.	
(6)	Important national highway (No. 5)	1,400	This is the main arterial highway at the center of distribution linking Hai Phong port and the interior parts. The traffic volume is high, and the percentage of heavy vehicles is large. The road has two lanes in each direction; since shops and business establishments are concentrated along highway, work at night is necessary. This route is selected since it is the shortest one for transmission of water to the off take point.	

(7)	National highway (No. 179) * South of Duong River	1,100	This is a road that connects the embankment road No. 195 and the road No. 5. Traffic volume is rather high. Even small scale road repairs are likely to cause traffic jams. These roads are two-lane roads. A part of the urbanized area has sidewalks, while shops and business establishments exist along the road. There are very few residential and public facilities. This route was decided because it is the shortest one for water to be transmitted to the off take point among the studied proposals in the new road plans and existing road networks including farm roads.	
(8)	Within the Hong River embankment	1,000	Piping to be laid through mostly access roads to fields and harbors, roads for managing ponds used for fish breeding, and also to roads for transporting dredged sand. Selected after considering access to river crossings.	
(9)	Hong River crossing	1,000	Not a large change from the pre-FS; location where the channel is most stable is selected. Since the location is within Kyuen Luong port, the longitudinal alignment must account for the interior water transport plans.	
(10)	National Highway (No. 1A)* Side road	1,000	The National Highway No. 1A is a trunk road and the traffic volume is high; however, the pipe laying route will be within the sidewalk of the side road.	

Figure 3.3.5 Transmission Pipeline Route and Site Status

(3) Selection of Position of Off Take Point

1) Overview of off take point

The off take points set according to "3.2 Demand Forecast of the Project" are 4 locations in Ha Noi City, 1 location each in Bac Ninh Province and Hung Yen Province, to form a total of 6 locations.

Table 3.3.2 Overview of the Proposed Locations of Off Take Points.

No.	Off take Point	Province	Area	Road Name
1	Lim	Bac Ninh	Tien Du	No.1-A
2	Phu Thi	Ha Noi	Gia Lam	No.181
3	Trau Quy	Ha Noi	Gia Lam	No.5
4	Sai Dong	Ha Noi	Long Bien	No.5
5	Eco Park	Hung Yen	Van Giang	No.179
6	Yen So	Ha Noi	Hoang Mai	No.1-B

2) Forms of off take point facilities

The position of off take point is set according to the size of the service area and the off take point facilities.

The form of off take point facilities for each off take point is set according to the concept given below.

① Common items

At each off take point, a flow meter chamber (or connection point) must be installed to install flow meters and water quality meters.

The form of the flow meter chamber is set based on the diameter of the pipeline.

② For receiving tank system

If the receiving system is a receiving tank, the areas needed for installation of the receiving tank (distribution reservoir) and the distribution pump must be estimated.

Since the clear water reservoir of the Duong River water treatment plant has adequate storage capacity (planned maximum daily distribution volume of up to 6 hours), the capacity of the receiving tank is set at the minimum capacity only such that no hindrance occurs to the operation of the distribution pump (role of pump well).

Although there is no clear-cut standard for the capacity of the pump well, 30 minutes to one hour of the hourly peak water supply capacity is necessary based on experience. Therefore, considering safety, one hour of the hourly peak water supply capacity should be ensured.

The provision of receiving tank at the off take point is out of the scope of this proposed project, so it is to be provided by the entity at the receiving end.

③ In case of direct water distribution

When the receiving system is a direct water distribution system, space for installing check valve is to be anticipated, to prevent the back flow from the distribution pipeline to the transmission pipeline when the transmission pressure drops.

3) Selection of location of off take point

Based on the concepts mentioned above, the location of the off take point is to be selected.

The off take point is to be selected from the site as close to the transmission pipeline route as possible; therefore, candidate sites were selected while looking at the map. Later, field survey of the candidate sites was carried out; an overall judgment was made considering various factors such as safety of site, surrounding environment, ease of access, and other factors. The results of selection of location for installation of each off take point are summarized below.

① Lim off take point (Bac Ninh Province, Tien Du Prefecture)

Based on the outcome of interviews with the water supply works in the Bac Ninh Province, the Lim off take point was selected near the boundary of the Tu Son Prefecture and the Tien Du Prefecture along the National Highway No. 1. The candidate site selected is shown in Figure 3.3.6.

Currently, industrial parks, independent factories, and houses are being developed near the candidate site. Although, the site appears unoccupied on the map, in actual condition selectable sites are very limited. The site at which the off take point can be installed has been selected at a position closest to Tu Son Prefecture and is within the range of conditions discussed during the interviews mentioned above.

（Source: Google Earth）

Figure 3.3.6 Candidate Site for No.1 Lim Off Take Point

② Phu Thi off take point (Ha Noi City, Gia Lam Prefecture)

Since the service area for the Phu Thi off take point is to the north of the National Highway No. 5, the site at which off take point could be installed was selected in the northern part of the National Highway No. 5 on the transmission route. The candidate site selected is shown in Figure 3.3.7.

One side of the candidate site consists of fields, and the front part of the road that will become the transmission pipeline route is a newly constructed road. Currently, there are no obstacles, and adequate site area can be procured. The upstream part of the transmission pipeline route is a densely populated residential area, and there is no appropriate site area near the transmission route. On the other hand, there are many factories in the downstream of the candidate site, and appropriate site area cannot be procured.

Considering the reasons mentioned above, the candidate site is selected (Figure 3.3.7).

(Source: Google Earth)

Figure 3.3.7 Candidate Site for the No..2 Phu Thi Off Take Point

③ Trau Quy off take point (Ha Noi City, Gia Lam Prefecture)

Since the service area is the existing water distribution zone in the Gia Lam Prefecture and the southern part of the National Highway No. 5, the Trau Quy off take point was selected in the area at the southern part of the National Highway No. 5 on the transmission route where the off take point can be installed. Water will be distributed using the existing distribution pipelines; therefore, as far as possible, the off take point will be installed at the upstream end of the distribution pipeline. The candidate site selected is shown in Figure 3.3.8.

The area around the candidate site is swampy land and fields. The land is surrounded by important trunk roads namely the National Highway No. 1 and the National Highway No. 5. Although there are no obstacles such as houses, the land around the candidate site is mostly swampy land, and land filling, etc., will be required at the time of construction. Adequate site area can be ensured for installation. Since the conditions at the upstream and downstream parts of the candidate site are similar, the candidate site was selected focusing on efficiency of water distribution.

(Source: Google Earth)

Figure 3.3.8 Candidate Site for No.3 Trau Quy Off Take Point

④ Sai Dong off take point (Ha Noi City, Long Bien district)

The service area for the Sai Dong off take point is the existing water distribution area in Long Bien district (Gia Lam WTP and Gia Lam airport WTP). The existing pipeline network will be used for distributing water. For this reason, an area where the off take point can be installed near the Gia Lam WTP at the most upstream part of the distribution pipeline network on the transmission route was selected. The maximum amount of water to be received at the Sai Dong off take point is about 80,000m^3/day in the Phase1, and it is 130,000m^3/day in the Phase2. About 6,500m^3 of receiving tanks (distribution reservoirs) need to be installed. Considering the above conditions, the candidate site is selected as shown in Figure 3.3.9.

On one side of the candidate site are fields, while the site is surrounded by the Gia Lam airport and the National Highway No. 5. There are no obstacles such as houses, and adequate site area can be procured. In areas other than the candidate site, there are residences, factories, industrial parks that are densely located, so adequate site area cannot be obtained on the transmission route. The candidate site was selected considering the reasons mentioned above.

(Source: Google Earth)

Figure 3.3.9 Candidate Site for No.4 Sai Dong Off Take Point

⑤ Eco Park off take point (Hung Yen Province, Van Giang Prefecture)

The service area corresponding to the Eco Park off take point is the Eco Park residential area. As shown in Figure 3.3.10, the flow meter chamber is proposed to be installed at the premises boundary closest to the transmission route and delivery be performed. The conveyance pipeline from the off take point to the water treatment plant in the residential area is to be provided by the Eco Park side, in principle.

One side near the candidate area consists of fields. Since there was no reason to select any other site area, this candidate site was selected.

(Source: Google Earth)

Figure 3.3.10 Candidate Site of the No.5 Eco Park Off Take Point

⑥ Yen So off take point (Ha Noi City, Hoang Mai district)

The Yen So off take point is the only point of entry for delivery on the pipeline. It is connected to the existing distribution pipeline of 800 mm diameter, according to the wishes of the HAWACO. For this reason, the position is selected such that space for installation of flow meter chamber on the existing 800-mm distribution pipeline route is available.The candidate site selected is shown in Figure 3.3.11.

The existing distribution pipeline of 800-mm diameter is laid within the sidewalk on the southern side of the National Highway No. 1. The area around the candidate site consists of residences and ponds. The installation of flow meter chamber does not obstruct houses, and it is installed between the pond side and the sidewalk. The size of the flow meter chamber will be about 12m x 5m including the check valve. It can be installed by the the sidewalk.

There is no space for laying transmission pipelines within the sidewalk on the south side, and besides, it is not possible to straddle the National Highway No.1; therefore, there is no location other than the candidate site for connecting with the existing distribution pipeline of 800-mm diameter. The candidate site was selected considering the above reasons.

(Source: Google Earth)

Figure 3.3.11 Candidate Site for No.6Yen So Off Take Point

3.3.5 Proposed Project Implementation Period

The scale of the project is large, and the cost of construction requires capital of 23,0000 million yen (Phase 1 and Phase 2: 300,000m^3/day), so the construction work has to be spread over several years.

The project is divided into different construction stages progressively to achieve additional 300,000 m^3/day of the facilities' capacity from the water demand estimates.

The Phase 1 construction period was proposed as 2012 to 2015, in response to the strong wishes of the Hanoi Water Works and the water demand trends, aiming to start supply in 2015 (at the rate of 150,000m^3/day).

On the other hand, completion of phase 2 (total capacity is 300,000m^3/day) is requested in the year of 2020, according to water demand estimates; however, there are many uncertainties in the expansion of actual demand. Therefore, the period should be fixed after considering the actual project results of Phase 1. Accordingly, the construction period of Phase 2 is planned from 2018 to 2019 in the financial analysis; however it is subject to changes.

The project period inclusive of operation and maintenance is proposed as 30 years in maximum; the project implementation period divided into phases for financial model is shown in Table 3.3.3.

Table 3.3.3 Scope of Project Implementation and Estimated Period

Item	Project Scale	Concession Year	Year of starting Operation	Termination of the Concession
Phase 1	150,000m^3/day	2012	2015	2042
Phase 2	150,000m^3/day	2018	2020	2042

3.4 Setting the Design Criteria

The basic design criteria required in "3.5 Conceptual Design" described later in this chapter, are set here.

3.4.1 Target Year

The target year of this proposed project is set as given below, based on "3.3.5 Proposed Project Implementation Period."

- Phase 1: 2015
- Phase 2: 2020

3.4.2 Basic Water Capacity

The basic water capacity in this proposed project is as given below, according to "3.2 Project Demand Prediction" and "3.5 Conceptual Design."

- Phase 1: 150,000 m^3/day
- Phase 2: 300,000 m^3/day

3.4.3 Treated Water Quality Standards

Design treated water quality is to conform to the drinking water quality standards of Viet Nam.

The important items in the standards are given below.

Table 3.4.1 Important Items in Drinking Water Quality Standards of Viet Nam

No	Standard items	Unit	Maximum water quality standard	Experiment process
1	Color	TCU	15	TCVN 6185 - 1996 (ISO 7887 - 1985) or SMEWW 2120
2	Taste・Odor	-	No aberration	Sense, or SMEWW 2150 B và 2160 B
3	Turbidity	NTU	2	TCVN 6184 - 1996 (ISO 7027 - 1990) or SMEWW 2130 B

4	pH	-	6.5 - 8.5	TCVN 6492:1999 or SMEWW 4500 - H^+
5	Hardness, as $CaCO_3$	mg/L	300	TCVN 6224 – 1996 or SMEWW 2340 C
14	Chloride ion	mg /L	250 300(**)	TCVN6194 - 1996 (ISO 9297 - 1989) or SMEWW 4500 - Cl^- D
20	Iron (Fe^{2+} + Fe^{3+})	mg/L	0.3	TCVN 6177 - 1996 (ISO 6332 - 1988) or SMEWW 3500 – Fe
22	Manganese	mg/L	0.3	TCVN 6002 - 1995 (ISO 6333 - 1986)
26	Nitrate	mg/L	50	TCVN 6180 - 1996 (ISO 7890 -1988)
27	Nitrite	mg/L	3	TCVN 6178 - 1996 (ISO 6777-1984)
30	Sulfate ion	mg/L	250	TCVN 6200 - 1996 (ISO9280 - 1990)
32	Oxygen consumption （$KMnO_4$ consumption）	mg/L	2	TCVN 6186:1996 or ISO 8467:1993 (E)
90	Residual chlorine	mg/L	0.3 - 0.5	SMEWW 4500Cl or US EPA 300.1
108	Standard plate count	MPN/100ml	0	TCVN 6187 - 1,2:1996 (ISO 9308 - 1,2 - 1990) or SMEWW 9222
109	Escherichia coli or fecal coliforms	MPN/100ml	0	TCVN6187 - 1,2: 1996 (ISO 9308 - 1,2 - 1990) or SMEWW 9222

（Source：Environment board・Standard of drinking water quality 2009）

3.4.4 Duong River Intake Water Level

The intake planned water level of the Duong River water treatment plant is determined based on the data of the past ten years.

Figure 3.4.1 shows a graph of the change in water level of the Duong River (water source for this Project), in the 8-year period from 2002 to 2009.

Also, Figure 3.4.2 shows a graph of the monthly maximum and minimum water levels in Duong River.

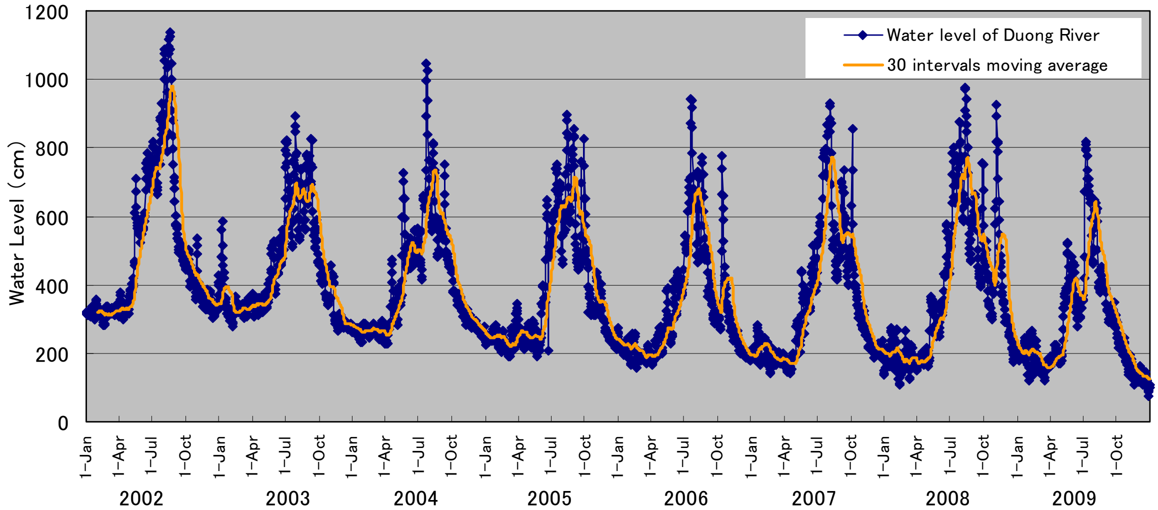


Figure 3.4.1 Change in the Daily Water Level of Duong River with Time (2002 to 2009)

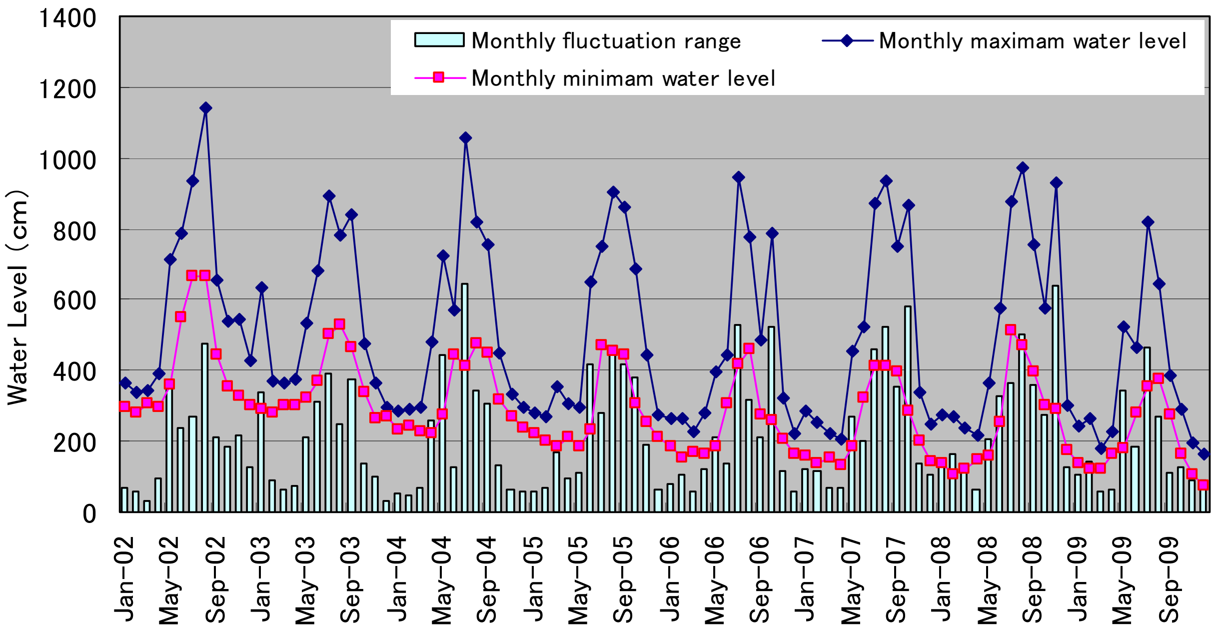


Figure 3.4.2 Change in the Monthly Maximum and Minimum Water Levels with Time (2002 to 2009)

From the Figures, it can be observed that in the past 8 years, the water level of the Duong River has shown a decreasing trend. The maximum water level was 11.42m in 2002, but in recent years, this level has dropped to below 10m. The same is the case with minimum water level too; the level in 2002 was 2.80m, but in 2009 it has dropped to as low as 0.75m.

However, observing the data for the last five years, except for 2009, the water level has generally been steady. In view of the above, it can be concluded that the decreasing trend in the water level of the Duong River will not continue henceforth as was the case from 2002 to 2005. Although there is a change in level for a specific year because of weather conditions in the upstream area, or because of construction and operation of dams, generally the water level is estimated to remain steady.

Based on the above reasoning, the intake design water level of the Duong River water treatment plant is set as given below.

Table 3.4.2 Duong River Intake Water Level (Set Value)

Item	Water Level (evaluation)	Setting reason
Maximum water level	11.5m	Due to maximum level (2002) 11.42m
Minimum water level	0.5m	Due to minimum level (2009) 0.75m
Fluctuation Range	11.0m	Difference of the above figures

The annual variation in the actual water level of rivers for the planned water level mentioned above is given in the table below; the variation in level is seen to be about 8m in practice. Large-scale variation in water level affects the operation of the water intake pump; therefore, measures on the pump side are considered necessary for stable intake of water.

Table 3.4.3 Annual Variation in the Water Level (2002 to 2009)

(Unit: m)

	2002	2003	2004	2005	2006	2007	2008	2009	Ave.
Fluctuation Range	8.62	6.29	8.34	7.18	7.92	8.00	8.66	7.43	7.80

3.4.5 Off Take Point Water Receiving System

(1) Scope of Responsibility for the Proposed Project

The proposed project is a water supply project, so the scope of the project envisages transmission pipelines also. Flow meters are to be installed at each off take point, and the distance up to the first valve after the flow meter will be the scope of responsibility for SPC.

In addition to flow meter at each off take point, various kinds of water quality instruments will be installed, and water quality will be monitored with the aim of adhering to the required water quality. (For details of monitoring items, refer to "3.5.3 Facility Plans for Water Intake and Water Treatment Plants".)

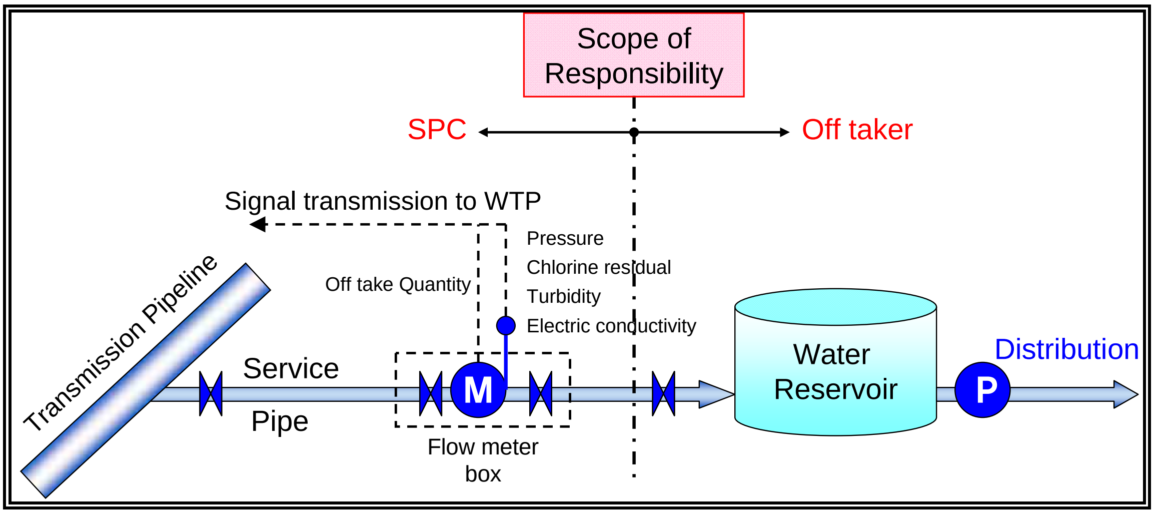


Figure 3.4.3 Scope of Responsibility for the Proposed Project at Each Off Take Point

(2) Water Transmission Mode

The basic water transmission mode shall be constant supply mode wherein a constant supply of water is transmitted to each off take point.

(3) Setting the Receiving System

1) Transmission conditions to off take point

The off take points which become the destination of transmission is at 6 locations. The water received at each off take point is to be about 10,000 to 80,000 m^3/day in Phase 1, and is about 18,000 to 136,000 m^3/day (large range) in Phase 2.

The distance of the off take points from the water treatment plant ranges widely from 5 to 25 km. The operation of the supply pump is expected to be complex.

2) Setting the receiving system

The conditions of off take point set in the study vary over a wide range with small and large supply amounts, long and short transmission distances, and so on. When connected directly to the distribution main pipes, the following issues are likely to occur in operation and maintenance.

- The supply conditions may sometimes vary with the time variation in distribution amount; thus, the load on the pump may be large, and operation and maintenance will become complex.
- In the event of an accident in the transmission pipeline or the distribution pipeline, the effect of the accident may reach other water distribution zones.

In view of the above, the receiving system is to be, in principle, a receiving tank system.

However, as mentioned above, since the demand for direct distribution of water is high and considering that receiving tanks of adequate capacity, to absorb changes with time, cannot be installed (will not be installed), the decision on setting the diameter of the transmission pipeline and the pump capacity will take into account the quantity of water that can be directly distributed (considering relevant time coefficients).

Only the off take point No. 6 of Yen So will be directly connected to the water distribution main; however, since water will be fed to the distribution area of existing water treatment plants and the actual operation will be entrusted to HAWACO, the water amounts linked to time variation will be accounted for by the existing water treatment plants, and the water supplied from the Duong River water treatment plant will be taken as constant supply that does not consider time coefficients.

3.4.6 Setting the Water Supply Pressure

Proper maintenance of water pressure contributes to enhancing the water supply services. The off take point target water pressure (water supply pressure) of the transmission pipeline is set based on the minimum dynamic water pressure of the distribution pipeline and the conditions of the pipeline network.

The water supply pressure at each off take point will be set with the range of the minimum and maximum water pressures specified in the Water supply - Distribution System and Facilities - Design Standard of Viet Nam (TCXDVN33-2006).

(1) Minimum Water Supply Pressure at the Off Take Point

The minimum water supply pressure at the off take point in this proposed project will be decided based on the minimum water pressure of 10 m established in the National Water supply Facilities Standards of Viet Nam and after considering the head loss in the distribution pipeline after branching.

However, basically the customer will be the Hanoi Water Works, therefore, the existing distribution pressure data will be referred to and the supply pressure will be set.

The actual data of distribution pressures at the Hanoi Water Works is given in Table 3.4.4.

Table 3.4.4 Water Pressure Data (HAWACO)

Distributed amount of facility (record) (m^3/day)	Date/month/year	Maximum water flow pressure head (m)
51,000	15/12/2008	28
21,000	15/12/2008	22
52,000	15/12/2008	15
21,000	15/12/2008	14
41,000	15/12/2008	18
32,000	15/12/2008	22
21,000	15/12/2008	10
61,000	15/12/2008	32
44,500	15/12/2008	13
Max.		32
Ave.		19

The head loss in the distribution pipeline network differs depending on the condition of laying of the distribution pipeline network; however, when water is directly distributed, a minimum of 20 m approximately is considered necessary judging from the actual distribution data.

The receiving system in the proposed project is basically a receiving tank system. However, in the Yen So off take point, which will be connected to the distribution pipeline network at the center of Ha Noi City, a direct connection to the pipeline network will be used.

According to the results of interviews in Ha Noi City, the required supply pressure at the off take point is 20 m; therefore, the supply pressure at the off take point is set as 20 m based on the outcome of interviews and on the actual data mentioned above. If the pressure drops below the minimum water pressure, a booster pump will be installed.

(2) Maximum Water Supply Pressure at the Off Take Point

The diameter of the transmission pipeline and the supply pump head has been set using the water amount in Phase 2 of the proposed project. Accordingly, since the pipeline loss is small in Phase 1 where the water volume is half, the supply pressure is expected to be high.

The maximum water pressure varies depending on the pipeline conditions in the service area; however, the existing distribution pipelines in the relevant service area have low water bearing pressure and many different kinds of pipes are being used. Therefore, occurrence of breakage and disconnection of existing pipelines connections at high water pressure are a cause for concern. For this reason, the maximum pressure at the off take point is taken as less than 40 m as specified in the Water supply - Distribution System and Facilities - Design Standard of Viet Nam. When the maximum pressure is exceeded, a pressure-reducing valve is installed.

(3) Water Supply Pressure

Based on the above discussion and consideration, the water supply pressure at the off take point is taken as shown below.

Maximum water pressure: At least 40m
Minimum water pressure: Above 20m

3.4.7 Topography of the Proposed Construction Sites

Topographical surveys were implemented as described below. These surveys are necessary during conceptual design of facilities such as intake plant, water treatment plant and transmission pipelines in the present study. The scope of topographical surveys is shown in Figure 3.4.3.

Table 3.4.5 Description of Implementation of Topographical Survey

Item	Description
Route survey	Topographical survey, profile leveling, and cross-section surveying were implemented to obtain information necessary for design of transmission pipelines
River survey	At locations of the pipelines crossing Hong River and the Duong River, topographical survey and river cross sectional surveys were implemented to study the cross-sectional shape at the crossing point and obtain information necessary for design of river crossings of transmission pipelines.
Detailed topographical survey	Detailed topographical surveys related to bridges, channels, small streams, trunk road intersections, and railway intersections were implemented to obtain information necessary for the design of general parts of transmission pipeline.
Site survey	Topographical survey and profile/cross leveling were implemented for sites where construction of water treatment plants was scheduled, and detailed topographical survey was implemented at sites where construction of intake facilities was scheduled to obtain information necessary for design of intake facilities and water treatment plants.

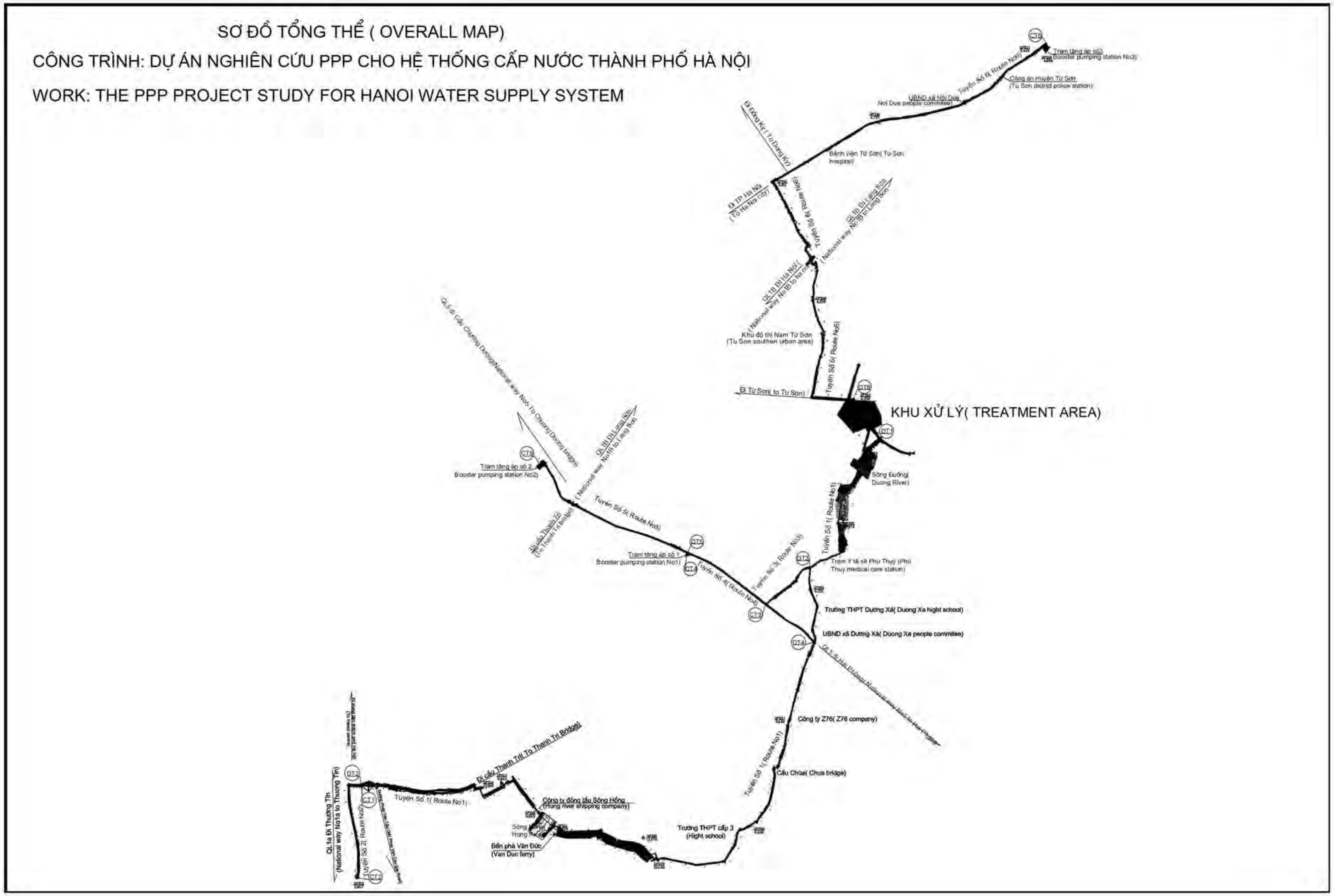


Figure 3.4.4 Topographical Surveys

3.4.8 Geological Conditions at Site where Construction is Scheduled

Study Team carried out geological survey of water treatment plant (WTP) and transmission pipeline route.

Figure 3.4.5 shows location of investigated points. Total investigated points are sixteen (16); three (3) points are for WTP site and thirteen (13) points are for transmission pipeline route.

The detail results of geological survey are in Appendix-4 (‘Geological Survey’).

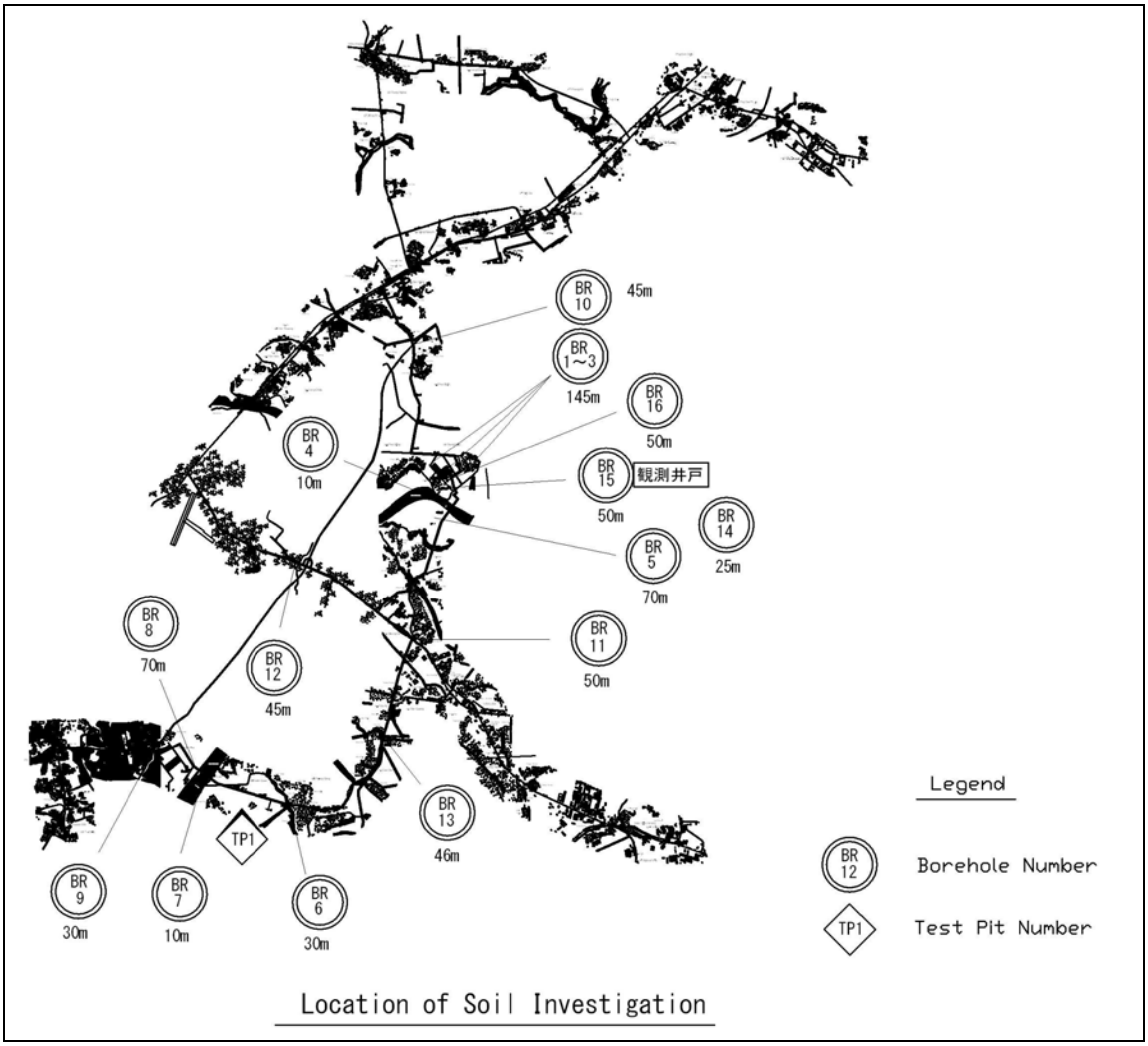


Figure 3.4.5 Points of Borehole and Test Pit

(1) The Outline of Geological Features

According to the geological feature map of Hanoi (F-48-XXVIII 2005) and the topographical map of the north-east region published by Department of Geology and Minerals of Vietnam, the Hong River Delta (Bac Bo plain) is a flat area with a ground level of 5 - 8 m above mean sea level and has a complicated geological history with up and down movements. Therefore, it is necessary to collect the detailed information on the geological feature such as composition and physical nature, in order to select the most available construction method and structure.

The Hong River Delta is mainly composed of Quaternary and the Neogene sediments, which compose of clay layer with sand, sand layer with clay, sand layer and so on. The thickness of each layer ranges from 0.8m to 44m.

The Duong River WTP construction site is covered with cohesive soil and sandy soil formed in Holocene age.

(2) Soil Composition and Physical-Dynamical Characteristics

Soils of construction site are mainly composed of top soil, clay, sandy clay, fine sand and medium sand. The characteristics of soil are largely changing by the survey point.
The outline of the physical-dynamical characteristic of typical soil layer is following.

- Soil layer 1:top soil
  Top soil is artificially covered with thickness of 0.5 to 1.5m.
- Soil layer 2:clay with brown and grayish brown color
  The layer with a thickness of 4.1 to 6.4m underlay top soil and is partially including sandy clay. N-value is 2 to 14.
- Soil layer 3:sandy clay with grayish black and grayish brown color
  The layer with a thickness of 2.6 to 23.5m underlay top soil or soil layer 2.
  N-value is 2 to 14.
- Soil layer 4:saturated fine sand with grayish black and grayish brown color
  The soil layer 4 with a thickness of 5.3 to 43.5m underlay soil layer 1 to 3, and is including sandy clay originated from soil layer 5. Furthermore, the layer overlay soil layer 7, which may be basic layer. N-value is 11 to 33.
- Soil layer 5:sandy clay with grayish brown and grayish black color
  The soil layer 5 with a thickness of 4.2 to 6.9m mainly underlay soil layer 4 and dot in soil layer 4 and 6. N-value is 2 to 14.
- Soil layer 6:medium sand with yellowish gray color
  The soil layer 6 with a thickness of 2.5 to 18.5m overlay soil layer 7 of being basic layer. N-value is 11 to 33.

- Soil layer 7:sandy gravel

  The soil layer 7 stand on the lowest layer with a GL of 32 to 46m, consecutively locate in a wide range of the survey area and would be basic layer for construction site. It is expected that a thickness of the layer is about 30m.

(3) Groundwater

The groundwater level is about GL -1.7 to -2.5m at all the survey points and does not depend on the topography. It is assumed that the groundwater level is largely related to the Hong River and the Duong River, but not many irrigation ponds and water canals according to the results of a water content test of soils.

(4) Aptitude for Supporting Stratum of Structures

The layer lying on basement of the Duong River WTP site is ‘soil layer 3: sandy clay’ and ‘soil 4: saturated fine sand’.

Based on the characteristics of each soil layer mentioned previously, aptitude for supporting stratum is the following.

- Sandy clay layer is not appropriate as a structure supporting base, because of uneven settlement with high probability by the reason of low cohesion, low stability and discontinuity of the layer (cohesion Cu=6.2 to 10.6 kg/cm^2, preconsolidation stress Po=65 to 153 kg/cm^2, thickness=3.3 to 11.4m). On the other hand, this sandy clay layer is appropriate for supporting base of transmission pipeline. For the expected groundwater, well point method might be necessary.
- Fine sand layer compose of two sequences, the upper part is fine sand including clay with N value of less than 10, the lower part is fine sand with N value of less than 30, and it has uneven layer thickness from 5.3 to 20.6m. Since the N value is uneven (different from point to point), a countermeasure against uneven settlement and an analysis as an elastic body is indispensable for directly using this layer as a base. Furthermore, it is needed to pay attention to the safety in use of friction piles.

Based on the above discussion results, Study Team recommend that regarding on WTP structure, using the lowest sandy gravel layer with N value of more than 50 is high aptitude for supporting layer. Therefore, pipe foundation is most appropriate, in order to maintain WTP facilities.

3.4.9 Unexploded Bomb Surveys

Viet Nam's Defense Ministry estimates that 20 to 30% of unexploded bombs dropped during the Viet Nam War still remain underground. The status of unexploded bombs may be divided into four classes; the central region is Class I and has the most number of unexploded bombs; the northern region including Ha Noi City, is Class II, and is also a region with many unexploded bombs.

Before starting the construction project, unexploded bombs must be surveyed and disposed of in accordance with the Defense Ministry Ordinance 146/2007/TTP-BQR and the Prime Ministerial decision directive 96/2006/QD-TTg (management and implementation of bomb survey and disposal work).

The study this time was implemented through interviews of personnel in unexploded bomb survey and disposal companies, construction companies and geological survey companies under the Ministry of Defense, and interviews of residents within the project area.

(1) Interviews

1) Interview related to unexploded bomb survey of disposal companies

Bombs were dropped mainly in the outskirts of the old city of Hanoi and not in the old city. Bombs were dropped mainly in the four districts and prefectures of Long Bien district, Gia Lam Prefecture, Dong Anh Prefecture, and Soc Son Prefecture; next in the list came Tu Liem Prefecture and Thanh Tri Prefecture. (Figure 3.4.6)

Figure 3.4.6 Unexploded Bomb Survey

Zones where unexploded bombs remain are particularly Long Bien bridge and Phu Dong bridge and their vicinity where bombs were dropped with the aim of disrupting transportation during the war. Unexploded bombs are also concentrated in the areas near the Gia Lam airport and the Long Bien district where oil plants are located. Most of the unexploded bombs remain in these areas, and they have also largely affected the adjacent Gia Lam Prefecture.

With regard to the type of unexploded bombs, chemical bombs were also used in the central region. While 250kg bombs were mainly used in the northern region, cluster bombs which are lethal weapons, were also frequently dropped.

The unexploded bombs along roads were discovered and removed before the start of construction of the roads. Although they are assumed to not exist, small bombs discovered during construction were abandoned at the sides of the roads, or were thrown into the rivers or channels. Therefore, there is a possibility of unexploded bombs remaining at locations other than underneath the roadbed. Also, the depth of location of unexploded bombs is expected to be about 5 to 6 m from the ground surface; none have been discovered at deeper points.

2) Interviews of construction companies and geological survey companies

The outcome of interviews with construction and geological survey companies showed that no unexploded bombs had been encountered until now.

3) Interview of residents within the project area

Interviews of residents along the transmission pipe laying route were held. The results indicated that small bombs of the cluster bomb variety had been found in fields in the agricultural belt in the outskirts of cities, although the results were inconclusive within urbanized cities.

(2) Measures against Unexploded Bombs during Construction

Implementation of surveys to locate unexploded bomb is one measure against coming across unexploded bombs during construction.

In areas to be surveyed, pipe laying is decided based on the site conditions of roads, fields, rivers, etc., other than under the existing roadbeds, and the conditions for earthwork and temporary plans.

Survey methods for unexploded bombs near the surface include shore-based horizontal magnetic prospecting for unexploded bombs near the surface, while vertical magnetic prospecting may be used together with boring or water jet for unexploded bombs at deeper points.

For rivers, similar surveys as for shore-based examinations will be implemented on board ships.

(3) Period and Expenses for Unexploded Bomb Survey

The time and cost required for the survey is influenced considerably by the level of difficulty of the survey in rivers, etc., which may require survey ships, and also depends on the topography. If the survey extends over a prolonged period, the cost will also increase; therefore, the work stages and this cost must be anticipated beforehand in the project cost.

The cost required for disposal of unexploded bombs is expected to be treated in Vietnamese gorvenment law.

3.4.10 Relevant Laws and Regulations and Permits and Licenses Required for Implementing the Project

(1) Laws and Regulations Related to Water Supply Works

To implement this proposed project, the technical regulations such as guidelines and standards and laws related to water works must be thoroughly understood.

The laws and regulations, and guidelines and standards related to the water supply works are summarized below.

Table 3.4.6 Laws and Regulations Related to the Water Supply Works

S. No.	Legal System and Number	Promulgating Agency	Overview
1	Government Ordinance no. 177	Prime Minister	Water resources law: the use of water resources management and related institutions, rights and laws pertaining to the main purpose of setting policy on roles
2	Decision No. 63	Prime Minister	Plans for the development of urban water supply for the year 2020
3	Directive No. 04	Prime Minister	Consumption and supply

S. No.	Legal System and Number	Promulgating Agency	Overview
			management for water purification
4	Cabinet Order No. 117	Ministry of Construction	Cabinet Order on the production and supply of water purification consumption
5	Cabinet Order No. 124	Ministry of Construction	Amendments of Cabinet order No.117
6	Cabinet Order No. 108	Ministry of Planning and Investment	Law related to policy and implementation of investment
7	Cabinet Order No. 40	Finance	ODA financing system for water supply project
8	Cabinet Order No. 37	Finance	Frameworks for the water tariff
9	Circular No. 104	Ministry of Construction, Ministry of Finance	Pricing principles for water purification methods and definitions, guidelines on the right decisions
10	Cabinet Order No. 84	Ministry of Finance, Ministry of Environment, Resources	Supplementary provisions on land use
11	Cabinet Order No. 78	Ministry of Planning and Investment	Regulations on BOT contracts
12	Cabinet Order No. 150	Treasury	Provisions on VDB
13	Law on Land Use	Treasury	Law on Land Use
14	Law on Investment	Treasury	Law on Investment
15	Corporate Law	Treasury	Law related to Management of Company
16	Environmental Protection Law	Ministry of Natural Resources	Law on Environmental Protection
17	Corporate Income Tax Law	Treasury	Corporate Income Tax Law
18	Ha Noi City People's Committee decision No. 36	Ha Noi City People's Committee	The provisions on water charges in Hanoi
19	Government decision No. 110	Prime Minister	Provisions on the functions of VDB

(Source: Overview of the discussions and collected information during field visit in Vietnamese)

Table 3.4.7 Technical Guidelines and Standards Related to the Water Supply Works

No.	Law	Organization	Overview
1	National standard for Drinking water quality	MOH	Water Quality（2009）
2	Standard 33	MOC	Design Criteria
3	Standard 11	MOI	Electric Equipment Standard
4	Electric Law	PM	Power Supply
5	Decree 32	PM	River Law

No.	Law	Organization	Overview
6	Standard 4325	MOC	Standard for Structure
7	Decree 01	MOC	Standard for Construction Plan
8	Decision 26	MOC	Architectural Standard

（Original is Vietnamese）

(2) Permits and Licenses Required for Implementing the Project

The processes for permits and licenses required for implementing the proposed project and an overview of the same are given below.

1) Process up to the approval of the project

To obtain approval for a new water supply works in Viet Nam, the Project Enterprise has to negotiate with numerous government bodies, undergo various formalities, and obtain permits and licenses.

The process up to the approval of the proposed project is shown in Figure 3.4.7.

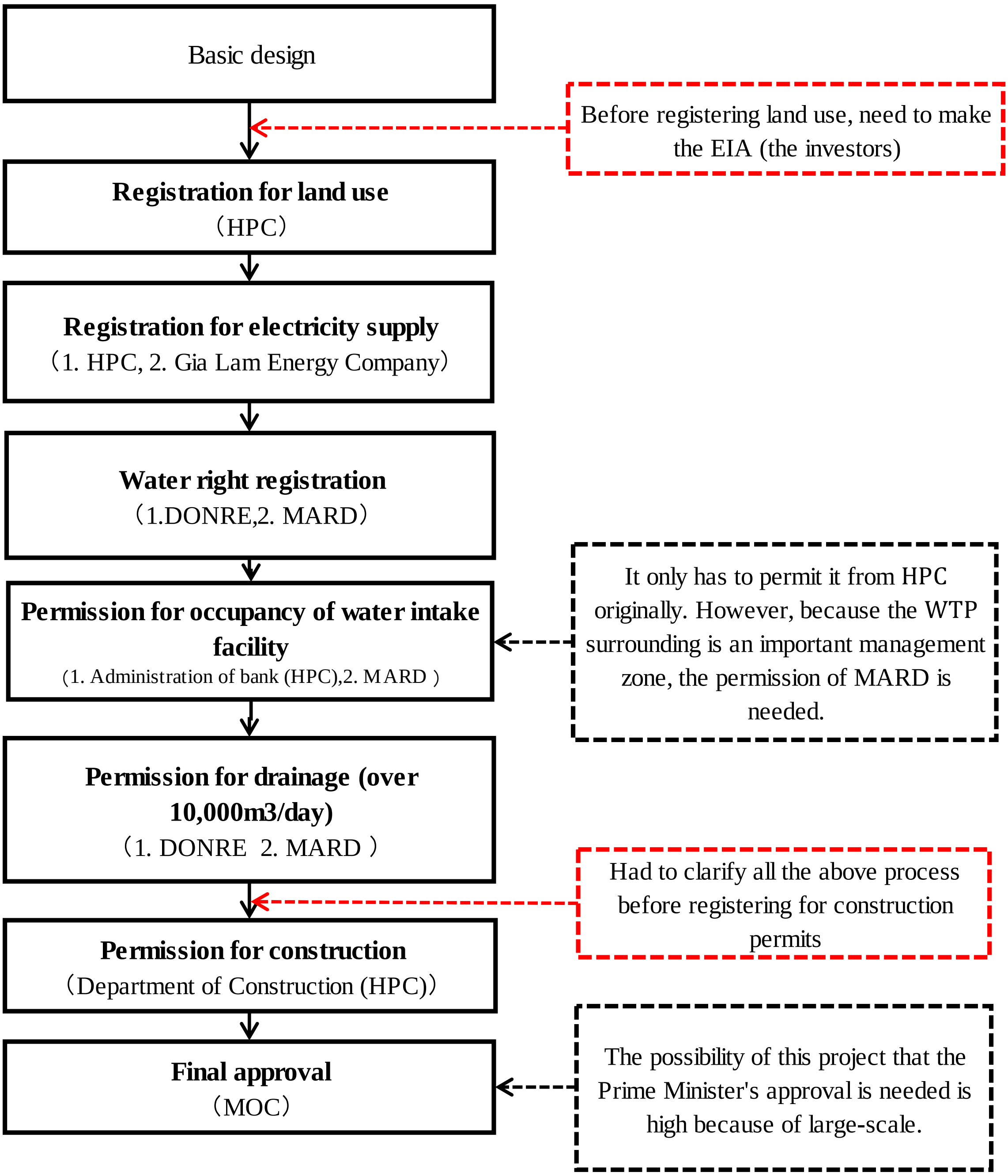


Figure 3.4.7 Process for Obtaining Permits and Licenses Required up to the Final Approval of the Project

2) Implementing EIA

The Project Enterprise has to implement Environmental Impact Assessment (EIA) related to the said project after completion of feasibility study. For details of the method of implementing EIA and the description, see Chapter 4.

3) Application for land utilization

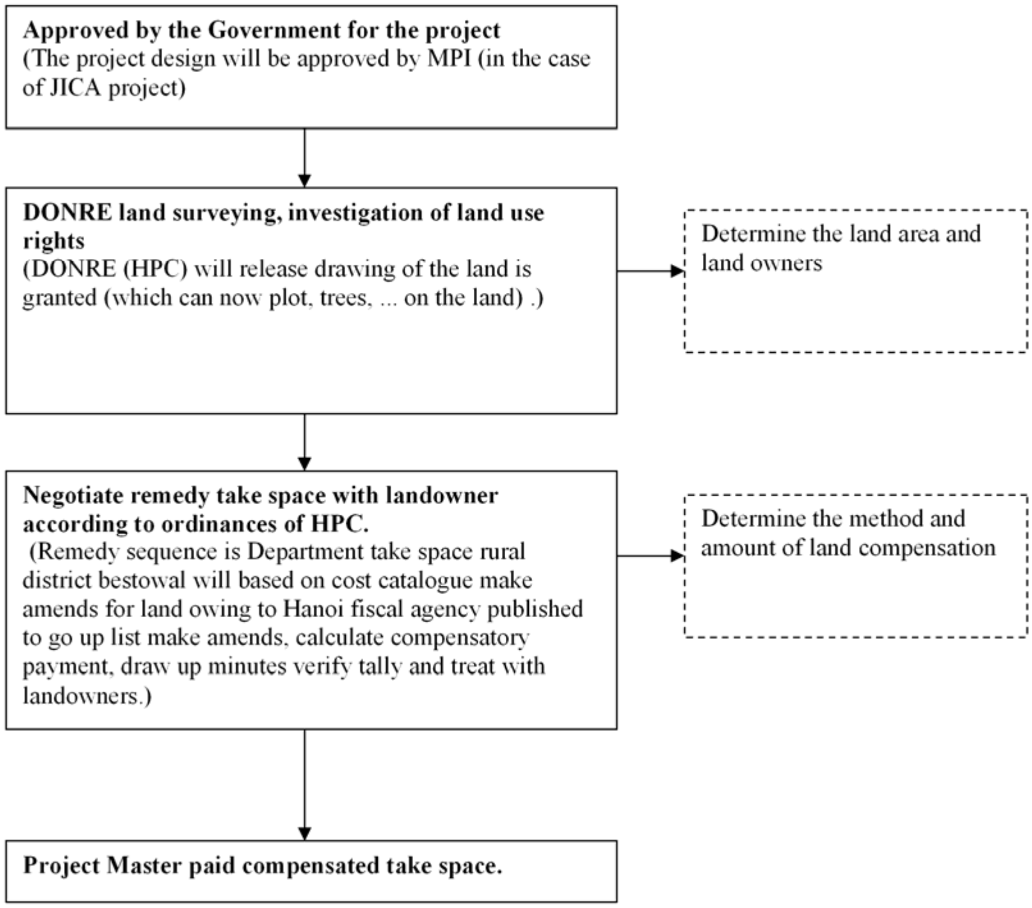
The Project Enterprise after implementing EIA, has to apply for land utilization to the Hanoi People's Committee.

The basic law related to land expropriation accompanying the implementation of the project in Viet Nam is the Law on Land established in 1983, which has been revised in 2003. As a supplementary rule to the above mentioned law, "Decree on compensation related to land expropriation for the purpose of maintaining defense, security, national interest and public benefits" (Decree No.22/1998/ND-CP) has also been established.

The water supply works in this decree has been clarified as a public works sector. For relevant matters in this study also, land expropriation of the area where water treatment plant is scheduled for construction should be in accordance with these formalities.

There are two stages to the agreement related to land expropriation. In the conceptual design (FS) stage, the Project Enterprise will apply for land utilization and an agreement that permits the use of land will be issued. Subsequently, after the technical design has been approved, agreement approving the decision for the actual land expropriation will be issued.

The procedure of the land expropriation in the proposed project is shown in Figure 3.4.8.



(*) Agreement to grant the land to be released in two stages.
The first is a Memorandum of Agreement that allows investors to use the land to be released in the report stage of feasibility study.
After the basic design is approved, a Memorandum of Agreement is the decision to grant land to be granted.

Figure 3.4.8 Process for General Land Expropriation in the Water Supply Works

Land ownership in Viet Nam is described in Article 5 "Land Ownership" in the "Law on Land" and the state owns and manages the land since "the state represents the citizens (state=residents), and the citizens are owners of the land."

The expropriation of the project area approved by the government in Viet Nam is indicated in Article 130 (Decree No.181/2004/ND-CP) of the "Government Laws Related to Implementation of the Law on Land" and Article 38 "Expropriation of Land" of the "Law on Land." Compensation for land expropriation, guarantee of resettlement are covered in Article 39 "Compensation and resettlement of persons whose land has been expropriated to use it for the defense, security, national interest, public benefits and economic development of the country".

In the decree, the water supply works is in the public works sector, so the state can expropriate land required for the proposed project.

The rights for land expropriation, allocation of land, lease, etc. rest with the national organization having these rights, as indicated in Article 38, Paragraph 2 “Land expropriation” of the Law on Land. The Project Enterprise has to submit the land use plan to the national organization having these rights and obtain permission. (“Government Laws Related to Implementation of the Law on Land” Article 130) However, the procedure of land expropriation is as indicated in Article 7, Paragraph 4 of the “Law on Land”. All formalities related to land expropriation, will be implemented by public organization such as the Public Committee, etc.

The Project Enterprise is not to be involved in any way with land expropriation directly according to the legal system.

4) Application for power supply

The Project Enterprise has to submit an application for power required for the project to the Hanoi People’s Committee (HPC) and the power supply corporation of Gia Lam Prefecture, which is the site for construction of the water treatment plant.

Since Hanoi is facing severe power shortage problems presently, the power situation is extremely difficult for new development projects. However, power is being supplied on priority for water supply works; therefore, the required power will be supplied henceforth too.

5) Application for water rights

Water source is a national asset in Viet Nam, and a permit for water rights is necessary for intake of water. Water rights are established by the Ministry of Natural Resources and Environment. In case of this project, application is to be made for water rights to the Department of Natural Resource and Environment (DONRE) in Hanoi.

Although it is generally difficult to acquire water rights permit, according to the government’s policy of promoting conversion of water source from groundwater to surface water, it can be acquired easily as permit for drinking water source as given in government notification No. 50.

Costs for formalities for acquiring water rights will be incurred, but once such rights are acquired, there is no need to renew them; moreover, there are no usage charges such as intake charges and so on.

6) Permission for exclusive use of rivers at intake facilities

The Duong River water treatment plant converts the surface water of the Duong River to a water source; therefore, intake facilities must be installed at the riverside, and the river must be used exclusively.

The permission for exclusive use of river is to be taken from the person in charge of dike management generally (Department of Dyke Management, HPC for Duong River), but the area near the site scheduled for construction of the water treatment plant is a critical management area. Besides the Department of Dyke Management, the permission of the Ministry of Agriculture and Rural Development of Viet Nam (MARD) is also necessary.

7) Application for drainage permit

The drainage generated after water treatment at the Duong River water treatment plant will be treated in the premises and the treated water will be discharged outside the premises.

Permission must be taken from the HPC and MARD for drainage above 50,000 m^3/day (river discharge) in Viet Nam.

8) Application for construction permit

After completing the formalities for application of permits mentioned above, application for construction permit is to be made to the HPC. To apply for construction permit, all the processes above should be cleared first.

When the construction permit is received, the final approval for the work must be obtained from the Ministry of Construction (MOC). Once this approval is received, detail design work can be started.

However, since the proposed project is a large-scale project, approval of the Prime Minister’s Office may also be necessary.

3.5 Design

3.5.1 Design Overview

An overview of design of facilities is given in Table 3.5.1.

Table 3.5.1 Facilities to be Designed

Facility	Designed scale		Remarks
	Phase 1	Phase 2	
Water Intake	150,000m3/day	300,000m3/day	* Construct only equipment in Phase 2
Water Conveyance			
Water Treatment			
Wastewater Treatment			
Water Transmission			* Construct only equipment in Phase 2
Transmission Pipeline	L=45.7km	—	
Distribution Pipeline	—	—	*only Planning

3.5.2 Design Policy

(1) Basic Concept of Design of Water Treatment Plant

The water treatment plant will be the first water treatment plant in Viet Nam to be constructed, managed and operated as a clean water supply project after the establishment of special purpose company (SPC) by JICA and private enterprises.

For this reason, the construction of facilities should form a stable supply base in response to diversified needs of the customer and changes in the social circumstances in recent years, and aim for a stable and safe water treatment plant, which is also a modern water treatment plant that accounts for the global environment and the regional environment.

Making full use of the privileged environment of the Japanese-Vietnamese PPP, efforts will be made to enhance the operation and maintenance level in the Hanoi Water Works through transfer of technology related to Japan.

Taking the above points into consideration, the basic concept of the water treatment plant is described below, and the design of the water treatment plant is carried out.

> "Building a modern water treatment plant worthy of Viet Nam, a country that continues to grow"

(2) Targets and Issues/Measures Related to Design

The four targets mentioned below are set aiming an advanced water treatment plant to suit the needs of the century, and accordingly various issues and measures are proposed.

Target	Policy
Water treatment plant offering steady supply	**Ensuring a stable water source** ・Ensuring stable intake volume taking a large river such as the Duong River as the water source **Stable facilities with adequate margin** ・Ensure efficient spare capacity ・Ensure clear water reservoir capacity that enables effective water operations ・Ensure sludge treatment facilities that can thoroughly treat large volume of sludge
Secure and safe water treatment plant	**Ensure stable supply of drinking water** ・Realization of facilities that can cope with high turbidity as measure for water quality of Duong River ・Water treatment process that enables measures such as Cryptosporidium or trihalomethane measures to be adopted ・Continuity by installing automatic water quality analysis instruments at the water treatment plant and the point-of-entry water quality monitoring ・Water source measures by installing oil fence **Ensuring safe operation and maintenance** ・Elimination of dangerous chemicals by using sodium hypochlorite
Appropriate operation and maintenance	**Introduction of energy conserving, low carbon and highly efficient monitoring and control system** ・Effective operation and management of various pumping equipment ・Efficient operation and maintenance by dosing chemicals effectively in response to changes in water quality **Crisis management measures to prevent water quality accidents** ・Turbidity control to prevent leakage of Cryptosporidium ・Use of fish monitoring tanks as a measure against unexpected water quality accidents **Transfer of operation and maintenance technology by Japan** ・Build-up of an O&M system for assigning Japanese engineers at the required locations ・Employee training and fostering by Japanese engineers with rich experience, and establishing a remote support system (from Japan)
Environmentally friendly treatment plant	**Introduction of energy conserving techniques** ・Efficient pump operation by inverter control ・Use of highly efficient transformers ・Use of filter basin washing system that does not require power from pump **Effective use of sludge** ・Effective use of treated sludge **Considerations of the surrounding environment** ・Installing open green belts

Considering these policies, the basic items related to the intake facilities and water treatment plant are set and summarized in the form of Table 3.5.2 to 3.5.5.

Table 3.5.2 Summary of Basic Items (1/4)

<table>
<tr><th>Type</th><th>Item</th><th>Basic items</th><th>Concepts of basic items</th><th>Remarks</th></tr>
<tr>
<td>Basic particulars
Basic items</td>
<td>1.Design water flow</td>
<td>[Phase 1]
(1) Design intake capacity: 159,000 m3/day
(2) Design supply flow: 150,000 m3/day (Daily maximum water supply flow)
125,000 m3/day (Daily average water supply flow)
104,000 m3/day (Daily minimum water supply flow)
(3) Water treatment capacity: The design water flow of each facility is as given in the table below.
<table>
<tr><th colspan="2">Item</th><th>Planned Inflow</th><th>Planned Outflow</th></tr>
<tr><td rowspan="3">Phase 1</td><td>Intake pumping station</td><td>159,000</td><td>159,000</td></tr>
<tr><td>Grit chamber</td><td>159,000</td><td>156,000</td></tr>
<tr><td>Raw water pumping station</td><td>156,000</td><td>156,000</td></tr>
<tr><td rowspan="5"></td><td>Dividing well</td><td>165,000</td><td>165,000</td></tr>
<tr><td>Mixing, flocculation, sedimentation basins</td><td>165,000</td><td>162,000</td></tr>
<tr><td>Rapid sand filter</td><td>162,000</td><td>154,500</td></tr>
<tr><td>Distribution reservoir</td><td>154,500</td><td>150,000</td></tr>
<tr><td>Transmission pumping station</td><td>150,000</td><td>150,000</td></tr>
</table>
[Phase 2]
(1) Design intake capacity: 318,000 m3/day
(2) Design supply flow: 300,000 m3 /day (Daily maximum water supply flow)
250,000 m3/day (Daily average water supply flow)
208,000 m3/day (Daily minimum water supply flow)
(3) Water treatment capacity: The design water flow of each facility is as given in the table below.
<table>
<tr><th colspan="2">Item</th><th>Planned Inflow</th><th>Planned Outflow</th></tr>
<tr><td rowspan="3">Phase 2</td><td>Intake pumping station</td><td>318,000</td><td>318,000</td></tr>
<tr><td>Grit chamber</td><td>318,000</td><td>312,000</td></tr>
<tr><td>Raw water pumping station</td><td>312,000</td><td>312,000</td></tr>
<tr><td rowspan="5"></td><td>Dividing well</td><td>330,000</td><td>330,000</td></tr>
<tr><td>Mixing, flocculation, sedimentation basins</td><td>330,000</td><td>324,000</td></tr>
<tr><td>Rapid sand filter</td><td>324,000</td><td>309,000</td></tr>
<tr><td>Distribution reservoir</td><td>309,000</td><td>300,000</td></tr>
<tr><td>Transmission pumping station</td><td>300,000</td><td>300,000</td></tr>
</table>
</td>
<td>Setting the design intake volume
3% is estimated as water for miscellaneous work (including water for fire extinguishing in the water treatment plant). 2% is estimated as raw water loss including drainage from the grit chamber and evaporation loss. 1% is estimated as the sludge drying bed loss.

* Design water flow of the water intake pumping station
Water flow inclusive of 6.0% of the design supply flow.
* Design water flow of the grit chamber
Water flow inclusive of 6.0% of the design supply flow.
* Design water flow of the raw water pumping station
Water flow inclusive of 4.0% of the design supply flow.

Setting the design water treatment capacity
The treated water required for work at the water treatment plant (sedimentation basin sludge, water for washing the filter basin, chemical dissolving water, cooling water for equipment, cleaning water, etc.), water for miscellaneous work, and other loss volumes are assumed to be 10% of the daily maximum water supply flow based on the past results of water treatment in Japan (sedimentation basin 2%, filter basin 5%, others 3%).

* Design water flow of dividing well, receiving well, sedimentation basin
Water flow inclusive of 10.0% of the design supply flow.
* Design water flow of filter basin
Water flow inclusive of 8.0% of the design supply flow.
* Design water flow of distribution reservoir
Water flow inclusive of 3.0% of the design supply flow.

[Treatment surplus capacity]
Surplus capacity will not be considered for this water treatment plant. If the number of systems (number of basins) increases, the treated water flow will be reduced, and the capacity of the facilities will be improved by operation and maintenance of facilities such as by establishing appropriate chemicals injection rate in water treatment, and the inadequacy will be compensated.</td>
<td></td>
</tr>
</table>

Table 3.5.3 Summary of Basic Items (2/4)

<table>
<tr><th>Type</th><th>Item</th><th>Basic items</th><th>Concepts of basic items</th><th>Remarks</th></tr>
<tr><td rowspan="2">Basic particulars
Basic items</td><td>2. Design raw water quality</td><td>1) SS (Suspended Solid)
Average turbidity: 450 mg/L (Facility design value)
: 240 mg/L (Annual sludge calculated value)
Maximum turbidity: 1,830 mg/Ll (Facility design value)
Minimum turbidity: 20 mg/L (Facility design value)

2) Turbidity (Inflow into Dividing well)
Average turbidity : 62 degree
: 33 degree
Maximum turbidity : 254 degree
Minimum turbidity :11 degree</td><td>[SS of raw water]
The SS of raw water was set based on the data of the past five years.
The average SS shows a decreasing trend in recent years. Barring exceptional years, the average during the rainy season in the last three years was almost equivalent to the average of five years. For this reason, the average value of turbidity of eight years was used.
The values of high SS by year and by season were observed but there was no clear trend of change with time. Henceforth also, the water quality is expected to change with the same level presently as in the past. However, low SS shows a decreasing trend in recent years; therefore, on this side, the water quality was set to change by the same level as in the past three years.

[Turbidity of raw water]
The turbidity of raw water was set based on the conversion data of SS of inflow into dividing well after sedimentation at Intake facility and Sedimentation Basin, and has also been set as design index of water treatment facilities.

[SS-turbidity conversion ratio]
The turbidity will be obtained by dividing SS (obtained from the results of water quality analysis) by SS-turbidity conversion ratio 1.8.</td><td>When turbidity of river water near intake exceed 1,830mg/L water intake from rivers will be regulated.</td></tr>
<tr><td>3. Dosing rate</td><td>1) Coagulants (liquid PAC)<table><tr><td rowspan="2">Setting the coagulant injection rate</td><td>Turbidity</td><td>Dosing rate</td></tr><tr><td>degree (kaolin)</td><td>PAC mg/L</td></tr><tr><td>Average (Annual)</td><td>33</td><td>30</td></tr><tr><td>Average (Rainy season)</td><td>62</td><td>30</td></tr><tr><td>Maximum</td><td>254</td><td>50</td></tr><tr><td>Minimum</td><td>11</td><td>20</td></tr></table>2) Hypochlorite<table><tr><td rowspan="2">Item</td><td colspan="3">Dosing rate</td></tr><tr><td>Maximum</td><td>Average</td><td>Minimum</td></tr><tr><td>Pre-chlorination</td><td>0.5</td><td>0.3</td><td>0</td></tr><tr><td>Intermediate chlorination</td><td>3.0</td><td>2.0</td><td>1.5</td></tr><tr><td>Post chlorination</td><td>1.0</td><td>0.6</td><td>0.2</td></tr></table></td><td>Need for pH adjustment
・ The average pH value of raw water was very steady about 8.0 during all season. Although the pH value showed a decreasing trend from 7.4 to 7.8 at the PAC injection rate of 30mg/L, this change was within the range of correct coagulation pH values, and it was concluded that there was no need to adjust the pH value at the turbidity of 11 to 240 degree in the tests this time.</td><td>Set based on Chapter 2.</td></tr>
</table>

Table 3.5.4 Summary of Basic Items (3/4)

<table>
<tr><th>Type</th><th>Item</th><th>Basic items</th><th>Concepts of basic items</th><th>Remarks</th></tr>
<tr><td rowspan="3">Basic particulars
Basic items</td><td>4. Sludge settling percentage and sludge concentration</td><td>1) Sludge settling percentage
<table>
<tr><td rowspan="3">Sludge settling percentage</td><td>Water intake</td><td>40% of raw water</td><td>(40%)</td></tr>
<tr><td>Grit chamber</td><td>60% of water intake</td><td>(24%)</td></tr>
<tr><td>Sedimentation basin</td><td>100% of grit chamber</td><td>(36%)</td></tr>
</table>
2) Concentration of wastewater sludge
<table>
<tr><th>Treatment process</th><th>Type</th><th>Conc.</th><th>Solids per unit volume</th></tr>
<tr><td rowspan="3">Sedimentation basin sludge</td><td>Annual average</td><td>3%</td><td>30 kg/m³</td></tr>
<tr><td>Rainy season average</td><td>2%</td><td>20 kg/m³</td></tr>
<tr><td>Maximum</td><td>7%</td><td>70 kg/m³</td></tr>
<tr><td rowspan="3">Sludge basin sludge</td><td>Annual average</td><td>3 %</td><td>30 kg/m³</td></tr>
<tr><td>Rainy season average</td><td>2%</td><td>20 kg/m³</td></tr>
<tr><td>Maximum</td><td>7 %</td><td>70 kg/m³</td></tr>
<tr><td rowspan="3">Thickening tank sludge</td><td>Annual average</td><td>5%</td><td>50 kg/m³</td></tr>
<tr><td>Rainy season average</td><td>5%</td><td>50 kg/m³</td></tr>
<tr><td>Maximum</td><td>10%</td><td>100 kg/m³</td></tr>
</table></td><td>・ For sludge settling percentage from the result of water quality analysis, 40% sludge of raw water were considered to settle in the intake pump station, it needed a retention time of two hours, while 60% sludge of the intake pumping station were considered to settle in the grit chamber, and it needed a retention time of ten hours.
・ The concentration of sludge from the sedimentation basin after wastewater treatment was set considering safety factors based on the differences in turbidity and reduction in case of underwater sludge collection system referring to the results of water treatment plants with central sludge collection system in Japan. The grit chamber desludging was assumed to be two times that of the sedimentation basin.</td><td>Set based on Chapter 2.</td></tr>
<tr><td>5. Schedule of construction of facilities</td><td>Facilities are planned to be constructed in two phases. The first phase is based on supply rate of 150,000 m³/day x 1 system and the second phase is based on a rate of 150,000 m³/day x 1 system.</td><td>Facilities that are to be constructed in Phases 1 and which will be used in Phase 2 are as below.
・ Intake
・ Intake pump building
・ Grit chamber
・ Raw water pump building
・ Dividing well
・ control building (600,000 m³/day facility common to both Phases)
・ Pump building
・ Chemical feeding building
・ Intake pipeline, raw water mains and transmission pipeline</td><td></td></tr>
<tr><td>6. Disaster measures</td><td>・ Ensure earthquake resistance of the facilities.
・ As measure against flooding due to typhoons, heavy rains, etc., develop land at a higher elevation than the surrounding land.</td><td>・Structural design to consider seismic factors of Viet Nam.
* The developed land elevation accounting for measure to prevent flooding is to be generally 1.0 m higher than the existing ground level.</td><td></td></tr>
</table>

Table 3.5.5 Summary of Basic Items (4/4)

Type	Item	Basic items	Concepts of basic items	Remarks
Basic particulars Basic items	7. Intake system	• The intake system from the Duong River will be a system in which water is drawn in by channel into the water intake pump station for the high water channel outside the dike. • The system will take in water by pump because of the relation between the Duong River water level and the elevation of the water treatment plant. • A grit chamber will be installed to reduce the load of the water treatment plant so that the raw water supplied to the water treatment plant is stored, and the coarse suspended solids matters sedimented and removed. • The system will take in raw water by pump because of the relation between the water level of the grit chamber and the elevation of the water treatment plant.	• Status of whether the pumping station outside the dike can be installed or not need to be discussed beforehand with the river management personnel • Measures to be taken to ensure that pump building is not inundated during a flood. • The grit chamber is to be installed having raw water storage function in order to account for the intake limitations during high turbidity and stoppage of intake due to water quality accidents. • The capacity of the grit chamber is to be at least adequate for 10 hours (combined volume of 12 hours flow with water intake facility). • Based on the scale of the grit chamber, it is likely to be a dug chamber, so the raw water will be pumped to the water treatment facilities by pump.	Set based on Chapter 2.
	8. Water treatment flow	The water treatment system will be a chemical settling and rapid sand filtering system.	• At this point of time, no advanced treatment is necessary to ensure purified water quality. • Although a specific treatment is not needed against the THM formation since the concentration is only one-fifth of Japanese water quality standards, intermediate chlorination will be added because it will decrease the possibility of THM and TOC formation. • As a measure against cryptosporidium, filter basin will be a facility that can slow down and start slowly.	
	9. Wastewater treatment flow	For wastewater treatment, an environmentally friendly closed system will be used that circulates the wastewater and reuses it without discharging it into the river.	• Polymer is not used during water treatment, therefore, water quality problems do not exist during circulation of wastewater and so a closed system is adopted. • Wastewater from the sedimentation basin is stored and regulated in the sludge basin, conveyed to the thickening tank, and then to the sludge drying beds where dehydration takes place. • The filter basin wash water drainage is returned to the dividing well from the wash water drainage basin. • The supernatant of the thickening tank is returned to the wash water drainage basin.	

3.5.3 Facility Plans for Water Intake and Water Treatment Plants

(1) Water Intake

1) Water Demand for the Planned Phases

Calculated water demand for each phase of the plan is shown in Table 3.5.6.

Table 3.5.6 Phase-wise Water Demand

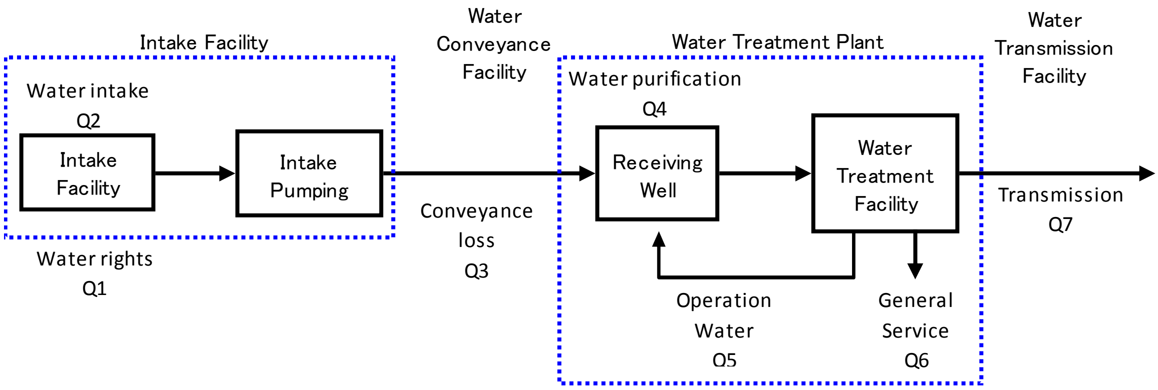
No.	Description	Water supply volume (m^3/day)		
		2015	2020	2030
1	Average daily water supply volume	101,621[*1]	666,394[*2]	728,867[*2]
2	Maximum daily water supply volume	162,099	829,707	904,585
3	Existing water treatment plant capacity	—	438,000	438,000
4	New demand volume	162,099	391,707	466,585
5	Adopted water supply volume	150,000	300,000	—

*1: Does not include 18,000m^3/day supplied to central Ha Noi City, or 10,000m^3/day supplied to Bac Ninh Province.

*2: Does not include 30,000m^3/day supplied to Bac Ninh Province.

2) Design Water Flow

Water systems lose certain amounts of water due to evaporation, leakage, draining and other causes as it travels from the intake source to the user. The volumes of water loss at and downstream of water distribution facilities are accounted for in the planned maximum daily water supply volume. Therefore, in this report, outline of the planned design intake flow and water purifications flow are considered, which is shown below.



- Water rights volume Q1: Water volume that has been secured through water rights licenses.
- Water intake volume Q2: Water loss that occurs at the water treatment plant is accounted for to determine the planned water intake volume.

  Therefore Q2 = Q3 + Q5 + Q6 + Q7 (for closed systems)

  * Q5 represents only the volume lost at the sun drying bed.
- Water purification volume Q4: As is the case with water intake volume, the planned water treatment volume is determined based on the maximum daily water supply volume, and by taking into account water for operations Q5 and general service water Q6 used at the water treatment plant.

  Therefore Q4 = Q5 + Q6 + Q7

3) Design Intake Flow

This water treatment plant consists of water intake facilities, water conveyance facilities, and water treatment facilities. Losses at the water intake facility are negligible and are therefore not included in calculations. In recent years, a large number of water treatment plants in Japan have come to employ closed systems that require energy in order to address issues related to the effective utilization of intake water and conveyed water, as well as to address issues related to the environmental effects of chemical-laden drainage.

In addition to the reasons stated above, due to the fact that the water treatment plant in question will require motive power (pump) in cases where treated drainage is drained outside of the system, or a 2,000mm diameter drain pipe must be laid for long distances if draining is to rely on flow-by-gravity, and also for economic reasons, Study Team plan to implement a closed system.

However, treated water at the sun drying beds will be deemed to be a water loss along with evaporation as, from a water quality management standpoint, it is preferable that this water is released. Therefore, the design intake flow constitutes a volume that takes into account the planned water supply, general service water, conveyance loss, and loss at the sun drying bed.

General service water used at the water treatment plant (including water for fire-fighting) includes water supply for the plant, cleaning water used in the plant, and sampling water, etc. In water treatment plants operating in Japan, these typically make up approximately 3 - 5% of the water supply. In this plan therefore, the volume of general service water is estimated to be 3%.

With regard to conveyance loss, the volume that is drained and evaporated at the settling basins must be taken into account. The drained volume may also include that which results from regular dredging, although this is not done at frequent intervals and has only a small effect on the intake volume. Therefore, the loss amounts to 1% or less at average turbidity. Meanwhile, while the amount of evaporation will vary widely depending on the climate, an estimated figure of 1% is used based on the retaining time at the settling basin as actual performance figures are not available for Viet Nam.

As for loss at the sun drying bed, an estimated figure of 1% is used, which includes osmosis discharge, water contained in sludge, and evaporation.

From this, the volume of general service water and loss is estimated to be 6% for this plan, resulting in the following equation.

- Phase 1 planned water intake volume: Q = 150,000m^3/day x 1.06 = 159,000m^3/day
- Phase 2 planned water intake volume: Q = 300,000m^3/day x 1.06 = 318,000m^3/day

4) Design Filtration Flow

The design filtration flow is based on the planned maximum daily water supply and is determined upon taking into account water for operations (discharged sludge removal from the sedimentation basin, water for cleaning the filter, water used for chemical dissolution, equipment cooling water, cleaning water, etc.), general service water, and other losses that occur at the plant. Of these, the cleaning water for the rapid filter that is consumed in the process of the water treatment process represents a considerable amount of water.

Additionally, this volume will be added to the water treatment capacity when considering reserve water treatment capacity for ensuring stable long-term water supply or other purpose. Such reserve capacity, however, will not be considered for this plant from the aspect of economic efficiency and space limitation.

The plant in the plan will, however, be equipped with multiple systems of water treatment facilities to reduce the impact of volume reductions that may occur during repairs that are carried out to remedy unforeseen accidents. Additionally, as for periodic cleaning and maintenance, sufficient water supply volumes can be secured by performing cleaning and maintenance during winter months when the water consumption is expected to be relatively low.

① Calculating the water loss volume

Based on past performance at water treatment plants in Japan, water for operations (discharged sludge removal from the sedimentation basin, water for cleaning the filter, water used for chemical dissolution, equipment cooling water, cleaning water, etc.), general service water, and other losses that occur at the plant are assumed to be 10% of the maximum daily water supply volume (sedimentation basin: 2%, filter: 5%, other: 3%).

Vietnamese standards for waterworks facilities are as follows:

[Water loss]

- Filter drainage is returned (drainage from the sedimentation basin is released): 3-4% of water supply volume
- Filter drainage is released into the river (drainage from the sedimentation basin is released): 5-10% of water supply volume

From the above, the water volume for this water treatment plant is defined as follows:

[Water treatment facilities]

- Planned water volumes at the dividing well, receiving well, and sedimentation basin: A volume to which has been added 10.0% of the planned water supply.
- Planned water volume at the filter: A volume to which has been added 8.0% of the planned water supply.
- Planned water volume at the distribution reservoir: A volume to which has been added 3.0% of the planned water supply.

The average and minimum planned water volumes are defined as follows as reference values for the facility plan:

[Phase 1]
Planned average daily water supply volume: Q = 150,000m^3/day/1.2 (load factor) = 125,000m^3/day
Planned minimum daily water supply volume: Q = 125,000m^3/day/1.2 (presumed value) = 104,000m^3/day

[Phase 2]
Planned average daily water supply volume: Q = 300,000m^3/day/1.2 (load factor) = 250,000m^3/day
Planned minimum daily water supply volume: Q = 250,000m^3/day/1.2 (presumed value) = 208,000m^3/day

② Reserve water treatment capacity

Reserve capacity in this context does not refer to capacity used to address minor accidents, cleaning or inspections that can occur on a relatively routine basis, but to capacity used to address large-scale or long-term reductions in water treatment performance.

Reserve water treatment capacity is secured for the following purposes:

a) To compensate for capacity reductions that occurs while carrying out renovation, modification, or enhancement work on the facility.

b) To compensate for capacity reductions that occurs during facility accidents or breakdowns.

While it is generally preferable to secure reserve water treatment capacity for the above purposes, doing so can also have major disadvantages from the perspectives of economy, maintenance, and management as the scale of the facility can become excessive.

Therefore, in cases where reserve capacity is not provided, it becomes crucial to take steps to minimize capacity reductions by providing larger numbers of treatment systems, and through operational procedures.

Reserve water treatment capacity will not be considered for this water treatment plant. The basic strategy for addressing capacity reductions at this plant will be to increase the number of systems (number of basins) to reduce the volume of water treated per system, and consequently reduce the amount of reduction that will result from a system shutdown, in addition to making changes to operational procedures such as increasing the filtering speed, and optimizing the chemical injection ratio to improve efficiency and compensate for shortfalls.

4) Summary of planned water volume

The planned water volumes for the Duong River water treatment plant as defined based on the above information are as follows:

① Phase 1

a) Design intake flow: 159,000m^3/day

b) Design water supply flow: 150,000m^3/day (maximum daily water supply volume)

125,000m^3/day (average daily water supply volume)

104,000m^3/day (minimum daily water supply volume)

c) Water treatment capacity: The following table shows the planned water volumes for each facility.

Table 3.5.7 Planned Water Volume for Phase 1

Items	Inflow water volume (m^3/day)	Outflow water volume (m^3/day)	Loss rate (%)	Water volume lost (m^3/day)	Remarks
Water intake pumping station	159,000	159,000	0	0	General drainage + settling basin drainage evaporation + solar loss
Settling basin	159,000	156,000	2.0	3,000	General drainage + settling basin drainage evaporation + solar loss
Water conveyance pumping station	156,000	156,000	0	0	General drainage + solar loss
Dividing well	165,000	165,000	0	0	General drainage + sedimentation drainage (including solar loss) + filter drainage
Chemical sedimentation basin	165,000	162,000	2.0	3,000	General drainage + sedimentation drainage (including solar loss) + filter drainage
Rapid filter	162,000	154,500	5.0	7,500	General drainage + returned filter drainage
Clear water reservoir	154,500	150,000	3.0	4,500	General drainage
Water transmission pumping station	150,000	150,000	0	0	

② Phase 2

a) Design intake flow: 318,000m^3/day

b) Design water supply flow: 300,000m^3/day (maximum daily water supply volume)
250,000m^3/day (average daily water supply volume)
208,000m^3/day (minimum daily water supply volume)

c) Water treatment capacity: The following table shows the planned water volumes for each facility.

Table 3.5.8 Planned Water Volume for Phase 2

Items	Inflow water volume (m^3/day)	Outflow water volume (m^3/day)	Loss rate (%)	Water volume lost (m^3/day)	Remarks
Water intake pumping station	318,000	318,000	0	0	General drainage + settling basin drainage evaporation + solar loss
Settling basin	318,000	312,000	2.0	6,000	General drainage + settling basin drainage evaporation + solar loss
Water conveyance pumping station	312,000	312,000	0	0	General drainage + solar loss
Dividing well	330,000	330,000	0	0	General drainage + sedimentation drainage (including solar loss) + filter drainage
Chemical sedimentation basin	330,000	324,000	2.0	6,000	General drainage + sedimentation drainage (including solar loss) + filter drainage
Rapid filter	324,000	309,000	5.0	15,000	General drainage + returned filter drainage
Clear water reservoir	309,000	300,000	3.0	9,000	General drainage
Water transmission pumping station	300,000	300,000	0	0	

(2) Raw Water Quality

The quality of water of the Duong River corresponds to category B according to Vietnamese river water quality standards (Table 3.5.9), and it is characterized as having a high level of turbidity throughout the year.

SS is the main contributor to the turbidity of the Duong River water and that is measured by the Ministry of Hydrometeorology and maintained as time-series database.

According to data from the Ministry of Hydrometeorology, the average SS of the river over the past 10 years has been about 300mg/L, with maximum SS occasionally exceeding 3,000mg/L. Additionally, past records show that there have been 1 to 29 days throughout the year where high SS levels of 1,000mg/L or greater have occurred.

Table 3.5.9 Vietnamese River Water Quality Standards (TCVN 5942-1995)

Item（Extract)	Unit	Type A (for drinking water)	Type B (Others)
pH	mg/L	6.0-8.5	5.5-9.0
BOD5	mg/L	<4	<25
DO	mg/L	>6	>2
SS	mg/L	20	80
Ammonium-Nitrogen	mg/L	0.05	1.0
Nitrate-Nitrogen	mg/L	10	15
Fe	mg/L	1	2
Fluorine	mg/L	1	1.5
Coliform Count	MPN/100ml	5,000	10,000
Agrichemicals (Wtihout DDT)	mg/L	0.15	0.15
DDT	mg/L	0.01	0.01

1) The previous data of raw water SS

The trend of raw water SS from 2001 to 2010 is shown in Figure 3.5.1.

The graph shows similar seasonal trends in each year, and it is observed that SS is reality high from May to Aug during rainy season and low from Nov to Apr during dry season. Although the annual maximum SS changes greatly with year, the annual range of fluctuation was moderate as a general trend year by year.

The trend of Duong River flow rate from 2002 to 2009 is shown in Figure 3.5.2, flow rate data of 2001 and 2010 was not obtained.

Since the river flow rate is greatly influenced by precipitation amount, the tendency of river flow is observed to increase in rainy season, and is considered to influence change of the raw water SS which shows similar tendency.

Considering the above discussion, it is important to forecast the future value of raw water quality in order to decide the level of raw water quality in dry season and rainy season, since high-concentration SS is expected to occur by increasing precipitation, etc.

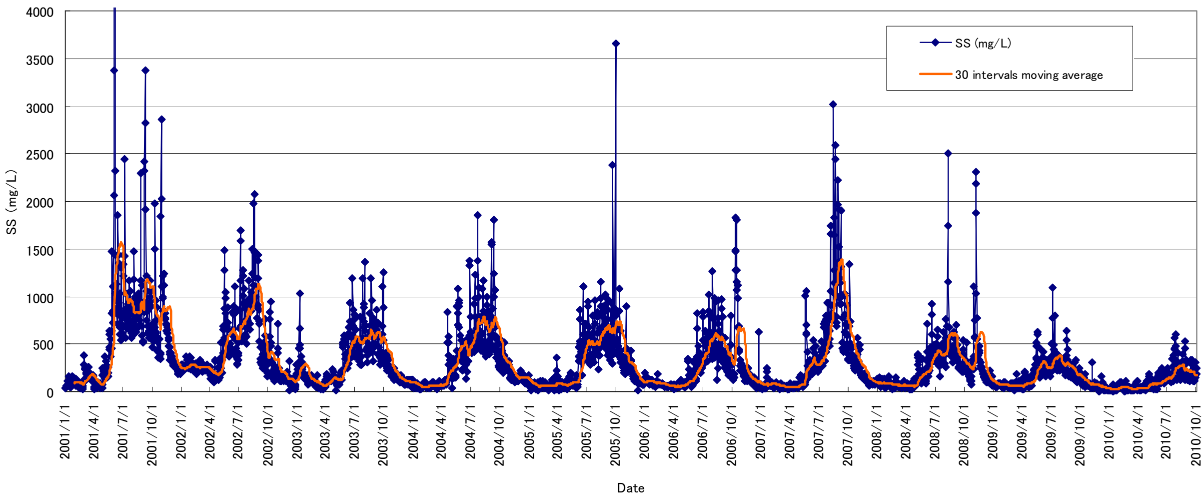


Figure 3.5.1 Trend of Raw Water SS in Latest 10 years

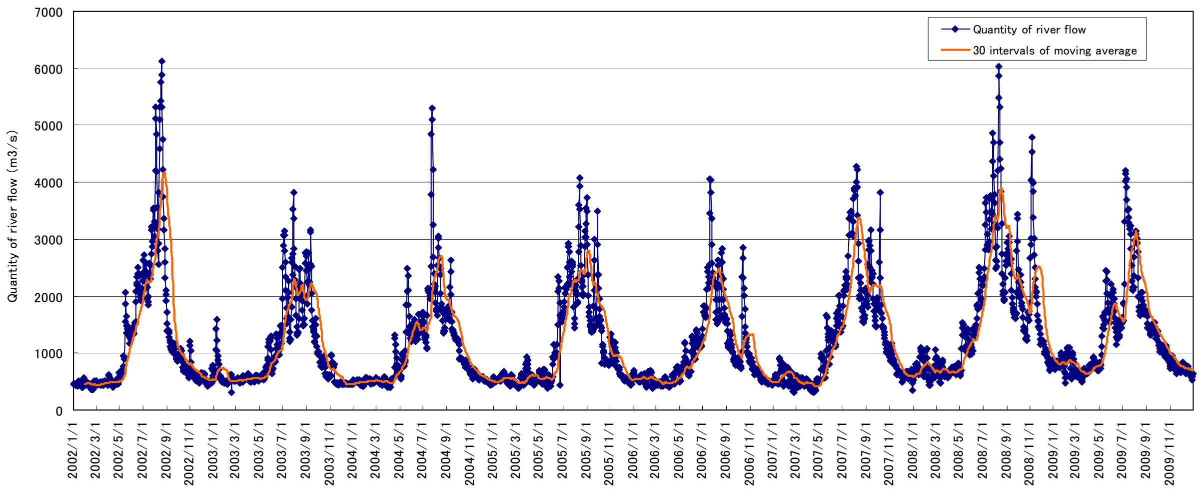


Figure 3.5.2 Trend of Duong River Flow Rate in Latest 8 years

2) The Forecast of the future value of raw water SS

① Condition of raw water SS in observed years

The number of days of occurence of raw water SS in a particular range for the latest 10 years is presented in Figure 3.5.3. The average, and maximum and minimum average value of SS in latest 10 years is shown in Figure 3.5.4.

Although the maximum value of raw water SS varies significantly with year, the average yearly SS value is about 300 - 400 degree. And while the three quarters yearly SS value is about 300-500 degree, there is no clear difference in the value of SS in a given year.

In Addition, the maximum value of SS in the latest ten years is 8,030 mg/L (which continued for only one day), and the value of SS of 2,000 or greater continued for maximum 4 days.

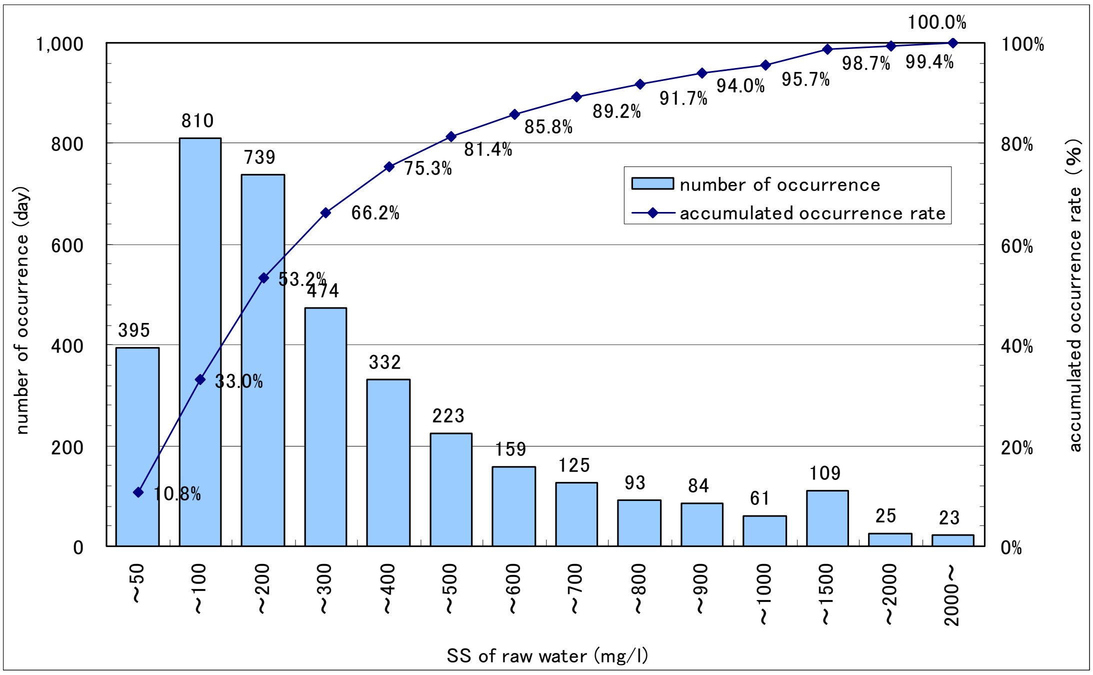


Figure 3.5.3 Number of Occurrence of Raw Water SS in Previous 10 years

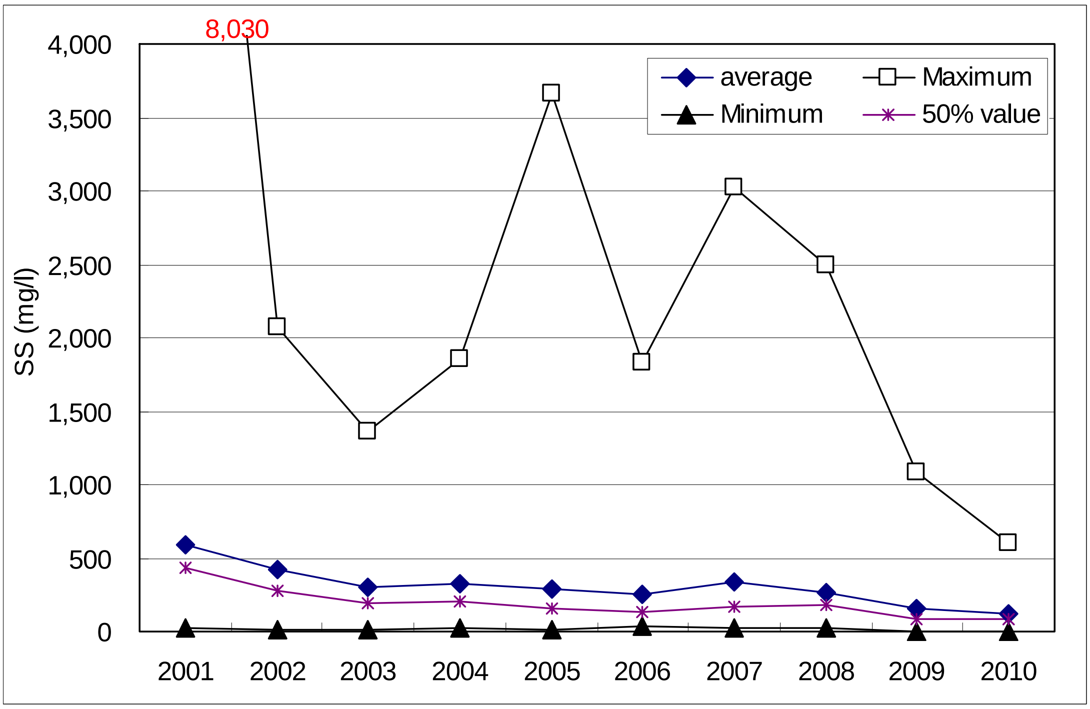


Figure 3.5.4 Trend of Raw Water SS in Previous 10 years

② Condition of raw water SS in dry season and rainy season

The precipitation varies significantly with season. Therefore, the level of SS in raw water has been analized in case of dry and rainy season, assuming dry season during the months of Feburary to April and rainy season during the months of July to September.

The aggregate calculation of raw water SS in each season, in dry and rainy, is shown in Table 3.5.10 and Figure 3.5.5 below.

- Dry season

  In the dry season, the range of maximum SS was observed to be 100 to 800 mg/L, while maximum SS in latest 5 years was 350 mg/L. In addition, average and quatile values of SS are observed to be changing with low value in latest 5 years.

  A dam was constructed in upstream of the Hong River and is considered as major factor resulting in the observed tendency. Also, raw water SS and water level is changing with low value in recent years, according to the results of hearing survey around the monitoring point.

  Based on the above discussion, it is assumed that similar tendency as observed in recent years will continue.

- Rainy season

  In the rainy season, raw water SS is on a downward trend in observed years with the exception of 2007, although it is not as remarkable as the dry season.

  As a factor of moderate tendency, it is assumed that high-concentration SS of the rainy season is greatly affected by not only water quality of upstream river stretches but also rain (especially typhoon).

  Therefore, it is considered that the current trend of raw water SS will continue similar to the case of SS in the dry season.

Table 3.5.10 Condition of Raw Water SS in Dry Season and Rainy Season

Dry season : from Feb. to Apr.

Year	Average	Maximum	50% value	75% value	98% value	Minimum
2001	114	381	86	172	270	24
2002	226	334	240	256	333	94
2003	105	235	114	138	189	19
2004	115	834	72	96	532	29
2005	68	353	58	81	176	13
2006	68	178	66	78	111	31
2007	55	100	53	68	95	25
2008	67	159	67	77	133	25
2009	71	212	62	83	184	16
2010	38	112	31	47	105	5

Rainy season : from Jly. to Sep.

Year	Average	Maximum	50% value	75% value	98% value	Minimum
2001	986	3,380	854	1,050	2,508	518
2002	794	2,070	752	993	1,742	162
2003	569	1,360	520	676	1,201	278
2004	663	1,850	546	787	1,611	255
2005	631	3,660	527	772	1,371	234
2006	492	1,260	442	587	986	124
2007	868	3,020	740	1,023	2,467	235
2008	444	2,500	387	487	1,256	157
2009	276	1,090	241	320	780	95
2010	218	604	169	269	539	97

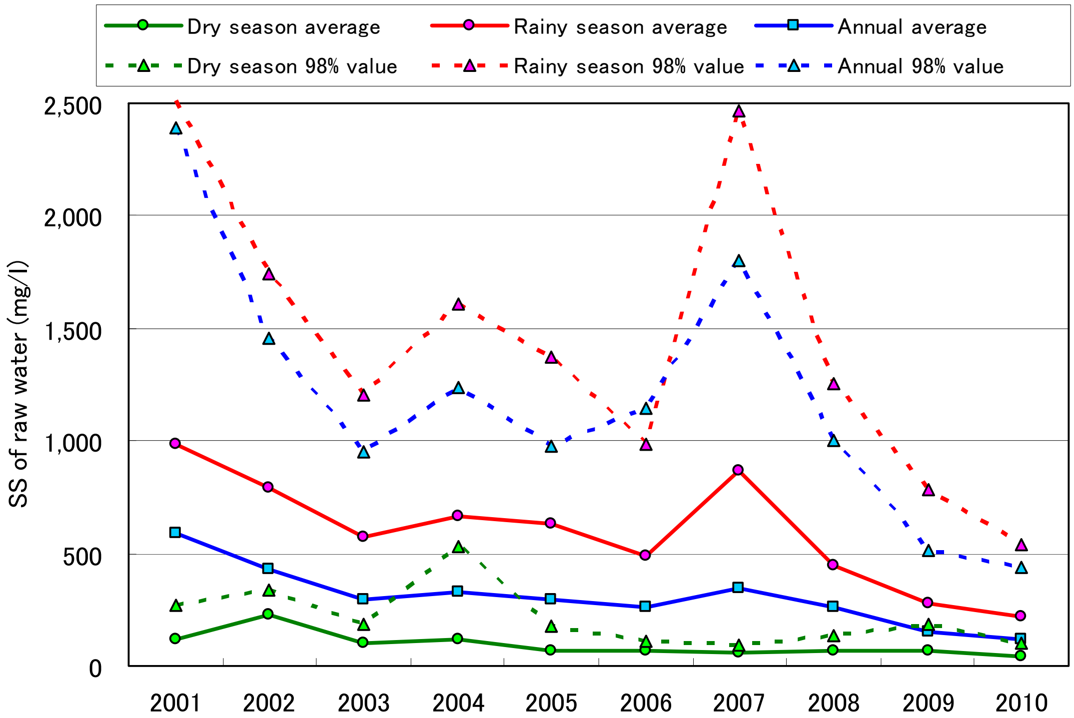


Figure 3.5.5 Trend of Raw Water SS in Dry Season and Rainy Season

③ Results of the setting value of raw water SS

Based on SS of Duong River for the latest ten years, a remarkable downward trend is experienced in recent years. Therefore, facility design value of SS is set based on the latest five years from 2006 to 2010.

The rainy-season average of SS expresses the data from July to September, and the maximum of SS expresses the highest value of SS at 98% (it cannot be intaken the river water since high-concentration SS is continued for one week throughout the observed years).

As mentioned above, facility design value of SS is set up as follows.

Rainy season average	: 450 mg/l (Facility design value)
Annual average	: 240 mg/l (Annual sludge calculated value)
Maximum	: 1,830 mg/l (Facility design value)
Minimum	: 20 mg/l (Facility design value)

(3) Water Quality Items for Treatment

Water quality items to be treated at this water treatment plant are defined as follows based on the results of water quality analysis.

- Bacteria number, E.coliform
- Lead (Pb), Aluminum (Al), Manganese (Mn), Iron (Fe), turbidity, color

(4) Selecting a Treatment Flow

1) Water treatment flow

The water treatment flow will be as shown in Figure 3.5.6 to address the state of raw water quality and items targeted for treatment.

Technologies used in water treatments can be classified into technologies for treating undissolvables including turbidity, algae, microorganisms, etc., and technologies for treating dissolvables including odor/taste, chromaticity, organic matter, disinfection byproducts, inorganic matter, etc.

Water treatment technologies can be broadly categorized as slow filtration, rapid filtration and membrane filtration processes for undissolvables, which are coupled with individual processes that are based on technologies for treating dissolvables. Table 3.5.11 is an extraction table for water treatment systems that treat stream surface water.

It is assumed that this water treatment plant will require technologies for addressing the aforementioned issue of SS, and a water treatment technology designed for SS of raw water concentrations of 450mg/L must be chosen (See Range of coloration in Table 3.5.11)

While iron and manganese levels exceed standards in some cases,a reduction in iron and manganese can be expected from the adhesion of manganese to sand in the current treatment flow (mid-chlorine treatment), and it is assessed that no special treatment will be required.

In addition, soluble aluminum can be treated by coagulation-sedimentation and rapid sand filter. Also, ammonia nitrogen can be treated by chlorine as it is below standards. THM formation potential can be expected to reduce by mid-chlorine treatment, and it is assessed that no special treatment will be required because THM formation potential level is not expected to exceed Japanese water quality standards.

Pesticide content is currently below standards, and therefore no special treatment is required in this respect.

Based on these deliberations, Study Team has selected the water treatment system shown in Figure 3.5.6.

Individual treatment processes will be discussed in “(7) Review of Water Treatment Methods.”

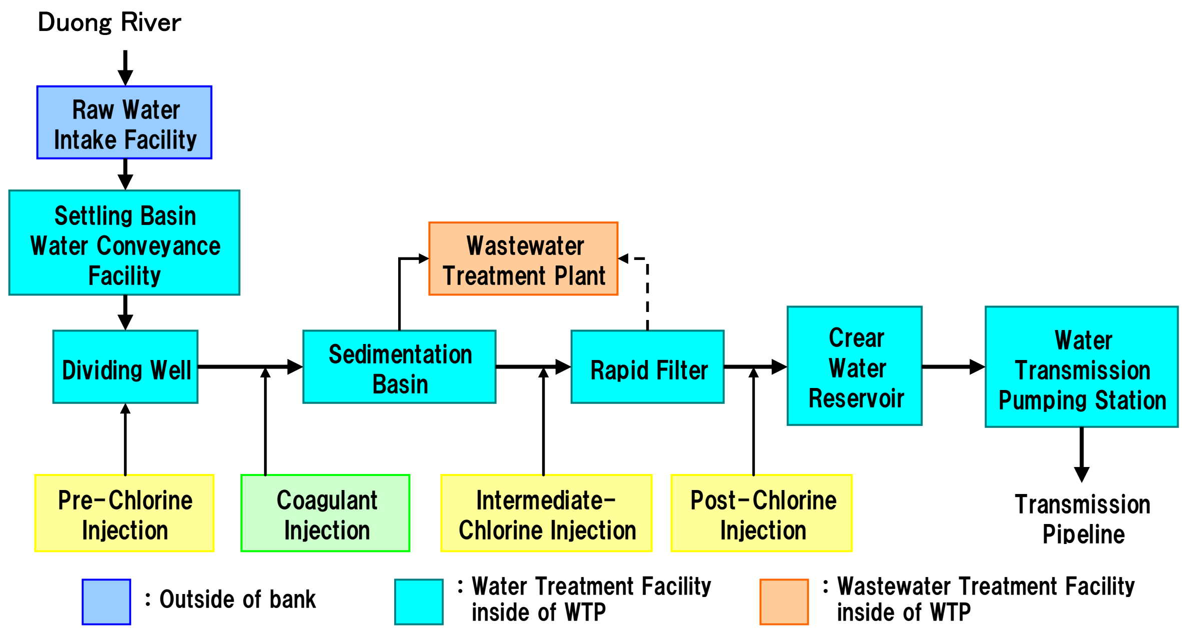


Figure 3.5.6 Water Treatment Flow

Table 3.5.11 Configuration and Extraction Table for Water Treatment System <River System> (Example)

Constituents targeted for removal								Water treatment system configuration						
Undissolvables		Dissolvables												
Turbidity	Algae	Chromaticity	Iron/ manganese	Odor/taste	Ammonia nitrogen	THMFP	Pesticides	Slow filtration process		Rapid filtration process			Membrane filtration	
								Scale of water treatment		Scale of water treatment			Scale of water treatment	
								Medium	Small	Large	Medium	Small	Medium	Small
Medium to high	Not present	×	×	×	×	×	×						Membrane filtration	
Medium to high	Not present	□	×	×	×	×	×			Chemical sedimentation + rapid filtration			Chemical sedimentation + membrane filtration	
Medium to high	Not present	○	×	□	×	□	□			Powdered charcoal + chemical sedimentation+ rapid filtration			Powdered charcoal + membrane filtration	
Medium to high	Not present	○	×	□	×	□	□			Chemical sedimentation + rapid filtration + particulate charcoal			Membrane filtration + particulate charcoal	
Medium to high	Not present	◎	○	◎	□	○	◎			Chemical sedimentation + ozone + particulate charcoal + rapid filtration				
Medium to high	Present	□	○	×	×	×	×						Membrane filtration + contact filtration of manganese	
Medium to high	Present	○	×	○	×	○	○						Membrane filtration + nanofiltration	
Medium to high	Present	○	□	○	□	○	○			Chemical sedimentation + particulate charcoal + rapid filtration			Membrane filtration + particulate charcoal	
Medium to high	Present	◎	○	◎	□	○	◎			Chemical sedimentation + ozone + particulate charcoal + rapid filtration			Membrane filtration + ozone + particulate charcoal	

[Turbidity of raw water] High: High turbidity of 100 degrees or greater.
Medium: Typical turbidity variations under 100 degrees. Low: Typically less than 5-10 degrees

[Treatment effectiveness symbol] ◎: Treatment is extremely highly effective. ○: Treatment is highly effective.
□: Treatment has limited effects. ×: Treatment has no effect.

(Prepared with information on the "Water Treatment Technologies Guidelines," Japan Water Research Center)

2) Drainage treatment flow

The drainage treatment process is to receive drainage and sludge from the water treatment facility, release or return treated water, dispose of generated sludge, and to enable the effective use of raw water. The drainage treatment system is primarily composed of four stages, namely the regulating, thickening, dewatering (used as resource if effective utilization is an objective), and disposal. When selecting individual processes, the most suitable process is selected based on the volume of solids generated and physical properties of the sludge, and their compatibility with the water treatment process.

The water treatment process adopted for this plan is based on "chemical sedimentation + rapid filtration" and therefore generates large amounts of drainage water and sludge, and the dirty water and sludge must be temporarily held and regulated before it is thickened. And as the site of the plant is relatively large and land prices are low, sun drying is the preferred method for dewatering. Dewatering conditions will be monitored when the plant reaches its Phase 1 operation of 150,000m^3/day and the possibility of implementing a mechanical dewatering process, which cost is not included in the total contruction cost, will be kept as an option should drying performance fall short of expectations.

Additionally, this plan will adopt a closed system for the reasons stated below, and the drainage produced from washing the rapid filter and supernatant water from the thickener will be returned to the dividing well and re-circulated.

Considering the above factors, the drainage treatment flow shown in Figure 3.5.7 will be implemented.

Individual treatment processes will be discussed in "(7) Review of Water Treatment Methods".

[Adopting a closed system]

In Japan, sedimentation facilities used in water treatment plants are considered to be a "designated facility" according to the Article 2 of the Water Quality Pollution Prevention Law. As such, restrictions are placed on the discharge of water from these facilities into public aquatic environments such as rivers and streams. Therefore, a large number of water treatment plants adopt a closed system where drainage from the drainage treatment facility is returned to the inlet of the water treatment system.

In mid to large-scale water treatment plants in particular, drainage resulting from the washing of filter basins that contain only low levels of coagulants or other chemicals are typically returned to the receiving well, the most upstream point in the water treatment process, to ensure the efficient use of raw water.

This water treatment plant will also employ a “closed system” for the following reasons.

① In the current state of affairs where closed systems have become the norm, it is not preferable that a new water treatment facility should release its drainage into rivers and streams from the standpoints of efficient water use and environmental impact.

② By re-circulating drainage produced in the water treatment process within the water treatment plant, operators are able to reduce the amount of re-circulated water intake to reduce not only the costs for maintenance and management, but also the plant's environmental impact on rivers and streams.

③ Polymers or other chemicals that can have adverse effects on health are not used in the processes of water treatment or drainage treatment. Therefore, there are no problems with the quality of the returned water and the water can be re-circulated safely.

④ As the turbidity of the raw water is high to begin with, the returning of turbid drainage will not have an effect on water treatment.

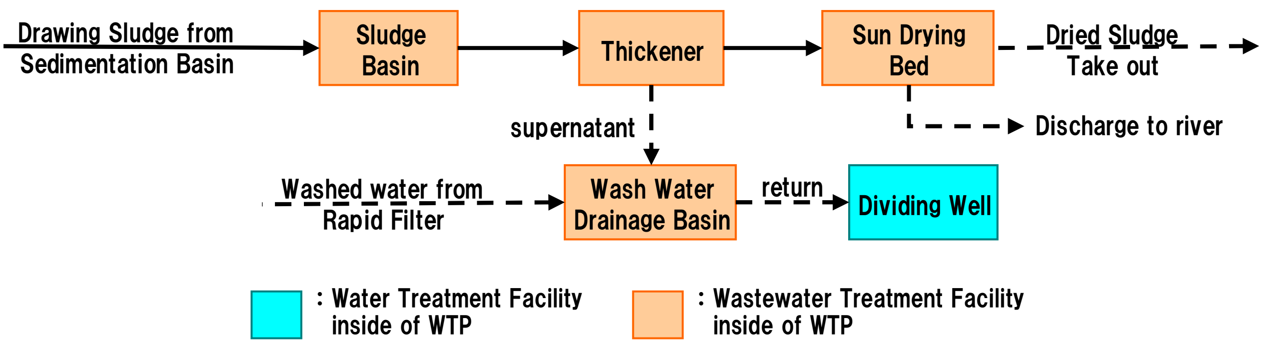


Figure 3.5.7 Wastewater Treatment Flow

(5) Chemical Dosing Plan

The chemical dosing plan will be set as follows based on the result of water quality analysis.

1) Coagulant dosing rate

From the result of Jar-Test, the most appropriate dosing rate was about 30 PACmg/L regardless of the difference in water quality and turbidity.

Accordingly, the coagulant dosing rate has been set as follows based on the above result.

Table 3.5.12 Planned Coagulant Dosing Rate

	Assumed turbidity of Inflow		Most appropriate dosing rate
	mg/L(NTU)	Degree (kaolin)	PACmg/L
Average dosing rate	59.4	33	30
Rainy season average dosing rate	111.6	62	30
Maximum dosing rate	457.2	254	50
Minimum dosing rate	19.8	11	20

In some cases momentary maximum turbidity reaches to level of 4,000 degree, and in such cases, it will be required to implement water intake regulation or accumulate in the Grit Chamber since high SS is expected to continue for only one day based on the record of previous eight years.

2) Chlorine dosing rate

① Necessity of chlorine dosing

Chlorine addition examination was implemented for the purpose of understanding the chlorine demand of raw water, since ammonia nitrogen and TOC were detected in raw water.

Chlorine demand of raw water was about 1.1mg/L - 2.2 mg/L from the results of analysis, and chlorine demand of Jar-Test supernatant was about 0.8 mg/L - 1.7 mg/L. Since ammonia nitrogen concentration was less than 0.03 mg/L and TOC was about 1 mg/L in the raw water, it was analized that chlorine consuming material can be removed by coagulant.

As mentioned above, points of chlorine dosing is considered to be optimal after coagulant (intermediate-chlorination).

However, pre-chlorination is needed in order to prevent the reproduction of algal, and post-chlorination is needed for keeping free residual chlorine concentration at the end of transmission pipeline.

② Setting of chlorine dosing rate

Chlorine dosing rate from the results of examination is shown below.

- Pre-chlorination

  Pre-chlorination is implemented as appropriate, and pre-chlorinition dosing rate is set as the minimum rate in order to prevent reproduction of algal.

- Intermediate-chlorination

  Intermediate-chlorination is implemented after sedimentation. Dosing rate is set based on the break-point from the results of chlorine demand examination for the purpose of maintaining free chlorine in the filtered water and the treated water.

- Post-chlorination

  Since free residual chlorine decrease with increasing of contact time in transmission pipeline, post-chlorine dosing rate is set as 0.6 mg/L for optimum residual chlorine at the end of transmission pipeline.

Table 3.5.13 Planned Chlorine Dosing Rate

Item	Dosing rate（mg/L）		
	Maximum	Average	Minimum
Pre-chlorination	0.5	0.3	0
Intermediate-chlorination	3.0	2.0	1.5
Post-chlorination	1.0	0.6	0.2

3) Necessity of other chemical dosing

- Necessity of pH control

  The average raw water pH is observed to be about 8.0, and also under optimum dosing rate (30 PACmg/L), pH remains in the appropriate range although it is decreased to about 7.4 to 7.8.

In addition, the water soluble aluminum is less than 0.06 mg/L in any case, which is lower than WHO technical level for treatment (below 0.1 mg/L). Therefore, addition of acid may not be needed for coagulation process.

(6) Review of Water Intake Methods

1) Water intake facility

The water intake facility (pumping station) must have the ability to intake the planned intake volumes consistently throughout the year. In particular, the following points must be taken into consideration: Water inlet will be obstructed by flowing debris including driftwood and vegetation; rolling stones and earth and sand that accumulate during floods will obstruct water intake; and riverbed scouring will result in low water levels during dry periods which in turn will affect water intake.

Table 3.5.14 shows the results of comparisons between different water intake methods at the Duong River for the purpose of this project. Due to the facts that a) increasing the water level by weir is not possible as the Duong River is used by boat traffic, b) the facility must not become an obstruction to the heavy boat traffic, and c) it is crucial that costs are kept low as a public works project, it was decided to adopt intake gate as the intake method.

In the Pre-FS, intake pipe was recommended with gravity flow to the grit chamber (sand settling basin), which is located at outside of the embankment. However it was changed into intake gate from the results of this survey. Main reason for this change was denial of permission to install raw water main deep under the embankment by Hanoi embankment administration office. Therefore, it is hydraulically impossible to send raw water with gravity flow by intake pipe method. The water intake facility must be equipped with water intake pump.

Additionally, because it is expected that a large amount of sand will accumulate along the water intake channel, periodic dredging will be performed using a boat.

[Planned water intake level]

- HWL + 11.50m (based on actual highest water level in the past 10 years of 11.42m)
- LWL + 0.50m (based on actual lowest water level in the past 10 years of 0.75m)

[Design conditions]

- Inflow speed: 0.8m/s or less
- Intake channel depth: LWL - 4.5m (effective depth: 3.5m, sand sedimentation: 1.0m
- Pump well water depth: LWL-4.0m (No less than 3.2. D: pump diameter)
- Inlet width: 2m (manual gate lifting)

[Facility specifications]

[Intake channel]

- Channel dimensions: Width 19m x height 14.5m (before pump well)
- Channel dimensions: Bottom width 13m (at water inlet) x top width 80m x height 14.5m

[Water intake pump well]

- Dimensions: Width 9.0m x length 12.0m x height 16.0m x 2 basins

[Ancillary facilities]

- Six angled drops, 6 gates, electrical room, plumbing room, return pipes (for test runs and sludge discharge), sludge pump boat, road bridge, water intake pump

2) Water conveyance facilities: Settling basin (raw water regulation basin)

The settling basin is a facility for removing sand that has flowed in with the raw water by settling.

Preferably this facility should be installed in a location that is near the water inlet inside of the levee. Its location should be determined based on the topography of the site and a comprehensive review of the locations of various facilities of the water treatment plant.

From the results of water quality analysis, the settling basin should have a capacity of 10 hours or greater of the planned treatment volume (for Phase2 water volume), and no auxiliary basin will be installed. In the future, when the plant will be expanded to 600,000m^3/day, one more basin will be added.

In terms of construction, flat basins will take up a large area and incur high construction costs in order to provide a water level that matches that of water treatment processes in subsequent stages. As such, a dug-in type, which is less expensive, will be employed with its bottom and side walls waterproofed with concrete. Water will be conveyed to subsequent stages of the water treatment process by pump.

Additionally, as this facility is also expected to see large amounts of sand sedimentation just as with the water intake facilities, a boat equipped with a sludge pump will be used for dredging and sand removal.

[Design conditions]

- Particle diameter: 0.005mm or larger
- Retention time: 10 hours or greater (for Phase 2 water volume)
- Effective depth: 5.5m
- Sand sedimentation height: 0.5m or greater

[Facility specifications]

[Settling basin]

- Dimensions: Width 156m x length 190m x height 5.5m x 1 basin
  (Includes sand sedimentation depth of 0.5m)
- Capacity: 158,000m^3 (Does not include sand sedimentation depth of 0.5m)

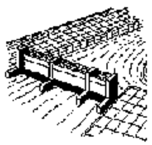
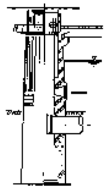
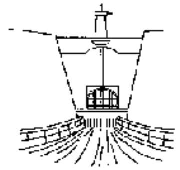
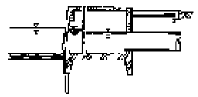
[Water conveyance pump well]

- Dimensions: Width 9.65m x Length 12.0m x height 8.8m x 2 basins

[Ancillary facilities]

- Six angled drops, 6 gates, electrical room, plumbing room, return pipes (for test runs and sludge discharge), sludge pump boat, road bridge, water conveyance pump.

Table 3.5. 14 Comparison of Different Types of Water Intake Facilities (Pumping Stations)

Item	Intake Weir		Intake Tower		Intake Gate		Intake Pipe	
Figure								
Feature	Possible for large amount of water intake by raising up water level using a weir.		Possible for stable water intake by installed fixed depth in the river.		Installed on riverbank. Take water to protected inland using pipe drain.		Installed on riverbank. Take water to protected inland through conduit.	
Points	Installed perpendicularly to the river. Effective for stable water intake and removing the sand.		Installed fixed depth in the river. Economical for a large amount of water intake.		Used for the river that has calm water level movement. Simple maintenance and stable for water intake.		Used for the river that has calm water level movement. No obstacle for the shipping.	
Capacity	Used for large amount of water intake using weir.	◎	Used for large amount of water intake directly from the river.	◎	Capable of intaking small amounts of water.	○	Capable of intaking medium amounts of water.	○
Stability	Completely possible. (Not appropriate for the river regime when intake gate is laid under the ground.)	◎	Possible. (Not appropriate for the river regime when intake gate is laid under the ground or exposed.)	○	Possible only for the case of calm flow of river. (Bottom of the river is needed to be stable.)	△	Possible. (Not appropriate for unstable bottom of the river when intake gate is laid under the ground or exposed.)	○
Inflow of Sediment	Very small amount of sediment flows in	◎	Small amount of sediment flows in	○	Sediment flows in	△	Small amount of sediment flows in	○
Depth of water	No influence	◎	Need average depth	○	Need average depth	○	Need average depth	○
Influence to Boat	Obstacle on ship route	×	Obstacle on ship route in some area	×	No influence	◎	No influence	◎
Cost	High	△	High (less cost than intake weir)	△	Low	◎	Low	◎

(7) Review of Water Treatment Methods

1) Water treatment methods

In this section, review is made in terms of the scale of the facility, treatment methods and other factors regarding individual processes in the water treatment system selected in the review above.

① Dividing well

The dividing well is installed for the purpose of achieving uniformity in the quality of water to ensure that subsequent water treatment processes including chemical dosing, sedimentation and filtration can be carried out correctly and easily.

The dividing well is a facility that will be shared in Phases 1 and 2. It consists of 2 basins with connection bypasses for inflow and outflow pipes in consideration of maintenance and management.

The water level will be approximately 8.5m higher than the planned GL, therefore, a cylindrical construction will be employed which provides structural advantages and are cheaper.

According to design guidelines implemented in Japan, a retention time of at least 1.5 minutes must be provided. Regarding the designs of this facility, a retention time of approximately 5 minutes will be allowed to account for the facts that it will be receiving returning drainage from filter basin washing, and it is expected to have fluctuations in water quality and volume.

[Design conditions]

- Retention time: 1 - 5 minutes

[Design specifications]

- Dimensions: ø 18.8m x 3.85m (cylindrical 2-tank construction)
  (Retention time: 6.0 minutes per basin)
- Ancillary facilities: Inflow bypass pipe, outflow bypass pipe, overflow pipe, discharge pipe, hypochlorite dosing point, inflow/outflow bypass valve room

② Chemical sedimentation basin

The chemical sedimentation basin is installed for the purpose of removing the bulk of the suspended material and floc by way of gravity settling to reduce the load on downstream filter basins. The facility consists of a receiving well, rapid mixing tank, flocculation basin, and chemical sedimentation basin.

In consideration for equipment maintenance and other factors, there will be 2 systems with 6 basins each per phase.

a) Receiving well and rapid mixing tank

The receiving well is installed for the purpose of measuring and controlling the volume of raw water, and to ensure that the series of downstream water treatment processes including sedimentation and filtration can be carried out correctly and easily. Also, the facility doubles as a rapid mixing tank where coagulants are added to coagulate suspended matter into fin.

Note that Pre-chlorination and PAC will be injected into the receiving well, and PAC blending and mixing will be performed by utilizing the drop from the overflow weir. Additionally, the subsequent stage will provide submerged weirs to ensure good blending downstream of the weir drop. (See Table 3.5.15 for the reason for this choice)

While basin shutdowns will very rarely occur as they are not equipped with mechanical facilities, there is concern for suspended matter accumulation due to the high turbidity of the water. Therefore, a two-basin configuration will be implemented in both phases (4 basins in all) to allow for shutdowns for cleaning.

[Reasons for choosing this mixing method]

- Low construction and running costs.
- The facility has no moving mechanical components, and therefore will not breakdown, and will be easy to maintain and manage.
- Mixing strength can decline if fluctuations in water volume are large. Water volume fluctuations in this water treatment plant will be small as it is equipped with an upstream raw water regulation basin.
- Large drop of 1.3m can be provided, expected to provide sufficient mixing effects.

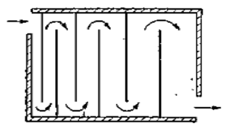
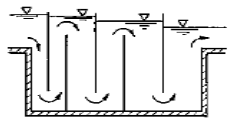
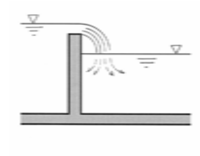
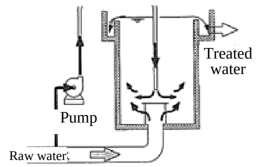
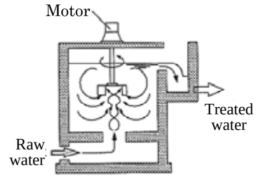
[Design conditions]

- Retention time : 1 - 5 minutes or greater
- Weir drop height : Provide at least 1.0m
- Water depth : At least 3.0m

[Design specifications]

- Dimensions: Phase 1: 4.0m x 7.5m x 4.7m per basin
  Phase 2: 4.0m x 7.5m x 4.7m per basin
- Ancillary facilities: overflow pipe, discharge pipe, Pre-chlorination dosing point, PAC dosing point, flow meter room, weir facility for mixing

Table 3.5.15 Comparison of Mixing Methods of Different Types of Rapid Mixing Tank

	Method utilizing the energy created by the water flow itself.						Pump mixing method		Mechanical mixing method	
	Horizontal baffled channel		Horizontal baffled channel		Horizontal baffled channel					
Structure	 (2) Horizontal baffled channel method (top view)		 (1) Vertical baffled channel method (cross section)							
Mixing effects	Allows for fast flow rates and is highly effective	○	Allows for fast flow rates and is highly effective	○	A large drop can be secured and is highly effective.	◎	Mixing effects are created by adjusting the water circulation.	◎	Effects are created by adjusting the rotation speed of the mixer.	◎
Raw water flow volume fluctuations	Mixing strength fluctuates widely when water volume fluctuations are large.	△	Mixing strength fluctuates widely when water volume fluctuations are large.	△	Mixing strength fluctuates widely when water volume fluctuations are large.	△	Affected somewhat by fluctuations in water volume.	○	Mixing strength (G value) is consistent and is not affected.	◎
Ease of maintenance and management	The facility has no moving mechanical components, and therefore will not breakdown, and will be easy to maintain and manage.	◎	The facility has no moving mechanical components, and therefore will not breakdown, and will be easy to maintain and manage.	◎	The facility has no moving mechanical components, and therefore will not breakdown, and will be easy to maintain and manage.	◎	The facility has moving mechanical components, and is therefore complicated to maintain and manage.	△	The facility has moving mechanical components, and is therefore complicated to maintain and manage.	△
Required motive power	0	◎	0	◎	0	◎	1.4	△	1.0	△
Installation footprint	Small	◎	Small	◎	Small	◎	Requires a pump room.(Large)	△	Small	○
Economy	Initial: 0.2 Running: 0	◎	Initial: 0.2 Running: 0	◎	Initial: 0.1 Running: 0	◎	Initial: 1.6 Running: 1.4	△	Initial: 1.0 Running: 1.0	○
Track record	Numerous	◎	Numerous	◎	Numerous	◎	Not numerous	△	Numerous	◎
Assessment	○		○		◎		△		○	

Note) Comparison of Economy is based on Mechanical mixing method, which is 1.0.

b) Flocculation basin

The flocculation basin is installed for the purpose of growing the fine floc produced in the mixing basin by slowly mixing the water so that the floc can be efficiently settled and separated in the sedimentation basin in a subsequent stage.

Methods for mixing is broadly categorized into mechanical mixing, and mixing that utilizes the energy of the flowing water itself, as shown in Table 3.5.16. For the reasons noted below, this design will use a <u>flocculator with a vertical shaft paddle</u>.

[Reason for choosing slow mixing]

- It is practicable to change mixing intensity according to the turbidity. Paddle flocculator enables to change mixing intensity and to achieve optimum flocculation.
- A 0.5m difference in water level is needed to utilize the energy of flowing water, which means the overall difference will be 1.8m when combined with the drop for the hydraulic jump method in the rapid mixing tank. This is difficult to implement as the required water level difference for the water treatment plant will be too large.
- Ideal mixing and flocculation can be achieved by changing the rotation speeds of stages 1 and 2.
- Of the different mechanical mixing methods, the vertical shaft paddle method involves lower construction costs.

Note that each phase involves six systems of four basins each. To ensure good mixing, the four basins will have baffled channels, with water flowing into each of the basins from the lower portion to ensure efficient mixing. Then, after mechanical mixing, the water flows over submerged weirs. To obtain a basis for defining the optimum chemical dosing rate once operations commence, flocculation conditions, which are key to the water treatment process, will be monitored.

Two stages of perforated baffles will be installed downstream of the flocculation basin to create a uniform flow into the sedimentation basin. Also, a sludge discharge facility will be installed to remove accumulated sludge.

Additionally, the facility will be covered with a roof to prevent density flows caused by rising temperatures and algae growth, and for the protection of facilities and equipment.

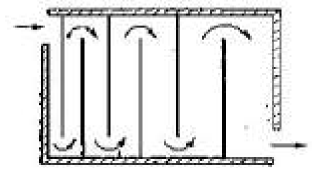
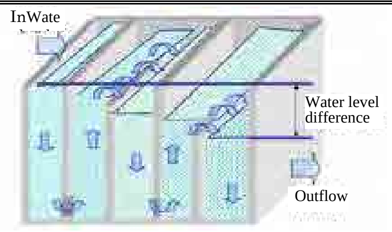
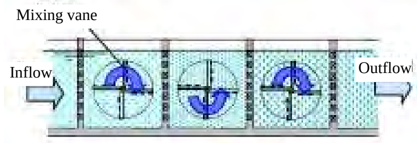
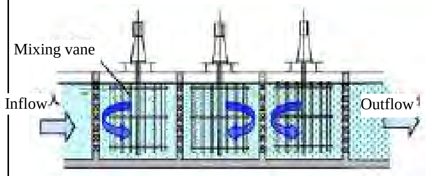
[Design conditions]

- Retention time : 20-40 minutes
- Water depth : 3.2m

[Design specifications]

- Dimensions: Phase 1: 7.0m x 7.0m x 3.2m x 4 basins x 6 systems
  Phase 2: 7.0m x 7.0m x 3.2m x 4 basins x 6 systems
- Ancillary facilities: 24 flocculators, 24 Vertical axis vertical baffled channel weirs, 2 stages of perforated baffles, sludge discharge facilities, inflow gate

Table 3.5.16 Comparison of Mixing Methods Used in the Flocculation Basin

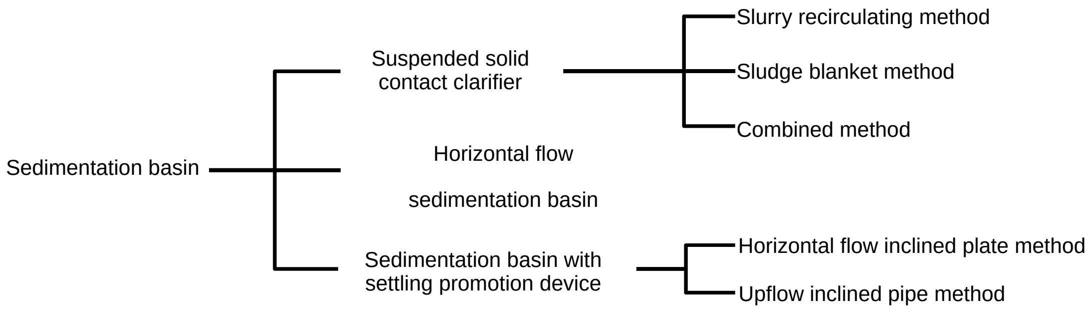
	This method utilizes the energy created by the water flow itself.				Mechanical mixing			
	Horizontal baffled channel method		Vertical baffled channel method		Horizontal shaft paddle method		Vertical shaft paddle method	
Construction	 (2) Horizontal baffled channel method (top view)							
Mixing effects	Requires a difference in water level of 0.5m to have sufficient mixing effects.	×	Requires a difference in water level of 0.5m to have sufficient mixing effects.	×	Ideal mixing and flocculation can be achieved by changing the rotation speeds of stages 1 and 2.	◎	Ideal mixing and flocculation can be achieved by changing the rotation speeds of stages 1 and 2.	◎
Raw water Flow volume fluctuations	Mixing strength fluctuates widely when water volume fluctuations are large.	△	Mixing strength fluctuates widely when water volume fluctuations are large.	△	Mixing strength (G value) is consistent and is not affected.	◎	Mixing strength (G value) is consistent and is not affected.	◎
Ease of maintenance and management	The facility has no moving mechanical components, and therefore will not breakdown, and will be easy to maintain and manage.	◎	The facility has no moving mechanical components, and therefore will not breakdown, and will be easy to maintain and manage.	◎	The facility has moving mechanical components, and is therefore complicated to maintain and manage.	△	The facility has moving mechanical components, and is therefore complicated to maintain and manage.	△
Required motive power	0	◎	0	◎	1.0	△	1.0	△
Installation footprint	Small	◎	Small	◎	Small	◎	Small	◎
Economy	Initial: 0.2 Running:0	◎	Initial: 0.2 Running:0	◎	Initial: 1.0 Running:1.0	△	Initial: 0.6 Running:1.0	○
Assessment	△		△		○		◎	

Note) Comparison of Economy is based on Horizontal shaft paddle method, which is 1.0.

c) Chemical sedimentation basin

[Sedimentation method]

The sedimentation basin is installed for the purpose of settling and separating the floc formed at the flocculation basin. Typical methods used in sedimentation basins are broadly categorized as suspended soild contact clarifier, horizontal flow sedimentation, horizontal flow inclined plate sedimentation, and upflow inclined pipe sedimentation.



While rapid suspended soild contact clarifier is less expensive to build than other types of basins, its shock dampening performance with regard to fluctuations in the quality and volume of raw water is not good. It also requires sophisticated technologies for slurry concentration management, and is therefore generally considered to be difficult to operate and manage. Additionally, because these operational and management challenges will be magnified where the water to be treated contains high levels of turbidity, this method has been excluded from consideration.

Therefore, the horizontal flow sedimentation basins and sedimentation basins with settling promotion device will be compared and reviewed to select the sedimentation basin best suited for this water treatment plant.

Table 3.5.17 shows a comparison of these methods. The upflow inclined pipe method has been chosen for the reasons below.

However, as the turbidity of the raw water is high, and sludge floc accumulation can cause damage to inclined pipes, the basin was partitioned into the first and second stages, where the first stage is a horizontal flow sedimentation basin, and the second stage is an upflow inclined pipe sedimentation basin.

[Reason for choosing this sedimentation method]

- It has a small installation footprint, and therefore enables effective land usage with regard to future layout of facilities
- The facility is robust against fluctuations in the quality or temperature of the raw water, providing consistent treatments.
- While the horizontal flow inclined plate has an extensive track record in Japan, it has not been used in Viet Nam. On the other hand, the upflow inclined pipe has been installed in large-sized water treatment plant in Viet Nam, in addition the initial cost can be reduced.
- The upflow inclined pipe has an extensive track record in Japan, and therefore represents an effective method of treatment from the standpoint of transferring Japanese technology to Viet Nam.

However, because no significant differences have been found between inclined plate and inclined pipe sedimentation basins, <u>the final decision is subject to reviews</u>.

[Sludge collector and discharge methods]
The choice of sludge collector and sludge discharge devices are dependent on the type and shape of sedimentation basin.

The chemical sedimentation basin at this water treatment plant is an upflow inclined pipe sedimentation basin, and the types sludge discharge of devices typically used in these types of sedimentation basins are link belt, rope type, central raking, and suction types.

The rotating central raking type will be used as it is robust against high levels of turbidity, is robust against mechanical accidents and breakdowns, and delivers worry-free performance from the experiences in Japan. Table 3.5.18 shows a comparison of these different types.

Central sludge collector type is recommended for the following reasons.

- It is suitable for high turbidity without major mechanical problems.
- Gravity sludge thickening is expected and sludge thickening is expected and sludge concentration becomes highen. Thus, sludge facilities become smaller size, which is economy.
- Many experiences in Japan.

[Design conditions]

- Surface area load factor: First stage (lateral flow) 15-30mm/min
  Second stage: (upflow inclined pipe) 7-14mm/min
- Average upflow rate: 80mm/min (upflow inclined pipe part)
- Retention time: At least 1 hour
- Outflow trough overflow volume: Not greater than $350m^3$/day-m
- Sludge discharge frequency: 3 times on average during the rainy season, up to 6 times

[Design specifications]

- Dimensions: Phase 1: 14.4m x 21.0m x 3.35m x 6 systems
  Phase 2: 14.4m x 21.0m x 3.35m x 6 systems
- Dimension of upflow inclined pipe : 0.37m x 0.53m x 3.0m
- Upflow inclined pipe: Phase 1: 1 stages x 38 rows x 7 rows x 6 systems
  Phase 2: 1 stages x 38 rows x 7 rows x 6 systems
- Sludge raking machine: Phase 1: 2 units x 6 systems
  Phase 2: 2 units x 6 systems
- Ancillary facilities: Sludge discharge facilities (valves and pipes), catchment trough discharge pipe, sprinkler pipe

In addition, the design conditions and specifications are described as follows. In terms of design conditions and design specification, the lateral sedimentation that was recommended by Viet Nam side has been considered.

If the horizontal sedimentation will be selected, it is difficult to install because of the limitation of land, since the length of sedimentation will be needed four times or greater than that of inclined pipe type basin of that length.

Therefore, JICA Study Team recommended the upflow inclined pipe method because of small dimension and efficient sedimentation.

Horizontal Sedimentation Basin

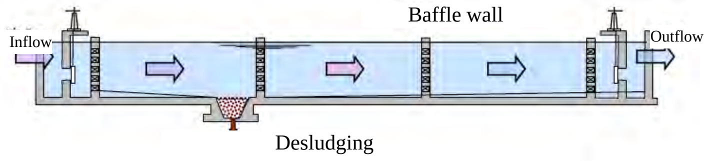
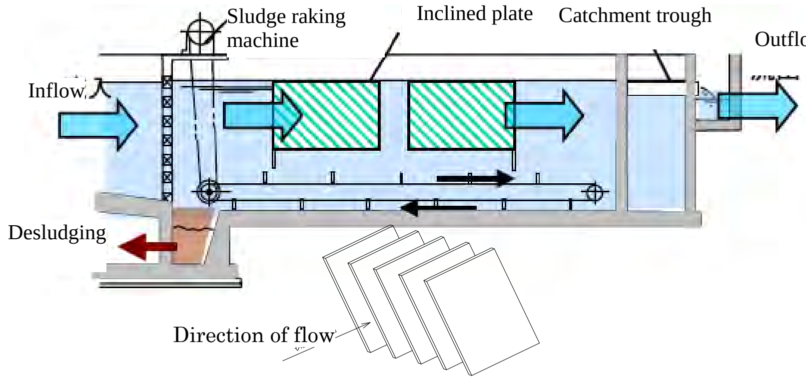
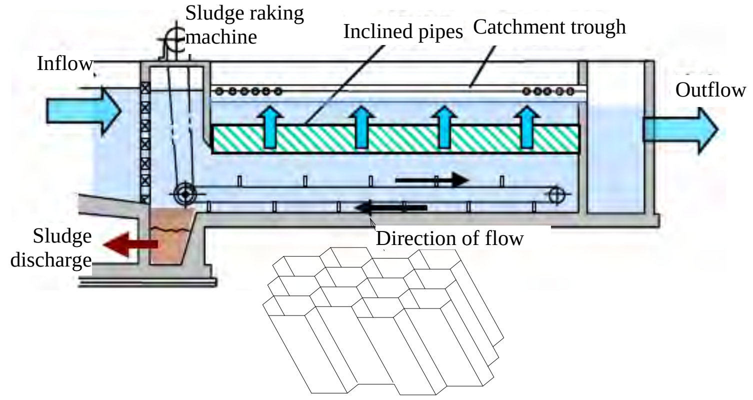
[Design conditions]

- Surface area load factor : lateral flow 15-30 mm/min
- Average velocity : 0.4 m/min
- Retention time : 3.6 hours or greater
- Outflow trough overflow volume : Not greater than 500 m3/day-m

[Design specifications]

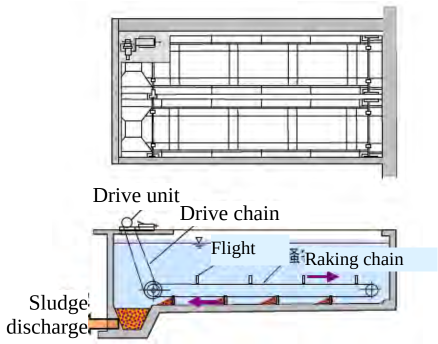
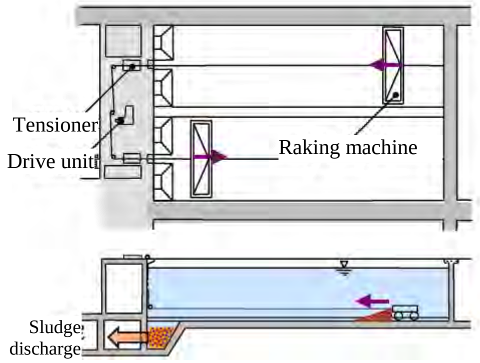
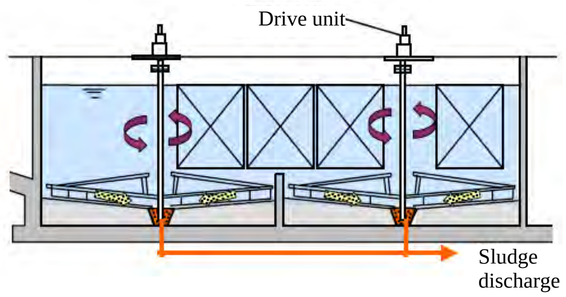
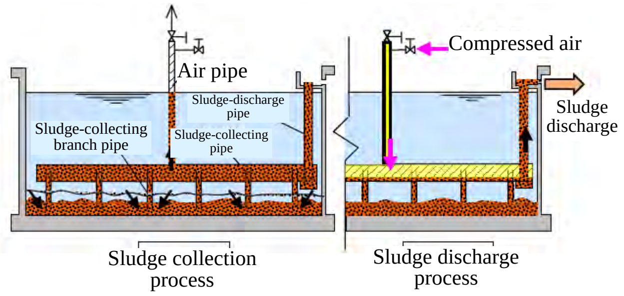
- Dimensions : Phase1 14.4 m x 86.4 m x 3.35 m x 6 systems
  Phase2 14.4 m x 86.4 m x 3.35 m x 6 systems
- Sludge raking machine : Phase1 4 Units x 6 systems
  Phase2 4 Units x 6 systems
- Ancillary facilities : Sludge discharge facilities (valves and pipes),
  catchment trough discharge pipe, sprinkler pipe

Table 3.5.17 Comparison of Sedimentation Methods

	Lateral flow sedimentation basin		Sedimentation basin with settling promotion device			
			Horizontal flow inclined plate		Upflow inclined pipe	
Construction						
Retention time	3-5 hours		Approximately 1 hour		Approximately 1 hour	
Surface load	15-30 mm/minute		4-9 mm/minute		7-14 mm/minute	
Flow rate	Not greater than 0.4m/minute		Not greater than 0.6m/minute		Not greater than 0.08m/minute (upward flow rate)	
Basin water depth	3-4m		4-5m		4-5m	
Installation footprint	100	△	30-40	◎	50-70	○
Supernatant water turbidity	Although intermediate perforated baffles will be installed, the facility can be affected by uneven flows or density flows, resulting in high turbidity of the supernatant water.	○	The settling promotion device has the effect of straightening the flow, which results in lower levels of turbidity in the supernatant water.	◎	The settling promotion device has the effect of straightening the flow, which results in lower levels of turbidity in the supernatant water.	◎
Robustness against fluctuation	Shock dampening performance with regard to fluctuations in the turbidity of raw water is not good. Is affected considerably by changes in raw water temperature. Is robust against changes in the volume of water to be treated.	○	Shock dampening performance with regard to fluctuations in the turbidity of raw water is good. The effect of changes in raw water temperature is small. Is robust against changes in the volume of water to be treated.	◎	Shock dampening performance with regard to fluctuations in the turbidity of raw water is good. The effect of changes in raw water temperature is small. Is robust against changes in the volume of water to be treated.	◎
Maintenance and management	Can be affected by density flows or uneven flows, resulting in high turbidity of the supernatant water.	○	Sludge floc can accumulate between and on the surfaces of the inclined plates, which necessitates periodic cleaning.	○	Sticky sludge floc can form bridges on the inclined pipes, which necessitates periodic cleaning.	○
Sludge raking machine	Any type of raking machine can be installed as there is nothing in the basin.	◎	There is a 1.5m clearance underneath the inclined plates where link belt, rope, central raking, or suction types of equipment can be installed.	○	There is a 2-3m clearance underneath the inclined pipes where link belt, rope, central raking, or suction types equipment can be installed.	○
Economy	Initial: 1.0 Running: 1.0	△	Initial: 0.6 Running: 1.0	◎	Initial: 0.8 Running: 1.0	○
Track record	Numerous Use of these facilities is on the decline due to land limitations.	○	Numerous This type of facility has an extensive track record in Japan but is not in use in Viet Nam.	○	Not numerous This type of facility has a track record in Viet Nam.	○
Assessment	△		◎		○	

Note) Comparison of Economy is based on Lateral flow sedimentation basin, which is 1.0.

Table 3.5.18 Comparison of Sludge Collector and Discharge Devices

	Link belt type		Underwater tow rope type		Central collector type		Air pressure suction type	
Structure								
	・Drive section: Motor, gearbox, reducer ・Underwater section: Chain, flight, underwater shaft, rails ・A single drive section can drive multiple raking sections		・Drive section: Motor, gearbox, reducer, rope winder ・Underwater section: Raking cart, rope, pulley, rails ・Single drive section drives multiple raking carts		・Drive section: Motor, gearbox, reducer, platform ・Underwater section: Central shaft and rake ・A single drive section drives 1 rake.		・Drive section: Suction pump ・Underwater section: Sludge suction pipes ・Available in mobile and stationary versions. In stationary systems, sludge suction pipes are laid on the entire bottom of the sedimentation basin.	
Method of operation	Raking plates are attached to an endless chain installed at the lower part of the sedimentation basin. Chain drives continuously to rake the sludge.		Raking carts are driven back and forth, and sludge is raked when the cart moves from the end of the basin towards the inflow area.		A rotating sludge collection rake continuously rakes sludge to the center of the sedimentation basin.		Sludge is suctioned by way of head differential or suction pump, and discharged via a sludge discharge trough.	
Shape and dimensions	The sedimentation basin is rectangular and is equipped with a sludge discharge pit on one end. The maximum width of raking plates is approximately 4-6m. More than one is installed if the basin width is large. There is no restriction to basin length.	○	The sedimentation basin is rectangular and is equipped with a sludge discharge pit on one end. The maximum width of raking carts are approximately 4-6m. More than one is installed if the basin width is large. There is no restriction to basin length.	○	Can be installed in either a rectangular or circular sedimentation basin. One sludge discharge pit is installed for a single raking machine. The maximum size of the raking machine is up to 5-20m, and multiple units are installed if the basin is long.	◎	Can be installed in either a rectangular or circular sedimentation basin. There are no dimensional limitations.	◎
Sludge collecting capacity	This performs continuous raking and is suited for situations where a large amount of sludge is produced. It is not very effective in terms of thickening the sludge as the volume of sludge that can be collected per pit is limited.	○	This performs intermittent raking and is not suited for situations where a large amount of sludge is produced. It is not very effective in terms of thickening the sludge as the volume of sludge that can be collected per pit is limited.	△	This performs continuous raking and is suited for situations where a large amount of sludge is produced. It is highly effective in terms of thickening the sludge as the volume of sludge that can be collected per pit is large.	◎	This system does not have the ability to rake sludge, which means that sludge that is a distance away from the sludge suction pipes will not be collected. It also has no thickening effect and the sludge will tend to be watery.	△
Ease of maintenance and management	Requires periodic replacements of sliding parts such as bearings, chains, sprockets, and shoes. Maintenance costs are the highest among the different types compared.	×	Requires adjustments to correct for cable slack, and periodic cable replacements. Link belt systems entail high costs.	△	Requires fewer inspections and part replacements. Maintenance costs are the lowest among the different types compared.	◎	Sludge will be retained in areas within the basin and will therefore require periodic cleaning of the basin.	△
Construction costs	1.5	△	1.2	○	1.0	○	0.8	◎
Running costs	1.0	○	1.0	○	1.0	○	1.0	○
Track record	Numerous	◎	Numerous	◎	Numerous	◎	Not numerous	△
Assessment	○		○		◎		△	

Note) Comparison of Cost is based on Central collector type, which is 1.0.

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③ Intermediate chlorine mixing basin

Intermediate chlorine dosing is performed at the intermediate chlorine mixing basin to remove iron and manganese, and as a countermeasure against trihalomethane.

Two of these basins will be installed per phase, with a single dosing point for each basin. Mixing is to be done by the vertical baffled channel method, and a contact time of approximately 20 minutes is secured including the above-sand depth water in the rapid filter basin.

[Design conditions]

- Contact time: Approximately 20 minutes are secured including the above-sand depth water.
- Mixing method: Vertical baffled channel method

[Design specifications]

- Dimensions: Phase 1: 3.65m x 10.50m x 6.8m x 2 basins.
  Phase 2: 3.65m x 10.50m x 6.8m x 2 basins
- Ancillary facilities: Drain pipe, chlorine dosing point

④ Rapid sand filter

The rapid sand filter is installed for the purpose of capturing fine floc that was not removed during the sedimentation, by way of filtration materials such as layers of sand.

In this plan, a 12-basin configuration (of which 2 will be standby) will be employed for each phase in consideration of factors such as filter sand replacements, inspections, repairs, and backwashing water volume. Additionally, just as in case of chemical sedimentation basins, it should be considered whether the facility will be covered with a roof to prevent density flows caused by rising temperatures and algae growth, and for the protection of facilities and equipment.

Although the filtration layer will consist of a single-layer configuration resulting into a filtration speed of 120-150m/day, consideration will be made to allow for a possible change to a multiple layer system depending on the conditions after operations begin. Filtration is typically performed either by gravity or under pressure. This plant will adopt the gravity filtration method, which is a method that is widely used in facilities of this scale. Constant-rate filtration, which maintains a constant flow volume, is typically used for gravity filters. The different types of constant-rate filtration are the flow volume control method which uses a flow volume adjustment valve or other equipment, the water level control method which is based on the water level of the filter basin, and natural equilibrium method, where the facility is designed so that the inflow and outflow volumes achieve a natural equilibrium. In this design, as shown in Table 3.5.19, the natural equilibrium method will be used as it has a solid track record and there is little risk of negative pressure.

Please note that "surface washing + back-flow washing" will be employed as the washing method as the facility will consist of a single-layer filter configuration. The underdrain system will consist of porous blocks which are inexpensive and easy to install.

With regard to selecting a backwashing method, the self-water cleaning (Siphon type) method is adopted as shown in Table 3.5.20 upon considering the reason described below.

[Reason for selecting this backwashing method]
The control valve is the most problematic factor in the operation of a rapid filtlation system. The siphon type method is based on a simple mechanism, and does not use electrical valves or gates for inflow, outflow, or backwashing. Another reason is that siphon method is less developing unevenness in the filter layer compared to other methods, and is a better choice in terms of water quality safety owing to its slow shutdown and startup operation.

Additionally, it requires the least amount of power, therefore it is energy saving method and environmental friendly.

In the comparison of common rapid filtration method, which is facilitated with valve control system and backwashing pumps, Siphon method is about 27 % energy saving in LCC.

[Design conditions]

- Filtration speed: 120m - 150m/day

[Design specifications]

- Dimensions: Phase 1: 5.2m x 10.5m x 2 beds/basin for 12 basins.
  Phase 2: 5.2m x 10.5m x 2 beds/basin for 12 basins.
- Filter sand layer thickness: 60cm
- Effective diameter of filter sand: 0.6mm
- Uniformity coefficient of the filter sand: 1.3 - 1.6

- Gravel layer thickness: 200mm (Maximum diameter: 20mm, Minimum diameter: 2mm, Layers: 4)
- Catchment : Porous block shape
- Ancillary facilities: One supply of filter sand, 1 set of inflow and outflow units, 2 surface washing pumps (shared between Phases 1 and 2), 1 set of surface washing facilities, 1 set of surface washing pipes, 1 set of inflow siphons, inflow weir, 1 set of drainage siphons, outflow valve, outflow pipe, sprinkler pipe

Table 3.5.19 Comparison of Constant-Rate Filtration Methods

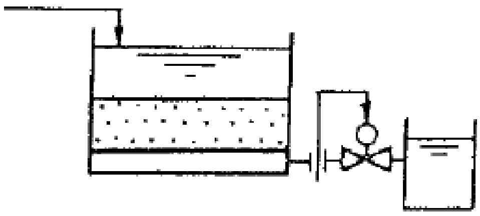
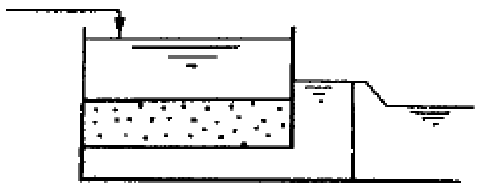
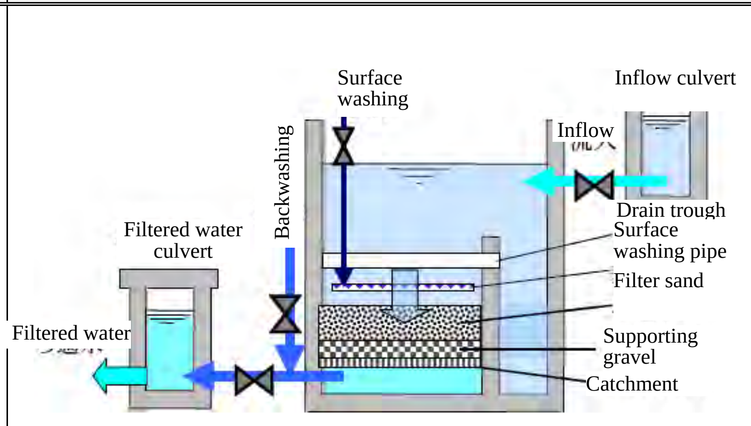
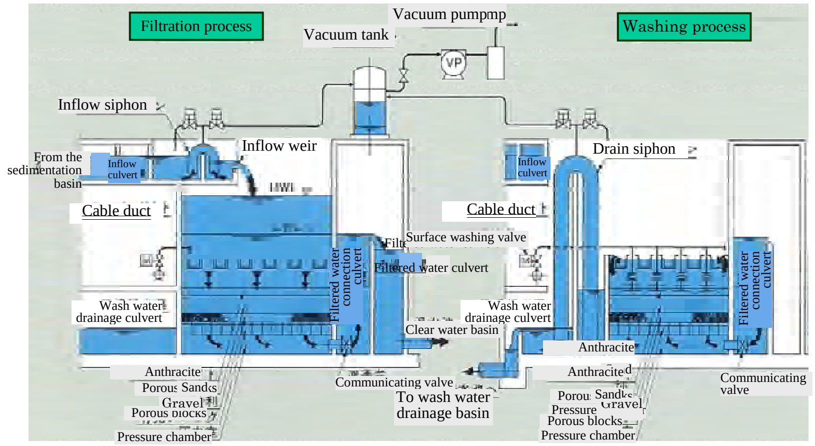
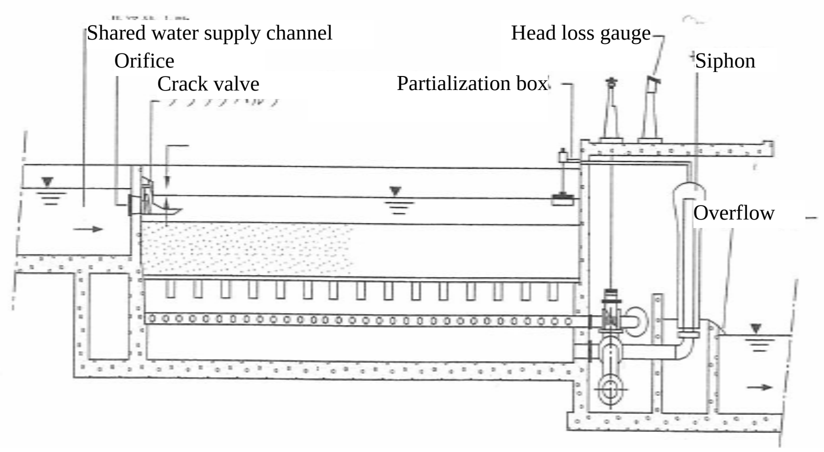
	Constant filtered flow volume control method	Natural equilibrium method
Schematic diagram		
Control mechanism	• A measuring device and flow volume regulator are installed on the filter outflow side. The regulator creates a large head loss in the early stages of the filtration to suppress the filtered flow volume. • As filtration progresses and the filter layer becomes progressively clogged, the valve is opened to a degree that is commensurate with the increase in the head loss in the filter layer to reduce the head loss at the regulator, maintaining a constant filtered flow volume. • In the water level control method, the water level in the filter basin is detected, and this information is sent to the water volume adjustment mechanism to maintain constant-rate filtration.	• A weir is installed on the outflow side at a position higher than the sand surface, and the gradual increase in the above-sand water depth in the filter basin itself prevents the water passage volume from declining from the clogging of the filter and a constant filtered flow volume is maintained. • Once the above-sand depth reaches the defined value, filtration will be stopped for washing. Therefore, the higher the above-sand water depth, the longer the filtration will continue.
Advantages	• The height difference between the sand surface and the inflow culvert can be kept small.	Control mechanism is simple. • Constant filtration can be achieved without regulating the flow volume on the outflow side. • There is no risk of negative pressure developing in the sand layer, and ensures high levels of safety in terms of preventing deterioration in the filtered water quality.
Disadvantag es	Mechanism is complex. • There is risk of deterioration to filtered water quality due to negative pressure occurring at times of high head loss.	• The filter basin must be deep.
Assessment	• There is little advantage to adopting this method as there are no height restrictions in this project.	• This method can be adopted as there are no height restrictions for water level or structures in this project.
		Adopted

Table 3.5.20 Comparison of Rapid Filtration Methods (Backwashing Methods)

	Existing rapid filtration		Siphon type (natural equilibrium rapid filtration with self-water cleaning)		Akazul filter (natural equilibrium)	
Structure						
Configuration	Consists of catchment, inflow culvert, various automatic valves, drain trough, etc. The basins are independent of each other. There is risk of negative pressure developing in the filter layer towards the end of the filtration process as the outflow port is located at a lower position than the filter layer. Backwashing is performed by pressurized water from a pump or elevated water tank.		Consists of catchment, inflow culvert, inflow siphon, drain siphon, drain trough, etc. All basins are connected with each other and partitioned by communicating valves. Additionally, because the water level at the outflow area is at a higher position than the filter layer, there is no risk of negative pressure. Backwashing is performed using filtered water in the clear water culvert.		Consists of strainer catchment, inflow regulating valve, and outflow regulating siphon, etc. All basins are connected with each other and partitioned by inflow regulating valves. The layer is made thick with the use of sand having large granularity. Backwashing is performed by pressurized water from a pump.	
Filtration speed	120-150m/day	○	120-150m/day	○	120-150m/day	○
Backwashing speed, backwashing method	0.6-0.8m/minute Washing is performed using pressurized water from a backwashing pump or elevated tank via automatic valves.	○	0.6-0.8m/minute Washing is carried out using the filtered water from the clear water culvert, utilizing the difference in water level in the filtered water outflow weir and drain trough in the basin. It does not require a backwashing pump or elevated water tank.	◎	0.8-1.0m/minute Washing is performed with pressurized water from the backwashing pump via automatic valve. Backwashing speed is high as the sand's granularity is large and layer is thick.	○
Leakage of suspended matter	There is risk of negative pressure developing in the filter layer.	△	There is no risk of negative pressure development in the filter layer, and hence no risk of leakage of suspended matter. It will naturally carry out slow shutdown and startup operations. No leakages will occur.	◎	There is risk of negative pressure development in the filter layer, and in such cases leakage of suspended matter may occur.	△
Flow volume regulator	It requires a regulating valve to balance inflow and outflow volumes.	△	This is a natural equilibrium type system.	◎	It requires a regulating valve to balance inflow and outflow volumes, which results in complex operations.	△
Ease of operations and controls	It requires a broad range of automatic large-gauge valves including backwashing valve.	△	Requires no large gauge valves	◎	It requires a broad range of automatic large-gauge valves including backwashing valve, flow volume regulating valve, and water discharge valve, and this results in complicated operations and controls.	△
Ease of maintenance and management	A large number of large gauge automatic valves are installed for each basin.	△	It consists of small gauge air operated valves and simple control circuitry.	◎	Inflow regulating valve and outflow regulating siphon, etc. are installed for each basin, which requires complex automatic control circuitry, complicating maintenance and management.	△
Economy	Initial: 1.0 Running: 1.0	○	Initial: 0.7 Running: 0.3	◎	Initial: 1.0 Running: 1.2	△
Track record	Numerous	◎	Numerous This type of facility has an extensive track record in Japan but is not in use in Viet Nam.	◎	Numerous This type of facility has an extensive track record globally, and is also used in Viet Nam at the Da River water treatment plant.	◎
Assessment	○		◎		△	

Note) Comparison of Cost is based on Existing rapid filtration, which is 1.0.

⑤ Clear water reservoir

The effective volume of the clear water reservoir will accommodate 3 times the hourly capacity at the maximum planned daily water transmission volume and will be defined to be 6 hours per two reservoirs in each of the phases in order to ensure a single reservoir having regulating capacity and to secure capacity allowance.

Additionally, because post-hypochlorite dosing will be conducted in the previous stage, a post-chlorine mixing basin will be installed in the inflow area of the clear water reservoir. No specific mixing time will be defined in consideration of the retention time in the clear water reservoir.

The mixing method will be the horizontal baffled channel method, and there will be 1 dosing point per basin.

[Design conditions]

- Mixing method: Horizontal baffled channel method
- Retention time: 6 hours

[Design specifications]

[Post-chlorine mixing basin]

- Dimensions: Phase 1: 4.5m x 37.0m x 5.0m x 2 basins
  Phase 2: 4.5m x 37.0m x 5.0m x 2 basins

[Clear water reservoir]

- Dimensions: Phase 1: 43.0m x 91.0m x 5m x 2 reservoirs
  Phase 2: 43.0m x 91.0m x 5m x 2 reservoirs
- Capacity: Phase 1 effective capacity: 19,300m^3 per reservoir x 2 reservoirs
  Phase 2 effective capacity: 19,300m^3 per reservoir x 2 reservoirs

2) Drainage treatment methods

In this section, review is made on the scale and methods of individual processes for performing drainage treatment.

① Wash water drainage basin

The wash water drainage basin is installed for the purpose of temporarily holding water that is returned from drainage treatment processes, primarily wash water drainage from the filter basins, and also supernatant water from the thickener and sun drying bed.

As this water treatment plant is based on a closed system, all the drainage stored at the wash water drainage basin is returned to the dividing well.

In consideration of maintenance and management, a 2-basin configuration will be employed and will be shared during both Phases 1 and 2.

As a basic operation, 1 basin will be used and the other will be standby.

The height of the water level at the wash water drainage basin will be defined to be a height that is able to receive filter basin wash water drainage by gravity flow, and a single basin will have the capacity to receive filter basin wash water drainage and the supernatant water from the thickener. Additionally, a return pump well will be installed as an integrated part of the wash water drainage basin.

[Facility specifications]

- Dimensions: Width 18.0m x Length 18.0m x Water depth: 4m x 2 basins
- Capacity: Effective capacity 1,296m^3 per basin x 2 basins
- Ancillary facilities: Return pump, pump well

② Sludge basin

The sludge basin is installed for the purpose of regulating the water volume and water quality in the stage prior to the point where the water treatment sludge that is discharged primarily from the sedimentation basin is sent to the thickener.

In consideration of maintenance and management, a 2-basin configuration will be employed and will be shared during both Phases 1 and 2. As a basic operation, 1 basin will be used and the other will be standby during the months except the rainy season.

In terms of capacity, safety will be taken into account and 1 basin will have the capacity to receive total sludge in a day drained from sedimentation basin at the average annual turbidity. The capacity will also be such that 2 basins will be able to receive the total sludge of the day from sedimentation basin at the average rainy season turbidity.

The height of the water level at the sludge basin will be defined to be a height that is able to receive sedimentation basin drainage by gravity flow, and the bottom of the basin will be given an incline of approximately 5% to facilitate sludge collection.

[Facility specifications]

- Dimensions: Width 18.0m x Length 18.0m x Water depth: 3.5m x 2 basins
- Capacity: Effective capacity 1,296m^3 per basin x 2 basins
- Ancillary facilities: Sludge transfer pump, sludge pump room

③ Thickener

The thickener is installed for the purpose of thickening the sludge stored in the sludge basin and to improve sludge dewaterability in the subsequent sun drying process. Thickening methods include gravimetric thickening, float thickening, and filter thickening. This plan adopts the gravimetric thickening method which is the most typical, and employs continuous thickening which is used in situations where large amounts of sludge is to be treated.

A 2-basin configuration will be employed and will be shared during Phases 1 and 2, and 1 basin will be standby during the months except the rainy season.

The height of the water level at the thickener will be defined to be a height that is able to return supernatant water to the wash water drainage basin by gravity flow. The sludge raking mechanism will consist of a rotating central raking type mechanism.

[Design conditions]

- Capacity: At least the volume of sludge produced in 24-hours
- Solids load: 45.1kg/(m^2-day)(at average rainy season turbidity)

The plan will include measures to directly transfer the sludge to the sun drying bed during times of high turbidity.

[Facility specifications]

- Dimensions: Phase 1: 23.0m x Water depth 3.5m x 2 basins.
  Phase 2: 23.0m x Water depth 3.5m x 2 basins.
- Capacity: Effective capacity 1,454m^3 per basin x 2 basins
- Ancillary facilities: Sludge extraction pump, sludge raking mechanism, overflow launder, pump room

④ Sun drying beds

Sun drying beds are installed for the purpose of drying sludge from the water treatment process that has been thickened in the thickener to moisture content of no greater than 85% by evaporation so that it can be transported out of the system.

The bottom and walls of the sun drying beds must be made of concrete to avoid contamination of the soil. It will be equipped with a filter layer and catchment pipes to promote the drying of the sludge. The supernatant water will be removed by an extracting device and released into the Duong River along with osmosis water via the drainage pump well.

In addition to sun drying beds dedicated to the water treatment process, another set of beds will be installed that will be dedicated to the settling basin. The sun drying beds will be provided with an approach road for heavy equipment used to transport the sludge.

While dewatering will basically be by means of sun drying beds, depending on the amount of sludge produced after operations begin and factors such as dewaterability, there may not be enough drying area for both phases. As such, the installation of mechanical dewatering facilities will be considered for Phase 2.

[Design conditions]

- Exclusive use for water treatment
  - Solids load: No greater than 50 kg/(m2-day) (at average annual turbidity)
    No greater than 70 kg/(m2-day) (at average rainy season turbidity)
  - Drying period: 90 days (at average annual turbidity)
    120 days (at average rainy season turbidity)
  - Holding: 1.0m
- Exclusive use for settling basin
  - Solids load: No greater than 112 kg/(m2-day) (at average annual turbidity)
    No greater than 112 kg/(m2-day) (at average rainy season turbidity)
  - Drying period:45 days (at average annual turbidity)
    30 days (at average rainy season turbidity)
  - Holding: 1.0m

[Facility specifications]

- Dimensions: Phase 1: Width 20.0m x Length 85.0m x Water depth 1.0m x 19 beds (of which 4 beds are dedicated to the settling basin)
  Phase 2: Width 20.0m x Length 85.0m x Water depth 1.0m x 19 beds(of which 4 beds are dedicated to the settling basin)

⑤ Sun drying beds drainage pumping well

The drainage pumping wells for sun drying bed have been considered in order to pump out supernatant and saturated water of sun drying beds into river.

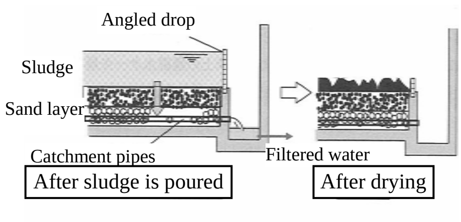
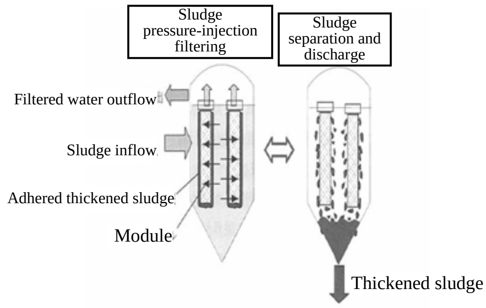
In addition, it is expected that during rainy season the sun drying bed will have large amount of water due to heavy rain, and accordingly the capacity of the sin drying bed drainage pumping well has been set in consideration of discharging water from sun drying beds.

Also, altogether 3 wells are considered, thereof which 1 well will be in operation and 2 wells will work as retaining wells during maintainance.

[Facility specifications]

- Dimensions: Phase 1: Width 8.0m x Length 12.5m x Water depth 4.0m x 1 well (pumping well part)
  Width 12.5 x Length 38.5m x Water depth 4.0m x 2 wells (regulation well part)
  Phase 2: Width 8.0m x Length 12.5m x Water depth 4.0m x 1 well (pumping well part)
  Width 12.5 x Length 38.5m x Water depth 4.0m x 2 wells (regulation well part)
- Ancillary facilities : drainage pump

Table 3.5.21 Comparison of Dewatering Methods

	Sun drying bed		Mechanical dewatering (filter press)	
Structure				
Dewatering mechanism	The moisture content is first reduced by thickening and filtering, and then the sludge is dried under the sun by evaporation.		The raw sludge is pressure-injected by pump into the filtration chamber in the dewatering unit, where solids and fluids are separated by filter cloth, and dewatering is carried out by the filtering effect of the cake layer.	
Required time	Drying period: 90 days (preliminary)		Short time type: 1 hour/cycle Long time type: 8-12 hours/cycle	
Cake water content	60-70%	○	50-60%	○
Installation space	It requires a long drying period of 120 days and therefore requires a large space. 1.0	△	The filter press and ancillary equipment are compact and require little space. 0.2	◎
Ease of maintenance and management	Shovels and trucks are required for collecting and transporting the dried cake, complicating management operations.	△	The filter press is operated automatically, and the dewatered cake can be held in a cake yard. These features make management easy.	○
Construction cost	1.0	◎	This facility is expensive because the filter press is heavy, and a building for housing the dewatering unit and ancillary equipment is needed. 10	×
Running cost	1.0	◎	It consumes large amounts of power as a pump is used to pressure-inject the sludge. 10	×
Track record	Numerous	◎	Not numerous.	△
Assessment	◎		△	

Note) Comparison of Construction and Running Cost is based on Sun drying bed, which is 1.0.

(8) Pump Facility Plan

1) Water intake and conveyance pumps

Water intake and conveyance pumps intake the surface water of streams and send it to the water treatment facility. The required capacity and lift for a single pump are as follows:

Capacity : 56m^3/minute
Head : 15m
Number of pumps : 5

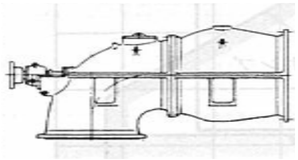
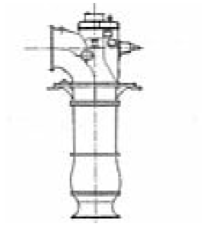
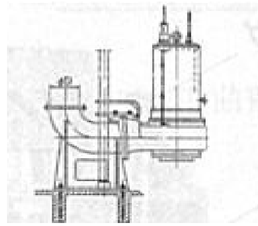
Based on the capacity and lift of a single pump, pumps will be chosen from either a centrifugal or mixed flow type. The choice for this plan is mixed flow pumps, and comparisons are made between horizontal shaft, vertical shaft, and submerged pumps.

<Pump type>
Based on the required capacity of 56m^3/minute and lift of 15m, pumps will be chosen from either a centrifugal or mixed flow type. As there are no submerged types of centrifugal pumps, mixed flow pumps will be selected for this plan.

[Result of selection]
A comparison of the above types of pumps is shown in Table 3.5.22. An submerged type is selected for the following reasons.

- These types of pumps do not require a pump room, resulting in inexpensive construction costs, including costs for engineering and construction.
- It requires the smallest installation space.
- While the pump itself is submerged and must be taken out of the tank when performing maintenance or inspections, it can be equipped with a release device to facilitate this procedure.
- It also has an extensive track record.

Table 3.5.22 Comparison of Mixed Flow Pumps

	Horizontal shaft		Vertical shaft		Submerged	
Structure						
Diameter range	400-2000	○	400-2000	○	250-800	○
Capacity range	15-600m^3/minute	○	15-600m^3/minute	○	5-90m^3/minute	○
Lift range	5-20m	○	5-20m	○	5-30m	○
Installation space	It requires a large space as it requires a pump room.	×	It requires a large space as it requires a pump room.	△	It requires little space as no pump room is required.	△
Ease of maintenance and management	Easy to maintain and manage.	◎	It is difficult to disassemble for maintenance as the motor is installed above the pump.	○	The pump itself and motor are submerged and must be taken out of the tank when performing maintenance or inspections. It can be equipped with a release device to facilitate this procedure.	○
Economy	Initial: 1.0 Running: 1.0	△	Initial: 0.7 Running: 1.0	○	Initial: 0.4 Running: 1.0	△
Track record	Numerous	◎	Not numerous	○	Numerous	◎
Assessment	○		△		◎	

Note) Comparison of Economy is based on Horizontal shaft type, which is 1.0

2) Water transmission pump

The water transmission pump transmits the treated water to the different off take points. The capacity and lift required per pump are shown below.

<South system>

Capacity : 9m^3/minute

Lift : 50.5m

Number of pumps: 3

<North system>

Capacity : 65m^3/minute

Lift : 57.5m

Number of pumps: 5

Based on the capacity and lift of a single pump, centrifugal pumps were selected.

Here, dual-suction pumps were selected, and a comparison is made between horizontal shaft and vertical shaft types.

<Pump type>

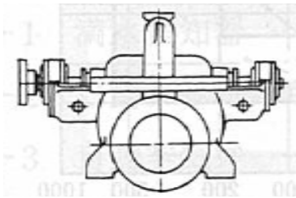
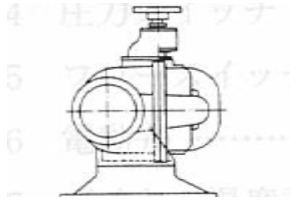
Based on the required capacity of 65m^3/minute and lift of 57.5m, dual-suction pumps (centrifugal) were selected.

[Selection results]

Table 3.5.23 shows a comparison of the types cited above. A horizontal shaft pump is chosen for the following reasons:

- Easy upkeep, management, maintenance, and inspections.
- Extensive track record.

Table 3.5.23 Comparison of Dual-Suction Pumps

	Horizontal shaft		Vertical shaft	
Structure				
Diameter range	200-1500	○	200-1000	○
Capacity range	5-300m^3/minute	○	5-150m^3/minute	○
Lift range	10-100m	○	10-100m	○
Installation space	It requires a large pump room and therefore requires a large space.	△	It requires a large pump room and therefore requires a large space.	△
Ease of maintenance and management	Easy to maintain and manage.	◎	It is difficult to disassemble for maintenance as the motor is installed above the pump.	△
Economy	1.0	○	1.0	○
Track record	Numerous	◎	Not numerous	△
Assessment	◎		△	

Note)Comparison of Economy is based on Horizontal shaft type, which is 1.0.

3) Chemical Dosing Pump

Chemical dosing pump is required for drawing chemicals from each chemical storage tank and conveying to required facilities at injection points.
The specification of the chemicals and the pump to be used is as follows.

< PAC dosing pump>

Usage PAC: 17% concentrations of poly aluminium chloride solution
Capacity: 0.5 ~ 5.0 L/min
Head: 0.3 MPa
Number of pumps: 8

< Chlorine dosing pump >

Usage Chlorine: 6% concentrations of sodium hypochlorite solution
Capacity: 0.1 ~ 3.0 L/min
Head: 0.3 MPa
Number of pumps: 14

Quantitative performance of these pumps is necessary for chemical dosing.
Also, in consideration of resistance against corrosion due to chemicals, the material of wetted part of these pumps is considered to be made up of resin titanium product.

[Result of selection]
A diaphragm type is selected for the following reasons.

- Engineering cost is cheaper than the other type.
- Ease in upkeep, management, maintenance, and inspections.
- It requires the smallest installation space.
- It also has an extensive track record of use.

(9) Electrical Instrumentation Equipment Plan

1) Power transmission and transformation equipment

This facility is a power facility that receives the power supply required at the water intake and treatment plants, which is the 22kV power that is supplied from the power company, converts this power into the required voltage for use in the plant, and distributes this power to main electrical rooms throughout the plant.

The water treatment and intake facilities are to be located on opposite sides of the levee. In cases where these locations are not considered to be on the same site, Vietnamese power supply regulations require that studies be made to determine whether each location requires power transmissions from separate EVNs.

① Power demand plan

Based on the contracted power supply, the demand power consumed at the water intake and treatment plants is expected to be approximately 3,000kW from the time service begins at the facility to the completion of Phase 1 (150,000m^3/day), and approximately 5,400kW at the time of the completion of Phase 2 (300,000m^3/day).

② Lead-in method

While it is difficult to identify the power that will be lead into the plant, the most likely scenario is that two 22kV lines will be added to the existing Chau Khe electrical power substation located north of the site of the planned water treatment plant and power will be transmitted via overhead transmissions lines (to be installed by the power company) over a distance of 16km to the water treatment plant. As such, the plan will proceed based on leading in two overhead 22kV lines to the plant.

The power that is lead into the 22kV electrical power substation must meet the following conditions:

- Must be able to accommodate two lines leading in from lines of different systems.
- Must be capable of supplying power capacities that will be required for future plans for the water treatment plant (10,000kVA at 600,000m^3/day).
- Must be consistent with future power supply plans for northern Viet Nam and Ha Noi City.
- Costs incurred by this project must be kept to a minimum.

The determination of lead-in lines that meet these conditions will require negotiations with EVN and relevant government agencies, and extensive discussions with these parties. Therefore, this review will be carried out based on close cooperation with our Vietnamese partner.

The planning for this project would be based on the VIWASEEN plan, which is two 22kV receiving lines each at both the water intake and treatment plants, although it is expected to pose the largest construction cost for this project.

③ Power transmission and transformation equipment

The power transmission and transformation equipment will be equipped with an indoor environmentally-compatible insulated switchgear that does not use SF6 as its insulating gas from the standpoint of its impact on the surrounding environment, ease of maintenance and management, safety, and small footprint. Meanwhile, the extra-high tension transformer will be installed outdoors to counter the heat generated.

④ Distribution facilities

As the intake pumping station will receive power singularly, it will be installed with power receiving, distribution, and motor panel facilities in the electrical building on its premises.

The 6.6kV power supplied from the water treatment plant's power transmission and transformation equipment will be routed via the electrical room in the water transmission pump building, and distributed to the electrical equipment rooms in the water conveyance pump building and administrative building. The water treatment electrical room will be installed alongside the electrical room of the administrative building. Additionally, low voltage (380V) power will be distributed from the electrical room of the administrative building to the chemical dosing facility, and from the electrical room of the water conveyance pump building to the drainage treatment facility. Facility layout from the perspective of power distribution systems will be configured as shown below. Low voltage 380V power will generally be distributed within the range of facilities with capacities of up to 300kVA, and low voltage transformers will have high-efficiency specifications for the purpose of energy conservation.

High-efficiency transformer is about 64.5% energy saving.

Table 3.5.24 Facility Layout of Power Distribution Facilities

Name of facility	Facility configuration	Remarks
Water intake facility	Water intake pump	Receives power singularly, and intake pump facilities comprise one group.
Water conveyance facility	Settling basin, water conveyance pump	Water conveyance pumping station facilities comprise one group
Water treatment facility	Dividing well, flocculation basin, sedimentation basin, rapid filter, and chlorine mixing basin	The dividing well, flocculation basin, sedimentation basin, rapid filter, and chlorine mixing basin comprise a water treatment facility group. This is located at the electrical room of the administrative building.
Water transmission facility	Water transmission pump, surface washing pump, and clear water reservoir	As the clear water reservoir is closely related to the water transmission pump, it is included in the water transmission facility group.
Chemical dosing facility	Chemical holding tank, chemical dosing facility	Chemical holding tank, and chemical dosing facility comprise one group as a chemical dosing facility.
Drainage treatment facility	Wash water drainage basin, sludge basin, thickener, sludge drying facility	Wash water drainage basin, sludge basin, thickener, and sludge drying facility comprise one group as a drainage treatment facility.
Administrative building	Central monitoring and control facility (SCADA), non-utility emergency power generator	Facilities at the administrative building are the central monitoring and control facility for all areas of the water treatment plant's premises, off take facility information, and non-utility power generator for security power facilities.

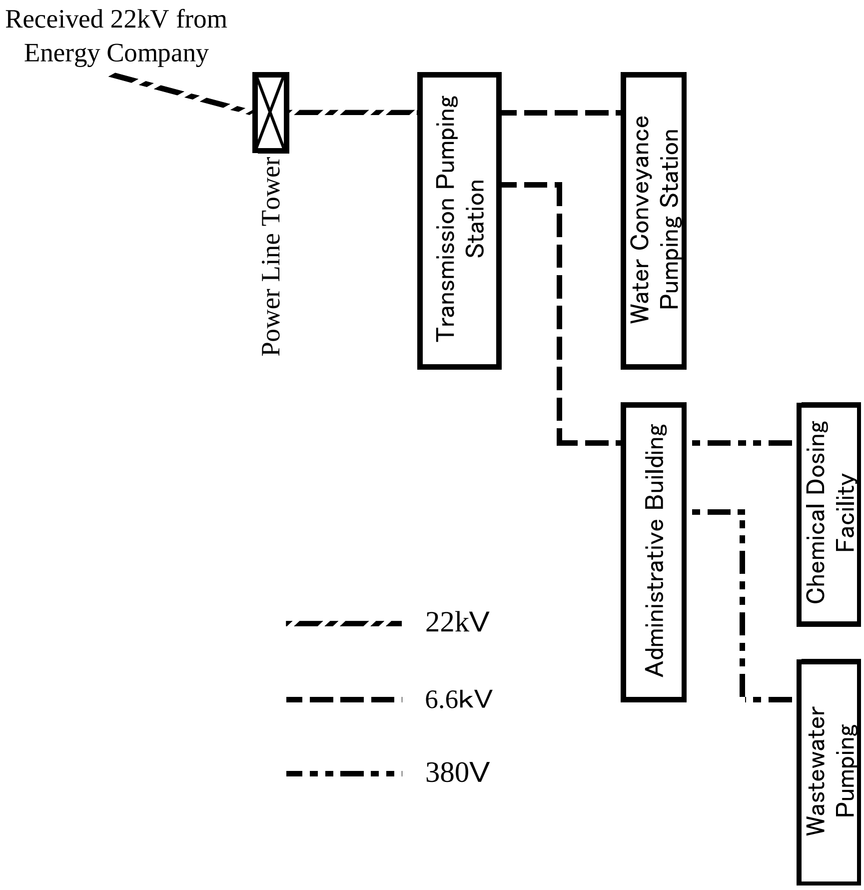


Figure 3.5.8 Electrical System Diagram of the Water Treatment Plant

2) Non-utility emergency power generating facility

Whether or not a generator is required must be determined based on a review of the overall reliability of the power distribution systems of the region where power is being used. The possibility of an interruption occurring to the power supply from the power company is not zero. Therefore, the plant must have the capability to operate the loads that are required for maintaining and managing the water treatment plant, and for ensuring the security of the plant by ensuring that the plant will be able to provide its minimum capabilities in the event of a supply interruption of the power utility or when the power transmission and transformation equipment is temporarily shut down for maintenance and management.

The fact that this water treatment plant is categorized as a rank A facility in Ha Noi City and is therefore given priority with regard to power supply and recovery, as well as the fact that it is exempted from supply interruptions for demand power adjustments, and other factors must be taken into consideration in the implementation of power generation capabilities to ensure power supply security.

① Target loads during emergency

The objective of this project is to supply water to HAWACO and other entities - of which many plan to install off take tanks - and not the direct distribution of water to the general public. Therefore, during a power outage, the supply of water to the general public can be continued using the water held in these off take tanks.

The inclusion of water transmission pumps and other key, large-capacity equipment in the emergency load will result in excessive generator capacity requirements and large investment outlays. Therefore, the capacity of the emergency power supply at the water treatment plant will be defined as one that is sufficient to cover only security power, power for monitoring and instrumentation facilities. Therefor make selection 100KVA for Intake Pumping Station and 250KVA for Water Treatment Plant. Additionally, monitoring facilities will be equipped with a UPS to prevent momentary voltage drops.

② Selecting an engine

Possible engines for driving the emergency power generation facility include diesel and gas turbine. In this plan, diesel is appropriate as it has good general versatility, small capacity, and its use is generally widespread.

③ Cooling method and fuel

The engine will be cooled by radiator and will be fueled with light oil, which is readily available.

3) Operation and control facilities

The wiring distance between the electrical rooms and the various operation and control facilities and equipment used in the water intake and treatment plants, as well as their operating voltages, operation and control methods, and other factors have been specified to be appropriate for their purposes.

① Load facilities

a) Voltage used by motors

Voltage is categorized into low 380V and high 6kV with 250kW being the boundary. Voltages used by large-capacity equipment at this facility are as follows:

- Water intake pump (200kW) 380V
- Water conveyance pump (200kW) 380V
- Surface washing pump (132kW) 380V
- North water conveyance pump (132kW) 380V
- South water conveyance pump (800kW) 6kV

② Speed control methods

a) Water conveyance pump

For start up and minimum capacity operation, 1set of conveyance pump will be adjusted by speed control system (VVVF).

b) Water transmission pump

As a general rule, this pump will transmit at a constant rate. However, in order to accommodate water transmissions that take into account demand fluctuations for different times of the day, the flow volume will be adjusted by controlling pump speed, and pressure will be adjusted by high-voltage inverter.

Inverter control operation enables to reduce electric consumption by 27% in comparison with fix revolving speed operation. In LCC base including construction and O&M cost, inverter control system is about 11 % less expensive than that of fix revolving speed system.

4) Control power supply facilities

Control power supply facilities for breakers and protective relays in high voltage circuits, display lamps, monitor/control devices, instrumentation/gauges and other equipment play a crucial role with respect to facility operation management. The choice of control power supplies that are required for this water treatment plant is shown below:

① Types of control power supplies

a) General control power supply

Commercial 230V AC power is used in drive control circuits and general control circuits (for auxiliary relay, etc.).

b) DC control power supply

Power transmission and transformation equipment for extra-high and high voltages will be powered by battery. Batteries are broadly categorized into lead and alkali batteries. This project will use stationary cotrol valve-type sealed lead batteries (VRCA) which are lead batteries that are characterized by their ease of maintenance and management, superior discharging performance and economy, and are a type of batteries that are in widespread use in Viet Nam.

c) AC uninterrupted power supply

The monitoring control device (SCADA), controllers at the various electrical rooms, and instrumentation equipment will be equipped with a UPS.

② Methods for installing control power supplies

Methods for installing control power supplies include a centralized scheme where the power supply is installed at either the administrative building or water transmission pump building, or a distributed scheme where they are installed at each electrical room that are found in various areas of the power plant. A distributed scheme will be employed for this water treatment plant as its facilities are spread over a wide area.

5) Instrumentation equipment

Instrumentation equipment is installed to ensure the smooth and proper operation of water treatment plant and to improve the effect of drinking water treatment. Further, by measuring, with instrumentation equipment, various water levels, flow rates, pressures, water quality, etc. in water treatment facilities, the control center monitors, records, and accumulates data on measurement locations. An appropriate instrumentation equipment plan considers the introduction of equipment aiming at the following effects:

① Purpose of introducing instrumentation equipment

- Improvement of quality management concerning water quantity, water pressure and water quality.

a) Raw water of waterworks is vulnerable to the effects of nature and city life and varies in turbidity and pollutants, and its amount and pressure change constantly. As for the ratio of water supply between day and night times, it is constant in some cases but drastically changes in other cases. Even if such drastic change occurs, it would be possible, with accurate control, to secure appropriate water amount, pressure, and quality and supply safe tap water consistently.

b) As response to a sudden water pollution accident, offensive taste/odor, disinfection by-product, etc., it will be possible to analyze the quality of raw water properly and take appropriate measures. Further, as response to protozoans such as cryptosporidium, it will be possible to take appropriate measures by analyzing the quality of raw water and measuring the turbidity of filtered water.

c) As for the quality of treated water, turbidity, residual chlorine, etc. are required to be checked every day. Through analysis of these items or real-time collection of information using an automatic water quality monitoring device, it will be possible to ensure safe tap water.

- Ensure stability / safety with reasonable control of facilities

a) Waterworks facilities are dispersed in wide area, including water source facilities and water supply facilities.

With introduction of communication or other equipment, these facilities can be accurately monitored and controlled.

b) Water supply amount is ensured by conducting drinking water treatment in accordance with demand forecast.

c) Equalization and stabilization of water supply pressure can be appropriately conducted with water supply control system, etc.

d) Quick and appropriate measures can be taken in case of abnormality (Accident response guidance).

- Improve working conditions by reducing workload, enhancing work environment, etc.

a) Since water supply for 24 hours per day is required in the waterworks business, shift work system is adopted by water treatment plants. Improvement in the reliability of instrumentation equipment enables worksites with such a shift system to reduce regular night shift workers and adopt a system where a stand-by worker can address any abnormality that may occur during the shift work.

- Improve economic efficiency by proper use of chemicals, power, etc.

a) Introduction of the best chemical dosing control can reduce chemical amount.

b) Introduction of an efficient operation control system can save energy.

② General measurement items and detection method

General measurement items are considered necessary for operation of water supply system, and instrumentation equipment is required to be installed as specified in Table 3.5.25.

Table 3.5.25 General Measurement Items

Classification		Measurement items	Measurement purpose	Detection method	Remarks
Water intake facilities	Intake pumping station	Intake pump level	Intake pump control, river water level monitoring	Capacitance type	
		Intake flow rate	River water intake flow monitoring	Ultrsonic system	
Water treatment facilities	Conveyance pumping station	Conveyance pump level	Conveyance pump control	Capacitance type	
	Chemical dosing facility	PAC storage tank liquid level	Storage monitoring	Pressure type	
		NaClO tank liquid level	Storage monitoring	Pressure type	
	Sedimentation basin	Influent flow rate	Intake flow rate control	Ultrasonic system	
		Withdrawn sludge amount	Sludge amount monitoring / control	Electromagnetic type	
	Rapid filter basin	Total filtlatioin flow rate	Post hypochlorine monitoring/control	Ultrasonic sysutem	
	Clean water reservoir	Water level of clean water reservoir	Clean water reservoir management, water supply pump control	Throw-in type	
Water supply facility	Water supply pumping station	North line water supply	Water supply monitoring and control	Electromagnetic type	
		North line water supply pressure	Water supply pressure monitoring	Pressure type	
		South line water supply	Water supply monitoring and control	Electromagnetic type	
		South line water supply pressure	Water supply pressure monitoring	Pressure type	
Wastewater treatment	Wash water drainage basin	Water level of wash water drainage basin	Water level monitoring	Capacitance type	
		Return water amount	Return water amount monitoring	Ultrasonic system	
	Sludge basin	Sludge basin water level	Water level monitoring	Capacitance type	
	Thickener	Withdrawn sludge amount	Sun drying bed injection monitoring	Electromagnetic type	
Outside facilities	Off take facility	Receiving water flow rate	Receiving water flow rate monitoring	Electromagnetic type	
		Receiving basin water level	Receiving water level monitoring	Submersion type	
		Receiving water pressure	Receiving water pressure mentoring	Pressure type	

③ Water quality measurement items and detection method

In order to ensure the proper functioning of drinking water treatment system, whether in the day or night time, in response to any change in the quality of raw water, instrumentation equipment is required to be installed at water treatment plants as specified in Table 3.5.26.

Table 3.5.26 Water Quality Measurement Items and Detection Method

<table>
<tr><th colspan="2">Classification</th><th>Measurement items</th><th>Measurement purpose</th><th>Detection method</th><th>Remarks</th></tr>
<tr><td rowspan="2">Water intake facilities</td><td rowspan="2">Intake pumping station</td><td>Turbidity</td><td>Early detection of abnormal water quality</td><td>Transmitted light / scattered light computing type</td><td></td></tr>
<tr><td>Electrical conductivity</td><td>Chloride concentration control</td><td>Electrode type</td><td></td></tr>
<tr><td rowspan="9">Water treatment facilities</td><td rowspan="2">Conveyance pumping station</td><td>Turbidity</td><td>Early detection of abnormal water quality</td><td>Transmitted light / scattered light computing type</td><td></td></tr>
<tr><td>pH</td><td>pH monitoring</td><td>Glass electrode type</td><td></td></tr>
<tr><td rowspan="2">Sedimentation basin outlet</td><td>Turbidity</td><td>Early detection of abnormal water quality</td><td>Transmitted light / scattered light computing type</td><td></td></tr>
<tr><td>pH</td><td>pH monitoring</td><td>Glass electrode type</td><td></td></tr>
<tr><td>Filter basin outlet</td><td>Residual chlorine</td><td>NaClO injection appropriateness check</td><td>Non-reagent type</td><td></td></tr>
<tr><td rowspan="4">Clean water reservoir outlet</td><td>Turbidity</td><td>Water-quality standard monitoring</td><td>Transmitted light / scattered light computing type</td><td></td></tr>
<tr><td>Residual chlorine</td><td>NaClO injection appropriateness check</td><td>Non-reagent type</td><td></td></tr>
<tr><td>Electrical conductivity</td><td>Chloride concentration control</td><td>Electrode type</td><td></td></tr>
<tr><td>pH</td><td>pH monitoring</td><td>Glass electrode type</td><td></td></tr>
<tr><td rowspan="4">Outside facilities</td><td rowspan="4">Off take facility</td><td>Turbidity</td><td>Early detection of abnormal water quality</td><td>Transmitted light / scattered light computing type</td><td></td></tr>
<tr><td>Residual chlorine</td><td>Water-quality standard monitoring</td><td>Non-reagent type</td><td>Residual chlorine</td></tr>
<tr><td>pH</td><td>pH monitoring</td><td>Glass electrode type</td><td></td></tr>
<tr><td>Electrical conductivity</td><td>Chloride concentration control</td><td>Electrode type</td><td></td></tr>
</table>

6) Monitoring and control facility

The monitoring and control system monitors and controls plant operation and processes plant operation information. The system consists of digital control equipment, operation facility, monitoring and control facility, and information processing facility, and serves as a core system for the operation management of the entire water treatment plant.

This water treatment plant will be positioned as a major treatment facility with a total capacity of 300,000 m^3/day, a half of which (150,000 m^3/day) is provided when the Phase 1 of this project is completed and the other half is provided when the Phase 2 project is finished. Accordingly, in order for such a large facility to ensure reasonable and efficient safe operation, monitoring, control, data collection and analysis, SCADA（Supervisory Control and Data Acquisition) System will be introduced and concentrated control is conducted by the administrative building, including the off take facility located outside the treatment plant.

In recent years, waterworks facilities in Japan have been using more PCs and accelerating signal transmission systems to downsize computers (i.e., use smaller ones with advanced functions) most appropriate for centralized management and distributed control. As a result, in addition to the monitoring, recording, and calculation functions, more and more water treatment facilities are introducing control functions for supporting the operation of water treatment facilities, such as facilities maintenance database system and operation support system.

The background of such progress is that system stabilization has been sought by sharing know-how that was dependent on area expansion and personnel, separating functions horizontally, and ensuring risk distribution. Moreover, the waterworks business that is open to society, such as information necessary for management and information disclosure, has been sought. Considering that similar response will be required soon for the waterworks business of Ha Noi, it is planned as follows with the aim to establish a modern monitoring and control system.

① Basic system requirement

a) The monitoring and control system is a centralized control system in the central administrative building.

b) The system configuration is based on centralized management and distributed control (hierarchy form) in consideration of the size of water treatment plant, maintenance system, future responsiveness, etc.

c) Facilities outside the treatment plant are placed under centralized control with regular transmission and emergency transmission using the mobile phone line (3G).

d) With the concept that Japanese advanced technologies are introduced in this water treatment plant, a system that can provide information to Ha Noi citizens is taken into consideration.

e) Response speed will be enhanced through the hierarchical separation of monitoring operation function from arithmetic control functions and the decentralization of arithmetic control function by facility.

f) For system components subject to information disclosure of the water treatment plant, those with more versatility are chosen.

Moreover, for transmission lines between components, general-purpose LAN is adopted considering the nature of transmission data.

② Basic function of major equipment

a) Structure and functions of display system

Displays are essential equipment for operation of the water treatment plant. However, displays are not operated constantly but are often used to check conditions in case of any abnormality. For this reason, display system is structured with focus on condition monitoring. A total of 4 display units are installed, and each unit has compatibility with the others.

[1] For condition monitoring /control (2units)
[2] For maintenance
[3] For water rate management
[4] For common backup

b) Functions of server

The server should have operation control function for controlling data directly related to the operation of water treatment plant, maintenance function for accumulating failure history, and guidance function for supporting special operation.

c) Functions of controller

The controller should have an automatic instrument loop function for each facility and ensure smooth operation of facilities. In addition, it should have a function that enables operation with the site monitoring panel even when the administrative building's function stops.

d) Main facility control method

[1] Intake pump: One-man control from the water intake electric facilities.

[2] Sand basin: In principle, on-site operation

[3] Conveyance pump: One-man control from the electric room of the water supply pump building and the central operation room

[4] Settling basin: In principle, manual operation from the electric room of the administrative building. Sludge is removed in programmed operation with timer control.

[5] Filter basin: Automatic cleaning operation from the electric room of the administrative building and the control center

[6] Water supply pump: Constant flow rate control (VVVF) from the central operation room and the water supply pump building based on water supply amount and pressure. Aiming at automatic control responding to demand prediction in the future, data is collected in the Phase 1 concerning changes in water supply amount and pressure with respect to time / day / week day / month / season, etc.

[7] PAC injection dose: Water intake proportional control by setting injection rate from the chemical dosing building and the central operation room. Aiming at optimum injection control based on water quality data, such as electrical conductivity, in the future, water quality data is collected in the Phase 1.

[8] NaClO injection dose: Water intake proportional control by setting injection rate from the chemical dosing building and the central operation room.

[9] Wastewater treatment: In principle, manual operation from the wastewater treatment electric room. Sludge is transferred in programmed operation with timer control.

7) Television system for monitoring the treatment plant

Television system will be equipped for the security from invader and to complement monitoring for operating conditions.

8) Outside facility monitoring system

It is necessary to transmit through communication facility to the control center of the water treatment plant the hourly fixed-time information (concerning flow rate, water pressure, water temperature, residual chlorine, electrical conductivity) from off take points scattered outside the treatment plant and warning of communication facility failure, abnormal measurement value, etc.

- Information transmission method

  For the information required in the water treatment plant, continuous monitoring is unnecessary but fixed-time information needed in maintenance is indispensable. In Viet Nam, progress in the proliferation of mobile phones is outstanding as known from its growth rate exceeding that of fixed-line phones and the 3G technical cooperation with NTT DoCoMo. Accordingly, the portable wireless system (packet communication system) using 3G technology is considered to be the most useful for the information transmission method.

  Comparison of information transmission channel types is as follows.

Table 3.5.27 Transmission Channel Comparison

	Private wired system	Telephone company line system	Multiplex wireless system	Portable wireless system
Outline	A system of telecommunication by using electric poles of telephone / power companies or establishing private poles and laying communication cables.	Consisting of the system using code items corresponding to transmission of data provided through telephone company's lines and the method of communication using frequency bands assigned according to applications.	Under control by RFD, which belongs to MIC, and assigned frequency is lent for 15 years. Frequency allocation requires approval of the prime minister, so review criteria are strict.	A system using the portable packet service (3G), provided by companies approved MIC, such as VNPT, EVE, and SPT.
Point-to-point method	1-1, 1-N, (1-1) x N	1-1, 1-N, (1-1) x N	1-1	1-N
Line speed	50bps - 100Mbps Speedup is possible according to devices installed.	50bps - 100Mbps	3Mbps - 13Mbps	64kbps - 100Mbps Slightly varies according to telephone companies.
Reliability	High reliability because of dedicated lines.	High reliability because of dedicated lines.	Users have to perform maintenance.	Access to 3G line network may not be available in the case of concentrated access to the line.
Maintainability	The maintenance system of private lines is complicated.	Line maintenance is conducted by telephone company, so it is possible for 24 hours a day and 365 days a year	Users have to perform maintenance.	Support is available as an option during the business hours of the telephone company.
Economic efficiency	High initial cost but the lowest running cost.	Low initial cost but high communication charge (continuous connection)	Expensive since wireless equipment is installed for each location.	Initial cost is the lowest and communication charge is also inexpensive because of fixed-time communication.
Advantages	Inexpensive but excellent security because dedicated line is used.	High communication charge but excellent security because dedicated line is used.	Safe from disasters as compared with wired system	Lower charge because no dedicated line is used. Since charge is based on packet traffic, there is no waste.
Disadvantages	Maintenance of private lines is necessary, so there is a large risk.	The environment of telephone company's lines has quality issues, such as disconnection and electromagnetic wave interference.	Vulnerable to attenuation caused by rain in some frequency bands, and domestic radio wave bands are becoming scarce.	There is no permanent connection or line quality assurance. Authentication is required for making connection.
Overall evaluation	×	○	○	◎

MIC : Ministry of Information and Communications

RFD : Radio Frequency Directorate

(10) Construction Facilities Planning

1) Necessary construction facilities

Table 3.5.28 lists the construction facilities necessary for this water treatment plant and the concepts of each facility.

Table 3.5.28 List of Construction Facilities

No.	Structure	Shapes	Policy
①	Water Intake Pumping Station	1 floor below, 1 floor above ground	Pump room is underground, electric room is above. Note that the intake pump room is unified construction with water intake. (Electric room is a separate building.)
②	Water Conveyance Pumping Station	1 floor below, 1 floor above ground	Pump room is underground, electric room is above. (Combined building)
③	Administrative Building	3 floors above ground	Includes electricity receiving transformation room, central monitoring room, electric room for water treatment facilities, water quality examination room, private electric generator room, office, conference room, etc.
④	Chemical Dosing Facility	2 floors above ground	Includes chemical storage tank, dosing pump, electric room. Note that the sodium hypochlorite storage room is separate building.
⑤	Transmission Pumping Station	1 floor below, 1 floor above ground	Water pipe room is underground, electric room is above.
⑥	Drainage Pumping Station	1 floor below, 1 floor above ground	Water pipe room is underground, electric room is above.
⑦	Public Facility	2 floors above ground	Facilities for residing staff common use. To be designed according to minimum design standard.
⑧	Employees House	3 floors above ground, 24 buildings	Company house for residing staff. To be designed according to minimum design standard.
⑨	Others		Includes; sodium hypochlorite storage room, sludge pump room, janitor's room, etc.

2) Block plan for the administrative building (zoning)

This part includes the detail on the block plan and the basic concept for the administrative building where personnel of the water treatment plant and SPC personnel reside.

Residential rooms necessary for the administrative building are as follows.

Table 3.5.29 Necessary Residential Rooms

No.	Name	Remarks
1	Receiving and transforming Room	Extra high voltage electricity receiving transformation room for WTPs
2	Water Treatment Electric Room	Electricity room for water treatment facilities such as sedimentation basin, filter tank etc.
3	Generator Room	Holds electric generator for emergency use
4	Central Monitoring Room	Holds central monitoring room
5	Water Laboratory	Holds water quality testing equipment and chemical storage facilities
6	Water Quality Meter Room	Holds automatic water quality monitoring instruments
7	Office Room	For WTP staff, total 70 persons (Japanese / Vietnamese use)
8	Director Room	
9	Office Room for SPC	Office for SPC staff
10	Meeting Room	Several rooms are arranged for staff meeting.
11	Sub Conference Room	
12	Main Conference Room	
13	Library	Library for WTP and SPC each
14	Work Room	
15	Staff Lounge	Separate rest rooms for male / female staff
16	Locker Room	Shower stalls to be added if necessary
17	Toilet	To be installed on each floor. Separate for men / women.

The following points should be taken into consideration in zoning of the administrative building.

- Floors where plant facilities and equipment are arranged should be separated from floors where personnel reside.
- Connection of wires etc. should be taken into consideration, e.g., the electrical room should be adjacent to the in-house generation room, etc. Also, rooms that are functionally related should be arranged closely in order to avoid confusion in traffic line
- Since the roof is the highest area in the premises and provides a broad view of the entire plant, it should be designed to allow visitors to access the roof.
- For the purpose of efficiency improvement, the toilet room on the first floor should be arranged so that people can access from outside. In addition, at least one multi-purpose toilet room should be provided.

Figures 3.5.9 - 3.5.13 show the plan, cross-sectional, and elevation views of the administrative building drawn in consideration of the above. Moreover, in the detail design, the layout and required space of 2nd and 3rd floors need to be discussed and to revised including the management of SPC.

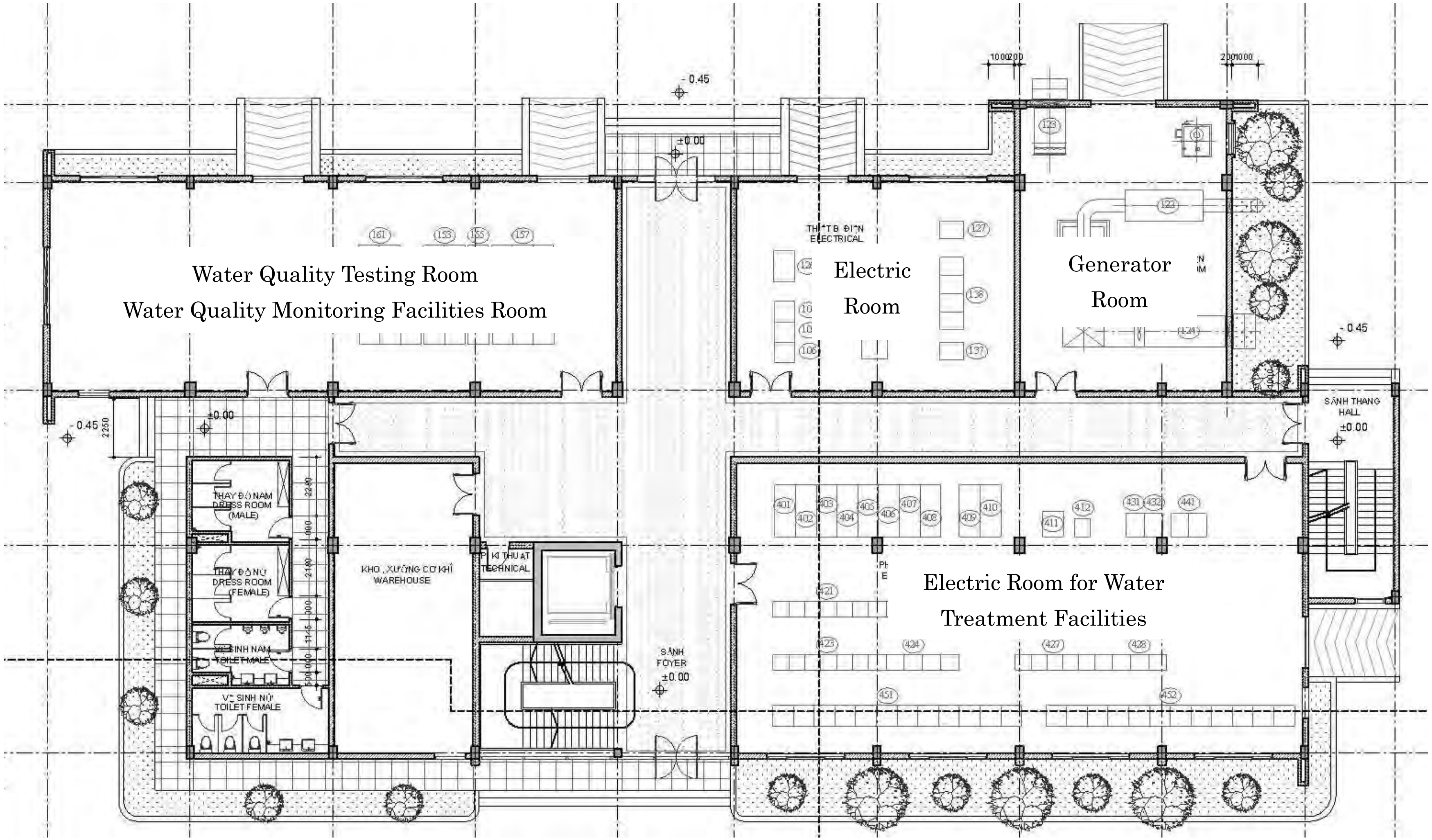


Figure 3.5.9 1st Floor Plan

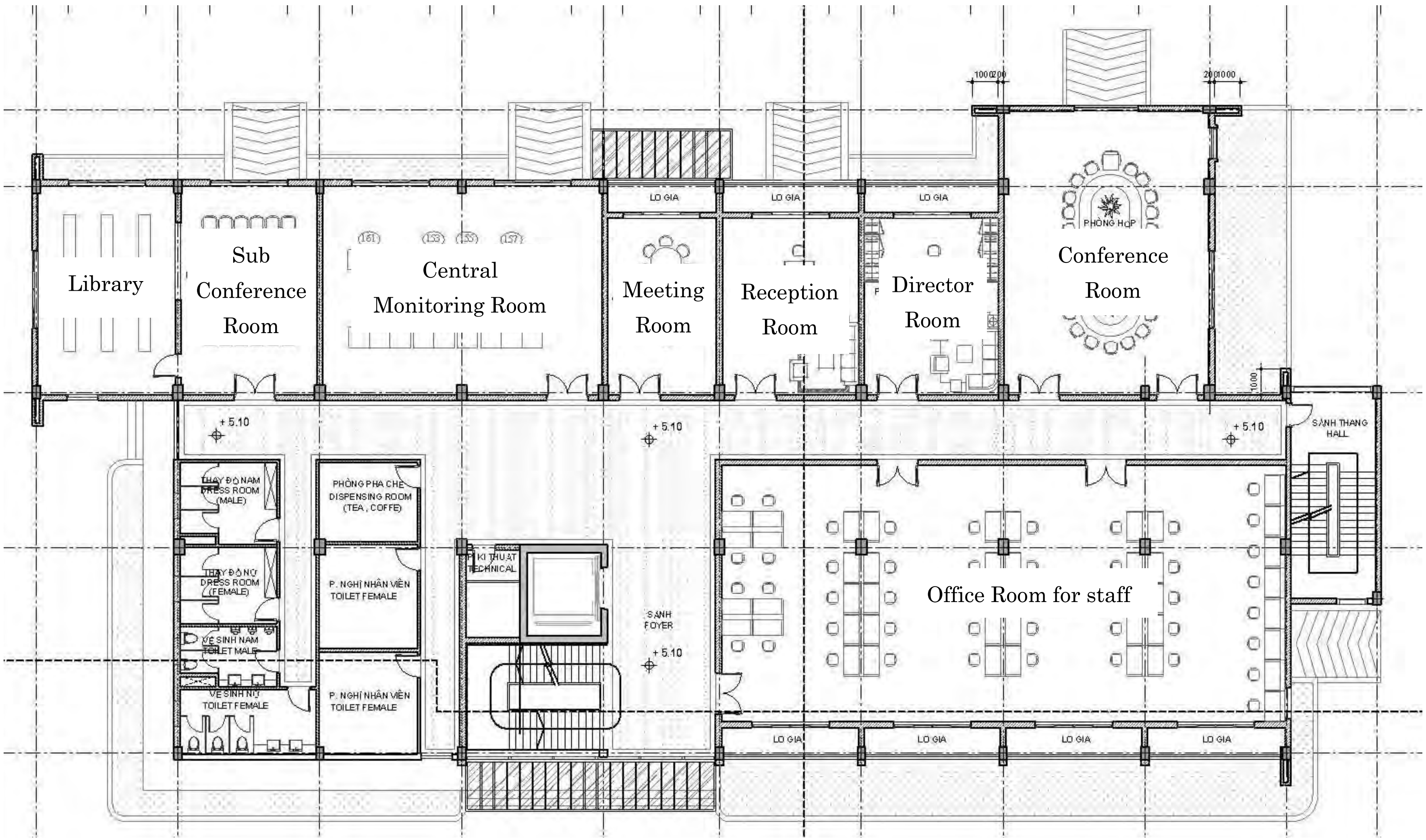


Figure 3.5.10 2nd Floor Plan

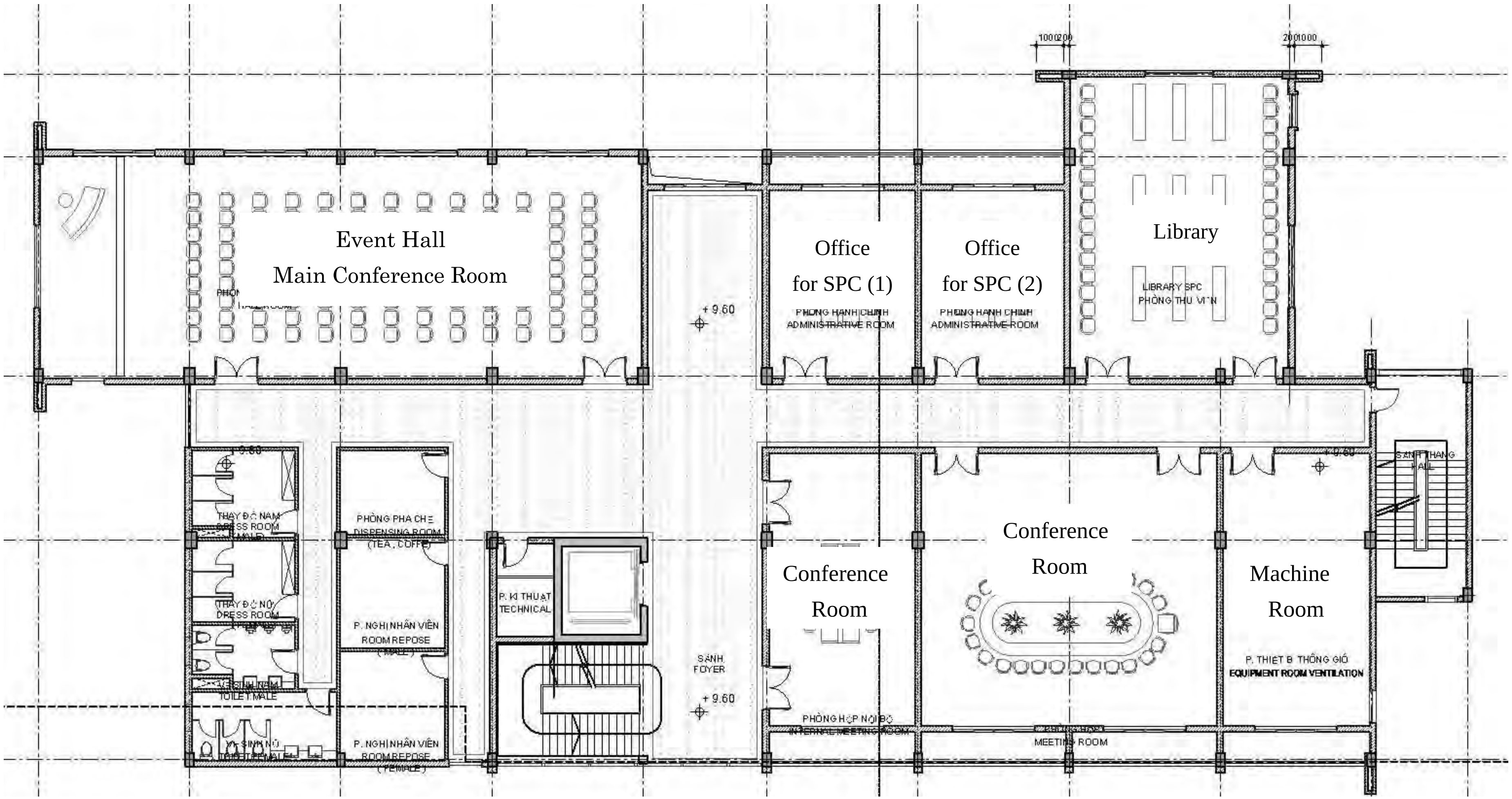


Figure 3.5.11 3rd Floor Plan

Figure 3.5.12 South Face of Administrative Building Elevation Plan

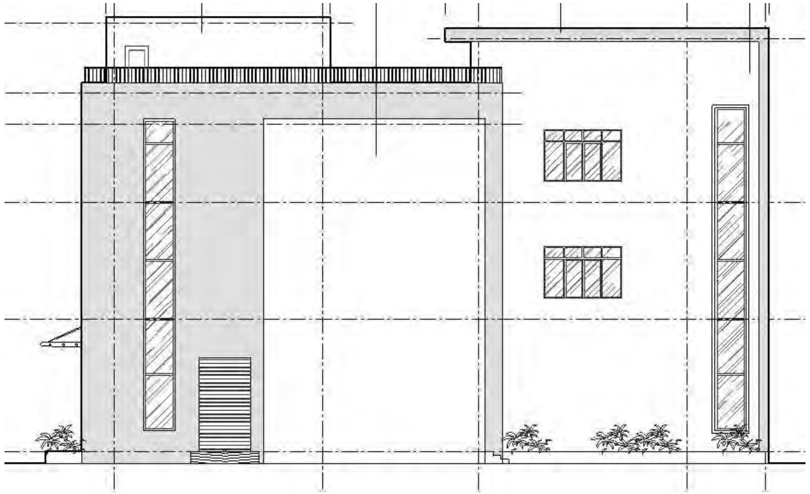


Figure 3.5.13 West Face of Administrative Building Elevation Plan

(11) Facility Arrangement Plan

1) Arrangement policy and constraints

The site of the water treatment plant is located at Phu Dong, Gia Lam Province, Ha Noi City, on the east side of National Route 1, one of the main highways in Viet Nam as shown in Figure 3.5.14. The north side of the premises is facing an access road and there are Duong River and the water intake facility in the south of the premises.

In considering the aforementioned conditions, arrangement of each facility in the premises will be planned. The basic policy and constraints on facility arrangement are as follows.

- ➢ The front gate should be located so as to face the access road and facilities with access to visitors etc. should be arranged together in the northern part of the premises to the extent possible.
- ➢ Plant facilities should be arranged together in the southern part of the premises to the extent possible since the water intake facility is located in the south and confusion in traffic lines in the premises needs to be avoided.
- ➢ Facilities should be arranged utilizing the alignment of the existing road running through the middle of the premises.
- ➢ The flow of water should be considered in facility arrangement so that total length of pipes may be shortened to the extent possible.
- ➢ The shape of a site for future use (600,000 m^3/day) should be considered so that it may be used for another purpose in the future depending on the situations.

Figure 3.5.14 Shape of the Site and Conditions of Surrounding Roads

2) Facility Arrangement Plan

Figure 3.5.15 shows the facility arrangement plan determined based on the aforementioned arrangement policy and constraints.

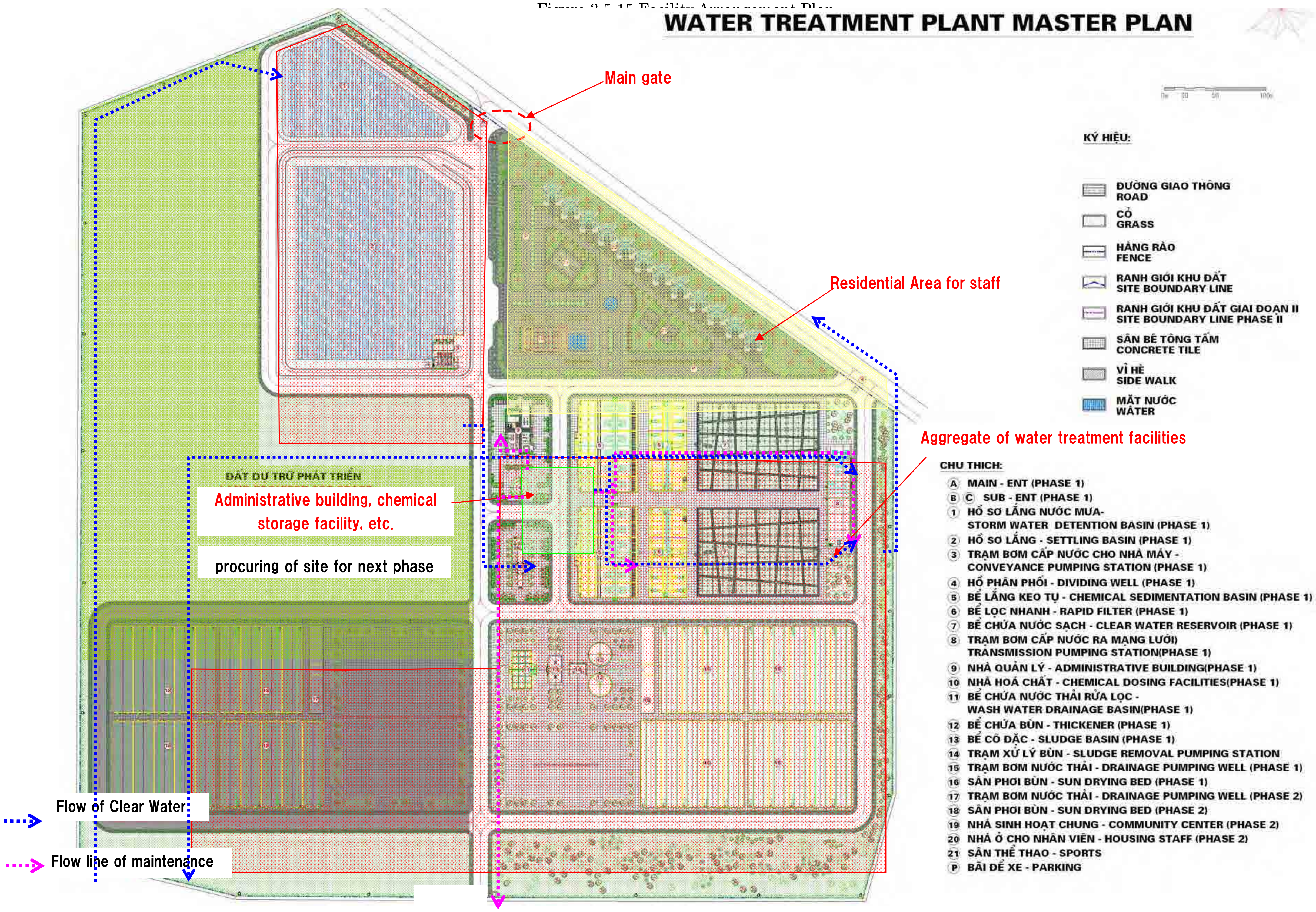


Figure 3.5.15 Facility Arrangement Plan

(12) Piping Plan

1) Indoor piping plan

① Pipe type

The types of pipes to be laid in the room should be steel pipes for easy maintenance and workability since a space of installation will be limited and a lot of bent and branch pipes will be installed.

However, a stainless steel pipe shall be adopted of the pipe type at the part of connection to underwater pump in considering to maintenance and durability. In addition, the pipe for chemical dosing shall be PVC pipe since it is excellent in corrosion resistance.

Also, the pipe type as mentioned above can be produced in Viet Nam.

② Diameter

The indoor pipe diameters are set based on diameter of connected pump as following Table 3.5.30

Table 3.5.30 Indoor Pipe Diameters

Section	Facility	Diameter (mm)	Remarks
Water Intake Pipe	Intake Pump Room	φ1600 φ1000	SP SUS
Water Conveyance Pipe	Conveyance Pump Room	φ1600 φ1000	SP SUS
Clear Water Pipe	Transmission Pump	φ2000 φ1600 φ1200 φ1000	SP SP SP SP
	Surface washing Pump	φ600	SP
Wash water Pipe	Rapid filter	φ600 φ500	SP SP
Sludge Pipe	Sedimentation basin	φ300	SP
	Sludge transfer pump	φ250 φ300	SP SP
Drainage Pipe	Wash water return pump	φ500 φ300	SP SP
	Sun drying bed drainage pump	φ300 φ250	SP SP
Chemical	Chemical dosing pump	φ50 φ25	SP SP

2) Outdoor piping plan

① Pipe type

The types of pipes to be laid in the premises should be, as is in the case of the transmission pipeline, ductile cast-iron pipes for those with a diameter of 800mm or less, and steel pipes for those with a diameter of 900 mm or more.

For pipes, however, steel pipes are used regardless of size considering workability, while Hume pipes are used as storm drain pipes.

Note that no lining is provided on the inner surface of pipes in Viet Nam since no regulations are stipulated, but mortar lining will be provided for the plant considering the life of pipelines, safety of water quality, etc.

② Diameter

According to the design guidelines in Japan, it is considered reasonable to set the diameter of pipes so as to keep the pipe flow velocity within a range of 0.5 to 1.5m/sec. However, a diameter needs to be enlarged to lower the flow velocity, which is not economical, while smaller pipe diameters will result in increase in pipeline loss, lower water level in the facilities, and deeper structure, which will consequently lower cost effectiveness.

Accordingly, outdoor pipe diameters are set as follows in this design aiming at the velocity of 1.0m/sec so as to minimize the friction loss in pipes.

Table 3.5.31 Outdoor Pipe Diameters

Section	Facility	Diameter (mm)	Remarks
Water Intake Pipe	Intake facility - Settling basin	φ1600	SP
Water Conveyance Pipe	Settling basin - Dividing well	φ1600	SP
Clear Water Pipe	Dividing well - Sedimentation Basin	φ1500	SP
	Sedimentation Basin - Rapid filter	φ1500	SP
	Rapid filter - Clear water tank	φ1500	SP
	Clear water tank - Transmission pumping station	φ1600	SP
Drainage Pipe	Dividing well overflow pipe	φ1000	SP
	Dividing well drainage pipe	φ300	DCIP
	Sedimentation Basin drainage pipe	φ100	DCIP
	Rapid filter surface washing pipe	φ600	DCIP
	Clear water tank overflow pipe	φ800	DCIP
	Clear water tank drainage pipe	φ400	DCIP
	Sedimentation basin drainage pipe	φ250	DCIP
	Sludge basin drawn pipe	φ300	DCIP
	Thickener inflow pipe	φ300	DCIP
	Rapid filter back-washing pipe	φ1200	SP
	Thickener supernatant pipe	φ300	DCIP
	Back-wash water return Pipe	φ500	DCIP
	Sun drying bed supernatant pipe	φ250	DCIP
	Sun drying bed drainage pipe	φ300	DCIP
	Thickener drawn pipe	φ250	DCIP
	Sun drying bed inflow pipe	φ300	DCIP
	Settling basin drainage pipe	φ300	DCIP

(13) Setting Facility's Water Level

1) Hydraulic Analysis

Minimum/maximum water levels of water treatment facilities should be determined after conducting Hydraulic Analysis and estimating unavoidable loss.

Water level conditions set for each facility through simplified Hydraulic Analysis are as follows.

Table 3.5.32 Water Level Setting in Each Treatment Process

Facility	HWL	LWL
Water Intake Facility	+11.50	+0.50
Settling Basin	+7.50	
Dividing Well	+14.20	-
Receiving Well	+13.20	+12.00
Flocculation Basin	+11.70	-
Sedimentation Basin	+11.50	
Intermediate-Chlorine mixing Basin	+10.50	
Rapid Filter	+9.90	+7.50
Post-Chlorine mixing Basin	+7.00	-
Clear Water Reservoir	+7.00	+2.00

2) Water level relationship

Figure 3.5.16 shows the water level relationship of Duong River Water Treatment Plant set based on the results of the aforementioned hydrologic accounting.

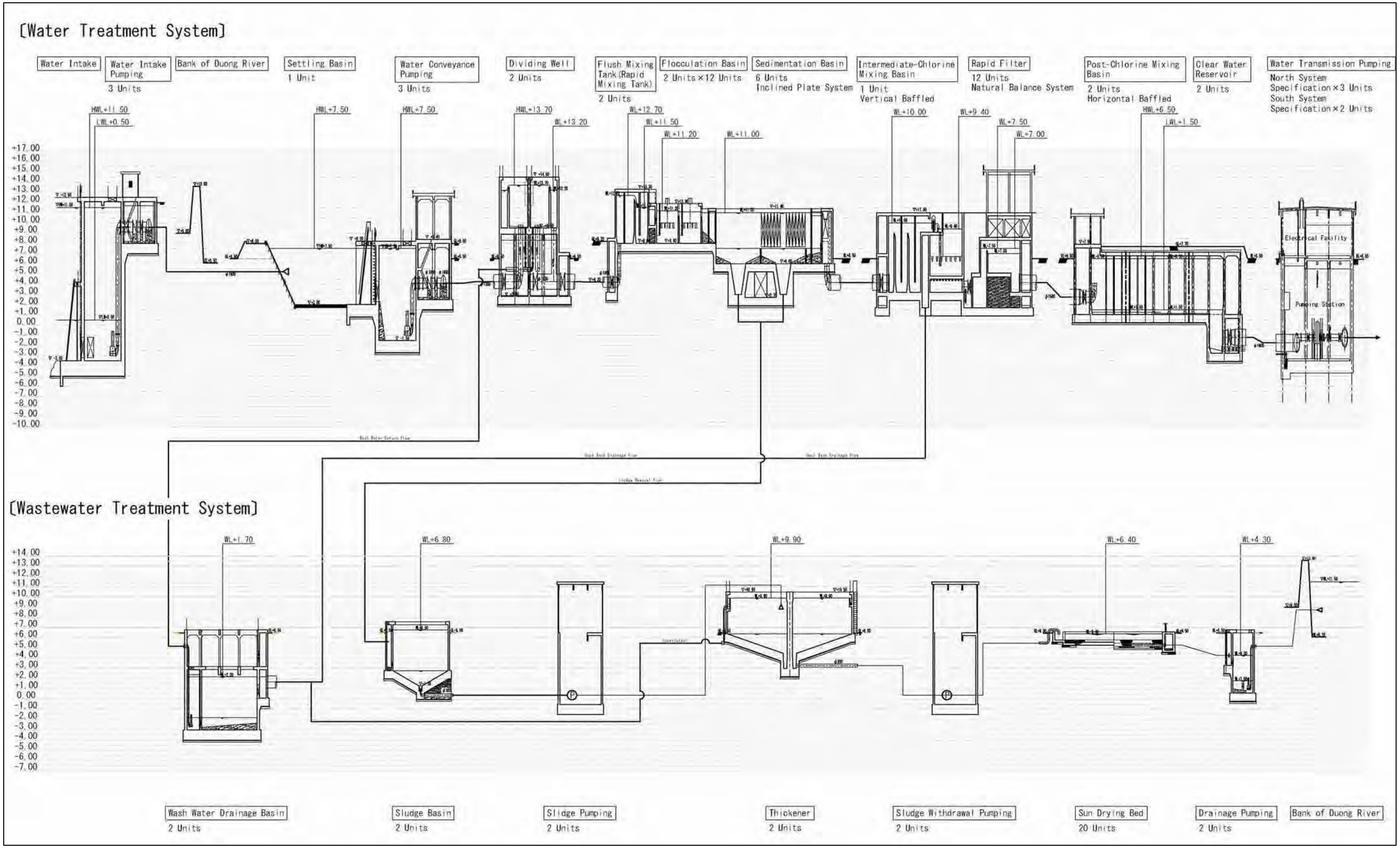


Figure 3.5.16 Water Level Relationship (Phase 1: 150,000 m3/day)

3.5.4 Transmission Pipeline Planning

(1) Outline of Transmission Pipeline Route

The transmission pipeline routes, totaling about 45km, consist of North Route extending from the water treatment plant to Lim Prefecture, Bac Ninh Province, and South Route extending from Gia Lam Prefecture, Ha Noi City, to Huang Mai District, Ha Noi City, through Long Bien District and Van Giang Prefecture, Hung Yen Province.

Areas along the transmission pipeline routes are expected to be rapidly urbanized due to the presence of adjacent housing estates and industrial parks, except for the area along the route of Long Bien District and Hoang Mai District, Ho Noi City, which has been urbanized, and complex development considering urban agriculture and the environment is desired for such areas.

The alternative transmission pipeline route from Phu Thi to Yen So, which is planned to be installed only in Ha Noi City, is considered. In the joint meetings between Japanese and Vietnamese sides, which was started from March, 2012, it was almost agreed that Supply Area up to Phase 2 was only Hanoi City.

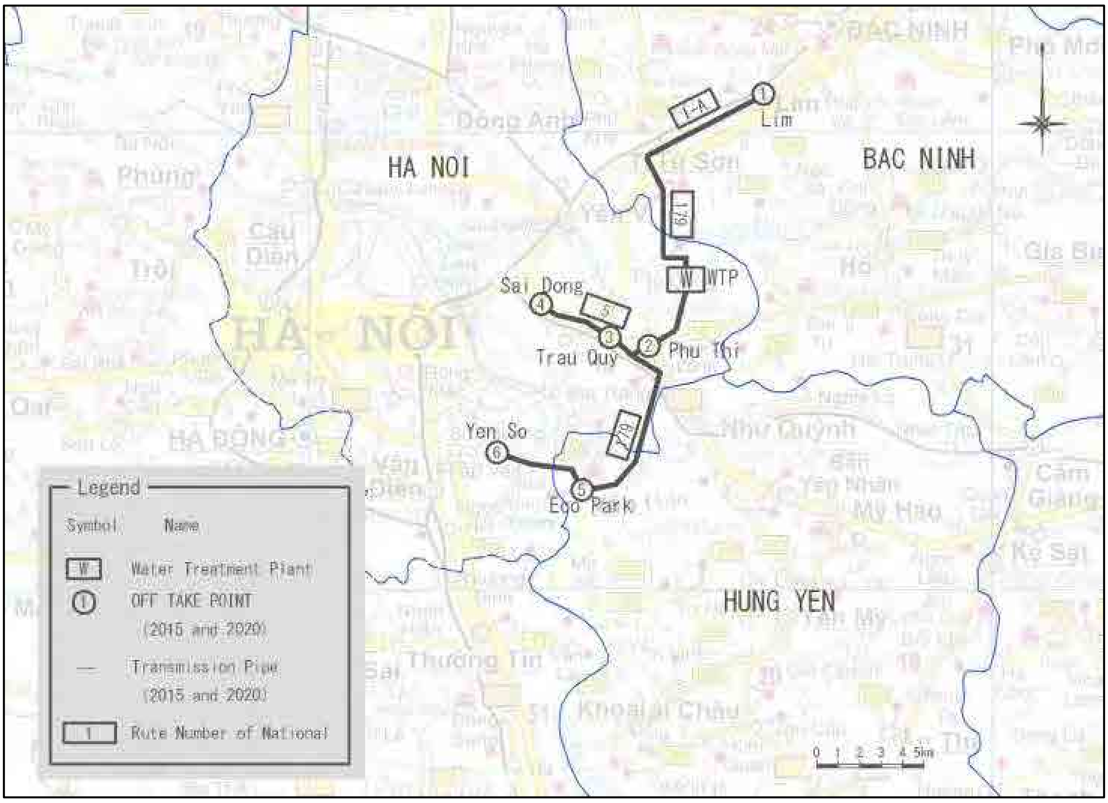


Figure 3.5.17 Outline of Transmission Pipeline Route

(2) Examination of Transmission Pipeline Diameter

The diameter of transmission pipeline will be determined as mentioned before based on the results of Hydraulic Analysis. And the water supply area being same for both Phase 1 and 2, the decision will be made based on the Hydraulic Analysis hydrologic accounting of Phase 2.

Hydrologic accounting Hydraulic Analysis calculation results are shown in Table 3.5.33.

Table 3.5.33 Hydrologic Accounting Calculation Result

C＝ 110 Elevation of starting Point = 0.500 m

【Main Planning Transmission Route】

Node		Quantity (m3/day)	Quantity of distribution	Diameter (m)	Length (m)	Effective Head of Headwaters (m)	Hydraulic Gradient (‰)	Head Loss (m)	Effective Head of Downstream (m)	Elevation (m)	Effective Head of Off Take Points (m)	Velocity (m/S)	Remarks	Receiving Pipe Diameter (m)
W	1'	30,000	0	0.70	8,367	45.000	1.432	11.980	33.520	5.000	28.520	0.907		
1’	1	30,000	30,000	0.70	5,930	33.520	1.432	8.490	25.030	6.000	19.030	0.907	Lim	0.40
W	2	324,653	32,657	1.60	5,770	57.000	2.094	12.080	44.920	5.900	39.020	1.875	Phu Thi	0.45
2	3'	291,996	83,100	1.40	1,230	44.920	3.298	4.060	40.860	5.500	35.360	2.203		
3'	3	208,896	37,046	1.20	2,603	40.860	3.760	9.790	31.070	4.300	26.770	2.146	Trau Quy	0.45
3	4	171,850	171,850	1.20	4,987	31.070	2.620	13.070	18.000	6.100	11.900	1.766	Sai Dong	1.00
3’	5	83,100	18,383	1.10	8,573	40.860	1.044	8.950	31.910	6.200	25.710	1.017	Eco Park	0.30
5	6	64,717	64,717	1.00	8,147	31.910	1.045	8.520	23.390	3.600	19.790	0.958	Yen So	0.80
Total		354,653			45,607									

【Substitute Planning Transmission Route】

Node		Quantity (m3/day)	Quantity of distribution	Diameter (m)	Length (m)	Effective Head of Headwaters (m)	Hydraulic Gradient (‰)	Head Loss (m)	Effective Head of Downstream (m)	Elevation (m)	Effective Head of Off Take Points (m)	Velocity (m/S)	Remarks	Receiving Pipe Diameter (m)
W	2	354,653	32,657	1.60	5,770	60.000	2.466	14.230	45.770	5.900	39.870	2.048	Phu Thi	0.45
2	3'	321,996	0	1.60	3,375	45.770	2.062	6.960	38.810	5.500	33.310	1.860		
a	3	321,996	37,046	1.40	643	38.810	3.951	2.540	36.270	4.300	31.970	2.429	Trau Quy	0.45
3	b	284,950	113,100	1.20	440	36.270	6.677	2.940	33.330	4.300	29.030	2.926		0.45
b	4	171,850	171,850	1.20	3,904	33.330	2.620	10.230	23.100	6.100	17.000	1.766	Sai Dong	1.00
b	c	113,100	113,100	1.20	6,503	33.330	1.208	7.860	25.470	3.600	21.870	1.163	Linh Nam	0.80
Total		354,653			20,635									

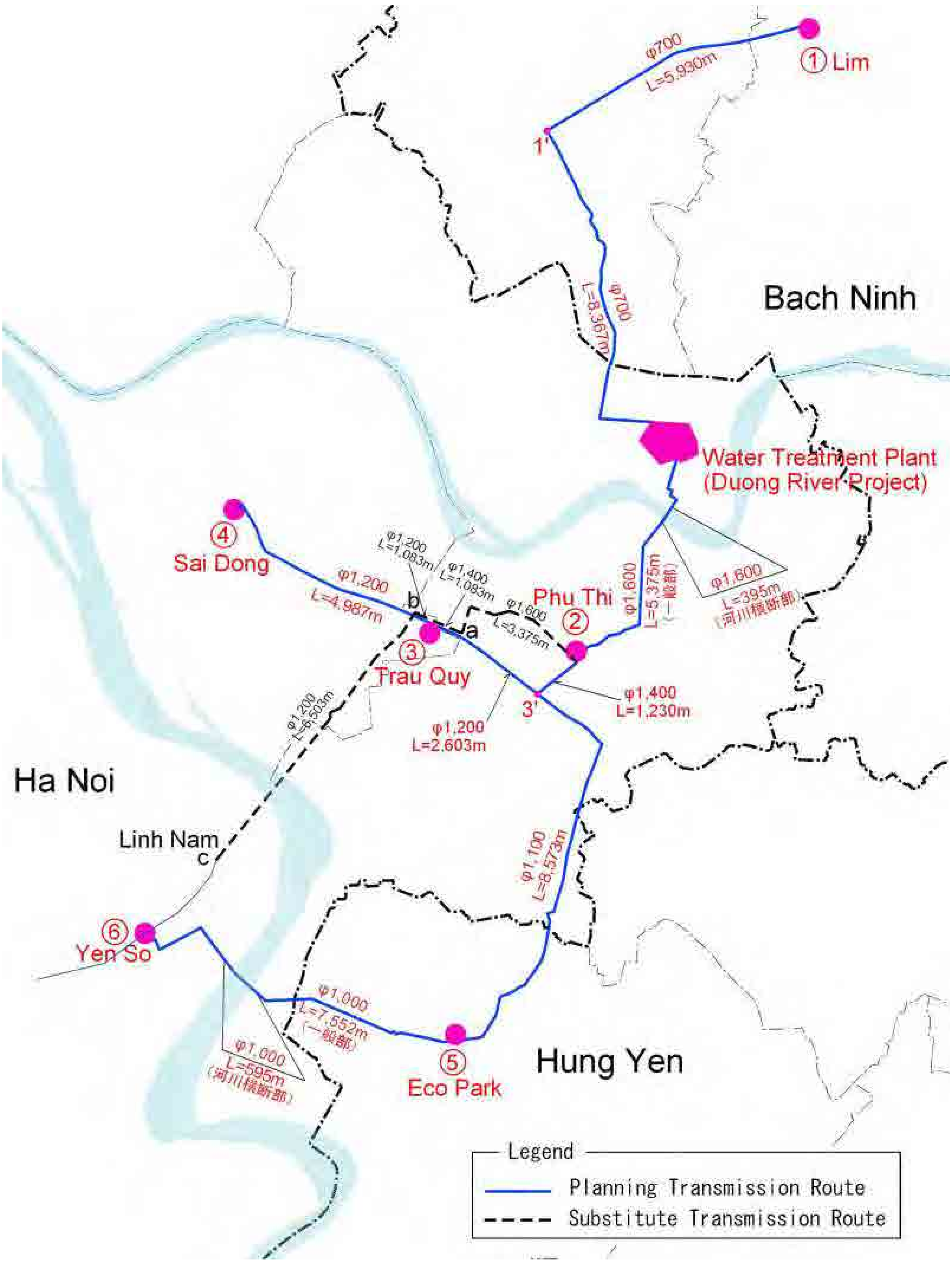


Figure 3.5.18 Pipeline Route and Plans

(3) River Crossing Method

There are two main river crossing points in the transmission pipeline route; the Duong River and the Hong River. The Duong River is about 280m in width the Hong River is about 510m, and many ships sail on these rivers. The characteristics of the Duong River and the Hong River are shown in Table 3.5.34.

Table 3.5.34 Characteristics of the Duong River and the Hong River

	Duong River	Hong River
Water Width × Water depth (in dry season)	280m ×13m	503m ×9m
Soil quality of river bed	Sand with silt	
Number of Sailing ships(per day)	About 230 - 300	About 150 - 200
Movement of River Bed	Scarcely	
State of Dredging	Collecting sand for construction use without dredging plan	
Maintenance of the River	Timely shore protection works were carried out	
Water Depth Plan	3.6m of minimum water depth set by JICA report 2003 on the Hong River Inland Water Transportation Improvement Plan	

The selection of river crossing methods depends on the scale of pipes and river, or the experiences of construction methods and costs. The following two methods are preferentially selected as enablement methods.

Furthermore, aqueduct bridge method and bridge-supporting method are not listed here because of high construction cost and no bridge near the proposed river crossing points.

- Immersed (Submerged) Method
  This method is generally used in Vietnam and has advantage in construction cost. However, the method has lack of safety in supplying large amount of water and are little cases in Japan, because of considering future river bed reforming.

- Pipe Thrusting (jacking) Method:
  This method has high safety because of non open cut method and has many construction experiences in Japan. However, the method has little experience in Vietnam, therefore, technical transfer of this method from Japan to Vietnam is required in adoption. Technology transfer is also one of aims of this project.

As a result of comparison on two methods above mentioned, Study Team recommend 'Pipe Thrusting (jacking) Method' as the river crossing method, because of not big difference in construction cost (Immersed Method: 100%, Pipe Thrusting Method 108%), high adaptability to the future of the river circumstance change such as river bed reform, abundant experiences of construction technique and simple operation & maintenance.

(4) Review of Provision of Water Hammer Pressure

When a pump suddenly stops because of power supply failure or some trouble, the flow velocity in pipeline will change within a short time, and an unusual pressure wave will occur. If the negative pressure below a saturated vapor pressure occurs in pipeline due to the pressure wave, water column separation of that point is carried out, and when joining together again after that, there is risk of the water hammer which a shock wave produces and pipeline may get damaged.

Therefore, in this study, the effects of negative pressure in case of each pipeline such as water intake, conveyance and transmission, is confirmed. Especially, transmission pipeline are to be laid for long distance stretching greater than 30km from WTP to each off take points, therefore, in the Pre-FS, countermeasures for water hammer was proposed to be necessary.

Thus, in this Project, water hammer examination is carried out to formulate effective countermeasures against water hammer based on the result of examination and, considering the Vietnamese design guideline of water treatment facilities.

1) Base conditions

① Examination objects

Water hammer pressure is examined for the following pipeline.

- Water intake pipeline :φ1600mm Steel pipe L= about 1,800m
- Water conveyance pipeline:φ1600mm Steel pipe L= about 200m
- Water transmission pipeline (Northern route) :φ700mm Cast-iron pipe L= about 13,800m
- Water transmission pipeline (Southern route) :
  (Route 1) Route for centre of Ha Noi city:
  φ1000～1600mm Steel pipe L= about 24,000m

(Route 2) Route for Gia Lam prefecture and Long Bien district
φ1200～1600mm Steel pipe L= about 14,850m

② Water volume conditions

Water volume conditions in each pipeline are shown in Table 3.5.35.

Intake, conveyance and transnission pipelines parts, which enable to prevent water hummar with flywheel, are used Phase 2 water volume (300,000 m3/day) to analyze water hummer.

Table 3.5.35 Objectivewater Volume for Water Hammer Analysis

Examination object	Water volume (m3/min)		Remarks
	Phase1	Phase2	
Intake pipeline	—	221.0	Phase2 only
Conveyance pipeline	—	221.0	Phase2 only
Transmission pipeline (north)	—	20.8	Phase2 only
Transmission pipeline (southern) Route 1	12.4 - 124.0	44.9 - 225.5	
Transmission pipeline (southern) Route 2	73.3 - 124.0	119.3 - 225.5	

③ Control target

A negative pressure which occurs in pipeline will be controlled to 5m - 7m or less, since the water column separation is carried out if a negative pressure will reach about 10m.

Therefore, the controlo target of negative pressure is set as 6m or less based on above discussion.

2) A policy of provision of water hammer

① General provision of water hammer

Generally used countermeasure in case of water hammer is listed below.

- Flywheel system
- Open surge tank
- One-way surge tank
- Air vessel (Air chamber)

- Air pipe (Air valve)

② Review policy of provision of water hammer

In considering the advantageous effect (and utility) and economical efficiency, a review policy is shown as follows

- Flywheel is the first countermeasure against the water hammer which is the most advantageous in terms of cost compared to the others measures. In addition, it does not require of any special maintenance.
- In case, if the countermeasure using only flywheel will not be enough to prevent water hammer, the method by one-way surge tank will be examined, which is the most effective countermeasure of water hammer.
- Considering the economical and maintenance aspects, a combination of countermeasures including flywheel and one-way surge tank may be applied. In the detail design, more precise review of this design is necessary.

3) Results of water hammer analysis

① Water intake pipeline

A countermeasure against water hammer will be required in this case since a maximum value of negative pressure is 11m or greater at immediately after pump when no water hammer countermeasure is applied.

In contrast to this, when flywheel is installed, the negative pressure can be controlled to safe level although it is little over 6m (the control target), in this case the maximum value of negative pressure is reduced to 7m.

Also, to make it safer, the water hammer countermeasure should be installed in combination with a rapid closing check valve. Therefore, in case of the water intake pipeline countermeasure against water hammer is proposed using combination of flywheel and rapid closing check valve.

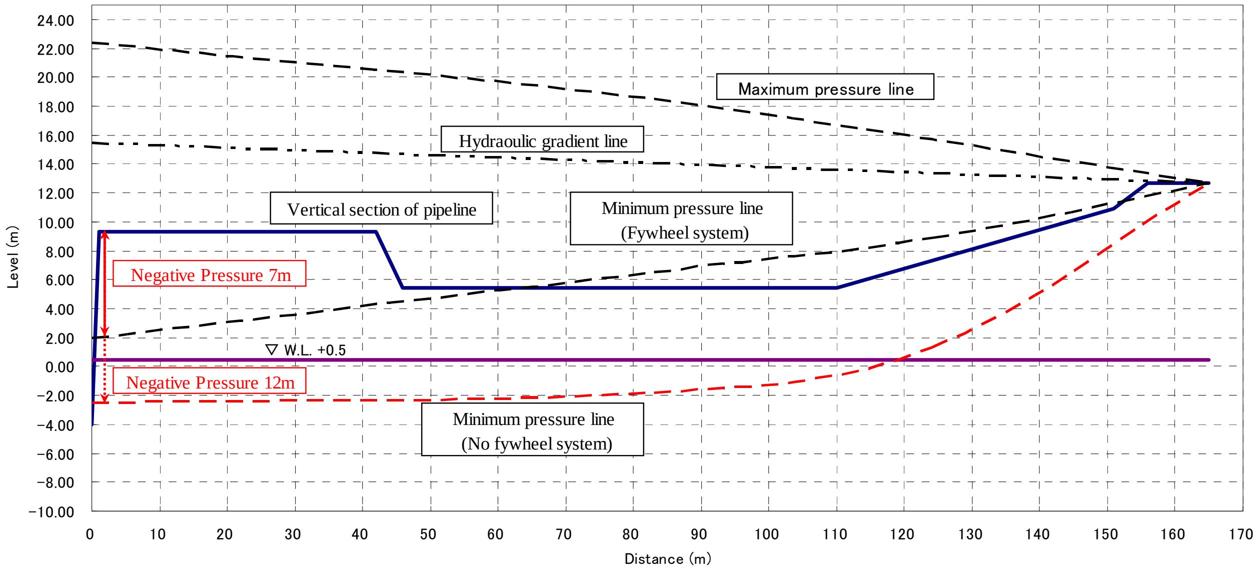


Figure 3.5.19 Results of Water Hammer Analysis of Water Iintake Pipeline

② Water conveyance pipeline

The maximum value of negative pressure in water conveyance pipeline is 5m or less which is 6m or less. Hence, countermeasure against water hammer is not required in this case.

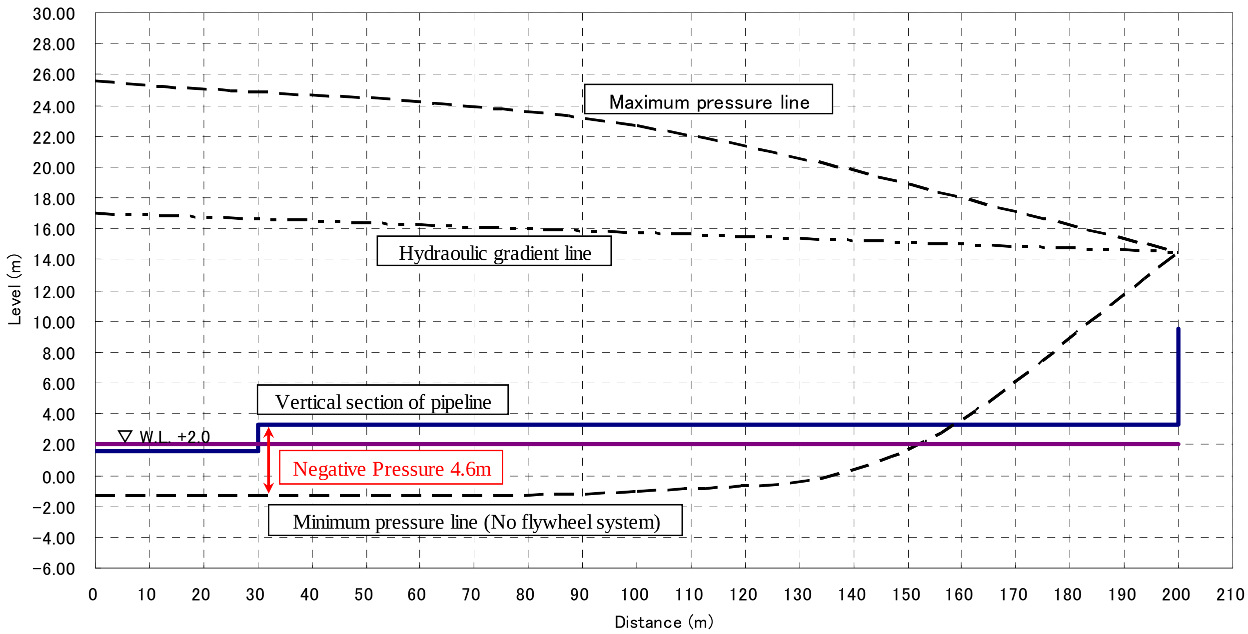


Figure 3.5.20 Results of Water Hammer Analysis of Water Conveyance Pipeline

③ Water transmission pipeline for northern area

The maximum value of negative pressure in the water transmission pipeline is 14m at the location of about 9,500m of pipeline and it is over 6m as control target.

In this case, installation of flywheel as countermeasure against water hammer is proposed, since the installation of flywheel will prevent occurrence of negative pressure in pipelines.

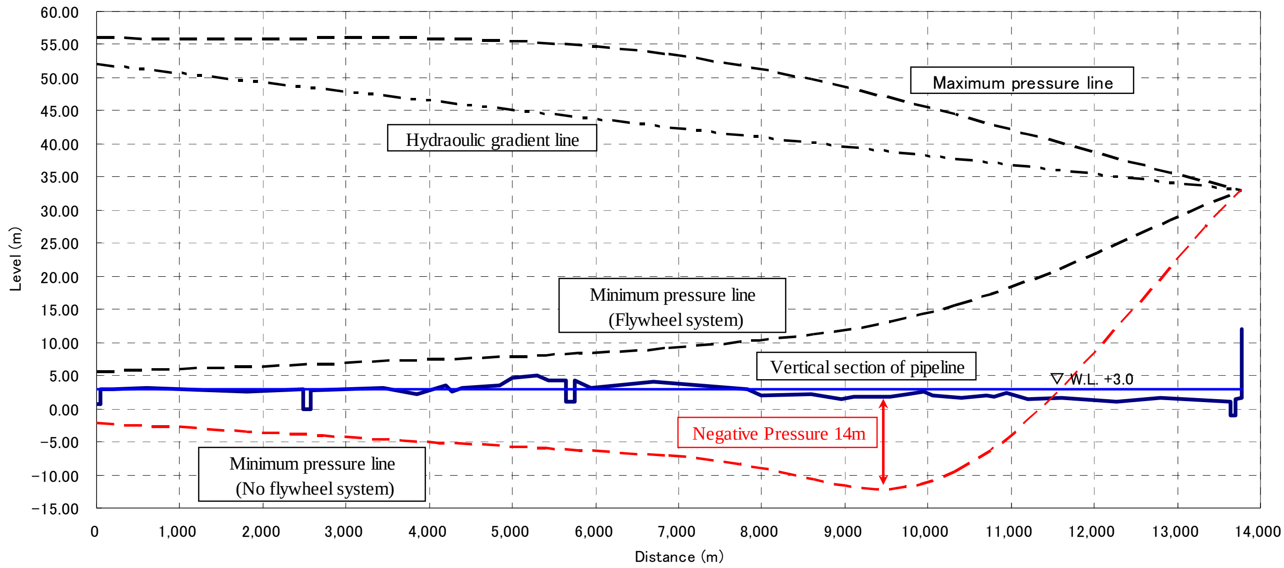


Figure 3.5.21 Results of Water Hammer Analysis of Water Transmission Pipeline (North)

④ Water transmission pipeline for southern area

It was implemented of water hammer analysis about each Route-1 and Route-2 of the water transmission pipeline for southern area, since the pipeline branches off at the location of about 7300m (on the No.5 National road) as it has been shown in Figure 3.5.22.

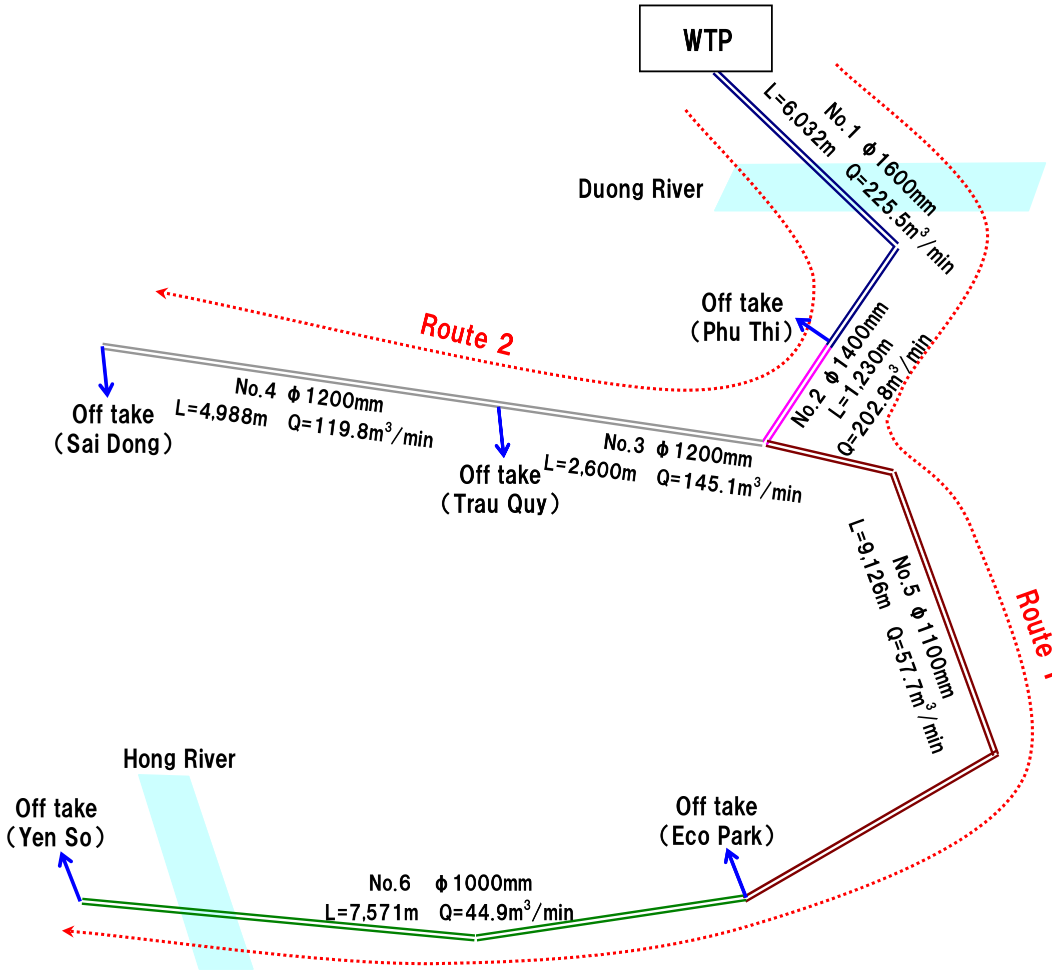


Figure 3.5.22 Schematic Layout of Water Transmission Pipeline (South)

- Route-1

  The maximum value of negative pressure in Route-1 is expected to be 23m or greater at the location of about 17,000m along pipeline and the occurrence of water hammer cannot be prevented by using the flywheel only. Therefore, in this case, use of surge tank is considered as the countermeasure.

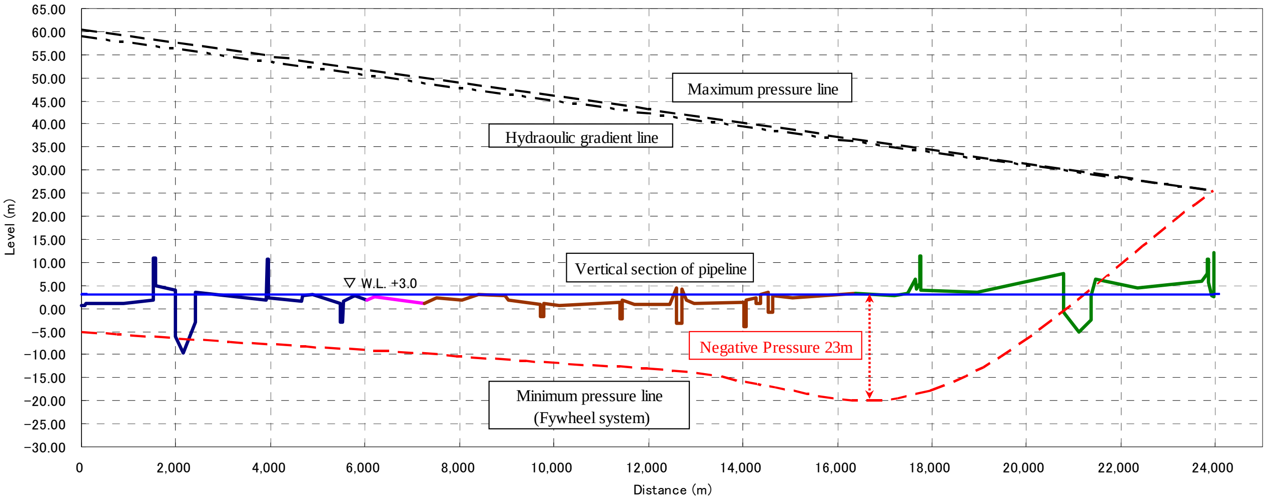


Figure 3.5.23 Results of Water Hammer Analysis of Water Transmission Pipeline South (Route-1)

- Route-2

  The maximum value of negative pressure along Route-2 is expected to be 23m at the location of about 10,100m of pipeline and the use of flywheel only cannot prevent the occurrence of water hammer. Therefore, similar to the case of Route-1, use of surge tank is considered.

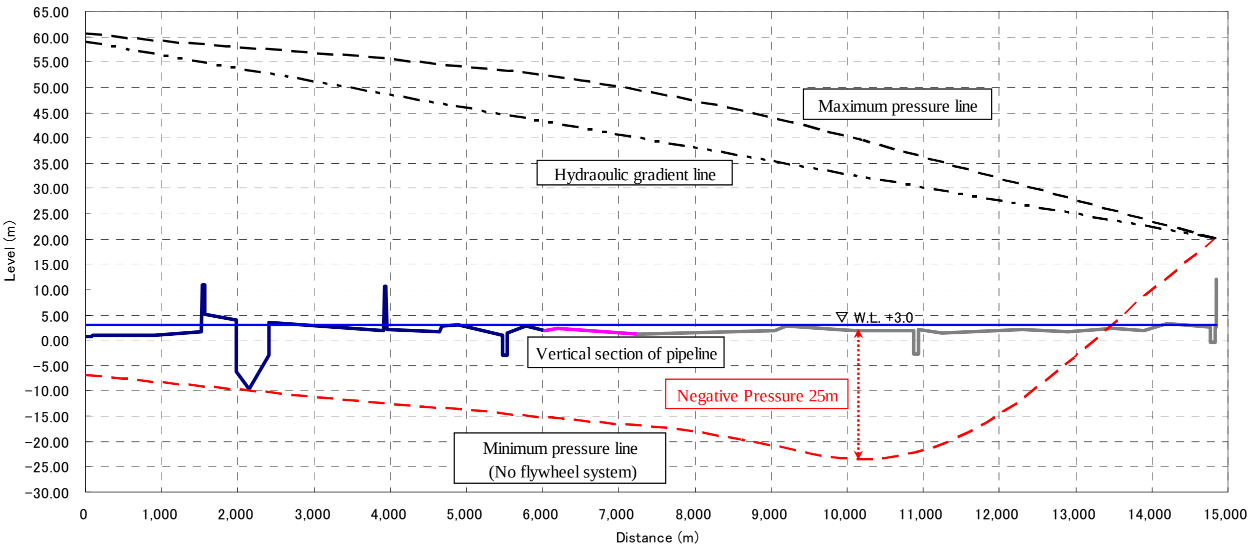


Figure 3.5.24 Results of Water Hammer Analysis of Water Transmission Pipeline South (Route-2)

- Review of surge tank dimension

  The type of surge tank is the one-way surge tank as described earlier.

Also, it is expected that if surge tank is installed as the water hammer protection at location immediately following pump, the capacity and height will be excessively large.

On the other hand, in case when the capacity of surge tank is made small through selection of installation position close to the off take point, it can also make height low. However, it is necessary to take into consideration the water hammer of the section from the pump to the surge tank since the distance from the pumping station becomes long.

Considering the above facters, the installation position of the surge tank is set as near 6,000m, which is before the bifurcation of the Route-1 and Route-2 (near Phu Thi off take point). In this case, from the results of calculation, the capacity of one-way surge tank is 333m3, and diameter of tank is about φ7.3m and effective water depth is 8m.

The analysis result of surge tank installation is shown in Figure 3.5.25 and Figure 3.5.26.

Based on the analysis, the maximum value of negative pressure exceeds control target value, in case of Route-1 and Route-2 when flywheel is not used. However, the maximum value of negative pressure is expected to be about 6m when a combination of one-way surge tank and flywheel will be installed.

Therefore, it is implemented of countermeasure against water hammer using of a combination of one-way surge tank and flywheel.

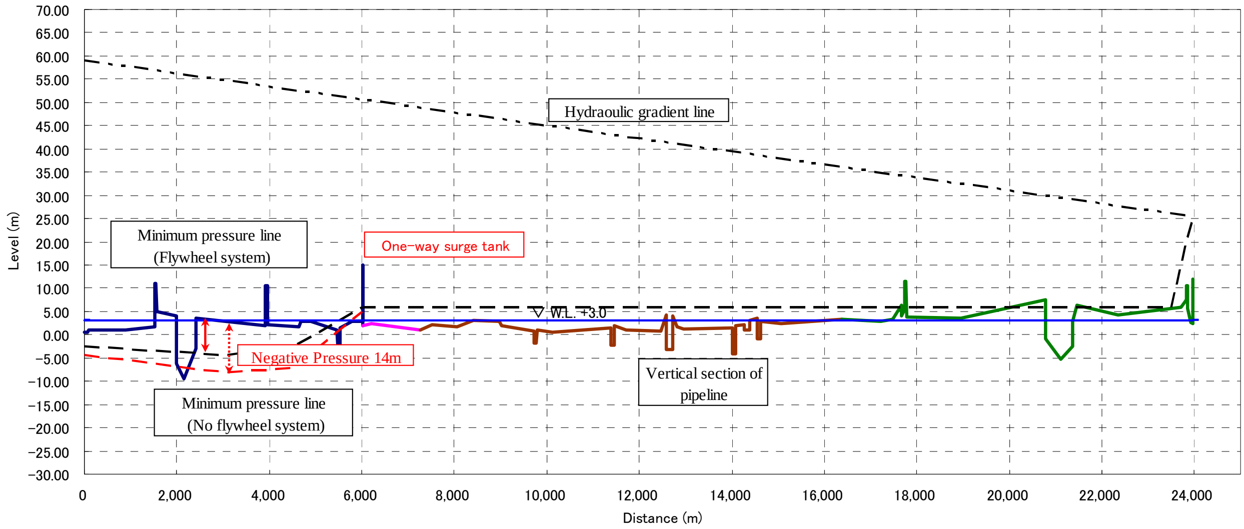


Figure 3.5.25 Results of Water Hammer Analysis of Water Transmission Pipeline South (Route-1, installation of one-way surge tank)

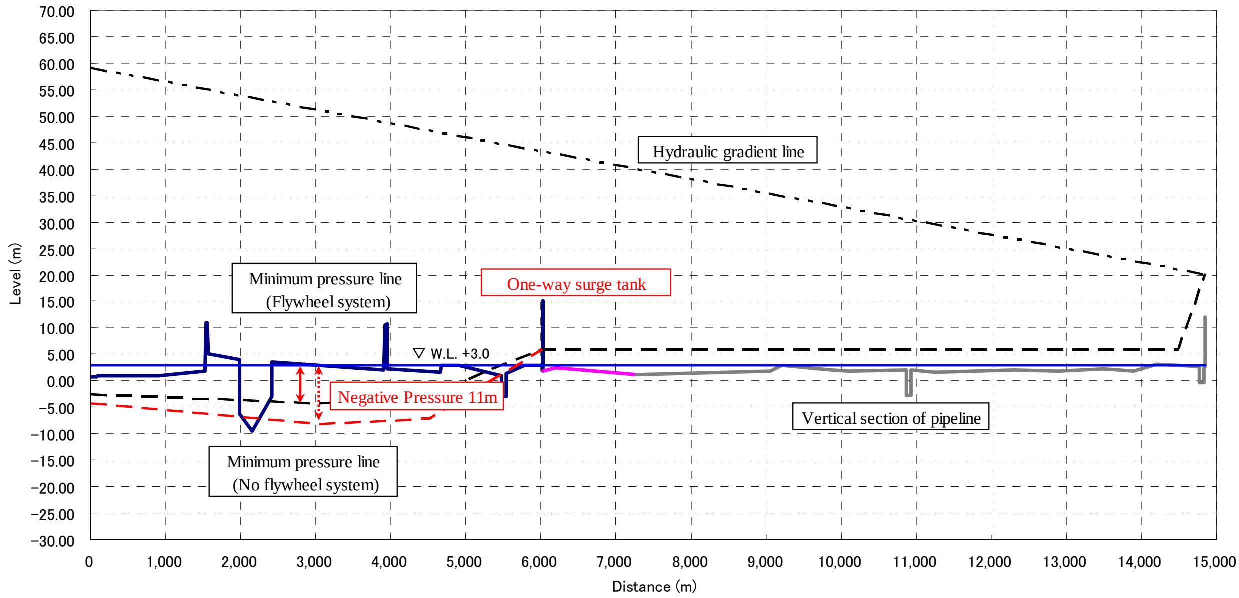


Figure 3.5.26 Results of Water Hammer Analysis of Water Transmission Pipeline South (Route-2, installation of one-way surge tank)

3.5.5 Distribution Network Development Plan (Outside the Scope of the Project)

Since this proposed project aims at water supply, the scope of SPC's business ranges from development of water intake facility to transmission pipeline. However, in the water supply areas of this proposed project, there are many “undeveloped areas” where no distribution network is present, except in some areas. Since water supply is impossible in such areas only with transmission pipeline development by SPC, delay in distribution network development will seriously affect the business management of this proposed project.

As described in “3.2 Demand Forecast of the Project,” for the “undeveloped area” as described above, development of distribution network is scheduled under “Gia Lam Prefecture Pipe Network Development Plan” formulated by Ha Noi City People's Committee and HAWACO, and is to be completed by 2015, which is the commencement year of this proposed project. However, some areas are excluded from the scope of Gia Lam Prefecture Pipe Network Development Plan, so the distribution network development plan includes such areas.

In view of such circumstances, JICA Study Team considers the review of the distribution network development plan reflecting the existing pipe network development plan.

(1) Conditions of Pipe Networks in Target Water Supply Areas

For preparing a distribution network development plan, conditions of constructed pipe networks should be grasped.

The pipeline networks already constructed within the target water supply areas of this proposed project are the distribution network covering the central area of Ha Noi City and Gia Lam Water Treatment Plant's pipeline network, both HAWACO.

Figure 3.5.27 shows the existing pipe network in the project area.

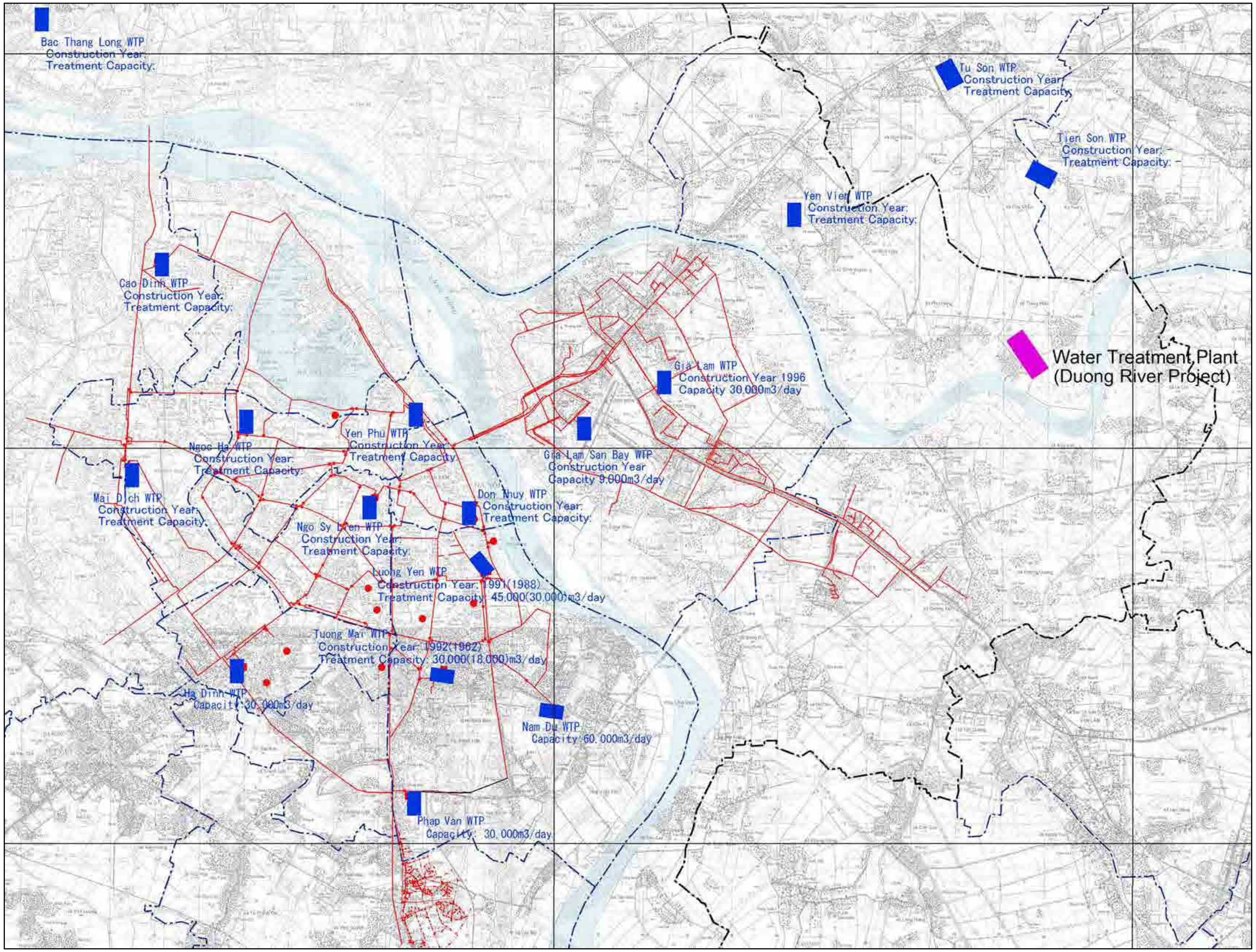


Figure 3.5.27 Existing Pipe Networks

(2) Pipeline Categories

In considering the distribution network development plan, pipelines are classified as shown in Table 3.5.36 in terms of their roles and functions.

Table 3.5.36 Categories and Roles of Pipelines

Pipeline category	Development category	Development policy (roles / functions)
Primary pipeline	Existing pipeline	Distribution trunk lines laid in each distributing area directly connected to each off take point, which is distribution station, with distribution network. Equivalent to or more than φ400mm.
	New development	Develop distribution trunk lines as primary pipeline along national highways and other roads (6m or more in width) that allow both-way traffic.
Secondary pipeline	Existing pipeline	Distribution network arranged so that pipe network can be formed in each distributing area using primary pipeline. As a subsidiary route, a route looping around secondary pipeline or main supply pipeline throughout water supply district are included.
	New development	Develop so that pipe network can be formed in each distributing area using primary pipeline. As a subsidiary route, develop a route looping around secondary pipeline or main supply pipeline throughout water supply district.
Tertiary pipeline	Existing pipeline	Tertiary pipeline is distribution network that is used to supply water to important facilities and constitutes pipe network connecting primary and secondary pipelines.
	New development	Develop supply lines to large-lot users as tertiary pipeline, considering large-lot users as important facilities.
Other	Existing pipeline	Distribution network not included in the above.
	New development	Position, as other pipeline, drawing pipe to each house from pipelines other than the above or secondary / tertiary pipeline.

(3) Determination of Pipeline Category

The following describes the method of determining actual pipeline based on the pipeline categories set forth in the preceding paragraph (extraction for existing pipe networks)

1) Primary pipeline

Primary pipelines are set to the distribution trunk lines in each distributing area directly connected to each off take point, and pipelines with φ400mm or more, or other pipelines holding equivalent flow rate are provided.

Such pipelines are provided in principle under national highways and other roads 6m or more in width that allow both-way traffic.

2) Secondary pipeline

Secondary pipelines constitute a distribution network that supplies water to main areas in each distributing area based on primary pipelines so that pipe network can be formed in each distributing area, and loop around primary pipelines.

In addition, secondary pipelines, as a subsidiary route, serve as a route looping around pipelines as mentioned above or main supply pipeline throughout water supply district.

Secondary pipelines are provided in principle under roads where passage of vehicles is possible.

3) Tertiary pipeline

Tertiary pipelines are set to the routes that allow the effective supply to important facilities.

As important facilities, housing estates and industrial parks, which are expected to be a large-lot user of this proposed project, are determined. To be specific, if at least two important facilities are located distant from the primary or secondary pipeline, a tertiary pipeline running near such facilities is planned.

Tertiary pipeline routes are provided in principle under roads where passage of vehicles is possible, same as in case of secondary pipelines.

4) Other pipelines

Other pipelines (φ75mm or more) than primary to tertiary pipelines above are also provided.

(4) Planning Area and Examination Method

1) Planning area

In order to enhance the certainty of the project, this survey also studies the distribution network development plan, which is outside the scope of this proposed project as mentioned above. This examination covers primary to tertiary pipelines as planning area, and includes selection of development routes for each off take point, determination of reasonable diameters to ensure water pressure, and estimation of project cost.

However, for “4) Other pipelines” above, they are excluded from various examinations on route location, pipe network analysis, etc., but only project cost is estimated by setting the development amount per unit area within the scope of development, considering that they are indispensable for water distribution.

Off take points to be covered by this examination are as specified in Table 3.5.37.

Table 3.5.37 Water Supply Districts Covered by Distribution Network Development Plan

Off take point		Subject of examination	
[1]	Lim (Bac Ninh Province)	Bac Ninh Province Water Works conducts development and operation.	—
[2]	Phu Thi (Ha Noi City)	A new development plan needs to be drawn up because distribution network of the area is not developed.	○
[3]	Trau Quy (Ha Noi City)	The distribution network development plan for the entire area is necessary including the existing pipeline network of the Gia Lam Water Treatment Plant.	○
[4]	Sai Dong (Ha Noi City)	The distribution network development plan for the entire area is necessary including the existing pipeline network of the Gia Lam Water Treatment Plant.	○
[5]	Eco Park (Hung Yen Province)	Implement development / operation in the Eco Park Housing Estate.	—
[6]	Yen So (Ha Noi City)	No examination of distribution network is made because of supplementary water supply to the city center. (Only terms of delivery are organized)	—

2) Examination conditions

① Setting of distribution amount

- Planned maximum distribution amount per day: Water amount set in "3.2 Demand Forecast of the Project" as indicated in Table 3.5.39.
- Planned maximum distribution amount per hour: Planned maximum distribution amount per day / 24 hours x Time factor *
  Set values are indicated in Table 3.5.38.

* Time factor is set as follows based on the waterworks facility standards (TCVN33:2006) for each off take point.

[Method of calculating maximum time factor (K_{max})]

$K_{max} = \alpha_{max} \times \beta_{max}$

α_{max} ＝ 1.2 (up to 1.5)

β_{max} = subject to the following table

Table 3.5.38 βmax Set According to Population Supplied

Served Population (1,000 people)	0.1	0.15	0.2	0.23	0.5	0.75	1.0	2.0
β_{max}	4.5	4.0	3.5	3.0	2.5	2.2	2.0	1.8
Served Population (1,000people)	4.0	6.0	10	20	50	100	300	≧1,000
β_{max}	1.6	1.4	1.3	1.2	1.15	1.1	1.05	1.0

（Source：TCVN33：2006）

② Minimum diameter of target pipe network

Minimum diameter of the target pipe network will be at least φ100mm in view of consistency with existing plans etc.

③ Conditions for distribution

According to the waterworks facility standards (TCVN33:2006), the minimum water pressure in transmission pipelines is stipulated to be 10m or more. However, in the case of direct distribution without installing off take tank or distribution pump, the off take pressure at each off take point must be determined considering pressure loss in distribution network.

For the effective water pressure at off take points, since the request that the effective water pressure of 20m is necessary at each off take point was found in the hearing of requests from HAWACO, which will control distribution networks, the starting point hydrodynamic pressure in the distribution network development plan is set to 20m.

However, in a distribution network analysis result, not less than 20 m of the effective water pressure in each actual off take point is ending with secured from having set up starting point hydrodynamic pressure as at least 20 m. Therefore, dynamic water pressure of each off take point obtained by a transmission pipeline hydrologic accounting result is used for calculative starting point hydrodynamic pressure.

④ Development target

According to the aforementioned waterworks facility standards (TCVN33:2006), 10m is required as effective water pressure, but considering the loss in the downstream of secondary pipelines, at least 15m in principle in secondary pipelines (and tertiary pipelines) is considered.

⑤ Examination case

Examination will be made about the water amount in cases of the Phase 1 (2015) and Phase 2 (2020).

Table 3.5.39 Water Amount Setting at Each Off Take Point

No.	Off Take Point	Distribution Area	Served Population (1,000people)		Hourly Factor		Maximam Daily Supply (m3/day)		Maximam Hourly Supply		Remarks
			2015	2020	2015	2020	2015	2020	2015	2020	
2	Phu Thi	Total	62.3	76.5	1.38	1.38	13,991	23,665	19,307	32,657	
		Dang Xa	11.2	16.3	1.38	1.38	2,263	4,189	3,123	5,781	
		Duong Quang	12.4	14.6	1.38	1.38	2,493	3,617	3,440	4,991	
		Kim Son	16.6	19.4	1.38	1.38	4,784	9,395	6,602	12,965	
		Le Chi	13.7	16.2	1.38	1.38	2,756	4,000	3,803	5,520	
		Phu Thi	8.4	10.0	1.38	1.38	1,695	2,464	2,339	3,400	
3	Taru Quy	Total	78.4	92.8	1.38	1.38	20,033	26,846	27,645	37,046	
		Trau Quy	27.1	32.1	1.38	1.38	7,727	10,506	10,663	14,498	
		Co Bi	10.5	12.5	1.38	1.38	2,759	3,080	3,807	4,250	
		Da Ton	13.2	15.6	1.38	1.38	2,652	3,847	3,660	5,309	
		Dong Du	5.0	5.9	1.38	1.38	1,008	1,464	1,391	2,020	
		Duong Xa	11.3	13.4	1.38	1.38	2,278	3,309	3,144	4,566	
		Kieu Ky	11.3	13.4	1.38	1.38	3,609	4,640	4,980	6,403	
4	Sai Dong	Total	257.5	333.3	1.32	1.26	79,940	136,389	105,521	171,850	
		Long Bien	257.5	333.3	1.32	1.26	79,940	121,389	105,521	152,950	
		Center of Ha Noi city	-	-	-	1.26	-	15,000	-	18,900	
	Total		398.2	502.7	-	-	113,964	186,900	152,473	241,553	

(5) Assumption of Pipe Network Arrangement and Pipeline Diameter

As mentioned, distribution trunk lines are assumed to have the pipe diameter of φ400mm or more, and aligned along national highways and other roads 6m or more in width that allow for both-way traffic as trunk line which is advantageous in transport and distribution of water in set distribution amount. From these trunk lines, distribution main pipes that share individual distribution blocks (areas in a certain size divided with roads where vehicles can travel) are branched so as to constitute the distribution main network.

1) Not laid under the road where any existing distribution main pipe is laid.

2) Not laid under the road where transmission pipeline is to be developed.

3) Effectively use existing distribution main pipes and avoid diameter increase as much as possible.

4) To prepare for emergency situation in distributing area, such as pipeline accident, a communication pipe should be laid at one location or more between adjacent distributing areas so as to enable mutual supply between adjacent distributing areas.

5) Distribution network fixes to be loop line as much as possible. About a loop pipe, development with connection piping and the diameter of order is performed in consideration of the correspondence in case of an accident etc.

(6) Pipe Network Analysis

In the distribution network development plan, the following is examined as to the construction / replacement of distribution network pipes necessary for ensuring proper water pressure and project implementation.

In addition, the model chart used as the base of pipe network analysis is as shown in Figure 3.5.28.

1) Node data

- Ground height at node (to be determined from the information of 1/5,000 topographic map)
- Water amount at node (node distribution/aggregation model)

2) Pipeline data
   - Target pipelines and minimum diameter (minimum diameter: φ100mm or more)
   - Pipeline extension (measured in meter using 1/5,000 topographic map)

3) Pipe network calculation
   - Node energy method
   - Flow formula: Hazen-Williams formula
   - Coefficient of velocity C= 110

4) Examination of whether development target has enough water
   - If any development target does not get sufficient water, assumed pipe diameter is reviewed and pipe network is re-calculated.
   - If any development target does not get sufficient only development pipe works, starting point hydrodynamic pressure is boosted.

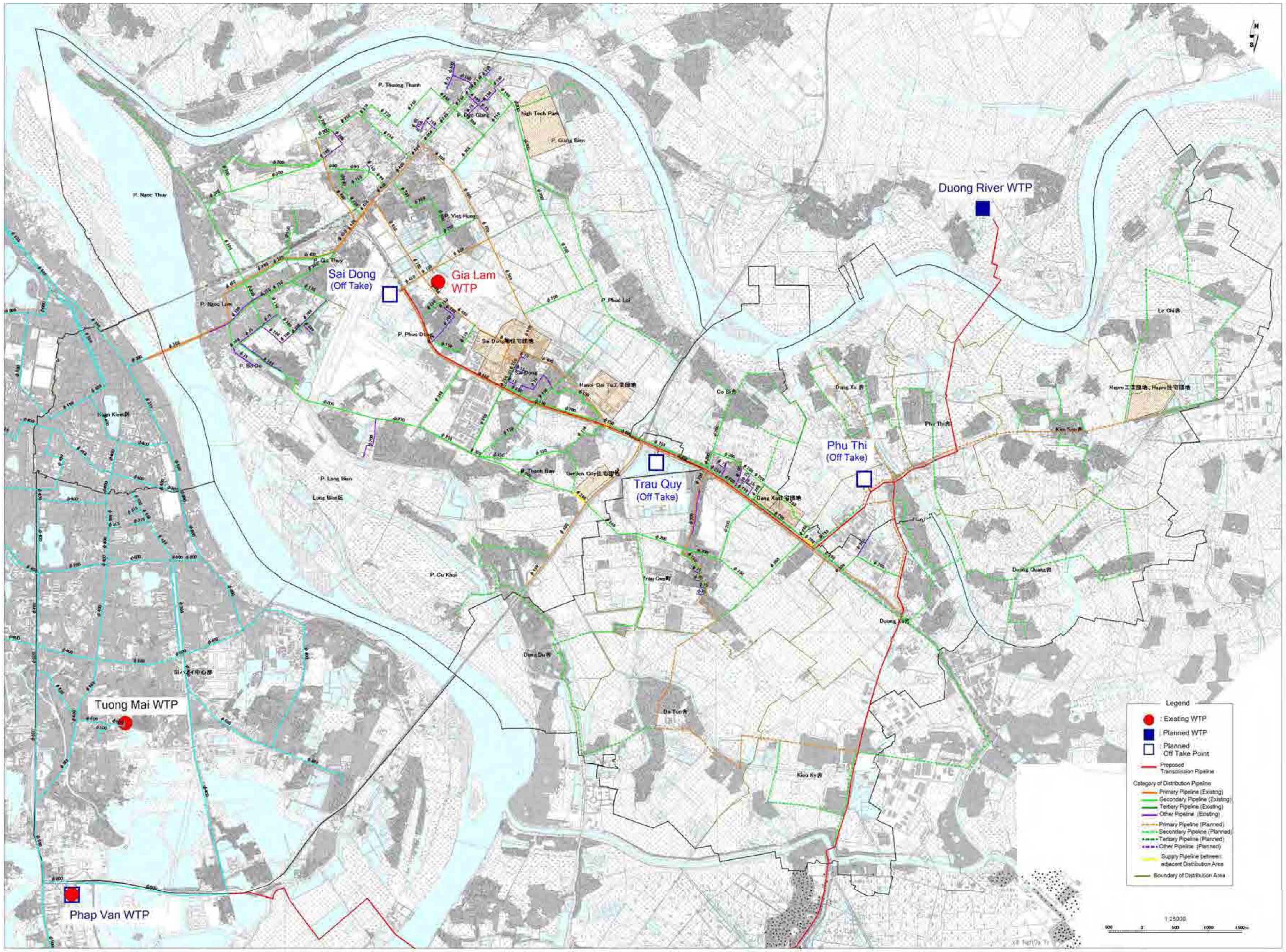


Figure 3.5.28 Base of Pipe Network Analysis

(7) Determination of Pipeline Diameter and Development Plan

About starting point hydrodynamic water level of distribution network analysis, two cases of the method (case of direct connection water supply) of setting up hydrodynamic water level obtained from transmission pipe hydrologic accounting result, and the method (water reservoir + distributing pump maintenance case) of setting up required hydrodynamic water level suitably in each off take point were calculated.

In addition, about a diameter setup of a new installing pipe and a laying substitute pipe, it is based on the following plans.

- The flow velocity of a pipeline is set up to become 0.8 - 1.2 m/sec.
- A hydraulic gradient is set up to become 3 - 5 ‰.
- About a constructed pipe, when the flow velocity exceeds 2.0 m/s in addition to the maintenance for water pressure reservation, a laying substitute is considered.

From an analysis result, the contents as following are needed about distribution network development in Gia Lam prefecture.

1) Phase 1 (2015)

A distribution network analysis result is shown in Figure 3.5.29 - Figure 3.5.31.
The distribution network development length which is needed in Phase 1 is the whole, and is a new installing pipe about 86 km and laying substitute pipeline about 5.8 km. A pipeline diameter is φ100 - φ1200 mm.

About Phase 1, since transmission pump of WTP is targeting amount of water of Phase 2, a margin is in pump head. Reservation of required water pressure is possible for starting point hydrodynamic pressure in each off take point at the distribution network end, without boosting from being secured not less than 45 m.

However, about the partial area at the westernmost end of the Sai Dong distributing area, intensified pressure is partially needed from it being less than the effective water pressure of 15 m, even if it performs pipeline development from the relation of foundation quantity.

As mentioned above, in Phase 1, distributing by the direct connection from transmission pipeline is possible enough, and installation of water reservoir and a distributing pump is fundamentally unnecessary. In detail design, more precise review is necessary.

2) Phase 2 (2020)

A distribution network analysis result is shown in Figure 3.5.32 - Figure 3.5.34.

The distribution network development length which is needed in Phase 2 is laying substitute pipeline about 11.4 km. A pipeline diameter is φ200 - φ900 mm.

In order that there may be no margin in the transmission pump head of WTP about Phase 2 unlike Phase 1, about Sai Dong distributing area which is distributing area of an end, it will be less than the effective water pressure of 15 m in most areas.

Therefore, it is needed additional water pressure (water reservoir + distribution pump) about Sai Dong distribution area

Although an effective pressure is less than 15m in part of Phu Thi and Trau Quy distribution area, which area is at the end of distribution network. Since additional water pressure is needed only an area less than 15m not for whole area.

3) Development summary of distribution network

It is shown development summary of distribution network in Phase 1 and Phase 2 in Table 3.5.40.

Development length is about 85.7km and it needs 25.9million USD for development cost at Phase1. And the replacement length is about 6.6km and it needs 6.2million USD as the replacement cost.

On the other hand, it does not have new development at Phase 2, replacement length is about 11.4km and it needs 10.4million USD as the replacement cost.

Distribution network will have to be developed systematically on the sidelines of operation start of WTP, in order to covering planned water demands.

Also, this result is at the time of this survey. Therefore, it is considered quantity of development distribution pipeline is less than this result, since the distribution network is developed by HAWACO now.

Table 3.5.40 Construction Length and Cost of Distribution Network

	Diameter (mm)	Length (m)			Construction cost (USD)		
		Phase 1		Phase 2	Phase 1		Phase 2
		Construction	Replacement	Replacement	Construction	Replacement	Replacement
Phu Thi	φ150	14,910.0			2,935,471.0		
Water Supply Area	φ200	17,512.9			3,892,952.7		
	φ250	7,422.5			2,046,014.7		
	φ300	2,337.8			784,841.4		
	φ400	6,296.6	1,108.8		3,758,675.4	860,453.4	
	φ450	1,170.6			827,940.3		
	φ500	648.8			526,461.7		
	φ600	2,504.3			2,585,056.9		
	φ800	74.3			116,653.9		
	Subtotal	52,877.7	1,108.8	-	17,474,067.9	860,453.4	-
	Diameter (mm)	Phase 1		Phase 2	Phase 1		Phase 2
		Construction	Replacement	Replacement	Construction	Replacement	Replacement
Trau Quy	φ100	900.2			146,275.1		
Water Supply Area	φ150	8,270.8			1,628,363.3		
	φ200	9,430.2			2,096,246.0		
	φ250	2,398.6			661,166.7		
	φ300	165.8			55,651.1		
	φ500			1,068.1			1,126,724.8
	φ700	63.4			82,012.8		
	Subtotal	21,229.0	-	1,068.1	4,669,715.1	-	1,126,724.8
	Diameter (mm)	Phase 1		Phase 2	Phase 1		Phase 2
		Construction	Replacement	Replacement	Construction	Replacement	Replacement
Sai Dong	φ100		497.3			105,073.4	
Water Supply Area	φ150	3,572.1	524.7		703,266.5	134,279.3	
	φ200	3,921.9	1,343.4	744.0	871,807.4	388,254.5	215,014.4
	φ250	639.6	687.7		176,300.2	246,386.6	
	φ300	1,217.7			408,800.4		
	φ350			981.5			547,109.9
	φ400	2,148.6	670.5	4,205.6	1,282,603.3	520,274.7	3,263,523.7
	φ500		429.8	4,021.0		453,365.4	4,241,791.3
	φ800		966.2			1,972,899.4	
	φ900			379.5			1,010,007.6
	φ1100		380.9			1,520,149.5	
	φ1400	57.8			273,025.5		
	Subtotal	11,557.7	5,500.4	10,331.7	3,715,803.4	5,340,682.8	9,277,446.9
Total		85,664.4	6,609.2	11,399.8	25,859,586.4	6,201,136.2	10,404,171.7

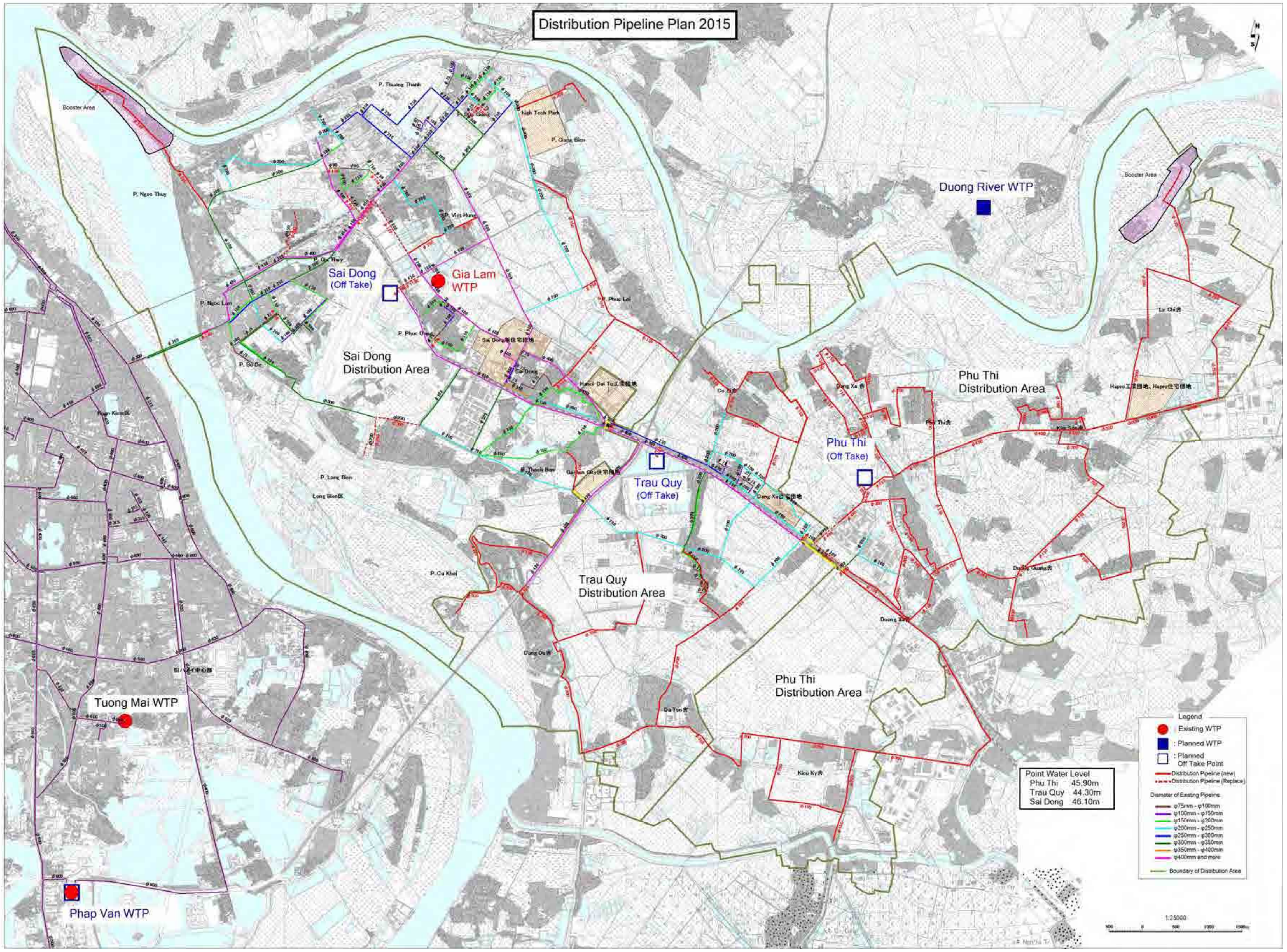


Figure 3.5.29 Development Plan of Distribution Network at Phase1

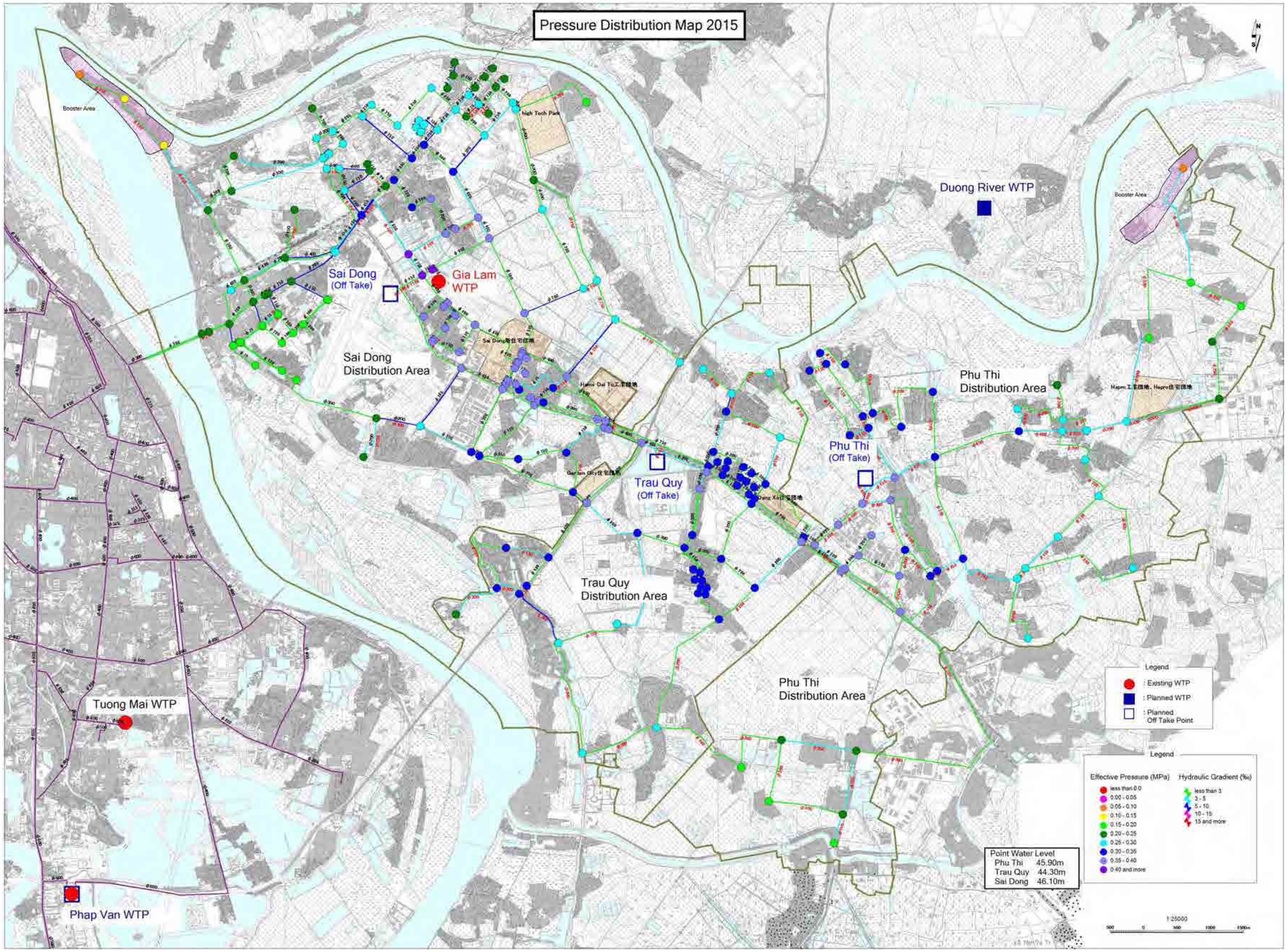


Figure 3.5.30 Water Pressure - Hydroulic Gradient Distribution Map at Phase1

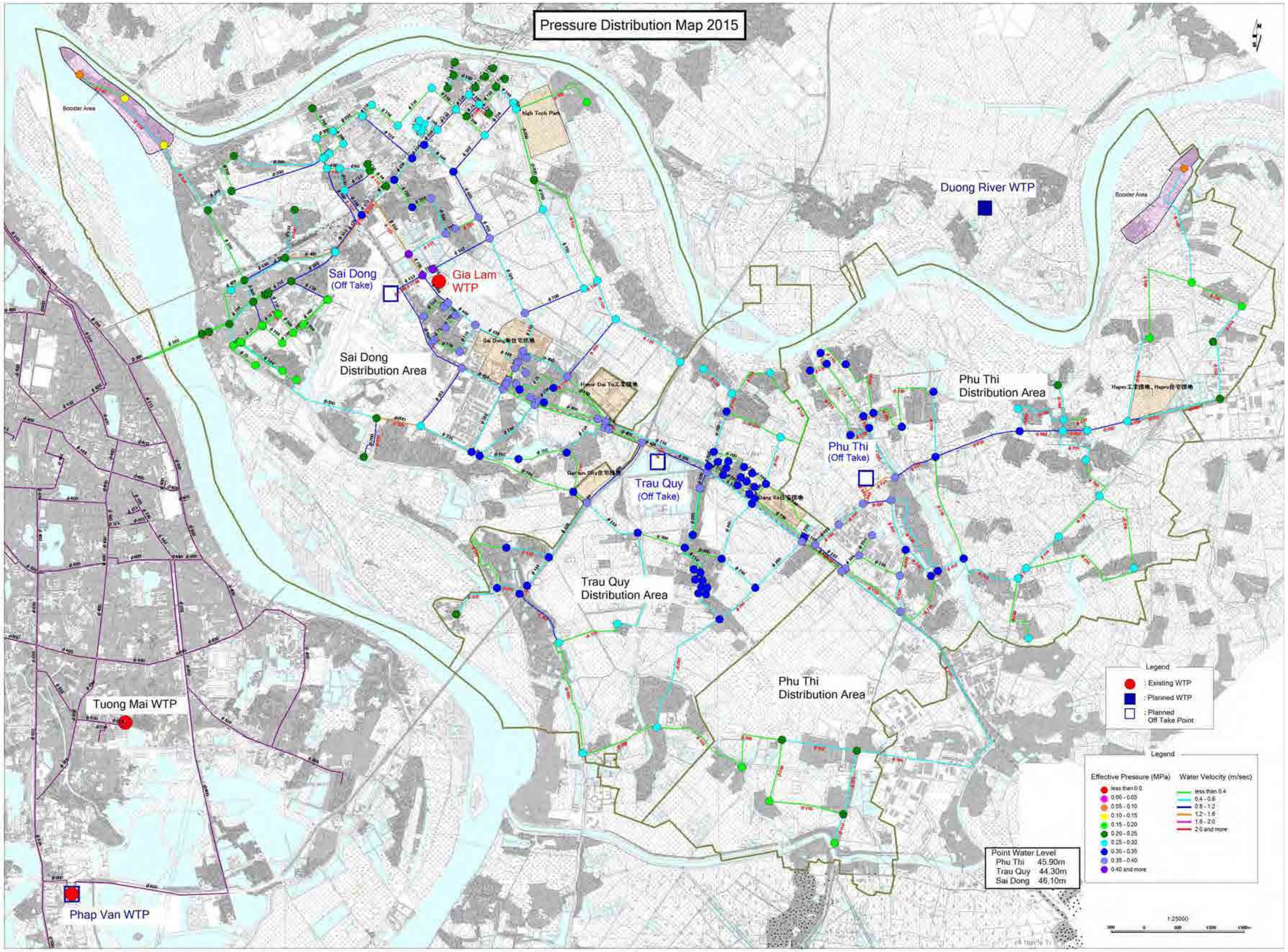


Figure 3.5.31 Water pressure - Velocity of Flowing Fluid Distribution Map at

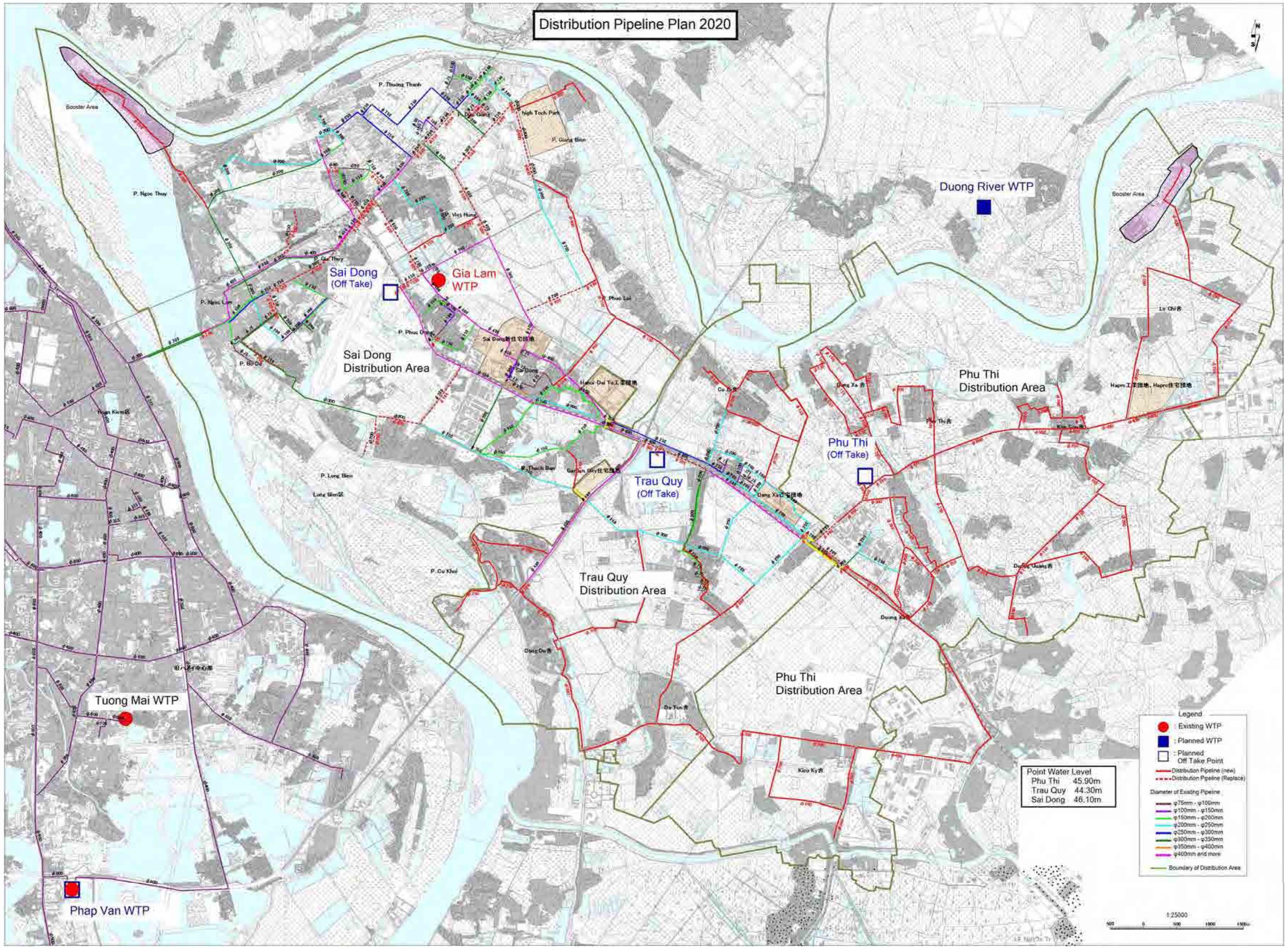


Figure 3.5.32 Development Plan of Distribution Network at Phase2

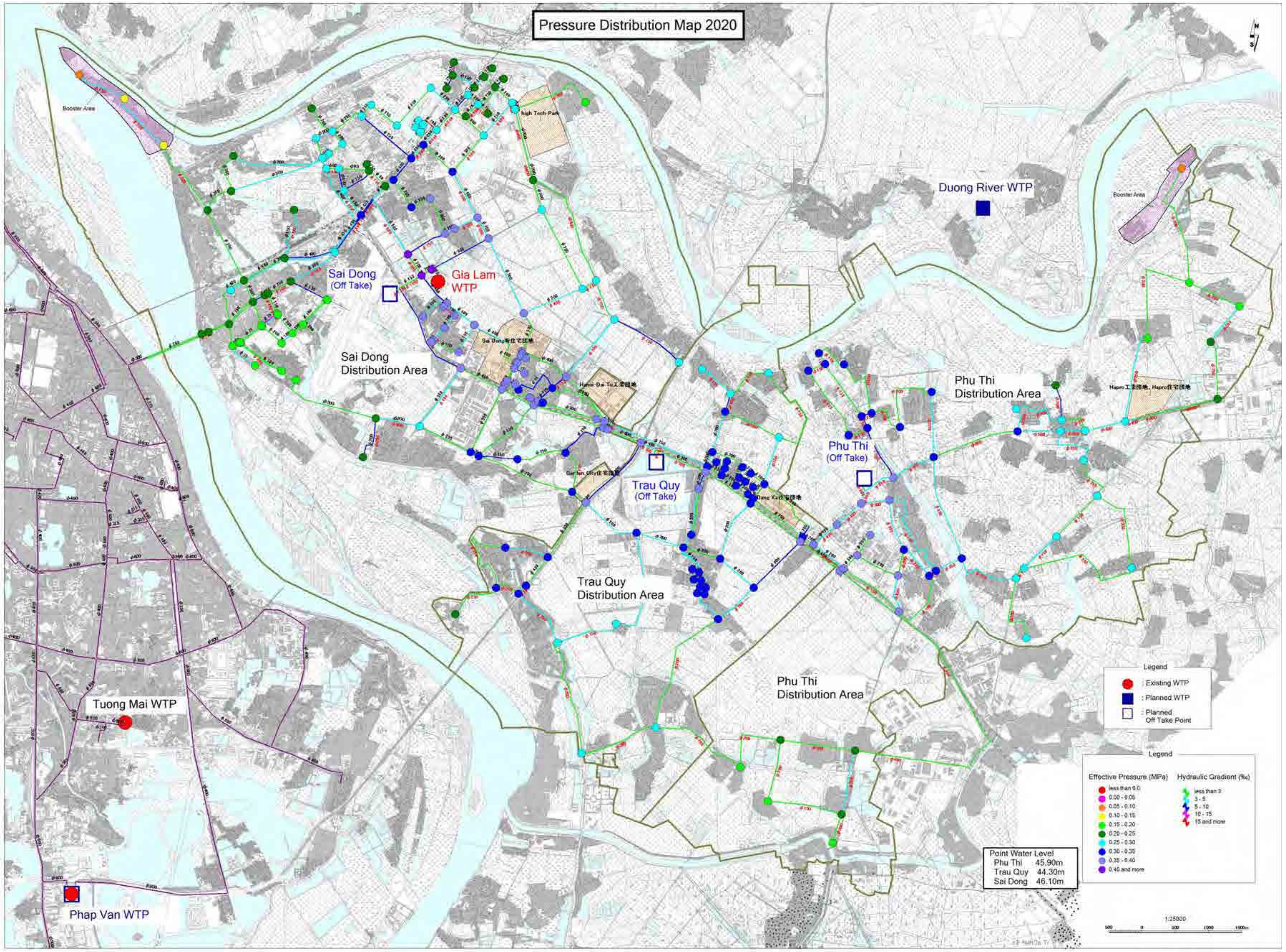


Figure 3.5.33 Water pressure - Hydroulic Gradient Distribution Map at Phase2

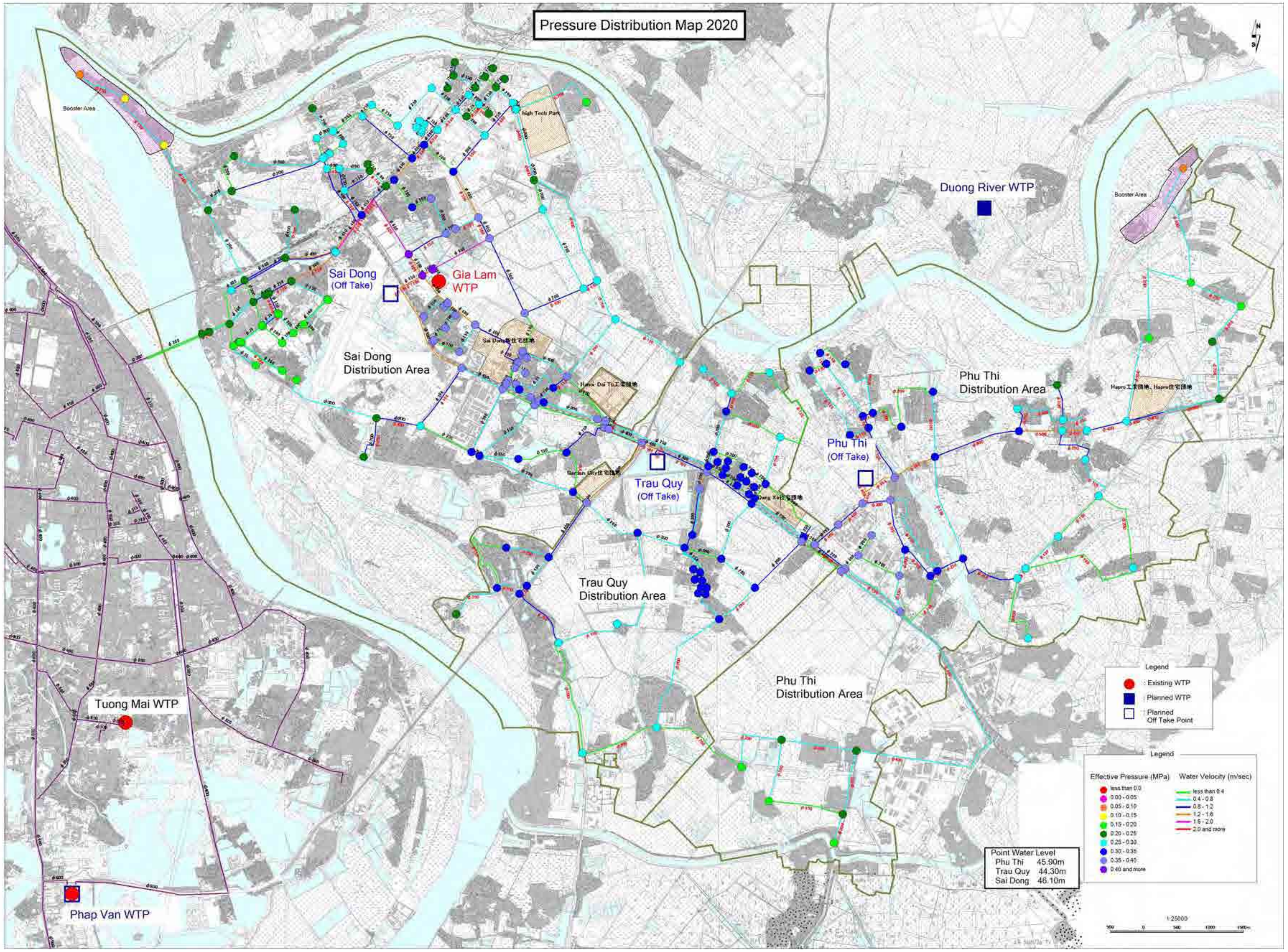


Figure 3.5.34 Water pressure – Velocity of Flowing Distribution Map at Phase2

3.5.6 Outline Design of Water Intake Facility / Water Treatment Plant

Tables 3.5.41 to 3.5.46 organize the results of outline design for water intake facility/water treatment plant based on the content of planning under "3.5.3 Facility Plans for Water Intake and Water Treatment Plants".

Table 3.5.41 Outline of Facilities (1/6)

Facilities, etc. being considered	Item	Basic matters	Outline of facilities	Construction work for Period 1	Remarks
Water intake facility	Water intake port	・ The intake port shall be positioned so that there will be no point of inflow of polluted water that becomes the source of pollution in the vicinity of the upstream side. ・ Although the water intake pumping station shall inherently be chosen from land outside of a weir, since permission from the weir administrator cannot be obtained with regard to the crossing of the area under the weir by using pipes or culverts, the station shall be installed in land outside of the weir, and water intake pipes shall be buried along the shape of the weir. Note that the installation of facilities in land outside of a weir is possible under the regulations of the country of Viet Nam. ・ Regarding the position of the water intake pumping station, it shall be installed so that the land for high water channel can be secured sufficiently and there will be no influence of a change in river shape resulting from river improvement or scouring in the future. Also, it shall be installed in an area of retention where there will be no direct flow during a flood. ・ As for the type of the pump, a submersible pump shall be used that is inexpensive and has a lot of track records in Southeast Asia. ・ With regard to water intake pumps, because there is the need to make adjustments in flow rate and in change of water level, energy-saving type inverter control shall be adopted. ・ Mechanically driven equipment and electrical equipment shall be installed at a level higher than the design high water level. ・ An oil fence for prevention of inflow of oils shall be installed in a water intake channel. ・ A screen (for removal of impurities by manpower) shall be installed upstream of the inflow port of the water intake pumping well. ・ A flashboard for preventing the inflow of sand and gravel shall be installed just before the inflow port of the water intake pumping well. ・ Sludge of earth and sand deposited in the water intake channel shall be dredged by means of a boat equipped with a sludge pump. ・ A reverse drainage pipe from the water intake pipe shall be installed. ・ The earth-and-sand yard for making the dredged up and drain automatically is installed.	[Design water intake level] ・ HWL＋11.50m (based on the actual highest water level recorded for the past 10 years: 11.42 m) ・ LWL＋ 0.50m (based on the actual lowest water level recorded for the past 10 years: 0.60 m) [Design conditions] ・ Speed of inflow: 0.8 m/S or less ・ Water depth in water intake channel: LWL-4.5 m (effective water depth: 3.5 m, sediment: 1.0 m） ・ Water depth in pumping well: LWL-4.0 m (3.2 D or more D: pump diameter) ・ Width of water intake port : 2 m (gate: manpower winching method) × 6gates [Facility parameters] 〔Water intake channel〕 Channel size: Width 19 m × Height 14.5 m (just before pumping well) Channel size: Bottom width 13 m × Top width 80 m× Height 14.5 m (water intake port area) 〔Water intake pumping well〕 Size: Width 9.0 m × Length 12.0 m × Height 16.1 m × 2 basins 〔Water intake pump〕 Type: Submersible pump Specifications: Diameter 700 × 56 m^3/minute × 15 m H × 200 kw Quantity: Phase 1 3 units (of which 1 unit is a spare) Phase 2 2 units Revolution control: VVVF control for all units Screen interval: at intervals of 3 - 5 cm Ancillary equipment: Flashboards in 6 places, gate 6 units, electricity room, piping room, return pipes (for trial run, for discharging sludge), sludge pumping boat, road bridge, earth-and-sand yard	All facilities 2 basins 3 units (of which 1 unit is a spare) 3 units All facilities All equipment	
	Water intake pipe	・ The velocity of flow shall be within the range of 1.5 - 2 m/s as water volume of Phase 2 as an economical diameter. ・ The type of a pipe shall be a steel pipe as an economical type of pipe. ・ A flow meter shall be installed in the water intake pumping station.	[Facility parameters] ・ Type of pipe: SP ・ Diameter: φ1600 mm ・ Number of pipes: 1 ・ Flow meter and flow meter chamber	All facilities	

	Settling basin (raw water storage reservoir)	・ The capacity of the settling basin shall be around the design amount of water to be treated for 10 hours or greater. ・ The basin shall be installed in the treatment plant and 1 basin shall be installed that is ready for use for the 2 phases in Phase 1. In future, 1 basin shall be added at the time of 600,000 m^3/day. ・ The construction of the settling basin shall be of the dug-down type because heightening the water level according to the conditions of drinking water treatment involves a high construction cost, and the basin shall have a construction such that water is shut off from its bottom plate and sides. ・ Since water cannot be transmitted to the dividing well in the water treatment plant by gravity flow, a water conveyance pump shall be installed. ・ No spare basin shall be installed. ・ As for the type of the pump, a submersible pump shall be used that is inexpensive and has a lot of track records in Southeast Asia. ・ Since the water conveyance pump needs adjustments in flow rate and in change of water level, energy-saving type inverter control shall be adopted. ・ A screen shall be installed upstream of the inflow port of the water conveyance pumping well, and a manual dust collector shall be installed. ・ A flashboard for preventing the inflow of sand and gravel shall be installed just before the inflow gate of the water intake pumping well. ・ The dust collector shall be of the net screen type, and 1 basin shall be provided with 1 unit. ・ Sludge shall be dredged with a sludge pumping boat ・ A reverse drainage pipe from the water conveyance pipe shall be installed.	[Design conditions] ・ Particle size being considered: 0.005 mm or more ・ Retention time: around for use for 10 hours or greater (in relation to the amount of water for the 2 phases) ・ Effective water depth: 3 m or more ・ Sediment height: 0.5 m or more [Facility parameters] 〔Settling basin〕 Size: Width 156 m × Length 190 m × Height 5.5 m × 1 basin (including sediment depth of 1.0 m) Capacity: 133,000 m^3 (excluding sediment depth of 1.0 m) 〔Water conveyance pump well〕 Size: Width 9.65 m × Length 12.0 m × Height 8.8 m × 2 basins 〔Water conveyance pump〕 Type: Submersible pump Specifications: Diameter 700 × 56 m^3/minute × 15m H × 200kw Quantity: Phase 1 3 units (of which 1 unit is a spare) Phase 2 2 units Revolution control: VVVF control for 1 unit Screen interval: at intervals of 2 - 2.5 cm Ancillary equipment: Flashboards in 6 places, gate 6 units, electricity room, piping room, return pipes (for trial run, for discharging sludge), sludge pumping boat	Portion corresponding to Phase 2 All facilities 3 units (of which 1 unit is a spare) 1 unit All facilities All equipment	

Table 3.5.42 Outline of Facilities (2/6)

Facilities, etc. being considered	Item	Basic matters	Outline of facilities	Construction work for Phase 1	Remarks
Water conveyance facility	Water conveyance pipe	・ The velocity of flow shall be within the range of 1.5 - 2 m/S as an economical diameter. ・ The type of a pipe shall be a steel pipe as an economical type of pipe. ・ A bypass pipe shall be laid that connects the water intake pipe and water conveyance pipe.	[Design parameters] ・ Type of pipe: SP ・ Diameter: φ1600 mm ・ Number of pipes: 1 ・ Flow meter and flow meter chamber	All facilities	
Water treatment facility	Dividing well	・ The dividing well shall be a facility common to Phase 1 and Phase 2. ・ The dividing well shall consist of 2 basins. ・ A bypass pipe shall be installed that connects the inflow pipe and outflow pipe. ・ Since the water level becomes about 10 m higher than the design GL, the well shall have a cylindrical construction such that it is advantageous in terms of construction and inexpensive.	Design conditions] ・ Retention time: 1 - 5 minutes [Design parameters] ・ Size: φ18.8 m × 4.0 m (circular 2-tank construction) (Retention time 1.8 minutes/basin: The capacity shall be increased in order to receive returned water) ・ Ancillary equipment: inflow bypass pipe, outflow bypass pipe, overflow pipe, drainage pipe, point of injection of hypochlorous acid, inflow and outflow bypass valve chamber	All facilities	
	Receiving well and rapid mixing tank	・ Pre-chlorine and PAC shall be injected in the receiving well. ・ The mixing and agitation of PAC shall be done by utilizing a weir drop in the overflow weir. ・ The latter stage shall be a submerged weir in order to do the mixing well after the weir drop. ・ Since the receiving well is not equipped with mechanical equipment, stoppage of the basin very seldom occurs, but because of its high turbidity, there is concern about deposit of turbid substances, and so the well shall consist of 2 basins by taking account of possible stoppage due to cleaning. ・ A flow meter shall be installed just before inflow of the receiving well. ・ The receiving well shall be provided with a baffle wall.	[Design conditions] ・ Retention time: 1 - 5 minutes or more ・ The height of the weir drop shall be 1.0 m or more. ・ The depth of water shall be 3.0 m or more. [Design parameters] ・ Size: Phase 1 : 4.0 m × 7.5m × 4.7 m × 2 basin Phase 2 : 4.0 m × 7.5m × 4.7 m × 2 basin ・ Ancillary equipment: overflow pipe, drainage pipe, PAC injection point, pre-chlorine injection point, flow meter chamber, weir equipment for agitation	For Phase 1	
	Flocculation basin	・ There shall be 6 series per phase. ・ 1 series shall consist of 4 basins. ・ In order to perform mixing well, 4 basins shall be diverted. ・ In order to perform agitation efficiently, a method shall be employed in which inflow to each basin is caused from the lower part, and after mechanical agitation, there occurs a side gate overflow. ・ As for the method of agitation, since there are great changes in the amount of change and in water quality, a vertical axis flocculator method shall be employed that makes the variable speed possible. ・ In the latter stage of the formation of flocculation, 2 stages of baffle walls shall be installed to make the flow to the sedimentation basin uniform. ・ Equipment for discharging deposited sludge shall be provided. ・ A roof shall be installed as preventive measures against density flow caused by a temperature rise, preventive measures against algae, and in order to protect facilities and equipment. ・ The situation of forming flocculation that becomes important in the drinking water treatment process shall be monitored by means of ITV and use it as a reference for setting the chemical dose rate.	[Design conditions] ・ Retention time: 20 minutes - 40 minutes ・ Depth of water: 3.5 m [Design parameters] ・ Size: Phase 1 7.0 m × 7.0 m × 3.2 m × 4 basins × 6 systems Phase 2 7.0 m × 7.0 m × 3.2 m × 4 basins × 6 systems ・ Ancillary equipment: flocculator 24 units, vertical axis up and down diverting weir 24 places, baffle wall 2 stages, sludge discharging equipment, inflow gate	For Phase 1	

	Chemical sedimentation basin	・ 6 series shall be installed per phase. ・ No spare basin shall be provided. ・ Considering possible provision of facilities of 600,000 m^3/day in future, the basin shall be a sedimentation basin with inclination pipes that enables the land to be utilized effectively. ・ Since the upstream half of the sedimentation basin is subjected to a great load from turbid substances, there is concern about damage, drop, etc. of the inclination pipe, and so the inclination pipe shall be installed in the downstream half only. ・ The sludge discharging equipment for the sedimentation basin shall be of the rotary center-collection method as a collection machine that is ready for use with high turbidity, involves few mechanical accidents and failures and enables operation to be maintained reliably. ・ From the sludge discharging hopper, sludge shall be transmitted to the sludge basin by gravity flow. ・ A roof shall be installed as preventive measures against density flow caused by a temperature rise, preventive measures against algae, and in order to protect facilities and equipment.	[Design conditions] ・ Surface area loading rate: Former stage (horizontal flow type) 15 - 30 mm/min. Latter stage (inclination pipe type) 7 - 14 mm/min. ・ Average velocity of flow: 0.4 m/min. (adoption of average velocity of flow of the horizontal flow type) ・ Retention time: 1 hour or more ・ Outflow trough overflow rate: 500 m^3/day▪m or less ・ Number of times of sludge discharge: 3 times on average in rainy season, 6 times at maximum [Design parameters] ・ Size: Phase 1 14.4 m × 30.3 m × 3.35 m × 6 series Phase 2 14.4 m × 30.3 m × 3.35 m × 6 series ・ Inclination pipe Phase 1 14.4 m × 21.0 m × 6 series Phase 2 14.4 m × 21.0 m × 6 series ・ Sludge collector Phase 1 2 units × 6 series Phase 2 2 units × 6 series ・ Ancillary equipment: discharging equipment (valve, pipe), collecting trough drainage pipe,	For Phase 1	

Table 3.5.43 Outline of Facilities (3/6)

Facilities, etc. being considered	Item	Basic matters	Outline of facilities	Construction work for Phase 1	Remarks
Water treatment facility	Intermediate chlorine mixing basin	・ 2 basins shall be installed per phase. ・ hypochlorous acids shall be injected in the inflow part. ・ The point of injection shall be provided in 1 place per basin. ・ The basin shall be of the up and down diverting type in order to perform mixing of chlorine. ・ Since the chlorine mixing basin is not equipped with mechanical equipment, stoppage of the basin very seldom occurs, but the basin shall consist of 2 basins per phase by taking account of stoppage resulting from maintenance. ・ As for the time of contact with chlorine, around 20 minutes shall be secured including the depth of water above the sand in the filter.	[Design conditions] ・ Time of contact: around 20 minutes including the depth of water above the sand ・ Mixing method: up and down diverting type [Design parameters] ・ Size: Phase 1 Width 3.65 m × 10.50 m × 6.8 m × 2 basins Phase 2 Width 3.65 m × 10.50 m × 6.8 m × 2 basins ・ Ancillary equipment: drainage pipe, point of chlorine injection	For Phase 1	
	Rapid filter	・ The filter shall be a rapid filter of the gravity type. ・ The filter shall be of the self back-wash method of the energy-saving type that does not require a back wash pump. ・ In the self washing method, operation of slow down and slow start can be done without starting operation with its mechanism. ・ The filter shall be a filter that is of low cost, of the energy-saving type, and of the siphon method, in which operation of inflow, outflow and drainage is done by using a siphon only without using an electrically driven gate or an electrically driven valve. ・ The filter shall have a filtering layer of the single layer. ・ The filtering sand thickness shall be one having an actual record of use in a filter of the siphon type. ・ The effective diameter and uniformity coefficient of filtering sand to be used shall have an actual record of use by taking into account the turbid substances and cryptosporidium stopping ratio, filtering continuation time, back wash speed, response to a wide range of water quality, etc. ・ The filter shall be cleaned by using both the surface wash and the back wash with water. ・ The number of filters shall be determined so as to enable self back wash to be performed. ・ The provision of 1 basin during cleaning and 1 stopping basin for control of the sand layer shall be considered. ・ The lower part water collection equipment shall be in the form of an effective block that enables construction work to be done easily at low cost. ・ A roof shall be installed as preventive measures against density flow caused by a temperature rise, preventive measures against algae, and in order to protect facilities and equipment.	[Design conditions] Filtering speed 120 m/day - 150 m/day [Design parameters] ・ Size: Phase 1 5.2 m × 10.5 m × 2 beds/basin × 12 basins Phase 2 5.2 m × 10.5 m× 2 beds/basin × 12 basins ・ Filtering sand layer thickness: 60 cm ・ Filtering sand effective diameter: 0.6 mm ・ Filtering sand uniformity coefficient: 1.3 - 1.6 ・ Gravel layer thickness: 200 mm (maximum size: 20 mm, minimum diameter: 2 mm, Number of layers: 4) ・ Water collection equipment: effective block shape ・ Ancillary equipment: filtering sand 1 set, inflow/outflow equipment 1 set, Surface wash pump 2 units (common to Phases 1 and 2), surface wash equipment 1 set, surface wash pipe 1 set, inflow siphon 1 set, inflow weir, drainage siphon 1 set, outflow valve, outflow pipe, water supply pipe	For Phase 1	

Chemical dosing facility	Chlorine	・ The purchased hypochlorite of soda method shall be employed. ・ Pre-hypochlorite treatment, mid-hypochlorite treatment and post-hypochlorite treatment shall be employed. At normal times, post chlorine injection equipment shall be installed by mainly using mid-chlorine treatment. Pre-chlorine treatment shall be done as preventive measures against algae in a sedimentation basin in summertime. ・ The injection equipment shall employ a method in which a service tank and an injection pump are provided for each of the pre-hypochlorite treatment, mid-hypochlorite treatment and post-hypochlorite treatment. ・ The pre-hypochlorite treatment shall have 1 series for Phase 1, and mid-hypochlorite treatment and post-hypochlorite treatment shall have 2 series for Phase 1, and each of them shall have a spare. ・ The quality of the material of storage tank is made of resin product excellent in corrosion resistance.	[Design conditions] ・ Dose rate (average mg/l): pre-hypochlorite treatment 0.5 mid-hypochlorite treatment 2.0 post-hypochlorite treatment 0.5 (maximum mg/l) : pre-hypochlorite treatment 1.0 mid-hypochlorite treatment 4.0 post-hypochlorite treatment 1.0 (minimum mg/l) : pre-hypochlorite treatment 0.3 mid-hypochlorite treatment 0.3 post-hypochlorite treatment 0.3 ・ Hypochlorite used: 6％ solution (specific gravity: 1.08) ・ Amount of storage: amount for 15 days at average dose rate ・ Service tank capacity amount for 8 hours at average dose rate [Design parameters] ・ Sotrage tank: cylindrical portrait form tank of resin product φ2.91m x 6.5mH x 36m3 x 3 tanks per phase ・ Service tank: cylindrical portrait form tank of resin product (Pre-chlorination) φ0.76m x 0.94mH x 0.3m3 x 1tank per phase (Intermediate-chlorination) φ1.42m x 1.85mH x 2.0m3 x 1tank per phase (Post-chlorination) φ1.0m x 0.9mH x 0.5m3 x 1tank per phase ・Chlorine transfer pump: Process magnetic drive pump ・Specifications: 0.2 m3/min x 20mH x 3.7kw ・Number of pumps: 2 units (*Phase1 only) ・Pre-chlorine dosing pump: diaphragm quantitative pump ・Specifications: 0.1 - 1.0L/min x 0.3MPa x 0.2 kw ・Number of pumps: 2 units per phase (of which 1units are a spare) ・Intermediate-chlorine dosing pump: diaphragm quantitative pump ・Specifications: 0.3 - 3.0L/min x 0.3MPa x 0.4 kw ・Number of pumps: 3 units per phase (of which 1units are a spare) ・Post-chlorine dosing pump: diaphragm quantitative pump ・Specifications: 0.2 - 2.0L/min x 0.3MPa x 0.2 kw ・Number of pumps: 2 units per phase (of which 1units are a spare)	For Phase 1	To be determined based on a water quality test.
	Coagulant (PAC)	・ As for the coagulant, PAC injection shall be employed. ・ The method of injection shall employ the revolution + stroke control method that uses a constant rate pump of the diaphragm type. ・ The injection equipment shall be 1 series for Phase 1, and shall have a spare injection machine.	[Design conditions] ◆ Dose rate: Average 30 mg/L Maximum 50 mg/L Instantaneous maximum 100 mg/L Minimum 20 mg/L) ◆ PAC to be used: 17％ PAC solution (specific gravity: 1.37) ◆ Amount of storage: amount for 30 days at average dose rate [Design parameters] ・ PAC storage tank: cylindrical portrait form tank ・Specifications: 2.91m ϕ ×6.5mH×38 m^3 ・Number of tanks: 3 tanks per phase ・ PAC dosing pump: diaphragm quantitative pump ・Specifications : 0.5 - 5.0 L/min x 0.3MPa x 0.4 kw ・Number of pumps: 4 units per phase (of which 2 units are a spare) ・Flow equalization: stroke adjustment ・ PAC dilution pump: self-suction centrifugal pump ・Specifications: 50mm x φ0.3 m^3/min x 10mH x 1.5kw ・Number of pumps: 4 units per phase (of which 2units are a spare)	For Phase 1	To be determined based on a water quality test.

Table 3.5.44 Outline of Facilities (4/6)

Facilities, etc. being considered	Item	Basic matters	Outline of facilities	Construction work for Phase 1	Remarks
Clear water reservoir /water transmission pump	Post chlorine mixing basin	・ The basin shall consist of 2 basins for Phase 1. ・ The point of injection shall be 1 place per basin. ・ The method of contact shall be the horizontal diverting method.	[Design parameters] ・ Size Phase 1 4.5 m × 37.0 m × 4.0 m × 2 basins Phase 2 4.5 m × 37.0 m × 4.0 m × 2 basins	For Phase 1	
	Clear water reservoir	・ The clear water reservoir shall consist of 2 basins per phase, and shall be of RC underground type. ・ It shall be ensured that the capacity of the clear water reservoir is for use for 3 hours for 1 basin and for use for 6 hours for 2 basins so that time change adjustments can be done with 1 basin.	[Design conditions] ・ Retention time: 6 hours [Design parameters] ・ Size: Width 42.8 m × Length 114.3 m × Water depth 4 m × 2 basins ・ Capacity: effective capacity 19,300m^3/ basin × 2 basins	For Phase 1	
	Water transmission pump	・ Consideration shall be given to the water transmission pumps so that they fit the water operation method, and the pumps shall be installed by dividing them into the north series and the south series. ・ As for the type of a pump, a pump of the horizontal axis double suction type shall be used which is of low cost and has high maintainability. ・ Since the water transmission pumps need adjustments in flow rate and water pressure change, inverter control of the energy-saving type shall be adopted.	[Design conditions] ・ Amount of water transmission: Phase 1 North series 10,000 m^3/day South series 140,000 m^3/day Phase 2 North series 30,000 m^3/day South series 270,000 m^3/day ・ Lifting height: Phase 1 North series 50m (altitude) ＊Lifting height for Phase 2 South series 57 m(altitude) ＊Lifting height for Phase 2 Phase 2 North series 50 m (altitude) South series 57 m (altitude) [Equipment parameters] ・ Water transmission pump 〔North series〕 Type: Horizontal axis double suction type pump Specifications: Diameter 300×10.5 m^3/ minute×49mH×132kw Quantity: Phase 1 2 units (of which 1 unit is a spare) Phase 2 1 unit Revolution control: VVVF control 〔South series〕 Type: Horizontal axis double suction type pump Specifications: Diameter 700×57 m^3/ minute×56mH×800kw Quantity: Phase 1 3 units (of which 1 unit is a spare) Phase 2 2 units Revolution control: VVVF control Ancillary equipment: Installation of flywheel + one-way surge tank as preventive measures against water hammer pressure	2 units 3 units	It shall be ensured that the off take pressure is 20 m or more so that direct distribution of water can be done. Review of lifting height Review of lifting height Study of measures against water hammers

Drainage treatment facility	Wash water drainage basin	・ The wash water drainage basin shall be a facility common to Phase 1 and Phase 2. ・ The basin shall consist of 2 basins, of which 1 basin shall be used as a spare during seasons except for rainy seasons, and during rainy seasons 2 basins shall be used including the spare basin. ・ The capacity of the wash water drainage basin shall be determined so that the drainage after cleaning with the filter and supernatant in the thickener can be received per basin. ・ The water level of the wash water drainage basin shall be of a height such that drainage cleaned with the filter can be received by gravity flow. ・ A return pumping well shall be installed as an integral unit with the wash water drainage basin.	[Facility parameters] ・ Size: Width 18.0 m × Length 18.0 m × Water depth 4 m × 2 basins ・ Capacity: Effective capacity 1296 m^3/basin × 2 basins ・ Return pump Type: Submersible pump Specifications: Diameter 250 × 9 m^3/minutes × 20 m H × 55 kw Quantity: Phase 1 2 units (of which 1 unit is a spare) Phase 2 1 unit ・ Ancillary equipment: Pumping well	All facilities 2 units	

Table 3.5.45 Outline of Facilities (5/6)

Facilities, etc. being considered	Item	Basic matters	Outline of facilities	Construction work for Phase 1	Remarks
Drainage treatment facility	Sludge basin	・ The sludge basin shall consist of 2 basins, of which 1 basin shall be used as a spare during seasons except for rainy seasons, and during rainy seasons 2 basins shall be used including the spare basin. ・ The capacity of the sludge basin shall be determined so that the amount of drainage of the yearly average turbidity in the sedimentation basin for 1 day can be received per basin and during rainy season average turbidity during rainy seasons can be received with 2 basins. ・ The water level of the sludge basin shall be of a height such that drainage from the sedimentation basin can be received by gravity flow. ・ A sludge transfer pumping chamber shall be installed as an integral unit with the sludge basin. ・ The sludge basin shall be provided with a gradient of around 50% in its bottom plate so as to enable sludge to be collected easily.	[Facility parameters] ・ Size: Width 18.0 m × Length 18.0 m × Water depth 3.5 m × 2 basins ・ Capacity: effective capacity 1134m^3/basin × 2 basins ・ Sludge transfer pump Type: Horizontal axis centrifugal pump Specifications: Diameter 150 × 1.6 m^3/minute × 10 m H × 7.5 kw Quantity: Phase 1 2 units (of which 1 unit is a spare) Phase 2 1 unit ・ Ancillary equipment: Pumping chamber	All facilities 2 units	
	Thickener	・ The thickener shall be of the continuous type that is used when there is a lot of sludge to be treated. ・ The thickener shall consist of 2 basins per phase, and 1 basin shall be used as a spare in seasons except for rainy seasons, and during rainy seasons 2 basins shall be used including the spare basin. ・ The water level of the thickener shall be of a height such that supernatant can be returned to the wash water drainage basin by gravity flow. ・ A sludge transfer pumping chamber shall be installed as an integral unit with the thickener. ・ The sludge collector shall be of the rotary center-collection method. ・ The square measure of thickener shall be planned based on the clarifying and enriching conditions.	[Design conditions] ・ Capacity: not less than the amount of sludge for 24 hours ・ Serface settling velocity: 2.7m/day (from the results of precipitation test) ・ Solid load: 20 kg /(m2•day) or less (at average turbidity during rainy seasons) * It shall be designed that at high turbidity direct transfer to the sun drying bed will be done. [Facility parameters] ・ Size: Phase 1 Diameter 23.0 m × Water depth 3.5 m × 2 basins Phase 2 Diameter 23.0 m × Water depth 3.5 m × 2 basins ・ Capacity: effective capacity 1454m^3/basin × 2 basins ・ Solids loading: 48.5kg /(m2・day) (at average turbidity during rainy seasons) ・ Sludge transfer pump Type: Horizontal axis centrifugal pump Specifications: Diameter 150 × 1.2 m^3/minute × 10 m H × 5.5 kw Quantity: Phase 1 2 units (of which 1 unit is a spare) Phase 2 1 unit Ancillary equipment: Sludge collector, overflow launder, pumping chamber	For Phase 1 2 units	

	Sun drying bed	・ The sun drying bed shall have a construction such that the bottom plate and wall are made of concrete so as to prevent pollution of soils. ・ In the sun drying bed, a filtering layer and a collecting pipe shall be installed in order to promote the drying of sludge. ・ In the sun drying bed, similarly in order to promote drying, equipment for taking out supernatant shall be installed. ・ A channel for access by heavy machinery shall be provided. ・ Infiltrating water and supernatant in the sun drying bed shall be treated to become conformant to the specified drainage criteria and shall be discharged to a river. ・ A sun drying bed dedicated to use for the settling basin shall be provided.	◆ For use in water treatment facilities [Design conditions] ・ Solid load: 50 kg /(m2▪day) or less (at annual average turbidity) 70 kg /(m2▪day) or less (at average turbidity during rainy seasons) ・ Number of days for drying: 120 days (at annual average turbidity) 90 days (at average turbidity during rainy seasons) ・ Filling up height: 1.0m [Facility parameters] ・ Size: Phase 1 Width 20.0 m × Length 85.0 m × Water depth 1.0 m × 15 beds Phase 2 Width 20.0 m × Length 85.0 m × Water depth 1.0 m ×15 beds ・ Ancillary equipment: drainage discharge pump (submersible pump), pumping well ◆ For use in settling basin [Design conditions] ・ Solid load: 112 kg /(m2▪day) or less (at annual average turbidity) 112 kg /(m2▪day) or less (at average turbidity during rainy seasons) ・ Number of days for drying: 45 days (at annual average turbidity) 30 days (at average turbidity during rainy seasons) ・ Filling up height: 0.8 m [Facility parameters] ・ Size: Phase 1 Width 20.0 m × Length 85.0 m × Water depth 1.0 m ×4 beds Phase 2 Width 20.0 m × Length 85.0 m × Water depth 1.0 m × 4 beds		
Electrical instrumentation facility	Power transmission and transformation equipment	・ At each of the water intake plant and water treatment plant, power is received by using 2 overhead lines of 22 kV from the electric power corporation, and power is fed into the electricity room in the plant by using cables and its voltage is stepped down to voltages to be used in the plant (6 kV, 380 V).	・ Power receiving method: 22 kV, 2 lines Overhead line lead-in ・ Capacity of main transformer: Water intake plant 1,250 kVA 2 banks, water treatment plant 7,500 kVA 2 banks		
	Instrumentation equipment	・ Various types of water levels, flow rates, pressures, water qualities, etc. in water treatment facilities shall be measured, and monitoring, recording and accumulation of the measured values shall be done in the central control room.	* For the details of measuring items and places of measurement, refer to the text.		
	Non-utility electricity generation equipment	・ In the water treatment plant, a non-utility emergency power generating facility shall be installed for security purposes.	・ Capacity of power generator: 250 kVA one unit ・ Voltage: 380V ・ Cooling method: air cooled radiator type		
	Monitoring and control equipment	・ A monitoring and control system (SCADA) for the entire water intake, water treatment, and off take facilities shall be installed in the central control room in the main administrative building, and indication of the state of operation of equipment, control of major equipment, indication of various types of measured values, preparation of daily and monthly reports, collection of various data, etc. shall be carried out.	・ Display equipment: indication of state, indication of failure, for operation and running as well as for common backup ・ Controller equipment: for use for power transmission and transformation, water intake, injection of chemicals, and water transmission facilities		

Table 3.5.46 Outline of Facilities (6/6)

Facilities, etc. being considered	Item	Basic matters	Outline of facilities	Construction work for Phase 1	Remarks
Construction facilities	Water intake pumping station	・ It shall be an electricity room for water intake pump equipment, and a pump room shall be provided in a separate building. ・ Since it is to be installed outside of the weir, considering safety during a flood, the floor height shall be designed to become greater than the weir height. ・ It shall be a facility to be ready for use in Phase 2.	・ Construction: made of reinforced concrete (RC) Building of 1 floor above ground ・ Foundation: pile foundation ・ Architectural area: 464.4 m2	All facilities (buildings only)	
	Water conveyance pumping station	・ A water conveyance pump room and a water conveyance pumping well are laid out in the underground portion, and in the portion above ground a water conveyance pump electricity room is laid out. ・ Since it is a facility to be installed adjoining the settling basin, its first floor shall be at the level of the weir of the settling basin or above. ・ It shall be a facility to be ready for use in Phase 2.	・ Construction: made of reinforced concrete (RC) 1 floor above ground, 1 floor underground ・ Foundation: pile foundation ・ Architectural area: 290 m2	All facilities (buildings only)	
	Administrative building	・ It is a facility where SPC personnel, water treatment plant personnel, etc. are stationed. ・ It contains an office as well as meeting rooms, a library, electricity rooms, a water quality test room, etc. ・ A view from the roof top shall be enabled as measures for responding to the needs of visitors. ・ It shall be a facility to be ready for use in Phase 2.	・ Construction: made of reinforced concrete (RC) Building of 3 floors above ground ・ Foundation: pile foundation ・ Architectural area: 3088.9 m2 ・ Rooms contained: Office, large meeting room, small meeting room, electricity room, water treatment electricity room, emergency-use electricity generation room, water quality test room (instrumentation room), library, etc. * For details, see the text.	All facilities (buildings only)	
	Chemical dosing building	・ It shall be installed a storage tank of PAC and Chlorine, a dosing pump, etc. ・ It shall be a facility to be ready for use in Phase 2.	・ Construction: made of reinforced concrete (RC) Building of 1 floor above ground ・ Foundation: pile foundation ・ Architectural area: 666.5 m2	All facilities (buildings only)	
	Water transmission pumping station	・ A water transmission pump room shall be laid out in the underground portion, and in the portion above ground a water transmission pump electricity room and an extra high voltage substation shall be laid out. ・ It shall be a facility to be ready for use in Phase 2.	・ Construction: made of reinforced concrete (RC) 1 floor above ground, 1 floor underground ・ Foundation: pile foundation ・ Architectural area: 3872 m2	All facilities (buildings only)	
	Sludge pumping station	・ A sludge discharge pump room shall be laid out in the underground portion, and in the portion above ground a sludge pump electricity room shall be laid out. ・ It shall be a facility to be ready for use in Phase 2.	・ Construction: made of reinforced concrete (RC) 1 floor above ground, 1 floor underground ・ Foundation: pile foundation ・ Architectural area: 168 m2	All facilities (buildings only)	
	Public facility	・ It is a living facility for stationed personnel	・ Construction: made of reinforced concrete (RC) Building of 2 floor(s) above ground ・ Foundation: pile foundation ・ Architectural area: 2030.4 m2	* To be constructed in Phase 2	
	Company housing	・ It is a living facility for stationed personnel.	・ Construction: made of reinforced concrete (RC) Building of 3 floor(s) above ground ・ Foundation: pile foundation ・ Architectural area: 272.7 m2 x 24 houses	* To be constructed in Phase 2	

3.5.7 Outline Design of Transmission Pipeline

(1) Survey of Underground Pipe

Underground pipe survey was carried out during field trips through hearing from the related Authorities. The following Table 3.5.47 summarizes underground pipe situation. Pipes for agriculture use are installed out of urbanized areas and drainage pipes are installed under roads in urbanized areas generally.

Table 3.5.47 Existing Underground Objects

Transmission Route	National Road	Agricultural Pipe	Drainage Pipe	Distribution Pipe	Oil Pipe	Wire of electric and telephone
Northern area※	No.179	exist	exist	exist	—	exist
	No.1-A	exist	exist	exist	—	—
Southern area※	No.182	exist	exist	—	exist	—
	No.5	exist	exist	exist	—	exist
	No.197	exist	exist	exist	—	—
	No.1	—	exist	—	—	exist

(2) Earth Covering of Pipeline

The earth cover of pipelines buried under the roads is specified generally as below, according to the Design Guidelines for Water supply Facilities of Viet Nam (TCXDVN33-2006).

However, the values below vary depending on the specifications of pipelines (material, pipe thickness, etc.) and the composition of pavement; therefore, checks with the road controllers are necessary during the detailed design stage.

- When diameter is less than 300 mm: 0.5 m or greater
- When diameter is greater than 300 mm:0.7 m or greater

The extension of transmission pipelines in this project has a total length of about 46km. The major part of this is the laying of pipelines along roads that has comparatively heavy traffic. For this reason, the effects of impact of passage of vehicles on the pipelines are a cause of concern.

Considering these factors, the general earth cover of 1.2 m (as practiced in case of Japan's water main) is decided to be used for supply pipelines in case of general parts.

(3) Prevention from Groundwater

According to geological survey, which was carried out in June, the result of Borehole No.BR5 showed 2.6m of clay layer thickness, which is rather thin. The transmission pipeline under Route 182 is ϕ1,600mm (diameter), this area may be affected by groundwater because of thin clay layer thickness.

3.5.8 Outline of Design Drawing

Based on the above results, the outline of design drawing is shown in Appendix 1 and Appendix 2.

3.6 Formulation of Work Execution Plan

A study on the current situation of the construction market will be undertaken through hearing from local general constructors and Japanese companies and others doing similar business in Viet Nam, and a work execution plan of higher feasibility will be formulated based on results of such study.

3.6.1 Natural Conditions at Site

Grasping of natural conditions at site is the most important factor for formulation of a work execution plan within a limited period of time. Furthermore, it can be said that to estimate appropriate expenses for countermeasure work against the given natural conditions is an important factor also from the viewpoint of calculation of the project expenses.

The following items were checked as natural conditions that should be taken into account for accomplishment of commencement of operation in 2015, which is the target year of Phase 1 of this proposed project, in this study.

(1) Rainfall

As described in "1.4 Outline of Natural Condition in Greater Hanoi", Hanoi has a temperate summer-rain climate, and its climate can be roughly divided into the rainy season from May through October and dry season from November through April.

The temperature in summer exceeds 30°C, and although on extremely hot days temperature in excess of 40°C are observed in recent years, the temperature in summer is not very much different from that in Japan, and it is judged that measures (measures against high temperature and low temperature) that accompany quality issues caused by temperature are not required during the construction period.

Regarding rainfall, on the other hand, the amount of rainfall rapidly increases in the rainy season (June through September in particular), and care is required for work execution during the rainy season. However, since concentrated rainfall in a short time often arises, it is judged that the influence exerted over the work quality can be reduced by taking appropriate countermeasures (such as covering with sheets).

The number of rainy days and amount of rainfall are principal factors for review of number of workable days in this project, and it can be judged from data that it is possible to execute the work for about 20 days a month. It is considered that particular attention should be paid to safety measures during rainfall in order not to allow occurrence of collapse of reclaimed surfaces and rise of groundwater level caused by rainfall, as many works involving excavation to a depth that is deeper than the present ground surface are needed in this project.

(2) Situation of Geology and Groundwater Level

1) Water intake facility and water treatment plant

The results of geological survey are shown in Appendix-. The scheduled site of construction of water treatment plant has high groundwater level, and it is as high as about +3.5 to 4.0 m (equivalent to the water level in Duong River), while the water treatment plant planned ground height is +6.5 m. However, since the results indicated above are based on boring exploration, an observation well to check groundwater level practically was constructed and the situation of groundwater level is currently under observation.

The altitude of the present water treatment plant construction scheduled site is +4.5 m in general, and the majority of the site is occupied by paddy fields. The access road is running in the south-east direction in the north of the water treatment plant construction scheduled site and through the center of the construction scheduled site. As the altitude of this road is +6.5 m, which is higher than the present ground level by about 2 m, the planned ground height of the water treatment plant was determined as +6.5 m to meet the altitude of the existing road.

The present ground has a clay stratum in the surface layer, but soft ground continues to a depth of around –35 to 40 m.

With the existing situation stated above taken into account, it is necessary to study treatment of the earth and sand including organic substances in the surface layer, countermeasures against soft ground (study of pile foundation) and countermeasures against groundwater level (groundwater level lowering method and countermeasures against heaving) before starting work execution.

2) Transmission pipeline

It is necessary to lay transmission pipeline in a broad range, that is, in a 30 km circle in the north and south of the water treatment plant. But, as shown in results of geological survey indicated in Appendix-4, there is no major difference in geology compared to the water treatment plant construction scheduled site.

The depth of burial of transmission pipeline varies by pipe diameter and other underground installation such as telephone cables and sewer lines. But a level of about 3 to 4 meters is assumed and earth retaining is required in general. However, since there is a possibility where reclaimed surfaces are fully stable by excavation without earth retaining based on the presently checked geological conditions, it is necessary to study the work execution method depending on the place of pipe laying and the kind of transmission pipe.

In addition, since pipeline laying involves excavation, for a relatively short period, large-scale countermeasures are not needed. However, it is necessary to study countermeasures against groundwater (dewatering measures) as required..

(3) Situation of Rivers

The water intake facility will be constructed in shoreline of a river, and the water level in the river exerts influence over the construction. Although the river flow velocity is relatively stable in the dry season (while the water level is low), it is considered that the flow velocity is high and unstable during the rainy season (while the water level is high). Therefore, it is necessary to pay full attention to overflow and other risks caused by swollenness.

Furthermore, to deal with rapid rising during the high water level season, it is necessary to study means for acquiring information on changes in the river water level in the upstream stretches.

In addition, it is scheduled that transmission pipeline shall cross the river at two locations, that is, Duong River and Hong River (Red River).

The river width at the point of river crossing with Duong River is about 280 m and the maximum water depth is around –9.0 m. At the point of river crossing with Hong River (Red River), the river width is about 520 m and the water depth is –6 m. If pipe jacking method is adopted, a depth that is deeper by 6 m than the bottom of the river is excavated with a pipe jacking machine, and therefore, it is necessary to fully study the bottom material situation for formulation of a work execution plan.

Furthermore, since both of starting vertical shaft and arriving vertical shaft are constructed in the river embankment, there is a risk of occurrence of shaft overflow while the water level is high, and it is necessary to select the dry season when the water level is stable as the work execution period and to take sufficient safety measures.

3.6.2 Procurement of Construction Materials and Equipments

(1) Construction Materials

1) Water intake facility and water treatment plant construction works

The principal construction materials for works in the water treatment plant and for works related to the water intake facility are reinforcing bars, concrete, land-fill materials, stone materials, etc. The ground condition is inferior in the vicinity of the proposed construction site and foundation piles are needed, but RC piles as be foundation piles are often used in Viet Nam where the possibility of occurrence of earthquake is minor in general. The materials of concrete are cement and aggregate, and almost all materials including cement and aggregate can be procured in the neighborhood of Hanoi. In addition, temporary materials, earth retaining materials (steel sheet piles, beams), forms and scaffolding supporting materials can also be procured in the neighborhood of Hanoi, as they are not special materials. Heavy temporary materials can also be procured in the southern area of Viet Nam.

It was also learned through hearing from local companies that these construction materials are supplied with almost no delay.

2) Transmission pipeline laying work

It is planned to use steel pipes, ductile cast iron pipes and HDPE pipes for the transmission pipeline laying work, with pipe diameter and use taken into account.

HDPE pipes are produced in Viet Nam and are broadly used, and there is no quality issue. HDPE pipes made in Viet Nam will be used for this project.

Regarding steel pipes and ductile cast iron pipes, however, since those which are produced in Viet Nam are limited to small-diameter pipes only, procurement in Viet Nam of these pipes of large diameters is not possible. Therefore, large-diameter pipes of ϕ700 mm and more, which are mainly used for this project, will be procured from a third nation.

Furthermore, at the river crossing point with Duong River and Hong River (Red River) where adoption of the pipe jacking method is being studied, water leaking performance of pipe joints is important in addition to pipe strength because earth covering is deep and the pipe jacking extension is also long. Therefore, it was judged that it is not possible to procure in Viet Nam the Hume concrete pipes to be used, and procurement from a third nation is assumed.

In addition, at points of river crossing with small-scale waterways, it is considered that work execution with pipes procured in Viet Nam will be possible, even if the pipe jacking method is adopted, since the extension is relatively short, the earth covering is also relatively shallow and the ground is composed of cohesive soil of high strength.

(2) Mechanical and Electrical Facilities

Facilities and equipment can be roughly classified into mechanical equipment such as pumping equipment and water treatment mechanical equipment and to electrical instrumentation equipment such as incoming and transforming equipment, power generation equipment, instrumentation equipment and supervisory control equipment.

Among pumping equipment, land type pumps such as conveying pumps can be procured in Viet Nam. But some of them require procurement from a third nation. As for submerged pumps, on the other hand, there is one possibility to be procured from Japan because pumps of large capacity are required compared to pumps used in general. Metering pumps such as chemical injection pumps might be also procured from Japan in the same manner.

Although no special products are used as water treatment mechanical equipment, water treatment mechanical equipment will be basically procured from a third nation because they are not produced in Viet Nam.

Electrical instrumentation equipment, on the other hand, can be procured in Viet Nam in general, but some of them are procured from a third nation..

(3) Construction Equipment

1) Water intake facility and water treatment plant construction work

For the water treatment plant construction work and the water intake facility construction work, construction equipments are nearly conventional type.

Use of machines indicated below is assumed as excavation and land reclamation machines.

Required Construction Equipment for Excavation and Sand Filling
Excavator, Shovel Loader, Crum Shell, Bulldozer, Dump Truck, Road roller, Motor Grader

All of them can be procured in the surrounding districts of Ha Noi. Due to the fact that many building frames are involved in this project, use of large-size land reclamation machines such as scrapers is not efficient. Conventional medium/large-size machines are more functional in relation to excavation and land reclamation.

- Required Construction Equipment for Concrete Structure
  Truck Crane (35t-50t), Concrete Pump
- Required Construction Equipment for Piling Work
  Pile Driving Machine
- Required Construction Equipment for Cofferdam Work
  Crawler Crane (80t), Vibrating Hammer (90-110kw), Truck Crane
  Boring Machine, Water Pump, Generator
- Other Construction Equipment
  Generator, Welding Machine, Water Pump

What are indicated above are principal construction machines for water treatment plant construction work and for works related to the sluice gate. As super-large-size machines are not needed, almost all of them can be procured in the neighborhood of Hanoi. It can be judged that medium/large-size work execution machines can be supplied without delay in the neighborhood of Hanoi.

2) Transmission pipeline laying work

For the transmission pipeline laying work, backhoes and dump trucks are used as work execution machines at points where no pipe jacking machine is used unlike points of intersection with a river or waterway, and in addition, cranes are used for pipe hoisting and laying. These machines do not require special skill and can be procured in the neighborhood of Hanoi.

Regarding the jacking method used for laying transmission pipeline, it was found as a result of site study that the tooth mouth jacking method is what has been used in practice in Viet Nam, and the semi-shield tunneling method that is required this time has not been experienced in Viet Nam. Therefore, equipment (such as pipe jacking machines, and slurry recycle plant. etc.) for application of the semi-shield tunneling method cannot be procured in Viet Nam.

(4) Workers

According to results of hearing from constructors implementing operations in Viet Nam, the construction market has been extremely vigorous in the recent years, migration and recruitment of capable workers and skilled workers are caught on and the worker fixation ratio is low. Because of such a situation, it appears that it is hard for constructors who newly enter into business to secure capable workers.

The works of construction of a water treatment plant and a water intake facility are not special works, but because of the fact that the construction period is short and high quality is required, it is necessary to select a company with many engineers having sufficient experience in Viet Nam.

For transmission pipeline laying work, engineers having experience in pipeline works in Viet Nam are of no problem in particular, but adoption of either pipe jacking method or caisson method is assumed for special sections such as points of river crossing with Duong River and Hong River (Red River), and high technology is required for these methods. In addition, achievements of use of such methods in Viet Nam are minor, and procurement of engineers from third nations including Japan is required because of this reason.

3.6.3 Work Execution Structure

Execution of work by local companies is basically assumed for implementation of this proposed project, which is a Japan-Viet Nam PPP project. However, since it is necessary to execute the work of high quality in a short construction period and places where work execution using Japanese technology becomes necessary are assumed, considerations should be made to permit smooth work execution with Japanese engineers allocated to essential points.

With the contents stated above taken into account, project organization shall be allocated the appropriate person in each section and well managed the structure.

3.6.4 Matters to be Prepared Before Work Execution

(1) Approach Roads for Construction

The gateway to the water treatment plant will be provided at two places, and the one on the north side is used as the main gateway. The gateway on the south side will be located along the existing road that moves down through the water purification plant site, because of convenience of access to the water intake yard construction site, and will be used as the gateway for carry-in to the water purification plant site of freights and materials that were shipped by ocean transportation. The road on the north side will be used as a main road because it leads to a trunk route. As the existing road will become unavailable as a public road as a result of construction of a water purification plant, a new roundabout road will be constructed on the external side of the boundary fence on the west side of the water purification plant site.

Approach road from water intake facility area to water treatment plant area will be provided as a construction yard for laying water intake pipe and drainage pipeline.

Construction yard will be filled at paddy field by excavated material of water intake facility and imported material. Beginning of construction yard will be used as approach between water intake facility and water treatment plant , and later construction yard will be used as yard for laying pipes. Heavy cargo ,such as pipes, steel material, stone and materials mixing concrete (cement, fine and course aggregate) will be transported by sea and river, and unloaded from temporary jetty located at embankment of Duong River,
and transported to material storage yard in the water treatment plant area using approach road.

These approach roads shall be kept good condition by periodical maintenance.

Furthermore, the transmission pipeline laying site will be spread over a broad range, although the construction period at each site will be short. Deliberation with the road administrator will be made as needed and the laying work will be executed, while maintaining safety of the traffic, in such a manner that will not obstruct living of the neighborhood.

The work relevant parties will be periodically educated regarding land transportation in general, not only on approach roads, to fully comply with laws and ordinances.

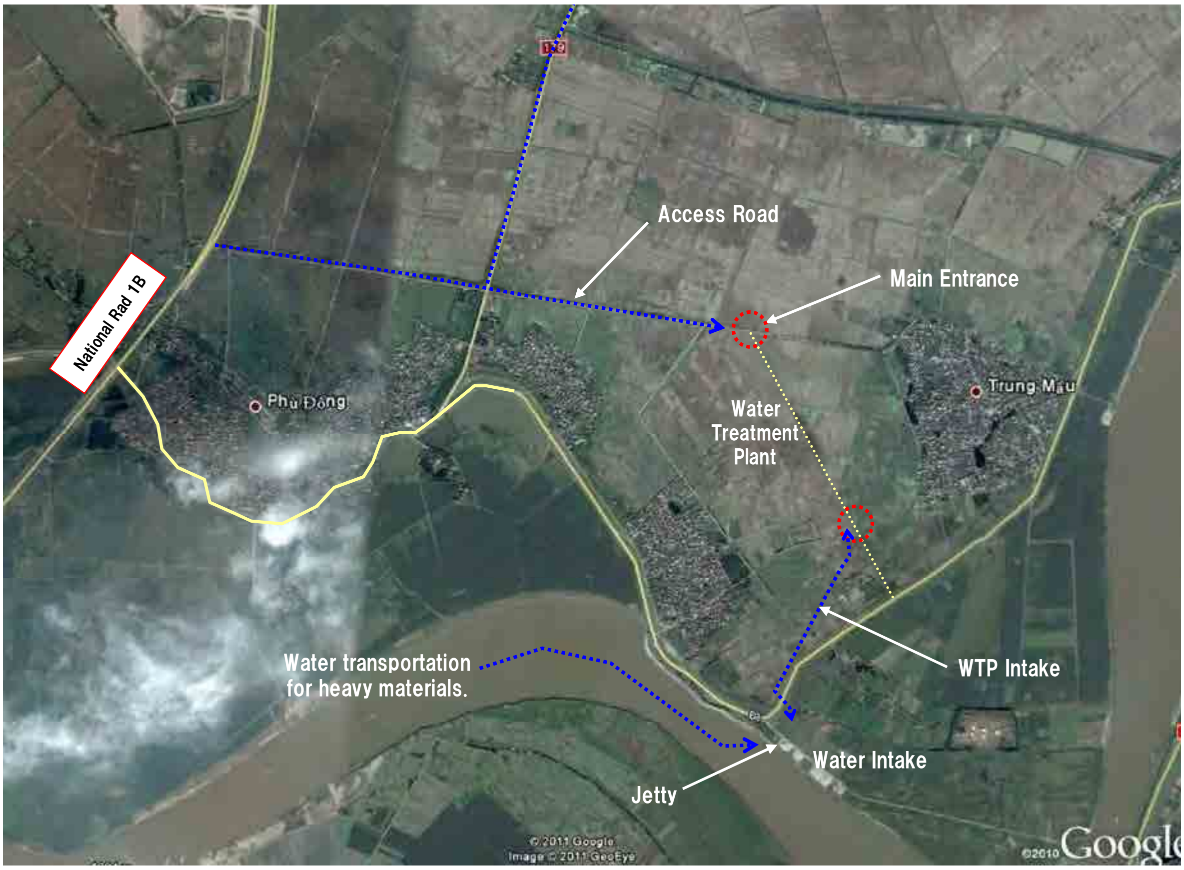


Figure 3.6.1 Approach Roads for Construction

(2) Site Office, Warehouse and Others

The site office and its accompanying facilities are shown in Table 3.6.1.

The site office and its accompanying facilities will be located in the vicinity of the north gateway of the water treatment plant (Figure 3.6.2). Concerning the scale of the site office, a space and installation for accommodating about 100 staff members is considered. The office will be equipped with a meeting room and library, and will also be provided with toilets and simplified kitchen facilities.

In addition, a car parking lot and a bicycle parking lot will be provided for the office. Furthermore, offices of relevant subcontractors will be located in the vicinity to permit quick actions of relevant subcontractors.

No warehouse is needed because there are no large-size goods requiring storage on the site. However, a 40-foot container will be provided for storage of tools, small-size equipment and materials.

Upon receipt of a permit for construction, the ground for these facilities will be immediately prepared and the office and others will be constructed.

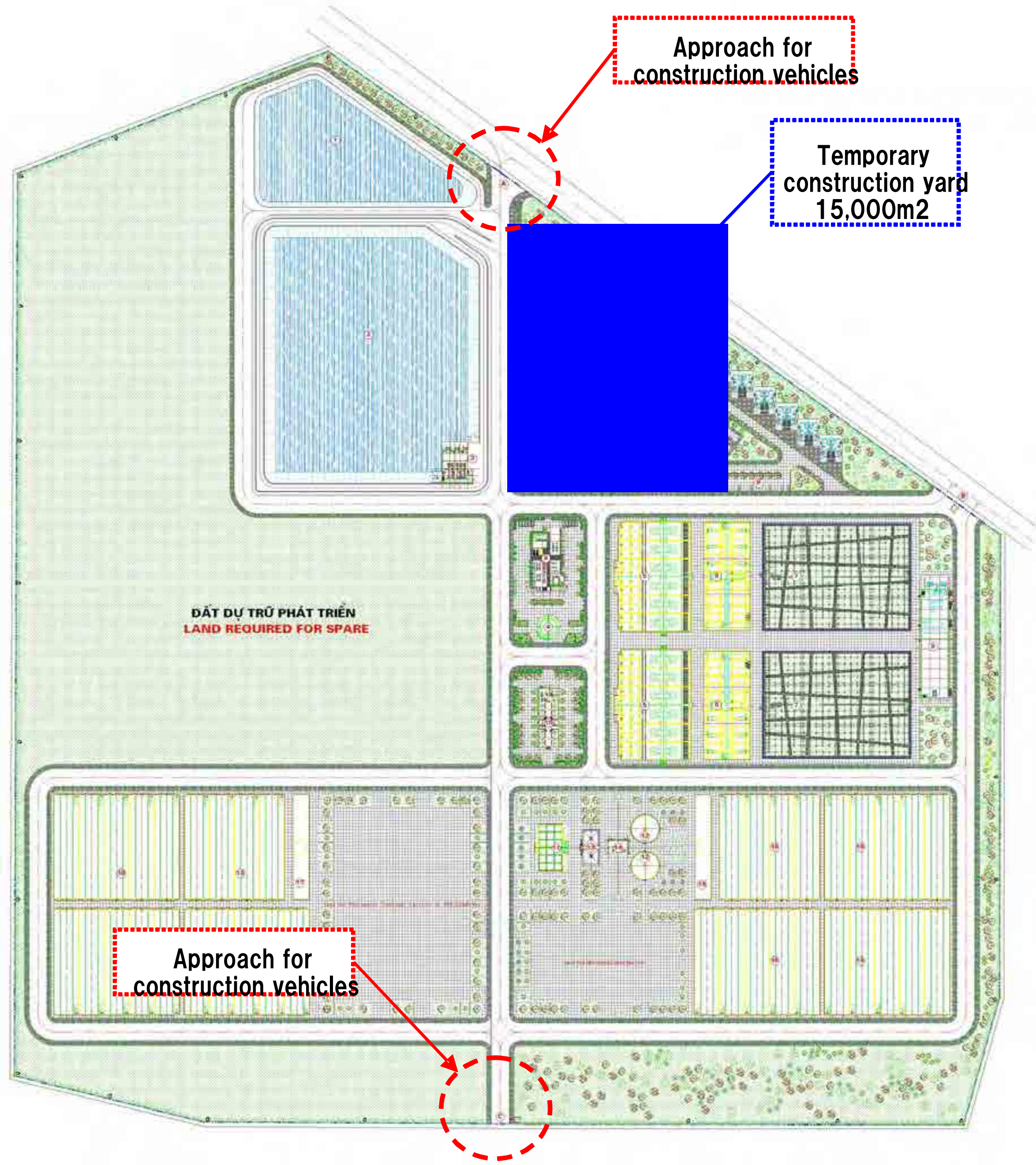


Figure 3.6.2 Location of Yard for Temporary Construction

Table 3.6.1 Areas of Temporary Facilities such as Site Office Required for Construction

【Inside of WTP】

	Item	Area (m2)	Contents
1	Project Office	600	Manager Rooms(4), Meeting Rooms(2rooms),
	(required stuffs 100Nos.)		Stuff Room, Library,Toilets,Pantry,Locker
2	Car Parking Area	320	Max 25Nos. For office stuff, Guest and Subcontractors
3	Bycycle Parking Area	120	Max 100 Nos/
4	Laboratory	0	not necessary
5	Site Office for Engineering Consultannt	32	1unit
6	Site Offices for Subcontractors	200	4units
7	Warehouse	150	40ft. Container
8	Parking Area for Construction Equipment		Max 20 Nos.
9	Temporary Fabrication Yard	900	Fabrication yard for RC structures and Buildings
			To be built sheds of half area
10	Temporary Stock Yard	1,500	Construction Materials for RC structures and Buildings
11	Temporary Fabrication Yard for Foundation Piles	1,600	Fabrication yard for RC piles for Foundation
12	Temporary Stock Yard for Foundation Piles	2,000	Stock Yard for RC piles curing
13	Yard for Ready Mixed Concrete Plant	2,000	Mixing Plant,Belt-conveyer,Aggregate Stock Yard.
			Cement Stock House, Water Tanks, Operation House
15	Temporary Stock Yard for Water Pipes	360	Pipes for Northern Area of WTP
16	Temporary Residences for Vitnames Workers (for 200	2,000	Residencial Houses(30mx10m) 5units,Assmbling House 1ur
	sub-total	11,782	
17	Roads and Green Area 20%	2,400	
	Total	15,000	

【Outside of WTP】

	Item	Area (m2)	Contents
1	Temporary Construction Yard for Water Intake Structure	1,600	Material Stock and Fabrication Yard for Water Intake Structure
2	Temporary Jetty at Duong River	450	Unloading Facilities for Construction Materials for WTP
3	Temporary Jetty at Hong River	1,600	Unloading Facilities for Water Pipes
	Total	3,650	

(3) Material Yards

The details and required areas of temporary material storage yard and temporary fabrication yard and so forth are as shown in Table 3.6.1 indicated above. For smooth supply of ready-mixed concrete for use of structure construction work and water intake work, a concrete plant that is dedicated to this project will be built on the site. Belt conveyors, water tank, aggregate storage yard, cement storage and administration house will be provided in addition to the plant main unit.

The transmission pipe storage yard will also be prepared in the water treatment plant site. As transmission pipes are laid in a broad range, they will be stored temporarily in two places. The yard in the water treatment plant site will be used for storage of pipes to be laid in the area located on the north side of the water treatment plant. For pipes to be laid in the area located on the south side of the water treatment plant, a yard will be prepared in the river embankment on the left side of Red River. This yard will be returned to the present state after completion of the construction work.

Storage of transmission pipes will be described later in “(7) Arrangement of materials and machinery for construction”.

The space for these material yards will also be secured on the north side of the water purification plant site adjacent to the site office and others. Concentration of these facilities will improve security, disaster prevention and theft prevention.

The temporary yard for construction of the water intake facilities will be provided in the vicinity of the facilities construction site in the river. However, since there is a possibility where this temporary yard is submerged in the flooding season, storage and processing will be implemented in the yard in the water treatment plant site as much as possible, and processing and storage in this temporary yard will be limited to a short time only.

(4) Method for Water Drainage during Construction

The polluted water that is produced during this work includes wastewater after use for washing construction materials and construction machines, wastewater of high turbidity that comes out of excavated soil, and in addition, living sewage water and human waste discharged out of the office and worker lodgment. Washing wastewater, turbid water and living wastewater will be accumulated through conduit lines in the rainwater storage reservoir to be constructed on the north side in the water treatment plant site, and the supernatant in the reservoir is discharged to the existing drainage canal after turbidity adjustment.

Excavation for construction of the rainwater storage reservoir will be started simultaneously with start-up of land preparation work, to permit early completion of the reservoir.

Excavation for construction of the rainwater storage reservoir will be started simultaneously with start-up of land preparation work, to permit early completion of the reservoir.

On the site of construction of the water intake facility and of laying of transmission pipes, a notch tank or a temporary storage basin will be installed for storage of washing water and turbid water, and the water will be discharged to the existing drainage canal after turbidity adjustment.

(5) Securing of Electric for Construction

A high-voltage line is running through a village that is adjacent to the water treatment plant site. The power line will be drawn into the water treatment plant site from said high-voltage line upon acquisition of an approval from relevant agencies. The principal points requiring power supply in the water treatment plant site during the construction period include the office, concrete plant, temporary processing yard, yard nighttime illumination and submerged pumps. Generators will be prepared in preparation for power failure and also as auxiliary power supply, in addition to said high-voltage temperature power supply.

At the site of construction of the water intake facility and at the site of laying of transmission pipes, generators will be constantly prepared for submerged pumps and nighttime illumination. High-voltage power supply will be used at the site of construction of the water intake facility, if it can be drawn into the site.

As occurrence of power failure is anticipated, a structure for watching the power supply for 24 hours a day will be established so the emergency power supply can be activated when needed.

(6) Securing of Water for Construction

The water required in the water treatment plant site can be roughly divided into supply water, living water and drinking water. Supply water is used for washing construction machines and materials (mainly in the processing yard) and for use by the concrete plant. Living water is what is needed by the office and worker lodgment, and drinking water is also what is needed by the office and worker lodgment. A well will be bored in the site and this well water will be used as supply water. Furthermore, since groundwater is pumped for dewatering work, this pumped water will also be used as supply water. The concrete plant is equipped with a water tank, and this tank is filled with supply water. A part of supply water is used as living water, and in addition, a water tank is installed adjacent to the office and worker lodgment. Drinking water is supplied to this water tank using a tanker lorry for use as a part of living water and also as drinking water.

At the water intake facility construction site, a well will be bored, well water will be stored in a tank and will be used as supply water. For use as drinking water, bottled drinking water available on the market will be provided in the resting place.

(7) Arrangement of Construction Materials and Equipments

1) Main construction materials

① Procurement

Almost all the principal construction materials can be procured in Viet Nam as described before.

For procurement of transmission pipes, however, procurement from a third nation is assumed because large-diameter pipes, which are to be used in this proposed project, are not produced in Viet Nam.

② Transportation

The construction materials that can be procured in the neighborhood of Ha Noi will be transported to the storage yard in the water treatment plant site basically by land transportation. Route 1 and Route 5, which are principal roads, are running in the vicinity of the water treatment plant site, and access is satisfactory. Therefore, there is no problem in particular regarding land transportation. In addition, water transportation through Hong River (Red River) and Duong River will also be studied depending on the situation. In case water transportation is adopted, a landing place (temporary jetty) will be provided adjacent to the water intake yard.

Pipes will be unloaded at Hai-Phong Port after ocean transportation, as they will be imported from a third nation as described before. For transportation from Hai-Phong Port to Ha Noi City, land transportation through Route 5 will be basically used.

③ Storage

The materials will be stored in the storage yard in the water treatment plant site except for a part of transmission pipes. Although the storage yard will be located in the water treatment plant site, the storage yard will be additionally surrounded with fences and security guards will be allocated for 24 hours a day. Security guards will also be allocated for 24 hours a day to two gateways for the water treatment plant site.

A part of transmission pipes will be stored in the water treatment plant site and the rest will be stored in the river bed on the left bank of Hong River (Red River). It is currently planned that the total extension of the transmission pipeline will be 46 km, that is, 15 km on the north side of the water treatment plant site and 31 km on the south side of the water treatment plant site. Storage in one place would be better from the viewpoint of security, but since the pipeline will be laid in a broad area, it was planned to store pipes in two places with convenience of land transportation during laying and profitability taken into account. The storage yard scheduled area on the left bank of Hong River (Red River) is located close to a transmission pipeline laying scheduled site. The sand that were dredged from the river have been piled in this area and the altitude is also sufficient. Upon leveling of the ground, this area can be used as a storage yard. This area also permits smooth access to an existing road.

Fences will be constructed along the periphery of this area and a surveillance structure for 24 hours a day will be established while pipes are stored in this area.

2) Main construction equipments

① Procurement

The main constituents of water treatment plant construction work and water intake facility construction work are earth works and building works. Earth works include excavation, carriage and land preparation, and construction equipments for these works can be procured in the neighborhood of Ha Noi. Dewatering work and earth retaining work include placing and extraction of steel sheet pipes, and a vibrating hammer and a large-size crane are used. These machines can also be procured in the neighborhood of Hanoi.

Furthermore, it is necessary to reduce the groundwater level at the time of excavation as described earlier, and adoption of the deep well method is being studied considering the existing situation in the field. The machines for this purpose can also be procured in the neighborhood of Hanoi.

Due to the fact that a huge volume of concrete will be used for implementation of this project, it is assumed that a concrete plant shall be constructed on the site for supply of ready-mixed concrete during the construction period. The concrete plant supplier is currently under study. According to hearing from local companies, a concrete plant can be procured in the neighborhood of Hanoi.

Special machines are not needed in general sections for laying of transmission pipeline, and machines for transmission pipeline laying work can be procured in the surrounding districts of Hanoi. However, in case if jacking method is adopted at locations of pipelines crossing rivers, procurement of propulsion machines and propulsion engineers from Japan is required because propulsion in long distances is involved.

② Transportation

As construction machines are to be procured in the surrounding districts of Ha Noi, except the propulsion machine, they will be transported to the site by land transportation. The propulsion machine will be shipped from Japan to Hai-Phong Port, and after customs clearance, will then be brought to the site by land transportation.

③ Storage

Construction machines will be stored in the construction machine storage yard located at the water treatment plant site. A 24-hour surveillance structure will be established for this storage yard. In a place other than the water treatment plant site, construction machines will be gathered in one place with 24-hour surveillance structure.

3) Arrangement and lodgment of workers

Workers other than those for the pipe jacking method applied to points of intersection with rivers in the laying of transmission pipeline can be secured in Viet Nam.

For the pipe jacking method, which is scheduled to be adopted for points of intersection with rivers, skilled Japanese operators will be engaged in the work day and night, because the extension is particularly long this time and work execution by a local general constructor alone is difficult.

Ordinary Vietnamese workers will be procured in the neighborhood of the construction site and be caused to commute to the site. For special workers, coordinators and skilled workers, however, lodgment will be prepared in the water treatment plant site because they will be procured from the whole nation. It is scheduled to construct a lodgment wing that accommodates about 200 persons and an assembly wing (containing shower, cafeteria and lounge).

The necessary scale will be secured in accordance with the criteria of Viet Nam for the lodgment for workers.

(8) Procurement of Mechanical and Electrical Facilities

Almost all the facilities and equipment can be procured in Viet Nam as described earlier. Some of them, however, are scheduled to be procured from third nations including Japan.

As the transportation route, ocean transportation is assumed except for articles procured in Viet Nam. In case of ocean transportation, facilities and equipment will be unloaded in Hai-Phong Port line construction materials and be transported to the site by land transportation along Route 5.

In addition, since the construction period of this project spreads over multiple years, the works on mechanical equipment and electrical instrumentation equipment will be executed after completion in outline of civil and building construction works, for securing equipment storage hard and preventing deterioration to equipment.

As the works on facilities and equipment will be executed by local companies under the supervision of METAWATER Co., Ltd., which is a member company of this Study Team, procurement of engineers from Japan will also become necessary

3.6.5 Overall Process Plan

The process plan for the whole of this proposed project that reflects results of Section 3.6.1 through Section 3.6.4 described above is shown in Table 3.6.2. The actual overall process plan shall be decided with Vietnamese sides.

Table 3.6.2 Overall Process Plan (To be decided with Vietnamese Sides)

Section	No.	Work Item	Description of Work	Construction Year 1 (1 2 3 4 5 6 7 8 9 10 11 12) / Construction Year 2 (13 14 15 16 17 18 19 20 21 22 23 24) / Construction Year 3 (25 26 27 28 29 30 31 32 33 34 35)	Remark
Preliminary Work	1	Preliminary Work	Topographical survey, Temporary road, Temporary fence, etc.		
	2	Construction of Temporary Facilit	Site office, warehouse, and the others		
Civil Work	3	Fabrication of Foundation Pile			
	4	Land Development			
	5	Intake Pumping Station	including pump electric facility	Preliminary work / Construction Work	
	6	Water Intake Facility			
	7	Water Intake Pipeline			
	8	Storm Water Detention Basin			
	9	Settling Basin			
	10	Water Conveyance Pumping Facility			
	11	Dividing Well			
	12	Flush Mixing Well/Flocculation Basin			
	13	Sedimentation Basin			
	14	Rapid Filter			
	15	Clear Water Reservoir			
	16	Sludge Basin			
	17	Thickener			
	18	Wash Water Drainage Basin			
	19	Sun Drying Bed			
	20	Drainage Pumping Well			
	21	Interal Connecting Pipe		Design, Fabrication	
	22	Drain Pipeline			
	23	Water Transmission Pipeline	Normal	Design, Fabrication, Preliminary work	
	24		River Crossing	Design, Fabrication, Preliminary work	
Architectual Work	22	Administrative Building			
	23	Chemical Storage/Dosing Facility			
	25	Sludge Drainage Pumping			
	26	Water Transmission Pumping Station			
Equioment Work	27	Mecanical Installation Work	Equipment of water treatment and pumping facility	Production Design / Fabrication / Installation Work	
	28	Electrical Installation Work	Equipment of water treatment and pumping facility	Production Design / Fabrication / Installation Work	
Other	29	Outdoor Facility	Including of exterior illumination		
	30	Toatal Test Operation	Water Treatment Plant, Wastewater Treatment Plant		

3.7 Estimation of the Project Cost

3.7.1 Preconditions of Cost Calculation

The Cost has been calculated considering the following conditions and assumptions.

- The project schedule is shown in the next section. (Phase1: 3 years, Phase2: 2 years) Therefore the cost of increase or decrease has not been included.
- The exchange rate considered for cost estimation is 1 dollar = 81.64 yen = 20,000VND (1 yen = 245 VND) as of year 2010.
- Project cost is based on the calculation during this investigation period, and the possible Inflation and exchange fluctuations are considered for the Financial Analysis.
- Total cost is the sum of the construction and the operation and maintenance. The construction cost is composed of the direct cost as the cost of construction and the indirect cost as the cost of measurement and geological investigation, site expense, design consultancy and physical contingencies, water right application fees, and cost on installation of power line (outside of WTP).
- Cost is divided into local cost (LC) and foreign cost (FC). Further, the FC is divided into US and Japanese Yen portion considering procurement possibility.
- The cost of measurement and geological investigation and site expense is based on existing plan. The design consultancy expense is assumed to be Phase 1: 2%, Phase 2: 1% of the cost of construction.
- The physical contingency is added to the direct cost and indirect cost as 10%.

3.7.2 Preconditions of Construction Expense Calculation

The construction expense has been calculated based on the following conditions.

- The procurement is possible in Viet Nam; hence the basis of architectural materials, the labor, and engineering works-construction machinery is through local procurements.
- The mechanical and electrical equipment is also considered to be procured from Viet Nam. However, procurement from Japan and third country is taken into consideration, on the assumption that the quality performance, the economy, and the ease of maintenance, etc are defined.
- General construction except of the special parts is entrusted to the local companies.
- In case of pipelines installation, at the location of River crossing, the pipe-thrusting technology practiced in Japan might be applied.
- The unit price of construction by the local construction trader is used and

calculation is based on multiplication standard of Viet Nam.

- The Water tariff and taxes will be exempted by Decree No.108/2009 (Decree on investment in the form of BOT, BTO or BT contract) and therefore has not been included in cost.

3.7.3 Construction Expense

The construction cost is estimated at about 22.7 billion yen. This part of the project mainly focuses on Phase 1 and Phase 2 of the entire project and project planning and cost estimates are prepared accordingly. The breakdown of the estimated cost is shown in Table 3.7.1 to Table 3.7.3.

Table 3.7.1 Breakdown of Construction Cost (Phase1)

Item	Content	L. C.	F. C.		Total
		VND (Mil. VND)	JPY (¥1,000)	USD ($1,000)	(JPY: ¥1,000)
Direct cost Water Intake and raw water transmission facility	Civil and Architecture works	162,933	0	905	738,926
	Mechanical works	77,771	116,872	3,517	721,435
	Electrical works	14,836	33,832	1,483	215,492
	Subtotal	255,540	150,704	5,905	1,675,853
Direct cost Water treatment facility	Civil and Architecture works	698,424	0	3,880	3,167,455
	Mechanical works	317,424	477,020	14,355	2,944,565
	Electrical works	51,322	117,039	5,132	745,468
	Subtotal	1,067,170	594,059	23,367	6,857,488
Direct cost Water supply	Civil and Architecture works	139,769	178,277	53,220	5,093,620
	Mechanical and electrical works	5,028	11,467	503	73,039
	Subtotal	144,797	189,744	53,723	5,166,659
Direct Cost	Total	1,467,507	934,507	82,995	13,700,000
Indirect cost	Design cost	33,565	137,000	0	274,000
	Measurement and geological investigation cost	0	0	1,078	88,000
	Site expense	84,044	0	0	343,035
	Water Right Application Fees	12	0	0	50
	Power line Installation Fee	122,500	0	0	500,000
	Others	22,469	366,840	0	458,550
	Subtotal	262,590	503,840	1,078	1,663,635
Direct + Indirect cost	Total	1,730,097	1,438,347	84,073	15,363,635
Contingency		0	1,536,365	0	1,536,365
Amount of total cost		1,730,097	2,974,712	84,073	16,900,000

Table3.7.2 Breakdown of Project Cost (Phase2)

Item	Content	L. C.	F. C.		Total
		VND (Mil. VND)	JPY (¥1,000)	USD ($1,000)	(JPY: ¥1,000)
Direct cost Water Intake and raw water transmission facility	Civil and Architecture works	80,049	0	445	363,032
	Mechanical works	15,175	25,331	933	163,428
	Electrical works	0	15,519	363	62,831
	Subtotal	99,550	40,850	1,741	589,291
Direct cost Water treatment facility	Civil and Architecture works	360,951	0	2,005	1,636,967
	Mechanical works	204,780	341,833	12,588	2,205,372
	Electrical works	25,360	90,987	2,130	368,369
	Subtotal	591,091	432,820	16,732	4,210,708
Direct Cost	Total	690,641	473,670	18,464	4,799,999
Indirect Cost	Design cost	5,880	24,000	0	48,000
	Measurement and geological investigation cost	5,635	0	0	23,000
	Others	19,685	321,382	0	401,728
	Subtotal	31,200	345,382	0	472,728
Direct + Indirect cost	Total	721,841	819,052	18,464	5,272,727
Contingency		0	527,273	0	527,273
Amount of total cost		721,841	1,346,325	18,464	5,800,000

- The cost might be changed during the progress of detailed design.
  (In the joint meetings between Japanese and Vietnamese sides, which was started from March, 2012, it was almost agreed that Supply Area up to Phase 2 was only Hanoi City.This could change the total cost. Finalization of scope, cost, and so on will be discussed in the joint meetings after submission of this Final Report.)
- Specifically the cost of mechanical and electrical equipment is based on estimation as manufactures, and Civil and Architecture works is based on Vietnamese standards.
- The break down for the indirect cost is as shown in Table 3.7.1 and 3.7.2, although the determination cooperated with Viet Nam companies would be required.
- The schedule in the next term shows percentage of each construction year in the direct cost (Phase1 : 13,700,000 thousand JPY / Phase2 : 4,799,999 thousand JPY).

Table 3.7.3 Initial Cost According to Period

Item	L. C.	F. C.		Total
	VND (Mil. VND)	JPY (¥1,000)	USD ($1,000)	(JPY: ¥1,000)
Phase1	1,730,097	2,974,712	84,073	16,900,000
Phase2	721,841	1,346,325	18,464	5,800,000
Total	2,451,938	4,321,037	102,537	22,700,000

3.7.4 Operation and Maintenance Cost

The operation and maintenance cost is calculated considering the following conditions.

The operation and maintenance cost is composed of costs on labor, chemical, electric power, maintenance, and other miscellaneous expenses. The breakdown of the operation and maintenance cost is shown in Tables 3.7.4 and 3.7.5.

Table 3.7.4 Operation and Maintenance Cost (Until beginning of Phase 2)

Item	Operation / Management cost (JPY: ¥1,000 (VND:1,000,000))							
	Construct 1st Year	2nd Year	3rd Year	Operate 1st Year	2nd Year	3rd Year	4th Year	5th Year
Labor cost	0 (0)	0 (0)	101,600 (24,892)	208,700 (51,131.5)	120,700 (29,571.5)	97,500 (23,887.5)	53,000 (12,985)	52,600 (12,887)
Chemical Cost	0 (0)	0 (0)	0 (0)	53,100 (13,009.5)	53,100 (13,009.5)	53,100 (13,009.5)	53,100 (13,009.5)	53,100 (13,009.5)
Electric Power Cost	0 (0)	0 (0)	0 (0)	95,900 (23,495.5)	95,900 (23,495.5)	95,900 (23,495.5)	95,900 (23,495.5)	95,900 (23,495.5)
Cost of Maintenance Check	0 (0)	0 (0)	0 (0)	34,600 (8,477)	43,800 (10,731)	57,300 (14,038.5)	82,500 (20,212.5)	169,900 (41,625.5)
Security Cost	800 (196)	800 (196)	800 (196)	800 (196)	800 (196)	800 (196)	800 (196)	800 (196)
Cost for Sludge Disposal	0 (0)	0 (0)	0 (0)	108,700 (26,631.5)	108,700 (26,631.5)	108,700 (26,631.5)	108,700 (26,631.5)	108,700 (26,631.5)
Cost of Procurement of	0 (0)	0 (0)	0 (0)	17,800 (4,361)	17,500 (4,287.5)	17,500 (4,287.5)	17,500 (4,287.5)	17,500 (4,287.5)

Equipment								
Cost for office establishment	68,300 (16,733.5)	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)
Total	69,100 (16,929.5)	58,600 (14,357)	160,200 (39,249)	577,400 (141,463)	498,300 (122,083.5)	488,400 (119,658)	469,300 (114,978.5)	556,100 (136,244.5)

(1 yen = 245VND)

Table 3.7.5 Operation and Maintenance Cost from the Beginning of Phase2

Item	Operation / Management cost（JPY: ¥1,000（VND:1,000,000)）					
	6th year	7th year	8th year	9th year	10th year	From 11th year*
Labor cost	125,800 (30,821)	103,800 (25,431)	58,600 (14,357)	58,600 (14,357)	58,600 (14,357)	81,080 (19,864.6)
Chemical Cost	106,100 (25,994.5)	106,100 (25,994.5)	106,100 (25,994.5)	106,100 (25,994.5)	106,100 (25,994.5)	106,100 (25,994.5)
Electric Power Cost	182,900 (44,810.5)	182,900 (44,810.5)	182,900 (44,810.5)	182,900 (44,810.5)	182,900 (44,810.5)	182,900 (44,810.5)
Cost of Maintenance Check	64,500 (15,802.5)	193,500 (47,407.5)	70,400 (17,248)	140,000 (34,300)	263,700 (64,606.5)	146,420 (35,872.9)
Security Cost	800 (196)	800 (196)	800 (196)	800 (196)	800 (196)	800 (196)
Cost for Sludge Disposal	217,300 (53,238.5)	217,300 (53,238.5)	217,300 (53,238.5)	217,300 (53,238.5)	217,300 (53,238.5)	217,300 (53,238.5)
Cost of Procurement of Equipment	18,400 (4,508)	18,300 (4,483.5)	18,400 (4,508)	18,300 (4,483.5)	18,400 (4,508)	18,360 (4,498.2)
Cost for office establishment	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)	57,800 (14,161)
Total	773,600 (189,532)	800,500 (196,122.5)	712,300 (174,513.5)	781,800 (191,541)	905,600 (221,872)	810,760 (198,636.2)

(*Average of the 6th – 10th year) (1 yen = 245VND)

➢ Additional Requirements of cost calculation

- It is required to discuss the cost based on Vietnamese standard such as electric power and chemical in detail with Viet Nam companies.
- About the cost of chemical, dosing ratio should be set up after water survey one year.
- Sludge treatment fee is calculated for the entire sludge disposals. Re-use of the sludge shall be considered.
- Cost for SPC office establishment is assumed on this FS, although detailed discussion with Viet Nam side is required.

＜Installing Effect of energy saving equipment＞

Electric Power Cost is saved about 10% by installing energy saving equipment, which contributes 3% reduction of total O&M Cost. Also, 1,726 tons/year of CO_2 reduction is expected.

Energy saving equipment: Siphon type rapid sand filtration, High-effective transformer, Inverter pump

3.8 Phased Execution Plan

The construction cost of this project is large. Also, the construction period is longer and huge investment to the scale of 22.7 billion yen (Phase 1 and Phase 2) has to be made for long duration.

Initially, the project will include construction of facilities with capacity to cover 300,000m^3/day of the total water demand. The execution schedule is planned in two phases, Phase 1 and Phase 2 in consideration of construction conditions and the funding plan.

The business period including the control of maintenance is supposed 28 years with Phase 1 and Phase2. The construction period of Phase 1 is planned for three (3) years. The construction schedule for Phase 2 is planned for two (2) years. It is better that the construction period of Phase 2 is decided after seeing the supply situation of Phase 1 (150,000 m3/day). In financial analysis, phase 2 is planned in 2018 and 2019 (or 2015 and 2016).

Figure 3.8.1 shows the execution schedule of the project in different phases.

Figure 3.8.1 Execution Schedule

(Agreement is needed between Japanese and Vietnamese side)

Item	Content		Design	Phase 1 Construction	Phase 1 Construction	Phase 1 Construction	Phase 1 Operation (Start Year for Phase 1)	Phase 1 Operation	Phase 1 Operation	Phase 2 Construction	Phase 2 Construction	Phase 2 Operation (Start Year for Phase 2)	Phase 2 Operation	Phase 2 Operation			Final Year
Water intake and raw water transmission facility	Civil/Architecture																
	Machanical/Electrical																
Water treatment facility	Civil/Architecture																
	Machanical/Electrical																
Transmission pipe	North Area	WTP - Node1'															
		Node1' - Node1															
	South Area	WTP - Node2															
		Node2 - Node3'															
		Node3' - Node3															
		Node3 - Node4															
		Node3' - Node5															
		Node5 - Node6															
		Crossing point (Duong River)															
		Crossing point (Hong River)															
Indirect construction	Land Acquisition																
	Measurement, Geological survey																
	Detail Design																
Percentage of each construction year in the direct cost				8%	53%	39%				52%	48%						
Construction period				Phase 1 (150,000m3/day)						Phase 2 (150,000m3/day							
Supply capacity							150,000m3/day					300,000m3/day					
Management period							30 years										

3.9 Proposal for Operation Management

At the present stage, EPC is considered as Figure 3.9.1. VIWASEEN and METAWATER will maximize their strength in the construction cost and EPC, that is, the strength of VIWASEEN in experiences of civil & architectural engineering and construction in Viet Nam and that of METAWATER in electrical & mechanical engineering and construction. For the maintenance management, HAWACO and Metawater may consider to establish a joint venture company to transfer the Japanese overall of maintenance management. O&M Company could be incorporated into SPC.

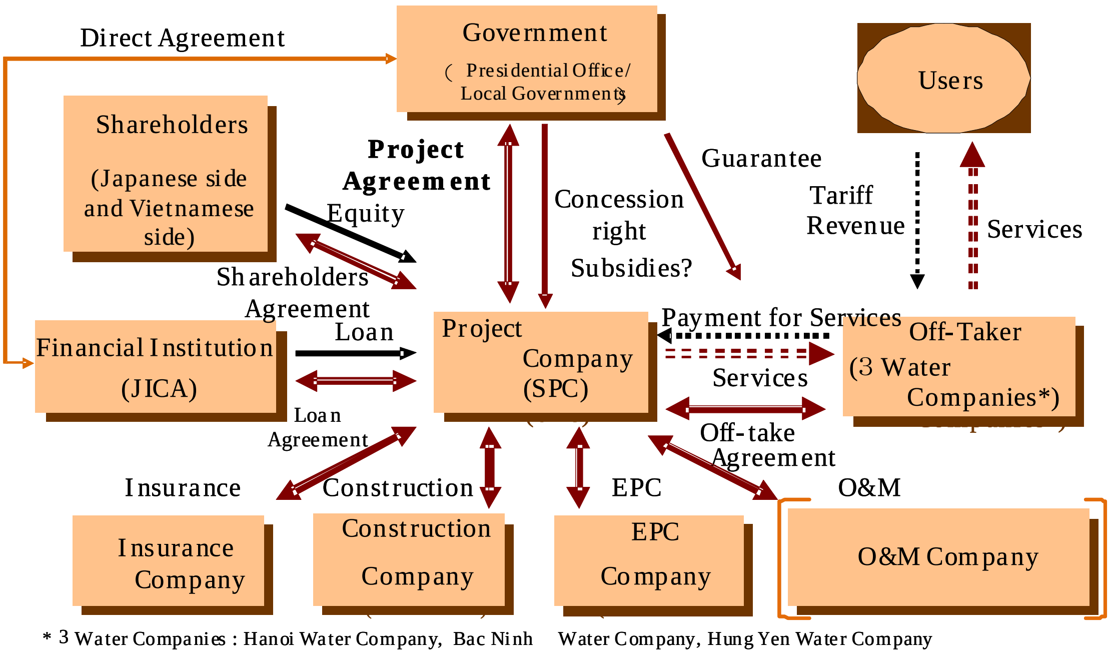


Figure 3.9.1 Proposed Project Structure

The off takers are planned to be HAWACO for Ha Noi City, and Bac Ninh Water Supply Company for Bac Ninh province. Details for off take contract are still to be considered, however take or pay is expected to be the basic principle. The followings are contracts, which are considered at this stage and will be examined further.

(1) Concession agreement among Vietnamese Government, VIWASEEN and METAWATER
(2) Off take contract
(3) Shareholder agreement
(4) EPC agreement between the SPC and EPC contractor
(5) Support agreement between the Vietnamese Government and SPC *
(6) Electricity supply contract
(7) Material supply contract
(8) Insurance contract
(9) O&M contract between SPC and O&M company
(10) Loan agreement between JICA and SPC
(11) Government to Government (JICA) Direct agreement
(12) Other administrative approvals

* O/M is also considered to be carried out in the SPC, in such a case, this contract is not needed.

3.10 Investigation Into the Operation and Maintenance Management System

3.10.4 Basic Policy of the Maintenance Management System

In the large water treatment plant that uses the high turbidity Duong River as its source, the water quality standards of the Vietnam National Technical Standards on Drinking Water Quality (Circular No. 04/2009/TT-BYT) will be adhered to. Upon also taking into account the relevant laws and ordinances, safe and secure operations will be achieved with Japanese technology and this technology and expertise will be passed on to Vietnamese officials.

In order for Vietnamese officials to be able to personally maintain and operate the Duong River Water Treatment Plant, Japanese engineers will draft a maintenance management system and water treatment operational plan that will also take into account the local culture and social system. The maintenance of continuous water quality as well as safe and stable operations will be achieved by Vietnamese officials.

Table 3.10.1 Laws and Ordinances on Operation and Maintenance Management

Law and ordinance	Issuing date	Content
Decree No.117/2007 of the Government	11/7/2007	Clean water production, supply and consumption
Circular No.01/2008 of the Ministry of Construction	2/1/2008	Guiding the implementation of Decree No.117/2007 of Government
Decision No.16/2008 of the Ministry of Construction	31/12/2008	Regulation on water supply safety assurance
Decision No.1929 of the Prime Minister	20/11/2009	Orientations for Development of water supply in Vietnam's urban centers and industrial parks up to 2025
Decision No.2147 of the Prime Minister	24/11/2010	National plan for non revenue water production up to 2025

3.10.5 Investigation Into the Local Maintenance Management System

(1) Operational Management Tasks

In this project, a centralized monitoring control system will be constructed and after understanding the situation of the plant (equipment operating conditions, water quality, water level, capacity etc.), the necessary information will be collected into one place. This will make it possible to monitor the entire facility with a relatively small number of people.

However, the operational status of the entire facility will be understood based on processing information, such as water quality and capacity, and so the monitoring tasks of the water treatment plant will demand strong judgment ability grounded on knowledge and experience, for example whether the equipment is being operated properly or whether or not there is an abnormality in the processing conditions. Furthermore, this will play an important role in the maintenance and continuation of a safe and stable water supply, such as determining the conditions of changes in water quality and fluctuations in demand as well as taking an appropriate and prompt course of action.

In particular, the quality of the Duong River, which is the source, has high turbidity throughout the year and there are cases where the maximum turbidity exceeds 3,000 degrees. This means that adjustments to the chemical dosing rate and equipment operation for these changes in water quality will become necessary, so it will be essential to constantly monitor the status of the water quality.

The scope of the principal operational monitoring work is shown:

- Monitoring and operation of the water treatment process and drainage process through SCADA
- Processing conditions, adjustments to the chemical dosing ratio from water quality data and equipment operation
- Water intake volume in response to demand for water supply, regulation and management of the transmission volume
- Monitoring of the processing state in each process by inspections
- Monitoring, operation and hygiene tasks that accompany preservation and maintenance tasks
- Working solutions and communication with related officials during an anomalous occurrence

In addition, important points to pay attention to in performing these tasks are given:

- Prevention of operational errors
- Prevention of errors in the assessment of situations
- Coordination with preservation and maintenance tasks and also water quality management tasks
- Construction of a system that can constantly monitor and operate the facility status, 24 hours a day, 365 days a year

A system will be implemented with staff divided into groups of four working in shifts and carrying out continuous monitoring 24 hours a day, 365 days a year, under the direction of the person in charge of operations monitoring, in order to clarify the chain of command.

In addition, it is necessary to prevent human error by operations monitoring staff always working in teams of two or more and mutually checking each other's work.

(2) Maintenance Inspection Tasks

In order to be able to always operate the water treatment plant facility in a normal state, it will become important to implement maintenance inspections of electrical equipment and mechanical equipment and through this reliably maintain functions intended of this facility. Therefore, it is necessary for those that have acquired expert knowledge and techniques to carry out these inspections.

The following is the scope of the maintenance inspection tasks:

- Early detection of abnormalities and their indications in equipment through patrol inspections
- Periodic maintenance inspections, maintenance and life extension of equipment functions through maintenance work
- Management of periodic inspections and other tasks by experts
- Minor repair work

Furthermore, according to the performance of these tasks, the following points are important to note:

- Maintenance of work safety
- Acquisition of qualifications necessary for these tasks
- Tasks grounded in the expertise and techniques of electrical equipment and mechanical equipment
- Prompt and accurate judgments and responses

Considering these conditions, a maintenance inspection system will be constructed consisting of electrical and machinery teams, for example, under the direction of the person in charge of maintenance preservation. A maintenance team with specialized skills will be created. This will enable the acquisition of highly specialized techniques and they will appropriately respond when there is equipment breakdown or an emergency at the facility. They will acquire technological strength so that they can investigate the causes of these problems and they will be able to perform safer and more secure operations

Thus, equipment inspection patrols will be carried out by maintenance staff based on the instructions of each electrical and machinery engineer.

1) Maintenance Inspections of Electrical Equipment

   In Japan, installation personnel of non-utility electrical generation facilities (transformation of power receiving equipment etc.) must determine the safety regulations and notify them to the supervising body according to the provisions of the Electric Utility Industry Law, Article 42, Paragraph 1.

   Items on routine patrol inspections, periodic inspections and detailed inspections are specifically stipulated in the safety regulations with the purpose of ensuring safety in relation to maintenance and operations.

In Vietnam as well, the Ministry of Energy has established a management system in the *Technical Regulations when Operating and Managing Power Plants and Power Grids*.

In addition, the power authorities have established items of inspection, standards, acceptance inspection items and more according to the *Electrical Safety Handling Regulations for Maintenance Management, Operation, Repairs and Construction of Electrical Circuits and Power Plants*, compliance regulations and safety policies for workers involved with electricity and also *Regulations related to Periodic Inspections of Power Grids and Transformer Stations*.

Part of the *Regulations related to Periodic Inspections of Power Grids and Transformer Stations* are displayed below:

① Electric Lines

Inspection Items	Periodic Inspection Period
Lightning protection	・Once every two years ・Lightning rod which counts certain numbers of lightning hits
Ground poles (inside piezoelectric lines, 110kV)	・Once every two years ・Electric lines that go through lightning-prone areas, city centers and residential districts: once per year
Grounded low-voltage electric lines and grounded electric meters	Once every four years
Electric insulators	In accordance with regulations on insulators
Voltage transformers, current transformers	Once every two years

② 110kV Receiving plant, relay receiving plant

Inspection Items	Periodic Inspection Period
110kV, 35, 22, 10, 6kV circuit breakers	・Hydraulic circuit breaker: once per year ・SF6 circuit breaker: Depends on the manufacturer's specifications. However, at least once every five years.
Main transformers, interior power transformers, wire wind resistance, neutral point transformers	Once per year
110kV, 35, 22, 10, 6kV lightning arresters	Once per year
110kV, 35, 22, 10, 6kV voltage transformer, current transformers	Once per year
Insulators	In accordance with insulator cleaning regulations
Grounding: grounded transformers, grounded TU, grounded TI, grounded lightning arrester cables, grounded lightning rods	Once per year
Transformers, electric line relays	Once per year
Protection circuits	Once per year
Capacitors	Once per year

③ Receiving Plant

Inspection items	Periodic inspection period
Transformers	Once per year
Grounding	Once per year
Lightning protection	Once per year
Insulators	In accordance with insulator cleaning regulations
Circuit breakers	Once every four years
Relay boards, RMU boards	Once every two years

④ Number of inspections, items and standards

The number of inspections, items and standards are carried out in accordance with the following regulations:

- Electrical Equipment Inspections, Acceptance Inspections, Number of Deliveries and Standards, published by the Ministry of Energy, Decision No. 48 NL/KHKT, dated March 14, 1987
- Operation of Transformers and Repair Procedures, published by the Vietnam Electricity Corporation, Decision No. 623 DVN/KTND, dated May 23, 1997
- Operation of Circuit Breakers and Repair Procedures, published by the Vietnam Electricity Corporation, Decision No. 1120 DVN/KTND, dated August 29, 1996
- Operation of SF6 Hydraulic Circuit Breakers and Maintenance Procedures, published by the Vietnam Electricity Corporation, Decision No. 708 DVN/KTND, dated June 7, 1997

In the event that the equipment is not specified in the above regulations, the manufacturer's regulations will be followed.

Furthermore, in order to maintain the reliability of the water system, a secure and stable electricity supply is essential and it is important to systematically carry out regular inspections, periodic inspections and detailed inspections.

An example of the inspection methods and inspection categories in Japan is given in Table 3.10.2.

Table 3.10.2 Example of Inspection Methods and Inspection Categories

Electrical Facilities	Inspection Method	Inspection Period: During a Patrol	Inspection Period: Periodic Inspection (1 year)	Inspection Period: Detailed Inspection (3-5 years)	Inspection Period: As the Occasion Calls
Section switches that become the boundary of responsibility Service wires etc. (overhead electrical lines, support cables)	Exterior inspection	○	○	○	Carried out as necessary
	Insulation resistance measurement		○	○	
	Section switch operation test		○	○	
Disconnectors, power fuses, circuit breakers, high-voltage load switches	Exterior inspection	○	○	○	
	Insulation resistance measurement		○	○	
	Circuit breaker and load switch operation test		○	○	
	Circuit breaker and load switch internal inspection			○	
Transformers, capacitors, generating lines, reactors, lightning arresters, meter transformers and other high-voltage equipment	Exterior inspection	○	○	○	
	Insulation resistance measurement		○	○	
	Internal inspection of transformers			○	
Power distribution panels Control circuits	Record the voltage, current and electric energy	○	○	○	
	Exterior inspection	○	○	○	
	Insulation resistance measurement		○	○	
	Protective relay operation test		○	○	
	Protection relay operational properties test			○	
	Control circuit test		○	○	
Accumulators	External inspection	○	○	○	
	Voltage measurement		○	○	
	External inspection	○	○	○	
Grounding devices	Ground resistance measurement		○	○	
	External inspection	○	○	○	
Building power receiving equipment and metal box office cubicles	External inspection	○	○	○	

(Source: Summary of Annex Table 2 Patrol Inspection Measurements and Repair Standards of the non-utility electric facility safety regulations)

2) Maintenance Inspections of Mechanical equipment

Mechanical equipment of water supply facilities are wide ranging; from pumps and electric motor devices to valves and agitators. They are important pieces of equipment that lead to subsiding of water, water outages and water quality abnormalities if they suddenly break down.

Therefore, in pumps for the minimization of the effects of equipment failure, continuation of operation is possible by installing standby equipment and then switching to this equipment in the event of a breakdown.

However, in order to lower the failure rate and reliably operate the standby equipment if by some chance they are needed, regular maintenance inspections should be properly carried out, but this will increase the reliability of the water system.

Inspections that exercise all five senses are necessary for mechanical equipment, such as the equipment condition during operation, abnormalities, offensive smells, vibrations, overheating, leakages, oil spills and more. Determinations of abnormalities by expertise acquired from experience are essential and it makes possible early detection of problems.

An example of inspection and maintenance for pumps in mechanical equipment is provided in Table 3.10.3.

Table 3.10.3 Example of Pump Inspection and Maintenance

Classification	Target Equipment	Inspection Contents	Inspection Period: During a Patrol	Inspection Period: One Year	Inspection Period: 5- 10 Years	Inspection Period: As the Occasion Calls
Daily Inspection	All	Exterior, vibrations, strange noises, temperature, changes in color, damage, leakages	○			
	Pumps	Oil amount of the axis bearing lubricant (oil, grease), oil spills, operation of oil rings, condition of the fuel filler opening and connectors, ground packing heat, amount of water dripping from seals	○			
	Control Unit and Meters	High water level detectors, low water volume detectors, operating conditions of the solenoid valves, pressure gauges, compound gauges, vacuum gauges, thermometer, readings of ammeters etc., conditions inside the control panel	○			
Periodic Inspection	All	Looseness in parts, corrosion, abrasion, deterioration, damage		○		
	Pumps	Replacement of axis bearing lubricant (oil, grease), conditions of replenishment, cleaning and coating, tightening of pressure nuts and bolts, exchange of Bush coupling rubber, adjustments, replacements and exchange of gland packing		○		
	Control Unit and Meters	High water level detectors, low water volume detectors, operating conditions and properties of the solenoid valves, calibration of pressure gauges, compound gauges, vacuum gauges and thermometers		○		
Detailed Inspection	Pumps	Overhaul inspections of impellers, casing, sleeves and axis bearings, replacement of worn parts, replacement of nuts and bolts, replacement of Bush coupling rubber, centering adjustments			○	
	Control Unit and Meters	Properties inspections and defective product replacement of high water level detectors, low water volume detectors and solenoid valves and properties inspections and replacement of defective gauges			○	

Test Measurements s	Pumps	Sequence testing for vibrations, discharge flow, pressure and activation time etc., protective device operating tests for temperature relays etc.		○		
Replacement Parts	Pumps	Bearings, gland packing, seals				○

(Source: Excerpt from *Guidelines for Waterworks Technical Management* 2006, by the Japan Water Works Association)

(3) Repair Tasks

In order to maintain and extend the original function of equipments, it is important to implement periodic inspections as well as replace equipment parts and consumable goods. Type and duration of each repair work are considered according to the method recommended by the manufacturer, in consideration of the actual consumption condition and trouble frequency of each equipment in order to formulate a realistic work plan and ensure implementation.

1) Electrical Equipment Repair

Electrical equipments are divided into electrical receiving, transforming and power facilities, monitoring and control facilities, and water quality instrumentation facilities. Electrical receiving, transforming and power facilities are combined in order to adapt many purposes of machines, and those of the individual parts can be replaced. On the other hand, most of monitoring and control facilities as well as water quality intruments are general-purpose products, and repairs of their individual parts are just few.

Therefore, repair method and period of each electrical equipment is different base on type of that. Base on formulating conscientious repair plan including the importance of that equipment, and implementation comprehensive management including procurement of spare parts and equipments, maintenance and life-extension of equipment functions and reduction of operation and maintenance cost shall be achieved together.

2) Mechanical Equipment Repair

If the operation parts of mechanical equipment such as pump are in deterioration, that function, efficiency and reliability shall become lower. Therefore, it is important to grasp correctly the situation of each machinery according to periodic inspection and overhaul, in order to execute equipment change suiting the condition of those consumption and deterioration. In particularly, in case water intake pump, water conveyance pump, and water tranmission pump, considered as important equipments, are in troubles or bad conditions, the water treatment plant shall become unable to operate as usual. Thus, it is essential to draft an repair plan in consideration of preventive maintainance.

(4) Water Quality Management Tasks

1) Outline of National Standards for Quality of Drinking Water

The standards for drinking water quality in Vietnam adhere to circular No. 04/2009/TT-BYT *Vietnam National Technical Standards on Drinking Water Quality* published by the Ministry of Health, dated June 17, 2009. This circular came into effect on December 1, 2009, and it is understood to be a replacement for the current standards in 1329/TC-BYT.

These regulations cover agencies, organizations and households that develop and sell clean water and also facilities that supply over 1,000m^3 per day of water for living. Thus, it is important to make a water-quality test plan that follows these standards and construct a system that is capable of testing water quality.

Some of these technical regulations are in the next Table.

Table 3.10.4 Technical Regulations (Extract)

No	Standard items	Unit	Maximum water quality standard	Experiment process	Test frequency level
Sensory and inorganic matters					
1	Color(*)	TCU	15	TCVN 6185 - 1996 (ISO 7887 - 1985) or SMEWW 2120	A
2	Taste・Odor(*)	-	No aberration	Sense, or SMEWW 2150 B và 2160 B	A
3	Turbidity(*)	NTU	2	TCVN 6184 - 1996 (ISO 7027 - 1990) or SMEWW 2130 B	A
4	pH(*)	-	6.5~8.5	TCVN 6492:1999 or SMEWW 4500 - H^+	A
5	Hardness, as $CaCO_3$(*)	mg/L	300	TCVN 6224 – 1996 or SMEWW 2340 C	A
6	TDS(*)	mg/L	1000	SMEWW 2540 C	B
7	Aluminium(*)	mg/L	0.2	TCVN6657:2000 (ISO 12020:1997)	B
8	Ammonia(*)	mg/L	3	SMEWW 4500-NH_3 C or SMEWW 4500-NH_3 D	B
14	Chloride ion(*)	mg /L	250 300(**)	TCVN6194 - 1996 (ISO 9297 - 1989) or SMEWW 4500 - Cl^- D	A
20	Iron (Fe^{2+} + Fe^{3+})(*)	mg/L	0.3	TCVN 6177 - 1996 (ISO 6332 - 1988) or SMEWW 3500 – Fe	A
22	Manganese	mg/L	0.3	TCVN 6002 - 1995 (ISO 6333 - 1986)	A
26	Nitrate	mg/L	50	TCVN 6180 - 1996 (ISO 7890 -1988)	A
27	Nitrite	mg/L	3	TCVN 6178 - 1996 (ISO 6777-1984)	A
30	Sulfate ion(*)	mg/L	250	TCVN 6200 - 1996 (ISO9280 - 1990)	A
Insecticides and their components					
32	Oxygen consumption ($KMnO_4$ consumption)	mg/L	2	TCVN 6186:1996 or ISO 8467:1993 (E)	A
90	Residual chlorine	mg/L	0.3 ~ 0.5	SMEWW 4500Cl or US EPA 300.1	A
Microorganism					
108	Standard plate count	MPN/100 ml	0	TCVN 6187 - 1,2:1996 (ISO 9308 - 1,2 - 1990) or SMEWW 9222	A
109	Escherichia coli or fecal coliforms	MPN/100 ml	0	TCVN6187 - 1,2: 1996 (ISO 9308 - 1,2 - 1990) or SMEWW 9222	A

（Source：Environment board・Standard of drinking water quality 2009）

Note: (*): Sensory criteria

(**): Criteria applied to seashore and island environment

2) Water Quality Test Frequency

Displayed are the water-quality test frequencies that are set forth in these regulations:

- Source water measurements prior to the introduction of water

All measurements of Levels A, B and C are conducted in order to inspect the source water prior to the introduction of water by the water supply location.

- Periodic testing

A-level test frequency: 15 items

a. A measurement at least once per week conducted by the water station

b. A test, measurement and observation at least once per month by the testing agency

B-level test frequency: 16 items

a. A measurement at least once every six months conducted by the water station

b. A test, measurement and observation at last once every six months by the testing agency

C-Level test frequency: 78 items

a. An observation at least once every two years conducted by the water station

b. A test, measurement and observation at least once every two years by the testing agency

Table 3.10.5 Relevant Laws and Regulations on Water Quality

Relevant Laws	Announce date	Contents
Ministry of Health, Circular No. 4	2009.6.17	Promulgation of official standards for drinking water quality (This circular went into effect on December 1, 2009, and is a replacement for the current 1329/TC-BYT)
Vietnam Construction Standards 5942-2005	2005	Quality standards of raw water
National Technology Standards 08:2008/BTNMT	2008	Quality standards of surface running water
National Technology Standards 01:2009/BYT	2009	Quality standards of drinking water
National Technology Standards 02:2009/BYT	2009	Quality standards of water for living
National Technology Standards 24:2009/BTNMT	2009	Standards of industrial drainage discharge
WHO Guidelines for Drinking-water Quality, 2008	2008	WHO guidelines for drinking water quality

3) Water Quality Testing Agency and Outline of Testing Cost

In Vietnam, national public water quality testing agencies are known as QUATEST 1 (Ha Noi city), QUATEST 2 (Da Nang city), QUATEST 3 (Ho Chi Minh city). There are also some provincial testing organizations, however, each one has different testing items.

The cost of every testing frequency level stipulated in *Vietnam National Technical Standards on Drinking Water Quality* per one time is approximated as below:

Testing frequency level	Approximately cost (VND)/Number of testing items
A	1,000 / 15 items
B	4,500 / 16 items
C	35,500 / 78 items

4) Water Quality Management Techniques

It is very important to conduct water quality management in each process, in order for it to be possible to appropriately respond to changes in the quality of raw water based on clean water always meeting quality standards, protecting its sanitary safety and keeping it in good condition.

In the World Health Organization (WHO), the concept of Hazard Analysis and Critical Control Point (HACCP) has been introduced which has been established in the food manufacturing sector in the *2004 WHO Water-quality Guidelines (Third Edition)*. This proposes a Water Safety Plan (WSP) which will see the construction of a water supply system that will conduct hazard assessments and hazard management at all stages, from the water source to the tap, and which will reliably supply safe water.

In Japan, based on these techniques, the Ministry of Health, Labour and Welfare formulated the *Guidelines for Water Safety Planning* and the Japan Water Works Association compiled water safety planning case data in typical water treatment processes. In small and medium sized business entities as well, it has become possible to formulate comparatively simple plans.

Heading into the future, in order to also supply safe and high quality tap water, it is vital to formulate, manage and operate a water safety plan for this project.

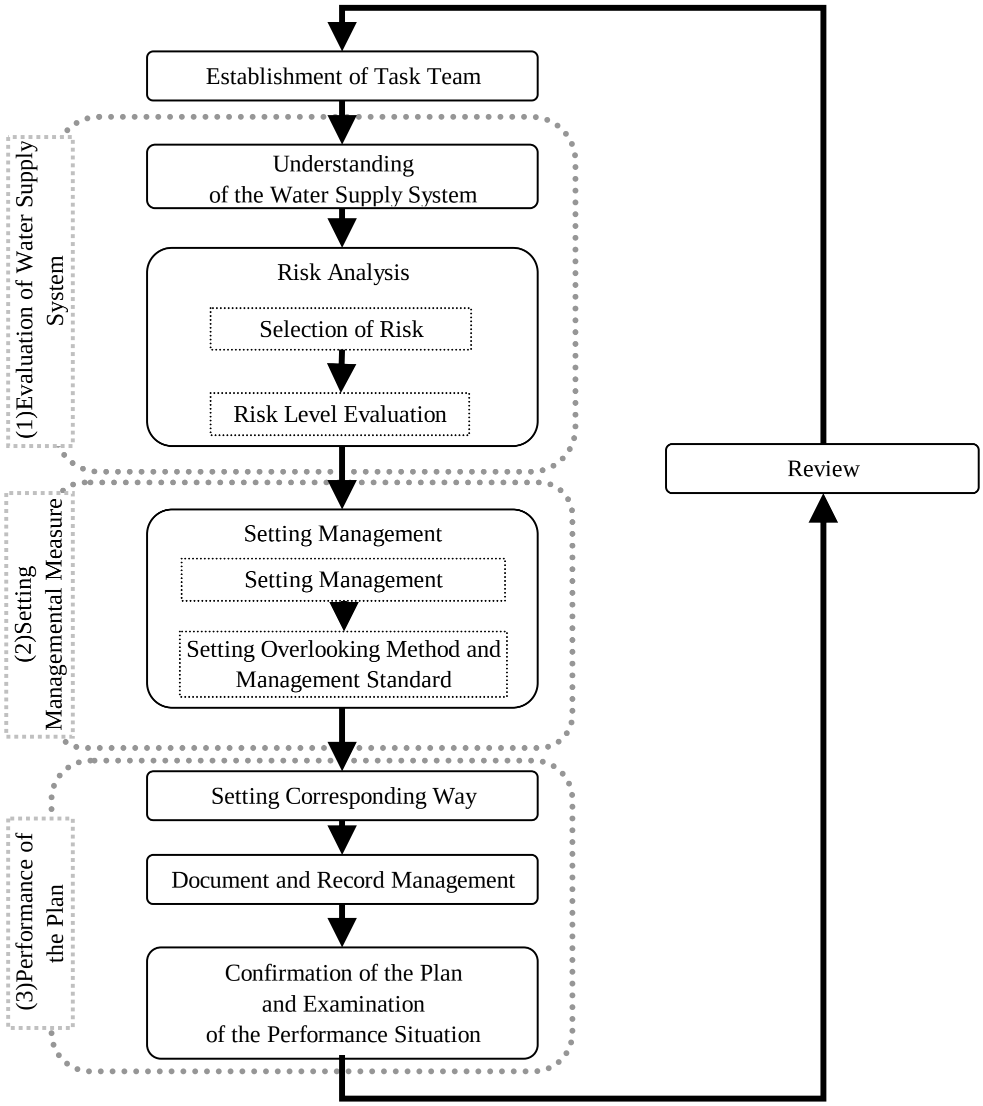


Figure 3.10.1 Flowchart of the Water Safety Plan Formulation and Operation
(Source: Excerpt from the Ministry of Health, Labor and Welfare's *Guidelines for Water Safety Planning*)

5) Water Quality Management System

Ensuring and supplying high quality and safe tap water is one of the most important challenges from the aspect of ensuring national public health. Therefore, it is necessary to construct a water quality management system.

Along with monitoring the water quality along the flow of the water supply system and taking an appropriate response to meet those conditions, in the event that there are fears about the safety of tap water, a system is required which quickly takes the best course of action.

The project details that are demanded in water quality management are listed:

- Formulation of a water quality management plan based on *National Standards for Quality of Drinking Water*
- Formulation of a water quality inspection plan
- Water quality inspection and inspection results analysis
- Determination of the chemical dosing ratio in all water treatment processes in response to the quality of raw water
- Management of water quality data
- Investigation of necessary operational methods to maintain and improve water quality.

Moreover, in performing the tasks, it is necessary to consider the following points.

- Compliance with the inspection items and frequencies as specified
- Prompt investigations to determine the cause of a problem and a clear course of action to take in the event of an abnormality occurring
- Ensuring the reliability of water quality inspection results

To satisfy these conditions, water quality management tasks will be carried out by one person responsible for water quality management and also expert engineers. Furthermore, in order to strictly manage water quality, it is essential to establish an organization with experts that independently perform these tasks and which is given a strong authority.

(5) Drainage Management Tasks

The sludge in the sediment basin and the wash water drainage in the filtered basin that is emitted from the water treatment process are separated into liquids and solids by the drainage processing facility, the sludge concentration is increased and it is then naturally dried in a sun drying bed. The cake moisture ratio at that time is expected to be around 70%. Furthermore, the merit of sludge treatment cost reduction by application of sludge dehydrator in future shall be considered.

The amount of solid materials that is projected to be generated in this project is shown:

Table 3.10.6 Amount of Solid Materials Generated at the Water Treatment Plant

Each Amount of Solid Materials Projected to be Generated	First Stage (150,000m^3 per day)	Second Stage (300,000m^3 per day)	Remarks
Intake port	approx. 15.8 ton-DS per day	approx. 31.7 ton-DS per day	Moisture content: 70%
Settling basin	approx. 13.9 ton-DS per day	approx. 27.8 ton-DS per day	Moisture content: 70%
Sun drying bed	approx. 10.1 ton-DS per day	approx. 20.2 ton-DS per day	Moisture content: 70%

Due to the fact that it is necessary to carry off-site the cakes that are sun dried, in this project it is expected that transferring work will be generated, such as the use of heavy machinery and trucks. Therefore, it is vital to construct a system that specializes in the management and implementation of these drainage processing tasks.

(6) Pipeline Management Tasks

Transmission pipeline accidents don't just occur due to sudden loss, reduction and turbid water; they can also be caused by secondary disasters, such as road collapse, traffic disorder and flooded housing. The social impact has a large effect. In order to prevent these in advance, periodic inspections and maintenance are important and it is necessary to establish frequent patrols and inspections and systematically conduct them.

The scope of the transmission pipeline maintenance tasks is displayed below:

- Management of transmission pipeline information and management of pipeline maps
- Patrol inspections of the entire transmission pipeline around once a week by a maintenance vehicle
- Detection of leakages, signs of leakages and events that lead to leakages by patrols
- Verification of operation conditions of all water distribution equipments such as distribution points, gate valves placed on distribution pipes
- Water quality tests (residual chlorine concentration, turbidity, etc.)
- Detection of water theft

Inspection patrols that include booster pump stations will be conducted in the form of one person with full responsibility for the transmission pipeline, who will manage these tasks, and an inspection team.

(7) Security System

In the event of a terrorist attack such as poison injection on the water supply facility (for example a substance being thrown into the source of water), it would create an extremely serious situation where people's lives and physical safety would be threatened and it would also paralyze people's daily lives and urban activities.

Therefore, this project considers the comprehensive construction of a security system which utilizes both the strong points of machines that are durable, continuous and accurate by installation of surveillance cameras inside the facility and that of humans that have accurate judgment ability and flexible behavior by stationing of security guards.

A 24-hours 365-days security system will be constructed with a different personnel system, because of qualitative and practical differences between the human security tasks and the tasks in the operation of the water treatment plant. Specifically, a security guard will be stationed to monitor the entrance and exit at the main entrance of the water treatment plant and security officers will patrol inside the plant.

It is believed that the stationing of security officer personnel that have received special education from the special characteristics of these functions will be effective and that it will be possible to ensure their continuous staffing by contracting domestic Vietnamese security firms.

According to the media "Statistics show that there are approximately 600 security firms and that they employ tens of thousands of people. The areas with a large number of firms are Ho Chi Minh with 165 companies, Ha Noi with 149, Dong Nai Province in the south-east has 51 and Hai Phong in the north has 45. Among these companies, there are some that overemphasize short-term profits, ignoring personnel investigations during recruitment and failing to conduct training after employment." (Source: Viet Jo, Vietnam Daily News, October 30, 2009)

Given the current state of this, it will be necessary when selecting a security firm to carry out a careful examination of the company's reliability from a variety of viewpoints, including past results, management conditions, financial results and details of these, their training system and back-up systems.

(8) Operation and Maintenance Management System

The tasks implemented in this project will be carried out at an early stage in a system with Vietnamese workers. Therefore, we propose the following personnel system. The initial on-site start-up will see a support system created by Japanese engineers and then a technology transfer to Vietnamese personnel will take place. Then, while matching the degree of technical mastery of Vietnamese employees, the number of Japanese engineers will be progressively reduced and an early-stage independent work system by Vietnamese staff will be implemented.

Moreover, also in case of entrusting an external expert with the Operation and Maintenance Management Tasks, it is planed to build a technical support system by Japanese engineers, in order to early stabilization of administration and improvement of quality of this water treatment plan.

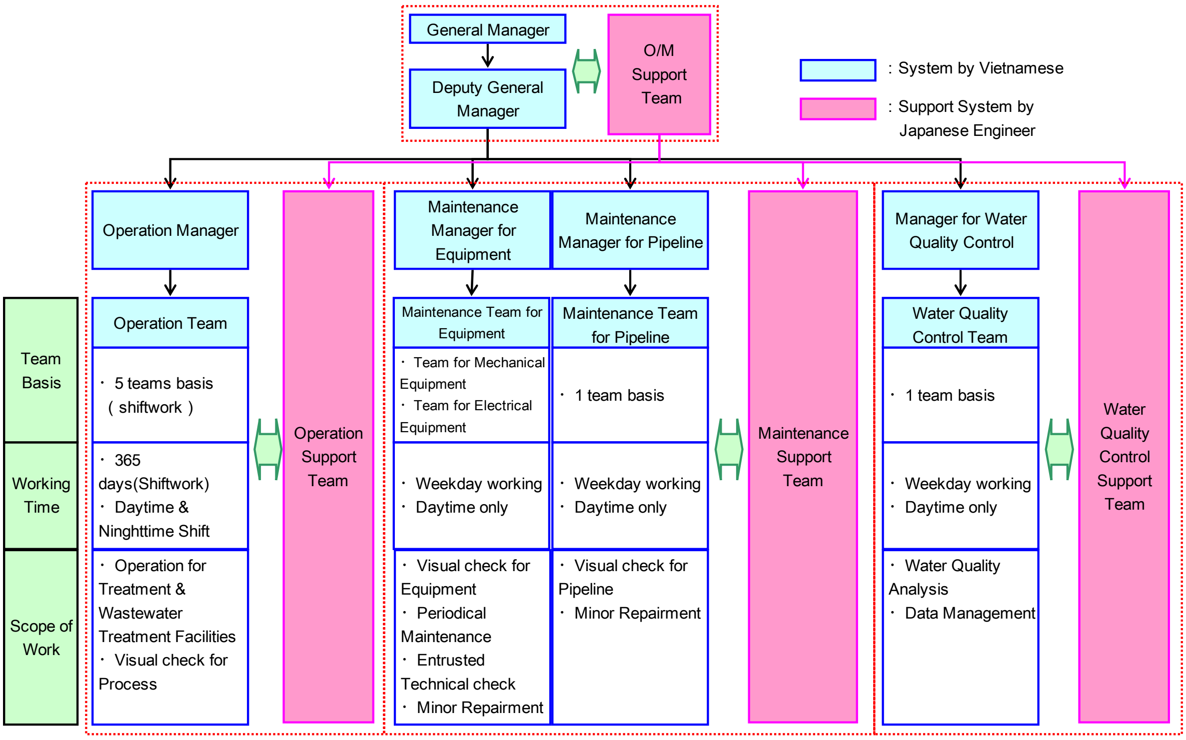


Figure 3.10.2 Vietnamese Operating System and Japanese Support System

3.10.6 Human Resource Development Plan

The following is necessary for the concept that in a few years' time there will be a personnel system with Vietnamese employees themselves capable of maintaining and operating the facility and also for the support method of Japanese engineers.

- The chief supervisor will be a Vietnamese employee from the outset and they will receive education with the help of Japanese engineers so that they are capable of making determinations by themselves
- A maintenance management system will be established by Vietnamese personnel from the commencement of operations
- In case an abnormality occurs, a maintenance unit will be constructed that can deal with the problem themselves

Moreover, a support system will be provided that ensures a structure that supports safe and stable operations and maintains work quality, even after the Vietnamese employees have become able to carry out maintenance and operations themselves.

- Systematic support from Japan (remote supervision, cameras, conferencing etc.)
- Maintenance and improvement of work and technology quality by monitoring from Japan
- Technical improvements and technological exchange through periodic training in Japan

When constructing the maintenance management system, the system will be built taking note of the need to ensure water quality, maintenance of work quality and so that it is possible to sustain operations by Vietnamese personnel in the future.

(1) Concept of the Support System

It has been determined that at the outset of the commencement of operations, support from Japanese engineers will be indispensible, because the equipment calls for advanced technical skills. However, in a system where Japanese engineers will be taking a central role, there is a possibility this could hamper the independence of Vietnamese staff.

Therefore, from the outset of the operations of this project, a chain of command will be determined to establish an operational system with Vietnamese personnel. We propose a system where Japanese engineers will provide assistance and guidance from the dimensions of each task group, for example management, operation, maintenance and water quality control.

The technology transfer from Japanese engineers will take place for those responsible for each task and care will be taken not to disrupt the Vietnamese chain of command.

Some of the points in technical assistance are indicated:

- A technical support system and method that doesn't disrupt the Vietnamese staff structure and chain of command
- Japanese engineers will place stress on taking a position of assistance and will provide technical support so that Vietnamese officials can independently carry out operations
- Technical assistance that allows Vietnamese officials to make determinations and work (experience) for themselves

Taking note of these points, we believe it is best to have a system where Japanese engineers provide support so that in a few years' time, Vietnamese officials will be able to operate the water treatment plant.

The following is the planned numbers of Japanese engineers for O&M when Japan takes the initiative of the management.

Table 3.10.7 Planned Numbers of Japanese Engineers

Elapsed Year	Phase 1				
	1st Year	2nd Year	3rd Year	4th Year	5th Year
Number of Japanese Engineers	8	4	3	1	1

Elapsed Year	Phase 2				
	6th Year	7th Year	8th Year	9th Year	After 10th Year
Number of Japanese Engineers	4	3	1	1	1

The first year when facilities start to be used is considered that the Vietnamese staff may have less knowledge about O&M of coagulation-sedimentation and rapid filtration system. Therefore 8 Japanese engineers will be put into and they will provide trainings and technical supports on 24 hours schedule. Also for the 6th Year when phase 2 will be launched, more Vietnamese staff will join O&M with enhancement of the facilities. Thus the number of Japanese engineers will be increased temporarily and will be reduced step by step depending on the level of proficiency of Vietnamese staff.

(2) Technological Exchange

Technological exchange and On the Job Training (OJT) that will be conducted through local operations is one effective way for technology transfer. However, for the engineers that are transferred, there is also the aspect that it will be difficult to understand the nature and background of this technology. Moreover, in order to also proactively incorporate new technology that is making advances day by day, we propose to introduce a regular training system in Japan.

Points on the training in Japan are shown here:

- By experiencing and understanding Japanese infrastructure and culture, the comprehension of the nature of technology transferred will be caused.
- In addition to specific technologies, there will be personal experience of Vietnamese officials of the way Japanese water service engineers work and high motivation.
- Expertise and technology outside of local equipment that will be important in the future for Vietnamese officials will be a part of training in Japan.

Based on the training plan, training opportunities will be provided to several people every year in Japan and by getting to actually see and touch cutting-edge technology, we expect further technological advances along with increased individual motivation.

3.10.7 Utility Procurement Plan

(1) Chemicals

1) Sodium Hypochlorite (Disinfectant)

Currently, in water treatment plants in Vietnam, the majority of facilities are using chlorine as a disinfectant. However, when compared to chlorine gas, which must be handled as an irritant poison and high pressure gas, sodium hypochlorite can ensure adequate safety, it doesn't require peculiar storage by exception facility as well as specialized engineers. Moreover, pH value fluctuation is shown just a few after injection so that it is easy to maintain. Therefore, this project has adopted sodium hypochlorite (liquid 6%) as a disinfectant.

In addition, sodium hypochlorite is also manufactured in Vietnam and so procurement and transportation can be easily achieved.

Table 3.10.8 Comparison of Chlorine Agents

	Liquid Chlorine	Commercial Sodium Hypochlorite	Sodium Hypochlorite Generation
Properties	Liquefied chlorine gas loaded into compressed gas cylinders	Liquid	A liquid manufactured by electrolysis of brine
Effective Chlorine Concentration	Over 99.4%	Product I: over 12.0% Product I: Less than 12.0%	No diaphragm process: about 1% Diaphragm process: about 5%
Quality	Stable.	Strongly alkaline. The higher the effective chlorine concentration, the more unstable so the higher the chlorine concentration the more it is subject to degradation.	Slightly alkaline. Stable compared with commercial sodium hypochlorite.
Storage	Subject to the General High Pressure Gas Safety Law and the Ordinance on Prevention of Hazards due to Specified Chemical Substances.	In the case of 12% sodium hypochlorite, caution is needed for declining concentrations. Long-term storage as sodium hypochlorite is not possible.	Long-term storage as a raw material is possible.
Dosing Facilities	Complex	Simple	Somewhat complex
Notes	The irritant odor of the gas and toxicity must strictly conform to regulations and it requires careful handling.	・Bubbles are generated by the degradation of sodium hypochlorite. ・It is important to take into account that there can be no air lock	・Difficulties caused by bubbles and small scale generation ・Hydrogen occurs during generation so from the dilution fan

		inside the pump and pipes.	to the safety concentration, it is diluted and released outside .
Anti-leakage Measures, Exclusion Facilities, others	・If there is a chlorine gas leak, it will lead to a serious incident. ・On a small-scale, gas leak detectors and reserves of neutralizers and absorbents are necessary. Furthermore, on a large-scale, exclusion facilities (such as for a neutralization response) will be established.	・Liquid protective buckets of storage tanks are necessary. ・Avoid mixing sodium hypochlorite with PAC (including waste liquid) (Mixing sodium hypochlorite with PAC generates chlorine gas). During a leakage, the pH will be high, so there is a great danger.	・Liquid protective buckets of storage tanks are necessary. ・Compared with commercial sodium hypochlorite, the pH is low, so there is less risk of danger.
Maintenance	Maintenance of chlorine injectors, vaporizers and exclusion facilities is required. Maintenance of dosing facilities is necessary. Maintenance of electrolytic dosing facilities is essential.	Maintenance of dosing facilities is necessary.	Maintenance of electrolytic dosing facilities is essential.

Source: *Excerpt from Drinking Water Technology Guidelines 2010* (Japan Water Research Center)

2) Polyaluminum Chloride (coagulant)

The coagulants used in the aggregation process at water treatment plants are generally aluminum sulfate or polyaluminum chloride. In this project, polyaluminum chloride (liquid 17%) is employed because when compared to aluminum sulfate, it has a wider range of coagulant uses, residual turbidity after injection is in low level, dilution for usage is not required, and maintenance is easy to handle.

In Japan, the purchase, transport and introduction in a 10% solution as Al_20_3 is common, but in Vietnam the approximately 30% powdered form as Al_20_3 is the mainstream and a huge amount of work is required to dissolve it.

In this project, the Duong River is used as the water resource, which has high turbidity throughout the year and so an aggregating effect is important. The amount used is also high and so the adoption of polyaluminum chloride in liquid, which is easy to handle and workload is small, offers stable operations.

3) Coagulant Aid

The result of Jartest using Duong river's water in order to verify the treatment effectiveness of Polyacrylamide (known as a nonionic polymer), proved that it is become difficult to inject the solution due to increasing the viscosity of that caused by dissolved concentration level. In addition, for the high toxicity of the impurity (Acrylamide monomer), yet is the inspection system not developed in Vietnam, so this coagulant aid shall not be used in this project.

4) pH Adjusting Agent

In Duong River, pH value is about 8 as usual. In case of using PAC as an coagulant, pH value after the Jartest indicates light alkalinity. From that slight increase of pH by adding a solution of Sodium Hypochlorite as Chlorine, the need to increase further the pH of raw water is judged to be low. Therefore, in this project, the pH adjusting agent shall not be used.

5) Procurement inside Vietnam

The chemicals used in this project are all all produced or saled in Vietnam, and can be easily procured and transported.

The procurement environment and approximate prices of the chemicals enable to be used in the water treatment process that are produced in Vietnam are already investigated.

(2) Electric Power

A very detailed pricing structure has been established for electric power in Vietnam. There are 'peak,' 'normal' and off-peak' rates depending on the application of the electric power, the receiving voltage and the time of day used. There is a meter system for these fees. Therefore, by drafting an operational plan that proactively takes advantage of low-cost electric power in the 'off-peak' band, which operates from late at night to early morning, and by constructing an operating system, it will be possible to reduce clean water costs.

Electric power prices for the receiving voltage of 22kV that will be used in this project are shown below:

Table 3.10.9 Electricity Prices by Time Band (Receiving Voltage 22kV)

Prices	Form Mon to Sat	Sun
Normal 1,068（VND/kWh）	4:00-9:30 11:30-17:00 20:00-22:00	4:00-22:00
Peak 1,937（VND/kWh）	9:30-11:30 17:00-20:00	-
Off Peak 670（VND/kWh）	22:00-4:00	22:00-4:00

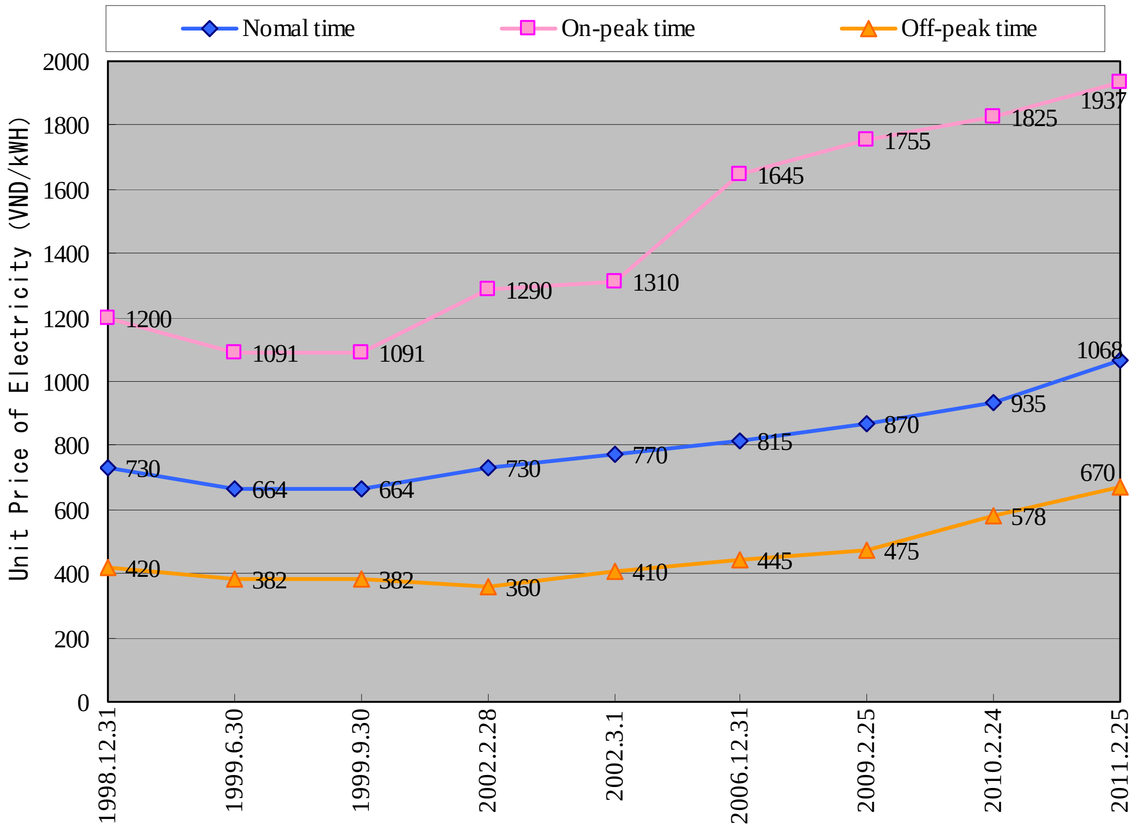


Figure 3.10.3 Changes in Electric Power Fees (Meter System)

*Source: Field survey conducted in February 2011

3.10.8 Investigation into the Disposal of Excess Water Treatment Soil

The amount of planned solid material to be generated in every treatment proccess in this project will be approximately 190 ton-DS per day in the first stage and 380 ton-DS per day in the second stage.

In Japan, in addition to excess cakes that are buried and disposed of, there are cakes that are put to an effective use, such as in horticultural soil and public works raw materials. Results from our field surveys show that in Vietnam, there is only landfill and disposal. While the potential for effective use in the future is undeniable, at present the project plan assumes that there will be landfill and disposal.

However, in this project, the plan is to establish a water intake facility and settling basin, partially remove the solid materials derived from the raw water turbidity by natural precipitation due to non-chemical dosing, then to convey water into the clean water process. Therefore, we want to investigate air drying, in a sun drying bed, of the sand that settles in the water intake facility and settling basin (approxi. 150 ton-DS per day in the phase I, 300 ton-DS per day in phase II) and it's effective usages.

In the rivers of Vietnam, river sand is being excessively reclaimed. Also in the city of Ha Noi, drawing up river sand alongside the Hong River (Red River) and Duong River is being actively performed.

The river sand is being used for civil construction works, and soil reclamation. Accordingly, in this project, the sand settled in the water intake facility and settling basin shall be used effectively in many ways.

(1) Method of Disposal in Vietnam

When disposing of the excess soil in the sun drying bed, the relevant laws and regulations on waste matter are as follows:

Table 3.10.10 Relevant Laws and Regulations on Waste Matter

Relevant Laws	Date of Announcement	Contents	Vietnamese	Japanese	English
Environmental Protection Act	2005.11.29	Activities, policies and methods for environmental protection; individual and organizational rights and obligations for environmental protection	○	○	
Government Ordinance No. 59	2007.4.9	Waste management	○	○	
Ministry of Construction Circular No. 13	2007.12.31	Operation of Government Ordinance No. 59 on waste management etc.	○		
Prime Minister's Decision No. 2149	2009.11.20	A comprehensive national strategy for waste management by 2025	○	○	
Ministry of Construction Circular No. 24	2010.12.24	Construction waste disposal	○	○	

(2) Outline of the Disposal Contractor

Treatment of excess soil in Vietnamese water treatment plants is primarily the work of the state-run Urban Environment and Industry JSC. (URENCO 10), which has a permit from the Vietnamese Ministry of Environment for waste treatment rights. The city disposal facilities of this disposal contractor as follows:

Table 3.10.11 City Disposal Facilities by URENCO

City Disposal Facility	Scale	Distance from Duong River Water Treatment Plant
Nam Son Treatment Plant	83ha (expansion planned to 140ha)	approx. 90km
Xuan Son Treatment Plant	40ha	approx. 80km
Bau Lac Water Treatment Plant	Under construction	
Nui Thoong Treatment Plant	30ha (Household waste only)	

(3) Disposal Method of Excess Soil in Japan

Excess water treatment soil that is discharged due to the water treatment process has been designated as industrial waste (sludge) in the Waste Management and Public Cleansing Act in Japan. Moreover, business operators must take proactive steps (for example promotion of waste reduction and recycling) and effectively use waste as a recyclable resource from the perspective of global environmental protection.

The effective utilization rate of excess water treatment soil in Japan continued to increase from 36.6% in FY2000 and since 2004 transitioned to 50%. In recent years the rate has remained flat at around 55%.

Excess water treatment soil is primarily composed of volatile solids (e.g. organic substances), silica and aluminum. The properties of this soil, which come from differences in the composition of the soil included in each river (lakes and marshes), vary considerably depending on the water treatment plant. Effective utilizations of this excess soil in Japan include soil for agricultural and home gardening, ceramics, public works materials (recycled soil for backfill), cement materials and ground materials, among other uses.

Some examples of effective utilizations in Japan are shown in Table 3.10.12.

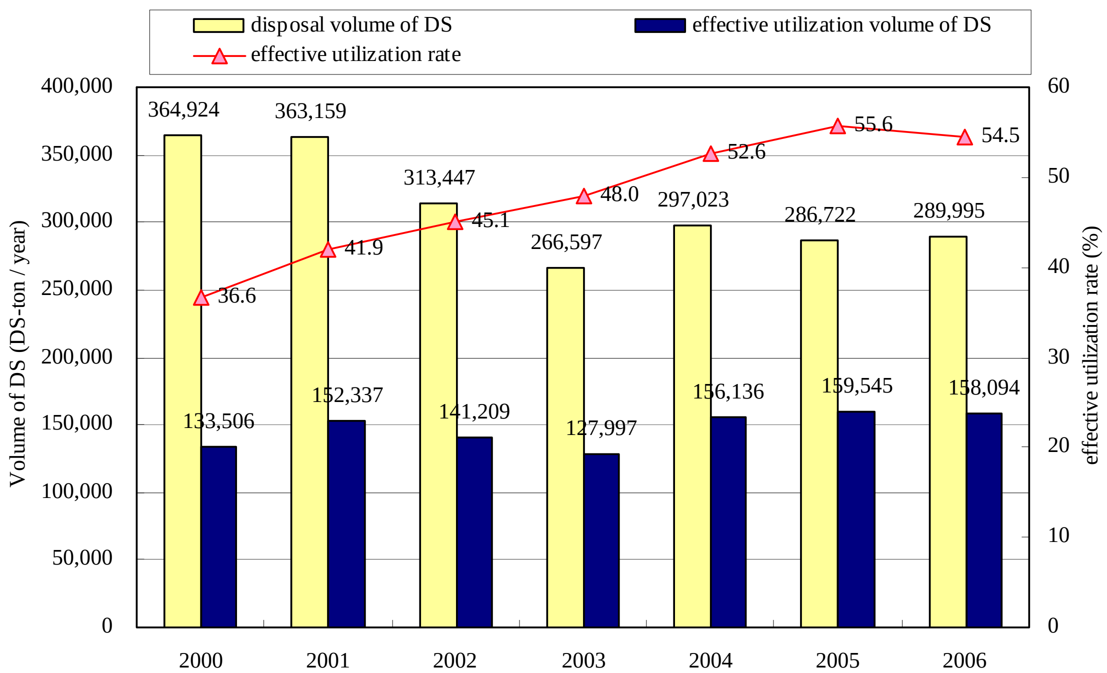
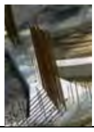


Figure 3.10.4 Amount and Effective Utilizations of Excess Water Treatment Soil

Table 3.10.12 Effective Using Methods and Aptitude Conditions

Using Purpose	Aptitude Conditions and Applications
Agricultural and domestic garden soil 	Soil dressing on agricultural land in soil erosion or poor stituation, soil back-filling to the site of grass flower cultivation land ruins, potted plant growing soil, seedling raising soil, domestic garden soi, ect. can be considered as usage. Aptitude conditions of these used soil are required as well ventilation and permeability, moderate water retention, 3 - 10mm in particle size, manganese and aluminum content within certain limits. Poor land use and soil angle of soil erosion on agricultural land, soil back to the site of grass flower cultivation, growing potted plant, soil and other times as vegetable seedlings can be considered as home gardening times Sat. These properties are required to iodine are well-ventilated permeability, and that there is moderate water retention, particle size is 3 - 10mm, is within certain limits, no content of weed seeds and sterilization, good pH value (neutral to slightly acidic), etc.
Ceramic materials	Tile, bricks (refractory bricks), pottery pipe, etc. are used as a substitute for clay material. However, each product has it's own standardization, so eventually, it is required to satify product quality sufficiently. In addition, the content of iron, manganese, aluminium, organic matters in soil causing many problems in manufacturing products with stable quality, and high energy cost by firing process, shall create limitation of effective use.
Civil engineering materials (Back-filling reclamation soil) 	As an alternative material to mountain sand, lime, cement are mixed together to produce granulated sand with an approriate size, then use as back-filling reclamation sand when laying water pipes.
Cement materials 	It can be effectively used as one of malt cement materials. The propotion ot clay component is about 20%.
Materials for ground	When improving soil by addition of materials for soil improvement, existing ground soil is mixed in the approriate ratio. Aptitude conditions of these used soil are required as be able to subdivide easily, neutral to slightly acidic pH, no content of weed seed, mixture of activated carbon within 25 to 30%, etc.

Source: *Except from Drinking Water Technology Guidelines 2010* (Japan Water Research Center)

Table 3.10.13 Specific Examples of Recycled Excess Water Treatment Soil

Water Supplier	Recycling Details of the Excess Water Treatment Soil
Bureau of Waterworks Tokyo Metropolitan Government	Approximately 80% is effectively utilized as granular improvement soil and cement materials in addition to soil for horticulture and ground improvement materials.
Yokohama Waterworks Bureau	Utilized as horticultural materials and part of the soil is put into 10kg bags at the water treatment plant and sold at one bag for 200 yen (tax included).
Chiba Prefectural Waterworks Bureau	Soil is recycled for cement materials and artificial lightweight aggregate. The most recent recycling rate has been maintained at roughly over 98% and in FY2006 was 100%. Moreover, in order to diversify processing of excess water treatment soil, studies have been taking place into turning excess water treatment soil into afforestation cultivation soil.
Kitakyushu City Waterworks Bureau	Soil for the ground, nursery soil, cement materials and river cleanup soil.* *The effective use in phosphorus removal treatment for the river cleanup of water treatment sludge is a first in Japan.

Souce: Excerpt from the *Handbook of Environmental Measures in the Waterworks Industry (Revised Edition)* by the Ministry of Health, Labour and Welfare

3.10.9 Technological Support of Large-scale Water Treatment Plants and Safe Operation System

(1) Technological Management and Support System by Remote Supervision

In order to carry out the safe operation of a large-scale water treatment plant that uses the surface water of the Duong River, which has high turbidity throughout the year, it requires Japan's sophisticated technology. It is also vital to construct structures and systems where expert engineers can provide ongoing technological support, assistance and cooperation.

In Japan, there are companies that are constructing remote support centers with expert engineers that support the operation maintenance management tasks in water treatment plants.

Taking advantage of this structure, we propose a technological support system by transmitting information, such as the monitor screen and images obtained by the Central Monitoring Room of the Duong River Water Treatment Plant and combining tools such teleconferencing at the same time. With this system, it will be possible to pick up the current local situation, even in Japan. Furthermore, we believe that while striving for a real-time community with on-site staff, it cause enable to reasonably provide Japanese technical support by working to solve problems.

Expert engineers in water supply have been posted to the Support Center and are implementing many technological assistances such as measures and support methods to cope with a variety of problems from the local site.

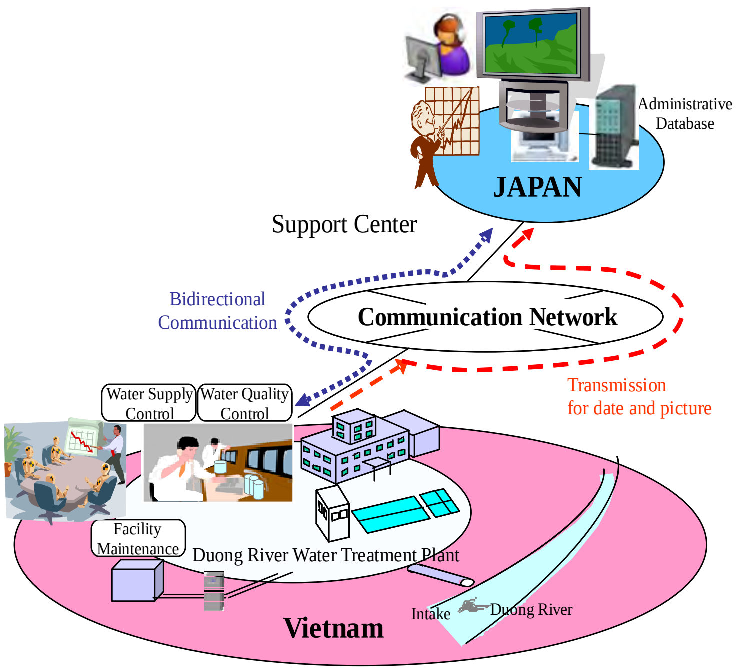


Figure 3.10.5 Image of the Support System by the Remote Surveillance System

(2) Monitoring System

It is important to periodically confirm that the quality of water meets *Vietnam National Technical Standards on Drinking Water Quality* (Circular No. 04/2009/TT-BYT) and that operations are being accurately performed based on the Water Safety Plan as well as ensuring the quality of water and maintaining and improving business quality. Therefore, we aim to maintain and improve technological and business quality by conducting regular on-site visits by Japanese expert engineers.

The points for on-site visits are given below:

- Whether management and operations are possible based on established protocol and standards
- Whether activities are being conducted that will lead to constant improvements in business and quality
- Whether the PDCA cycle is being followed and the quality of service continues constantly

This monitoring will be conducted annually and will observe and offer guidance on the quality of maintenance management tasks and the management and operation conditions from various perspectives, including: ① The condition of water quality management, ② the facility operating conditions, ③ the status of implementation of on-site tasks and ④ the status of utilities procurement.

Furthermore, in future, it may also be required water distribution management systems and water leakage management systems, implemetations of stituation surveys by Japanese companies that already have water technologies including their applicability are considered to be effective.

4. Confirmation of Environmental and Social Considerations and Study on the Required Measures

4.1 Introduction

(1) Background

The Greater Hanoi is formed of capital Hanoi and surrounding six provinces namely Bach Ninh, Hung Yen, Hai Duong, Vinh Phuc, Ha Nam, and Hoa Binh. The metropolis plays significant role in the development and economy of the region and country as a whole. Serving as one of the economic centers of Country, the population of newly expanded Ha Noi City has increased to about 6 million. It is essential to maintain the pace of development of infrastructures and services for increased population in tune with the economic growth and to continue sustainable development. In this respect, development of infrastructure in the Greater Hanoi is very important as a national strategy. The improvement of water supply services is one among these services and infrastructures.

The water supply system of Ha Noi City has been augmented and upgraded many times in the past, also including the Projects under the financial assistance of Finland, Japan International Cooperation Agency (JICA), and the World Bank, depending on the needs. Even after implementation of projects for improvement of water supply services in the northern and southern part of Hong River in Hanoi, the urban water supply system is currently unable to meet the increasing demand. It is reported that only 38% of population of newly formed Greater Hanoi is covered with the existing water supply system.

For the improvement of water supply services in Hanoi "The Comprehensive Urban Development Program in Hanoi Capital City (HAIDEP)" was prepared as a part of city planning by JICA in March, 2007. According to this program, by 2020, the population is estimated to increase to 4.5 million, and corresponding water demand is estimated as 1.8 million m^3/day. Also, in June 2007, a long-term plan namely "Hanoi metropolitan area water service plan" was prepared by National Institute of Urban and Regional Planning (NIURP) of the Ministry of Construction (MOC).

To improve the existing condition of water supply services, the Government of Viet Nam has a plan to carry out two major Water supply Projects for the Greater Hanoi by using privatization. Of these, one is for southern part of Hong River (Da River Project) and the other is for northern part of Hong River (Duong River Project, this project). Da River water supply project is already started with capacity of 600,000 m^3/day by Viet Nam Construction and Import Export Corporation (VINACONEX, a State owned enterprise) in 2007 under the Build, Own, and Operate (BOO) scheme. Under the Da River project, water is planned to supply to the western areas of Hanoi, Ha Tay, and Hoa Binh (southern part of Hong River area) using 70 km of transmission pipeline.

To supply the water to the northern part of Hong River, Duong River project was proposed by the Viet Nam Water supply, Sewerage and Environment Construction Investment Corporation (VIWASEEN, a State owned enterprise) in April, 2008. Under this project, the water is planned to be supplied to Ha Noi City, Bach Nihn, Hai Duong and Hung Yen originally. Responding to this proposal, the Prime Minister’s Office requested VIWASEEN to carry out more study on Duong River Project in August, 2008. The original proposal of the VIWASEEN’s 2008 Plan (bulk water supply) is as follows:

Table 4.1.1 Original Proposal of VIWASEEN Plan

Phase	Target Year	Capacity (m^3/day)	Length of Transmission Pipelines (km)
1	2015	150,000	80
2	2020	150,000	120
	2025	300,000	200
Total		600,000	

In March 2009, Japan External Trade Organization (JETRO) carried out a “Study on the PPP Project Formation for Hanoi Water supply System in the Socialist Republic of Viet Nam”. Under this Study, water supply improvement plan was prepared for the metropolitan area of Hanoi using the surface water source from Duong River. The proposed water supply facilities included water treatment plant with a capacity of 300,000 m^3/day and 200km of pipelines. Possibility of adopting PPP for implementation of this Project was also analyzed. Based on the result of the JETRO Study, this Project preparation is carried out by JICA to improve the situation of water supply services in the north of Red river and some parts in the south of Red river in Hanoi.

To improve the living environment in Hanoi and its neighborhoods through improvement of water supply services, this Preparatory Survey is undertaken for provision of water treatment plant, raw water and clear water pumping stations, and transmission up to the off take points. The purpose is to use raw water from the river and provide treated water to the population that still do not have access to treated water supply. As a part of this Study, Environment and Social Considerations is also made to ensure social and environmental soundness of the Project. For this purpose, a brief environmental impact assessment report is prepared.

(2) Objective of the Environmental and Social Impact Assessment

The purpose of the Environmental and Social Impact Assessment is to ensure that proposed project components are environmentally and socially sound and sustainable and that the environmental consequences of the project are recognized at early stage and taken into account in the project design.

The major objectives of this part of the Study are to establish baseline data on environmental and social conditions of the project area, to predict the impacts on relevant environmental and social attributes due to the construction and operation of the proposed water supply facilities, to suggest appropriate and adequate mitigation measures to minimize/reduce adverse impacts, and to prepare environmental mitigation and monitoring plan.

This Report is prepared specially for use by the VIWASEEN to carry out complete environmental impact assessment and prepare Environmental Impact Assessment (EIA) report, to be submitted to the Department of Natural Resources and Environment (DONRE) for appraisal and approval before the implementation of the Project. The Report is composed of Information on Legal and administrative framework, Description of proposed project, Identification of impacts during construction and operation stages and related mitigation measures, and Environmental management plan including mitigation and monitoring.

In the joint meetings between Japanese and Vietnamese sides, which was started from March, 2012, it was almost agreed that Supply Area up to Phase 2 was only Hanoi City. However, in this chapter, Bach Ninh and Hun Yen Study area is included.

4.2 Administrative and Legal Framework

(1) Administrative Framework

There are several Ministries and Departments that play key roles during the preparation and implementation of the water supply projects and services in urban and rural sectors (Table 4.2.1). The government agencies related to water supply projects include Ministry of Planning and Investment, Ministry of Construction, Ministry of Agriculture and Rural Development, Ministry of Natural Resources and Environment, Viet Nam Water supply, Sewerage and Environment Construction Investment Corporation, Department of Natural Resources and Environment, Hanoi Department of Agriculture and Rural Development, Hanoi People's Committee, etc. Functions of some of these Ministries and Agencies are described below.

Table 4.2.1 Agencies Related to Environmental and Social Considerations and Other Permissions for this Project

Organization	Functions concerning Environmental and Social Considerations and Other Permissions related to this Project
Ministry of Natural Resources and Environment (MONRE)	– Management of land, water, and mineral resources, geology, environment – Formulation of policies related to environment management – Monitoring of national environmental status – Approval of EIA for projects approved by National Assembly, the Prime Minister, or inter-ministerial or inter-provincial projects
Department of Natural Resources and Environment (DONRE)	– Management of land, water, and mineral resources, geology, environment on regional basis – Registration for land use – Registration for water rights – Permission for occupancy of intake facilities – Permission for WTP effluent discharges – Appraisal and approval of EIA report for this Project
Ministry of Planning and Investment (MPI)	– Planning and investment – State budget allocation – Domestic and foreign investment to improve water supply services – Approval of the ODA project on behalf of the Government
Ministry of Construction (MOC)	– Management of construction; architecture, planning construction of urban technical infrastructure, industrial parks, economic zones – Developing urban housing and offices, business property, building materials – State management over public services – Guiding and supervising the issuance, and extension of construction permits – Guides and examines the selection of contractors in construction activities – Appraisal of the investment projects for construction works, evaluation of technical designs and cost estimates of construction works – Provides guidance with respect to inspection of the work in construction, evaluation, technical design, design drawing and estimate of construction work – Final approval of this project before applying for construction permit
Ministry of Agriculture and Rural Development (MARD)	– Management in the fields of agriculture, forestry, fishery, salt production, irrigation/water services and rural development nationwide – Management of construction, exploitation, usage and protection of hydraulic works, and water supply and drainage works in rural areas

Organization	Functions concerning Environmental and Social Considerations and Other Permissions related to this Project
	– Management of river basins; the exploitation, usage and integrated development of rivers in accordance with the master plans and action plans – Management of dike construction and protection, headwork for prevention of floods and typhoons – Efforts to prevent and combat flush flooding, floods, typhoons, drought, and landslides along riversides and coastal areas – Permission for occupancy of intake facilities in this Project to be discussed with Department of Agriculture and Rural Development (DARD)
Hanoi People's Committee	– To sign with seal the approval of EIA report – To sign with seal the Permission for Construction under this Project
Hanoi Authority for Planning and Investment (HAPI)	– Specialized Agency on investment in the water supply business activity of the People's Committee
Viet Nam Water supply, Sewerage and Environment Construction Investment Corporation (VIWASEEN)	– Investor for implementing investment project of Duong river Water supply System and Water Treatment Plant – VIWASEEN is the owner of the this Project and therefore shall prepare the EIA report, either by itself or through hired consultants, to be submitted for appraisal and approval

Source: Based on interview with the related agencies, web-pages, etc.

(2) Ministry of Planning and Investment

The Ministry of Planning and Investment (MPI) of Government of Socialist Republic of Viet Nam is the organization responsible for performing the functions of State management over planning and investment, including advices on strategies, planning and plans on national socio- economic development, mechanism and policies for general economic management and some specific fields, domestic and foreign investment, industrial parks and export-processing zones, management of official development assistance (ODA) source, bidding, enterprises, and business registration throughout the country; and perform the State management over public services in the fields under its management as prescribed by law. The Ministry also submits to the Government and/or the Prime Minister overall strategies, planning, projects, long- term, five-year and annual plans on national and territorial socio-economic development.

With respect to the domestic and foreign investment, the Ministry is responsible for the following activities:

- To submit to the Government planning, plans and lists of domestic investment projects and projects calling for foreign investment capital
- To coordinate with the Ministry of Finance and concerned ministries and branches in inspecting and evaluating the efficiency of capital investment in capital construction works

- To evaluate investment projects; to license projects according to its competence; to authorize the licensing under the Prime Minister's regulations; to perform uniform management over the licensing of foreign investment projects in Viet Nam and Viet Nam's investment projects in foreign countries

- To assist the Government in managing activities of domestic investment, foreign direct investment in Viet Nam and Viet Nam's investment in foreign countries.

With respect to the ODA management, the responsibility of the Ministry includes:

- To act as a principal body in ODA attraction, coordination and management; to guide managing agencies in formulating lists and contents of programs and projects prioritized for ODA mobilization; to sum up and submit list of ODA-funded programs and projects to the Prime Minister for approval

- To prepare and organize the mobilization and coordination of, ODA sources in compatibility with the strategies and planning on ODA attraction and use

- To prepare contents of, and conduct negotiations, on international framework treaties on ODA; to represent the Government in signing international framework treaties on ODA with donors

- To guide concerned units and organizations to prepare ODA-funded programs and projects; to assume the prime responsibility and coordinate with the Ministry of Finance in determining forms of using ODA capital to be allocated by the State budget; to evaluate and submit to the Prime Minister for approval documents of ODA-funded programs and projects falling under the Prime Minister's approving competence

- To monitor and support the preparation of contents of, and negotiations on, specific international treaties on ODA with donors

- To coordinate with the Ministry of Finance in elaborating plans on ODA capital disbursement and annual plans on reciprocal capital for ODA-funded programs and projects entitled to allocations from the budget sources; to join the Ministry of Finance in the work of capital disbursement and the mechanism for debt repayment and retrieval of ODA loan capital

- To monitor and evaluate ODA-funded programs and projects.

The organization chart of the Ministry is illustrated below in Figure 4.2.1. All the departments are headed by the Director General and these departments assist the Minister in performing the State management functions.

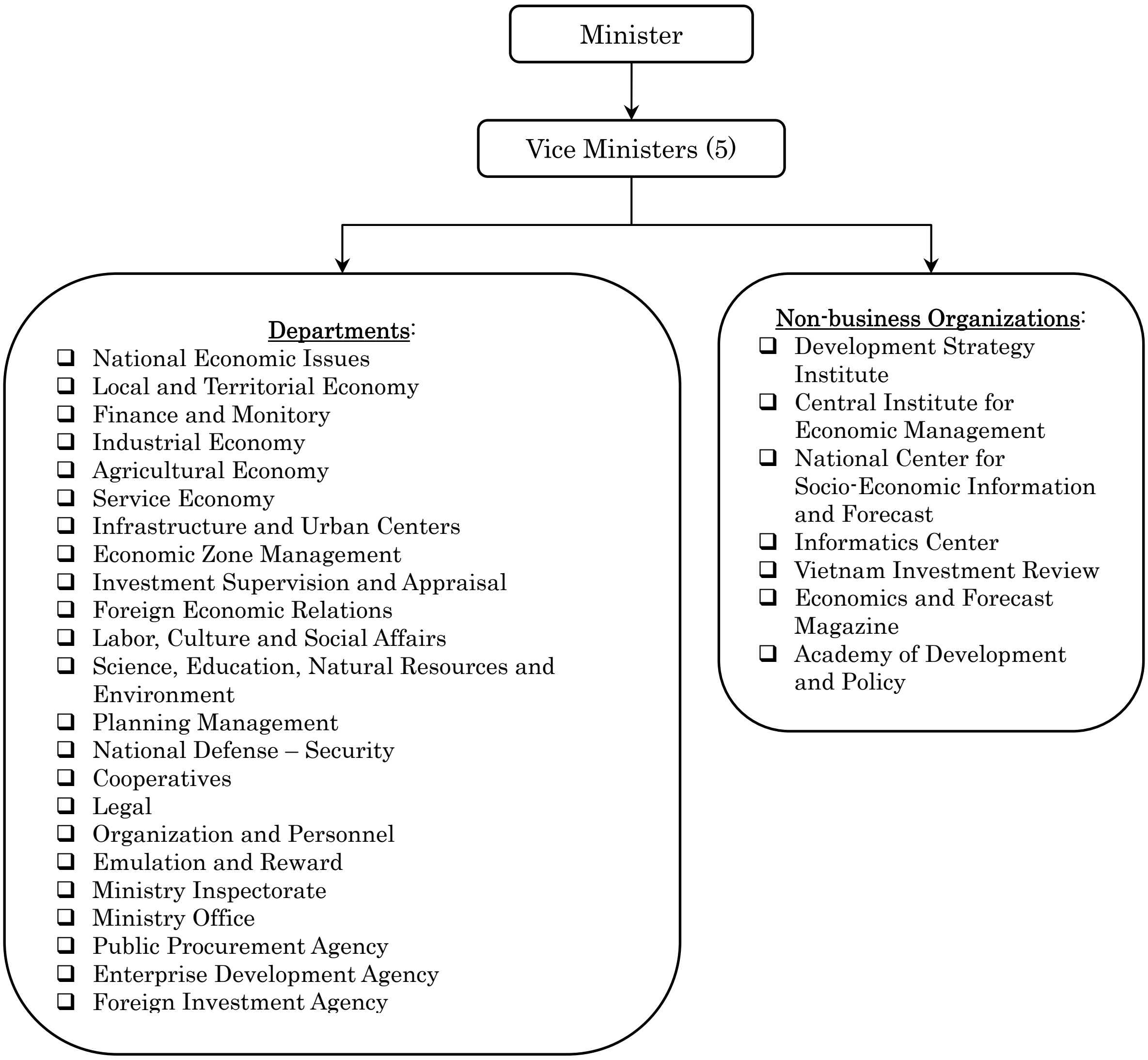


Figure 4.2.1 Organization Chart of MPI

This project involves foreign investment and therefore shall require approval from the MPI before obtaining several rights and agreements and before processing land acquisition for the Project.

(3) Ministry of Construction

The Ministry of Construction of the Government of Socialist Republic of Viet Nam is the organization that performs the function of State management of construction; architecture, planning construction of urban technical infrastructure, industrial parks, economic zones, developing urban housing and offices, business property, building materials, and State management over public services in accordance with the law.

The Ministry is responsible for guiding and supervising the implementation of the provisions of law in the construction field and for guiding and supervising the issuance, extension, adjustment, and recovery of construction permits in accordance with law. The MOC also guides and examines the selection of contractors in construction activities in accordance with the Construction Law and laws on tendering and is also responsible for guidance and examination of the quality control of construction works.

The MOC also carries out, whenever assigned by the Government, appraisal of the investment projects for construction works, evaluation of technical designs and cost estimates of construction works; and provides guidance with respect to inspection of the work in construction, evaluation, technical design, design drawing and estimate of construction work in accordance with the management of investment projects in construction. The organization chart of MOC is presented in Figure 4.2.2 below.

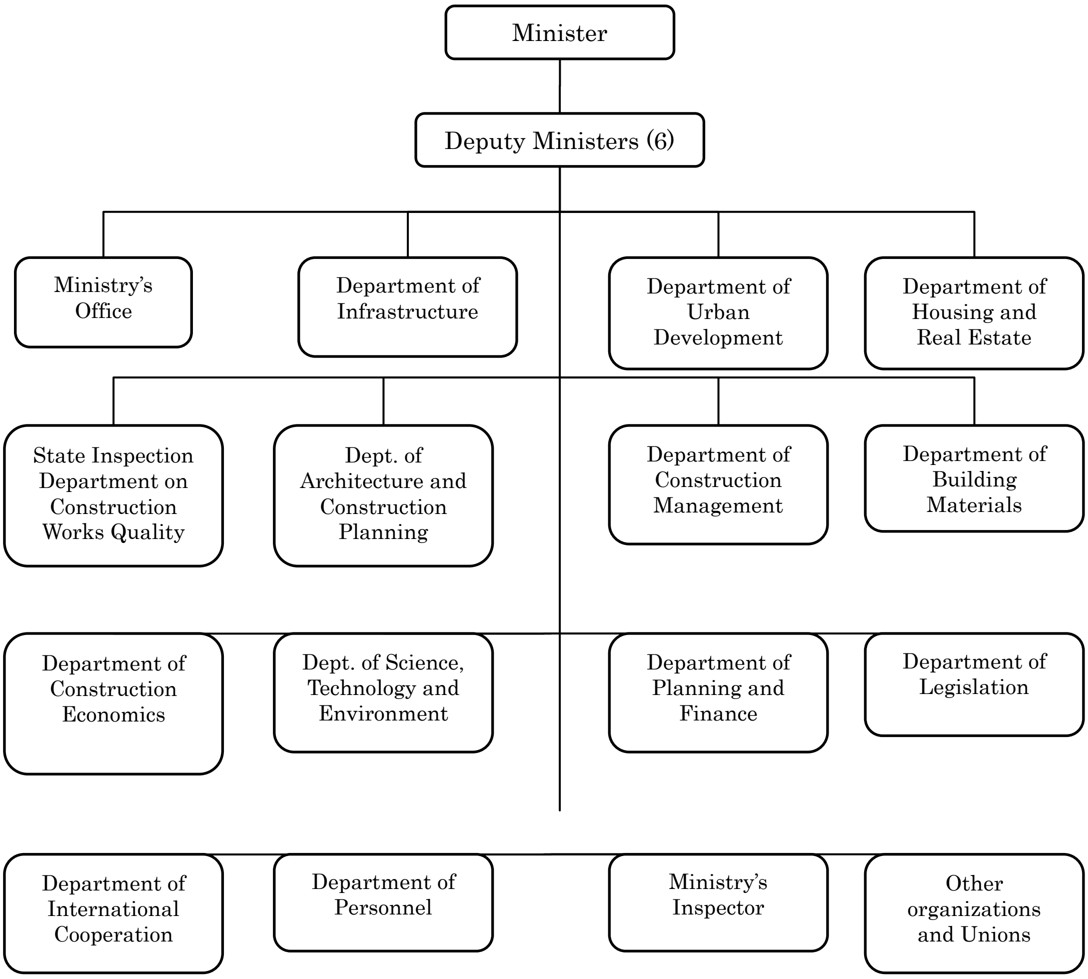


Figure 4.2.2 Organization Chart of MOC

In the normal procedure of Project approval, this project also requires approval from the Ministry of Construction before its implementation. The Project is submitted to the MOC and under this Ministry, Administration of Technical Infrastructure processes the documents.

(4) Ministry of Natural Resources and Environment

The Ministry of Natural Resources and Environment (MONRE) plays a key role in the management of land, water resource, mineral resources, geology, environment, hydro-meteorology, survey and mapping, seas and islands, and other public services that are under the Ministry management. The Ministry has several departments and divisions to take care of related resources.

Viet Nam Environment Administration (VEA) is a subsidiary body under the Ministry of Natural Resources and Environment (MONRE) to advise and assist the Minister of the MONRE in the field of environment management and to provide public services in compliance with the laws.

Department of Water Resources Management is an organization under Ministry of Natural Resources and Environment, which functions to provide assistance to the Minister in implementing state management on water resources including rain water, surface water, ground water, and sea water within the territorial land and sea of the Socialist Republic of Viet Nam.

The MONRE is responsible for providing the conditions and guidelines for environment service agencies. The MONRE is authorized to organize councils or chose service organizations for appraisal of the environment impact assessment report or strategic EIA report, in respect of projects decided or approved by the National Assembly, the Government or the Prime Minister or inter-provincial or inter-ministerial projects.

The MONRE, in coordination with concerned ministries and branches, is responsible for guiding formulation methods for identifying national environmental standards which need to be promulgated for environmental protection.

The MONRE is responsible for, in coordination with concerned ministries, ministerial level agencies and provincial level People's Committee, submitting to the Prime Minister the decision on list of establishments causing serious environmental pollution on a scale beyond the handling competence or ability of ministries, ministerial level agencies and provincial level People's Committee. The MONRE shall specifically guide the inspection and supervision of the handling of such polluting establishments.

The MONRE is also responsible for organizing national environmental status monitoring. For this purpose, the Ministry shall formulate a national environment monitoring master plan and submit it to the Prime Minister for approval, and direct the collection and management of environment monitoring data.

In case of water supply projects, if the capacity of the project is greater than 500,000 m^3/day, the EIA requires approval from the MONRE. Otherwise the EIA requires approval from local agency such as Department of Natural Resources and Environment (DONRE). The organization chart of MONRE is presented in Figure 4.2.3.

Under the MONRE, Viet Nam Environment Administration (VEA) was established in 2008 to advise and assist the Minister of the MONRE in the field of environment management and to provide public services in compliance with the laws. The VEA is responsible for development of laws and regulations, policies, strategies, national target plans, programs, and projects on environment. It is also responsible for organizing implementation of measures to prevent, mitigate and respond to environmental contamination and for controlling environmental quality. It also implements nationwide survey, monitoring, assessment of biodiversity, assessment of trans-provincial or transboundary degraded ecosystems and proposes measures to conserve, rehabilitate and maintain sustainable use of biological resources. It is responsible for assessment and appraisal of EIA report on behalf of the MONRE. It is also responsible for preparation and management of environmental database and for implementation of environmental awareness programs, etc. The organization chart of VEA is presented in Figure 4.2.4.

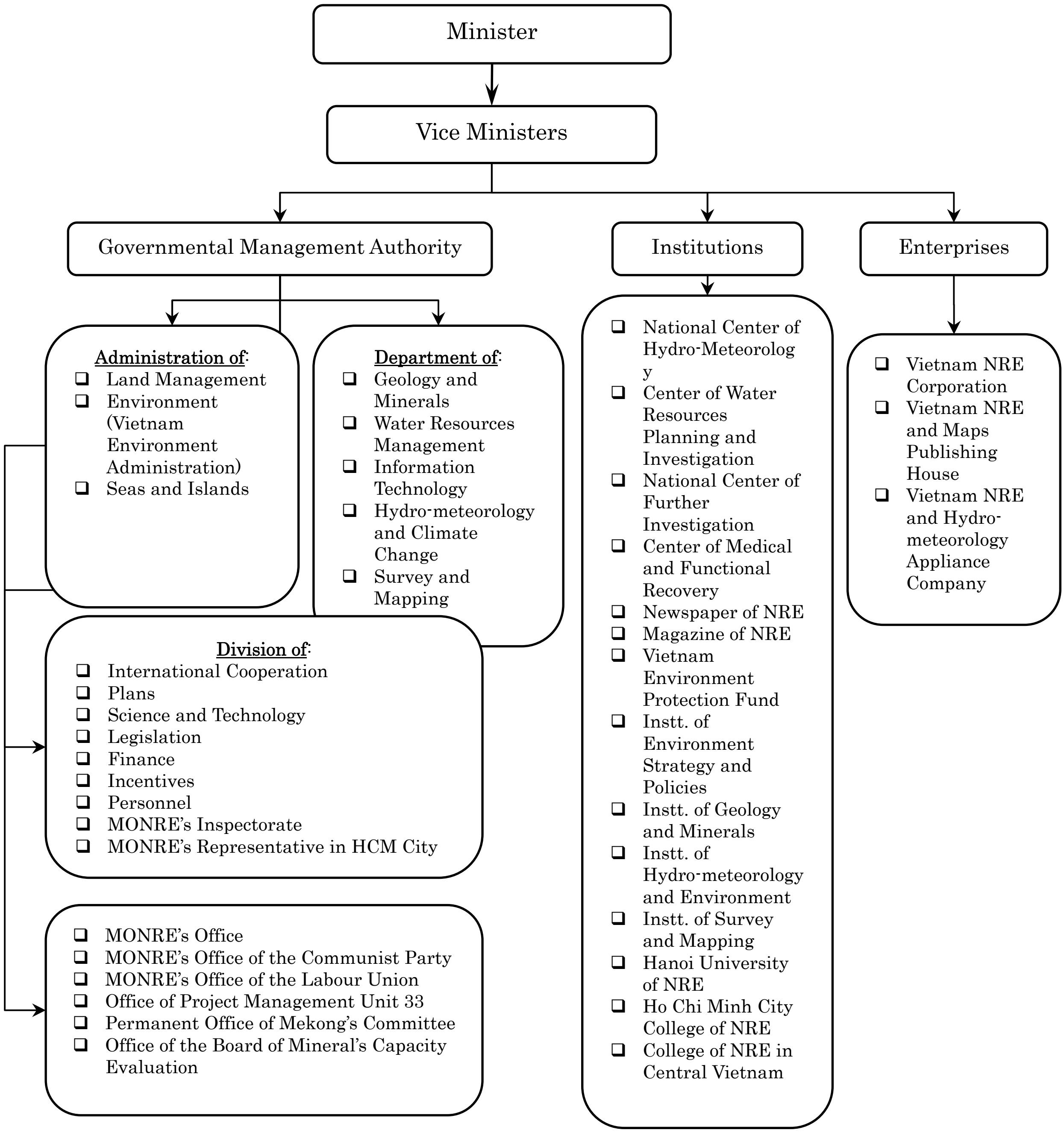


Figure 4.2.3 Organization Chart of MONRE

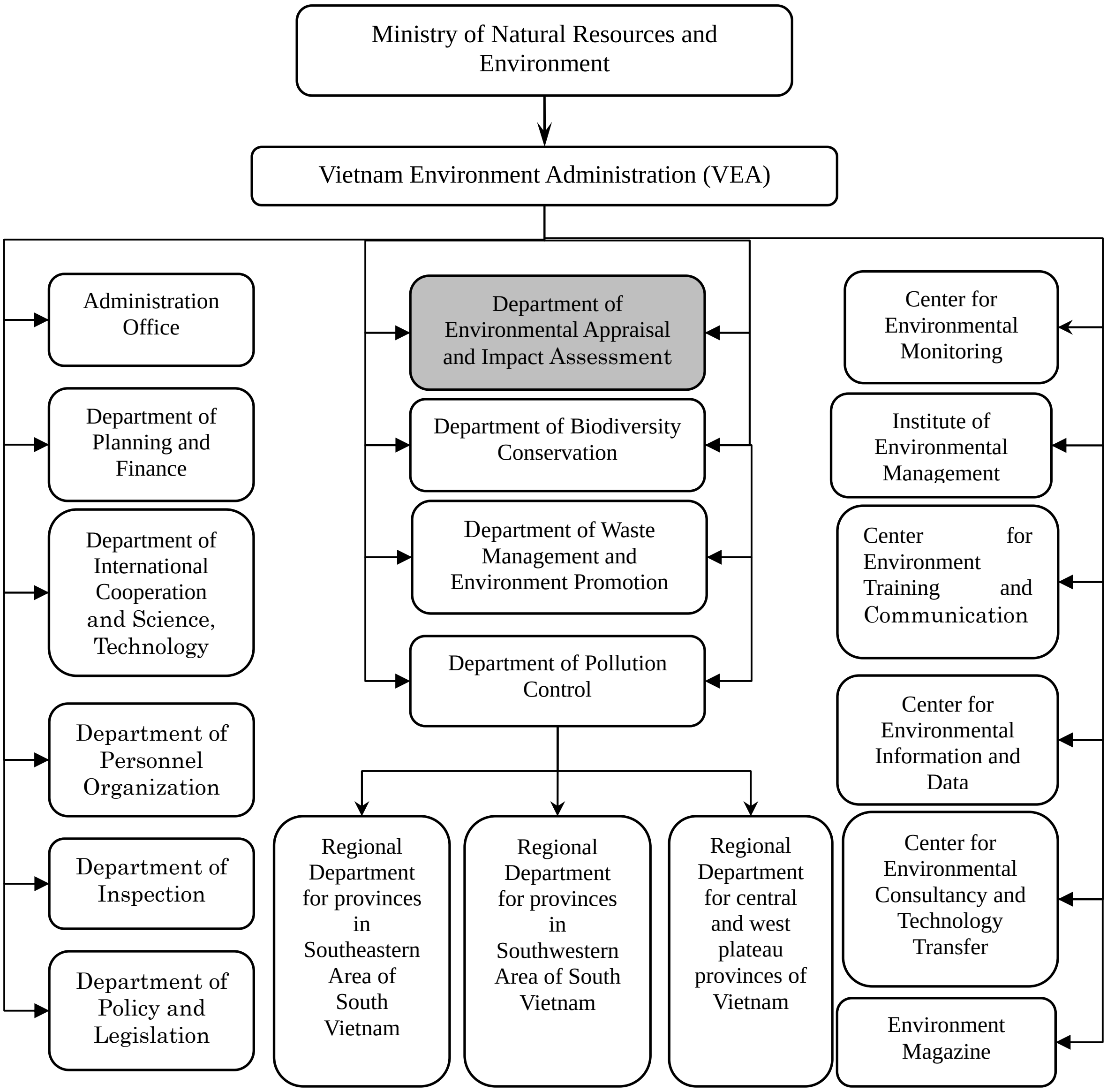


Figure 4.2.4 Organization Chart of VEA

(5) Ministry of Agriculture and Rural Development

The Ministry of Agriculture and Rural Development (MARD) is a governmental agency performing state management functions in the fields of agriculture, forestry, fishery, salt production, irrigation/water services and rural development nationwide in Viet Nam, including state management functions with regard to delivery of public services and management of the State's ownership of rural state owned enterprises in accordance with legal documents.

The MARD is responsible for submitting development master plans and strategies; annual, five-year and long-term plans as well as key programs and projects within the Ministry's mandated areas to the Government and Prime Minister, and to Guide, supervise and be responsible for and organize the implementation of legal documents, strategies, master plans, programs, projects, standards, techno-economic norms relating to agriculture, forestry, salt industry, irrigation/water services and rural development.

In the field of water resources, the role of MARD is to unify the management of construction, exploitation, usage and protection of hydraulic works, and water supply and drainage works in rural areas; to unify the management of river basins; the exploitation, usage and integrated development of rivers in accordance with the master plans and action plans approved by authorized agencies; and to unify the management of dike construction and protection, headwork for prevention of floods and typhoons, and efforts to prevent and combat flush flooding, floods, typhoons, drought, and landslides along riversides and coastal areas.

In this Project, the intake facilities (pipes and pumping facilities) are to be constructed within the embankments of the Duong River and pipelines are to cross the embankments. Therefore, permission would be needed from either the MARD or the Department of Agriculture and Rural Development (DARD) for occupancy of the intake facilities.

The organization chart of MARD is presented below in Figure 4.2.5.

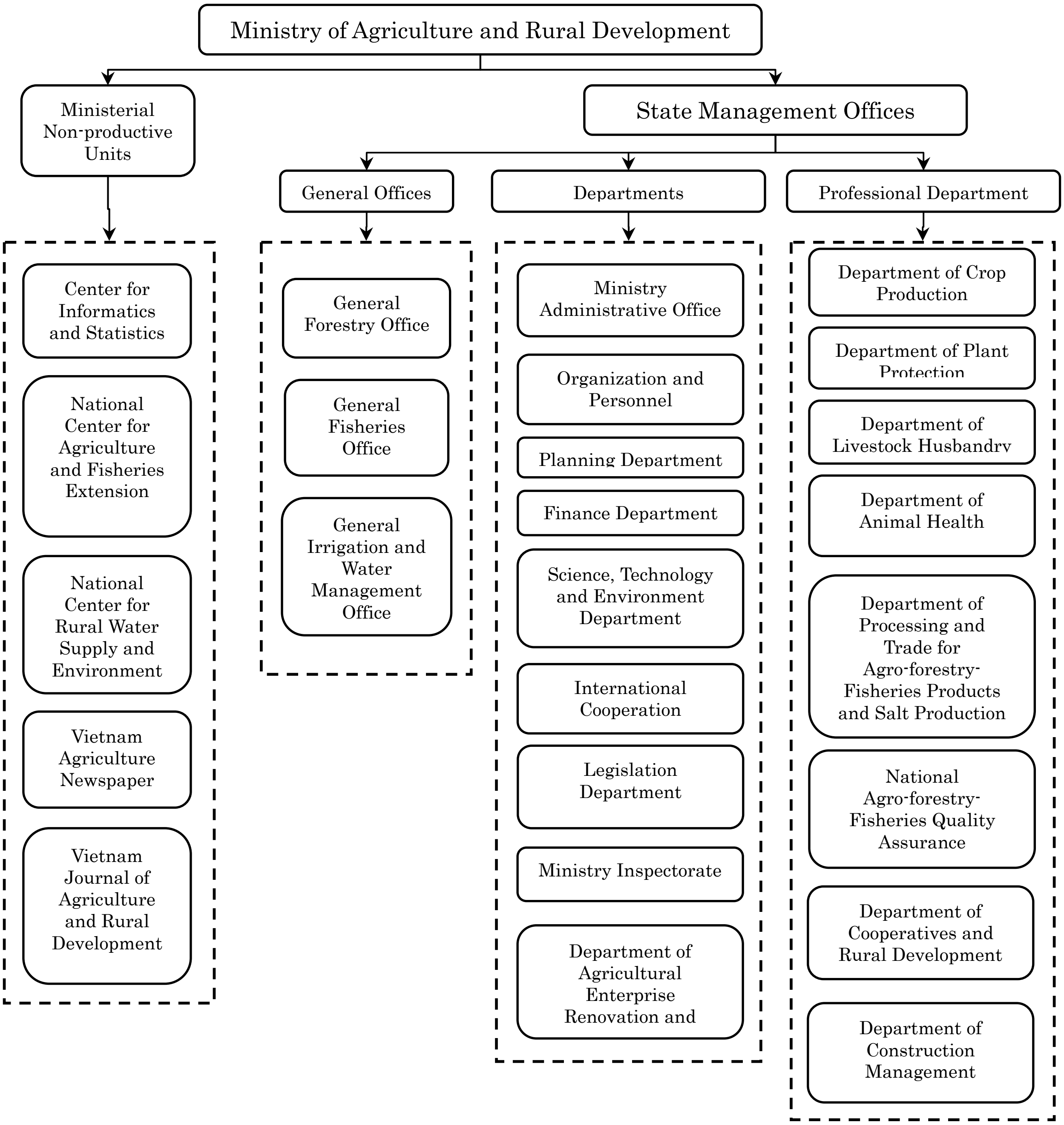


Figure 4.2.5 Organization Chart of MARD

(6) Department of Natural Resources and Environment

The Department of Natural Resources and Environment (DONRE) is an agency under Hanoi People's Committee (HPC) overall management and is also professionally directed by MONRE. The DONRE plays significant role in providing management assistance to HPC in sectors including land, water resources, minerals, climate, meteorology, survey and mapping in Hanoi.

In this Project, raw water shall be withdrawn from Duong river and the effluent from the sedimentation basin of water treatment plant is proposed to discharge into River on daily basis. For this purpose, water right registration and permission for discharge into river would be required. These permissions are processed by Departments in DONRE. Also, preparation and approval of EIA report shall be required at the Feasibility Study stage of this Project. In this regard, the EIA report shall be prepared by the Project owner and submitted to the DONRE for approval and appraisal. Environmental Protection Agency under DONRE is responsible for appraisal of the EIA report submitted by the project owner. Based on this appraisal of DONRE, the HPC approves the EIA report of the project.

The DONRE on behalf of HPC is also responsible for Registration of the Land use for the Project.

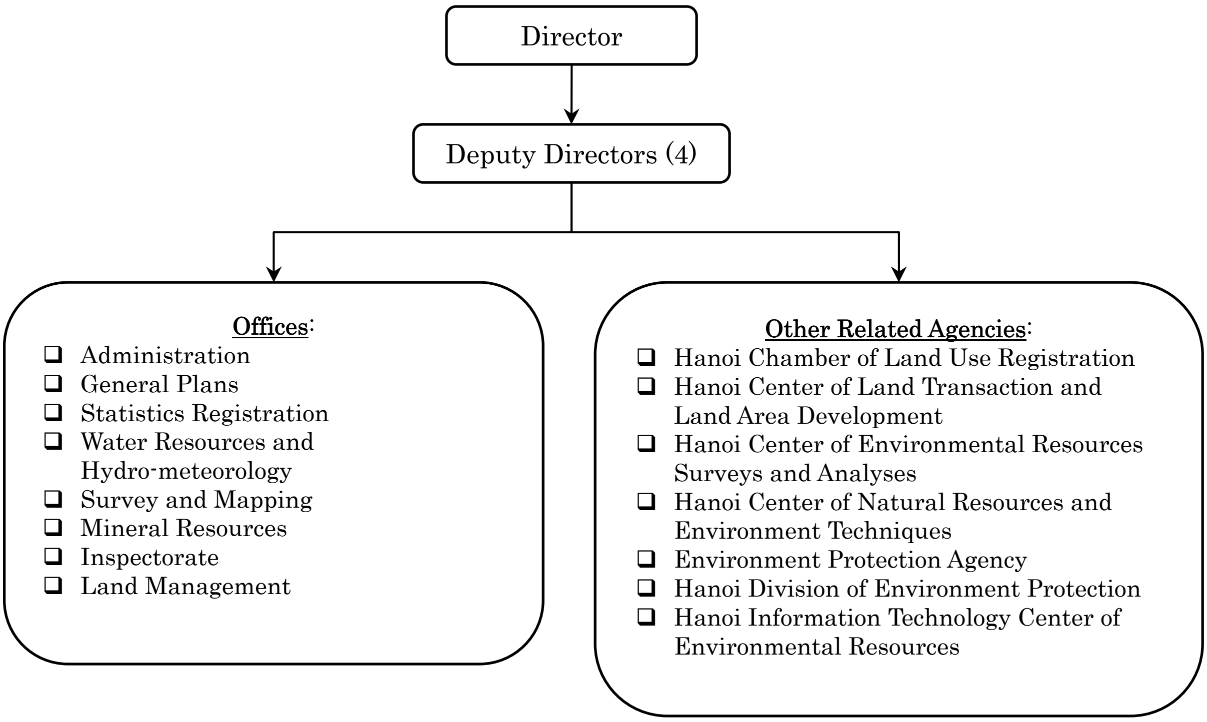


Figure 4.2.6 Organization Chart of DONRE

(7) Viet Nam Water supply, Sewerage and Environment Construction Investment Corporation

Viet Nam Water supply, Sewerage and Environment Construction Investment Corporation (VIWASEEN), established in October 2005, is a state-owned enterprise under Ministry of Construction operating in the form of Mother-Member Company. VIWASEEN was reorganized from independent state-owned companies of Ministry of Construction including Water supply and Sewerage Construction Company (WASEENCO), Water supply and Sewerage Construction and Investment Company (WASECO), Water supply and Sewerage Consultancy Company No.2 (WASE). At present, VIWASEEN is one of the leading enterprises operating in design, construction, installation, import and export of equipment and materials for water supply and sewerage projects, civil and industrial works at different scales. With operation all over the country, VIWASEEN is a prestigious Enterprise in domestic sector on implementation of Water supply, Sewerage and Environment investment construction projects which are funded by international official support (ODA), other loan from international finance organization as ADB, WB, former JBIC, etc. and domestic mobilization capital.

Recently, the VIWASEEN has been renamed as Viet Nam Water and Environment Investment Corporation. In April 2010, the Prime Minister agreed with the proposal from the Ministry of Construction and approved VIWASEEN to be the Investor for implementing investment project of Duong River Water supply System and Water Treatment Plant.

The organization chart of VIWASEEN is presented in Figure below. It has 16 member companies with governing share hold by the mother company. VIWASEEN has 10 dependent members and has associated with several companies including Petro Viet Nam, etc.

For this project, if the VIWASEEN becomes the owner, it will be responsible for the preparation of the EIA, and its submission to the relevant organization for approval.

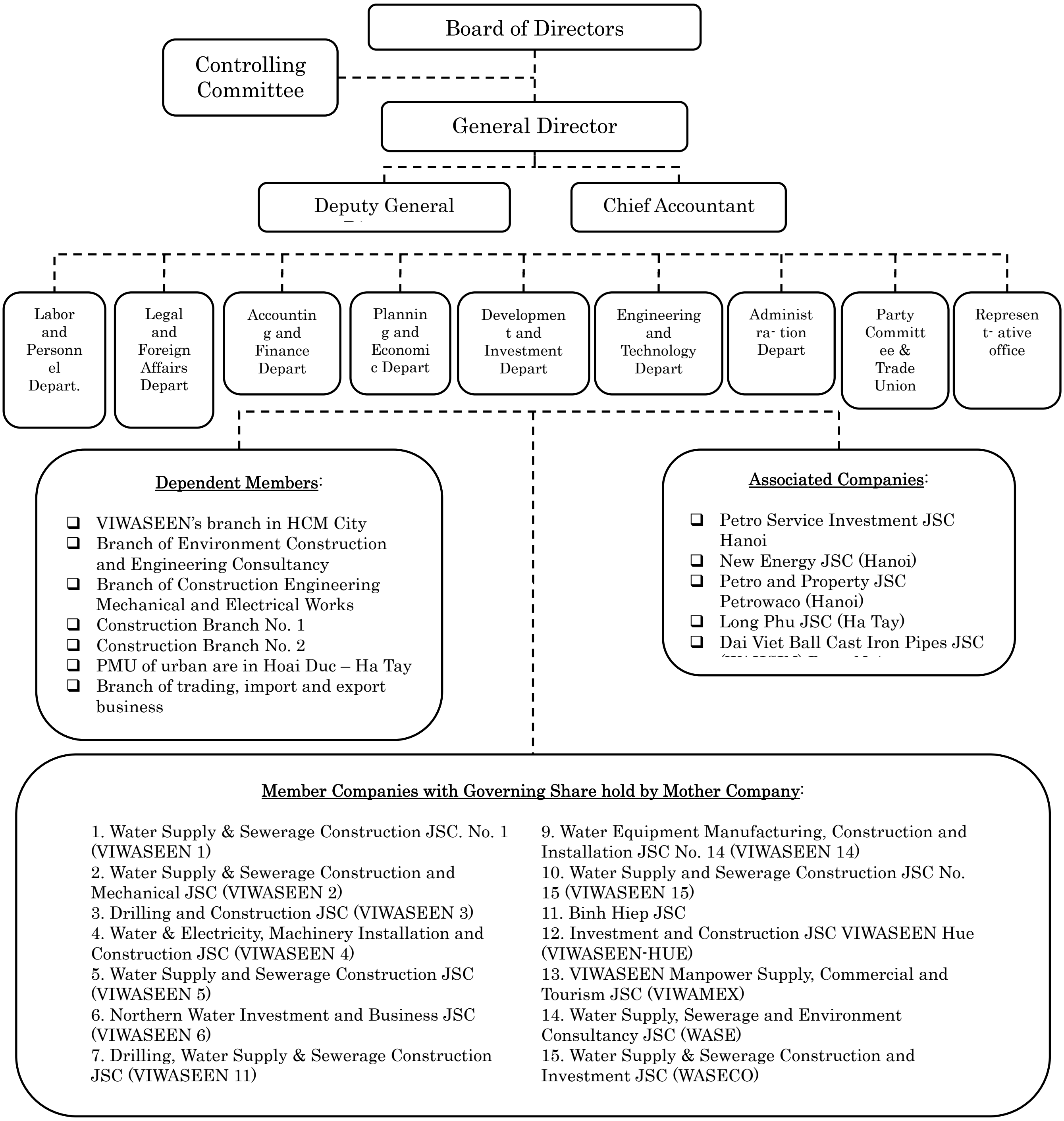


Figure 4.2.7 Organization Chart of VIWASEEN

(8) Legal Framework of Environmental and Social Consideration

Viet Nam is experiencing a rapid development and fast growth of industrial sector based on its economic development strategy. Socioeconomic development activities are causing pressure on environment. For sustainable development, policies have been formulated towards environmental protection and sustainable utilization of resources to protect land, water and other natural resources. To address the protection and utilization of these resources, the Government of Socialist Republic of Viet Nam has formulated and promulgated several Laws and Regulations. Existing legal framework in Viet Nam related to environment and social issues, is briefly described in this section and some of these Laws are listed in Table 4.2.2.

Table 4.2.2 Relevant Laws and Decrees in Environmental and Social Sector

Laws	Contents
Law on Environmental Protection (No. 52/2005/QH11)	– Principles for formulation and application of environmental standards; Contents and systems of national environmental standards; – Objects, contents, appraisal and approval of strategic environmental assessment, and environmental impact assessment reports, and environmental protection commitments – Conservation and rational use of natural resources – Environmental protection in production, business and service activities – Environmental protection in urban centers and residential areas – Protection of marine, river and other water source environment – Waste management – Prevention of, response to environmental accidents, remedy of environmental pollution and rehabilitation of environment – Environment monitoring and information – Resources for environmental protection – International cooperation in environmental protection – Responsibilities of agencies for environmental protection – Inspection, handling of violations, settlement of complaints and denunciations related to environment, and compensation for environmental damage
Decree No. 80/2006/ND-CP; Detailing and Guiding the Implementation of the Law on Environmental Protection	– Environmental standards – Strategic environmental assessment, environmental impact assessment and environmental protection commitments – Environmental protection in production, business and service activities – Waste management – List of projects EIA report – MONRE to guide and organize the implementation of this Decree – List of projects to prepare EIA report include the project on exploitation of surface water with capacity greater than 10,000 m^3 per day. – Project exploiting surface water greater than 500,000 m^3 per day requires approval of EIA report from the MONRE.
Decree No. 21/2008/ND-CP; Amending and Supplementing Articles of Decree No. 80/2006/ND-CP	– Amendments were made to a number of articles of Decree No. 80/2006/ND-CP – List of projects to prepare EIA report presented in Decree No. 80/2006/ND-CP replaced by the list presented in this Decree – Projects to exploit surface water with capacity greater than 50,000 m^3 per day are required to prepare EIA report.
Circular No. 05/2008/TT-BTNMT; Guiding Strategic Environmental	– Elaboration and appraisal of strategic environmental assessment reports – Elaboration, appraisal and approval of EIA; Implementation, Examination and certification of the implementation of EIA

Laws	Contents
Assessment, Environmental Impact Assessment and Environmental Protection Commitment	– Elaboration, registration and certification of environmental protection commitment documents – Examination of and reporting on the appraisal and approval of EIA reports and certification of environmental protection commitment documents
Law on Land (No. 13-2003-QH11)	– Ownership of land, classification of land – Right of State with respect to land and State administration of land (including land use zoning and planning, allocation land, lease of land, Land recovery, Registration of land use rights, etc.) – Regime for use of all types of land (including agricultural, non-agricultural and unused land) – Rights and obligation of land users – Administrative procedures for administration and use of land – Land inspectorate, resolution of disputes, complaints and denunciations about land and dealing with breaches of Laws on Land
Decree No. 181/2004/ND-CP on Implementation of the Law on Land	– System of organization of land administration and services of land management and use – Land use zoning and planning – Allocation of land, lease of land, conversion of land use purpose, land recovery and land requisition – Registration of land use rights, formulation and management of cadastral files, issuance of certificates of land use right, and land statistics and land inventories – Land use rights in real estate market – Regime for use of agricultural land – Regime for use of non-agricultural land – Management of unused land and commissioning use of unused land – Rights and obligations of land users – Order and administrative procedures for management and use of land – Resolution of land-related disputes and complaints – Identifying and dealing with breaches of law on land by administrators
Decree No. 197/2004/ND-CP on Compensation, Support and Resettlement when Land is recovered by the State	– Compensation for land – Compensation for property – Support policies – Resettlement – Organization of implementation
Decree No. 149/2004/ND-CP on Licensing of Water Resources Exploitation, Extraction and Utilization and Wastewater Discharge in Water Sources	– Licensing, extension, amendment, termination and revoking of permits on exploration, exploitation and utilization of water resources and wastewater discharge into water sources – Rights and obligations of licensing agencies, application receiving and managing agencies and permit holders – Process and procedure of licensing of exploration, exploitation and utilization of water resources and wastewater discharge into water sources – According to this Decree, MONRE shall be the authorized Licensing Agency responsible to issue, extend, amend, terminate and revoke permits for using surface water and extracting 50,000 m^3/day or

Laws	Contents
	higher for purposes other than agriculture, and for wastewater discharge into water sources at a rate of 5000m^3/day or higher.
Circular No. 02/2005/TT-BTNMT Guiding the Implementation of the Decree No. 149/2004/ND-CP	– Authority and power to grant, renew, amend, suspend and revoke licenses; duration and extension of licenses – Procedure and processes for granting, renewing, extending and amending of licenses – Management of applications and licenses – Implementation arrangements

Source: English version of the relevant Laws/Decrees/Circulars

(9) Law on Environmental Protection

The Law on Environmental Protection (No. 52/2005/QH11) was promulgated by the President of Viet Nam in December 2005. This law has 15 chapters including a total of 136 articles. The law mainly describes about principles for formulation and application of environmental standards; Objects, contents, appraisal and approval of strategic environmental assessment, and environmental impact assessment reports, and environmental protection commitments; Conservation and rational use of natural resources; Environmental protection; Protection of marine, river and other water source environment; Waste management; Environment monitoring; and Resources for environmental protection.

Articles 18 to 23 of Chapter III, section 2 of this law describes about environmental impact assessment which indicates clearly that any project which utilizes natural resources on large scale is required to prepare environmental impact assessment reports. Also, according to Article 19, the project owner or a consultant hired by the project owner shall prepare the EIA report during the feasibility study stage. Article 20 describes the contents of the EIA report which shall include description of project construction activities, project area, schedule, etc.; assessment of environmental status of project site; environmental impacts; mitigation measures; environmental protection measures during project construction and operation; environmental monitoring; cost estimates for environmental protection works within total cost estimates of project; opinion of commune/ward or township people’s committee; and citation of sources of figures, data, etc.

(10) Decree No. 80/2006/ND-CP and Decree No. 21/2008/ND-CP

The Decree No. 80/2006/ND-CP was issued by the Prime Minister in August 2006 and provides details and guidance on the implementation of a number of articles of the Law on Environmental Protection. This decree comprises 25 Articles in 3 Chapters.

Appendix I of this decree includes the list of projects that are required to prepare EIA report and enumerates 102 projects. According to this list, any project on exploitation of surface water with capacity greater than 10,000 m^3/day is required to prepare EIA report. According to appendix II of this decree, any project exploiting surface water greater than 500,000 m^3/day requires approval of EIA report from the MONRE.

Decree No. 21/2008/ND-CP was issued by the Prime Minister in February 2008, to amend and supplement a number of Articles of the Decree No. 80/2006/ND-CP detailing and guiding the implementation of a number of articles of the law on environmental protection. It includes only 2 Articles. In this Decree, a new list of project that require to prepare EIA reports is presented including total 162 projects and this list replaces the list presented in Decree No. 80/2006/ND-CP. According to this list, a project on exploitation of surface water with capacity greater than 50,000 m^3/day is required to prepare EIA report.

(11) Circular No. 05/2008/TT-BTNMT

This Circular was issued in December 2008 by the Ministry of Natural Resources and Environment providing guidance related to Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment. It includes 6 Sections and describes in detail about elaboration and appraisal of strategic environmental assessment, EIA, and environmental protection commitment.

Section III of this Circular describes about EIA and includes explanation on elaboration of EIA, community consultation, submission of documents for EIA appraisal, appraisal of EIA report by appraisal council, finalization of EIA report, re-appraisal of EIA reports, approval of EIA reports, certification and sending of approved EIA documents, responsibilities of project owner after EIA approval, responsibilities of approving agency after EIA approval, etc.

(12) Law on Land

Law of Land (No. 13-2003-QH11) was enacted in 2003 by the National Assembly of Viet Nam replacing the 1993 Law on Land, the 1998 Amendment of Law on Land, and 2001 Amendment of Law on Land. The law includes 7 chapters and 146 Articles. The law, among other items, describes about the classification of land, right of State with respect to land and administration of land including planning and zoning, allocation, lease and recovery, and registration of land use right, etc.

According to Article 5 of this law, land belongs to the entire people with the State as the representative owner. It also describes that the State shall exercise the right to decide land use purposes by passing decisions and by considering and approving land use zoning and land use plans; to decide the quotas on allocation of land and on duration of land use; to decide allocation of land, lease of land, land recovery, and permission for conversion of land use purpose; and to determine land prices. According to Article 7(4) of this law, People's committees at all levels shall exercise the rights of the representative owner of land and State administration of land within their respective localities. Article 13 of this Law classifies the lands broadly into three categories: agricultural land, non-agricultural land, and unused land.

Article 38 of the law describes that the State shall recover land if it is to be used for objectives of national defense and security, national interest, public interest, or economic development. Article 39 indicates that the State shall carry out land recovery, pay compensation and carry out site clearance after land use zoning and planning have been proclaimed or when an investment project with land use requirements in conformity with the land use zoning and planning is approved by the competent State body. Article 44 of the law states that People's committees of districts, towns and provincial cities shall make decisions to recover land from family households, individuals, and communities of citizens.

Article 42 of the law explains about compensation against land acquisition and resettlement when recovery of residential land is carried out.

Decree No. 181/2004/ND-CP was issued by the Prime Minister in October 2004 on implementation of the Law on Land. It includes 14 chapters and 186 Articles.

(13) Decree No. 149/2004/ND-CP and Circular No. 02/2005/TT-BTNMT

Decree No. 149/2004/ND-CP was issued by the Prime Minister on the request of MONRE. This Decree explains on the licensing of water resources exploitation, extraction and utilization and wastewater discharge in water sources. It includes 5 chapters and 25 Articles.

Among major items, the Decree explains on licensing, extension, amendment, termination and revoking of permits on exploration, exploitation and utilization of water resources and wastewater discharge into water sources; Rights and obligations of licensing agencies, application receiving and managing agencies and permit holders; and Process and procedure of licensing of exploration, exploitation and utilization of water resources and wastewater discharge into water sources.

According to Article 13 of this Decree, MONRE shall be the authorized Licensing Agency responsible to issue, extend, amend, terminate and revoke permits for using surface water and extracting 50,000 m^3/day or higher for purposes other than agriculture, and for wastewater discharge into water sources at a rate of 5000m^3/day or higher.

Article 7 of this Decree describes that the surface water utilization permit shall be issued initially for duration of 20 years from the date of its approval and can be renewed for up to 10 years. The wastewater discharge permit is issued for 10 years initially which can be extended for 5 years. Article 18 of Decree explains that the permit holders shall pay fee and charges and shall pay resource tax and fees for environment protection.

Circular No. 02/2005/TT-BTNMT was issued by MONRE to provide guidance for implementation of the Decree No. 149/2004/ND-CP regulating the licensing of water resources exploration, exploitation, and utilization and wastewater discharge into water sources.

(14) JICA Guidelines for Environmental and Social Considerations

The objectives of the JICA Environmental Guidelines (*Guidelines for Environmental and Social Considerations, April 2010*), are to encourage project proponents to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA's support for and examination of environmental and social considerations are conducted accordingly.

JICA, which is responsible for ODA, plays a key role in contributing to sustainable development in developing countries and pays great attention to environmental and social impacts of project implementation. The measures for environmental and social considerations are implemented by ensuring a wide range of meaningful stakeholder participation and transparency of decision-making, as well as by working for information disclosure and by ensuring efficiency.

The JICA Environmental Guidelines is based on a policy, which stipulates that all projects it supports are carried out in an environmentally responsible manner and that projects must comply with all local environmental laws and procedures in addition to appropriate JICA guidelines. While encouraging the appropriate consideration of environmental and social aspects, it is JICA's policy to provide active support to projects that promote environmental conservation and to projects that contribute to the protection of the global environment, such as attempts to reduce greenhouse gas emissions.

JICA Environmental Guidelines outline JICA's responsibilities and procedures, along with its requirements for project proponents, etc. in order to facilitate the achievement of objectives. In doing so, JICA endeavors to ensure transparency, predictability, and accountability in its support for and examination of environmental and social considerations. It includes mainly basic policies, objectives, basic principles, responsibility of JICA, requirement of project proponents, covered schemes, dissemination, Process of environmental and social considerations (including information disclosure, categorization, impacts to be assessed, consultation with local stakeholders, concern about social environment and human rights, laws, regulations and standards of reference, advice of the advisory committee for environmental and social considerations, decision-making by JICA, ensuring appropriate implementation of and compliance with the Guidelines); Procedure of environmental and social considerations (for projects on preparatory survey, loan aid, grand aid and technical cooperation projects, preliminary studies of grant aid undertaken by MOFA, and technical cooperation for development planning).

(15) JICA's Procedures of Environmental and Social Considerations for Loan Aid Projects

1) Environmental Review

JICA conducts an environmental review in accordance with the project category, and refers to the corresponding environmental checklists for each sector when conducting that review. If JICA does not conduct preparatory surveys, it classifies projects promptly after receiving official requests and discloses such categorization on its website. Also, JICA discloses the classification of projects based on detailed information on its website prior to the environmental review.

〔Categorization〕

JICA classifies projects into four categories (category A, B, C or FI) according to the extent of environmental and social impacts, taking into account an outline of project, scale of the project, site conditions, etc. Of the categories defined in the Guidelines, only categories A and B that are most related to this Project is discussed below.

① *Category A*: A project is classified as category A if it is likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess is also classified under this category. In principle, this category includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and project located in or near sensitive areas. An illustrative list of such projects is provided in Appendix 3 of the JICA environmental guidelines.

② *Category B*: A project is classified under this category if it is likely to pose potential negative environmental and social impacts that are less severe than those of Category A. In most cases, normal mitigation measures can be designed more readily for such projects. The impacts in this case are site-specific.

2) Procedure of Environmental Review

① *Category A Projects*

- Project proponents must submit EIA reports.
- If large-scale involuntary resettlement is expected, a Resettlement Action Plan (RAP) must also be submitted.
- If measures for indigenous people are required in project, an Indigenous People Plan (IPP) must be submitted.
- JICA publishes the status of host countries' submission of major documents related to environmental and social considerations on its website. Prior to its environmental review, JICA discloses EIA reports and other documents. EIA report is disclosed 120 days prior to concluding agreement documents.
- JICA undertakes its environmental reviews based on the EIA and other documents submitted by project proponents.
- In the review, potential positive and negative environmental impacts of project are examined. Also, necessary to avoid, minimize, mitigate, or compensate for potential negative impacts and measures to promote positive impacts are examined. JICA also examines the results of information disclosure and local stakeholders' consultation.
- JICA discloses the results of environmental reviews on its website after agreement documents are concluded.

② *Category B Projects*

- JICA undertakes its environmental reviews based on the information provided by project proponents and others.
- In the review, potential positive and negative environmental impacts of project are examined. Also, necessary measures to avoid, minimize, mitigate, or compensate for potential negative impacts and measures to promote positive impacts are examined. When an EIA procedure has been conducted, the EIA report may be referred to but is not mandatory.
- JICA discloses EIA report and environmental permit certifications, RAPs, IPPs, when these documents are submitted by the project proponents.
- JICA discloses the results of environmental reviews on its website after concluding agreement documents.

3) Monitoring and its Confirmation by JICA

- JICA confirms with project proponents, etc. the results of monitoring the items that have significant environmental impacts, over a certain period of time, in order to confirm that environmental and social considerations are given due attention.
- Information necessary for monitoring confirmation by JICA must be supplied by project proponent, etc. by appropriate means, including in writing. When necessary, JICA may also conduct its own investigations.
- When third parties point out that environmental and social considerations are not being fully undertaken, JICA forwards such claims to project proponent and encourages them to take appropriate action.
- When necessary, JICA may request the cooperation of project proponent in conducting investigations in order to confirm the state of the undertaking of environmental and social considerations.
- If JICA judges that there is a need for improvement in a situation with respect to environmental and social considerations, it may ask project proponent to take appropriate actions in accordance with the agreement documents.
- JICA discloses the results of monitoring conducted by project proponent on its website to the extent that they are made public in project proponent. When third party requests further information, JICA discloses it, subject to approval by project proponent.
- If JICA conducts a detailed design study by itself, JICA carries out an environmental review for the target project before the commencement of the study. JICA reviews detailed resettlement action plans if necessary. JICA discloses the final report on its website.

(16) Environmental and Social Considerations Needed for Projects

The environmental and social considerations required for funded projects are stated in the Guidelines. It includes Underlying Principles; Examination of Measures; Scope of Impact to be Examined; Compliance with Laws, Standards and Plans; Social Acceptability; Ecosystem and Biota; Involuntary Resettlement; Indigenous Peoples; and Monitoring. As stated in the Appendix 1 of JICA Environmental Guidelines, appropriate environmental and social considerations are undertaken, according to the nature of the project, based on the items described below.

1) Underlying Principles

Environmental impact which may be caused by a project must be assessed and examined from the earliest planning stage possible. Alternative proposals or minimization measures to prevent or reduce adverse impact must be examined and incorporated into the project plan.

Such examination must include analysis of environmental costs and benefits in as quantitative terms as possible and be conducted in close harmony with economic, financial, institutional, social and technical analysis of the project.

The findings of the examination of environmental and social considerations must include alternative proposals, mitigation measures and be recorded as separate documents or as a part of other documents. The EIA reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impact.

For projects that have particularly large potential adverse impact or are highly contentious, a committee of experts may be formed to seek their opinions, in order to increase accountability.

2) Examination of Measures

Multiple alternative proposals must be examined to prevent or minimize adverse impact and to choose a better project option in terms of environmental and social considerations. In examination of measures, priority is to be given to the prevention of environmental impact, and when this is not possible, minimization and reduction of impact must be considered next. Compensation measures must be examined only when impact cannot be prevented by any of the aforementioned measures.

Appropriate follow-up plans and systems, such as monitoring plans and environmental management plans, must be prepared; and costs of implementing such plans and systems, and financial methods to fund such costs, must be determined. Plans for projects with particularly large potential adverse impact must be accompanied by detailed environmental management plans.

3) Scope of Impact to be Examined

Environmental impact to be investigated and examined includes factors that impact human health and safety as well as the natural environment, such as: air, water, soil, waste, accidents, water usage, climate change, ecosystems, and fauna and flora. Social concerns include: involuntary resettlement of the affected population, local economy such as employment and livelihood, utilization of land and local resources, the indigenous people, equality of benefits and losses and equality in the development process, cultural heritage, landscape, gender, children's rights, local conflicts of interest, working conditions including occupational health, and communicable diseases such as HIV/AIDS.

In addition to the direct and immediate impact of projects, derivative, secondary and cumulative impacts are also to be examined and investigated to a reasonable extent. It is also desirable that the impact which can occur at any time throughout the project cycle be considered throughout the life cycle of the project.

4) Compliance with Laws, Standards and Plans

Projects must comply with laws, ordinances and standards related to environmental and social considerations established by the governments that have jurisdiction over project site (including both national and local governments). They are also to conform to environmental and social consideration policies and plans of the governments that have jurisdiction over the project site.

Projects must, in principle, be undertaken outside protected areas that are specifically designated by laws or ordinances of the government for the conservation of nature or cultural heritage (excluding projects whose primary objectives are to promote the protection or restoration of such areas). Projects are also not to impose significant adverse impact on designated conservation areas.

5) Social Acceptability

Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which the project is planned. For projects with a potentially large environmental impact, sufficient consultations with stakeholders, such as local residents, must be conducted via disclosure of information from an early stage where alternative proposals for the project plans may be examined. The outcome of such consultations must be incorporated into the contents of the project plan.

Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities, all of whom are susceptible to environmental and social impact and who may have little access to the decision-making process within society.

6) Ecosystem and Biota

Project must not involve significant conversion or degradation of critical natural habitats and critical forests. Illegal logging of forests must be avoided. Project proponents are encouraged to obtain certification by forest certification systems to prevent illegal logging.

7) Involuntary Resettlement

Involuntary resettlement and loss of means of livelihood are to be avoided where feasible, exploring all viable alternatives. When, after such examination, it is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with people who will be affected.

People to be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by the project proponents, etc. in timely manner. The project proponents, etc. must make efforts to enable the people affected by the project, to improve their standard of living, income opportunities and production levels, or at least to restore them to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting the means for an alternative sustainable livelihood, and providing the expenses necessary for relocation and the re-establishment of a community at resettlement sites.

Appropriate participation by the people affected and their communities must be promoted in planning, implementation and monitoring of resettlement action plans and measures against the loss of their means of livelihood. Also, appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

For projects that will result into large-scale involuntary resettlement, action plans must be prepared and made available to the public. In preparing a resettlement action plan, consultations must be held with the affected people and communities based on sufficient information made available to them in advance. Consultation should be carried out in form, manner, and language that are understandable to affected people. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

8) Indigenous Peoples

Any adverse impacts on indigenous people are to be avoided through viable alternatives. In case when avoidance is not feasible, measure must be taken to minimize impacts and to compensate indigenous people for their losses.

When a project may have adverse impact on indigenous peoples, all of their rights in relation to land and resources must be respected in accordance with the spirit of the relevant international declarations and treaties. Efforts must be made to obtain the consent of indigenous peoples in a process of free, prior, and informed consultation.

Measures for the affected people must be prepared as an indigenous peoples plan and must be made public in compliance with the relevant laws of the country. In preparing such plan, consultations must be held with the affected people based on sufficient information available to them in advance. Consultation should be carried out in form, manner, and language that are understandable to affected people. Also desirable is that the indigenous peoples plan include elements mentioned in the World Bank Safeguard Policy, OP 4.12, Annex B.

9) Monitoring

It is desirable that, after a project begins, the project proponents monitor: (i) whether any situations that were unforeseeable have arisen, (ii) whether the performance and effectiveness of mitigation measures are consistent with the assessment, and that they then take appropriate measures based on the results of such monitoring.

In cases where sufficient monitoring is deemed essential for the achievement of appropriate environmental and social considerations, such as the projects for which mitigation measures should be implemented while monitoring their effectiveness, project proponents must ensure that project plans include monitoring plans which are feasible.

It is desirable that project proponents make the results of the monitoring process available to project stakeholders.

When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, it is desirable that a forum for discussion and examination of countermeasures be established based on sufficient information disclosure and include the participation of stakeholders in the relevant project. It is also desirable that an agreement be reached on procedures to be adopted with a view to resolving the problem.

(17) EIA Report Content required by JICA Guidelines

According to the Appendix 2 of JICA Guidelines, the following conditions should be met in preparation of the EIA Report for Category A Projects:

- When assessment procedures already exist in host countries, and projects are subject to such procedures, Project proponents, etc., must officially complete those procedures and obtain the approval of the government of the host country.
- EIA reports must be written in the official language or a language widely used in the country where the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them.
- EIA reports are required to be made available in the country and to the local residents where the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and that copying be permitted.
- In preparing EIA reports, consultation with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records, etc. of such consultations must be prepared.
- Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project.

As stated in the Guidelines, EIA reports (for category A Projects) should cover the items enumerated below.

- Executive Summary
- Policy, legal and administrative framework
- Project description
- Baseline data
- Environmental Impacts
- Analysis of alternatives:
  - With project; and
  - Without project.
- Environmental Management Plan (EMP).
- Consultation.

(18) Environmental Impact Assessment according to Regulations in Viet Nam

The Law on Environmental Protection (No. 52/2005/QH11) describes about the necessity of carrying out environmental impact assessment. Articles 18 to 23 of Chapter III, section 2 of this law describes about environmental impact assessment which indicates clearly that any project which utilizes natural resources on large scale is required to prepare environmental impact assessment reports. Also, according to Article 19, the project owner or a consultant hired by the project owner shall prepare the EIA report during the feasibility study stage. Article 20 describes the contents of the EIA report which shall include description of project construction activities, project area, schedule, etc.; assessment of environmental status of project site; environmental impacts; mitigation measures; environmental protection measures during project construction and operation; environmental monitoring; cost estimates for environmental protection works within total cost estimates of project; opinion of commune/ward or township people's committee; and citation of sources of figures, data, etc.

Decree No. 21/2008/ND-CP, issued in February 2008, details and guides the implementation of a number of articles of the law on environmental protection. In this Decree, a revised list of projects that require to prepare EIA reports is presented. According to this list, a project on exploitation of surface water with capacity greater than 50,000 m^3/day is required to prepare EIA report.

Circular No. 05/2008/TT-BTNMT was issued by MONRE to provide guidance related to Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment. Section III of this Circular describes about EIA and includes explanation on elaboration of EIA, community consultation, submission of documents for EIA appraisal, appraisal of EIA report by appraisal council, finalization of EIA report, re-appraisal of EIA reports, approval of EIA reports, certification and sending of approved EIA documents, responsibilities of project owner after EIA approval, responsibilities of approving agency after EIA approval, etc.

Proposed project in this Study includes construction of water treatment plant with a capacity of 150,000 m^3/day in the first phase and additional 150,000 m^3/day in the second phase and transmission pipelines for conveying treated water from the WTP to the off takes. The raw water for WTP is proposed to be withdrawn from Duong River. The amount of surface water that will be used in this Project is greater than 50,000 m^3/day, the limit defined in the list of projects provided in Decree No. 21/2008/ND-CP. Therefore, the project owner is required to prepare EIA report.

Based on the abovementioned laws and decrees and discussion with the organizations related to appraisal and approval of EIA, the procedure flow chart for EIA appraisal and approval is prepared and presented in Figure4.2.8.

Based on the discussion with the Hanoi Environmental Protection Agency of Department of Natural Resources and Environment (DONRE), the EIA report shall be submitted to the Special Department for EIA submission. According to the law, the EIA report shall be prepared at the feasibility study stage of the Project by the project owner or any competent consultant hired by the project owner. For this project, the EIA shall be appraised by the DONRE and based on the appraisal report of DONRE, the Hanoi People’s Committee (HPC) shall approve the EIA. However, if the Project needs the approval from the Prime Minister, the EIA for this Project shall be appraised and approved by the Ministry of Natural Resources and Environment (MONRE).

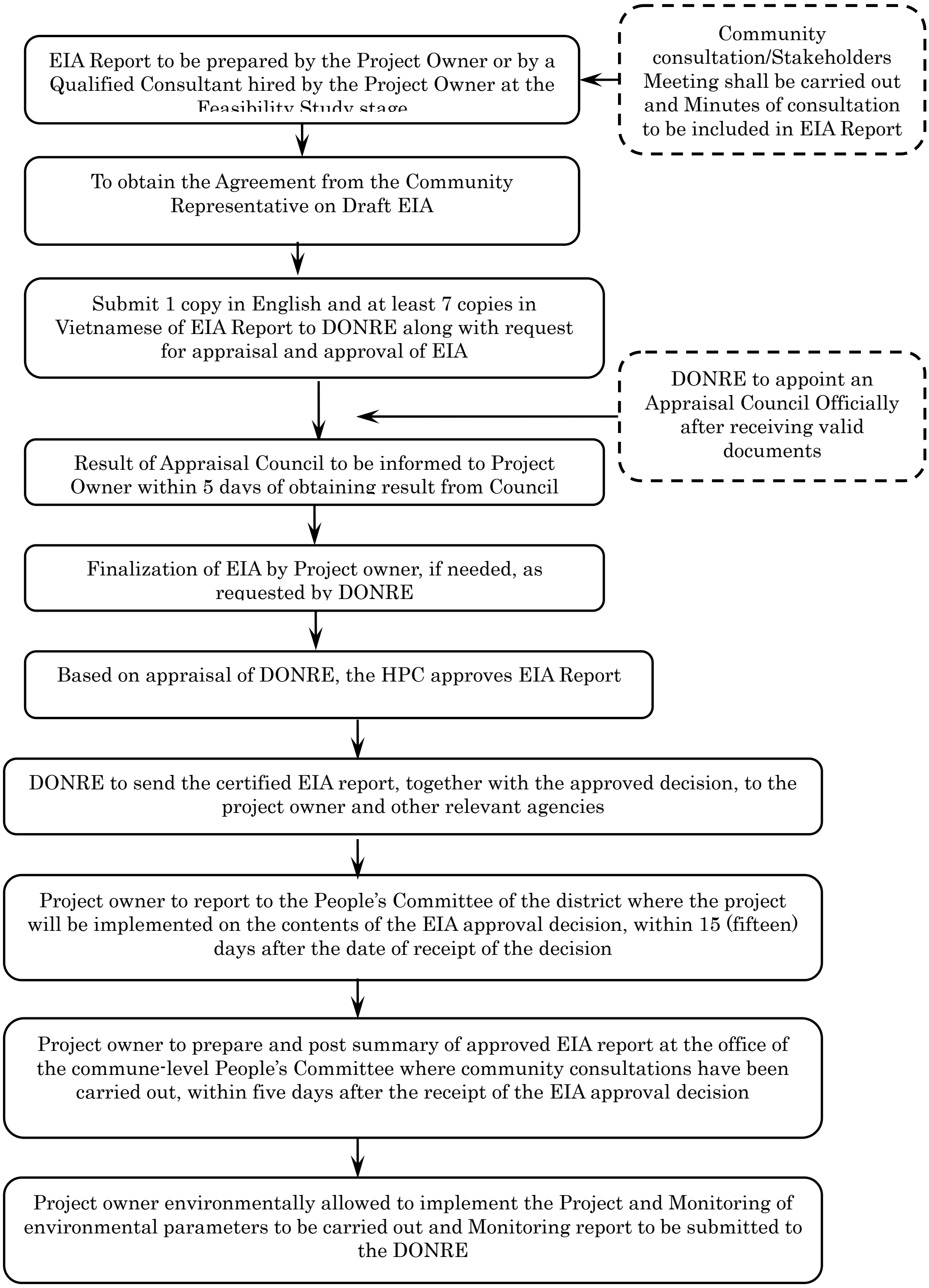


Figure 4.2.8 Law-based EIA Appraisal and Approval Procedure

Source: Based on the interview with the Hanoi Environment Protection Agency and Circular No. 05/2008/TT-BTNMT

(19) Project Approval Procedure

Before the start of the implementation of the Project, approval of several permissions and registrations are required in case of Viet Nam. These approvals include Registration for land use, Registration for electricity supply, Water right registration, Permission for occupancy of intake facilities, Permission for discharge to water body, Permission for construction and the Final approval for project implementation. A procedure flow chart is prepared and presented in Figure 4.2.9.

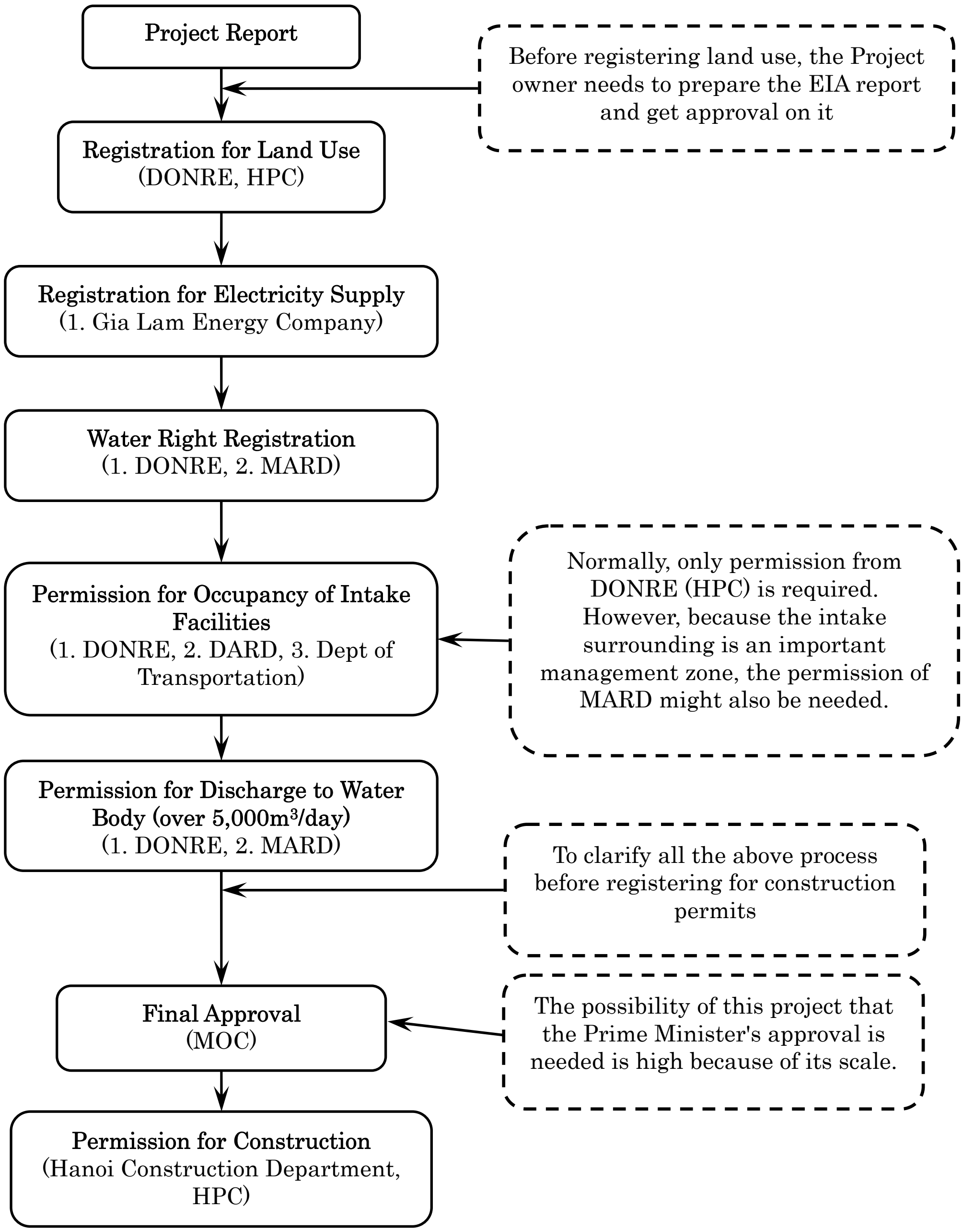
Several different organizations are responsible for providing permissions and carrying out registrations and the project owner should apply to these agencies for obtaining such approvals. These permissions and registrations are explained below.

It is important to mention here that to optimize the time, application procedures for multiple numbers of permissions or registrations could be taken up simultaneously. However, before obtaining the permission for construction, all the registrations and permissions should be obtained. Also, Final Approval must be obtained from the Ministry of Construction before obtaining the permission for construction from Hanoi Construction Department, HPC.

1) Registration for Land Use

The office of general plans is responsible for processing the registration of land use. For this purpose, the project owner should submit relevant documents (mentioned in Figure 4.2.10) along with the project report, investment permission from Department of Planning and Investment, decision of project approval from head of project owner, Agreement from HPC, etc.

If the submitted documents are found to be as per requirement, DONRE officially announces the Project area boundary and decision for land clearing. The local government related to the project area discusses with the landowners and HPC if necessary to decide the land prices based on the officially announced rates. Minutes of all the meetings are prepared while negotiation. Final price is announced and the price is paid by the Project owner. After local government reports completion of land clearing, DONRE reports to HPC for decision on land acquisition and decision to hire the land. Project owner pays the money to hire land and land use permission is issued by DONRE (on behalf of HPC) to the Project owner.



*HPC:	Hanoi People's Committee
*DONRE:	Department of Natural Resources and Environment
*MARD:	Ministry of Agriculture and Rural Development
*DARD:	Department of Agriculture and Rural Development
*MOC:	Ministry of Construction

Figure 4.2.9 Procedure of Project Approval

Submission of Documents to DONRE (Office of Administration):

- Investment permission from Department of Planning and Investment (HAPI) and also including the following documents
  - Project report prepared by owner and approved by Hanoi construction Department
  - Related agreements – electricity, water right, environment approval, firefighting, etc.
  - Decision of project approval from project owner (e.g. Head of board of directors, VIWASEEN)
  - Agreement from Hanoi People's Committee or the Prime Minister

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Documents Processing by DONRE:

- Check documents if any required agreement is missing and request the Project Owner to submit if any agreement is missing.
- If document is found to be complete, DONRE officially announces the Project area boundary and decision for land clearing.
- Local government discusses with landowners and other agencies such as HPC if necessary and price is announced. Price to be paid by the Project owner.
- When provincial local government reports completion of land clearing, DONRE reports to HPC for decision on land acquisition and decision to hire the land.

↓

After receiving decision of hiring land, three steps are undertaken:

- Handover of land to project owner and actual survey carried out.
- Project owner to contact the department of finance for payment against hiring the land.
- Project owner to pay the money to the bureau of taxation to hire the land.

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Land use permission is issued by DONRE, on behalf of HPC, to the Project Owner

Figure 4.2.10 Procedure of Land Use Registration

2) Water Right Registration and Permission for Discharge to Water Body

In Viet Nam, according to Decree No. 149/2004/ND-CP and Circular No. 02/2005/TT- BTNMT, permission is needed for the exploration, exploitation and utilization of water sources and discharge of wastewater into water bodies. According to the law, the Ministry of Natural Resources and Environment is responsible to issue, extend, amend, terminate and revoke permits for extracting and using surface water more than 50,000 m^3/day, for purposes other than agriculture, and for wastewater discharge into water bodies at rate of 5,000 m^3/day or higher. Based on the discussion with the Department of Natural Resources and Environment (DONRE), the application for obtaining permission of water utilization and discharging into river in case of this Project is to be submitted to DONRE for approval. Office of Water Resources and Hydrometeorology within DONRE is responsible division for processing the water right registration and permission for discharge to water body.

Department of Natural Resources and Environment is the implementing agency of the MONRE at provincial and city level and reports directly to the related provincial People's Committee.

3) Permission for Occupancy of Intake Facilities

Under this project, the intake pipes and pumps are to be installed within the embankment zone (floodplain zone) of Duong River. Also, the raw intake pipes and transmission pipes are to cross the dikes/embankments along Duong and Hong rivers. Therefore, permission shall be needed from the DONRE and Department of Agriculture and Rural Development (a provincial level office of MARD).

4) Registration for Electricity Supply

For operation of intake pumps, equipment at WTP, and transmission pumps, large amount of electricity shall be needed. Therefore, processing of registration for electricity supply should also be made at the Gia Lam Energy Company.

5) Final Approval of Project Implementation

Final approval on project is obtained from the Ministry of Construction (MOC). The Administration of Technical Infrastructure (ATI) is relevant department in MOC that takes care of obtaining the final approval of project from MOC. The Project owner submits the request to the MOC and the ministry requests ATI to process it before granting approval. The approval letter is finally signed by either the Minister or the Deputy Minister. Based on the discussion with the ATI, procedure flow chars is prepared and presented in Figure 4.2.11.

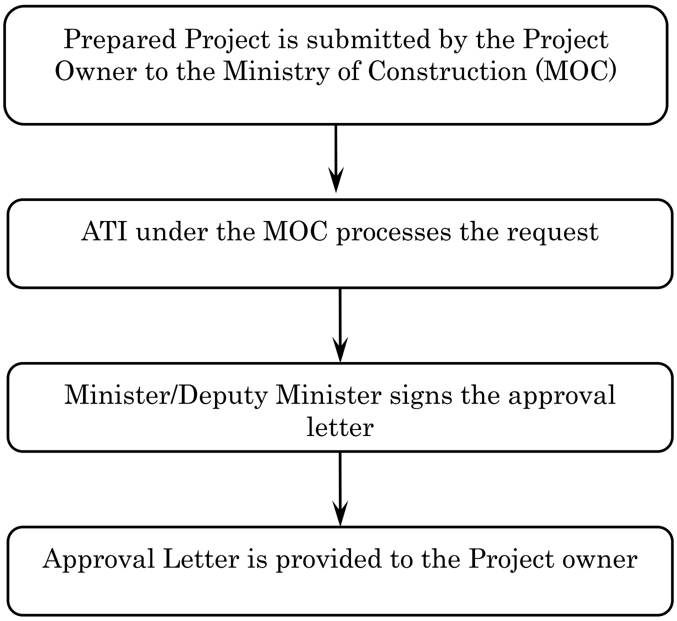


Figure 4.2.11 Procedure for Obtaining Final Approval

6) Permission for Construction

Hanoi Construction Department (HPC) is responsible for providing permission for construction of facilities. Office of Construction Permission and Management under the Hanoi construction department is responsible for processing the application. After obtaining the permission for construction, the constructions works for project can be started.

4.3 Project Description

(1) General

Rapid economic and industrial growth in Greater Hanoi has also resulted into accelerated increase of population in the metropolis. The population of Greater Hanoi has increased to about 6.5 million in 2009. However, provision of services and utilities including water supply has not been able to keep in pace with the rising population. There is lack of adequate water supply facilities which has resulted into poor level of water supply services.

(2) Existing Situation of Water Supply System

Water supply service in Greater Hanoi is facilitated by using treated water by several companies namely Hanoi Water Limited Company (HAWACO), Fresh Water Business and Construction Investment JSC (VIWACO), Son Tay Water supply Company, Ha Dong Water supply Company, and Bac Ninh Water supply and Sewerage Ltd. Company.

HAWACO covers the northeastern areas of Greater Hanoi including Dong Da, Ba Dinh, Hai Ba Trung, Cau Giay, Ho Tay, Long Bien, Gia Lam, Dong Anh, Soc Son, Hoang Mai, Thanh Xuan, Thanh Tri, and Tu Liem. For this area, treated water from 21 WTPs are used to distribute water to the users, the source of water is mainly groundwater in all these cases. The total capacity of the WTPs is 604,000 m^3/day.

VIWACO covers the southern and a part of central areas of Greater Hanoi including part of Thanh Xuan, Tu Liem, Thanh Tri, and Cau Giay. The water supply is facilitated using treated water from one WTP having capacity of 300,000 m^3/day and using Da river as raw water source.

Son Tay water supply company covers the western and a part of central Greater Hanoi including Son Tay, Ba Vi, Phuc Tho, and Thach That. The water supply is made using treated water from 2 WTPs with a total capacity of 20,000 m^3/day, the water source is groundwater for these WTPs.

Ha Dong water supply company covers Ha Dong area located in the central part of Greater Hanoi. In this case, the water supply is facilitated using treated water from 2 WTPs with a total capacity of 36,000 m^3/day. The source of water for these WTPs is groundwater.

Bac Ninh water supply and sewerage Ltd. Company supplies water to Bac Ninh area utilizing treated water from 6 small WTPs with a total capacity of 27,300 m^3/day. These WTPs uses groundwater as water source.

In the area of Hung Yen, the water supply is facilitated through treated water from 19 water supply systems with a total capacity of about 24,119 m^3/day. In these cases also, the main source of water is groundwater.

Hence, the total capacity of all these water supply systems together is about 1,011,419 m^3/day. Considering losses in the water supply systems, the available water is not enough to cater to the needs of increasing population and water demand for industrial uses. Also, in the existing condition, the source of water supply remains to be mainly groundwater. Recently, due to overexploitation of groundwater, land subsidence and deterioration of groundwater quality have been reported. Considering these issues, the Government of Viet Nam has shifted the policy from use of groundwater as source to the use of surface water as source.

Considering the above factors, provision of additional treatment facilities and distribution system is indispensable to satisfy the requirements and to improve the level of water supply services in Hanoi and its neighborhoods. Consequently, the Government of Viet Nam is planning to carry out two major water supply projects namely Da River project (for water supply to the southern part of Hong river in Hanoi) and Duong River project (for water supply to the northern part of Hong river).

In April 2008, Duong River project was proposed by VIWASEEN, to supply water to Ha Noi City, Bac Ninh, Hai Duong, and Hung Yen. In April 2010, the Prime Minister approved VIWASEEN to be the investor for implementing Duong River water supply system project.

(3) Project Objectives

The overall goal of this project is to improve quality of life through improvement in water supply services in Hanoi, Bac Ninh, Hai Duong, and Hung Yen areas, to cater to the increasing needs of domestic and industrial demands. Also, the objective is appropriate water resources management by moving from groundwater to river water sources. This can be achieved through construction of additional water treatment facilities using river water as raw water source. It is expected that outcome of this Study will be used for facilitating implementation of construction of water treatment facilities, transmission pipelines, and off takes. To accomplish these goals and objectives, this Study is undertaken in order to prepare project components to provide an additional capacity of 300,000 m^3/day of treated water in two phases. The proposed project shall include project cost and implementation plans and evaluation of the project. As a part of this Study, it is also required to prepare Environmental and Social Consideration report which can be used by the VIWASEEN to prepare EIA report and submit to DONRE/MONRE for its approval before implementation of proposed project activities.

(4) Description of Proposed Project

To improve the existing level of water supply services, the components of proposed project include water treatment facilities with a total capacity of 300,000 m^3/day, transmission pipelines, and six off takes. The facilities proposed to be constructed for water treatment include intake, raw water pumps, dividing wells, flush mixing tanks, flocculation tank, chemical sedimentation tanks, chlorine mixing tanks, rapid filter, chemical dosing facilities, clear water reservoir, water transmission pump, wash water drainage basin, sludge basin, thickener, sludge drying beds, electrical and instrumentation facilities, effluent pump, effluent channel from WTP to river, and administrative building. In addition, transmission pipelines with a total length of about 130 kms and off takes at six locations shall be constructed. The information on these facilities is presented in Table 4.3.1 and Table 4.3.2 below. Location map of main facilities in this Project is presented in Figure 4.3.1. The layout plan for proposed water treatment facilities is shown in Figure 4.3.2.

Table 4.3.1 Proposed Components Under this Project

Facility	Area (ha)	WTP	SR	Pump	Pipe	Major activities
1. Intake Facilities				●	●	・ Construction of intakes structures including Grit chamber, water intake pumps, and intake pipes ・ Operation and maintenance of intake pumps
2. Construction of new WTP with Total Capacity of 300,000m^3/day		●	●	●	●	・ Construction of WTP including dividing well, Flush mixing tank, Flocculation tank, Chemical sedimentation tank, Intermediate chlorine mixing tank, Chlorine dosing house, Rapid filter, Chemical dosing facilities, Clear water reservoir, Water transmission pump, Wash water drainage basin, Sludge basin, Thickener, Sludge drying beds, Electrical and instrumentation facilities, effluent pump, effluent channel from WTP to River, and administrative building. ・ Operation and maintenance of the treatment facilities
3. Water Transmission Facilities (Total length about 45km)			●	●	●	・ Construction of transmission pipelines crossing Rivers at 2 locations ・ Operation and maintenance of pipes
4. Off takes at 6 locations					●	・ Installation of pipelines, valves, and bulk water meters ・ Operation and Maintenance of off takes

Note: WTP: Water treatment plant, SR: Service reservoir (Ground level)

Table 4.3.2 Information on Proposed Sites for Facilities Under this Project

No.	Facility	Location
1.	Intake Facilities	Gia Lam
2.	Construction of new WTP (Capacity 300,000m^3/day)	Gia Lam
3.	Water Transmission Facilities (Length about 45km)	– Bac Ninh: Tien Du, Tu Son – Hanoi: Gia Lam, Long Bien, Hoang Mai – Hung Yen: Van Giang
4.	Off takes at 6 locations	1. Lim (Bac Ninh) 2. Duong Dinh (Gia Lam, Hanoi) 3. Tran Quy (Giam Lam, Hanoi) 4. Sai Dong (Long Bien, Hanoi) 5. Van Giang (Hung Yen) 6. Phap Van (Hoang Mai, Hanoi)

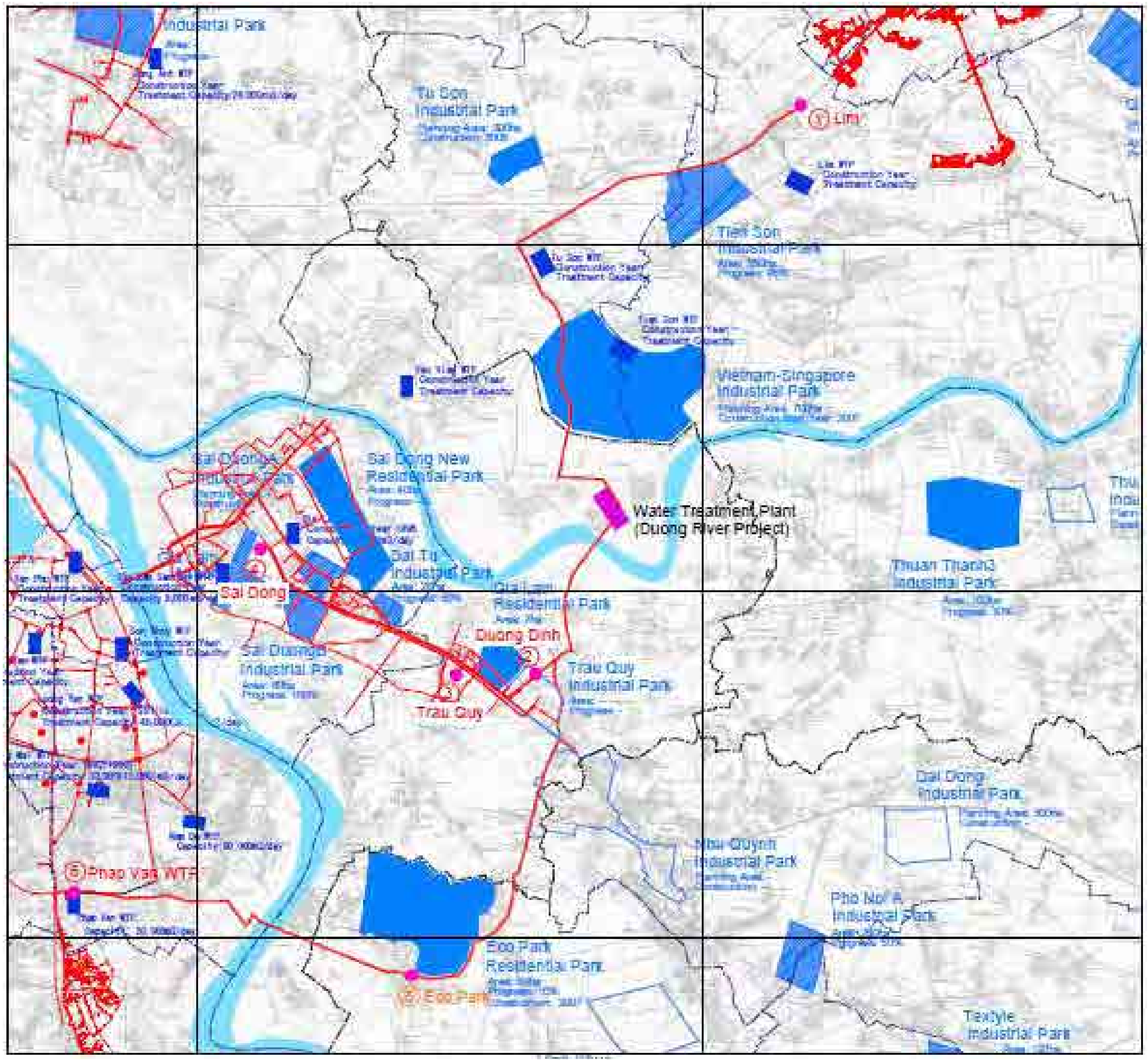
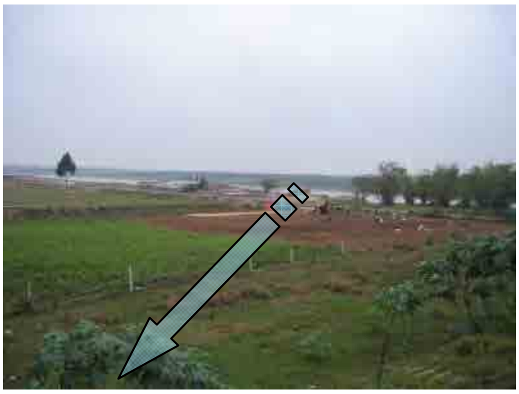


Figure 4.3.1 Location Map of Main Facilities Proposed in this Project

Total areal extent of 58.23 ha shall be required for the construction of water treatment facilities and about 15 ha for the laying of transmission pipelines. The land proposed for construction of water treatment facilities and some part of the proposed land for transmission pipelines is owned by the private owners. Therefore, land acquisition shall be required for the construction of the facilities under this Project. Some of the photographs showing proposed locations of intake, WTP, effluent channel, transmission pipelines, and off takes are presented in Figure 4.3.3 to Figure 4.3.6.

Figure 4.3.2 Proposed Water Treatment Facilities

Location of Intake



Location of Intake: View from far

Intake pipe to be aligned along dike to WTP

Raw water pipe from dike towards WTP

Rice fields at proposed location of WTP

Proposed location of WTP

Few individual graves exist in the rice fields of proposed WTP location

Few individual graves exist in the rice fields of proposed WTP location

Figure 4.3.3 Photographs Showing Location of Project Components (1)

Access road at the location of Proposed WTP site

Access road at the location of Proposed WTP site

Effluent channel proposed to be aligned along road to Duong River

View of Duong River at the location of intake and Transmission

Location of transmission pipelines crossing Duong River and going to south

Transmission pipelines going south of Duong river

Transmission to align along roads within embankments

Transmission to cross south of Duong embankments

Figure 4.3.4 Photographs Showing Location of Project Components (2)

Transmission pipelines to be laid along and under roads

Transmission pipelines to be laid along and under roads

Transmission pipelines to be laid along and under roads

Transmission pipelines to be laid along and under roads

Location of Transmission Pipeline on Hong River

Location of Off take Point 1

Location of Off take Point 2

Location of Off take Point 2 (another view)

Figure 4.3.5 Photographs Showing Location of Project Components (3)

Location of Off take Point 3

Location of Off take Point 3 another view

Location of Off take Point 4

At Off take Point 4 pipelines will have to cross railways and drain through trenchless method

Location of Off take Point 5

Transmission pipelines shall be laid along roads near Off take Point 5

Figure 4.3.6 Photographs showing Location of Project Components (4)

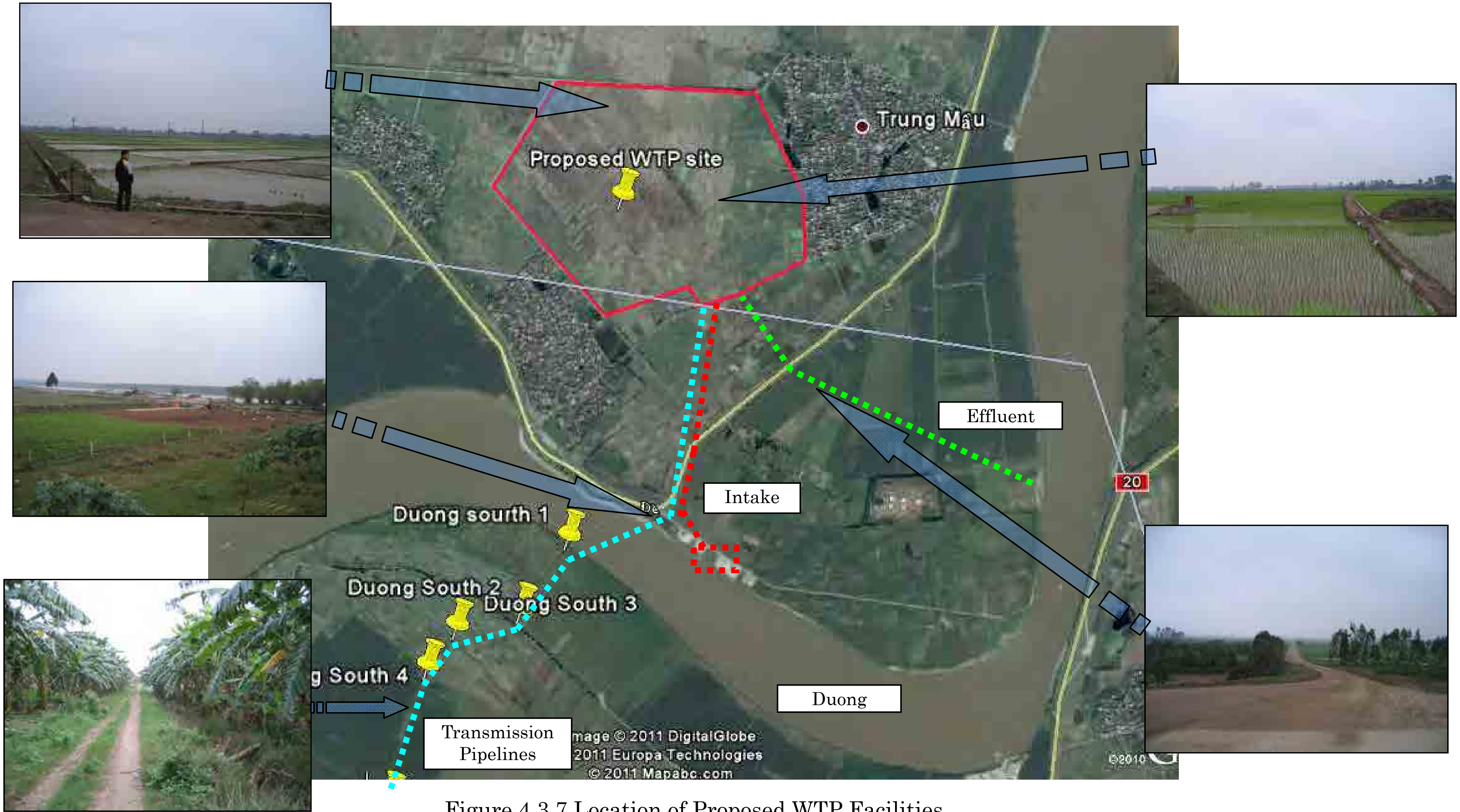


Figure 4.3.7 Location of Proposed WTP Facilities

4.4 Baseline of Environmental Data

(1) Physical Environment

Hanoi is the second largest and capital city of Viet Nam. The city has long been a center of political and cultural activities in Viet Nam. In past, Hanoi was located on the right bank of Hong River, however, now the urban agglomerates extends on both sides of the River. Hanoi is divided into 10 inner districts, 1 town and 18 suburban districts. It extends over an area of about 3,345 km^2 and has a population of approximately 6.47 million with population density of 1935 persons/km^2.

Hanoi is the economic center of Viet Nam. Industrial production in the city has experienced a rapid boom since the 1990s, with average annual growth of 15-20% during last two decades. As a whole, in Viet Nam, Agriculture contributes about 20% of Gross Domestic Product (GDP) and Industrial and Services sectors contribute about 40% each. The economic development and growing population has fueled rapid construction in the city. Rapid growth in population (almost 3.5% per year) has surpassed well ahead of city services and resulted into lack of adequate services in terms of homes, roads, electricity, telephone, water supply, and sewerage, etc. However, Hanoi has the highest Human Development Index among the cities in Viet Nam.

(2) General Description of Project Area

In general, the water supply projects are expected to have positive impacts in terms of improvement in water supply services in the project area and also with respect to improvement in the living environment in and around project area. However, it is important to envisage and analyze any potential negative impacts that could be caused by implementation of the project during pre-construction, construction and operation stages and to implement measures in order to mitigate negative impacts due to proposed project components.

There are two areas that are expected to experience minor adverse impacts by implementation of proposed project. Hence, in principle, these areas are set as the Scope of Study for preparation of this report. These areas include:

- The proposed site of water treatment and its supplementary facilities under this Study (the proposed area in Gia Lam, Figures 4.3.1 and 4.3.7)
- The sites proposed for alignment of transmission pipelines and off take points.

The baseline data is collected using the available data for Hanoi or the data for a relatively broader area in case when data for Hanoi is not available. Based on the collected information, in this part of the Study, the baseline data is described under the following categories.

- Physical Environment : Topography, Climate, and Pollutions (Water Pollution, Air Pollution, Noise)
- Biological Environment: Protected Area, and Flora & Fauna
- Socio-economic Environment: Population, Socio-economic indicator, Public Health, Cultural Heritage, Transportation

The area proposed for construction of water treatment facilities is located in Gia Lam in the northeastern part of Greater Hanoi away from the populated city area. The transmission pipelines and off take locations shall be located in the northern part of Duong River and in the central part of Greater Hanoi. The pipelines shall be aligned mainly along the roads and six off takes shall also be located near the roads in areas that are currently either fallow land or farming land.

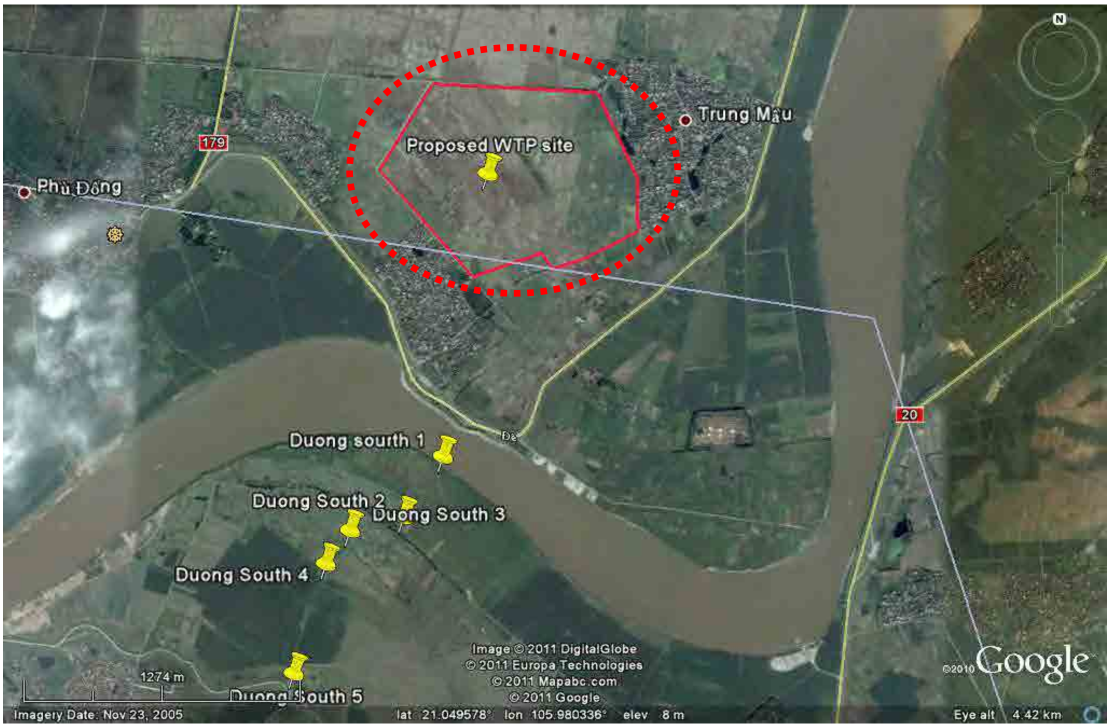
(3) Topography

1) Topographical Feature

① Proposed Location of WTP in Gia Lam

The following are salient features related to topography of the area around the proposed location of water treatment plant in Gia Lam (Figure 4.4.1 and Figure 4.4.2):

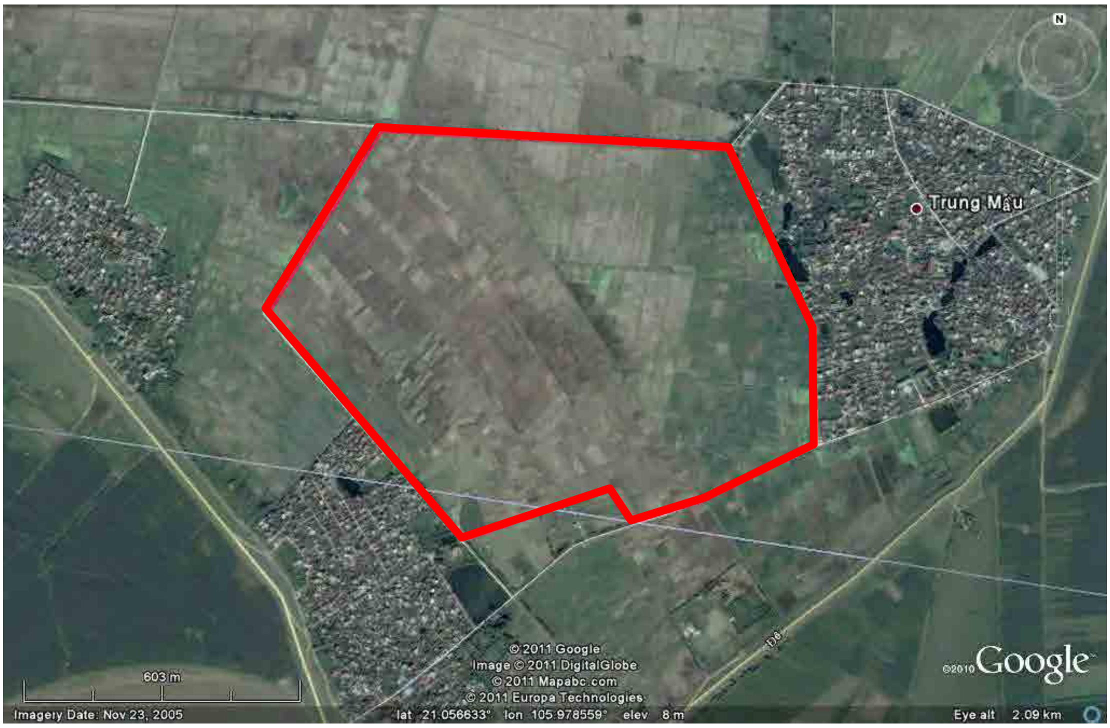
- Proposed site for water treatment plant is located in Gia Lam, in northeastern part of Greater Hanoi and to the north of Duong River.
- The topography of the land is relatively flat (altitude ranging from 4-8 m) and surrounded by road on the north side. Towards the eastern and western side of this area, there are some houses. To the south lies the Duong River and dikes on the river.
- The effluent from sludge lagoons in the WTP is to be discharged through channels into Duong River downstream of the intake location.



Source: Google

Figure 4.4.1 Map Showing Location of WTP

In the neighborhoods of the proposed location of WTP, there are a number of houses on the east, west and southwestern side of the site. At present, proposed site for WTP is occupied by farming lands. In these fields, rice is grown twice a year when plenty of water is available and in some of the fields vegetables are also grown during dry season. Also, the proposed site, for laying of raw water pipelines from Duong River to the location of WTP, is farming land in which rice is grown currently. These farming lands are owned by the private landowners and land acquisition will be required before the implementation of the Project. In some of these fields, few individual graves exist in present condition. Altogether, about 50 small graves are present including the very old earthen graves. The relocation of these graves shall be required at the stage of land acquisition and before land clearance.



Source: Google

Figure 4.4.2 Map showing Location around Proposed WTP Site

② Transmission Pipelines

Main points related to topography in the areas where pipelines are to be laid are listed below.

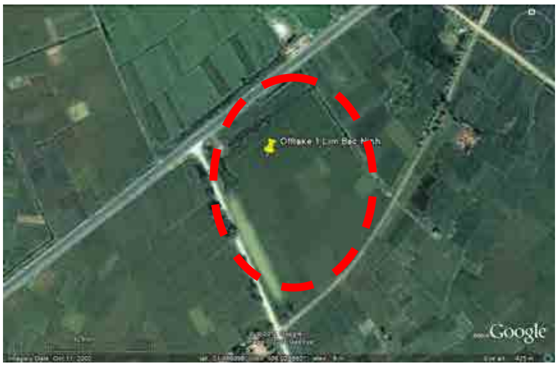
- The transmission pipeline from WTP is proposed to be laid towards Tien Du, Tu Son areas of Ban Ninh (in north and east of WTP).
- Transmission towards south of Duong is to cross the embankments on Duong River and then pipe is to be laid towards south. On the way, one branch is to be laid towards west for carrying water to off takes proposed to be located in Duong Dinh, Tran Quy, and Sai Dong.
- The pipeline going towards south is to supply water to the off take point that is proposed to be located in Van Giang and after crossing Hong River to the off take point in Phap Van.
- At two locations, the transmission pipelines are proposed to cross rivers, one at Duong River and the other at Hong River. For crossing the rivers, pipe shall be laid through trenchless technology.
- The elevation in areas where pipelines are to laid varies from 3-12 m and the topography is almost flat except when Rivers and streams exist.

In most of the cases, the transmission pipelines are proposed to be laid underground either along the road or under the roads. Some of the stretches near Duong River and Hong River, where the pipelines is proposed to be laid, is occupied by the farming lands growing vegetables such as cabbage, etc. and fruits such as banana. These lands are owned/rented by the private owners. Therefore, land acquisition shall be required for these cases. For those parts, where pipelines is proposed to be laid along or under the roads, in some stretches, the houses are located close to the roads and appropriate measures will be required during construction to minimize disturbances.

③ Off take Points

Main points related to topography in the area where off takes are to be located are listed below.

- Off take 1 is located in Lim area of Bac Ninh beside the road and the location is mainly occupied by rice fields now. The area has almost flat topography and the elevation varies from 5-7 m in the area.
- Off take 2 is located near the gas station in Duong Dinh area of Gia Lam, Hanoi and the proposed area is either fallow or used for rice cultivation. The proposed area is flat with elevation ranging 5-7 m.
- Proposed site for off take 3 is located in Tran Quy area of Gia Lam, Hanoi and is presently a small pond having a lot of water hyacinth. The topography of the area is flat with elevation from 3-4 m.
- Off take 4 location is situated in Sai Dong area of Long Bien, Hanoi near the Helipad site and mainly occupied by the rice fields. There is also a big drain flowing nearby. Also, a big size pipeline exists in the area. The topography of the area is almost flat with elevation ranging 8-9 m.
- Off take 5 is located in Van Giang area of Hung Yen and is a part of industrial zone to be developed soon. The topography of the area is almost flat.
- Off take 6 is proposed to be located in Phap Van area of Hoang Mai, Hanoi.



Location of Off take 1 in Lim (Bac Ninh)

Location of Off take 2 in Duong Dinh

Location of Off take 3 in Tran Quy

Location of Off take 4 in Sai Dong

Source: Google

Figure 4.4.3 Map showing Area in Neighborhoods of Some of the Off Takes

(4) Climate

Hanoi experiences a warm humid subtropical climate with high precipitation. The city experiences typical climate of northern Viet Nam, where summers are hot and humid, and winters are relatively cool and dry. The project area experiences summer during May to September, which is relatively hot and humid, and majority of the annual rainfall (about 1,680 mm) occurs during this period. The winters are usually short and are relatively dry, and mild. In spring, light rain may occur.

The meteorological data in Hanoi is shown in Table 4.4.1 and Figure 4.4.4. This data is the average value based on the webpage of World Meteorological Organization. The outline of climate in this area is described based on this data.

1) Temperature

In the hottest of the summer months - June, July, and August - the average daily maximum temperature is 32.5°C, and the average daily minimum is 25.8°C. The average daily maximum temperature during December-February is about 20°C, and the average daily minimum is 14°C. Hence, in winter it is not very cold.

Table 4.4.1 Climate Data for Greater Hanoi

Months	Average High Temperature (°C)	Average Low Temperature (°C)	Relative Humidity (%)	Monthly Rainfall (mm)
January	19.3	13.7	72	18.6
February	19.9	15.0	84	26.2
March	22.8	18.1	82	43.8
April	27.0	21.4	82	90.1
May	31.5	24.3	81	188.5
June	32.6	25.8	74	239.9
July	32.9	26.1	79	288.2
August	31.9	25.7	78	318.0
September	30.9	24.7	76	265.4
October	28.6	21.9	75	130.7
November	25.2	18.5	66	43.4
December	21.8	15.3	73	23.4

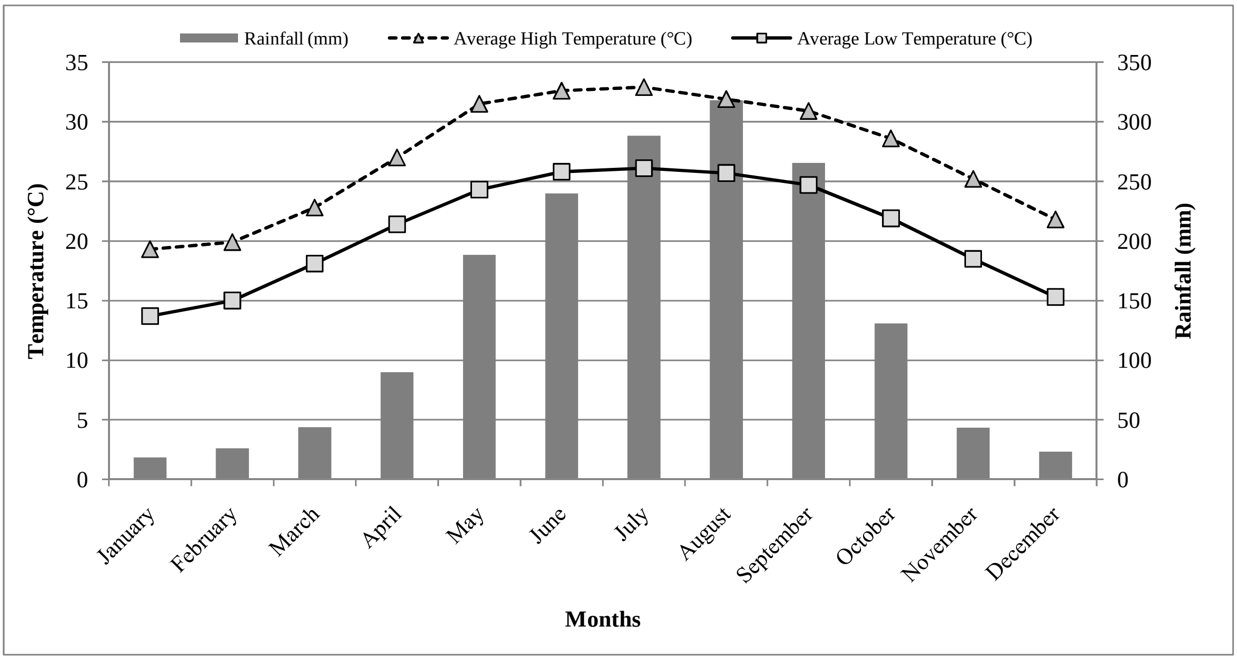
Source: World Meteorological Organization webpage

2) Relative Humidity

The average minimum and maximum of humidity is 66% and 84%, respectively. As a general trend, the relative humidity is high in winter and drops to the minimum at the end of summer and beginning of winter in November and December.

3) Rainfall

Based on the data presented in Table 4.4.1, it is observed that average monthly rainfall lies in the range of 18-318 mm. Average annual rainfall is about 1,680 mm. Usually, the rainy season starts in May and ends in October. During the period of highest rainfall, within duration of three months (July-September), the total rainfall is about 900 mm which is more than 50% of the total annual rainfall. .



Source: World Meteorological Organization webpage

Figure 4.4.4 Rainfall and Temperature Data for Hanoi

4) Wind

On average, in winter, the wind blows from north and northeast and in summer the wind blows from southeast and south. The wind speed is about 1.5 to 2.5 m/s in Hanoi and its neighborhoods.

5) Evaporation

The seasonal variation in amount of evaporation is influenced by humidity, wind and precipitation. It has been observed that evaporation is small in the months of February, March, and April (about 2 mm/day). It has a tendency of becoming higher in summer and the maximum of average daily evaporation is 3-4 mm/day in June and July. Hence, there is not much of variation in daily evaporation.

(5) Water Pollution (Surface Water and Groundwater)

The existing status of water pollution in the project area is described under the heads of surface water and groundwater.

1) Surface Water Quality

Rapid urbanization and industrialization has resulted in growing demand for water uses. Many rivers run through Hanoi. Red River runs across the city and provides as a source of irrigation and water for domestic purposed and is also used as a means of transportation. Duong River is the second largest river in Hanoi. It is used for transportation and it supplies water for agricultural production and as a source of domestic water supply after treatment.

High levels of pollution have been reported in four streams passing through Hanoi including Kim Nguu, To Lich, Set and Lu attributed to the discharge of untreated wastewater both from industrial and domestic sectors. According to the State of Environment in Viet Nam, rivers are also found to be polluted with substances like Nitrogen and Phosphorus.

2) Groundwater

Most of the WTPs in Hanoi are of small capacity and use groundwater as water source. Due to increased demand and excessive utilization of groundwater for drinking and industrial purposes, severe deterioration in water quality has been observed in many areas. Decrease in groundwater level has resulted into increased salinity.

Investigations have been made by the UNICEF, and Hanoi University on level of groundwater contamination in Hanoi and nearby. Based on the reports that groundwater is contaminated in the area due to presence of ammonia, manganese, iron and arsenic. Based on the result of the UNICEF report, the level of arsenic contamination in groundwater in Red river basin is presented in Table 4.4.2. From the Table, it can be observed that even in case of wells in Hanoi, of the 824 wells sampled, in 23.3% cases the arsenic level exceeded 0.05 mg/L and in 49.3% of wells sampled, the arsenic level exceeded 0.01mg/L.

Considering these factors, the Vietnamese Government is planning to move towards utilization of surface water rather than groundwater, for providing water supply services.

Table 4.4.2 Situation of Arsenic Pollution in Groundwater in Red River Basin

Item	No. of Sample	More than 0.01mg/L		More than 0.05mg/L	
		No. of Sample	%	No. of Sample	%
Hanoi	824	414	49.3	199	23.3
Ha Tay	1368	638	46.6	338	24.7
Hung Yen	3384	700	20.7	310	9.2
Ha Nam	7042	4517	73.4	3534	62.1
Nam Dinh	605	156	21.3	104	13.8
Ninh Binh	75	26	34.7	8	10.7
Thank Hoa	347	17	4.9	17	4.9

Source: UNICEF(2004b)

(6) Air Pollution

Air quality in urban centers of Viet Nam is deteriorating in line with increased urbanization and industrialization. Most of the urban areas in Viet Nam are polluted by particulate matters (PM_{10}). In most urban centers, the average value of SO_2, CO, NO_2 concentration is lower than or approximates the acceptable limit. However, near the industrial areas sometimes, the values of SO_2 exceed the limit. With the increasing number of motorbikes and automobiles, transport waste has now added to the air pollution in Hanoi.

In Hanoi, the air quality is measured hourly at some monitoring stations. DONRE Hanoi is a lead agency mandated to regulate and manage air quality in Hanoi. Data based on the Lang monitoring station in 2007 is presented in Table 4.4.3 including the hourly average concentration of air quality parameters. However, during the congestion in streets of Hanoi, the air quality becomes worse.

Table 4.4.3 Monthly Average Concentrations in 2007 in Hanoi

($\mu g/m^3$)

Month	PM_{10}	NO_2	SO_2	CO	O_3
January	141.0	26.38	24.26	728.68	14.54
February	144.6	18.95	19.07	569.85	18.75
March	132.4	17.09	14.05	581.68	18.99
April	138.4	19.32	16.86	413.52	29.5
May	129.8	10.41	8.92	382.03	27.57
June	140.8	7.78	8.47	335.88	42.59
July	129.9	7.63	8.47	313.72	41.06
August	149.9	12.06	8.29	377.88	43.14
September	160.6	26.25	6.03	530.42	43.92
October	152.9	23.88	8.26	522.57	43.08
November	155.5	39.14	26.03	738.92	23.54
December	141.1	37.62	16.90	489.65	18.13

Source: Urban Air Quality Modeling and management in Hanoi, Viet Nam, Phd Thesis, Ngo Tho Hung

(7) Noise

The acoustic environment in Hanoi is characterized by high noise levels mainly due to transport movements, construction activities, industry and daily living activities. Noise levels are relatively high throughout the day and night. Typical daytime noise levels in residential areas are 75-78 dB(A) and can reach 80-85 dB(A) near the major roads.

It has been reported based on monitored data on major roads in Hanoi that average noise levels during the daytime varies in the range of 64-80 dB(A) and during the evening it is in the range of 67-73 dB(A). This indicates that in most cases the noise levels are exceeding the maximum limits defined by TCVN 5949: 1998. Even near the locations of the educational institutions, the noise levels have been reported to be very high.

(8) Biological Environment

1) Protected Areas in Viet Nam

In Viet Nam, protected areas are designated in a variety of different ways. Special-use Forests (SUF) is commonly perceived as protected areas and include national parks, nature conservation areas (nature reserves and species/habitat conservation areas), and landscape conservation areas. There are 126 approved SUFs comprising 28 national parks, 48 nature reserves, 11 species/habitat protected areas, and 39 landscape-protected areas.

Also, there are 4 sites designated as World Heritage Sites: Ha Long Bay, My Son sanctuary, Hoi An ancient town, and Complex of Hue monuments. Two sites are designated as Man and Biosphere Reserve: Can Gio mangroves and Cat Tien.

There is one site designated as Wetlands of International Importance (Ramsar) which is Xuan Thuy Ramsar Reserve.

In addition, 68 sites have been proposed as Wetland Protected Areas, and 15 areas have been proposed as Marine Protected Areas.

A map showing protected areas around Hanoi has been shown in Figure 4.4.5.

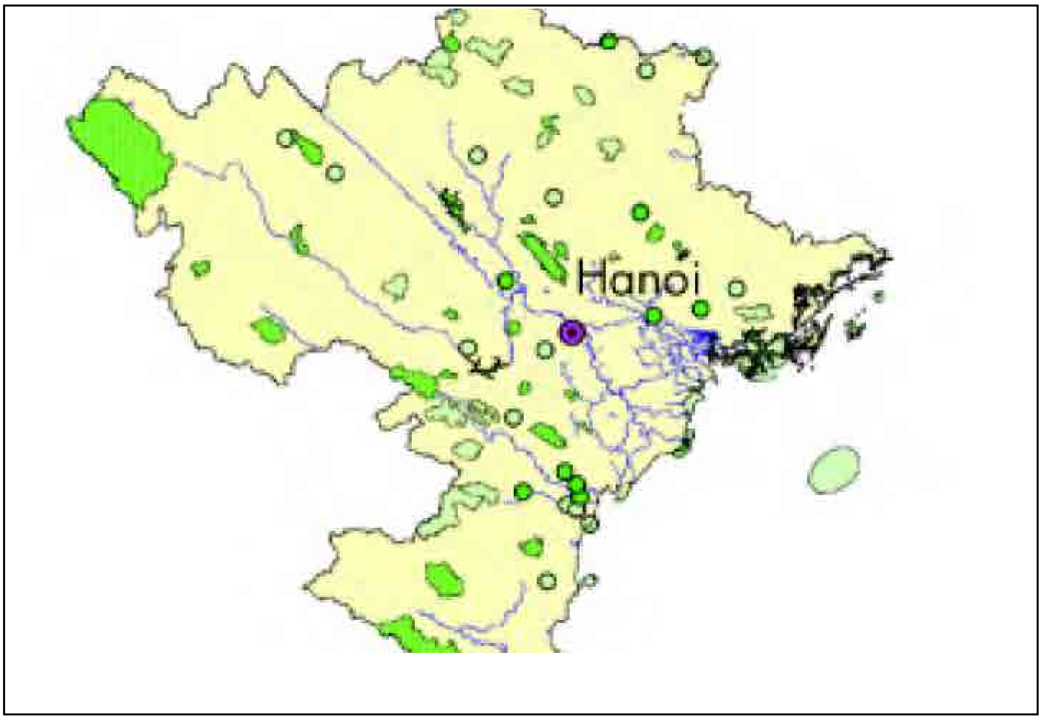


Figure 4.4.5 Protected Areas in around Hanoi

No protected areas exist in or near the proposed sites for project activities. Therefore, the project activities are not expected to have any impact on protected areas.

2) Existing Situation of Flora and Fauna

① Proposed Site of WTP in Gia Lam

Proposed location of WTP is occupied by the cultivated lands and in the present situation farming is practiced. The farmers mainly grow rice and vegetables in the fields. The effluent channel, to discharge supernatant from sludge settling basins, is proposed to be aligned along road from location of WTP to Duong River. Also, the raw water pipeline is to be laid in areas where farming is practiced. With the construction of the WTP and related facilities, these farming lands will be converted to location of facilities. However, any rare species of flora or fauna does not exist in the proposed area of WTP facilities. Therefore, project construction and operation activities are not expected to have any significant impact on flora or fauna. Moreover, after construction of facilities, plantation could be again undertaken along the boundary of the WTP complex and wherever possible.

② Transmission Pipelines

Major part of transmission pipelines is proposed to be aligned along roads, either under the roads or underground beside the roads. Some stretch of transmission pipelines is proposed to be laid in areas currently occupied by cultivated lands. In the fields in such areas, cabbage, banana, and other vegetables are grown seasonally. In the proposed area no rare species of flora or fauna occurs. Therefore, it is judged that proposed project shall not have negative impact on any flora and fauna in the proposed area for transmission pipelines.

③ Off take Points

In this Project, six off takes are proposed. Presently, the proposed areas of off takes are occupied either by cultivated land, or fallow land. In case of proposed site for off take 3, there exists a small pond which has water hyacinth. In most of the cultivated areas among proposed sites for off takes, presently rice is grown. Therefore, it is judged that there are no flora and fauna which should be considered to have potential negative impact at the sites of off takes.

(9) Socio-Economic Environment

1) Population

The population of Greater Hanoi is estimated at about 6.5 million. Average population density in 2009 is reported as about 2,000 persons/km^2, although the population density in core area of metropolis is considerably high.

The ethnic groups representing population in Hanoi include Kinh, Tay, Chinese, Muong, Nung, Thai, Dao, San Diu, San Chay, H'mong, Gia Rai and Khmer.

2) Socio-economics of Hanoi

The salient features of the socio-economic conditions in Hanoi are described below.

- GDP per capita (per capita gross domestic product) of Hanoi (USD 1,950) is almost about twice compared to the national average value (USD 1,052).
- The economy of Hanoi is mainly contributed by services, industrial and construction sectors (almost about 98.5%) and only 1.5% is contributed by agriculture sector.
- In Hanoi, the workforce comprises about 56% in tertiary sector and about 22% in primary and secondary sectors each. However, on national level, workforce in primary sector is dominant.
- The poverty ratio of Hanoi in 2008 was reported as 2.4%, which was lower compared to national average (13.4%) and value for Red River Delta (8.6%).
- The unemployment rate in Hanoi is still around 6% and is high compared to the national (4.65%) and Red River Delta (5.35%) figures.
- The condition of service level in health sector in Hanoi is better than the national average.

3) Public Health

Hanoi being c apital city and experiencing rapid urbanization and industrial development, is a densely populated city. The city faces several health issues including communicable diseases, issues related to the urban lifestyle and rapid socio-economic development. The data on basic health indicators have been reported as follows:

- Average life expectancy is about 76 years
- In 2004, infant mortality was reported to be 5.3% and corresponding value for children under 1 and 5 years of age was reported as 8.5% and 9.8%.

In the city, cases of respiratory diseases occur due to high level of air pollution, especially among the population living near the roads. The occurrence of diseases such as diarrhea, cholera, dysentery, dengue fever, hepatitis, etc., has also been reported.

4) Cultural Heritage

Hanoi is rich in cultural and historical heritage despite rapid development and land use changes. There are numerous heritage structures throughout city, many of which are located around the traditional ancient quarter of Hanoi north of Hoan Kiem Lake, the ancient citadel complex and the Temple of Literature complex to the west. In addition, several pagodas and temples have been constructed recently located in the suburbs and outskirts of city. The Temple of Literature is a significant heritage that has been declared a World Heritage site in 2010.

5) Transportation (Access Road to WTP in Gia Lam)

Proposed site for construction of WTP is located in Gia Lam (Figures 4.4.1 and 4.4.2). An access road exists near the proposed site of the WTP (Figure 4.4.6). The width of the road is about 7m, and it is paved road of single-sided one lane. On both sides of the road, mainly cultivated lands exist. However, at some locations there are some residences.

It was observed that some big size trucks use the road, going through proposed WTP area, for carrying sand from Duong River to be used at construction sites in the city. Although, exact information on number of such large vehicles passing through this road is not available, these vehicles are not very frequently observed on this road.

Figure 4.4.6 Access Road to WTP Site

Pedestrian are still very low in number with few small vehicle users. However, especially during the construction stage, traffic control is required for safe and smooth traffic. Also, caution shall be required while large and heavy vehicles are passing each other.

4.5 Impact Identification and Mitigation Measures

(1) Overall Impact Identification and Scoping Matrix

The first step in EIA is to identify potentially significant impacts due to implementation of proposed project components. The various aspects considered in impact identification of the project are as follows:

- Project components
- Project stages
- Impact generating activities
- Type of impact

Considering these factors, a matrix table has been used to identify the overall impacts. The matrix thus identifies the environmental parameters likely to be affected, and the activities responsible for this. The matrix for pre-construction stage, construction stage, and operation stage is shown in Table 4.5.1. For various activities, the scoping includes identification of impact on social, natural and pollution parameters. In the scoping matrix, the level of impact have been rated as A, B, or C depending on their degree of impact varying from serious to very low or unknown, respectively. The sign "+" and "-" have been used after these ratings to indicate the higher and lower strength, respectively.

Table 4.5.1 Result of Scoping for Project Components

Impact Items				Impact Factors by Stages															
				Pre-Construction		Construction								Operation					
	No.	Likely Impacts	Overall Rating	Land acquisition/Compensation	Change of Land use plan, Control of various activities by regulations for the construction	Reclamation of Wetland, etc.	Deforestation/Land Clearance	Alteration to ground by cut land, filling, etc.	Operation of Construction Equipment and Vehicles	Construction of Treatment facilities	Traffic Restriction in construction area	Influx of construction workers, construction of base camp	Construction of pipelines	Increase of Water supply	Increase of Discharged Water	Appearance/ Occupancy of Facility and related building structures	Operation of Treatment Facility	Operation of Off takes
Social Environment	1	Resettlement (or Loss of Properties)	B-	B-	B-		B-											
	2	Local economy such as employment and livelihood, etc.	B+	B+														
	3	Utilization of land and local resources	B-				B-	B-										
	4	Social institutions such as social capital and local decision-making institutions																
	5	Social infrastructures and services																
	6	Poor, indigenous and ethnic people (inclusive IDPs and refugees), gender and children rights																
	7	Misdistribution of benefits and damages																
	8	Cultural heritage (ex. Burial grounds)	B-	B-														
	9	Local conflict of interests																
	10	Water Usage, Water Rights or Common Rights																
	11	Sanitation	B												B			
	12	Hazards (Risks) Infectious diseases	B												B			
	13	Accidents	B						B		B		B					
Natural Environment	14	Topography and Geographical features																
	15	Soil Erosion																
	16	Underground water																
	17	Hydrological Situation																
	18	Coastal Zone																
	19	Flora, Fauna and Biodiversity	B-				B-											
	20	Meteorology																
	21	Landscape	B													B		
	22	Global Warming																
Pollution	23	Air Pollution (dust)	B					B	B	B							B	
	24	Water Pollution	B					B-							B		B	
	25	Soil Contamination																
	26	Waste	B							B							B	
	27	Noise and Vibration	B					B	B	B			B-				B-	B-
	28	Ground Subsidence																
	29	Offensive Odors																
	30	Bottom sediments																

Rating: A: Serious negative impact is expected. B: Some negative impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.) No Mark: Little impacts are expected and IEE/EIA is not necessary. +: the strength of impact is bigger; - the strength of the impact is smaller.

(2) Foreseeable Adverse Impacts of Project at Various Stages

The implementation of Project is expected to have several positive impacts. During the construction and operation stages, working opportunities will be generated. In the operation stage, the project will facilitate supply of clean and hygienic water to citizen of Greater Hanoi in areas that are still not covered by water supply services. The provision of clean water will also result into reduction of waterborne diseases such as cholera, diarrhea, typhoid and skin and eye diseases. However, the project may cause some negative impacts.

The level of negative impact due to Project activities is shown in Table 4.5.2. In general, the magnitude of negative environmental and social impacts of the project activities is not serious.

The adverse impacts have been classified under three categories, namely pre-construction stage, construction stage and operation stage. Impacts during pre-construction and construction stage may be regarded as temporary or short-term whereas those during operation stage are likely to have long-term effects.

1) Pre-Construction Stage

During planning stage, the most significant impact is expected in the form of land acquisition and land clearance. The proposed site of WTP and a part of the proposed site for transmission pipelines, and proposed sites for off takes is occupied by farming lands where the owner grow rice, vegetables and fruits or are fallow lands. The land will need to be acquired after appropriate compensation to the owners and upon the agreement of owners. In some of the rice fields at the location of the proposed WTP, there exist individual graves. These graves would require relocation upon agreement with the responsible persons. After acquisition, the land clearance will be required. Also, registration of land use will be required by the project owner.

2) Construction Stage

During the construction stage, the most significant impact will be in the form of generation of dust, and noise by the construction vehicles. Also, during cutting and filling of land some dust is expected to be generated. The dust, noise and vibration are also expected to be generated during the operation of construction equipment. The construction of pipelines is to be carried out along roads that are wide and sometimes narrow also and have heavy traffic during daytime. For laying pipelines, ditch will be dug, except in the cases of crossing rivers where trenchless method will be applied. Therefore, traffic problem is expected and proper traffic management and construction management are required to mitigate these impacts.

Table 4.5.2 Expected Negative Impact Level of Project Activities

Major activities		Impact level	Main reasons
Pre-Construction	1. Land acquisition (Compensation)	B+	Areas required for construction of water treatment plant (WTP) is extensive and are mainly farming lands used for growing rice and vegetables. Also, some part of transmission pipelines is proposed to cross through farming lands for growing vegetables and fruits. Proposed land for construction of off takes are either fallow lands or farming lands. The proposed land belongs to private owners. Land acquisition will be required from owners after payments of appropriate compensation. In addition, at the location of WTP, rice fields also include few scattered graves which will require to be relocated in agreement with the owners. The clearance of land will also be needed upon acquisition. Also, registration for land use shall be required before the start of implementation stage.
	2. Land clearance	B+	
Construction	1. Cutting and filling land	B-	Cutting and filling of land may cause dust which could affect the surrounding area.
	2. Operation of equipment and heavy vehicles	B-	Construction machines may cause noise, vibration, dust and traffic accidents.
	3. Influx of construction workers, construction of base camp	B-	Many workers will come to the project site. Most construction workers and technicians may be hired from the surrounding villages, and other areas. The increased chance of interaction may spread infectious diseases through interaction.
	4. Construction of pipelines along roads	B+	The construction of transmission pipelines shall be carried out mainly along roads that are wide, and sometimes narrow also. The roads have heavy traffic during daytime. For installation of pipes, ditch shall be dug and therefore construction management and traffic management will require due attention to avoid traffic problem and accidents during construction.
Operation	1. Increase of discharged water (Wastewater)	B	Improvement in water supply is expected to cause increase in wastewater discharged by users. The increase of discharged wastewater may cause deterioration of water environment of the receiving bodies and living environment. Discharged wastewater may also create a suitable habitat for malaria-infected mosquitoes even during dry seasons.
	2. Operation of treatment facilities	B-	Operation of water treatment plant and pump may increase the level of noise and vibration. The effluent from WTP is to be discharged into Duong river. Discharged solid waste from water treatment plant may cause negative impact through its dumping.

Note: A: Serious impact expected; B: Certain impact expected
+: the strength of impact is bigger; - the strength of the impact is smaller.

3) Operation Stage

During the operation stage of Project facilities, operation of water treatment plant and pumps may generate noise. During the operation of WTP, effluent shall be discharged into Duong River on daily basis and dried sludge from sludge drying beds will be periodically removed to landfill sites. Therefore, it is important to monitor the quality of the effluent and the dried sludge in order to avoid pollution of receiving bodies. Also, with the operation of water supply facilities in this Project, increase in water uses is expected to generate increased wastewater. In long run, if generated wastewater is not collected and treated appropriately, it might cause pollution of receiving water bodies (river, streams, etc.).

(3) Mitigation Measures for Adverse Impacts during Pre-Construction, Construction and Operation Stages

During pre-construction stage of the project, land acquisition and clearance will be required for the proposed site of the WTP and in case of some stretches of the transmission pipelines. Major part of the proposed land for WTP are cultivated land owned by private owners and mainly rice and vegetables are grown in these fields. The farmers will lose their land. The impact could be minimized by appropriate measures such as compensation and opportunities of work, etc.

At the construction stage, impacts could be in terms of noise, vibration, increased traffic, dust and solid waste disposal. All these impacts could be mitigated through proper mitigation management at construction stage.

During the operation stage of WWTP, major impacts could be in the form of noise, sludge disposal, and discharge of effluent from sludge basins. These impacts can also be mitigated through monitoring and implementing countermeasures.

The impacts have been discussed in the previous Section. Major impacts are not expected either at construction stage or operation stage and only minor impacts are envisaged. These impacts could be mitigated or minimized through measures undertaken during construction and operation stages of the proposed Project. These measures have been discussed in detail and presented in the following Table 4.5.3 and Table 4.5.4.

Table 4.5.3 Proposed Mitigation Measures during Pre-Construction and Construction Stage of the Project

Items	Impacts	Mitigation Measures
<Land Acquisition and Clearance>	Farmers will lose farming lands.	• List of land owners to be prepared by Project owner. • Land owners to be compensated by similar land if available, otherwise to be compensated by appropriate land price by the project owner • During construction of facilities, affected land owners could be provided opportunity to work as workers, if possible.
<Landscape>	No significant impact expected	• Installation of information desk to collect complaints from residents and neighborhoods.
<Air Pollution>	Generation of particulates and exhaust gases	• Dust control through water sprinkling at construction site • Preventive maintenance of construction machineries and vehicles • Attentive operation and speed restrictions of construction vehicles and equipment • Monitoring of air pollution parameter before and after project • Arrangement of information desk and deployment of responsible person
<Noise and Vibration>	Generation of noise and vibration from heavy vehicles and equipment	• Announcement of construction schedule and contents at site • Attentive operation and speed restrictions of construction vehicles and equipment • Monitoring of noise and vibration parameters
<Flora and Fauna>	Few trees might be required to cut in the proposed location along the alignment of the pipes	• Cutting of trees to be avoided as much as possible • In unavoidable cases, new trees to be planted after construction completes.
<Traffic/ Public Facilities>	Carrying in and out of materials/construction waste can result into possible adverse impacts on health, air pollution level, and noise and vibration along access road	• Announcement and public notification concerning construction contents and its schedule • Assigning of watchman or traffic control staff • Education on traffic rules for construction workers, drivers of water tankers and inhabitants • Covering the loading platform
	Construction of pipelines along busy roads can cause traffic problems and accidents	• Traffic management to be carried out appropriately with proper instruction near the site of construction. • Management of pipe laying works to be carried

Items	Impacts	Mitigation Measures
		out carefully if undertaken during daytime. Otherwise, laying could be carried out at night in areas where the generated noise does not disturb residents.
<Solid Waste>	Disposal of construction waste and soil	• Disposal at appropriate location such as landfill site, etc.

Table 4.5.4 Proposed Mitigation Measures during Operation Stage of the Project

Items	Impacts	Mitigation Measures
<Noise and Vibration>	Noise from blower, pumps, and generators is expected	• Facilities shall be installed inside buildings to reduce noise level significantly • Noise and vibration to be monitored
<Sludge Disposal>	Generated sludge will be from sedimentation tanks and not hazardous in nature	• Sludge removed from sedimentation tank shall be thickened using sludge tanks and thickener at WTP. • Thickened sludge will be dried in sludge drying beds and can be removed using trucks to be disposed of at appropriate landfill site. • Quality of dried sludge to be monitored.
<Discharge of effluent from sludge basin>	High level of pollutant in the supernatant of sludge tank will cause pollution in Duong river.	• Effluent quality to be monitored. • In case when effluent quality is worse than required discharge levels, corrective measures to be adopted.
<Water Pollution> <Public Health Condition>	With the increase in available water to the users, increase in wastewater discharge is expected within few years. If not collected and treated properly, it will result into poor sanitary and living environment.	• In long run, planning is required towards appropriate handling and disposal of generated wastewater.

It is recommended to establish a staff structure within the implementing agency that should be responsible for implementing these measures against potential negative impacts (except monitoring) considering the following points:

- In case of the adverse impacts during construction stage, the Contractor which is responsible for constructions shall carry out the measures on the basis of directions of Project owner which is responsible for construction management.
- Project owner shall be responsible for making decision on important issues.
- During the operation stage, the Project owner shall carry out mitigation measures against negative impacts.

4.6 Environmental Management Plan

(1) Construction of Sludge Treatment Facilities

The construction of facilities shall be constructed under this Project, for treatment of wastewater obtained after backwashing and from sedimentation tank at the WTP. These facilities shall include wash water drainage basin, sludge basin, thickener, and sludge drying beds. The cost of construction of these facilities is included in the total cost of the Project.

(2) Risk Analysis

During the operation stage, attention should be paid to the following aspects as Risk Analysis.

1) Power Supply

In the water treatment plant, starting with pumps for pumping of raw water, control panels, chemical dosing equipment, chlorination equipment, blower for backwashing, and many instruments are working by electricity. If power failure occurs, the instruments will stop, and consequently, the operation of water treatment plant will stop. If the operation of WTP remains interrupted for long time, it will influence the provision of safe water supply services.

As a countermeasure, the power supply to the WTP should be made on priority basis. Also, the provision should be made to receive power from electric generator facilities. It is expected that by considering these measures during facilities planning, negative impacts in case of power failure could be avoided or at least mitigated.

2) Electrical and Mechanical Equipment Failure

Operational disruption due to electrical and mechanical equipment failures can be avoided by the provision of spare parts and stand-by facilities available at site. Operation and maintenance instructions and manuals for emergency should be provided at the time of training of the operation staff in the water treatment plants.

3) Safety while using Disinfectant

In the treatment process at WTP, disinfection is planned to be carried out using sodium hypochlorite. Sodium hypochlorite is a strong oxidizer. Oxidation reactions are corrosive, and therefore, solutions burn skin and cause eye damage, in particular, when used in concentrated forms. The solutions contain more than 6% sodium hypochlorite by weight.

Also, depending on temperature and storage time, sodium hypochlorite degrades with time and degradation affects its strength.

Therefore, storage facilities should be appropriately planned. Also, the operators should be provided training for its safe use and storage, and steps to be undertaken in case of any accidents.

(3) Environmental Plan

When performing Environmental and Social Impact Assessment and evaluating the effect, it is also important to carry out monitoring in order to grasp the information on any new negative influence due to these activities. The monitoring plans and the responsible agencies are described below.

(4) Monitoring Plan

It is proposed to undertake following monitoring plans related to the negative impacts that has been described earlier. The monitoring plan is categorized under construction stage and operation stage. For preparing the monitoring plan, it is considered that during construction stage influence will be short duration and therefore it is important to have measurement result immediately rather than caring for the level of accuracy and accordingly measurement methods should be selected. However, in the operation stage it is required to evaluate the level of influence and make judgment. Also, it is required to find out if any new negative impact has come up during operation stage. Therefore, measuring method should be selected considering sufficiency in terms of accuracy and its simplicity in use. In case when new influence is expected in future, the measuring method should be improved based on the need of new impacts and desired accuracy or measured parameters. Monitoring programs for construction and operation stages are described below in Table 4.6.1 and Table 4.6.2.

1) Construction Stage

On the access road and construction site, the noise generated by operation of vehicles carrying materials in/out of construction site and due to use of heavy construction machines should be measured using a portable noise level meter. When complaints are received from residents in neighboring areas (although they are not located very near to construction site), the measurement result should be referred, and sound insulating wall should be installed if needed. Also, the reduction of operating speed of vehicles and sound reductions measures should be considered.

During construction activities, on the access road and the construction site, the particulates are generated by operation of vehicles carrying materials in/out and heavy construction machines. When complaints are received from residents at complaint window located on site, related to particulates in air due to project activities, the level of particulates along the access road and at construction site should be measured with a portable particulate measurement instrument. The measurement result should be referred and the frequency of water sprinkling should be reconsidered. In order to control the level of particulates in air, watering shall be carried out and measurement shall again be carried out in order to evaluate the effect. Monitoring program for construction stage is summarized in Table 4.6.1 below.

Table 4.6.1 Monitoring Program for Construction Stage

Object	Monitoring Location	Parameters	Frequency	Implementing Agency	Monitoring Cost*
Noise	–Access road –WTP –Off take locations	Noise (maximum level)	Arbitrary number of times during the construction period, especially when the level is high.	Project Owner	JPY 30,000 (Expenses on buying equipment for measurement)
Request and complaint from residents	–surrounding area of access road and construction sites	Contents and number of requests and complaints	During the construction, a reception counter to be installed to respond any time.	Project Owner	No expense
Air Quality	–Access road –WTP –Pipelines –Off takes	Suspended Particulates Matters	Arbitrary number of times during the construction period, especially when the level is high.	Project Owner	JPY 300,000 (Expenses on buying equipment for measurement)

* Personnel costs are not included.

The result of monitoring shall be recorded in the monitoring form. Formats which could be used for monitoring noise, surrounding environment and air quality during construction stage are presented in Table 4.6.2, Table 4.6.3 and Table 4.6.4 below.

Table 4.6.2 Monitoring Form for Noise (Construction Stage)

Item	Unit	Measured Value (Max.)	Vietnamese Standards*	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise level	dB		75dB (6:00~18:00hrs) 70dB (18:00~22:00hrs) 50dB (22:00~6:00hrs) 85~88 (for Trucks)***		85 dB**	

* Values according to the Noise standards in public and residential areas in Viet Nam (TCVN 5949: 1995) for the case of small industries located in residential areas.

** Regulation value in Japan (during construction work period)

*** Values according to the Noise level standards for road motor vehicles in Viet Nam (TCVN 5948: 1995).

Table 4.6.3 Monitoring Form for Surrounding Environment (Construction Stage)

Monitoring Item	Monitoring Results during Report Period
Number of requests and complaints	
Content of requests/complaints	

Table 4.6.4 Monitoring Form for Air Quality (Construction Stage)

Item	Unit	Measured Value (Max.)	Country's Standards*	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Suspended Particulate Matter (SPM)			0.2 mg/m^3 (24 hour average)			

* Values according to the Ambient Air Quality Standards in Viet Nam (TCVN 5937: 2005)

2) Operation Stage

Periodical water quality measurement of inflow shall be performed. Also, water quality parameters should be measured periodically for treated water in the distribution facilities such as off takes. For the sample of off take, measurement should be carried out for presence of hazardous substances twice every year.

The level of noise shall be measured outside the buildings of the pumps, generator and, blower facilities, and at the boundary of WTP. Although, it is judged that there is no influence on the neighborhoods, especially measurement of sound level at night is recommended.

It is also important to monitor the quality of effluent discharged from the WTP into Duong River on monthly basis. Also, the quality of dried sludge needs to be monitored to avoid pollution. Monitoring program required at operation stage is summarized in Table 4.6.5.

Table 4.6.5 Monitoring Program for Operation Stage

Object	Monitoring Location	Parameters	Frequency	Implementing Agency	Monitoring Cost*
Water Quality	–Intake	pH, Turbidity Hazardous Substances (Fluoride, Fe, Mn, NO_2-N, NO_3-N)	Daily 2 times per year	Project Owner or Agency responsible for O&M of project facilities	Expenses on Analytical instruments and chemicals for monitoring will be required.
	–Distribution Facilities such as at Off takes	pH, Turbidity, Residual Chlorine E Coli Hazardous Substances (Fluoride, Fe, Mn, NO_2-N, NO_3-N)	Daily Weekly 2 times per year	Project Owner or Agency responsible for O&M of project facilities	Expenses on Analytical instruments and chemicals for monitoring will be required
	–Beginning or End of Effluent channel	pH, Temperature, BOD_5, COD, Suspended Solids (TSS), Total Coliforms, Fecal Coliforms, Residual Chlorine Oils and grease, Arsenic (As), Cadmium (Cd), Lead (Pb), Chromium (Cr), Copper (Cu), Zinc (Zn), Manganese (Mn), Nickel(Ni), Organic Phosphorus, Total Phosphorus, Iron (Fe), Tetrachloroethylene, Tin(Sn), Mercury(Hg), Total Nitrogen, Trichloroethylene, Ammonia as N, Fluoride, Phenol, Sulfide, Cyanide	Monthly Four times a year	Project Owner or Agency responsible for O&M of project facilities	Expenses on Analytical instruments and chemicals for monitoring will be required.

Object	Monitoring Location	Parameters	Frequency	Implementing Agency	Monitoring Cost*
Sludge Quality	Dried sludge from sludge drying beds	Zinc, Copper, Nickel, Cadmium, Lead, Mercury, Chromium, Molybdenum, Selenium, Arsenic	Two times a year	Project Owner or Agency responsible for O&M of project facilities	Measurement apparatus purchased for monitoring at construction stage can be used.
Noise	Outside the buildings of: −Pump −Generator −Blower, and WTP Site boundary	Noise (maximum level)	Monthly	Project Owner or Agency responsible for O&M of project facilities	Measurement apparatus purchased for monitoring at construction stage can be used.

* Personnel costs to be added.

The result of monitoring shall be recorded in the monitoring form. Format which could be used for monitoring water quality (both raw and treated water), effluent from WTP, and noise during operation stage is presented in Table 4.6.6 to Table 4.6.9 below.

Table 4.6.6 Monitoring Form for Raw Water Quality (Operation Stage)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Vietnamese Standards*	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-			6 – 8.5			
Turbidity	NTU						
Fluoride	mg/l			1.0 mg/l			
NO_2-N	mg/l			0.01 mg/l as NO_2			
NO_3-N	mg/l			10 mg/l as NO_3			
Mn	mg/l			0.1 mg/l			
Fe	mg/l			1.0 mg/l			

* Values according to the Surface Water Quality Standards in Viet Nam (TCVN 5942: 1995)

Table 4.6.7 Monitoring Form for Supplied Treated Water (Operation Stage)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Vietnamese Standards*	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-			6.5 – 8.5			
Turbidity	NTU			2 NTU			
Residual Chlorine	mg/l			0.3~0.5		5**	
E. Coli	MPN/100 ml			0			
Fluoride	mg/l						
NO_2-N	mg/l			3 mg/l as NO_2			
NO_3-N	mg/l			50 mg/l as NO_3			
Mn	mg/l			0.3 mg/l			
Fe	mg/l			0.3 mg/l			

* Standard of drinking water quality 2009, Environment Board.
** In the WHO guideline, 5 mg/l is shown as upper limit.

Table 4.6.8 Monitoring Form for Effluent from WTP (Operation Stage)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Vietnamese Standards*	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
pH	-			6 – 9			
BOD_5	mg/l			30			
COD	mg/l			50			
Suspended Solids	mg/l			50			
Residual Chlorine	mg/l			1			
Total coliform	MPN/100 ml			3000			
Fecal coliform	MPN/100 ml						

- Values according to the Industrial Wastewater Discharge Standards in Viet Nam (TCVN 5945: 2005)

Table 4.6.9 Monitoring Form for Noise (Operation Stage)

Item	Unit	Measured Value (Max.)	Vietnamese Standards*	Standards for Contract	Referred International Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise level	dB		75dB (6:00~18:00hrs) 70dB (18:00~22:00hrs) 50dB (22:00~6:00hrs) 85~88 (for Trucks)***		40 dB**	

* Values according to the Noise standards in public and residential areas in Viet Nam (TCVN 5949: 1995) for the case of small industries located in residential areas.

** Regulation value in Japan (during night time)

*** Values according to the Noise level standards for road motor vehicles in Viet Nam (TCVN 5948: 1995).

(5) Institutional Setup

The fundamental information about the organization that should carry out monitoring activities is itemized below.

- ➢ The constructor shall carry out monitoring during construction stage, and shall report to the Project owner.
- ➢ WTP laboratory shall carry out monitoring during operation stage in principle.
- ➢ For the parameters that are difficult to be measured by the WTP laboratory of project owner, a suitable organization should be requested.

Establishment of an administrative unit is required in order to carry out the above monitoring. The Unit shall include members from organizations relevant to water supply system, organizations which take charge of environmental management, organizations which manage the water bodies, and local administrative organizations and residents. It is proposed to have proper coordination among these agencies for effective monitoring. Moreover, collected information on monitoring should be compiled in the form of a database that can be accessed by all related organizations whenever needed.

(6) Occupational Health and Safety Measures

During the construction and operation stage of the project, consideration should be given to workplace air quality, ambient temperature and humidity, noise limits, specific conditions on working in confined place, and general conditions on health and safety. The work involves working at high places and guidance on care to be taken while working in such places should be provided to workers. General health and safety practices should be followed by workers on site.

The following mitigation and management measures should be adopted to ensure that the health and safety of staff and any visitors at the site is not affected negatively during construction and operation stages:

- Development and implementation of an Operational Health and Safety Plan with appropriate training
- Provision of training in use of protection equipment and chemical handling (sodium hypochlorite)
- Clear marking of work site hazards and training in recognition of hazard symbols
- Development of site emergency response plans, and
- All personnel working or standing close to noisy areas or equipment will be required to wear noise protectors.

4.7 Conclusion

Implementation of proposed project is expected to have positive impact in the form of improved water supply services in parts of Greater Hanoi that still does not have access to safe water. However, some negative impacts are expected. In order to minimize or avoid the occurrence of such negative impacts, there are some points that need consideration.

(1) Items that need Careful Consideration

Although any major problem is not expected due to project components, there are some items that require careful examination during the construction and operation stages of the project implementation and are described below in brief.

1) Pre-construction Stage

Land acquisition is one of major items that need consideration during pre-construction stage of the Project. Also, the landowners must be compensated appropriately before implementation of Project starts.

2) Construction Stage

The adverse impacts during the construction stage are temporary and the influence is limited to the construction period. In particular, the attention is required towards the influence of traffic due to heavy vehicles carrying construction materials in and out of the construction site. The “arrangement of traffic control staff”, “sprinkling of water on the road”, etc. which are already described under the countermeasures against the environmental adverse impacts should be carried out appropriately. Also, the countermeasures for mitigation and elimination of other environmental adverse impacts, such as noise generation, air pollution, and solid waste disposal that may occur during construction stage, should also be undertaken as suggested.

3) Operation Stage

During the operation stage, countermeasures are needed against impacts due to noise, management and disposal of generated sludge, and discharge of effluent from sludge basin.

Appropriate countermeasures should be carried out to mitigate these impacts. Also, monitoring should be carried out and based on the degree of influence, decision should be made on suitable countermeasures and early implementation of such measures.

(2) Important Items to be Undertaken for Implementation of this Project

Important steps that need to be undertaken for implementation of this Project are listed below:

- The Project owner shall prepare the full EIA of the Project and submit it to the relevant division of the Department of Natural Resources and Environment (DONRE), or to the MONRE whichever application for this Project.
- Also, the Project Owner in coordination with other relevant Agencies should carry out the Land Acquisition which is very important for the implementation of this Project.
- There are several other Registrations and Permissions needed before implementation of the Project starts and all the procedure should be pursued by the Project Owner.
- The Stakeholders Meeting should be organized by the Project Owner to explain about the Project outline and objectives, facilities to be constructed and their locations, expected benefits and adverse impacts of Project activities at construction and operation stages, and mitigation measures to minimize the adverse impacts. Through the Stakeholders Meetings, the Project Owner shall obtain the understanding of the Stakeholders on the Project. The participants shall include representative of community owning the land at proposed location of the WTP, representatives of the local governments, and representatives from DONRE, People's Committee, Project owner, etc. The Minutes of Meetings of the Stakeholders Meetings should be prepared and presented along with the EIA report.
- In principal, the Project owner should carry out all activities of the proposed mitigation measures and monitoring plan during the construction and operation stages. The contractor shall carry out monitoring during construction stage, and shall report to the Project Owner. However, during operation stage, the monitoring of environmental parameters shall be carried out by the Project Owner or the Agency that is responsible for the operation and maintenance of the facilities under this Project.
- Implementation of monitoring plan shall be recorded and reported to the Department of Natural Resources and Environment (DONRE) and relevant authorities periodically, both during the construction and operation stages.

From the above mentioned points, it is concluded that suggested countermeasures should be undertaken to mitigate potential adverse impacts due to implementation of this project. With the mitigation of adverse impacts, this project is expected to have potential benefits in terms of improved water supply services and improvement of living environment in Greater Hanoi. Hence, it is recommended to undertake this project in the interest of environment and living conditions of the residents in the Project area.

5. Investment Environment (Risk Analysis)

Different from the pure private businesses of which business cycle is normally short in few years, this kind of public utility business to be planned for 20 to 30 years project life cycle features that the cash flow with huge debt services burdens heavily at the beginning stage of the business and that the investor’s return is expected to be recovered mainly on the later stage of the long span of the project term. In order for the private investors to make proper decision at the investment to such a project, local investment climate should be essentially that assured sound politically/economically/socially and business continuation should be assured for a long time span covering the project term. Since the clean water supply project is an important public service to assure the principal life line, potential demand expansion will be prospective whatever the political/economic/social conditions be. Private business, however, might become critical by changes in the governmental policy. In this point of view, we have been evaluating the investment climate carefully as follows.

5.1 Political Situation

Viet Nam got out of the chaos after unification of north and south regions by the inauguration of Doi Moi policy in 1989 and has developed constantly since then in its political/economic aspects, as in Figure 5.1.1. It has, however, passed only 22 years of stable development, which is shorter than the planned term of this project. Then, we hereby evaluate the prospects of Viet Nam taking the world wide lessons learned into consideration as follows.

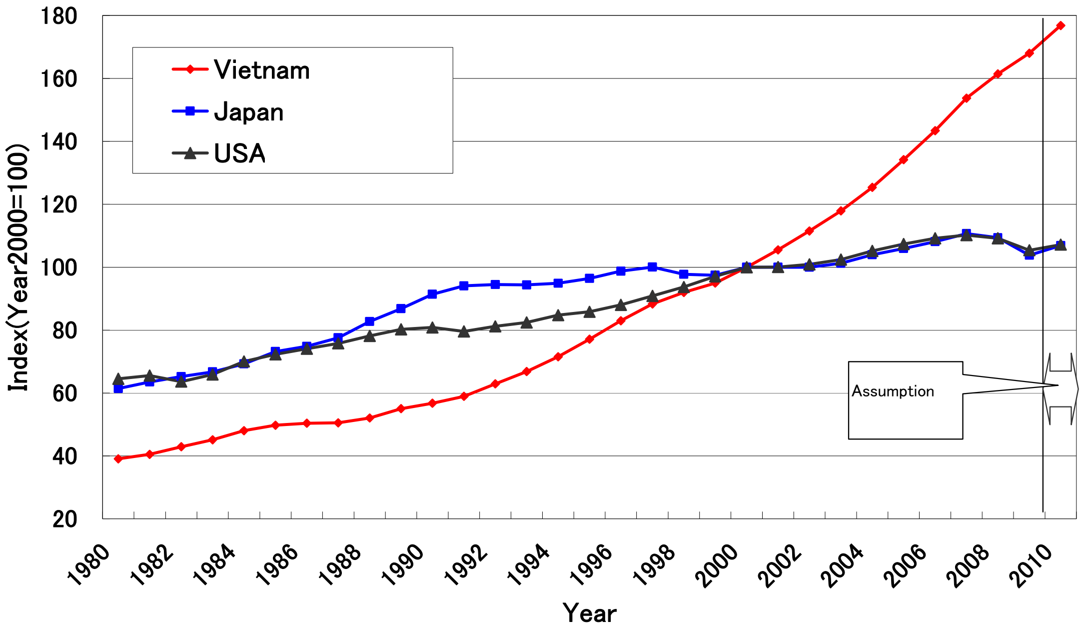


Figure 5.1.1 Per-capita Substantial GDP Transition

(1) Worldwide Movement

Worldwide political/economic movements are featured in the globalism of the market economy, within the great progress of democratic mind and in the world wide dramatic information technology development.

1) Economic crisis in Euro Regime

Insolvency in some countries in Euro regime as such in Greece is one of the greatest issues in the world since it has expanded to the total scale crisis in all over the EU and also over the world. Greece, a county with such long history, could not have been on the verge of ruin within such a short time frame. We should take in an event caused by misleading under the globalism in its economy.

2) Chain reactions of the coup attempt in Arabian countries

Ben Ali power regime, which has been appreciated as one of the most stable regime in the Arabian countries, collapsed suddenly after 23 years in power. Its flames leaped to the neighboring Libya and Egypt. Even though the regime has not been changed, other Arabian countries and other regions in the world like China have been influenced by this movement. Egyptian Mubarak regime collapsed after 30 years in power and Libyan Qadhafi regime has been on the verge of collapse after 41 years of power.

(2) Movements in Asia

In Asia, following incidents have been reported remarkably to feature the globalism of the market economy and progresses in democracy as the world wide movement.

1) Indonesian economic crisis and change in regime under the South East Asian economic crisis.

Suharto regime collapsed after 31 years in power by the mob led mainly by the students' activity under the South East Asian economic crisis. It was a quite instantaneous incident which had not been assumable seeing it's quite stable power before it happened. It is construed that the dishonest accumulation of wealth by the Suharto family, which had never been a serious political issue while the country has been enjoying the constant economic growth owing to its wealthy underground resources and comfortable climate for living, recalled the peoples' potential dissatisfaction. Throughout the chaos in the economic crisis, however, the Indonesian economy recovered its previous good trend.

2) Political conflicts dividing the nation into halves in Thailand.

Changes in politic power in Thailand had happened so frequently and final solutions were always given by the Majesty of the King peacefully that people had not been caring about it so much before the Prime Minister Thaksin's dishonest activity was revealed in 2006. The recent political situation in Thailand after that is featured in bipolarization of the political power nationwide into the civilian power and rural power, which has jeopardized the position as the top runner in the Indochina region.

3) Current regime and its future prospects in Viet Nam

Following issues about the future prospects in Viet Nam should be discussed before making decision to invest in the project, taking the above lessons learned from the worldwide tendency into consideration

- Possibility of a sudden change in political/social base established by the communist party's regime

After the inauguration of Doi Moi policy, Viet Nam has been developed greatly under the sole power of communist party. Changes might happen in this regime by some movement to realignment of political/economic/ social base. Current political regime is well maintained by the bureaucratic administration under a collective leadership by the Head of State, the Prime Minister, and the Chief Secretary of the Communist Party. Political power is so well balanced among those 3 top leaders that the current regime is deemed as that well organized in a stable condition. However, it should be carefully watched not to be creating hard dictatorship through a long maintaining power by a single leader

5.2 Economic Situation

Lessons learned from the collapse of the so-called bubble economy in Japan, economic crisis in South East Asia and insolvency problems in EU member countries realized us that, so dramatically the economy is developing, so critically it ends up. As a result, economic crisis makes the popular feeling unstable and is likely to make the political/social situation unstable. Economy in Viet Nam having good potentiality could rebound to a sound state in a long range as Indonesia recovered from the crisis experienced in the late '90s. And the current economic situation in Viet Nam at this moment is in danger of economic crisis as analyzed below.

(1) Currency Exchange Rate Devaluation of VND

Monetary valuation is going to be discussed integrally with the theory of purchasing power parity.

- "Comparison of the monetary value change level with the value change in products." versus "Price indices".
- "Comparison of the value between the currencies" versus "foreign exchange". (Refer to Figure 5.2.1)

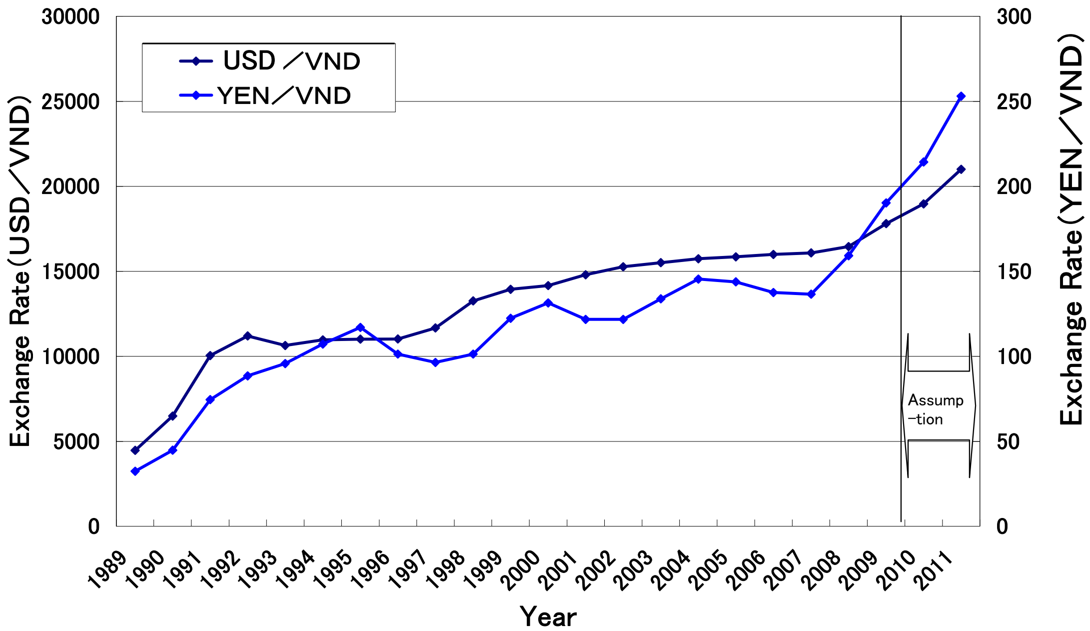


Figure 5.2.1 Foreign Exchange Rate Transition

Clean water off take price is assumed to be contracted in USD with payments to be made in local currency (VND), and for a part of the payment, the condition is going to be that this will be made in proportion to the inflation rate referring to the consumer price indices. In order to check the mechanism of the currency valuation out of the past data, the 3 currencies composing the project cost (VND, USD and JPY) are compared in Figure 5.2.2 by the GDP deflator converted into USD basis for the past 30 years after 1980, where USD and VND are shown setting the value of basic year 2000 as 100% and for JPY is the index of year 2000 to be 110% to match the long term level evenly for 3 currencies.

The data shows that the long span trends of USD and JPY for 30 years are quite similar to each other. In case of VND, since the data before Doi Moi policy inauguration could not be evaluated reasonably, comparison with other two currencies was made for about 20 years after 1989. It concludes that the product’s value in Viet Nam in a long range is comparatively higher than that of USA/Japan. It is a quite natural tendency generally shown in the developing countries as a transient feature. It does not necessarily mean that this tendency is breaking the purchase power balance. High growth era of the Japanese economy after the World War II saturated within 30 years. Viet Nam’s economy might be saturated in around another 10 years accordingly.

Following is the detailed analysis of the economy in Viet Nam. Before inaugurating Doi Moi policy in 1989, the economy suffered frequent extra high inflation and subsequent currency devaluation. The exchange rate was devaluated within 9 years from USD1.00=VND0.21 in 1980 to USD1.00=VND4,500 in 1989 (1/22,000 of the rate in 1980).

Breaking away from such a chaos state, the economy in Viet Nam after Doi Moi policy inauguration for about 20 years steadily grew under a constant devaluation of VND by 10%/year in average as shown in Figure 5.2.2. In the early ’90s, the Vietnamese products were highly appreciated under a dramatic development in industries. After that, the economy in Viet Nam was put into stagnant stage through the South East Asian economic crisis but was not as serious as Thailand and Indonesia. It did not take so long after that to recover from it. From the year 2002, foreign investment increase boosted the industries in Viet Nam and its wave has been kept high until now. It looks, however, that the current economy has been overheated and it must be the time to take an adjustment policy.

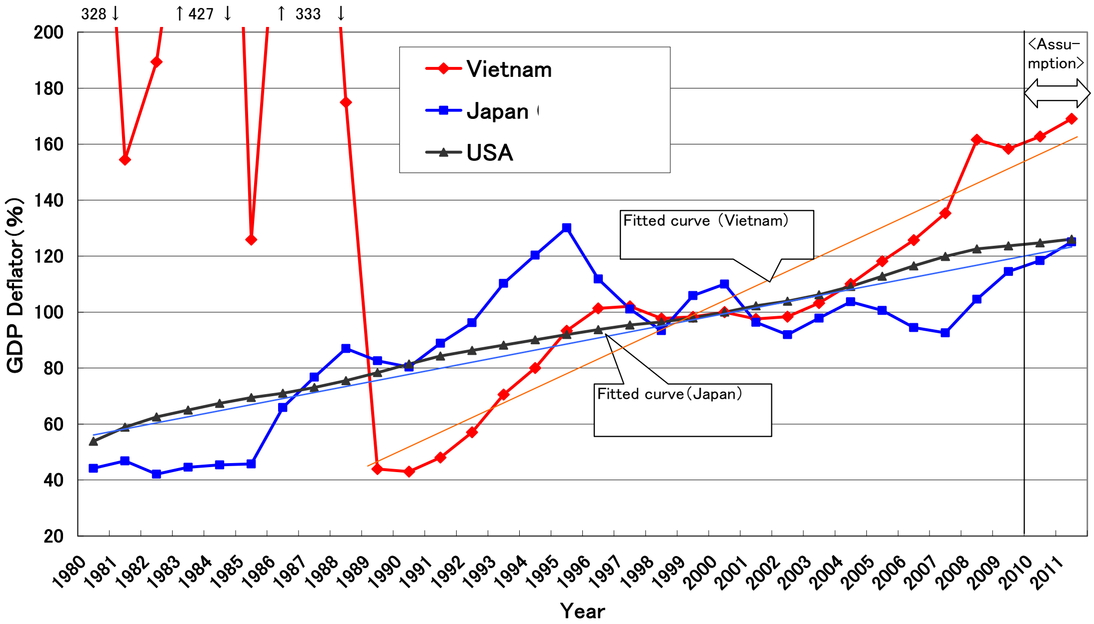


Figure 5.2.2 GDP Deflator Transition

Japanese economy movements in this period are as follows. For about 10 years after the Plaza agreement in 1985, Japanese yen continued to be appreciated until 1995. Japanese products were valued higher and higher in USD and lost its international competitiveness very much in its trade. After that, Japanese economy suffered long stagnation so-called lost decade. However, owing to the USA's policy shifted to strong USD intention, Japanese industries have recovered its international competitiveness. Recent economy, however, seems to have been on the readjustment stage under the drastic appreciation of Yen after year 2007.

In order to discuss the currency valuation in due course, it is required to analyze the worldwide tendency taking other major region's currencies into consideration. Following analysis was made for reference accordingly.

1) Comparison between the world-wide industrially advanced countries

Figure 5.2.3 shows the GDP deflator trends in the industrially advanced countries with adjustment to the basic year to approximate the fitted curves between each other. It indicates that European major currencies have kept similar tendency between each other before the Euro regime inauguration in 1999 with the exception of the United Kingdom in 1990's. Japan also showed the tendency similar to European currencies in that era. It means that the world economy in that era was bipolarized into two regions. After the Euro regime inauguration, it was changed to trilateral structure. USD has been in the center of JPY and Euro and recently all three settled in equivalent level.

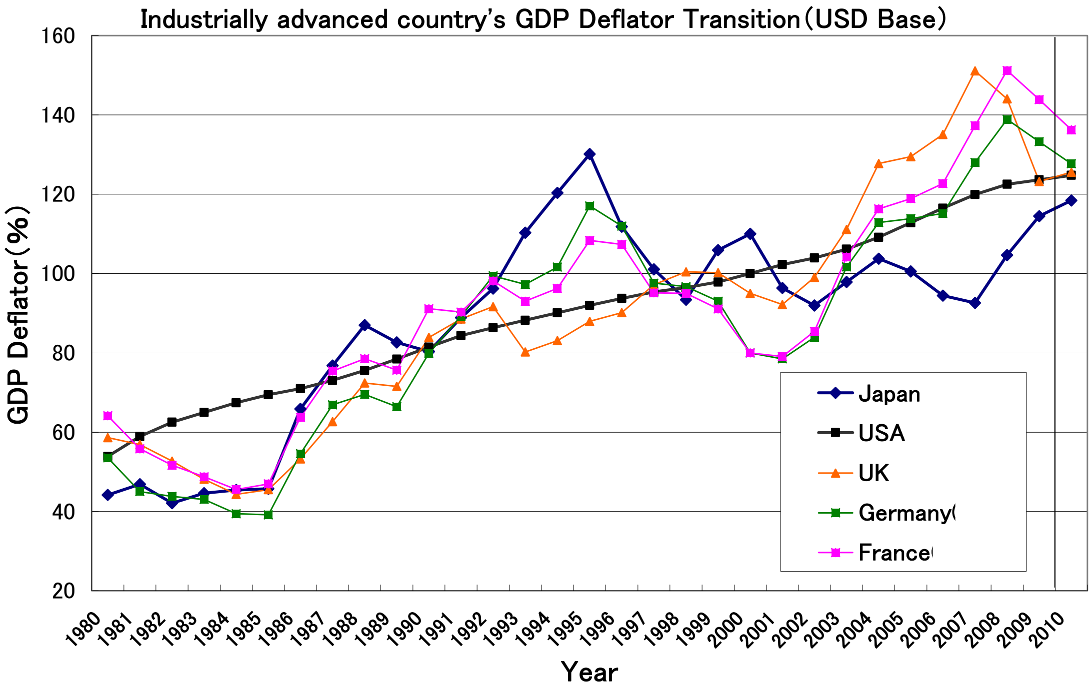


Figure 5.2.3 Industrially Advanced Country's GDP Deflator Transition

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2) Comparison between the under developed countries in Asia

Figure.5.2.4 shows the GDP deflator trends in the under-developed countries in Asia with adjustment (only Indonesia is adjusted) to the basic year to approximate the fitted curves between each other. Before the economic crisis in 1997, each country showed independent tendency. After the crisis, however, all the countries have shown quite a resembled tendency between each other. Among them, Viet Nam has kept the mid position and supposed to be with lesser stress in the region. Needs for adjustment in overheating economy is nothing special to Viet Nam in similarity with that experienced in the neighboring countries. It is construed that this similarity comes from the regional regularization due to the globalization of economy and the regional trade alliances. It is expected that the lessons learned from the economic crisis in the late '90s would control the economy in Viet Nam to soft-land from the recent overheating mode.

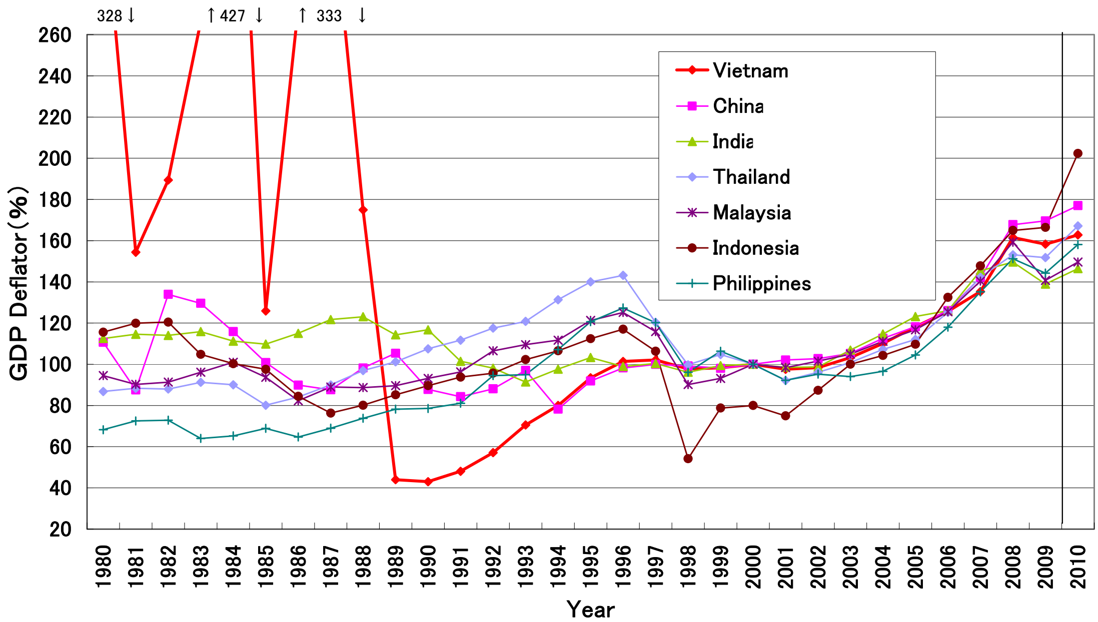

Figure 5.2.4 Under-developed Country's GDP Deflator Transition

With the conclusions from the above analysis, the currency valuation risk shall be reasonably evaluated as follows.

- Purchase powers of the major industrially advanced countries are currently almost equivalent to each other. However, the purchasing power of JPY had been fluctuated against USD with maximum +/-40% of stress. Concerning the project term (long term) currency risk in JPY, by analyzing variance for 30 years data, 5% or more allowance is required to protect the project. On the other hand, changes in the value of money up to 10% as trend shift risk shall be considered in the sensitivity analysis.
- In the under-developed countries, economic trends generally feature with chain reaction of "overheated investment, high inflation, devaluation of the currency". However, the inflation rate adjustment for the pegged currency "USD" does not completely cover the devaluation of the currency. It means that the USD based inflation rates in under-developed countries are generally higher than that in USA. Therefore, the off take price escalation by inflation rate will make the financial plan more profitable than discussing with the USD base off-taking price. It should be cautioned, however, that a sudden devaluation of the currency could cause difficulty in the cash flow of the project company. Should the government fail to put the proper economic policy into practice to land softly from the overheated economy, economic crisis might happen.

As the conclusion, though the long term assumption is more difficult than that in the industrially advanced country, financial plan shall be secured with sensitivity analysis. For incidents which are not manageable by the private sector should be treated as a force majeure event, and guarantee and compensation by the Government shall be required.

(2) Financial Market Analysis

Due to the recent overheated investment, financial market in Viet Nam has difficulty to function properly. Inflation rate in 2010 was reportedly around 14% and the lending rate in the financial market has exceeded 20%. Though it is natural that the interest rate covers the devaluation of the currency by the inflation, the current market overheating situation is going to hike the interest rate regardless of the governmental control could not be overlooked.

Interest rate applied to the incentive loan by the Viet Nam Development Bank (VDB) was 6.9%/year (maximum repayment period: 12 years) in December 2009, which was assumed as the base condition in the financial plan at the pre-feasibility study. The rate has hiked after that to 11.4% (in February 2011). First year's debt service cash flow under the equal capital repayment schedule has increased from 15.23% to 19.73% of the loan amount. It means that the debt service cash out flow at the beginning stage of the project expanded by 30% due to the hike of interest rate. It will deteriorate the project feasibility with the risks in cash flow difficulty at the beginning stage of the project term based on the premise that equity cannot be withdrawn if interest rate is under PIRR(Project IRR).

Foreign currency loan (JPY/USD) is exposed to currency exchange risk. Though the risk might be mitigated by the purchasing power parity theory in the long range of the project term, sudden big fluctuation of the exchange rate is the great impact to the financial plan especially at the early stage of the project before keeping sufficient cash reserve. Since VND is going to be constantly devaluated pegging to USD, the currency risk in USD could be managed within a reasonable range. On the other hand, Since Japanese Yen fluctuates against USD unpredictably, it also fluctuate very much against VND. JPY is deemed as the high risk currency for the global business, risk analysis, evaluation and countermeasures shall be made in accordance with the concept mentioned in above item (1).

On the other hand, while the foreign currency application will ease cash flow difficulty at the beginning stage of the project, currency risk will provably burden the debt service on the later stage of the project term due to VND depreciation. Capacity payment method proposed in Chapter 7.

(3) Challenge of Economic Policy

The most urgent matter to be solved in Viet Nam is recovering the foreign currency reserve currently under the exhaustive situation. After constantly increased from 11% (in 2000) to 33% (in 2007) of the GDP, the foreign currency reserve in Viet Nam has turned to decrease in 2007. The value at the end of year 2010 was 10% of the GDP. On this trend, the reserve will be drained in the beginning of year 2012. (Refer to Figure 5.2.5 and Figure 5.2.6). The level at the end of year 2010 is so critical that it could not cover 2 months of import amount (about USD 6 billion/month), while the cautious level is regarded internationally as 3 months of import amount.

In order to recover the economy from the above hardship condition, Vietnamese Government has set, as the policy for the year 2012 by Central Bank, the targets for calming down of the inflation and monetary tightening. We are going to keep watching its achievement.

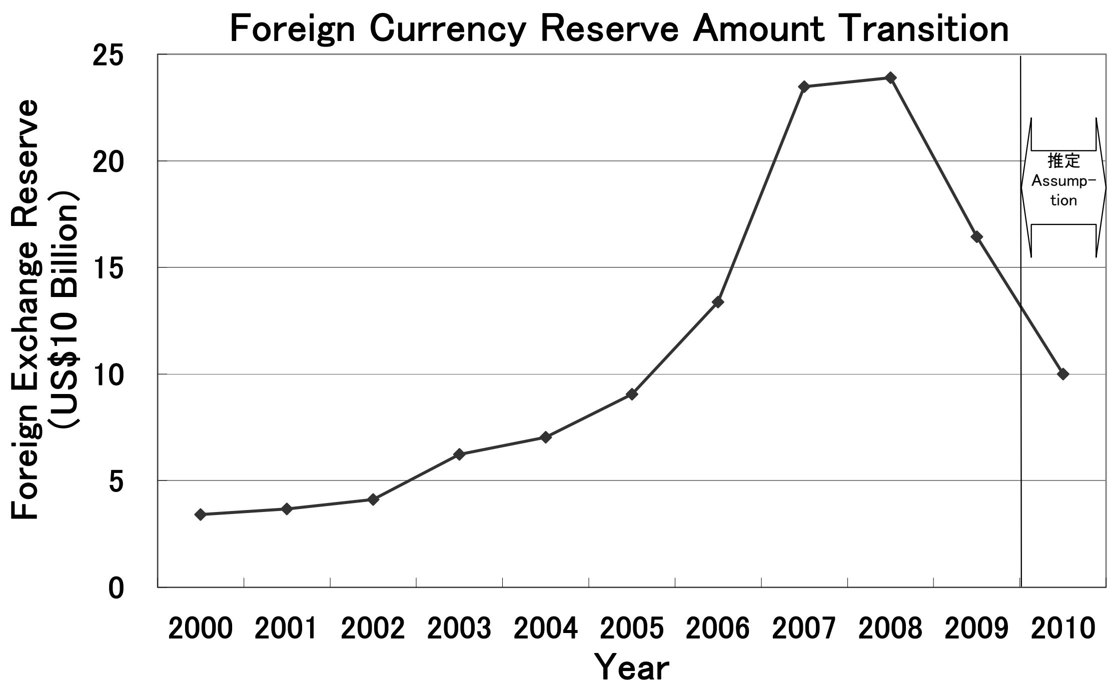

Figure 5.2.5 Foreign Currency Reserve Amount Transition

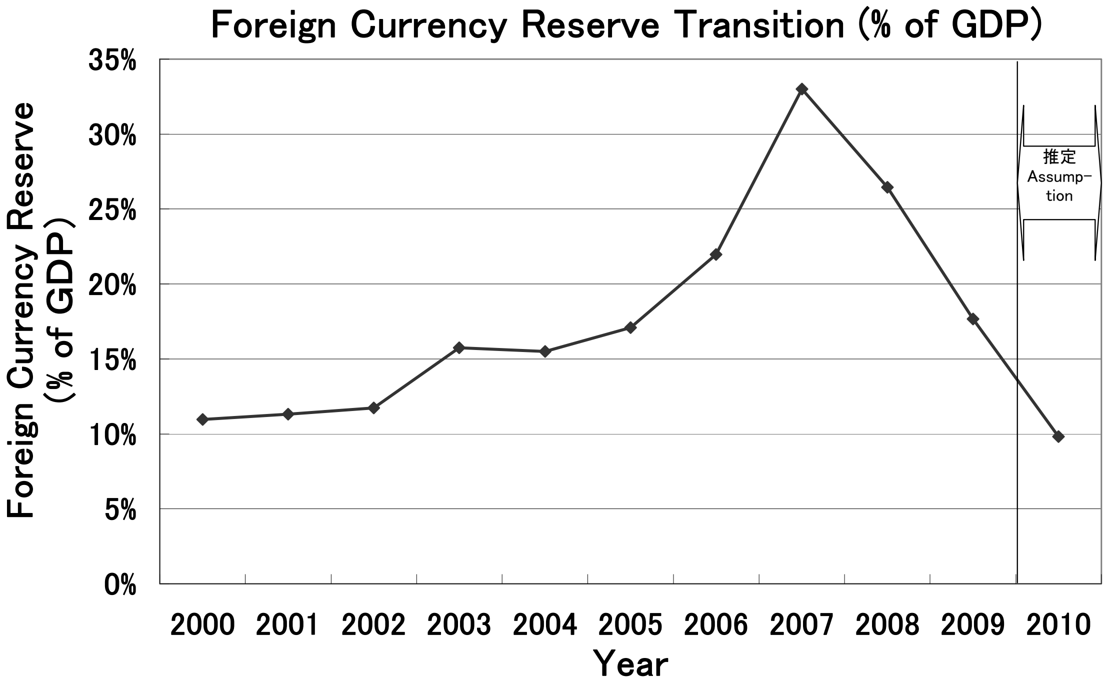

Figure 5.2.6 Foreign Currency Reserve Transition (% of GDP)

Decreasing tendency in recent years of the foreign currency reserve in Viet Nam is mainly due to the constitutive trade deficit. Improvement of trade balance by industrialization and foreign investment promotion are urgently needed in Viet Nam to recover the foreign reserve to a safe level. Besides, the raise of private capital to overseas are also a big concern and countermeasures are needed. The economic policies to solve this problem may cause severe damage in other economic aspects such as temporary stagnation, currency devaluation, etc. Effects of the countermeasures should be carefully evaluated accordingly.

The external debt of Viet Nam decreased from 41% (in 2000) to 31% (in 2006) of the GDP and after that turned to increase and reached 42.2% at the end of year 2010 (Figure 5.2.7). Since the GDP has been tripled in USD in this decade, the external debt value also tripled in this decade (Figure 5.2.8). It means that, should the high economy growth ends, the external debt would heavily burden the next generation.

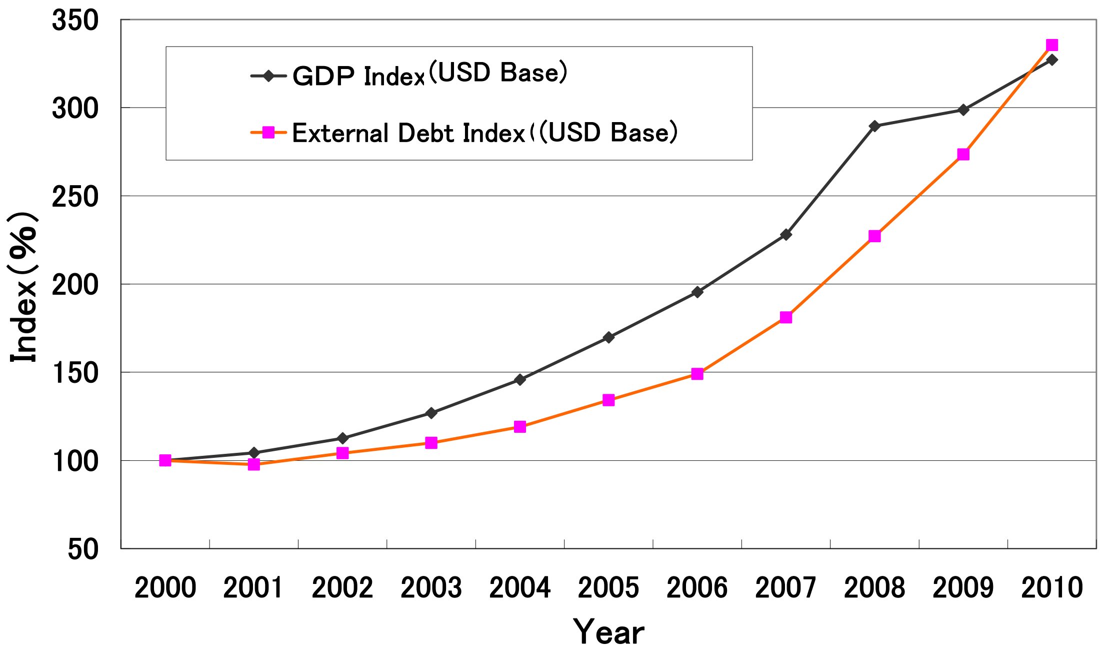

Figure 5.2.7 External Debt Amount Transition

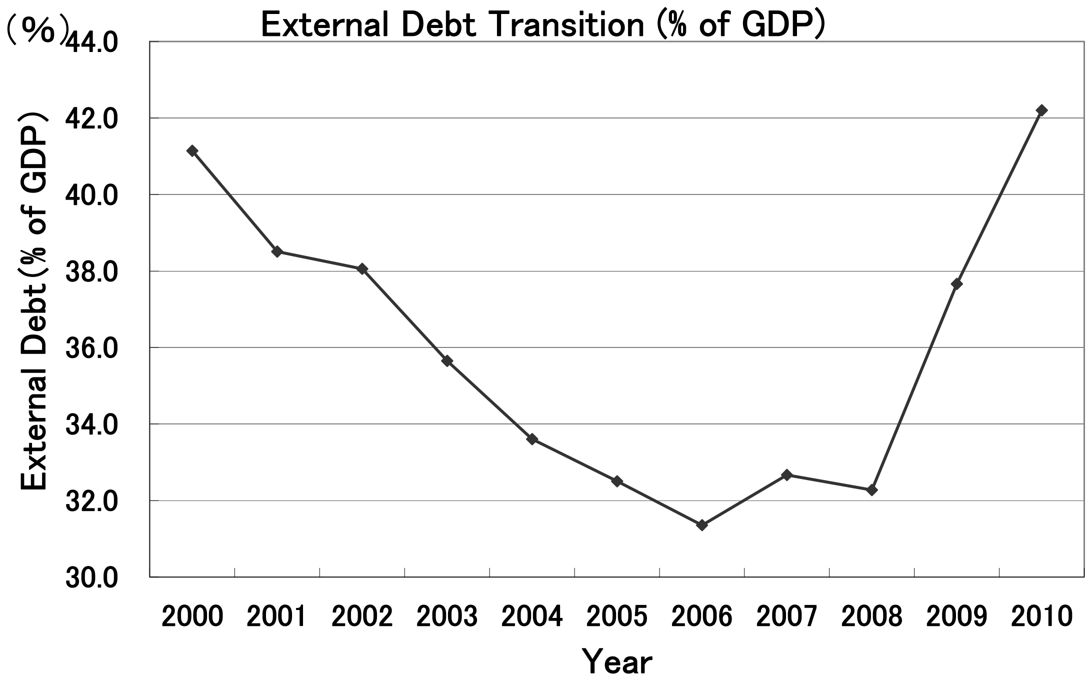

Figure 5.2.8 External Debt Transition (% of GDP)

5.3 Clean Water Supply Business Situation

(1) Demand Change

Population in Viet Nam is currently about 88 million and increasing at a rate approximately 1%/year as shown in Figure 5.3.1, which is quite similar to Japan in the 1950's. As the clean water supply system in Japan was well popularized in that era, it must be now high time in Viet Nam to have it popularized dramatically.

Clean water supply in Hanoi is analyzed and evaluated as follows in demand side and supply side views.

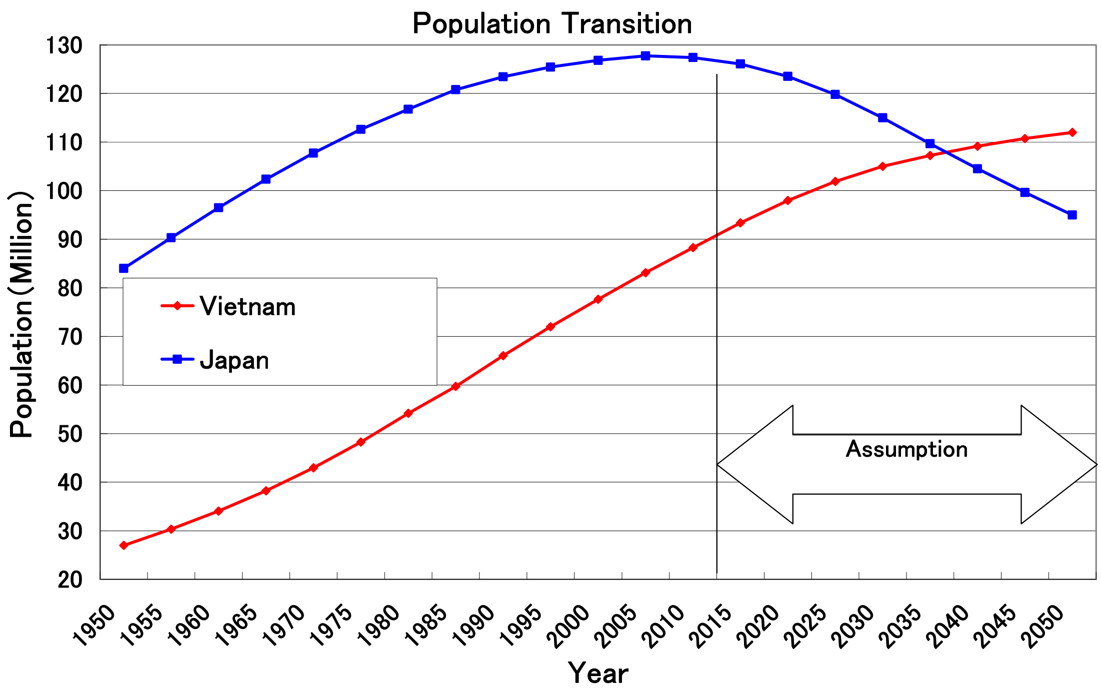

Figure 5.3.1 Population Transition

As shown in Figure 5.3.2, water production capacity has increased in Hanoi in the '90s after inauguration of Doi Moi policy. After the year 2005, however, new resource development stopped. It is supposedly due to reasons that the underground resource development is getting into difficulty by health hazardous pollution problems and ground subsidence problems.

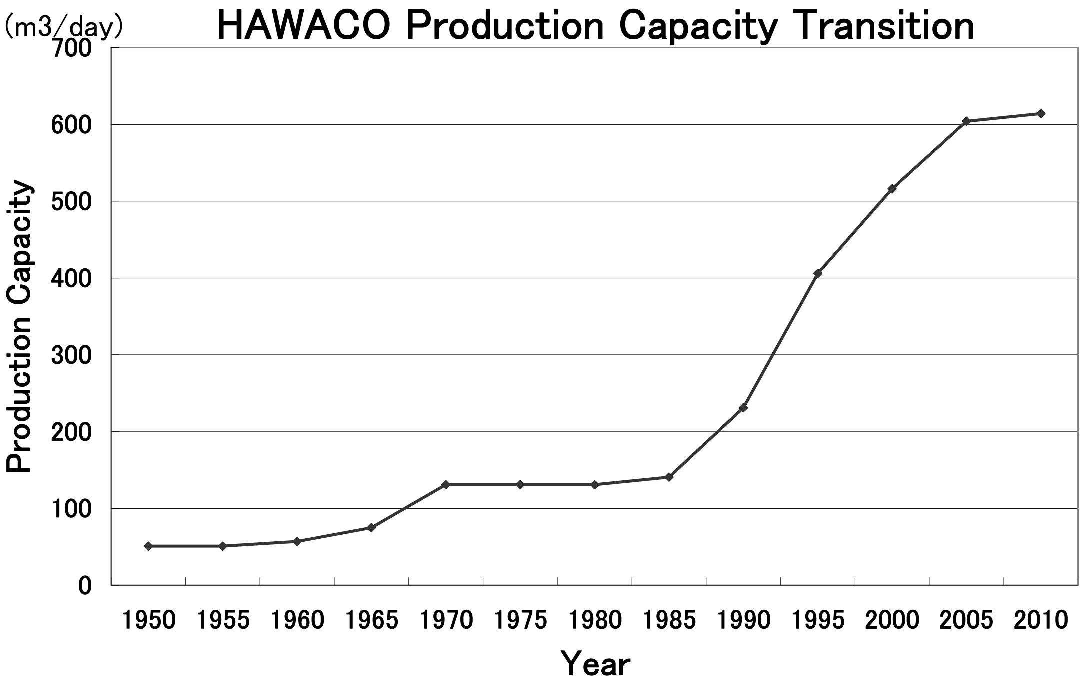

Figure 5.3.2 HAWACO Production Capacity Transition

As shown in Figure 5.3.3, HAWACO's business volume increased 50% within 4 years from the year 2005 to year 2009, while production volume increased only 15% for the same term. The difference between the production volume and supply volume is supposedly from Figure 5.3.4 as the saving by water distribution loss cut. Besides, the water production expanded in the same time frame while the production capacity increased only 2%. It is supposedly due to the availability increase. It means that the slowed down investment mentioned in above item (1) has been overcome by improved production and distribution efficiency. Potentiality of efficiency improvement is, however, limited to a certain level within its designed capacity. Availability of the production facility is now almost reaching 100% of designed production capacity. Without development of new production facilities, clean water business in Hanoi could not continue to satisfy the demand in the near future.

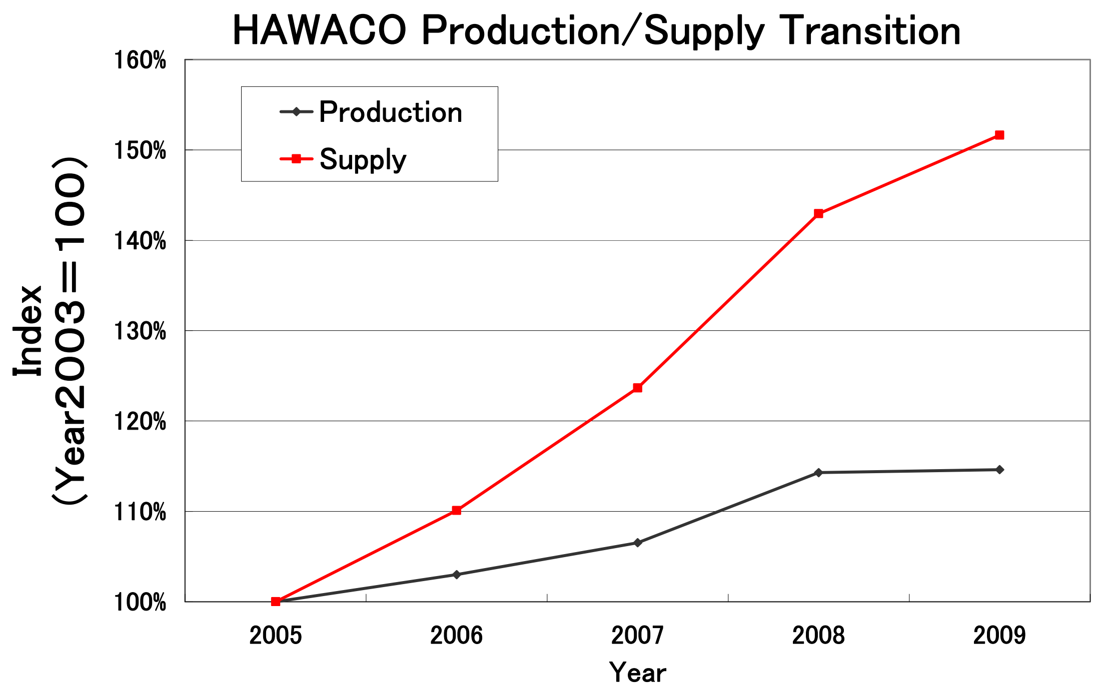

Figure 5.3.3 HAWACO Production/Supply Transition

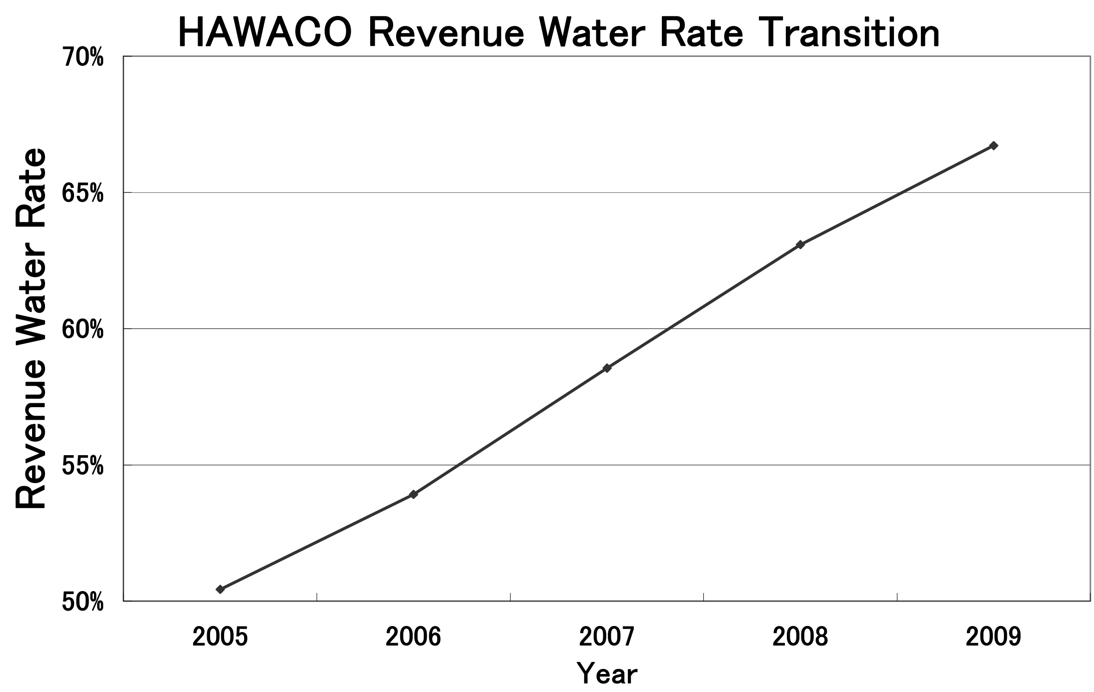

Figure 5.3.4 HAWACO Revenue Water Rate Transition

The demand at the planned supply area of the clean water has been studied carefully in order to verify the project plan is that having economic rationality and that is justifiable of the public investment decision making. Based on the evaluation using the following pessimistically assumed data, the Phase I developing capacity is designed as 150,000m3/day.

- Clean water connection：47％
- Clean water usage rate：2.3%
- Clean water consumption：71 L/man-day
  (total average including industrial/public use：102 L/man-day)

Water consumption changes seasonally within +/-10% as shown in Figure 5.3.5 judging from the existing plant operation data. This plant is, however, planned to supply constantly at the full capacity for the optimization of the profitability with the exception of a stop caused by a sudden power outage and an inspection.

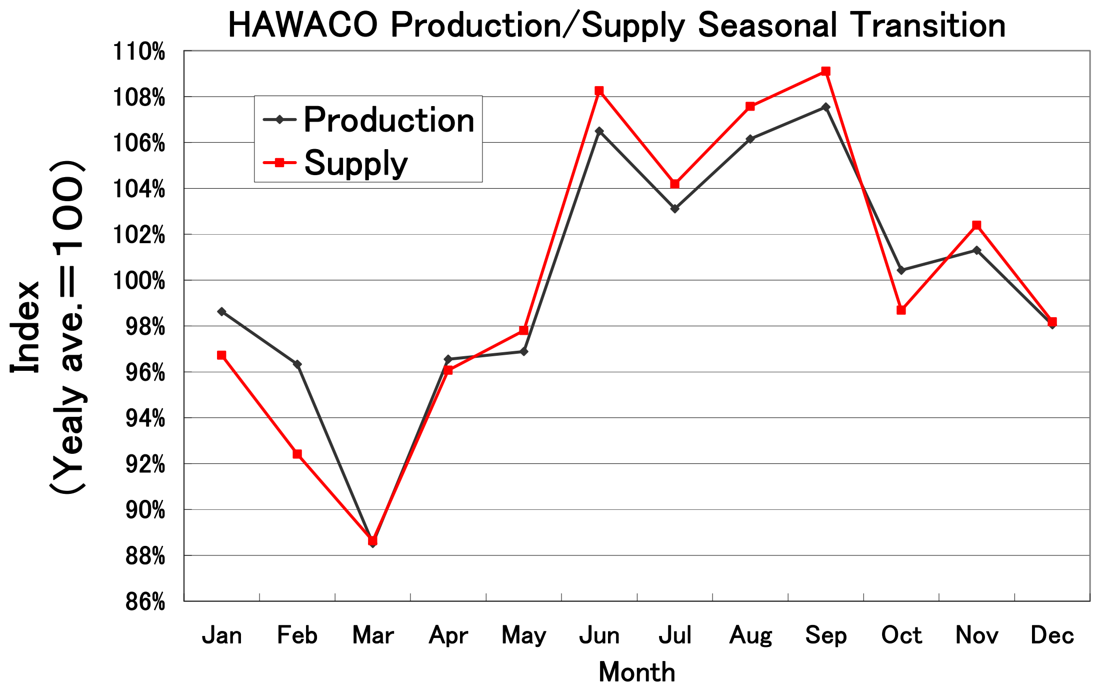

Figure 5.3.5 HAWACO Production/Supply Seasonal Transition

Demand prospects could not be assured absolutely, of which risks could not be taken by private sectors under the following uncertainties.

- Unpredictable political/economical/social situation change
- Distribution network connection delay by public water supply company
- Competition with alternative supplier
- Inhabitant’s dependence on private wells

(2) Off Take Tariff Pricing Rules

Though we have had the idea of take or pay based tariff setting, we are going to shift to the Capacity Payment Method (hybrid pricing with capacity payment covering fixed costs and usage payment covering variable costs) which could be acceptable more reasonably as proposed in Chapter 7.

Off take price should be agreed with the off taker at a level commercially feasible, which shall be on the other hand a reasonable level to make the off taker’s business feasible and an acceptable level by the regional People’s committees. The water tariff for consumer has been kept at weighted average of VND 3,300/m3 level for 5 years as shown in Figure 5.3.6 and Figure 5.3.7 until it has hiked to VND 6,500/m3 level in 2010. Taking the current level of consumer price into consideration, the reasonable off take price level shall be agreed with the off takers.

Tariff rate shall be agreed to be revised in proportion to the consumer price indices. Though the past trend of the consumer water tariff increase does not match with (shortfall) the inflation rate as shown in Figure 5.3.8, taking the value addition by shifting to surface water resources into consideration, off take price escalation in proportion to the inflation rate would be targeted reasonably by the payment formula with coefficient which is mentioned in Chapter 7. In addition, contract in which revenue amount is linked to repayment amount could be introduced to avoid such forex risk because there is the possibility that revenue amount does not match with repayment amount when project cost shall be financed with foreign currency. Either SPC or financial institution shall bear the forex risk when such contract could not be introduced. In any of these cases, margin for the forex risk shall be secured to compensate the loss which could be given by forex risk by way of return for SPC and margin on interest rate for financial institution. It is important to structure the project scheme in which preferable treatment by government and governmental guarantee could be granted to mitigate the burden for the off-taker in order not that the burden reaches unreasonable level because margin shall be transferred to the off-taker by way of tariff stream.

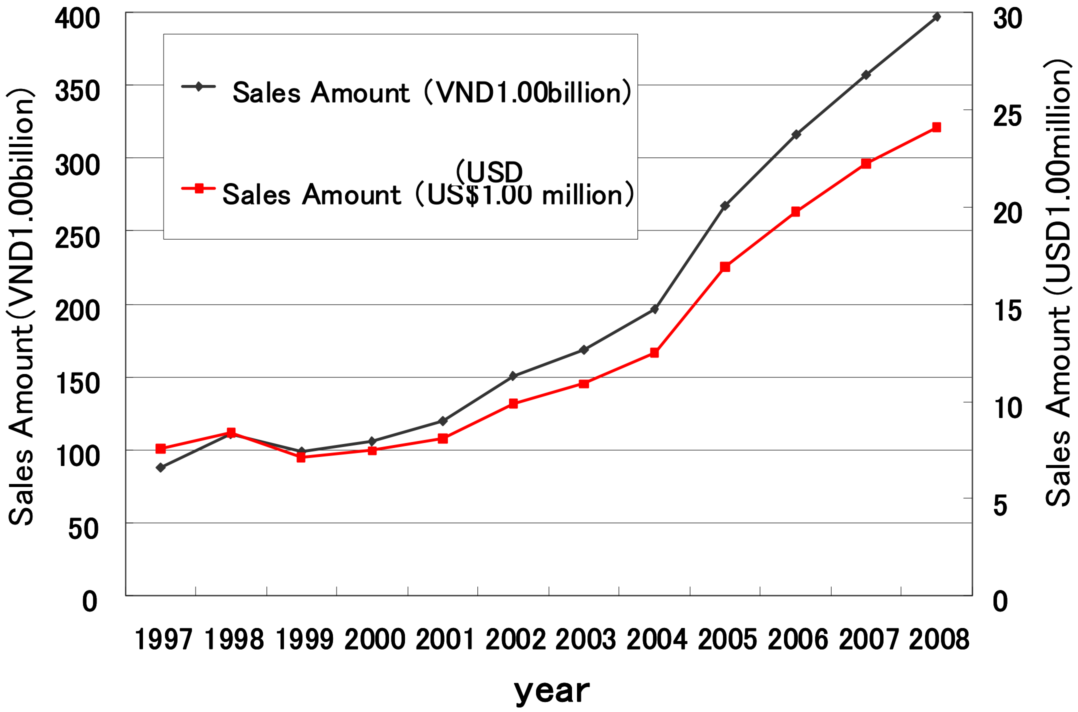

Figure 5.3.6 HAWACO Sales Amount Transition

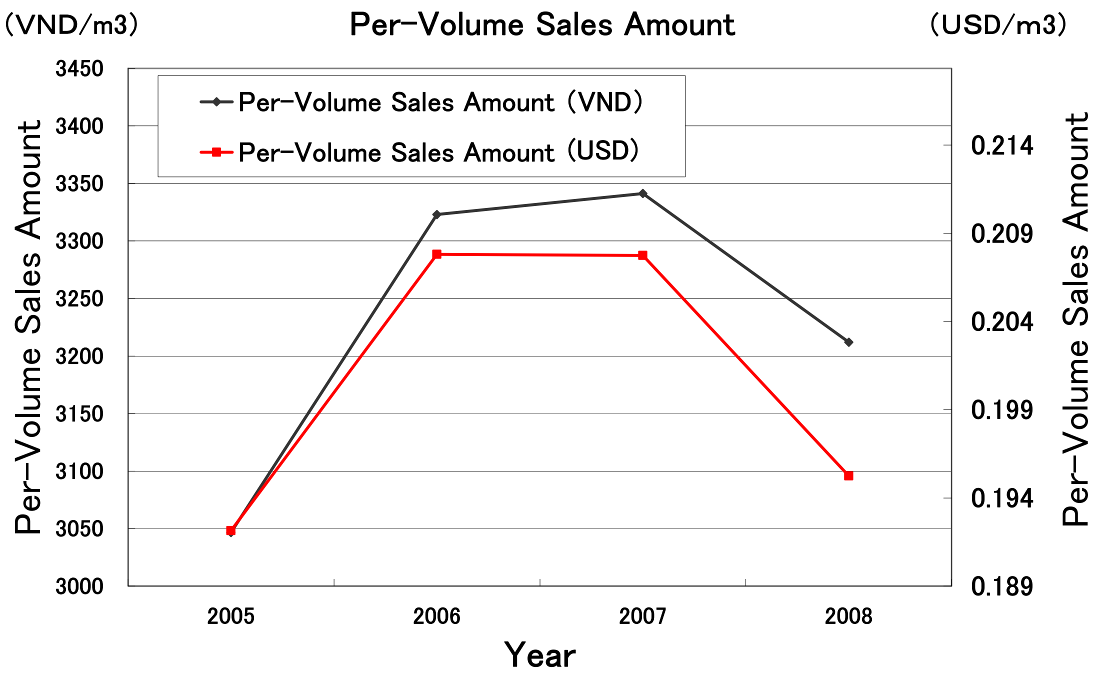

Figure 5.3.7 HAWACO Per-Volume Sales Amount

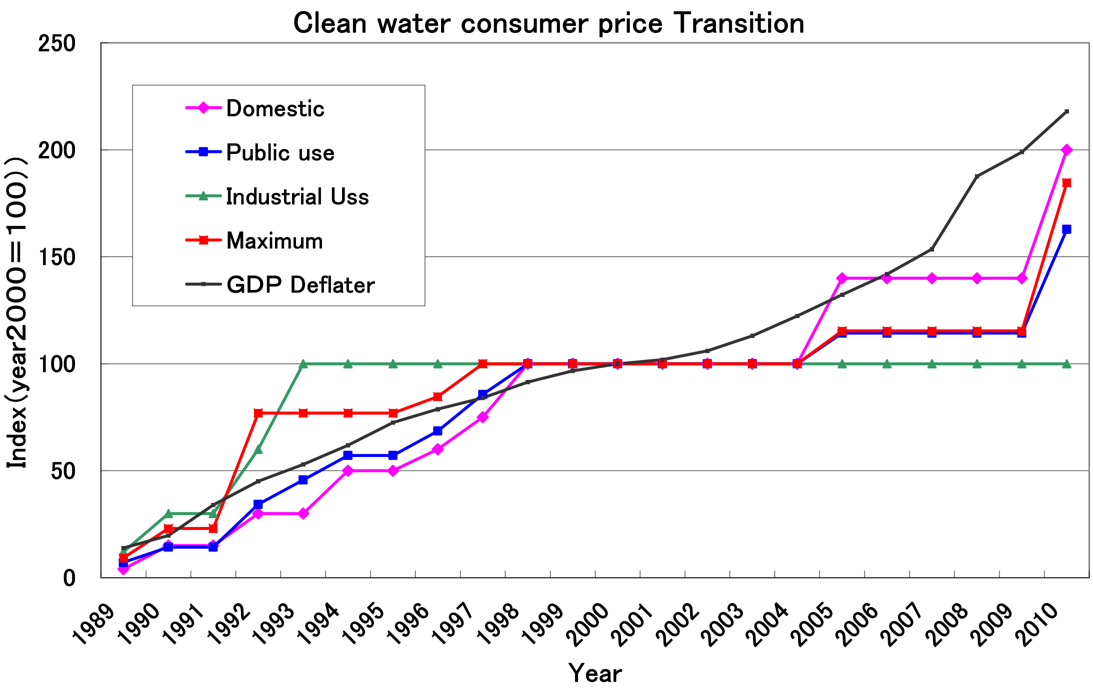

Figure 5.3.8 Clean Water Consumer Tariff Rate Transition in Hanoi

5.4 Factors for Documentation

In this subchapter, Study Team shall abstract major risks to be managed in this project and consider the countermeasures which constitute related agreements based on the political, economical and social environmental change and results of risk analysis from the preliminary feasibility study regarding this project conducted last year.

5.4.1 Project Risks Managed by Contracts

Public Private Partnership (PPP) Project provides design, construction, operation and maintenance of facilities for a long term by defining appropriate and detail risk allocation between the public sector and the private sector. The allocation is reflected to project agreements and PPP realizes high quality public services at lower costs for the public sector and also ensures stable and lasting cash flows. Stable debt service derived from the project enables project financing for the private sector.

It is important to define all risks for the first step of risk analyses extracting associated risks in detail as much as possible depending on the characteristics of the project, understand the causes and structure the risk mitigation measures and countermeasures. Of these risk mitigation measures and countermeasures, study team estimated the required cost of risks can be mitigated by economical measures (i.e. insurances and financial products). Furthermore, from the point of view of the investor, identified risks are evaluated as dual countermeasures by quantifying the incremental costs associated with realization of those risks or by conducting qualitative analyses if quantitative analyses are difficult for occasions that these risk mitigation measures and countermeasures are not conducted.

It is essential for any PPP project that a particular risk should be assumed by the party best able to manage and control that risk. Efficient risk management will lower the costs at the realization of those risks. Therefore, it is required to consider who is the most appropriate to mange risks rather than who is responsible.

(1) Extraction of All Risks

It is important for risks management of projects to identify all key risks associated with the project at an early stage prior to detailed work on project documentation. As a general rule, a particular risk should be assumed by the party best able to manage and control the risk and risks should not remain with SPC, the project company, if possible.

In extracting risk items, risks are categorized as commercial risks, financial risks and external factor risks, and commercial risks are further categorized as risks that affect revenues and those that affect costs (risk items extracted in UK HM Treasury's "Green Book" have been referred to in order to cover risks involved in an ordinary infrastructure PFI project).

Risk Categorization

Commercial Risk	Financial Risk	External Factor Risk
• Revenue related - Off-taker risk - Demand risk - Tariff increase risk • Cost related - Development plan risk - Design risk - Construction/Completion risk - Operation and Maintenance risk - Raw water risk - Inflation risk - Technology risk - Infrastructure risk	- Financing risk - Sponsor risk - Foreign exchange risk - Interest rate risks - Tax/accounting risk - Residual value risk	- Law/regulation risk - Permission risk - Social/Environment risk - Country risk - Force Majeure (natural disaster, terrorism, war etc.)

Figure 5.4.1 Risk Categorization

(2) Risks Assumed to the Project

Key risk items, allocation, mitigation measures and related project documents are identified in the following matrix (Table 5.4.1). The matrix has been revised based on changes to the project environment, situation of due diligence conducted on the contents of the project and stage of progress on discussions with the Vietnamese side, etc.

Furthermore, in reviewing the risks and for determining their importance, a three-staged evaluation has been performed on the level of impact the risks have on the project and the probability. Importance that is comprehensively determined based on impact and probability has been categorized in scores from 1 to 3, according to the below matrix. In addition, a circle is placed in the column of the assumed major bearer of risk, and a triangle for the assumed partial bearer of risk.

Impact	Large	2	3	3
	Middle	1	2	3
	Low	1	1	2
		Low	Middle	High
		Probability		

Figure 5.4.2 Risk Evaluation Scale

Table 5.4.1 Risk Matrix of the Expected Project

Project stage	No.	Category 1	Category 2	Category 3	Risk	Risk details	Impact Small Medium Large	Possibility Small Medium Large	Score
General	1	External Factor	Law/Regulation	Approval	Central/Local Government can't obtain necessary approvals.	Necessary measures are not taken for the approvals required by central/local governments (concession rights, water rights, water supply licenses etc.).	M	S	1
	2	External Factor	Law/Regulation	Approval	SPC can't obtain necessary approvals.	Necessary measures are not taken for the approvals required by SPC (concession rights, water rights, water supply licenses etc.). Concession rights provided to VIWASEEN cannot be maintained and assigned to SPC.	L	M	3
	3	External Factor	Law/Regulation	Law/Administration	Law/regulation/policy change (Specific Laws)	Possibility to have a new law or change in laws and policies result in cost increase of the project. (Specific law/policy changes directly affect the project).	M	S	1
	4	External Factor	Law/Regulation	Law/Administration	Law/regulation/policy change (General Laws)	Possibility to have a new law or change in laws and policies result in cost increase of the project. (general law/policy changes directly affect the project).	M	M	2
	5	External Factor	Law/Regulation	Tax	Tax change (Specific issues)	Possibility to have changes in tax results in cost increase of the project.	M	S	1
	6	External Factor	Law/Regulation	Tax	Tax change (General issues)	Possibility to have changes in general tax results in cost increase of the project.	M	M	2
	7	External Factor	Law/Regulation	Law/Regulation	Legal compliance	Law violence	M	M	2
	8	External Factor	Force Majeure		Force Majeure	Have unforeseeable events (war, civil war, dispute, terrorism, nuclear pollution, chemical pollution, fire, lightning, typhoon, flood, earthquake, riot etc.)	M	M	2
	9	Commercial	Construction/Completion, Operation and Maintenance	Third-party liability	Third-party liability(Government side)	Liability for the damages resulting during the process of construction and O&M regarding marginal infrastructure developed by Government side(i.e. Ha Noi city)	S	S	1
	10	Commercial	Construction/Completion, Operation and Maintenance	Third-party liability	Third-party liability(SPC side)	Liability for the damages resulting during the process of construction and O&M regarding infrastructure developed by SPC side.	S	S	1
	11	Financial	Interest rate		Interest rate	Cost increase due to rising interest rates.	L	M	3
	12	Financial	Financing	Financing	Financing - SPC	SPC cannot raise funds at appropriate term/currency. Interest.	L	M	3
	13	External Factor	Social/Environment	Project interruption	Business interruption by government	Cancellation or postponement by the reason attributed to the government	M	S	1
	14	External Factor	Law/Regulation	Procurement	Procurement procedure	Project is procured through competitive bidding not through the single tendering.	M	M	2
	15	Commercial	Revenue	Demand	Demand lower than demand projection	Demand is lower than 150k ton/day for Phase 1 and 2.	L	M	3
	16	Commercial	Revenue	Demand	Contract with appropriate size	Plan is changed during the project period and affects the size of facility.	L	M	3
	17	Commercial	Cost	Technology	Scope of Work and Interface	Trouble arising from interface between the water facility and water distribution facility.	M	S	1
	18	Commercial	Revenue	Demand	Competitor	Take or pay contract is not introduced aiming to avoid competitive environment.	L	M	3
	19	Financial	Residual Value	Project termination	Residual value-1	At Asset transfer under BOT scheme, some conditions to assure asset value will be imposed.	M	S	1
	20	Financial	Residual Value	Project interrupt	Residual value-2	Asset transfer value paid by HAWACO to SPC when the contract is cancelled by SPC before maturity.	M	M	2

Project stage	No.	Category 1	Category 2	Category 3	Risk	Risk details	Impact Small Medium Large	Possibility Small Medium Large	Score
				ion					
	21	Financial	Residual Value	Project interruption	Residual value-3	Asset transfer value paid by HAWACO to SPC when the contract is cancelled by HAWACO before maturity.	M	M	2
	22	Financial	Residual Value	Project interruption	Residual value-4	Asset transfer value paid by HAWACO to SPC when the contract is cancelled by change in laws/regulations and force major before maturity.	M	M	2
	23	Financial	Sponsor		Sponsor risk	No fulfillment of capital injection by sponsor or increase in credit risk of sponsor.	M	M	2
	24	Commercial	Cost	Subcontract companies	Poor performance of subcontract companies	Poor performance of subcontract companies to perform the project.	S	S	1
	25	Commercial	Revenue	Tariff revision	Payment Method	Inappropriate formula for payment to SPC.	L	M	3
	26	Financial	Fluctuation in exchange	Currency	Currency	Mismatch between the currency of payment and currency received.	L	M	3
	27	Commercial	Cost		Additional cost by Government	Increase in capital spending by the reason attributed to the government.	M	M	2
	28	Commercial	Revenue	Off-Taker Risk	Default in paying service payment	Is the back-up of payments necessary?	L	M	3
	29	External Factor	Country risk		Country risk	Conditions for country risk coverage will not be met.	M	M	2
	30	Commercial	Cost	Technology	Interface between water intake and water distribution	Trouble in water supply arising from interface between water intake facilities and water distribution facilities.	M	M	2
	31	Commercial	Cost	Development plan	Government Subsidy/ Capital Injection/ Development as public work	Necessary government subsidy, capital injection, or development of related infrastructure is not provided.	L	L	3
	32	Commercial	Cost	Infrastructure	Delay in GOV's work	Delay in construction by delay in Government work (i.e. land acquisition, land lease and marginal infrastructure (power, road and telecommunication).	L	L	3
Construction	33	Commercial	Cost	Design	Increase costs due to changes in design	Design change due to Government intention results in cost increase.	M	S	1
	34	Commercial	Revenue	Design	Increase costs due to changes in design by SPC	Design change due to SPC will not be allowed.	M	S	1
	35	Commercial	Cost	Design	Delay in design completion, cost increase	Delay in design completion, cost increase due to SPC.	M	S	1
	36	Commercial	Cost	Construction/Completion	Delay in construction completion due to HaNoi City etc.	Delay in construction completion due to Ha Noi City etc.	M	M	2
	37	Commercial	Cost	Construction/Completion	Delay in construction completion due to SPC	Delay in construction completion due to SPC	M	M	2
	38	External Factor	Social	Environment	Environment (Hanoi)	Environment issues on selection of land, work conducted by Government sector (land acquisition, ground work) will occur.	M	S	1
	39	External Factor	Social	Environment	Environment (SPC work)	Environment issues on work conducted by SPC will occur.	M	S	1
	40	External Factor	Social	Residents	Residents	Residents movement opposing the project	M	S	1
	41	External Factor	Social	Land	Land Acquisition	Land acquisition for WTP and pipes are not completed.	M	S	1
	42	Commercial	Cost	Construction/Com	Defect	Land defect	M	S	1

Project stage	No.	Category 1	Category 2	Category 3	Risk	Risk details	Impact Small Medium Large	Possibility Small Medium Large	Score
				pletion					
	43	Commercial	Cost	Construction/Completion	Mistakes in land survey	Cost increase arising from the land survey by Ha Noi city.	M	S	1
	44	Commercial	Cost	Construction/Completion	Mistakes in land survey	Cost increase arising from the land survey by SPC.	M	S	1
	45	Commercial	Cost	Construction/Completion	Defect in the facilities developed by SPC	Defect in the facilities developed by SPC	M	S	1
	46	External Factor	Law/Regulation	Approval	Lack of necessary permissions	Lack of necessary permissions	M	S	1
	47	Commercial	Cost	Inflation	Increase in Inflation	SPC's EPC costs will increase due to inflation.	L	M	3
	48	Finance	Forex		Changes in forex	Cost increase in changes in forex	L	L	3
Operation	49	Commercial	Cost	Operation and Maintenance	Deficiency in capability of HAWACO	Trouble in water supply or cost increase by deficiency in capability of HAWACO.	S	S	1
	50	Commercial	Cost	Operation and Maintenance	Water volume and quality	Bear the obligation to provide excessive water volume and water quality.	S	S	1
	51	Commercial	Cost	Raw water	Availability of raw water	Raw water supply is less than expected and supply water volume will be lower than the requirement.	M	S	1
	52	Commercial	Cost	Raw water	Change in quality of raw water	Raw water quality will be changed and treatment cost will be increased.	M	S	1
	53	Commercial	Cost	Infrastructure		Accidental failure of electricity or gas supply.	M	M	2
	54	Commercial	Cost	Operation and Maintenance	Additional capital spending other than original plan.	Additional capital spending by SPC other than original plan.	M	S	1
	55	Commercial	Cost	Inflation	Inflation rate increase	SPC's O&M costs will increase due to inflation.	L	M	3
	56	Finance	Forex		changes in forex	Cost increase in changes in forex.	L	L	3
	57	External Factor	Country risk	Forex	Overseas remittance	・Breakdown of overseas remittance system through which SPC repay debt service and distribute dividend. ・Stop of clearing function by decrease of foreign currency reserves.	L	M	3
	58	Commercial	Cost	Construction/Completion	Commissioning	Lack of time for sufficient commissioning and excessive conditions for operation.	M	S	1
	59	Commercial	Technology		Technology obsolescence	Excessive obligation for introduction of technology innovation.	S	S	1
	60	Commercial	Revenue	Off-Taker	Service provision for the Third-party	Inhibition of service provision to the Third-party.	M	M	2

(3) Risk Mitigation Measures and Countermeasures

In Table 5.4.1 showing the extracted risks, risk mitigation measures and countermeasures have been reviewed. Risk mitigation measures and countermeasures were categorized into those that can (1) prevent risks in advance through agreement between related parties, control method, or project structuring, etc, (2) mitigate risks, (3) transfer risks to a part of the related parties, (4) share risks between related parties, and, (5) supplement through tools, such as insurance, and possible countermeasures were reviewed. Many of such measures require discussions and agreements between parties relevant to the project and action items have been provided. This report takes into consideration the scores calculated based on the level of impact on the project and the probability, and the possibility of risk mitigation measures and countermeasures, in order to specify the results of review on major risks for the project at the current stage. The detail risk allocation is currently discussed among Metawater and Vietnamese counterparts. Following risks are considered to have a significant impact on project feasibility and assumed to have a certain level of probability, and it is noted that mitigation measures should be identified at an early stage.

In case the risk mitigation measures and countermeasures are not executed, sensitivity analyses have been conducted with regard to the impact of risks on project feasibility. Study team quantitated the influence on the project of risks scored with “3” according to its impact and probability in the Table 5.4.1 through the analysis of EIRR sensitivity (refer to Chapter 7. Financial Analysis)

Table 5.4.2 Risk Allocation

	No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact	Probability	Score	Risk Bearer * Operation Co. could be incorporated into SPC										Mitigation Measures		Related Documents				
							Small Medium Large.	Small Medium Large.		SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Prevention Mitigation Transfer Allocation Insurance		Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
General	1	External Factor	Law/ Regulation	Approval	Central /Local Government can't obtain necessary approvals.	Necessary measures are not taken for the approvals required by central/local governments (concession rights, water rights, water supply licenses etc)	M	S	1	-	-	-	-	-	△	-	○	-	-	Transfer	Central Government (MOC) will take necessary procedure as well as support the project for Ha Noi City Government take necessary approvals.	-	○	-	-	-
	2	External Factor	Law/ Regulation	Approval	SPC can't obtain necessary approvals.	Necessary measures are not taken for the approvals required by SPC (concession rights, water rights, water supply licenses etc). Concession rights provided to VIWASEEN cannot be maintained and assigned to SPC.	L	M	3	-	○	-	-	-	-	-	-	○	-	Prevention/ Allocation	Concession rights were provided to VIWASEEN under Presidential Decree (No. 685/TTg-KTN) and the possibility to change will be low. Metawater will agree with VIWASEEN under shareholders agreement on the assignment and conditions of concession rights.	○	-	-	-	○
	3	External Factor	Law/ Regulation	Law/ Administration	Law/regulation/policy change (Specific Laws)	Possibility to have a new law or change in laws and policies result in cost increase of the project. (Specific law/policy changes directly affect the project)	M	S	1	-	-	-	-	-	-	-	-	○	-	Transfer	Cost increase in policy change will be borne by the Government. If the part of SPC work is prohibited by the change in law, SPC will not be obligated to perform and exempt from any penalties.	-	○	-	-	-
	4	Exter	Law/	Law/	Law/re	Possibility to have a new	M	M	2	-	-	-	-	-	-	-	-	○	-	Transfer	Cost increase in policy					

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No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	Risk Bearer * Operation Co. could be incorporated into SPC SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures Prevention Mitigation Transfer Allocation Insurance		Related Documents Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
	nal Factor	Regulation	Administration	gulation/policy change (General Laws)	law or change in laws and policies result in cost increase of the project. (general law/policy changes directly affect the project)															change will be borne by the Government.	-	○	-	-	-
5	External Factor	Law/ Regulation	Tax	Tax change (Specific issues)	Possibility to have changes in tax results in cost increase of the project.	M	S	1	-	-	-	-	-	-	-	-	○	-	Transfer	Cost increase in tax system change will be borne by the Government.	-	○	-	-	-
6	External Factor	Law/ Regulation	Tax	Tax change (General issues)	Possibility to have changes in general tax results in cost increase of the project.	M	M	2	-	-	-	-	-	-	-	-	○	-	Transfer	Cost increase in tax system change will be borne by the Government.	-	○	-	-	-
7	External Factor	Law/ Regulation	Law/ Regulation	Legal compliance	Law violence	M	M	2	-	-	○	○	○	-	-	-	-	-	Allocation	Cost increase in law violence will be borne by each player who is subject to the law.	○	○	-	○	-
8	External Factor	Force Majeure		Force Majeure	Have unforeseeable events (war, civil war, dispute, terrorism, nuclear pollution, chemical pollution, fire, lightning, typhoon, flood, earthquake, riot etc.)	M	M	2	○	-	-	-	-	-	-	-	○	-	Transfer Insurance	・Cost increase and damage caused by force majeure will be borne by the Government. SPC will not be responsible on non-performance due to force majeure. ・SPC will purchase available insurance (fire, earthquake, political risk etc.)	-	○	-	-	-
9	Commercial	Construction/Co	Third-party	Third-party liability	Liability for the damages resulting during the process of construction	S	S	1	-	-	-	-	-	△	△	△	○	-	Transfer	・Stipulate the obligation to bear the Third-party liability by the attributed	-	○	-	-	-

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No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures: Prevention Mitigation Transfer Allocation Insurance	Mitigation Measures	Related Documents: Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
		mpletion, Operation and Maintenance	liability	(Government side)	and O&M regarding marginal infrastructure developed by Government side(i.e. Ha Noi city)															entity depending on the reason in the project agreement.					
10	Commercial	Construction/Completion, Operation and Maintenance	Third-party liability	Third-party liability (SPC side)	Liability for the damages resulting during the process of construction and O&M regarding infrastructure developed by SPC side.	S	S	1	-	-	-	-	-	△	△	△	○	-	Allocation Insurance	・Stipulate the obligation to bear the Third-party liability by the attributed entity depending on the reason in the project agreement.	-	○	-	-	-
11	Financial	Interest rate		Interest rate	Cost increase due to rising interest rates.	L	M	3	△	-	-	-	-	-	-	-	-	○	Transfer	SPC will conclude a swap agreement.	-	○	-	○	-
12	Financial	Financing	Financing	Financing - SPC	SPC cannot raise funds at appropriate term/currency. Interest.	L	M	3	○	○	-	-	-	-	-	-	-	○	Prevention	・ Project income is denominated in VND (pegged to US$) and loans denominated in US$ or conversion of Yen loans to US$ loans is preferable. ・ Provide appropriate security package for financial institutions. -assignment of rights	-	○	○	-	-

No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	Risk Bearer * Operation Co. could be incorporated into SPC SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures Prevention Mitigation Transfer Allocation Insurance		Related Documents Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
																				under contract /assets/ equity -Step-in right under direct agreement -management of deposit account ・raise long-term funding considering project profitability ・shareholders loan will be considered.					
13	External Factor	Social/Environment	Project interruption	Business interruption by government	Cancellation or postponement by the reason attributed to the government	M	S	1	-	-	-	-	-	△	△	△	○	-	Transfer	Stipulate the obligation to bear the damages by attributed player in the project agreement.	-	○	-	-	-
14	External Factor	Law/Regulation	Procurement	Procurement procedure	Project is procured through competitive bidding not through the single tendering.	M	M	2	○	-	-	-	-	-	-	-	-	-	Transfer	Win assurance for transfer of the project right which VIWASEEN has from VIWASEEN to SPC or acquisition of the project right to SPC.	-	-	-	-	○
15	Commercial	Revenue	Demand	Demand lower than demand projection	Demand is lower than 150k ton/day for Phase 1 and 2.	L	M	3	-	-	-	-	○	○	-	-	-	-	Prevention	Review demand forecast. Take or pay contract with HAWACO. Consensus building with Ha Noi city on guarantee for off-take contract.	-	○	-	○	-

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No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	Risk Bearer * Operation Co. could be incorporated into SPC: SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures: Prevention Mitigation Transfer Allocation Insurance		Related Documents: Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
16	Commercial	Revenue	Demand	Contract with appropriate size	Plan is changed during the project period and affects the size of facility.	L	M	3	-	-	-	-	○	○	-	-	-	-	Prevention	Negotiate with Ha Noi city ①Divide phase 1 and 2 ②Package phase 1 and 2 and provide an option for the phase 2 ③Package phase 1 and 2 and cost of phase 2 can be revisited before its start.	-	○	-	○	-
17	Commercial	Cost	Technology	Scope of Work and Interface	Trouble arising from interface between the water facility and water distribution facility	M	S	1	-	-	○	-	○	-	-	○	-	-	Allocation	Already agreed with HAWACO that SPC accepts responsibility within a inch of distributing reservoir.	-	○	-	○	-
18	Commercial	Revenue	Demand	Competitor	Take or pay contract is not introduced aiming to avoid competitive environment.	L	M	3	-	-	-	-	○	○	△	-	○	-	Transfer	By introducing "Take or Pay" contract, confirm with Ha Noi City/HAWACO that whole water supply shall be taken they do not allow competitive business to be implemented during the project period. Further negotiation is required for the commitment of 300k ton/day.	-	○	-	-	-
19	Financial	Residual Value	Project termination	Residual value-1	At Asset transfer under BOT scheme, some conditions to assure asset value will be imposed	M	S	1	-	-	-	-	-	○	-	○	-	-	Transfer	Transfer price under BOT law is zero and low risk possibility.	-	○	-	-	-
20	Financial	Residual	Project	Residual	Asst transfer value paid by HAWACO to SPC	M	M	2	-	-	-	-	-	○	-	○	-	-	Transfer	・Stipulate the obligation to pay the value to recover the	-	○	-	-	-

No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	Risk Bearer * Operation Co. could be incorporated into SPC SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures Prevention Mitigation Transfer Allocation Insurance		Related Documents Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
		Value	interruption	value-2	when the contract is cancelled by SPC before maturity.															initial investment in compensation for asset transfer when project is interrupted with the payment formula in the project agreement.					
21	Financial	Residual Value	Project interruption	Residual value-3	Asst transfer value paid by HAWACO to SPC when the contract is cancelled by HAWACO before maturity.	M	M	2	-	-	-	-	-	○	-	○	-	-	Transfer	Stipulate the obligation to pay the value to recover the initial investment and the present value of unrealized profit in compensation for asset transfer when project is interrupted with the payment formula in the project agreement.	-	○	-	-	-
22	Financial	Residual Value	Project interruption	Residual value-4	Asset transfer value paid by HAWACO to SPC when the contract is cancelled by change of law or force majeure.	M	M	2	-	-	-	-	-	○	-	○	-	-	Transfer	Stipulate the obligation to pay the value to recover the initial investment and the present value of unrealized profit in compensation for asset transfer when project is interrupted with the payment formula in the project agreement.	-	○	-	-	-
23	Financial	Sponsor		Sponsor risk	No fulfillment of capital injection by sponsor or increase in credit risk of sponsor.	M	M	2	-	○	-	-	-	-	-	-	-	-	Prevention	Stipulated the obligation to bear the damages by attributed sponsor in the shareholders agreement.	○	-	-	-	-
24	Commercial	Cost	Subcontract companies	Poor performance of subcontract	Poor performance of subcontract companies to perform the project.	S	S	1	-	-	○	○	○	-	-	-	-	-	Prevention	Select eligible company through the due diligence on its capability when choose subcontractor.	-	-	-	-	-

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No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact	Probability	Score	Risk Bearer * Operation Co. could be incorporated into SPC										Mitigation Measures		Related Documents				
						Small Medium Large.	Small Medium Large.		SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Prevention Mitigation Transfer Allocation Insurance		Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
				companies																					
25	Commercial	Revenue	Tariff revision	Payment Method, Payer	・Is appropriate formula set for payment to SPC? ・Who pays for SPC? Are there any risks of Payer?	L	M	3	-	-	-	-	○	-	-	○	-	-	Allocation	・Under take or pay contract, capacity payment will be introduced to assure collection of initial investment and fixed O&M costs despite water supply or non-supply. Combination of the following 2 payments. ①Capacity payment: paid for availability of facilities for initial capital investment and fixed O&M costs. ②Variable payment: paid for actual usage for variable O&M costs (ex. electricity, chemicals etc.) ・Cost increase due to forex/inflation will be add on to the off-take price. ・Monthly payment ・Payment guarantee from the Central Government or Hanoi City. ・Water companies will pay regardless of their distribution of water/tariff collection.	-	○	-	○	-
26	Financial	Fluctuation	Currency	Currency	Which currency payment will be denominated in?	L	M	3	-	-	-	-	-	-	-	-	-	○	Mitigation	Payment denominated in USD will be exchanged to	-	○	-	○	-

No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact	Probability	Score	Risk Bearer * Operation Co. could be incorporated into SPC										Mitigation Measures		Related Documents				
						Small Medium Large.	Small Medium Large.		SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Prevention Mitigation Transfer Allocation Insurance		Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
		n in exchange																		VND. VDB shall bear the forex risk adding spread on interest rate as risk margin.					
27	Commercial	Cost		Additional cost by Government	Increase in capital spending by the reason attributed to the government.	M	M	2	-	-	-	-	-	-	-	○	-	-	Transfer	Stipulate the obligation of the government to pay in lump sum when the capital spending increases by the reason attributed to the government in the project agreement.	-	○	-	-	-
28	Commercial	Revenue	Off-Taker Risk	Default in paying service payment	Is the back-up of payments necessary?	L	M	3	-	-	-	-	○	○	○	-	-	-	Transfer Insurance	・Payment guarantee from Hanoi City will be required. ・Performance guarantee insurance	-	-	-	○	-
29	External Factor	Country risk		Country risk	Conditions for country risk coverage will not be met.	M	M	2	-	-	-	-	-	-	-	-	○	-	Mitigation/Insurance	Need to set up necessary security package for JICA/NEXI's approval.	-	-	-	-	○
30	Commercial	Cost	Technology	Interface between water intake and water distribution	Trouble in water supply arising from interface between water intake facilities and water distribution facilities.	M	S	1	-	-	○	-	-	-	-	-	-	-	Prevention	Award only one company a contract to design and build water intake facilities and water distribution facilities.	-	○	-	-	-

	No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	Risk Bearer * Operation Co. could be incorporated into SPC SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures Prevention Mitigation Transfer Allocation Insurance		Related Documents Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
	31	Commercial	Cost	Development plan	Government Subsidy / Capital Injection/ Development as public work	Necessary government subsidy, capital injection, or development of related infrastructure is not provided.	L	L	3	-	-	-	-	-	△	△	△	○	-	Transfer	At this point no government subsidy is expected.	-	○	-	-	○
	32	Commercial	Cost	Infrastructure	Delay in GOV's work	Delay in construction by delay in Government work (i.e. land acquisition, land lease and marginal infrastructure (power, road and telecommunication).	L	L	3	-	-	-	-	-	△	△	△	○	-	Transfer	Receive completion guarantee from GOV on local infrastructure.	-	○	-	-	○
Construction	33	Commercial	Cost	Design	Increase costs due to changes in design	Design change due to Government intention results in cost increase.	M	S	1	-	-	-	-	-	-	-	○	○	-	Transfer	・Cost increase will be borne by the Government. ・Significant change will be limited in the project agreement.	-	○	-	-	-

No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact	Probability	Score	Risk Bearer * Operation Co. could be incorporated into SPC										Mitigation Measures		Related Documents				
						Small Medium Large.	Small Medium Large.		SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Prevention Mitigation Transfer Allocation Insurance		Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
34	Commercial	Revenue	Design	Increase costs due to changes in design by SPC	Design change due to SPC will not be allowed.	M	S	1	-	-	○	-	-	-	-	-	-	-	Allocation	EPC company will bear the costs.	-	○	-	-	-
35	Commercial	Cost	Design	Delay in design completion, cost increase	Delay in design completion, cost increase due to SPC	M	S	1	-	-	○	-	-	-	-	-	-	-	Transfer	Design company will bear the costs. Significant increase will be borne by the government.	-	○	-	-	-
36	Commercial	Cost	Construction/Completion	Delay in construction completion due to Ha Noi City etc.	Delay in construction completion due to Hanoi City etc.	M	M	2	-	-	-	-	-	△	△	○	○	-	Transfer	Cost increase will be borne by the government (MOC)	-	○	-	-	-
37	Commercial	Cost	Construction/Completion	Delay in construction completion due to SPC	Delay in construction completion due to SPC	M	M	2	-	-	○	-	-	-	-	○	○	-	Transfer Insurance	・Construction company will bear the costs. Significant increase will be borne by the government. ・Performance guarantee Insurance	-	○	-	-	-

No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact	Probability	Score	Risk Bearer * Operation Co. could be incorporated into SPC										Mitigation Measures		Related Documents				
						Small Medium Large.	Small Medium Large.		SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Prevention Mitigation Transfer Allocation Insurance		Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
38	External Factor	Social	Environment	Environment (Hanoi)	Environment issues on selection of land, work conducted by Government sector (land acquisition, ground work) will occur.	M	S	1	-	-	-	-	-	△	△	○	○	-	Transfer	Government is responsible for land preparation and costs will be borne by the Government.	-	○	-	-	-
39	External Factor	Social	Environment	Environment (SPC work)	Environment issues on work conducted by SPC will occur.	M	S	1	-	-	○	○	○	-	-	-	-	-	Allocation		-	○	-	-	-
40	External Factor	Social	Residents	Residents	Residents movement opposing the project	M	S	1	-	-	-	-	-	△	△	△	○	-	Transfer	Government is responsible for land acquisition for the infrastructure and WTP planning and cost increase / damages due to resident's movement will be borne by the Government. (The PO, MOC, Ha Noi City)	-	○	-	-	-
41	External Factor	Social	Land	Land Acquisition	Land acquisition for WTP and pipes are not completed.	M	S	1	-	-	-	-	-	△	△	△	○	-	Transfer	Land is owned by central government and right to use is provided to Hanoi City. Cost increase for land acquisition / latent defect will be born by The Government.	-	○	-	-	-
42	Commercial	Cost	Construction/Completion	Defect	Land defect	M	S	1	-	-	-	-	-	△	△	△	○	-	Transfer	・Stipulate the obligation of Presidential Office, MOC or Ha Noi city etc to accept liability for damages arising from land defect in the project agreement because land acquisition is	-	○	-	-	-

No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures Prevention Mitigation Transfer Allocation Insurance		Related Documents Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
																				obliged to the government by laws. ・Soil surveys obliged in related laws were completed.					
43	Commercial	Cost	Construction/Completion	Mistakes in land survey	Cost increase arising from the land survey by Ha Noi city.	M	S	1	-	-	-	-	-	△	△	△	○	-	Transfer	Stipulate the obligation of MOC to bear the damages arising from mistakes in land survey by Ha Noi city in the project agreement.	-	○	-	-	-
44	Commercial	Cost	Construction/Completion	Mistakes in land survey	Cost increase arising from the land survey by SPC.	M	S	1	-	-	○	-	-	-	-	-	-	-	Allocation	・Stipulate the obligation of SPC to bear a certain level of damage arising from mistakes in land survey by SPC in the project agreement. ・Land survey company bear the damages of SPC.	-	○	-	-	-
45	Commercial	Cost	Construction/Completion	Defect in the facilities developed by SPC	Defect in the facilities developed by SPC	M	S	1	-	-	○	-	-	-	-	-	-	-	Allocation	Stipulate the obligation of EPC company to bear the damages arising from defect in facilities developed by SPC in the shareholders agreement and project agreement.	○	○	-	-	-
46	External Factor	Law/Regulation	Approval	Lack of necessary permissions	Lack of necessary permissions	M	S	1	○	-	○	-	-	-	-	-	-	-	Allocation	Stipulate the obligation to bear the damages by the attributed entity depending on the reason in the shareholders agreement.	○	-	-	-	-
47	Commercial	Cost	Inflation	Increase in Inflatio	SPC's EPC costs will increase due to inflation.	L	M	3	△	△	○	-	○	-	-	-	○	-	Transfer	Update inflation assumption and re calculate off take price	-	○	-	○	-

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	No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact	Probability	Score	Risk Bearer * Operation Co. could be incorporated into SPC										Mitigation Measures		Related Documents				
							Small Medium Large.	Small Medium Large.		SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Prevention Mitigation Transfer Allocation Insurance		Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
					n																when the facilities are delivered.					
	48	Finance	Forex		changes in forex	Cost increase in changes in forex	L	L	3			-	-	○	○	-	-	-	-	Transfer	Update forex assumption and re calculate off take price when the facilities are delivered.	-	○	-	○	-
Operation	49	Commercial	Cost	Operation and Maintenance	Deficiency in capability of HAWACO	Trouble in water supply or cost increase by deficiency in capability of HAWACO.	S	S	1	-	-	-	-	○	-	-	-	-	-	Prevention/ Transfer	・Capability of HAWACO is reliable because HAWACO is actually providing service to Ha Noi City. ・SPC is responsible only for the water distribution despite the ability of receiver, HAWACO and service level is monitored by the ability of the water distribution of SPC. ・HAWACO shall buy the equity of SPC and stipulate the necessary cooperation in shareholders' agreement.	○	-	-	○	-
	50	Commercial	Cost	Operation and Maintenance	Water volume and quality.	Bear the obligation to provide excessive water volume and water quality.	S	S	1	-	-	-	-	-	△	△	△	○	-	Transfer	・Already confirmed that water quality standard stipulated in local law obliged in Ha Noi city and other marginal city is reasonable level and O&M company can sufficiently comply.	-	○	-	○	○

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No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	Risk Bearer * Operation Co. could be incorporated into SPC SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures Prevention Mitigation Transfer Allocation Insurance		Related Documents Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
																				・Stipulate the water quality standard stated in local laws in the project agreement and off-take agreement.					
51	Commercial	Cost	Raw water	Availability of raw water	Raw water supply is less than expected and supply water volume will be lower than the requirement.	M	S	1	-	-	-	-	-	-	-	-	○	-	Transfer	Raw water supply risk will be borne by MOC/Ha Noi City.	-	○	-	-	-
52	Commercial	Cost	Raw water	Change in quality of raw water	Raw water quality will be changed and treatment cost will be increased.	M	S	1	-	-	-	-	-	-	-	-	○	-	Transfer	・Quality of raw water quality risk will be borne by Hanoi City (water company). ・Quality of raw water will be defined in project agreement/off-take agreement and low quality will not cause non performance of SPC.	-	-	-	-	-
53	Commercial	Cost	Infrastructure		Accidental failure of electricity or gas supply	M	M	2	-	-	-	-	-	○	○	○	-	-	Transfer	・Stipulate the obligation of MOC, Ha Noi City and marginal cities to bear the damages arising from the accidental failure of electricity or gas supply in the project agreement. ・Install in-house power generation system for	-	○	-	○	-

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No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	Risk Bearer * Operation Co. could be incorporated into SPC SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures Prevention Mitigation Transfer Allocation Insurance		Related Documents Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
																				emergency.					
54	Commercial	Cost	Operation and Maintenance	Additional capital spending other than original plan.	Additional capital spending by SPC other than original plan.	M	S	1	-	-	○	○	-	-	-	○	-	-	Allocation	・Stipulate that SPC bear the responsibility for additional investment only when SPC can not meet the performance pre-agreed in the project agreement. ・ Necessary additional investment plan shall be developed by EPC company and agreed between SPC and awarding agency at the signing of project agreement.	-	○	-	-	-
55	Commercial	Cost	Inflation	Inflation rate increase	SPC's O&M costs will increase due to inflation.	L	M	3	△	△	-	○	○	-	-	-	○	-	Transfer	Off-take price will be adjusted by change in inflation/interest rate annually.	-	○	-	○	-

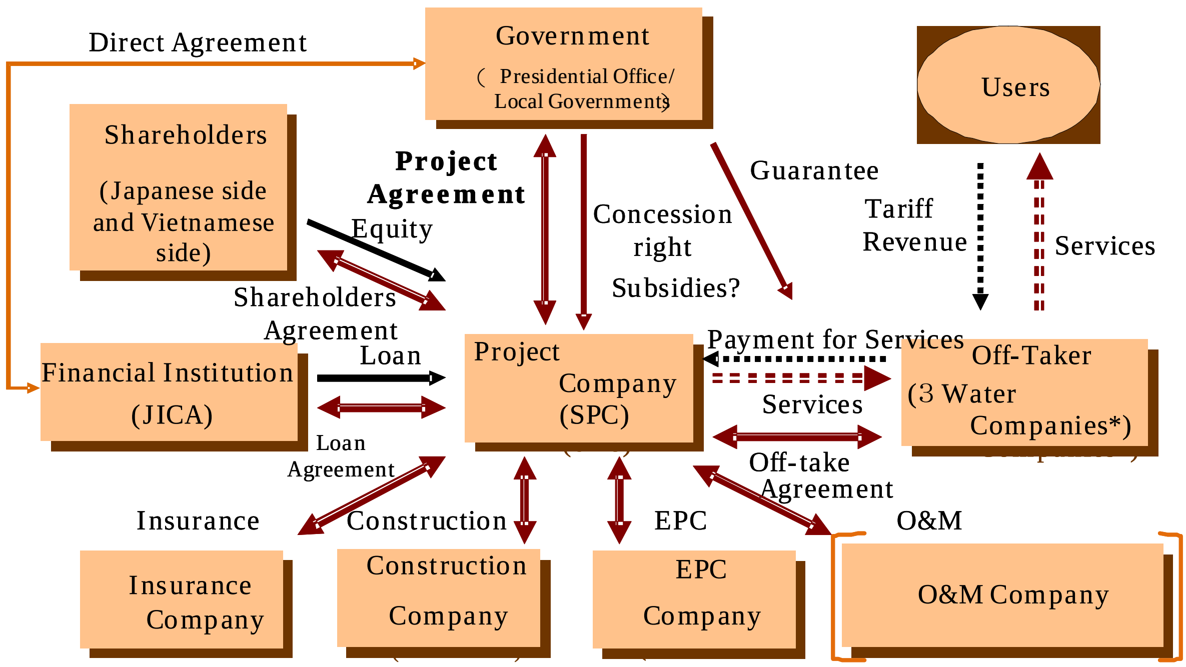
No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact Small Medium Large.	Probability Small Medium Large.	Score	Risk Bearer * Operation Co. could be incorporated into SPC SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Mitigation Measures Prevention Mitigation Transfer Allocation Insurance		Related Documents Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
56	Finance	Forex		changes in forex	Cost increase in changes in forex	L	L	3	-	-	-	-	○	○	-	-	-	○	Transfer Mitigation	・Payment formula of off take price includes forex changes. ・ Introduce currency matching for revenue and costs to mitigate forex risks. Revenue will be USD based and loan will be denominated in USD. ・ Cost for significant changes in exchange rate will be negotiated to be borne by Ha Noi City or HAWACO.	-	○	-	○	-
57	External Factor	Country risk	Forex	Overseas remittance	・Breakdown of overseas remittance system through which SPC repay debt service and distribute dividend. ・Stop of clearing function by decrease of foreign currency reserves.	L	M	3	○	○	-	-	-	-	-	-	-	-	Prevention/ Insurance	・Open a USD account with the bank overseas and transfer the cash from the account opened in Vietnam. ・ Coverage by trade insurance.	-	○	-	-	-
58	Commercial	Cost	Construction/Completion	Commissioning	Lack of time for sufficient commissioning and excessive conditions for operation.	M	S	1	-	-	○	○	-	-	-	-	-	-	Allocation	・EPC contract with the conditions of “Fixed Price”,”Turn Key” and “Date Certain”. ・ Clarification of the conditions to deliver the facilities.	-	-	-	-	○

	No.	Category 1	Category 2	Category 3	Risk	Risk Details	Impact	Probability	Score	Risk Bearer * Operation Co. could be incorporated into SPC										Mitigation Measures		Related Documents				
							Small Medium Large.	Small Medium Large.		SPC	Shareholder	EPC Company	*Operation Co,	Water Co.	Hanoi City	Provinces	MOC	Presidential Office	Financial Institution	Prevention Mitigation Transfer Allocation Insurance		Shareholders Agreement	Project Agreement	Loan Agreement	Off-Take Agreement	Others
	59	Commercial	Technology		Technology obsolescence	Excessive obligation for introduction of technology innovation.	S	S	1	○	-	○	○	-	-	-	○	-	-	Allocation	Stipulate the obligation of MOC to bear the damages arising from the change in service level pre-agreed	-	○	-	-	-
	60	Commercial	Revenue	Off-Taker	Service provision for the Third-party	Inhibition of service provision to the Third-party.	M	M	2	○	-	-	-	-	○	-	-	-	-	Prevention	Stipulate the right of SPC to provide service for the Third-party in the project agreement and off-take agreement.	-	○	-	-	-

5.4.2 Contractual Scheme and Project Documents

(1) Contractual Scheme

Basic project and contractual scheme is shown in the following figure. O&M Company could be incorporated into SPC.



* 3 Water Companies : Hanoi Water Company, Bac Ninh Water Company, Hung Yen Water Company

1) Parties to the Agreement

① Central Government

It is assumed that the central government is a counterpart of the project agreement. Presidential Office and Ministry of Construction (MOC) are the related organizations to the project. Concession right at the first stage was provided to VIWASEEN under the Presidential Decree issued by the Presidential Office, and concession right at the second stage is assumed to be provided by the Presidential Office to SPC. In addition, MOC is in charge of the urban water sector and it is estimated that MOC is a related organization on project details including development planning. 【BOT Law Article 3】

In order to clarify the government support on authorization of concession rights and water rights, necessary approvals on design, construction, operation of facilities, financing and foreign exchange transactions, related infrastructures, land acquisitions etc., Project Agreement will identify the project details, project term, service requirements, payment conditions and formula, measures identified in BOT law such as tax exemptions, and risk allocation between the Vietnam government and project company. 【BOT Law Article 38-45】

In case the project agreement is not contracted with the Presidential Office, but MOC, it will be negotiated to have a commitment from the Presidential Office separately.

② Local Governments

The project provides water services for Ha Noi City, Bac Ninh Province, Hung Yen Province and the final beneficiaries are people at those city and provinces (Currently, it is almost agreed that supply area up to phase 2 is only Ha Noi City). Although the project does not provide water services directly to these areas, it is necessary to confirm whether the project is in line with development plans of local governments, status of local infrastructure development and work sharing, support for local water companies and guarantee for off takers.

It is considered to include local governments as counterparts of project agreements.

③ Off taker

Off takers of the project are Hanoi Water Company, Bac Ninh Water Company, and Hung Yen Water Company (Currently, it is almost agreed that supply area up to phase 2 is only Ha Noi City). SPC will contract long-term off take agreements with three water companies and agree on the volume, quality, and price of water supply. It is expected to have “Take or Pay” contract and the project company will not take demand risk. The performance guarantee of three off takers by local government will be negotiated.

④ VIWASEEN

VIWASEEN is a state owned company which holds a concession right, issued by the Presidential Office and is going to be a shareholder of SPC as well as sub contract construction. In order to assign the rights and obligations under the concession right currently held by VIWASEEN as a project contract stipulated under the BOT Law, a guarantee must be obtained from the Presidential Office. SPC will agree with VIWASEEN on assignment and condition of concession right at the first stage under the shareholder's agreement. It is identified in construction agreement that VIWASEEN is in charge of construction, bears associated risks, and takes appropriate risk mitigation measures.

⑤ SPC

SPC is established as LLC and it is to be a project company conducts design, construction, maintenance and operation of the project. Necessary measures to establish SPC will be taken according to BOT Law Article 27, and Enterprise law. Shareholders' Agreement defines role sharing and rights and obligation of share holders.

It is expected to have shareholders, such as Metawater, JICA as Japanese partners, and VIWASEEN, Hanoi Water Company, Bac Ninh Water Company, and Hung Yen Water Company as Vietnamese partners. Shareholding ratio will be 49:51 for Japanese partners and Vietnamese Partners. State capital will be under 49% as regulated in BOT Law, the minimum equity amount will be followed BOT Law Article 5.

⑥ Financial Institutions

It is expected to have loans under Private Sector Investment and Finance of JICA. Equity will be defined under Shareholders' Agreement mentioned at 5) and the detail conditions of loans will be defined at Loan Agreement.

2) Related Agreements

Considering the above project scheme, execution of the following agreements would be required.

Table 5.4.3 Documents List of the Project

No.	Documents	Signer
1	Government to Government Agreement	Vietnam Government, Japanese Government
2	BOT Contract（Project Agreement）/Investment Registration	MOC, SPC / MPI, SPC
3	Base Accord（MOU） (The case SPC provides service for Bac Ninh water company、HungYen water company)	HAWACO (Bac Ninh Water Company or Hung Yen Water Company), SPC
4	Off take agreement (The case SPC provides service for Bac Ninh water company、HungYen water company)	HAWACO (Bac Ninh Water Company or Hung Yen Water Company), SPC
5	Government and off taker Agreement	MOC, HAWACO
6	Ha Noi people's committee and off taker Agreement	Ha Noi people's committee, HAWACO（Bac Ninh Water Company or Hung Yen Water Company）
7	Off takers Agreement (The case SPC provides service for Bac Ninh water company, Hung Yen water company)	HAWACO (Bac Ninh Water Company, Hung Yen Water Company）
8	Consortium Agreement/Shareholders Agreement	Metawater, VIWASEEN, HAWACO, JICA
9	Government Guarantee	SPC, MOC
10	Land free rent Agreement	SPC, Ha Noi people's committee,
11	Design Contract	SPC, Design company
12	EPC Contract（Civil engineering, Building, Machinery equipment and Electric machine）	SPC, VIWASEEN
		SPC, Metawater
13	Construction management Contract	SPC, Construction management company
14	Soil treatment Agreement	SPC, Soil treatment company
15	O&M Agreement	SPC, O&M company

No.	Documents	Signer
	(O&M Company could be incorporated into SPC)	
16	Chemicals purchase Agreement	SPC, Chemical company
17	Power purchase Agreement	SPC, Power company
18	Loan Agreement	SPC, JICA
19	Direct Agreement	SPC, Financial institution
20	Swap Agreement	SPC, Financial institution
21	Collateral Agreement	SPC, Financial institution
22	Overseas Investment Insurance	SPC, NEXI
23	Insurance （Performance Guarantee Insurance, Construction Insurance, Third-party Liability Insurance）	SPC, Insurance company
24	Project Management Agreement	SPC, Metawater

(2) Terms and Conditions of Agreements

Of the above list, general contents of provisions and notes, etc for major agreements are specified below.

1) Intergovernmental Agreement (No.1)

As commitment by the central government will enable the project to proceed with speed under a top-down method, it is required to execute an agreement covering the following matters between the Japanese and Vietnamese Governments.

① Specify the positioning of this project within various development plans, such as the metropolitan development plan, and confirm the importance;

② Guarantee on assigning the BOO concession right currently held by VIWASEEN as a BTO concession right to a SPC of which VIWASEEN is a shareholder;

③ Water desalination capability of the project to be 300,000 m3 / day.

2) BOT Contract（Project Agreement）/ Investment Registration (No.2)

Under the BOT Law, preferential treatment is approved regarding the tax system, use of land, government guarantee, etc, and investor's rights and obligations can also be stipulated in the project agreement when executing such agreement in accordance with the BOT Law. A project agreement under the BOT Law is to be executed for this project to ensure a smooth implementation, but as VIWASEEN is currently issued a BOO concession right from the Presidential Office, a negotiation would be required with the Vietnamese Government for making the necessary amendments to this so as to be able to assign this to the SPC as rights and obligations under the BOT Law.

In Vietnam, investment projects must be registered by project under the Common Investment Law and large-scaled projects must be registered with MPI to receive an investment registration certification. An investment registration in compliance with the BOT Law is also stipulated under the BOT Law.

A company making an investment can select the investment project, investment partner, location, investment period, market for selling the product and capital contribution ratio based on the Common Investment Law and other relevant legal documents. Furthermore, an investor can also determine the form of investment in general. The items subject to a screening are the adequacy of the project against various national plans, project's request on land use, project schedule, environmental measures, etc, and the country's investment control authorities directly list the investment preferential treatments granted to the investor on the investment registration certificate.

With respect to this project, as VIWASEEN currently already holds a concession right as a BOO project, and as it is identified that a new registration is not required, it would be preferable to obtain Government support from the point of proceeding with the project with speed, and the following 4 matters should be confirmed in advance in relation to the off take agreement in this regard:

① Conditions for validation/Deadline of validation of the Concession Right

An agreement will not naturally come into effect through the execution of a concession right agreement (issuance of an investment certificate for this project) alone in most cases and conditions of effectiveness (establishment of the project entity, execution of relevant agreements, investment (loan) execution, etc) for the concession right is stipulated in the agreement and also the period of effectiveness in some cases (if a concession right does not become effective by such period, it will become invalid, etc).

Assuming that the features are as above, it should be confirmed that the conditions and period of effectiveness are not difficult to meet. Negotiating to not establish a period of effectiveness would be an option.

② Cancellation Events for the Concession Right and the Consequence

It is required to confirm in advance possible cancellation events for the concession right and the consequences, by classifying events into cases where the SPC is responsible, government side circumstances (government is responsible), force majeure, revision to laws and regulations, etc.

Confirming whether possible cancellation events are avoidable, and the conditions for collecting invested amounts in case a concession right is actually cancelled (in particular, whether the conditions sufficiently protect lenders) would be required. It would be further preferable if the conditions possibly allowed investments to be immediately collected upon cancellation of a concession right in case the counterparty government’s credit deteriorates (where such government is responsible).

③ Measures Taken at the Termination of the Concession Right

It is preferable to confirm in advance the conditions required of the subject assets (e.g. required economical value) and the method of confirmation at the time of termination of the project. Confirmation is also required on whether there is no gap with the conditions assumed in the project plan.

The items to be specified in the investment certificate to be issued have been summarized in the below table:

Table 5.4.4 Points to be stipulated by BOT Contract（Project Agreement）/Investment Registration and Remarks

Matters to be Stipulated	General Contents of Provisions	Notes
Investment project	➢ To specify the details of projects subject to the issuance of concession right and the method (BOT)	➢ Need to confirm that there is no gap between the details and methods assumed in the project plan. ➢ Need to confirm the wording and conditions to check whether competing concession rights will not be issued to third parties. ➢ Need to confirm whether it is possible to have all the supply areas for the 3 public water supply companies and assume the case in which only Ha Noi city could be included in this project. ➢ Need to confirm whether changes to the contents of the project is possible, such as whether it is possible to increase the water supply amount for the 3 public water companies in the middle of the project term, or to start water supply to other public water companies in the middle of the project term.
Investment partner	➢ Provisions on assumed shareholders	➢ None in particular.
Location	➢ Provisions on assumed project site	➢ Need to confirm whether there are no issues in revising the water distributing pipe laying plan as a result of progress on construction works and geographical conditions due to the area for laying the pipes

Matters to be Stipulated	General Contents of Provisions	Notes
		being extensive.
Investment period	➢ To specify the project implementation schedule (major milestones), such as the period for starting construction, for starting operation. ➢ To specify the preferred period for the concession right	➢ Need to confirm whether there is no gap with the project implementation schedule assumed in the project plan, and contractual consequence in case of delay should be investigated in details to confirm there are no unanticipated risks. ➢ The period for the concession right assumed for this project is 31 years.
Market for selling the product	➢ To specify the water supply area	➢ Need to confirm whether it is possible to have all the supply areas for the 3 public water supply companies and assume the case in which only Ha Noi city could be included in this project.

3) Memorandum of Understanding (Basic Agreement) (No.3)

It is preferable to execute a memorandum of understanding with the off taker prior to executing the off take agreement in order to increase the probability of realizing the project. If the project is to go through a tender procedure, this will be regarded as the execution of a basic agreement, which would be a provisional agreement prior to the execution of a formal agreement.

Table 5.4.5 Points to be stipulated by Memorandum of Understanding (Basic Agreement) and Remarks

Matters to be Stipulated	General Contents of the Provision	Notes
Obligation to make efforts to execute an agreement	➢ To stipulate the obligation to make efforts to execute the off take agreement	➢ As the SPC holds the concession right required for implementing the project, it should be stipulated that it may engage in negotiations as a preferred operator candidate.
Obligation to establish a SPC	➢ To stipulate the obligation to establish a SPC according to investment ratio, amount and form, etc ➢ To stipulate the period for the establishment	➢ None in particular.
Restrictions on disposal, such as share transfer	➢ To stipulated in the shareholders' agreement that the board of director's approval is required for share transfer. ➢ To stipulate the outline of the restrictions on share transfer	➢ It is preferable to confirm the other party's intentions at this time, prior to executing a shareholders' agreement, on whether it is possible to grant a call option, put option, etc as a method for exit.
Conducting of operations	➢ To stipulate the establishment of a SPC and the obligation of consortium member companies to conduct the operations required for fulfilling the off take agreement	➢ Need to confirm whether there are no issues in the public water supply companies engaging in O&M. ➢ To stipulate that the distribution reservoir method will be applied for the connection point with the water pipe. If otherwise, the off taker will take the necessary measures (to bear increased cost).
Off take agreement execution date	➢ An off take agreement to be executed by the date determined by both sides	➢ Need to obtain prior agreement on the due date from each public water supply company.

Matters to be Stipulated	General Contents of the Provision	Notes
Preparation required for performing the off take agreement	➢ To engage in necessary preparations ➢ To take over the preparations made by consortium companies since the establishment of the SPC	➢ Need to stipulate the obligation of the off taker to acquire the approval and license that must be acquired. ➢ To stipulate the support by the off taker provided for the SPC to acquire the required approval and license. The provision on the obligation to acquire a concession right is of particular importance.
Cost bearing	➢ To stipulate the bearing of cost incase the off take agreement is not executed	➢ The off taker side needs to bear the cost in case the SPC is not responsible.

4) Off Take Agreement (No.4)

This will stipulate the conditions for supplying water in accordance with the BOT Agreement. The need to confirm consistency with the BOT Agreement described in the above section and the possibility of matters that could be included in the BOT Agreement and not this agreement are as pointed out above. Matters that could be included both in this agreement and the BOT Agreement have again been listed.

Table 5.4.6 Points to be stipulated by Off Take Agreement and Remarks

Matters to be Stipulated	General Contents of the Provision	Notes
Project details and method	➢ To specify the details of projects subject to the issuance of concession right and the method (BOT)	➢ Need to confirm that there is no gap between the details and method assumed in the project plan. ➢ Need to stipulate that is it prohibited to acquire water from other suppliers and that it is possible to supply water to other water suppliers.
Conditions and period of effectiveness for the agreement	➢ Same as for the BOT Agreement, to stipulate the conditions of effectiveness for the off take agreement (establishment of the project entity, execution of relevant agreements, investment (loan) execution, etc) ➢ The period of effectiveness can be stipulated (if a concession right does not become effective by such period, it will become invalid, etc)	➢ Need to confirm that the conditions and period of effectiveness are not difficult to meet. ➢ Negotiating to not establish a period of effectiveness would be an option.
Project implementation schedule	➢ To specify the project implementation schedule (major milestones), such as the period for starting construction, for starting operation	➢ Need to confirm whether there is no gap with the project implementation schedule assumed in the project plan, and contractual consequence in case of delay should be investigated in details to confirm there are no unanticipated risks.
Treatment in case of a change in designing	➢ To specify the treatment for increased cost arising from changes	➢ To stipulate the procedures for a change in designing. ➢ To stipulate that no cost bearing will

Matters to be Stipulated	General Contents of the Provision	Notes
		arise due to a change that the SPC is not responsible for.
Roles of parties involved in the implementation of the project	➢ To specify the roles (rights and obligations) of each party involved, such as acquisition of land, handling of shared land, approval and license, funding, in addition to the details of the project	➢ Need to confirm whether the provisions stipulate that the off taker side will be responsible for operations that cannot be conducted by the private sector, whether the roles of the government and the off taker are clearly stated, and whether in case the operations to be conducted by the off taker is not conducted, the conditions are such that the private sector is able to collect the investment made.
Requirements for starting construction	➢ To specify the requirements for starting construction, such as confirmation by the off taker of details of the designing and the acquisition of approval and license required	➢ Need to confirm that the contents are reasonable, as if requirements are strict, it could lead to a delay in completion.
Confirmation of completion	➢ To specify the requirements and confirmation process for the facility's completion.	➢ There are many methods. For example, an Independent Engineer (IE) could confirm progress on plant construction, engage in completion checks, and the contractual completion confirmation can be performed through an IE check. In particular, for a BOT project, the ownership of the facility is not transferred to the other party at the time of completion. As such, it is assumed that in many cases, an inspection by the other party is not required in particular (an IE check is

Matters to be Stipulated	General Contents of the Provision	Notes
		sufficient), and if the other party is requesting for an inspection, this could be subject to negotiations (for deletion). ➢ Need to confirm consistency with the Construction Agreement.
Treatment in case of a delay in completion	➢ To specify treatment in case of a delay in completion by classifying cases into those where the SPC is responsible, the other party is responsible, force majeure, revision to laws and regulations	➢ Points to be checked would be, in cases other than where the SPC is responsible, shifting this to charges (or, although this may be difficult, lump-sum payment in an amount equivalent to the increased cost) and in cases where the SPC is responsible, “whether there is a cap amount”, “whether this can be collected from the contractor in return”, or, “whether reserve fund is sufficient.”
Conditions for selling water	➢ To specify the location for selling water, water quality, amount of water to be sold, method for measuring such amount, etc	➢ Need to confirm whether managing the selling of water is not difficult due to the location being far from the purification plant, etc, and whether the required water quality is not difficult to meet, etc.
Conditions for the charges on water to be sold	➢ Normally, there is a Capacity Payment for the water capacity (regardless of the actual amount of water sold), and the Variable Payment for the actual amount of water sold. Unit price for the payment is adjusted for inflation or for foreign	➢ Refer to Chapter 7 for the current assumption on the structure of charges on water for sale under this project.

Matters to be Stipulated	General Contents of the Provision	Notes
	exchange according to the nature of the corresponding cost (impacted by inflation, denominated in foreign or local currency, etc) ➢ Capacity Payment will be reduced in case the time it was impossible to sell water that meets a certain level in terms of water quality exceeds a certain limit	
Provision on daily water selling operations	➢ To specify the method for determining daily amount of water to be sold and rules on making decisions on changes	➢ Need to confirm that operation is reasonable.
Provision on regular reporting	➢ To specify matters on operation plan (annual, term), report on performance, KPI	➢ Need to confirm that KPIs are reasonable.
Cancellation events for the agreement and the consequences	➢ To specify cancellation events and the consequences by classifying cases into those where the SPC is responsible, the off taker is responsible, force majeure, revision to laws and regulations	➢ Need to confirm whether the cancellation events are reasonable, and the conditions for collecting the investment in case the agreement is actually cancelled (in particular, whether the conditions sufficiently protect lenders). ➢ Need a provision on the handling of remaining assets. ➢ Consistency with the concession rights agreement is particularly important.
Measures taken at the termination of	➢ To stipulate the conditions required of the subject	➢ Need to confirm that there is no gap between the conditions assumed in

Matters to be Stipulated	General Contents of the Provision	Notes
the off take period	assets (e.g. required economical value) and the method of confirmation at the time of termination of the off take period, and the method for taking over services prior to the termination of the project (preparing trainings or manuals)	the project plan.
Transfer of the agreement	➢ To specify the requirements when transferring the agreement	➢ Need to confirm whether the "step in" -a method where a lender can transfer the project to a third party in case issues arise with the SPC, for the normalization of the project- can be executed smoothly (e.g. possible to collateralize, restrictions on the transfer itself is not unreasonable).
Compensation for damages	➢ To stipulate compensation for damages to the other party for which it is responsible	➢ More preferable if there is an upper limit to the amount of compensation for damages to be borne by the private operator.
Means of settling disputes	➢ To stipulate the means of settling dispute that arise between related parties	➢ Confirm that the rule is fair, such as both parties select a mediator and the 2 mediators select a 3rd mediator for settling the situation.
[Others] Confirmation on legal admissibility	➢ Need to confirm that the contents of the agreement is based on the off taker's authorization, that the agreement is executed following adequate procedures, and that it is legal and valid	➢ Normally, a legal opinion from a lawyer practicing the local law on the matters in the left will be obtained for confirmation.

5) Shareholders' Agreement (No.8)

Literally, this is an agreement relating to the decision making, etc between shareholders. Major matters to be stipulated and notes are as shown below. It should be noted that the operation risk under the concession right agreement and off take agreement is basically passed through to the operator.

Table 5.4.7 Points to be stipulated by Shareholders' Agreement and Remarks

Matters to be Stipulated	General Contents of the Provision	Notes
Details of operations of the SPC	➢ To specify details of operations of the SPC (as stipulated under the articles of incorporation)	➢ Need to confirm that details of operations are included to the extent appropriate.
SPC's number of shares to be issued at establishment and the total number of shares that can be issued	➢ To specify the SPC's number of shares to be issued at establishment and the total number of shares that it can issue	➢ Need to confirm that the investment amount required under the project plan can be met within the number of shares that it can issue.
Number of shares held, by shareholder	➢ To specify the number of shares held, by shareholder, at establishment and after a capital increase if any is expected	➢ Need to confirm consistency with the project plan.
Expected date of establishment	➢ To specify the expected date of establishment	➢ Same as above.
Capital increase plan	➢ To specify the expected date of capital increase and such amount (shareholders' subscription amount), if any is expected	➢ Same as above. In addition, need to clearly stipulate each shareholder's capital increase obligations. It would be more preferable if backups were specified in case a part of the shareholders becomes unable to subscribe for the capital increase.

Matters to be Stipulated	General Contents of the Provision	Notes
Conditions for the selection of directors and auditors	➢ To specify which shareholder can send in how many directors and auditors, etc	➢ Need to confirm consistency with the project plan.
Outline of the board of directors	➢ To specify the quorum and decision making method	➢ Same as above.
Project period	➢ To specify the project period	➢ Same as above.
Establishment of the right of pledge on shares	➢ Prior agreement on establishing lender's right of pledge on shares	➢ It is highly possible that lenders will request for the establishment of the right of pledge on shares. Basically need to request for a provision on agreement.
Restrictions on share transfer	➢ To specify requirements for share transfer	➢ Need to confirm consistency with concession right agreement, loan agreement, etc.
Transfer price in case of a share transfer	➢ To specify the transfer price in case of a share transfer	➢ Preferable to decide on " an ultimate price in case agreement cannot be reached on price" in order to avoid the risk of not being able to proceed with share transfer due to the price in case issues arise with a part of the shareholders. (E.g. equivalent to net asset price for the latest closing)
Restrictions on dividend	➢ To specify restrictions on dividend from the SPC	➢ As there are restrictions on dividend under the loan agreement, it is preferable to agree in advance to comply with such restrictions.
Prohibition for shareholders to file a petition for the SPC's bankruptcy	➢ Prohibit shareholders from filing a petition against the SPC for bankruptcy	➢ It is normal that such an agreement is requested against lenders. Preferable to include this in advance.

Matters to be Stipulated	General Contents of the Provision	Notes
Matters for board resolution	➢ To specify resolution matters and method at the board meeting	➢ Need to confirm that the rules enable a smooth decision making.
Matters and requirements for resolution at the shareholders' meeting	➢ To specify quorum, matters and requirements for resolution by the shareholders' meeting	➢ Need to confirm that requirements are strict for important matters.

6) Government Guarantee (No.9)

For eliminating the project's uncertainty, a government guarantee should be acquired particularly for the following 2 matters:

① Guarantee for the USD-denominated VND-payments

Under the current payment formula, foreign exchange risk is hedged by using the USD-denominated VND-payment method. Thus, it is important to have this payment method guaranteed.

② Guarantee for the Off Take Agreement

The assumption for the off take agreement is to receive a government guarantee. Although there are no particular matters to be noted under matters to be stipulated, it is further preferable to accept a guarantee that is legally binding on the counterparty government. In order to do so, provisions on jurisdiction and governing law could be clearly specified, and legal admissibility could be confirmed by obtaining a legal opinion.

It may be difficult to receive a guarantee which is "legally binding" in actual cases and there could be cases where an "assurance" like guarantee is obtained with no detailed provisions. There actually were similar cases in the past, such as the power generation project in Indonesia.

7) EPC Agreement (No.12)

Table 5.4.8 Points to be stipulated by EPC Agreement and Remarks

Matters to be Stipulated	General Contents of the Provision	Notes
Guaranteed Completion Date	➢ To specify the Guaranteed Completion Date which is the start date for Liquidated Damage payments (to be described later)	➢ A construction agreement with a Guaranteed Completion Date in the left is referred to as a Date Certain Agreement. Need to confirm whether such provision is included. This needs to be consistent with the scheduled completion date in the concession right agreement and off take agreement, and would be preferable if the deadline was not too tight.
Contract price	➢ To specify the contract price	➢ Basically, need to be Fixed Price (to be completed at this price unless there is a Change Order) without escalation (no adjustment for inflation to the Fixed Price).
Conditions for delivery	➢ To specify the conditions for approving completion and making delivery	➢ Need the conditions to specify that delivery will be made upon passing the performance test conducted over a certain period of time (Turn Key agreement). Process for confirming completion need to be consistent with the off take agreement.
Performance Bond	➢ To specify details of the Performance Bond	➢ Basically, this needs to cover the performance bond requested in the off take agreement, etc. It would be better to establish this

Matters to be Stipulated	General Contents of the Provision	Notes
		upon hearing comments from third parties (e.g. Independent Engineer).
Insurance	➢ To specify details of the insurance to be purchased	➢ It would be better to establish this upon hearing comments from third parties (e.g. Insurance Advisor).
Method for Change Order	➢ To specify the process for a Change Order	➢ As a Change Order could generally become the major cause for a cost overrun, need to confirm whether “the process is reasonable” and “a Change Order can be determined upon approval from lenders (lenders may reserve their right to approve)”, etc. It would be better to establish this upon hearing comments from third parties (e.g. Independent Engineer).
Liquidated Damage	➢ To specify the amount of liquidated damages (amount per day) in case of a delay in completion	➢ Need to be in an amount that can cover the liquidated damage to be paid by the SPC under the concession right agreement and off take agreement, and the interest on SPC’s borrowings.
Warranty against defects	➢ To specify the details of the warranty against defects	➢ It would be better to establish this upon hearing comments from third parties (e.g. Independent Engineer).
Transfer of the agreement	➢ To specify requirements when transferring the agreement	➢ Need to confirm whether the “step in” -a method where a lender can transfer the project to a third party in case issues arise with the SPC, for the

Matters to be Stipulated	General Contents of the Provision	Notes
		normalization of the project- can be executed smoothly (e.g. possible to collateralize, restrictions on the transfer itself is not unreasonable).
[Others] Confirmation on legal admissibility	➢ Need to confirm that the contents of the agreement is based on the counterparty's authorization, that the agreement is executed following adequate procedures, and that it is legal and valid	➢ Normally, a legal opinion from the counterparty's lawyer on the matters in the left will be obtained for confirmation.

8) O&M Agreement (No.15)

This is an agreement with the operator on the operation and maintenance of the facilities. Major matters to be stipulated and notes are as shown below. It should be noted that the operation risk under the concession right agreement and off take agreement is basically passed through to the operator. O&M Company could be incorporated into SPC.

Table 5.4.9 Points to be stipulated by O&M Agreement and Remarks

Matters to be Stipulated	General Contents of the Provision	Notes
Details of operations	➢ To specify details of operations of the operator	➢ All operators' operations required of the SPC under the concession right agreement and off take agreement need to be included.
Requirements for starting operations	➢ To specify the requirements for starting operations	➢ Need to ensure that payments under this agreement will not occur unless SPC has income under the off take agreement.
Contract period	➢ To specify the contract period	➢ Need to cover the project period stipulated under the concession

Matters to be Stipulated	General Contents of the Provision	Notes
		right agreement and off take agreement.
Treatment in case of a delay in starting operations	➢ To specify treatment in case of a delay in starting operations by classifying cases into those where the SPC is responsible, the counterparty is responsible, force majeure, revision to laws and regulations	➢ At minimum, the conditions need to reflect those under the off take agreement.
Conditions for operations	➢ To specify the location for selling water, water quality, amount of water to be sold, method for measuring such amount and the operation process (flow for selling water, operation plan flow, reporting flow, etc)	➢ At minimum, the conditions need to reflect those under the off take agreement.
Conditions for paying the price for operations	➢ To specify the conditions for paying the price for operations	➢ At minimum, the conditions need to reflect those under the off take agreement, excluding those to be externally procured by the operator such as chemicals and electricity, etc.
Cancellation events for the agreement and the consequences	➢ To specify cancellation events and the consequences by classifying cases into those where the SPC is responsible, the operator is responsible, force majeure, revision to laws and regulations	➢ At minimum, the conditions need to reflect those under the off take agreement. Consistency with the concession right agreement is also of particular importance.
Measures taken at the termination of the off take period	➢ To stipulate the conditions required of the subject assets (e.g. required economical	➢ At minimum, the conditions need to reflect those under the off take agreement.

Matters to be Stipulated	General Contents of the Provision	Notes
	value) and the method of confirmation at the time of termination of the off take period, and the method for taking over services prior to the termination of the project (preparing trainings or manuals)	
Transfer of the agreement	➢ To specify requirements when transferring the agreement	➢ Need to confirm whether the "step in" -a method where a lender can transfer the project to a third party in case issues arise with the SPC, for the normalization of the project- can be executed smoothly (e.g. possible to collateralize, restrictions on the transfer itself is not unreasonable).
[Others] Confirmation on legal admissibility	➢ Need to confirm that the contents of the agreement is based on the counterparty's authorization, that the agreement is executed following adequate procedures, and that it is legal and valid	➢ Normally, a legal opinion from the counterparty's lawyer on the matters in the left will be obtained for confirmation.

9) Direct Agreement (No.19)

Provisions that are ordinarily seen in this type of agreement will be incorporated, for example, establishing a cure period of about 6 months and paying consideration to the congealment

6. Economic Analysis

6.1 Purpose and Summary of the Project

(1) Purpose

The Ha Noi City water system is at the core of the Ha Noi metropolitan area, and has been developed in conjunction with the expansion of urbanization, but still relies on groundwater. This is because, due to the Hong River (Red River) running from East to West through the city, there is an ample supply of good quality ground water, allowing for simplified treatment processes and limited investment funds.

However, with rapid urbanization and industrialization in recent years, ground water quality has deteriorated, and the level of groundwater in the city center has decreased, making land subsidence a social issue. Supply shortages have also become apparent in the urban center because of insufficient water treatment plant capacity.

The purpose of this project is to solve the above mentioned issues of deteriorating water quality in the Ha Noi metro area and land subsidence, as well as to increase the water supply in order to meet water demand in the metro area.

(2) Summary

This project plans to take water from the surface of the Duong River, to construct water treatment plants, and to provide purified water to water utilities in 1 city and 2 provinces (Ha Noi City, Bac Ninh Province and the Eco Park Housing Estate in the North of the Hung Yen Province)

Table 6.1.1 Project Summary

	Planned Term	Planned Water Volume
First Stage	2012-2014（Completion in 2015）	150,000 ㎥/day
Second Stage	2016-2019（Completion in 2020）	300,000 ㎥/day
Operating Period	2015-2059（40 years from 2020）	
Target Areas	1 City, 2 Provinces (Ha Noi City, Bac Ninh Province, Hung Yen Province)	
Pipeline Extension	Approx. 130km（First Stage: 100km, Second Stage: 30km）	
Number of Water Wholesalers	19 (First Stage: 15; Second Stage: 4)	

6.2 Current Condition of Water Services

Given below is the summary of the current condition of water services in each city/province.

(1) Central and Eastern Ha Noi City

The areas covered in this project in Central Ha Noi (Tay Ho District, Ba Ding District, Dong Da District, Hoan Kiem District, Hai Ba Trung District, Cau Giay District, Hoang Mai District, and part of Tu Liem Province) and Eastern Ha Noi (Long Bien District, and part of Gia Lam Province) are summarized.

HAWACO (Ha Noi Water Company) have implemented a water project in Central and Eastern Ha Noi, sourcing water from ground water. This is summarized below.

Table 6.2.1 Summary of Ha Noi City Water Project (2009 Results)

City	Area	Name	Area (km2)	Popul. (1000s)	
Ha Noi City	Central	Total		1,956.8	523,435
		Connected	185.77	1,819.8	505,628
		Not Connected	0	137.0	17,807
		Penetration	100.0%	93.0%	96.6%
	East	Total	123.81	347.3	38,940
		Connected	72.30	248.3	33,000
		Not Connected	51.51	99.0	5,940
		Penetration	58.4%	71.5%	84.7%

Table 6.2.1 demonstrates that the coverage ratio of Central Ha Noi City is 100% in terms of the area, 93% in terms of population, and 97% in terms of volume. In practice, however, because of excessive demand, there are still areas that suffer from water outages at peak hours of the day, and supply is not meeting demand.

With regard to Eastern Ha Noi, there is a water treatment facility in Gia Lam, which has the capacity to supply 30,000 m^3/day. They are currently undergoing expansion to increase this capacity to 60,000 m^3/day.

(2) Bac Ninh Province

Water is supplied in Bac Ninh mainly by the Bac Ninh Province Water Authority.

Bac Ninh Province has the following existing water treatment plants: Cho Water Treatment Plant, Tu Son Water Treatment Plant, Tien Son Water Treatment Plant, Lim Water Treatment Plant, Bac Ninh Water Treatment Plant, and Que Vo Water Treatment Plant.

With the increase in both population and industry, recently, water demand f has been rising within the province, and on the other hand water scarcity has become a problem. In order to address this, Bac Ninh Province Water Authority has prepared its own master plan to build new WTP at 4 locations. However, if this project can supply sufficient water amount, the demands for the new WTP may be reduced, and therefore Ban Ninh Province is affirmative with the project.

At the time of interview, water supply to Lim prefecture and Bac Ninh city, in which the water shortage is severe, was deeply required. In this case, this project can provide sufficient water supply from Duong River to be a substitute to the new WTP.

(3) Hung Yen Province

The EcoPark Housing Estate (occupancy from 2012, total area of 499ha) is currently under development in the Northern part of Hung Yen Province, and this project plans to provide water to EcoPark.

Figure 6.2.1 Positions Relative to Planned Water Treatment Plant

6.3 Demand Forecasts and Project Positioning for Target Areas

By setting out the expected future water demand in each target area (Central and Eastern Ha Noi, Bac Ninh Province, Hung Yen Province), this section describes the relevant project positioning. Demand forecasts are organized on the basis of the water area, population served, water volume and water usage rates for the target areas for 2009, 2015 (est.) and 2020 (est.). Then, based on the forecast data for demand, the future water supply system will be organized and the positioning of this project clarified.

(1) Central and Eastern Ha Noi City

1) Demand Forecasts

The water area, population served and water volume for Central and Eastern Ha Noi are set out below.

Table 6.3.1 Water Area, Population Served, and Water Volume for Ha Noi City

City	Area	Name		Area (km2)			Population (1000s)			Volume (m3/day)		
				2009	2015	2020	2009	2015	2020	2009	2015	2020
Ha Noi City	Central	Total		185.77	185.77	185.77	1,956.8	1,768.5	1,727.8	523,435	536,626	557,291
			Connected	185.77	185.77	185.77	1,819.8	1,768.5	1,727.8	505,628	536,626	557,291
								(to be supplied by Project)⇒			18,000	80,000
			Not connected	0	0	0	137.0	0.0	0.0	17,807	0	0
	East	Total		123.81	123.81	123.81	347.3	426.7	535.4	38,940	116,815	175,833
			Connected	72.30	123.81	123.81	248.3	398.2	502.7	33,000	113,964	171,900
								28.5	32.8		2,851	3,933
			Not connected	51.51	0.00	0.00	99.0	0.0	0.0	5,940	0	0

① Water Area

Central Ha Noi has an area of 186 km2, and this entire area makes up the water supply area. For Eastern Ha Noi, of its 124 km2, 72km2 are connected, and the other 52 km2 are not connected.

For 2015 and 2020, all of Central and Eastern Ha Noi make up the water supply area.

② Population Served

- Changes in Population Served for Central Ha Noi

The population of Central Ha Noi is currently 1.96 million people, and of these, 1.82 million (93%) are connected, and 140,000 (7%) are not connected. Even amongst connected districts there are still unconnected homes which are using well water, and on a population basis, the coverage ratio is 93%.

Central Ha Noi is overcrowded, and this trend is expected to only increase in the future. The government has therefore launched a plan for the planned reduction of the population in this area.

Based on the aforementioned circumstances, the population projections for 2015 and 2020 are less than the population in 2009, at 1.77 million and 1.73 million respectively. Moreover, it is expected that by 2015, water will be supplied for the entire population.

- Changes in Population Served for Eastern Ha Noi

The current population of Eastern Ha Noi City is 350,000, of which 250,000 (71%) are connected, and 100,000 (29%) remain unconnected.

The population of Eastern Ha Noi is expected to increase to 430,000 by 2015 and 540,000 by 2020. The number of these served with water is expected to be 400,000 and 500,000 respectively, with the remainder of the population expected to remain unconnected.

③ Total Water Volume

- Changes in Water Volume for Central Ha Noi

As of 2009, the volume of water supplied to Central Ha Noi was 523,000 m^3/day. Of this, 506,000 m^3/day was supplied by existing water facilities, and the remaining 18,000 m^3/day was supplied from wells (unconnected homes). Water volume is expected to increase to 537,000 m^3/day by 2015 and 557,000 m^3/day by 2020, with unconnected homes using wells expected to disappear.

- Changes in Water Volume for Eastern Ha Noi

  The volume of water supplied to Eastern Ha Noi as of 2009 was 39,000 m^3/day. Of this amount, 33,000 m^3/day was supplied by existing water facilities, and the remaining 6,000 m^3/day from wells. The volume of water will increase to 117,000 m^3/day by 2015, and 176,000 m^3/day by 2020, with the volume supplied by wells at 3,000 m^3/day and 4,000 m^3/day, respectively.

The water supply forecasts for 2015 have not been made in consideration of population growth up to 2020, but with settings for various factors and leakage rates etc. it is believed that support will be possible to a certain degree above the expected population increases.

④ Water Usage Rates

By utilizing a variety of factors concerning the use of water, the usage rate can be calculated as a portion of total water supplied. The table below shows the factors required to estimate water demand for the Long Bien District and Gia Lam Province in Central and Eastern Ha Noi.

Table 6.3.2 Setting Factors Required to Estimate Water Demand

No.	Item		2015	2020
a)	Domestic use	Common	Population x per unit mass	
b)	Public use	Central	-	a) x 18%
		Long Bien District	a) x 15%	a) x 18%
		Gia Lam Province	a) x 10%	a) x 15%
c)	Official use	Common	a) x 10%	
d)	Industrial use	Central	a) x 5%	
		Long Bien District	a) x 5%	
		Gia Lam Province	a) x 7%	
e)	Industrial park	Common	22m^2/ha	
f)	Leakage	Central	-	a)～e) x 30%
		Long Bien District	a)～e) x 25%	a)～e) x 25%
		Gia Lam Province	a)～e) x 22%	a)～e) x 22%
g)	Load	Central	a)～e) x 20%	
		Long Bien District	a)～e) x 20%	
		Gia Lam Province	a)～e) x 30%	

Using these factors, the water demand for public use, office use and industrial use can be calculated on the basis of domestic use, and then with consideration of load and leakage rates, the usage ratio can be calculated as a portion of total water supply (Table 6.3.3). However, since there are no industrial parks located in Central or Eastern Ha Noi, they are not included as part of water demand.

Table 6.3.3 Usage Rate as Proportion of Total Water Supply

2015	Usage rate (Refer domestic use as 100)			Usage ratio		
	Central	Long Bien District	Gia Lam Province	Central	Long Bien District	Gia Lam Province
Domestic use	100.0	100.0	100.0	87.0	61.5	64.5
Public use	0.0	15.0	10.0	0.0	9.2	6.5
Office use	10.0	10.0	10.0	8.7	6.2	6.5
Industrial use	5.0	5.0	7.0	4.3	3.1	4.5
Industrial park				0.0	0.0	0.0
Leakage	0.0	32.5	27.9	0.0	20.0	18.0
Change	23.0	32.5	46.5	-	-	-
Usage rate	138.0	195.0	201.4	100.0	100.0	100.0

2020	Usage rate (Refer domestic use as 100)			Usage ratio		
	Central	Long Bien District	Gia Lam Province	Central	Long Bien District	Gia Lam Province
Domestic use	100.0	100.0	100.0	57.8	60.2	62.1
Public use	18.0	18.0	15.0	10.4	10.8	9.3
Office use	10.0	10.0	10.0	5.8	6.0	6.2
Industrial use	5.0	5.0	7.0	2.9	3.0	4.3
Industrial park				0.0	0.0	0.0
Leakage	39.9	33.3	29.0	23.1	20.0	18.0
Change	34.6	33.3	48.3	-	-	-
Usage rate	207.5	199.5	209.4	100.0	100.0	100.0

Table 6.3.3 shows that in 2015, almost 90% of the water demand in the city center will be for domestic use, while in the East, excluding the approximately 20% of leakage, about 60% (3/4) of the remaining 80% of water volume will be for domestic use. By 2020, domestic use is expected to account for about 60% of water demand in the entire region.

2) Project Positioning

Based on the above discussion, this section organizes the water supply system for Ha Noi City, and develops the positioning and summary of this project.

① .Ha Noi City Water supply System and Project Positioning

Figure 6.3.1 demonstrates the water supply system for Central and Eastern Ha Noi.

For Central Ha Noi, of the 523,000 m^3 supplied as of 2009, 506,000 is supplied by HAWACO, and the remaining 18,000 m^3 comes from the use of wells, etc.

By 2015, of the 537,000 m^3 supplied by HAWACO, the amount received/distributed by this project is expected to be 18,000 m^3. By 2020, the amount received/distributed by this project is expected to comprise 80,000 m^3, of the 557,000 m^3 supplied by HAWACO.

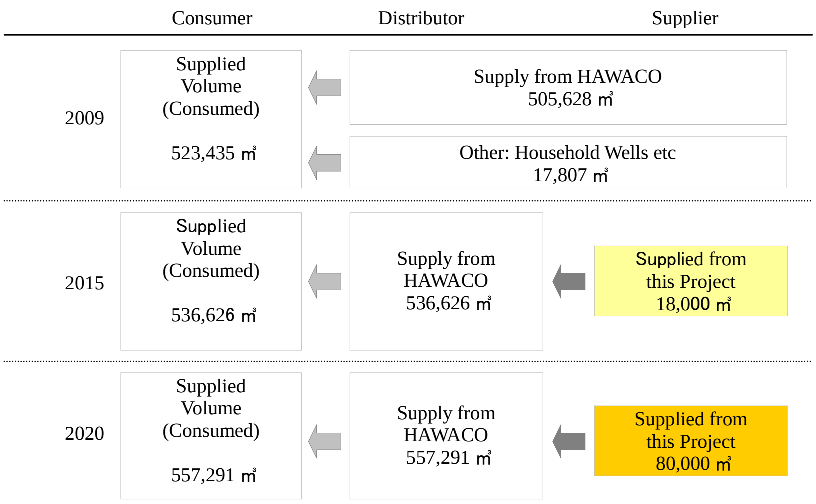


Figure 6.3.1 Central Ha Noi Water supply System

Figure 6.3.2 sets out the water supply system for Central Ha Noi. Of the 39,000 m^3 of water supplied as of 2009, 33,000 m^3 was supplied by HAWACO, with the remaining 6,000 m^3 coming from the use of wells, etc. By 2015, all of the 114,000 m^3 of water supplied by HAWACO will be received/distributed under this project. Similarly, all of the 172,000 m^3 of water supplied by 2020 by HAWACO is planned to be received/distributed under this project.

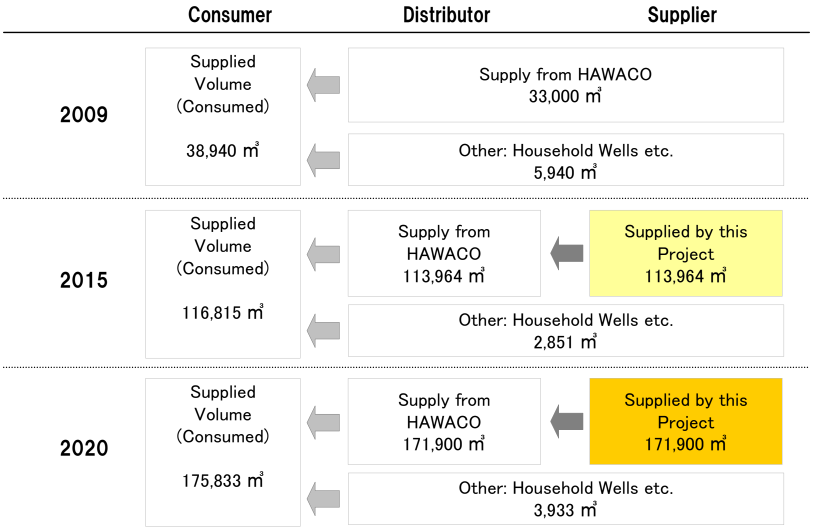


Figure 6.3.2 Eastern Ha Noi Water Supply System

② Project Summary

➢ Central Ha Noi

This project plans to construct a water pipeline from the Duong River water treatment plant, through the Hung Yen EcoPark Housing Estate, to the Phap Van water treatment plant situated in central Ha Noi. The water treatment function of the existing Phap Van treatment plant has been in decline, and the water has become polluted. Therefore, once the Duong River water treatment facility and water pipeline have been constructed, the Phap Van water treatment plant will stop its treatment function and will be used as a pumping station to supply water.

The three water treatment plants in Central Ha Noi are to be phased out during the first and second stages of the project due to deteriorated water quality, and as their replacement, a large-scale water treatment plant is planned for construction.

- Eastern Ha Noi

  For Eastern Ha Noi, water receiving points plan to be established around the existing Gia Lam water treatment plant, so as to supply water from the Duong River water treatment plant not only to the area currently supplied by the Gia Lam plant, but also to the South East (Figure 6.3.3). Moreover, the groundwater drainage used by the Gia Lam water treatment plant will be drained into the Dong Anh Province in the North of the city via a newly constructed arterial drainage pipeline following Highway 5 (Figure 6.3.3). Thus, pipelines will distribute water to areas in the South East and North of the city that had been using well water for their domestic water.

  Currently, the Gia Lam water treatment plant supplies 30,000 m^3, but together with the South East drainage plans, work is planned to be carried out to extend this supply capacity to 60,000 m^3. Until the Duong River water treatment plant is completed, supply will be gradually extended into the South East regions, as water continues to be supplied into existing areas.

  For areas in the East and South East that currently have no water supply, large-scale development is planned in parallel with the expansion of existing water supplies, but where this is not carried out they are expected to continue using well water.

  Upon completion of the Duong River water treatment plant, it will gradually take over from the existing infrastructure, and expand water supply into the South East.

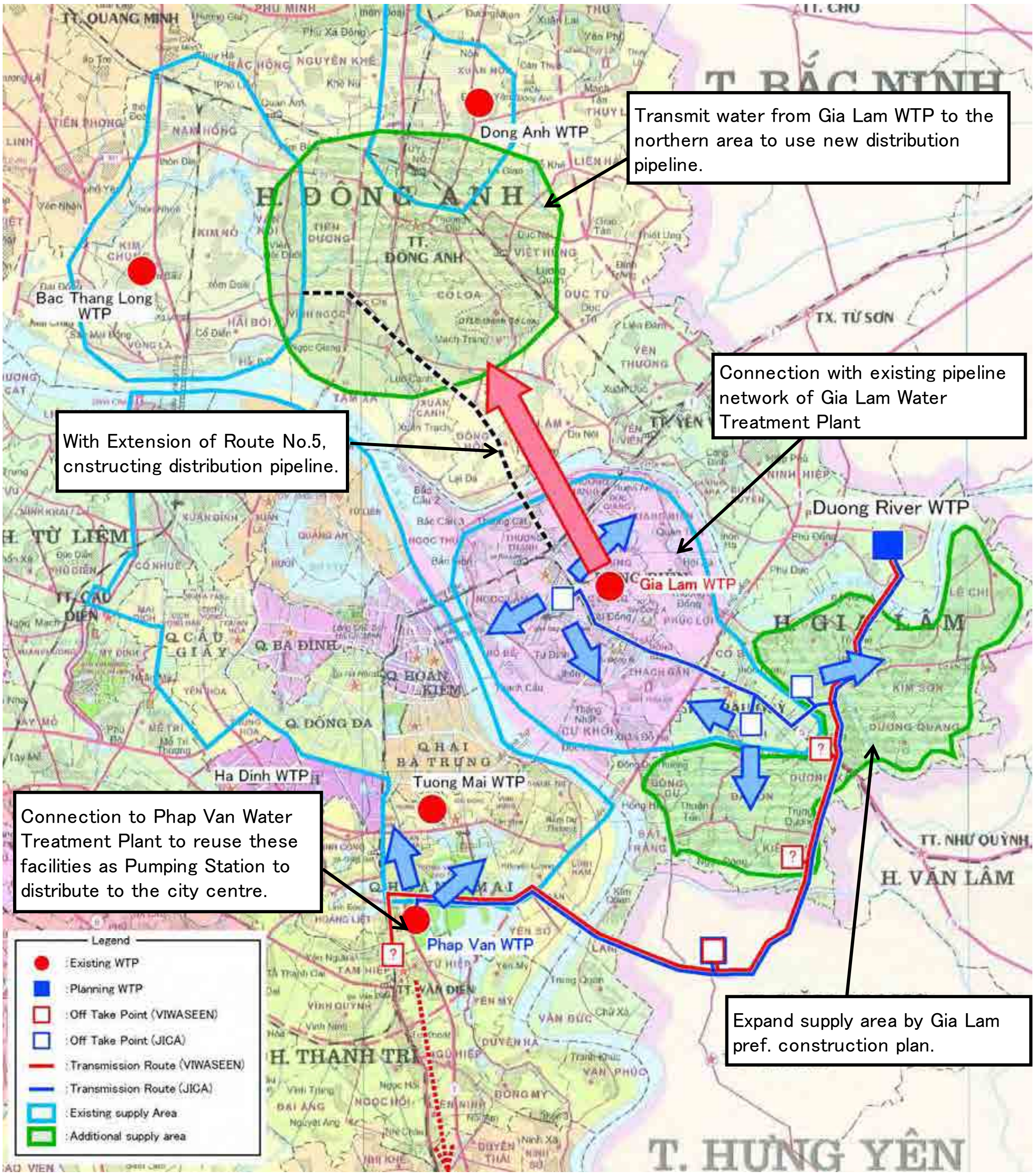


Figure 6.3.3 Summary of Existing Water Supply and This Project

(2) Bac Ninh Province

1) Demand Forecasts

Given below is the water area, population served and water volume for Bac Ninh Province. Water projects are implemented in Bac Ninh Province by the Water Authority, and there are no details available regarding the range and population supplied. The volume of water is as requested from the Bac Ninh Water Authority, and this project will supply purified water from the Duong River water treatment plant to the Bac Ninh Province Water Authority, who will then distribute the water according to demand. Water volume will be increased to 10,000 m^3/day by 2015, and to 30,000 m^3/day by 2020 (Figure 6.3.5).

Table 6.3.4 Bac Ninh Province Water Area, Population Served and Water Volume

City	Area	Name	2009	2015	2020	2009	2015	2020	2009	2015	2020
Bac Ninh	East	Total	−	−	−	−	−	−	−	10,000	30,000
		Connected	−	−	−	−	−	−	−	10,000	30,000

With regard to Bac Ninh Province, water is supplied from water receiving points established in Tien Son Province, and this water supply is assumed to be used for domestic purposes.

2) Project Positioning

This project will establish a water receiving point for water from the Duong River water treatment plant in the South West of Bac Ninh Province (Tien Son Province), which will receive water from the new water treatment plant planned for construction. Bac Ninh Province shall be responsible for all maintenance and operations of pipes required for distribution of the water, and through this project water is expected to be supplied to Central Bac Ninh Province, Yen Phong Province, and Tu Son Province (the exact range is unknown).

Through the development of distribution pipelines by the Water Authority, households that are not currently connected to water supplies will be able to take advantage of the new water system. It is also assumed that through the water supply of this project, water will be supplemented in areas where water supply becomes insufficient due to population growth.

	Consumer		Distributor		Supplier
2009	Supplied Volume (Consumed) X(2009)m³	⇐	Supplied by Bac Ninh Province X(2009)m³		
2015	Supplied Volume (Consumed) X(2015)m³	⇐	Supplied by Bac Ninh X(2015)m³	⇐	Supplied by this Project 10,000 m³
2020	Supplied Volume (Consumed) X(2020)m³	⇐	Supplied by Bac Ninh Province X(2020)m³	⇐	Supplied by this Project 30,000 m³

Figure 6.3.4 Bac Ninh Province Water Supply System

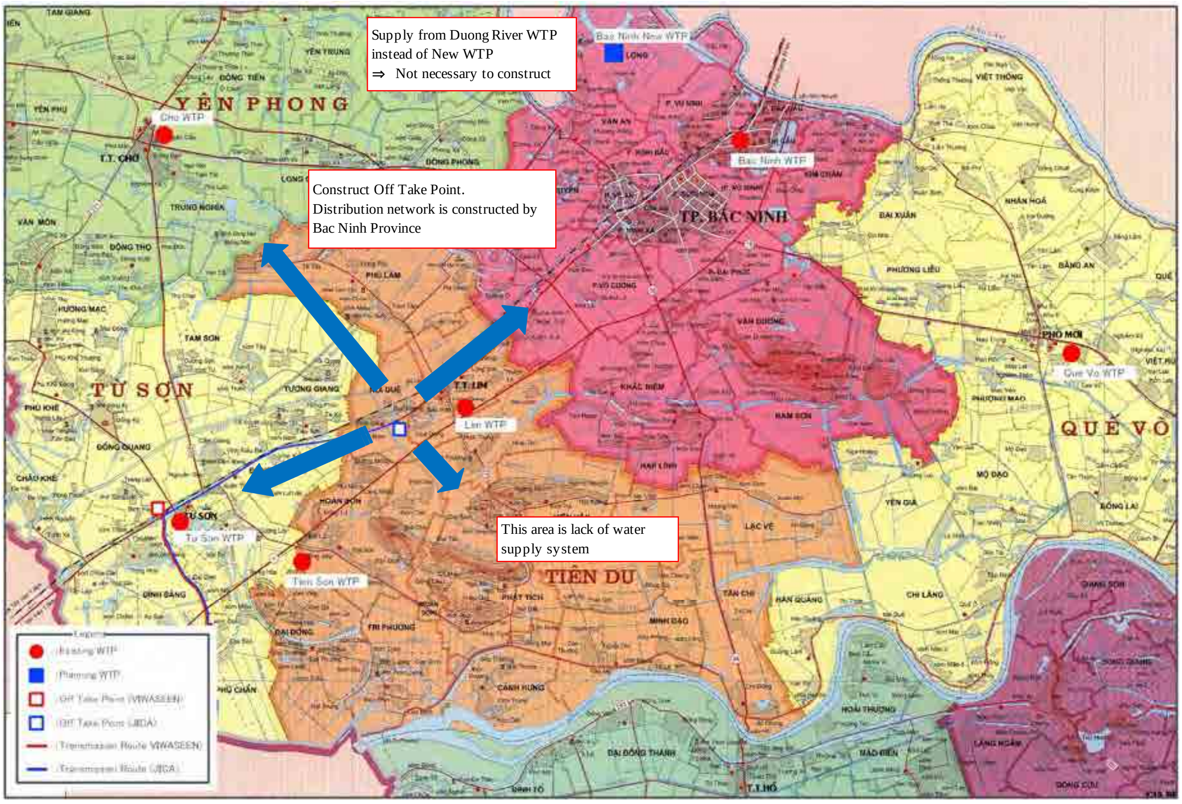


Figure 6.3.5 Existing Water Supply for Bac Ninh Province and Summary of This Project

(3) Hung Yen Province

1) Demand Forecasts

Given below is the water area, population served, water volume and usage rates for Hung Yen Province.

Table 6.3.5 Water Area, Population Served and Water Volume for Hung Yen Province

City	Area	Name									
			2009	2015	2020	2009	2015	2020	2009	2015	2020
Hung Yen	East	Total	0.54	1.25	2.50	0.0	34.0	68.0	0	18,383	30,214
		Connected	0.54	1.25	2.50	0.0	34.0	68.0	0	18,383	30,214

The Hung Yen Province water supply project is managed by the Housing Estate (Eco Park) Management Company. Thus, the management company will serve as a wholesaler for the purified water supplied by this project through the Duong River water treatment plant, with the management company (or contractor) then being responsible for the water supply. The water area will increase from 0.54 ㎢ to 1.25 ㎢ and then ultimately to 2.50 ㎢, along with increases in the population served from 34,000 to 68,000. The water volume will increase from 18,000 m^3/day to 30,000 m^3/day.

For Hung Yen Province, water will be supplied to the Housing Estate and the commercial establishments within the Estate. Therefore, while most of the water will be for domestic use, a portion is also expected to be used for business purposes.

2) Project Positioning

By installing water pipes and receiving points in Hung Yen Province under this project, water will be supplied to the EcoPark Housing Estate (currently under construction) in Van Giang Province in the North Western part of Hung Yen Province. The management company of the EcoPark Housing Estate will be responsible for the distribution of water within the Estate.

	Consumer	Distributor	Supplier
2009	None	None	
2015	Sup. Vol. (Consumed) 18,383 m³	Sup. by EcoPark Mgmnt Co. 18,383 m³	Supplied by this Project 18,383 m³
2020	Sup. Vol. (Consumed) 30,241 m³	Sup. by EcoPark Mgmnt Co. 30,241 m³	Supplied by this Project 30,241 m³

Figure 6.3.6 Hung Yen Province Water Supply System

Eco Park is currently under construction, and it is scheduled for occupancy from 2012. Its total area is 499 ha. For the period until this project begins supplying water to the Estate in 2015 (i.e., from 2012-2015), a large-scale water treatment plant will be established inside the Estate, drawing groundwater for its water supply.

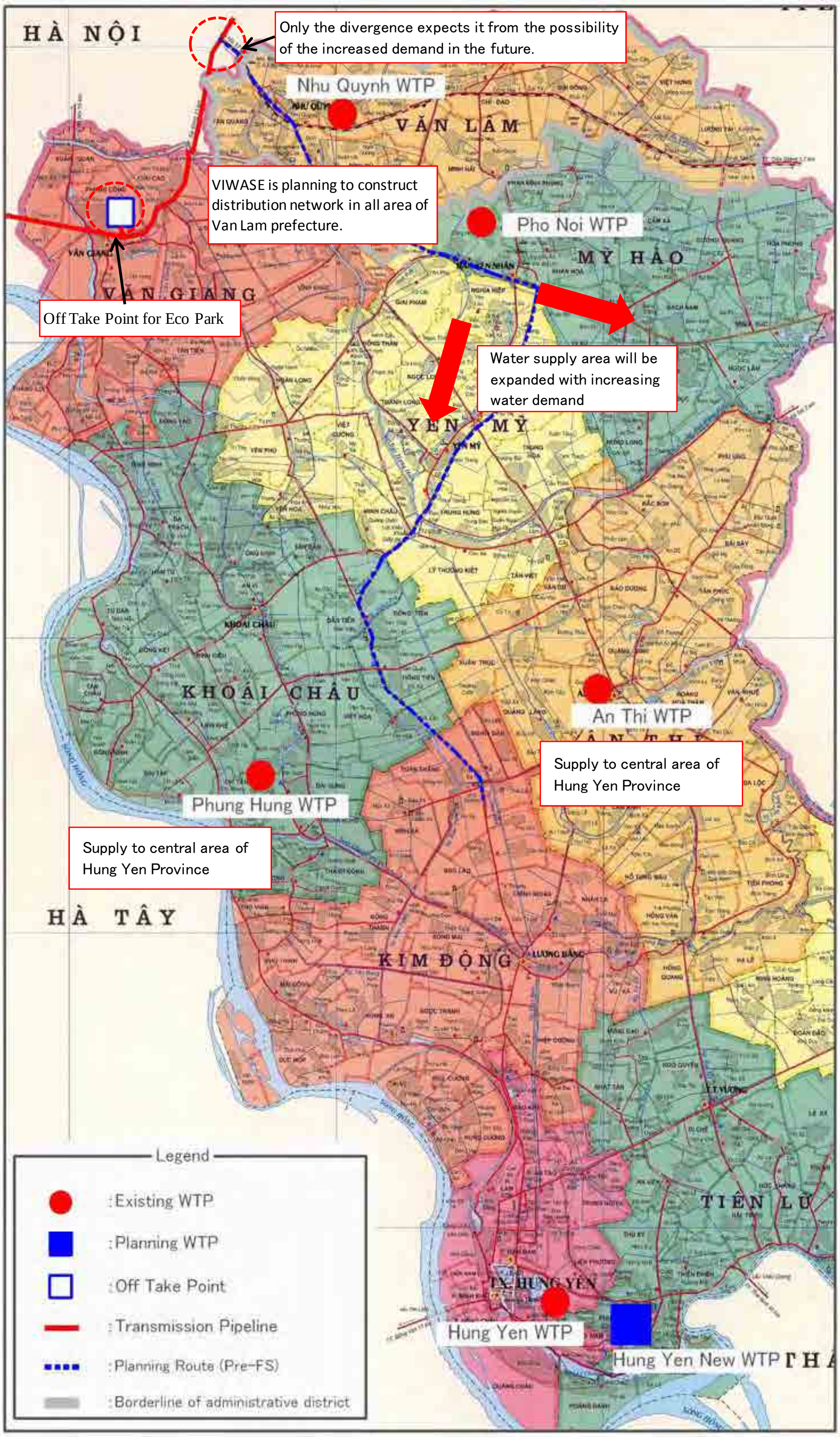


Figure 6.3.7 Current Water Utilities and Project Summary for Hung Yen Province

6.4 Extraction and Quantification of Economic Costs

Economic analysis has been carried out in accordance with the principles of the “Handbook for the Economic Analysis of Water supply Project, 1999 ADB” (hereafter referred to as the “ADB Handbook”).

This section sets out the expected project and maintenance costs for this project, and also examines the economic value of these various costs based on the ADB Handbook.

(1) Estimated Project Costs

Construction cost and maintenance costs for the project are estimated as below.

1) Construction Costs

Table 6.4.1 Construction Costs

	Phase1	Phase2	Total
Construction Costs(100 Mill JPY)	165	57	222

(Using Exchange rate of 2011)

2) Maintenance Costs

Table 6.4.2 Stage 1 Maintenance Costs

	Phase1			Phase2		
	fixed cost		variable cost	fixed cost		variable cost
	1000yen	1000VND	1000VND	1000yen	1000VND	1000VND
2015	239,161	19,830,330	63,079,110	0	0	0
2016	160,360	18,955,253	63,832,326	0	0	0
2017	156,223	18,953,914	63,832,326	0	0	0
2018	133,122	18,833,453	63,832,326	0	0	0
2019	220,900	18,852,739	63,832,326	0	0	0
2020	130,649	19,463,469	63,083,672	59,209	2,080,113	60,936,550
2021	267,052	19,342,730	63,083,672	39,400	2,046,042	60,936,550
2022	76,760	19,341,669	63,083,672	44,200	2,080,113	60,936,550
2023	131,531	19,341,530	63,083,672	65,800	2,046,042	60,936,550
2024	193,723	19,341,669	63,083,672	121,000	2,080,113	60,936,550
2025	65,998	19,341,530	63,083,672	34,600	2,046,042	60,936,550
2026	99,386	19,341,669	63,083,672	39,400	2,080,113	60,936,550
2027	74,961	19,341,530	63,083,672	44,200	2,046,042	60,936,550
2028	272,421	19,341,669	63,083,672	65,800	2,080,113	60,936,550
2029	394,353	19,341,530	63,083,672	121,000	2,046,042	60,936,550
2030	59,972	19,341,669	63,083,672	34,600	2,080,113	60,936,550
2031	73,398	19,341,530	63,083,672	39,400	2,046,042	60,936,550
2032	114,967	19,341,669	63,083,672	44,200	2,080,113	60,936,550
2033	108,812	19,341,530	63,083,672	65,800	2,046,042	60,936,550
2034	195,610	19,341,669	63,083,672	121,000	2,080,113	60,936,550
2035	217,276	19,341,530	63,083,672	34,600	2,046,042	60,936,550
2036	87,372	19,341,669	63,083,672	39,400	2,080,113	60,936,550
2037	105,521	19,341,530	63,083,672	44,200	2,046,042	60,936,550
2038	161,107	19,341,669	63,083,672	65,800	2,080,113	60,936,550
2039	213,411	19,341,530	63,083,672	121,000	2,046,042	60,936,550

With regard to exchange rates, for conversions from Yen to VND, the average prevailing exchange rates※1 for the period of May 22 to May 28, 2011 has been used.

JPY→VND	256.41	VND

*1: See the Foreign Exchange Rate related pages at the Ministry of Finance Trade Statistics website (http://www.customs.go.jo/toukei/info/index.htm)

(2) Economy Priced Project Costs

The economic analysis of the project captures the social value of the project costs and benefits, and evaluates the project's profitability. In doing this, due to the effects of systems and potential market mechanism inadequacies in relation to market prices in the target country, prices may not be legitimate, requiring the analysis to use a calculation of what the prices should be. For this purpose, the ADB Handbook sets out conversion factors for foreign currency, electricity costs and labor costs, in an attempt to set the economic price of project costs for financial analysis.

1) Conversion Rate Setting

① SERF: Shadow Exchange Rate Factor

Because the trade market includes inappropriate tariffs and export subsidies, as well as import quotas to protect domestic production, the Shadow Exchange Rate (SER) was developed. The SERF represents the ratio between the Official Exchange Rate (OER) and the SER when calculating international trade prices in local currency equivalents (SERF=SER/OER)

Here, based on the materials and reports published on ADB/JICA/JBIC websites, information has been gathered for the economic analysis of this domestic Vietnamese project, so that SERF values can be set. This was based on the criteria below.

Country of Analysis	Viet Nam
Year of Analysis	From Fiscal 2008
Target Areas for Analysis	Power/Energy, Water Resource Development/Public Health, Poverty Reduction

The results are listed below. The figures for each report have been determined based on the detailed methods and guidelines for SERF calculation in the "Guidelines for the Economic Analysis of Projects (ADB, 1997)".

Note that since the SERF has an inverse relationship with the Standard Conversion Factor (SCF) for the calculation of conversions of domestic prices to international prices, based on the SERF and SCF values for the following cases, in this study we have used the average SERF value of 1.08.

Table 6.4.3 Example of SERF and SCF Values

projects	SERF(shadow exchange rate factor)	SCF(standard conversion factor)	Field	Announced
Socialist Republic of Viet Nam: Song Bung 4 Hydropower Project Phase II-documents produced under TA	1.1		Electricity	2008.5
Second Northern Greater Mekong Subregion Transport Network Improvement Project: RRP Linked Documents		0.9	Transport	Unknown, Related Docs from Feb/Nov 2010 etc.
Greater Mekong Subregion Ben Luc-Long Thanh Expressway Project: RRP Linked Documents	1.04		Highways	Unknown, Related Docs from Feb 2010
Second provincial towns water supply and sanitation project		0.96	Water	2008.12
Strengthening water management and irrigation systems rehabilitation project		0.9	Water	2010.3

② SWRF: Shadow Wage Exchange Rate

Sometimes in the labor market there is a minimum wage system, which exceeds the true opportunity cost of labor. In such cases, it may be necessary to view the value produced by unskilled workers at some discounted rate compared to the actual amount of wages paid.

In the case of this project, given that labor costs have not been classified as a portion of construction costs, and given also that workers involved in maintenance are expected to be skilled workers, the SWRF has been set at 1.0.

③ Power Cost Conversion Rate

According to the ADB Handbook, with an understanding of the breakdown of the production costs involved in the use of electricity in the project (operating costs such as capital, labor etc.), as well as consideration of the SERF and SWRF, it is recommended that the market price of power costs is converted to its economic value.

However, since we are unable to estimate the electricity production cost, the conversion of electricity costs is not given further consideration.

2) Converting Project Costs to Economic Costs

Table 6.4.4 and 6.4.5 demonstrate the project costs as economic prices, based on the above conversion rates.

Table 6.4.4 Economic Price of Construction Costs

	Total
	100 Mill VND
Phase1	40,425
Phase2	13,965

Table 6.4.5 Economic Price of Stage 1 Project Costs (Million VND)

	Phase1				Phase2			
	Total	fixed cost		variable cost	**Total**	fixed cost		variable cost
		yen basis	VND basis	VND basis		yen basis	VND basis	VND basis
2015	**149,139**	66,229	19,830	63,079	**0**	0	0	0
2016	**127,195**	44,407	18,955	63,832	**0**	0	0	0
2017	**126,048**	43,262	18,954	63,832	**0**	0	0	0
2018	**119,530**	36,864	18,833	63,832	**0**	0	0	0
2019	**143,857**	61,172	18,853	63,832	**0**	0	0	0
2020	**118,727**	36,180	19,463	63,084	**79,413**	16,396	2,080	60,937
2021	**156,379**	73,953	19,343	63,084	**73,893**	10,911	2,046	60,937
2022	**103,682**	21,257	19,342	63,084	**75,257**	12,240	2,080	60,937
2023	**118,849**	36,424	19,342	63,084	**81,204**	18,222	2,046	60,937
2024	**136,072**	53,646	19,342	63,084	**96,524**	33,508	2,080	60,937
2025	**100,702**	18,276	19,342	63,084	**72,564**	9,582	2,046	60,937
2026	**109,948**	27,522	19,342	63,084	**73,927**	10,911	2,080	60,937
2027	**103,184**	20,758	19,342	63,084	**75,223**	12,240	2,046	60,937
2028	**157,865**	75,440	19,342	63,084	**81,238**	18,222	2,080	60,937
2029	**191,630**	109,205	19,342	63,084	**96,490**	33,508	2,046	60,937
2030	**99,033**	16,608	19,342	63,084	**72,598**	9,582	2,080	60,937
2031	**102,751**	20,326	19,342	63,084	**73,893**	10,911	2,046	60,937
2032	**114,262**	31,837	19,342	63,084	**75,257**	12,240	2,080	60,937
2033	**112,558**	30,133	19,342	63,084	**81,204**	18,222	2,046	60,937
2034	**136,594**	54,169	19,342	63,084	**96,524**	33,508	2,080	60,937
2035	**142,594**	60,169	19,342	63,084	**72,564**	9,582	2,046	60,937
2036	**106,621**	24,195	19,342	63,084	**73,927**	10,911	2,080	60,937
2037	**111,646**	29,221	19,342	63,084	**75,223**	12,240	2,046	60,937
2038	**127,040**	44,614	19,342	63,084	**81,238**	18,222	2,080	60,937
2039	**141,524**	59,098	19,342	63,084	**96,490**	33,508	2,046	60,937

6.5 Extraction and Quantification of Economic Benefits

This section organizes the economic benefits of the first stage of this project, up to 2015.

Based on the fundamental principles of the ADB Handbook, these economic benefits have also been quantified, in accordance with, the conditions set for this project.

(1) Expected Benefits for Each Water Supply Zone

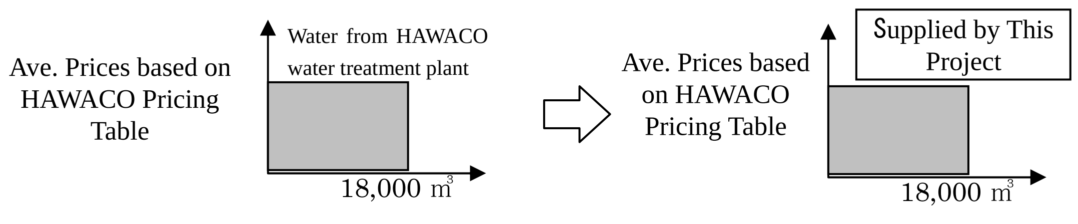
In this section, the benefits expected from the supply of water to each area has been examined.

1) Benefits for Central Ha Noi City

For Central Ha Noi, along with deliberate policies to reduce the population, the plan is to not only supply water through this project, but also to invest in the renewal of water treatment plants held by other operators, and to ensure sufficient clean water to meet demand.

It is not possible to identify the beneficiaries of this project, since the project will share a portion of the already established water supply pipeline network. However, it is possible to say that for users that are connected to water supplies as of 2009, the switch in supply of 18,000 m^3 from current water treatment plant operators to this project will benefit users with better quality water.

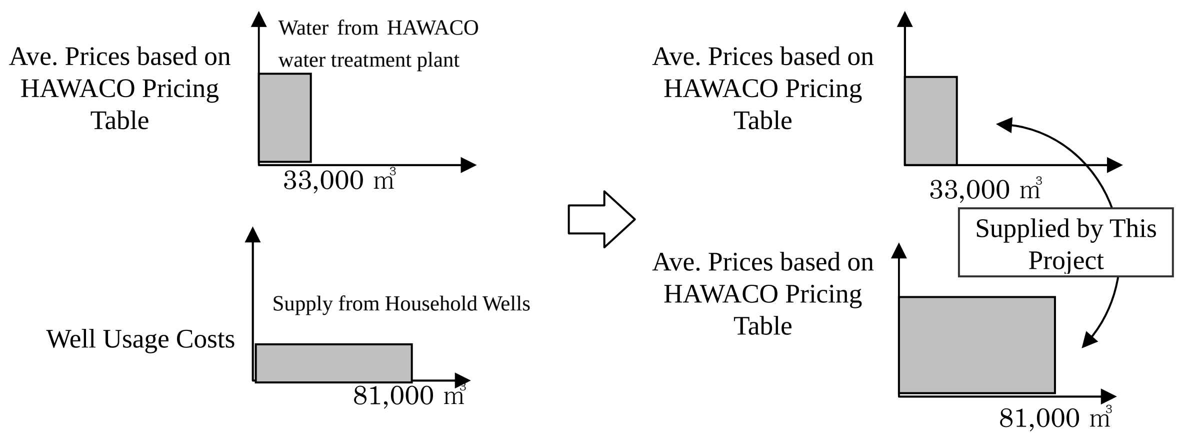
In this case, since there will be no change in circumstances for consumers that are already using HAWACO water services, water charges will be determined on the basis of their pricing table, irrespective of the actual source of the water.



2) Benefits for Eastern Ha Noi City

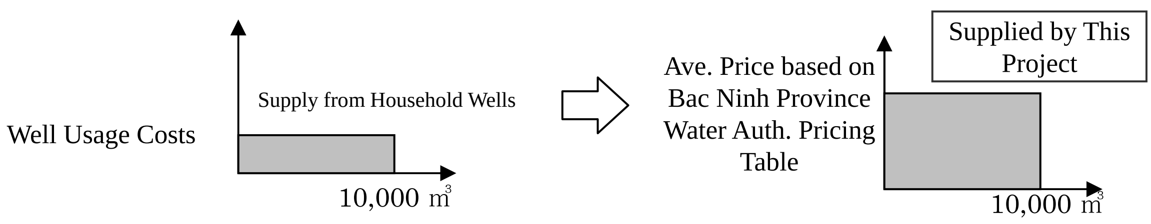
For Eastern Ha Noi, as of 2015 the source of all water will switch to this project.

As such, it is possible to classify the benefits into those for users that are receiving the 33,000 m^3 of water supplied as of 2009, for whom switching to this project as the source of their water will result in the benefit of better water quality, and those that will have the benefit of increased water quality as a result of switching from household wells, as the water supply increases to 81,000 m^3 to meet demand by 2015.



3) Benefits for Bac Ninh Province

For Bac Ninh Province, this project will supply about 10,000 m^3 of water, providing benefit by increasing the number of water supply users.



4) Benefits for Hung Yen Province

Eco Park in Hung Yen Province is currently under development, and therefore water is currently not being supplied. As this development progresses, this project will be implemented, providing residents of EcoPark the benefit of receiving water without having to rely on household wells.

(2) Quantification of Economic Benefits

1) Basic Principles from ADB Handbook

According to the ADB Handbook, for areas that meet their water demand through public wells, the implementation of this project would typically provide the benefits of reduced water usage costs (A in the figure below), and the benefit of increased demand induced by the reduction in costs (B in the figure below).

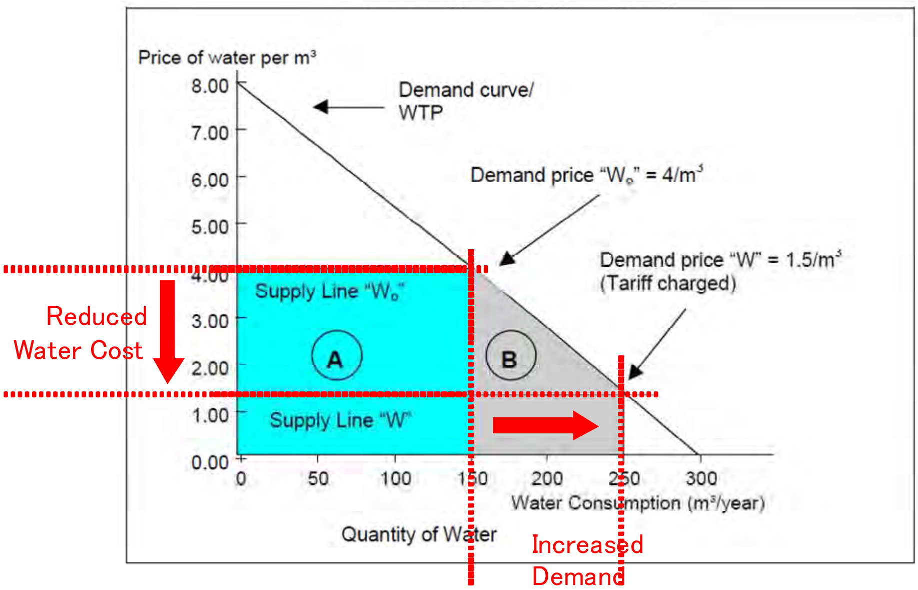


Figure 6.5.1 Benefits of Water Project (A+B)

In the former case, by stipulating that the traditional cost of using water (4/ m^3) exists as one's Willingness to Pay (WTP), the difference between this and the actual price paid (1.5/ m^3) can be considered as a benefit.

At the same time, in the latter case, given that at a cost of 4/ m^3 the potential user had given up use, the WTP can be assumed to be somewhere between 1.5/ m^3 and 4/ m^3, with the difference between this and the actual price paid (1.5 m^3 m^3) considered as the benefit.

2) Comparisons with this Project

① Changes in Water Costs through Implementation of this Project

Viet Nam is a country with a policy for setting low water prices, making it difficult for water providers to recover the costs of operating from water rates. In a prior study ("2008 Report on the Promotion of Contributions to International Water Supplies", Labor & Welfare Ministry), it was reported that the average cost of water services in Ha Noi was around 3,500 m^3 VND/, which is equivalent to approximately 3/4 of the cost of providing that water. Thus, for current water users, even if their water source is switched to this project, water charges are maintained around the current low cost level, resulting in no change to the cost of using water.

Moreover, since homes that are not connected to water supplies use household wells that do not require time to fetch the water, the cost of their water use is assumed to be less than water rates. However, as water quality continues to deteriorate around Ha Noi City as observed through the presence of arsenic in well water, it is expected that people will switch to the supplied water in order to ensure safe water.

Thus, since both water users and non-connected households prior to the implementation of this project are unlikely to see a reduction in water usage costs following implementation, it is not possible to set the WTP based on the cost of usage prior to implementation, as shown in the ADB Handbook.

② Changes in Demand through Implementation of this Project

In Ha Noi City and its surrounding, as demand for water is expected to increase owing to increased populations, and as the implementation of this project will not lead to reductions in water usage costs (as described above), there will be no cause for induced water demand.

3) Quantification in this Study

For water services in Viet Nam, current water usage costs (water rates and the cost of household wells) are lower than the operating costs of this project, which means that for this project, the benefit will be the non-cost factor of water quality. Thus, the value of the clean water provided through this project cannot be measured on the basis of water usage costs.

As such, with regard to the WTP for the high quality water supplied by this project, the benefit can be calculated as a representation of the cost to procure such water.

Note that this WTP represents the value of the higher quality water, which is considered to have a common value for both current users of the water system and current household well users.

(3) Setting Conditions for Quantifiable Benefits

1) Setting Maximum Amount of Payment

The supplied water is not only for domestic use, but may also be used for public, commercial or industrial purposes, etc. However, the scope of this project is to supply water to water suppliers, and since it is not possible to specify how the consumer will use the water, for the purposes of this study, it is assumed that all of the water supplied will be for domestic use.

The quality of the water supplied by this project is expected to be of a similar quality as water sold in plastic bottles. Thus, it can be expected that there will be consumers that have the same WTP for the water that will be supplied as they do for water that they purchase. Therefore, the maximum WTP is be set at 2 million VND/m^3, based on the general price of a 5 gallon bottle of water (at 2,000VND/L).

2) Setting Minimum Amount of Payment

This project will supply water through current water suppliers, and it can be assumed that consumers will at least be willing to pay the average unit prices that they currently pay to service providers.

According to "2008 Report on the Promotion of Contributions to International Water Supplies (Labor & Welfare Ministry)", average unit price of water in Ha Noi is about 3,500 VND/ m^3, and according to HAWACO revenue data, their average price was 3,441 VND/ m^3 in 2008, and 3,500 VND/m^3 as of 2009. However, HAWACO are set to revise water charges in January 2010, and based on the average revision rate, the average price from 2010 will be set at 4,500 VND/ m^3 (@3,500x129%=4,415) (Table 6.5.1).

Table 6.5.1 Revision Rate for Water Charges

	Water Charges (2005-09)	Water Charges (2010-)	Revision Rate
To 16 ㎥/month	2,800	4,000	143%
16～20 ㎥/month	3,500	4,700	134%
20～35 ㎥/month	5,000	5,700	114%
From 35 ㎥/month	7,500	9,400	125%
Ave. Revision Rate			129%
Ave. Unit Price	3,500	4,500	-

3) Proportion of Consumers Willing to Pay Maximum Amount

Given below is the ratio of sources for drinking water and domestic use water according to the Living Standards Survey Report (Viet Nam Office of Statistics, 2008). The proportions of water purchased are 1.0% and 0.2%, representing a significantly low level compared to other sources. Thus, the proportion of consumers that have a maximum amount WTP will be close to zero, creating a demand curve where the average price will decrease across the board.

Table 6.5.2 Ratio of Sources for Drinking Water and Domestic Water
(Central Viet Nam, 2008)

		Drinking Water	Domestic Use
Water supply	Private Taps	60.7	55.4
	Public Taps	5.4	5.1
Purchased Water		1.0	0.2
Pumped Wells		16.4	23.5
Wells		9.1	11.7
Other		7.5	4.1

Source: Living Standards Survey Report (Viet Nam Office of Statistics, 2008)

4) Quantification of Economic Benefits

From the above settings, the economic benefits of the water supply can be described by the trapezoid area shown in Figure 6.5.2 below.

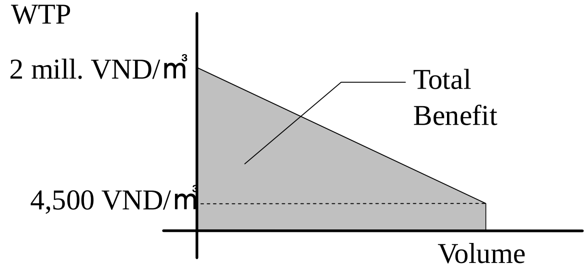


Figure 6.5.2 Assumed Total User Benefit

(4) Quantification of Economic Benefits

Based on the above conditions, with a leakage rate of 20% between the water receiving point and the distribution to consumers, the economic benefit for the term of the project (Development Period: 2012-2014; Operating Period: 25 years, from 2015-2039) can be quantified.

Note that the causes of benefit will differ based on the water supply area and conditions and whether or not households are currently connected to the water supply, but since the WTP is considered as the same for all consumers, the benefit obtained can be quantified in relation to the overall availability of the water supply.

Table 6.5.3 Quantification of Economic Benefits

	Planned Water Volume	Leakage	Avail. Water supply		Benefit
	（1,000m^3/day）	（1,000 m^3/day）	（1,000 m^3/day）	（1 mill. m^3/yr）	（100 Mill. VND/yr）
	a	b=a×20%	c=a-b	d=c×365÷1000	e
2012-14	0	0	0	0	0
2015-39	150	30	120	43.8	438,986

6.6 Economic Cost-Benefit Analysis

From the difference between the economic costs and benefits calculated as mentioned, the project's Net Present Value (NPV) can be calculated.

For guidance on setting social discount rates when calculating the NPV, the "Guidelines for the Economic Analysis of Projects (ADB, 1997)" is used as reference. These guidelines suggest that in principle a social discount rate of 12% is used when making ADB-based project evaluations.

Incidentally, for project evaluations prepared by ADB over the past 3 years, they have followed the above guidelines, and have used the social discount rate of 12% in their reports. Thus, this report also performs the analysis with a social discount rate of 12%.

As demonstrated in the Table below, the calculated NPV comes to 241 trillion VND (about 940billion yen).

Moreover, the Economic Internal Rate of Return (EIRR), which represents profitability based on the social costs and benefits, comes out at 222%. This implies that this project has sufficient social benefits.

Table 6.6.1 Calculation of Net Present Value and Economic Internal Rate of Return

	Benefit(B)	Annual Expenditure(C)	Annual Net Benefit（B-C）
	100 Mill. VND/yr	100 Mill. VND/yr	100 Mill. VND/yr
2012		13,475	-13,475
2013		13,475	-13,475
2014		13,475	-13,475
2015	438,986	1,491	437,494
2016	438,986	1,272	437,714
2017	438,986	1,260	437,725
2018	438,986	1,195	437,790
2019	438,986	1,439	437,547
2020	438,986	1,187	437,798
2021	438,986	1,564	437,422
2022	438,986	1,037	437,949
2023	438,986	1,188	437,797
2024	438,986	1,361	437,625
2025	438,986	1,007	437,978
2026	438,986	1,099	437,886
2027	438,986	1,032	437,954
2028	438,986	1,579	437,407
2029	438,986	1,916	437,069
2030	438,986	990	437,995
2031	438,986	1,028	437,958
2032	438,986	1,143	437,843
2033	438,986	1,126	437,860
2034	438,986	1,366	437,620
2035	438,986	1,426	437,560
2036	438,986	1,066	437,919
2037	438,986	1,116	437,869
2038	438,986	1,270	437,715
2039	438,986	1,415	437,570
Social Discount Rate	12%		
Net Present Value (NPV)	241 Trill VND（9,403 Bill yen）		
Economic Internal Rate of Return (EIRR)	222%		

6.7 Potential Variability in Economic Benefits

Based on the cost-benefit analysis conducted in 6.6, it was confirmed that there are sufficient social benefits of this project. However, given that some bold assumptions have been used in the setting of the WTP for analysis purposes, there is some room for the economic benefits to change.

Here, the focus is on the EIRR value, and the maximum level for the WTP to ensure a specified level of profitability is calculated, making sure to clear the 12% level that is applied to ADB investment projects as the social discount rate, and the project's NPV is also calculated under these conditions.

Table 6.7.1 Maximum WTP Corresponding to EIRR (Economic IRR), and Project NPV

	EIRR	Maximum WTP			Project NPV			
Base Case	222%	2,000,000	VND/m^3	(100.0%)	241	Trill. VND	9,403	100 Mill. Yen
Case 1	15%	34,500	VND/ m^3	(1.7%)	8,130	100 Mill. VND	32	100 Mill. Yen
Case 2	14%	32,500	VND/ m^3	(1.6%)	5,685	100 Mill. VND	22	100 Mill. Yen
Case 3	13%	30,000	VND/ m^3	(1.5%)	2,629	100 Mill. VND	10	100 Mill. Yen
Case 4	12%	28,000	VND/ m^3	(1.4%)	183	100 Mill. VND	7,153	10,000 Yen

These results show that in relation to the base case from the price of purchased water, when the WTP set at the 1.4% level (Case 4) the EIRR clears 12%, and with the slight changes of the WTP in level from 1.5% to 1.7% (Cases 1-3) a certain amount of NPV can still be expected.

Therefore, even if the economic benefits are reduced through the WTP setting, from the perspective of profitability for the risk takers that are contributing to this project, it can be considered reasonable to expect a positive NPV for the project at a level of 14%-15% of EIRR.

7. Financial Analysis

In this chapter, Study Team shall consider the feasibility of the project from the standpoint of investor and select the project scope, financial terms, and payment conditions with the water purveyor to facilitate the project.

7.1 Case Study and Results

7.1.1 Case Description

(1) Phased Development

This project shall be developed in two stages ultimately aiming to build water treatment plants and related facilities which can purify 300 thousand m3 of water per day. At the first phase of this project, it is planned to build, operate and maintain a water treatment plant with the capacity of 150 thousand m3 of water per day and common facilities with the capacity of 300 thousand m3 of water per day.

(2) Case Study

Depending on the scope of work and assets, “water treatment plant” and “water conveyance system”, which SPC undertakes and owns, following 2 cases are analyzed. Note that “water treatment plant” includes water intake and raw water transmission facilities and “water conveyance system” includes booster pump and transmission pipe.

Other infrastructure which supports water provision such as water distributing pipes shall be developed by Ha Noi City.

SPC shall maintain and operate the water treatment plant and water conveyance system in both cases and all tariff revenues are assumed to be income stream for SPC under both cases.

Table 7.1.1 SPC

Case	Estimated Scenario	
	Build and Own of Water treatment plant	Build and Own of Water Conveyance system
1	SPC	SPC
2	SPC	Ha Noi City (or MOC)

Construction of water conveyance system shall be financed by Ha Noi City under case 2. However, transmission pipeline system is assummed to be constructed by SPC. Therfore Case 2 is analyzed as case study.

7.1.2 Project Scheme

Following is the chart of project cash flow described in an above subchapter. O&M Company could be incorporated into SPC.

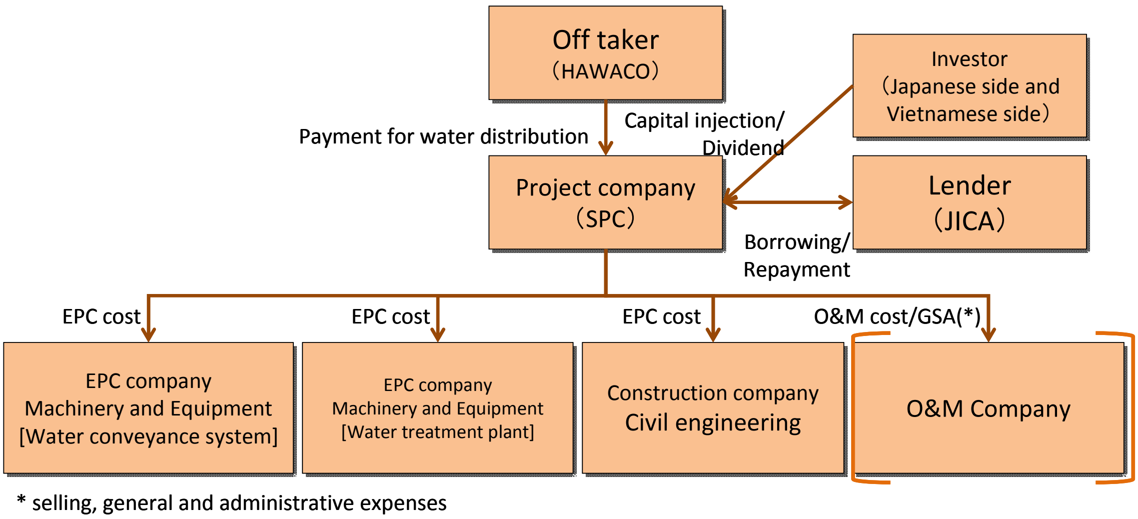


Figure 7.1.1 Project Cash Flow of Case 1

7.2 Major Assumption

7.2.1 Preconditions

(1) Corporate Structure

1) SPC established as Joint Stock Company under BOT Law (Decree No.108/2009).
2) Shareholders are expected to be Japanese 49% and Vietnamese 51%.

(2) Project Period

Ha Noi City plans this Project to develop Phase 1 in 2015 and Phase 2 in 2020 in the Master Plan. Therefore, in financial analysis, project stage follows Ha Noi City Master Plan. Project period is equal to the loan period (including construction period) provided by JICA. Initial investment of phase 1 shall be carried out between 2012 and 2014 and those of phase 2 shall be carried out between 2018 and 2019. Besides, one year for liquidation of SPC shall be scheduled.

The following is the main project schedule.

Table 7.2.1 Main Project Schedule

Items	Assumptions
Project Anniversary	1 January 2012*
Foundation of SPC	6 months prior to Signing day of LA
Signing day of LA	6 months prior to Construction Period
Construction Period	Phase 1 : 2012 to 2014（3 years）* Phase 2 : 2018 to 2019（2 years）*
O&M・Revenue Commencement	The day from which operation shall be commenced and tariff shall be charged. Phase1 : 1 January 2015* Phase2 : 1 January 2020*
O&M Period	<u>Phase 1 only:</u> 22years （JICA Loan Period（25 years）－Construction Period（3 years））
	<u>Phase1 & 2:</u> 28 years （3 years (years until construction of phase 2 shall be commenced)＋JICA Loan Period（25 years））
End of Concession Period	<u>Phase 1 only:</u> End of 2036 （2012＋JICA Loan Period（25 years）－1）
	<u>Phase 1 & 2:</u> End of 2042 （2012＋｛6 years(years until construction of phase2 shall be commenced)＋JICA Loan Period（25 years）｝－1）
Liquidation of SPC	A year later after the end of O&M Period <u>Phase 1 only:</u> End of 2037 <u>Phase 1 & 2:</u> End of 2043

* Above schedule was proposed as of 2011 in which the financial analysis for this study was being developed. Under the assumption discussed in 2012, project anniversary shall be 1 December 2012,

construction period shall be from 2012 to 2015 and operation shall start 1 December 2015 as per phase1/construction period shall be from 2015 to 2016 and operation shall start 1 January 2017 as per phase 2.

(3) Operation Rate

The operation rate at ordinary times is set at 96% in consideration of the below.

Table 7.2.2 Shutdown Rate

Events	Volume	%
Sudden electric outage (4 hrs or more)	2-day stop	
Measures in case of exceeding the upper limit in the water intake turbidness design	7-day stop	
Stop for inspections	2-day stop	
Sudden failure/recovery	2-day stop	
Total	13 days/365 days	Approximately4% (3.6%)

Large-scaled repairs will take place on the 25th year after the facility starts operations. Thus, such repair will occur for Phase 1 works, only when Phase 1&2 are executed. Operation rate for the facility subject to such repair will be set at 50%, and the rate for Phase 2 works will be assumed at the normal rate of 96% as previously stated.

(4) Initial Investment Costs

Initial investment costs include direct costs and indirect costs at 2011 price including finance costs. As for sensitivity analyses, cost down ratios of every 10% up to 30% are assumed.

Direct costs are estimated for civil engineering, mechanical and electrical work depending on each facility, (i) water intake and raw water transmission facilities, (ii) water treatment plants, and (iii) water conveyance system.

Indirect costs consist of design, survey, land compensation, water right application, leading wire contribution and start-up costs. All costs except start-up costs are allocated among each facility for calculation of costs by phases.

Table 7.2.3 Estimates of Direct Costs and Indirect Costs as of 2011 Price

(Unit: billions in VND)

Items	Phase 1	Phase 2	Total
Intake and raw water transmission facilities	483.0	160.6	643.6
Water treatment plant	2,038.4	1,178.6	3,217.0
Water conveyance system	1,563.9	-	1,563.9
Start-up costs	115.6	101.4	217.0
Total	4,200.9	1,440.6	5,641.5

(Figures are originally estimated with several kinds of currencies and exchanged into JPY by the rate as of 2011. Each figure was adjusted that total amount of each item equals to the figure shown in total.)

In addition to the above, interest rate during construction of 2-3%, and financing costs (upfront fee, 1.5% of loan amount; and commitment fee. 1% of undisbursed amount) are included in the initial investment costs. All costs are estimated in nominal term with inflation.

(5) Rehabilitation Costs

Under the scenario conducting Phase 1 & 2, 15% of mechanical and electrical work is estimated as rehabilitation cost invested in year 25 after commissioning of Phase 1 facilities. The cost is calculated as a nominal basis based on the inflation rate starting from year 1.

Funds for rehabilitation costs will be reserved from free cash flow before debt services every year and assumed to be disbursed from a reserve account.
However, the case without additional investment (rehabilitation costs) after 25 years of operation is also considered.

(6) O&M Costs

O&M costs and selling and general administrative expenses constitute the annual operation costs which are booked by adding the inflation rate (producer price index).

Table 7.2.4 Component of O&M Cost

Operation Costs		Remarks
O&M Costs	Fixed cost	Amount with inflation rate added to the amount planned in advance
	Variable cost	"Unit Price per cubic meter × Water Purification Capability × operation rate × water sales amount" considering the inflation rate for that fiscal year on.
SGA Costs	Variable cost	

(7) Tax

1) Corporate Income Tax：CIT

① 10％ corporate tax for water operator is applied although the standard rate of corporate income tax is 25%. 10% CIT is applied during the project period for the financial analyses because the period applied for can be extended to 30 years by conducting repair although the normal application period for 10% CIT is for 15 years. In addition, CIT exemption for four years from the year SPC gained profit first time and 50% of reduction of CIT another nine years are applied based on the BOT law Article 38 and Circular No. 103 of CIT.)

② Loss carry forward of 5 years is applied.

2) Customs

Customs are exempted. (BOT Law Article 38)

3) VAT

Since VAT for water business is reduced at 5% (regular rate is 10%), VAT received can be lower than VAT paid. Assuming VAT is refunded in a timely manner, the financial analyses do not count this effect to SPC's cash flow. Cost shall increase by the amount "interest rate×1/4×5641.5 billion VND" when tax refund delay by 3 months.

4) Right of Water Use

The law regulating royalty fee is currently under revision and the team reviews the details. The royalty fee for right of water use is not considered at the financial analyses. However, application fee is included as an indirect cost.

(8) Fee for Land Use

Fee for land use is exempted under BOT law and is not included in the analyses (BOT Article 38, 3)

(9) Deposit on Construction Completion (BOT Law Article 23)

- Investment amount of up to VND 1.5 trillion, maximum 2% of the investment amount
- Investment amount of over VND 1.5 trillion, maximum 1% of the rest of investment amount

Cost shall increase by the amount "interest rate×years from signing of project agreement to construction completion×5641.5 billion VND×approx 1%" when tax refund delay by 3 months, although this is not considered under this analysis.

(10) Financing Plan

Conditions for the financing plan will be the same for Phase 1 and 2 as specified below. Due to the JPY denominated portion of the investment being low at approximately 20% and the VND and USD financing being approximately 40% each, it would be preferable to have the borrowings denominated in VND or USD. However, as Vietnam applies the managed float system as specified later under "Foreign Exchange Rate Fluctuation", the cost of borrowings is relatively high if denominated in VND. For this reason, the charges for collecting invested amounts in the Payment Formula as previously described under "Earnings" will be denominated and fixed in USD and paid in VND, the borrowings will be made in JPY and swapped into USD.

1) Equity

- Assumption that 20% of total financing amount

2) Loan

- Assumption that 80% of total financing amount
- Borrowed in Yen and swapped into USD
- Interest rate for Yen loan of 2.0%
- Swap cost 1.0%
- Repayment period of 25 years,
- Grace period of 5 years for each Phase 1 and 2
- Other fees: Upfront fee 1.5%, Commitment fee 1%, Lawyer/Agent fee etc.

- Set up Debt Service Reserve Account（allocate debt service amount for one year for each tranche）

Shareholders' loan could be considered in the future.

(11) Depreciation and Rehabilitation

1) Assets for initial investments are depreciated during the BOT project period based on Regulation on Depreciation No.203-2009-TT-BTC, Article 12.
2) Assets for rehabilitation investments are depreciated during the BOT project period based on Regulation on Depreciation No.203-2009-TT-BTC, Article 12.

(12) Inflation (Producer Price Index)

- Viet Nam : 6.4%/year (Refer to Attachment 1-1)
- The U.S. : 3.5%/year (Refer to Attachment 1-2)
- Japan : 0%/year (Refer to Attachment 1-3)

The above data are applied to the inflation of cost of civil engineering/ construction, equipment, electronics etc.

(13) Foreign Exchange Rate Fluctuation

Foreign exchange rate of 2010 is assumed as noted below and the fluctuation trend during 2000-2009 is applied for the future assumption of forex fluctuation.

1) Forex at base year (2010)
   - VND/USD : 1USD=20,000VND
   - VND/JPY : 1JPY=245VND
   - JPY/USD : 1USD=81.64JPY

2) Fluctuation rate
   - VND/USD : 2.0％/year (Refer to Attachment 3-1)
   - VND/JPY : 3.7％/ year (Refer to Attachment 3-2)
   - JPY/USD : -1.64%/ year (Refer to Attachment 3-3)

Fundamentally, if there is a difference in the interest rate of a currency between 2 countries, there will be a pressure for interest rate arbitrage and the foreign exchange rate will end up in a rate so that the value of the 2 currencies will be the same even when different interest rates are applied (interest arbitrage transaction). However, attention is required, as the application of such foreign exchange managed float system may produce a difference in the interest rate of 2 countries.

Nominal interest rate adds inflation rate to the actual interest rate. Assuming that the actual interest rate for 2 countries is the same, the difference in nominal interest rate of the countries would be the result of adjustment made by purchasing power parity (inflation rate). However, as currency exchange in a country that applies a managed float system is determined without correlation with purchasing power parity, a difference arises between the interest rate of the 2 countries. The relation of VND/JPY in this calculation is described as an annual 6.4% price rise. As the trends in the rate of fluctuation in exchange is assumed at an annual 3.4% for VND/JPY, the reduction of VND against the JPY is held down lower that the actual situation. As a result, VND's actual interest rate remains higher than it originally should be. In such cases, if foreign currency risk is ignored, the burden of interest payment for borrowings denominated in the country's own currency would be lower. It should also be noted that the foreign currency risk is expected to be avoided through the Payment Formula structure and by applying a USD-JPY swap transaction as described under "7.2.2 Earnings."

7.2.2 Earnings

As specified under Chapter 5, SPC's earnings are assumed to be the price for supplying clear water to HAWACO. The agreement style assumed is the "Take or Pay", namely "Fixed + Variable style" in which "Capacity Payment" and "Variable Payment" is combined. In the final report Study Team shall recommend "Take or Pay" method as the most appropriate payment formula from the standpoint of cost-based pricing model although Study Team considered "Variable" style in which payment for SPC is calculated with fixed price adding inflation factor multiplied by provided water amount while interim report. "Take or Pay" method is fit the theory of Inter-Circular No.95/2009/TTLT-BTC-BXD-BNN established by MOF in 2009.

In order to avoid the foreign exchange risk which is a large concern for the project, a negotiation will be made on the condition for payments from HAWACO so such payments will be denominated in USD and paid in VND. The below table outlines the structure of the payment mechanism and shows the relation with price fluctuation and foreign exchange.

(1) Payment Formula

1) Background of introduction

This project shall be financed by private sector (not budgeted by Vietnam Government) to reduce burden on national treasury in Vietnam.

Funding method shall be called “Project Finance” when borrowing money shall be repaid only by the money earned from project activity.

It is indispensable to secure stable money to repay borrowing money when project cost is funded by private sector, namely “Project Finance”.

① High spread shall be added on base interest without predictable and stable cash flow.

② Low spread shall be added on base interest if project bears small risk.

Capacity Payment is standard payment formula for project finance to decrease project risk (uncertainty) and IPP projects in Vietnam adopt Capacity Payment.

Uncertainty of cash flow by volatility of Inflation and exchange rate shall be avoided through the use of Capacity payment.

2) Outline of Capacity payment

Capacity Payment is the payment formula in which cost and return are divided between fixed portion and variable portion to avoid demand risk. Component “Capacity-1” is calculated without inflation factor to avoid inflation risk. Component “Capacity-1” is paid with the same currency as borrowing to avoid forex risk.

Table 7.2.5 Outline of Payment Formula

<table>
<tr><th colspan="2" rowspan="2">Component</th><th rowspan="2">Paid for</th><th colspan="2">Price Revision</th><th rowspan="2">Composed of</th></tr>
<tr><th>Inflat ion</th><th>Forex</th></tr>
<tr><td rowspan="3">Capacity Payment</td><td>Capacity-1</td><td rowspan="3">Availability (Water Purification Capability ×Availability Ratio)</td><td>×</td><td>○</td><td>• principal and interest + Additional Investment + Tax + Equity + Dividend</td></tr>
<tr><td>Capacity-2 (Foreign Currency Portion)</td><td>○</td><td>○</td><td>• O&M Fixed cost</td></tr>
<tr><td>Capacity-2 (Local Currency Portion)</td><td>○</td><td>×</td><td>• O&M Fixed cost</td></tr>
<tr><td rowspan="2">Variable Payment</td><td>Variable (Foreign Currency Portion)</td><td rowspan="2">Volume (Actual Purchased amount)</td><td>○</td><td>○</td><td>• O&M Variable cost</td></tr>
<tr><td>Variable (Local Currency Portion)</td><td>○</td><td>×</td><td>• O&M Variable cost</td></tr>
</table>

Table 7.2.6 Outline of the Payment Formula

<table>
<tr><th colspan="2">Earnings Item</th><th>Description</th><th>Price Fluctuation</th></tr>
<tr><td rowspan="3">Capacity Payment</td><td>Charges for collecting invested amounts</td><td>• “Unit Price per cubic meter × Water Purification Capability × Availability Ratio”
• For water selling price per cubic meter, calculate back the price that will produce IRR 15%
• Components are “Repayment and Interest Payment Amount + Investment Return + Corporate Tax, etc”</td><td>×</td></tr>
<tr><td>Operation fixed charges (with inflation)</td><td>• Book operation fixed costs (fixed portion of the O&M costs) for which inflation should be accounted, by adding the inflation rate for that fiscal year
• This project assumes inflation for the entire amount of operation fixed costs (fixed portion of the O&M cost)</td><td>○</td></tr>
<tr><td>Operation fixed charges</td><td>• Book operation fixed costs (fixed portion of the O&M costs) for which no addition for inflation is</td><td>—</td></tr>
</table>

	(without inflation)	required • Not applicable for this project	
Variable Payment	Operation variable charges (with inflation)	• Book operation variable costs (variable portion of the O&M costs, SGA costs) for which inflation should be accounted. • Calculate "Unit Price per cubic meter × Water Purification Capability × operation rate" considering the inflation rate for that fiscal year on. • This project assumes inflation for the entire amount of operation variable costs (variable portion of the O&M costs, SGA costs)	○
	Operation variable charges (without inflation)	• Book operation variable costs for which no addition for inflation is required • Not applicable for this project	—

Of the above table, "Charges for collecting invested amounts" include earnings that match the repayment for borrowings. It is expected that having this amount in the same currency as the borrowings will avoid foreign exchange risk between earnings and repayment. Although the project assumes the borrowings to be denominated in JPY (refer to "Foreign Exchange Rate Fluctuation" as referred to hereafter), as a negotiation is to be held for having payments from HAWACO to be denominated in USD and paid in VND, it will be possible to avoid foreign exchange risk for earnings that match repayments by swapping the JPY borrowings into USD in advance. As the expenditure that matches with the remaining earnings items are almost all denominated in VND, a negotiation should be held for the items to be denominated in VND and paid in VND.

The inflation rate in the above table shall be the same rate as the "producer price index" which is the inflation rate being added to the O&M costs. This is set conservatively in consideration of the fact that "(1) the payments to the SPC is a procurement for HAWACO who are the off taker, and it is possible that they will request the inflation rate to match the producer price index" and "(2) as Vietnam's rate of consumer price index increases is higher than that of producer price index increases, it is preferable for agreements to be executed stipulating a revision in charges based on the consumer price index. However, as mentioned in Chapter 5, the City of Ha Noi's trend in water charge (demander price) revisions is not catching up with the rise in prices, applying such an optimistic price index in advance would be an extremely high risk." In addition, the City of Ha Noi's trend in water charge (demander price) revisions accompanying a rise in inflation rate is not catching up with the rise in prices as stated, and is realistic to revise this every several year. As this simulation, as stated, will incorporate the inflation rate in the calculation of the Payment Formula in advance, the assumption is that there will be no negotiations for a revision of the off take price and it is assumed that there will be a revision every year. It would be necessary to review a detailed scheme on revisions to the charge, going forward.

3) Component of unit price

Following table explains unit price as of 2015. 12,778VND shall be calculated by dividing total amount in 2015 by Water Purification Capability in 2015. Unit price shall vary by cost or water purification capability every year.

Table 7.2.7 Unit Price as of 2015

Component		Amount	Explanation
Capacity Payment	Capacity-1	466,824,717,551VND (72%)	• 0.4USD/m3 × 150,000m3/day × 365days×96% • 1US=22,081.616VND • 0.4USD=(principal and interest + Additional Investment + Tax + Equity + Dividend +) / Total water supply amount
	Capacity-2	70,266,749,500VND (11%)	• O&M cost estimated for 2015
	Capacity-2	27,041,954,102VND (4%)	• O&M cost estimated for 2015
Variable Payment	Variable (Foreign Currency Portion)	N/A	• N/A
	Variable (Local Currency Portion)	81,178,661,084VND (13%)	• O&M cost estimated for 2015
Total		645,312,082,237VND	

4) Components of Capacity-1

Components of Capacity-1 are following and price per m3 is equal to 8,044VND when total amount is divided by accumulated water purification capability during the project period. 8,044VND shall be approx. 0.4USD when it is exchanged by the exchange rate as of 2010, 20,000VND per 1USD

Table 7.2.8 Components of Capacity-1

Component	Amount	%
principal and interest	6,683,847,579,850VND	32%
Additional Investment	509,014,098,168VND	2%
Tax	741,106,221,739VND	4%
Equity	1,205,033,521,574VND	6%
Dividend	8,879,974,803,845VND	42%
VND depreciation for USD	3,139,517,645,518VND	15%
Total	21,158,493,870,693VND	100%

5) Merit for the Vietnam by introducing Capacity Payment

2 merits could be given to the Vietnam by capacity payment. One merit is attraction effect of foreign investment finance from abroad. Investment finance from abroad could be considered positively by foreign company since capacity payment is the basic payment formula in project finance market. It could contribute to the economical development in Vietnam. Another merit is the isolation of the initial investment cost from inflation. Unit price for the water provision shall increase annually by 6.4% in theory when annual inflation rate is assumed as 6.4% because calculation method for unit price defines that unit price shall increase according to annual inflation rate. Against that idea, unit price by capacity payment is cheaper although capacity payment seems much expensive only for the first 7 years. This is because Capacity payment does not consider escalation factor for the portion “Capacity-1”.

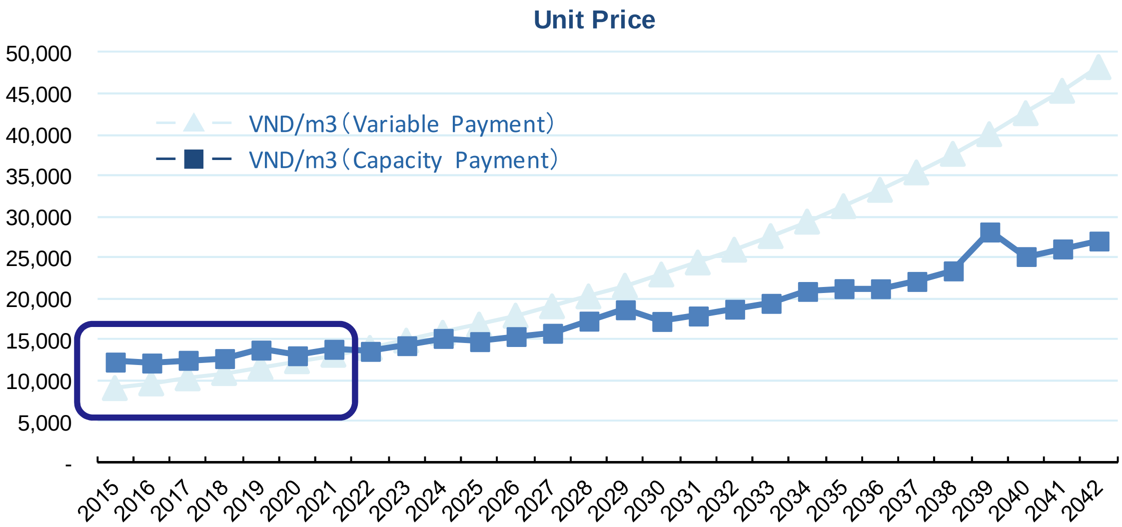


Figure 7.2.1 Trends in Unit Price by Payment Formula

7.3 Cash Water Fall

Below is a summary of the SPC's cash waterfall which summarizes the previously mentioned assumptions. Dividend is of a realistic structure where the initial investment amount is redeemed at the time the SPC is liquidated, and where interim dividend will only be paid if the profit and loss statement is a positive figure and the required reserve is accumulated.

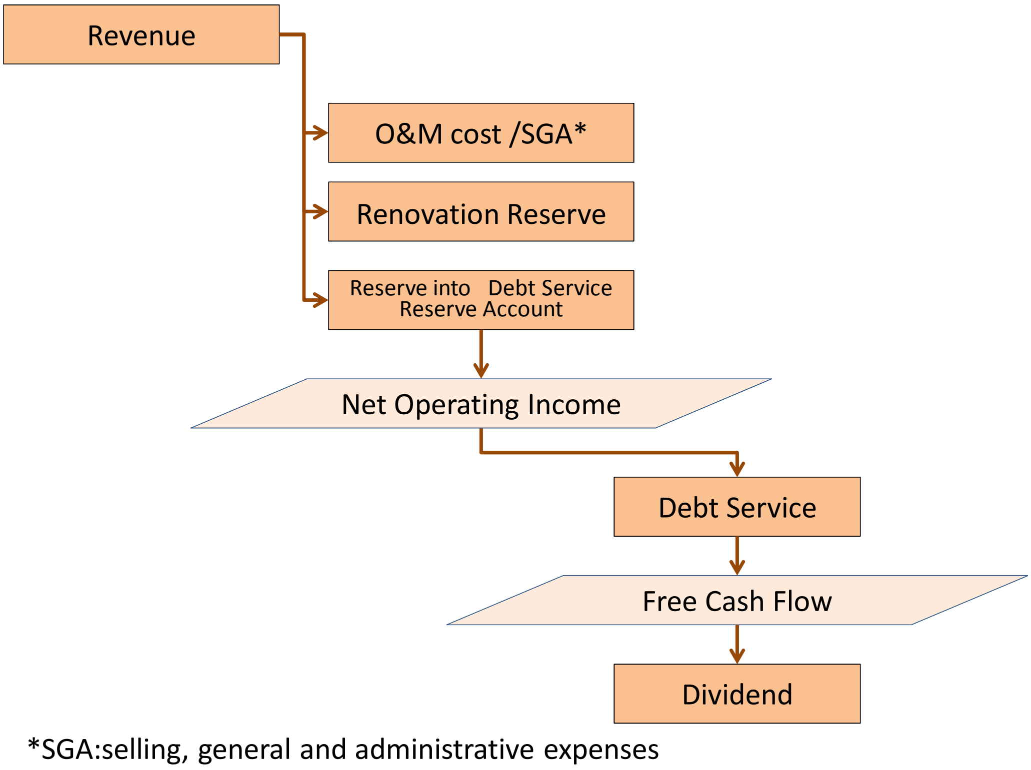


Figure 7.3.1 Cash Water Fall

7.4 Consideration of Bank Loan

In this chapter, Study Team considers “bank loan” case, using overseas investment loans provided by JICA through local bank.

7.4.1 Major Assumption of Bank Loan

(1) Case Description

Following is a scheme that JICA finances VDB denominated in JPY, and VDB finances SPC denominated in VND.

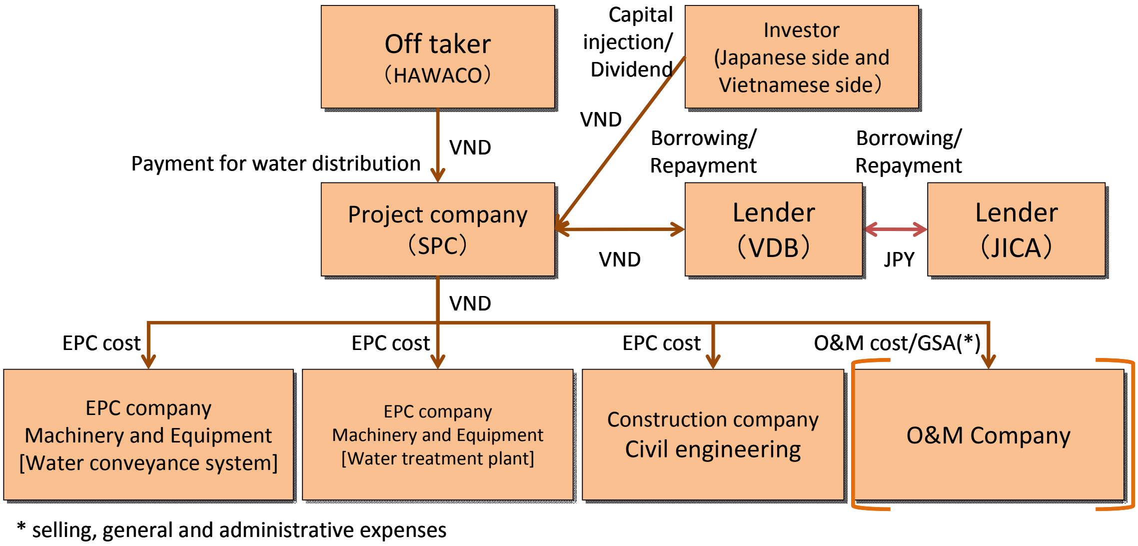


Figure 7.4.1 Financial Scheme of Bank Loan

(2) Bank Loan Based on the Base Case

Study Team considered bank loan borrowing in VND based on the base case in chapter 7.6 Sensitivity Analysis No.4 and 5. However, in the case of denomination in VND, burden of interest payment is larger and DSCR and EIRR is lower at the beginning of water supply because interest rate level would be higher than borrowing in JPY. Therefore, couple of cases are analized.

Table 7.4.1 Result of Calculation of Bank Loan by Sensitivity Analysis

No. in Table 7.6.3		EIRR(Dividend base)	Minimum Cash (Millions in JPY)	Minimum DSCR
	Base case	14.97%	100	1.38
4	borrowing in VND with interest rate 11%	9.81%	-617	0.75
5	borrowing in VND with interest rate 12%	9.14%	-1,114	0.71

(3) Change from Base Case

Base case is changed regarding following points as measures to improve project profitability.

1) Additional Investment

Additional investment, intended in 25 years after the beginning of supply, shall not be implemented because it shall be difficult to recover capital in the rest of the projects period (only 3 years shall be left). Technically, instead of large investment after 25 years, periodical maintenance shall be conducted.

2) Project Period

In this case, construction period shall be shorten to collect water tariff much earlier timing although construction Period is assumed that from 2012 to 2014 (3 years) for Phase1 and from 2018 to 2019 (2 years) for Phase2 in the base case. O&M period shall be shorten to 25 years from 28 years corresponding to machine's service life because additional investment shall not be implemented.

Table 7.4.2 Project Schedule in Bank Loan Case

Items	Assumptions
Construction Period	Phase 1 : 2012 to 2015（3 years） Phase 2 : 2015 to 2016（2 years）
O&M・Revenue Commencement	The day from which operation shall be commenced and tariff shall be charged. Phase1 : 1 December 2015 Phase2 : 1 January 2017
O&M Period	25years (Phase1 machine's service life)

Items	Assumptions
End of Project	31 December 2039 (2015＋25 years (Phase1 machine's service life)－ 1)
Liquidation of SPC	31 December 2040 (a year After the end of O&M period)

3) Financing
   - D:E ratio : 80:20 and 70:30
   - Currency : VND
   - Interest : 14.5% （Shown by VDB in the meeting attended by VDB and JICA on 9th March 2012, Based on ”Decree No.75/2011/ND-CP (30th August 2011)” and ”Decree No.78/2010/ND-C”）

4) Price Increasing Rate
   - Vietnam : 6.46%/year

5) Exchange Fluctuation Rate
   - VND/JPY : 3.7%/year

7.4.2 Result from Analysis of Bank Loan

Study Team conducted financial analysis modifying assumption which mentioned in above sub-chapter after changing borrowing currency from JPY which assumed in the base case to VND. Also, about water price, capacity payment method is assummed, which was explained in chapter 7.2.

Feasibility is examined by seeking unit price which achieves the level of EIRR around 15% in JPY. According to this calculation, unit price is more than that of both cases, the 80:20 for D:E ratio and 70:30 for D:E ratio in base case.

The other hand, cash balance from 2017 to 2019 shall improve by above proposed measures and high DSCR shall be achieved because the timing water revenue occurs is accelerated in 2017 although cash management is severely difficult for SPC from 2017 to 2019; the completion timing of phase 2 construction in the base case because repayment of principal begins in 2017 with grace period of 5 years. 5 years are enough period for grace period since grace period more than 5 years only bring the demerit of financial burden on interest payment.

However, reasonable water price(unit price) is expected to be less than 10,000VND/m3 according to the current situation. Therefore, twenty (20) cases are analyzed.

Table 7.4.3 Result from Analysis of Bank Loan

Reference		Bank Loan 1	Bank Loan 2
D:E ratio		80:20	70:30
Unit Price in 2015		**21,629VND/m3**	**24,078VND/m3**
Unit Price in 2020		20,938VND/m3	23,387VND/m3
Unit Price in 2039		24,019VND/m3	26,468VND/m3
EIRR	JPY	14.95%	14.99%
	VND	21.76%	21.81%
DSCR	Minimum	1.66	2.15
	Min DSCR Year	2016	2016
	Average	2.77	3.60
Minimum Cash at hand	in millions JPY	—	—
	in billions VND	27.49	27.49

※ The above results are calculated with general capacity payment in which stable unit price is adopted for invested capital recovery throughout the project period.

7.4.3 Plans to Decrease Unit Price

(1) Needs to Decrease Unit Price

In Vietnam, local People's Committee has authority of revision of water tariff. According to above calculation results, revision of tariff and negotiation with People’s Committee of Ha Noi City are necessary. However local People's Committee can revise the tariff only within the range the Ministry of Finance determine. Calculation method of tariff is designated in the "Circular No. 100/2009/TT-BTC", and Ha Noi city is classified as a special municipality. Tariff of this project should be negotiated with the level less than 12,000 VND/m3.

Table 7.4.4 Tariff of Water in Vietnam

Region	Lower Limit	Higher Limit
urban area (special municipality and category 1)	3,000VND/m3	12,000 VND/m3
urban area (category 2, 3, 4, 5)	2,000 VND/m3	10,000 VND/m3
Rural area	1,000 VND/m3	8,000 VND/m3

(2) Trend of Tariff Policy

Ho Chi Minh City is classified into the special municipality as is the case with Ha Noi city and water tariff in Ho Chi Minh City was raised by 10% from 1th January 2012 setting a new tariff range for household from 4,800 to 11,000 VND/m3 which differed by the amount of water usage. The other hand, tariff for household in Ha Noi city ranges from 4,000 to 9,400 VND/m3 which differs by the amount of water usage. In the future, the tariff in Ha Noi city could be revised keeping step with Ho Chi Minh City.

(3) Measure to Decrease Unit Price

In the discussion related bank loan up to this point, in order to achieve this project while ensuring feasibility, Study Team estimates unit price should be 21,629-25,076 VND/m3 in 2015 price. However, given condition of maximum unit price is 12,000 VND/m3, significant improvements are required as prerequisites of the financial analysis. For this reason, the Study Team proposes measure to decrease unit price in 2015 such as following conditions:

1) Income

If payment formula is done by capacity payment commonly used in projects using project finance, such as power project, there is a benefit that can be stably and continuously recovered the expenses required for the initial investment without the risk of rising prices and demand risk over the project period. However, in order to avoid the risk of inflation, it is excluded elements of price increasing; as a result there is a disadvantage that level of unit price becomes more expensive as compared to the price level at the time of the beginning business.

While in Vietnam the unit price is 12,000 VND/m3 with regard to the provisions of the upper limit of the unit price, in case of bank loan, unit price is 21,629-25,076VND/m3 in

2015 and there may be no room for support, it is difficult to apply way of general capacity payment. For this reason, the survey team changes the formula, step up increasing unit price at a fixed rate regardless of the actual inflation rate, instead of the capacity payment. It is necessary to agree with the increasing rate at the time of the contract business, borrowing in VND at variable interest rates is expected. Therfore increasing rate satisfying feasibility agreed in advance is recalculated and applied every year.

2) CAPEX

Study Team has reflected the reduction of price until the selection of base case and reduced additional 5%. The amount of initial investment reduced by 5% is the following.

Table 7.4.5 Estimates of Direct Costs and Indirect Costs as of 2011 Price which are Reduced by 5%

Items	Phase1	Phase2	Total
Intake and raw water transmission facilities	458.9	152.5	611.4
Water treatment plant	1,936.5	1,119.7	3,056.2
Water conveyance system	1,485.7	-	1,485.7
Start-up costs	109.8	96.4	206.2
Total	3,990.9	1,368.6	5,359.5

(Unit: billions in VND)

(In addition to the above, interest rate during construction of 2-3%, and financing costs (upfront fee, 1.5% of loan amount; and commitment fee. 1% of undisbursed amount) are included in the initial investment costs.)

3) Financing

- D:E ratio : Inspected 2 types, 80:20 and 70:30

7.4.4 Result from Financial Analysis for the Purpose of Decreasing Unit Price

The measures described above, improvement of payment formula has largest impact to reduce the unit price in 2015. Result from recalculation of case 1 and 2 with changed payment formula, in the case of D:E ratio 80:20, the unit price is 14,379 VND/m3, in the case of 70:30, 16,237 VND/m3. The significant changes show changes of payment formula is prerequisite for the implementation of business.

However, unit price is still expensive level. In terms of the D:E ratio, as the following analysis, Study Team assumed it is possible to be financed at a ratio of 80:20 through the VDB.

Table 7.4.6 Result of Calculation of Bank Loan Modified Payment Formula

Reference		Bank Loan 3	Bank Loan 4
D:E ratio		80:20	70:30
Unit Price in 2015		**14,379VND/m3**	**16,237VND/m3**
Unit Price in 2020		19,664VND/m3	22,204VND/m3
Unit Price in 2039		64,598VND/m3	72,941VND/m3
EIRR	JPY	15.07%	15.05%
	VND	21.89%	21.87%
DSCR	Minimum	1.01	1.36
	Min DSCR Year	2015	2015
	Average	4.56	5.99
Minimum Cash at hand	in millions JPY	—	—
	in billions VND	27.49	27.49

Next, in order to ask the Vietnamese government for the interest rate incentives are granted in the BOT projects in Vietnam, Study Team assumed unit prices are 9,500 VND/m3, 11,000 VND/m3 and 13,000 VND/m3 in 2015 on the 5% reduction of initial investment, and calculate backwards borrowing rate to achieve EIRR 15% in each case. So far, EIRR 15% in JPY is assummed, however EIRR 15% and 20% in VND are analyzed in the next.

Results shown in following Table 7.4.7 and 7.4.8 show that borrowing rate is 5.99% in case 8, satisfied both essential conditions for local partners, VIWASEEN and HAWACO that unit prices is 9,500 VND/m3 in 2015 and for Study Team EIRR 20% denominated in VND which is approximate EIRR 15% denominated in JPY.

However, in Chapter 5, considered the level of interest rates such as 20% of community-acquired loan rate, it is very difficult for VDB to apply such level of interest.

Table 7.4.7 Result of Calculation of Interest, EIRR 15% Denominated in VND

Reference		Bank Loan 5	Bank Loan 6	Bank Loan 7
Unit Price in 2015		**9,500VND/m3**	**11,000VND/m3**	**13,000VND/m3**
Unit Price in 2020		12,991VND/m3	15,043VND/m3	17,778VND/m3
Unit Price in 2039		42,677VND/m3	49,416VND/m3	58,401VND/m3
Interest Rate		**16.22%**	**24.10%**	**35.32%**
EIRR	JPY	8.56%	8.57%	8.65%
	VND	15.00%	15.01%	15.09%
DSCR	Minimum	0.53	0.45	0.38
	Min DSCR Year	2015	2015	2015
	Average	2.79	2.50	2.24
Minimum Cash at hand	in millions JPY	—	—	—
	in billions VND	27.49	27.49	27.49

Table 7.4.8 Result of Calculation of Interest, EIRR 20% Denominated in VND

Reference		Bank Loan 8	Bank Loan 9	Bank Loan 10
Unit Price in 2015		**9,500VND/m3**	**11,000VND/m3**	**13,000VND/m3**
Unit Price in 2020		12,991VND/m3	15,043VND/m3	17,778VND/m3
Unit Price in 2039		42,667VND/m3	49,416VND/m3	58,401VND/m3
Interest Rate		**5.99%**	**10.62%**	**17.31%**
EIRR	JPY	13.28%	13.28%	13.27%
	VND	20.00%	19.99%	19.98%
DSCR	Minimum	1.45	1.01	0.78
	Min DSCR Year	2015	2015	2015
	Average	4.80	4.28	3.81
Minimum Cash at hand	in millions JPY	—	—	—
	in billions VND	27.49	27.49	—193.58

7.4.5 Plans to Build Consensus with Local Companies as a Partner

EIRR20% is uncommon and a very high level in Vietnam, currently. Therefore, another analysis based on the following conditions is studied.

1) Interest

Interest of borrowing in Phase1 adds to the principal including the interest earned until the start of water supply in Phase2.

2) Project Period

If not replacement investment, basically operation period should be set as maximum 25 years, machine's service life, in this study, Study Team sets 28 years of operation period same as base case. At this stage, instead of investment after 25 years, periodical maintenance shall be carried out for technological feasibility.

3) Payout Ratio

Annual dividend rate is set at 50% from the rigors of business profitability formally set to be able to recover the initial investment amount at the time of liquidation SPC.

7.4.6 Result from Financial Analysis for the Purpose of Building Consensus with Local Companies as a Partner

Through discussions with local partner companies so far, to build consensus, it is prerequisite to agree on the level of EIRR target. It is necessary to propose measure to cover divergence between terms presented by Japanese companies and those by partner companies.

There is no change of the goal of level of EIRR is 15% denominated in JPY or 20% EIRR in VND. Study Team conducts analysis under this assumption. First, the above incorporating improving measures on the above, Study Team estimates unit price 9,500 VND/m3 in 2015 and also the level of borrowing interest rates to achieve EIRR15% denominated in JPY or 20% EIRR in VND and confirm the possibility of resolving the situation by applying a preferential interest rate policy. Additionally, set 10% and 11% interest rate if certain incentives are applied, estimate how much the unit price. Results of the analysis are as follows.

Table 7.4.9 Results of Calculation of Interest, to Achieve EIRR 20% Denominated in VND, after Improvement of Dividend Payout Ratio

Reference		Bank Loan 11	Bank Loan 12
Accrual of Interest		Yes	No
Unit Price in 2015		**9,500VND/m3**	
Unit Price in 2020		12,991VND/m3	
Unit Price in 2042		51,494VND/m3	
Interest Rate		**6.58%**	**9.83%**
EIRR	JPY	13.28%	13.29%
	VND	20.00%	20.01%
PIRR	VND	14.80%	15.25%
DSCR	Minimum	1.50	0.88

Reference		Bank Loan 11	Bank Loan 12
Accrual of Interest		Yes	No
	Min DSCR Year	2017	2015
	Average	5.67	4.72
Minimum Cash at hand	in millions JPY	—	—
	in billions VND	27.49	27.49

Table 7.4.10 Results of Calculation of Interest, to Achieve EIRR 15% Denominated in JPY, after Improvement of Dividend Payout Ratio

Reference		Bank Loan 13	Bank Loan 14
Accrual of Interest		Yes	No
Unit Price in 2015		**9,500VND/m3**	
Unit Price in 2020		12,991VND/m3	
Unit Price in 2042		51,494VND/m3	
Interest Rate		**7.18%**	**7.41%**
EIRR	JPY	15.00%	15.00%
	VND	21.82%	21.82%
PIRR	VND	14.74%	15.32%
DSCR	Minimum	1.41	1.17
	Min DSCR Year	2017	2015
	Average	5.42	5.46
Minimum Cash at hand	in millions JPY	—	—
	in billions VND	27.49	27.49

Table 7.4.11 Results of Calculation of Interest, to Achieve EIRR 20% Denominated in VND, after Improvement of Dividend Payout Ratio (Interest Rate 10%)

Reference		Bank Loan 15	Bank Loan 16
Accrual of Interest		Yes	No
Unit Price in 2015		**9,836VND/m3**	**9,546VND/m3**
Unit Price in 2020		13,451VND/m3	13,054VND/m3
Unit Price in 2042		53,317VND/m3	51,743VND/m3
Interest Rate		**10.00%**	
EIRR	JPY	13.29%	13.28%
	VND	20.01%	20.00%
DSCR	Minimum	1.14	0.87
	Min DSCR Year	2017	2015
	Average	4.68	4.70
Minimum Cash at hand	in millions JPY	—	—
	in billions VND	27.49	27.49

Table 7.4.12 Results of Calculation of Interest, to Achieve EIRR 20% Denominated in VND, after Improvement of Dividend Payout Ratio (Interest Rate 11%)

Reference		Bank Loan 17	Bank Loan 18
Accrual of Interest		Yes	No
Unit Price in 2015		**10,195VND/m3**	**9,831VND/m3**
Unit Price in 2020		13,942VND/m3	13,444VND/m3
Unit Price in 2042		55,262VND/m3	53,287VND/m3
Interest Rate		**11.00%**	
EIRR	JPY	13.26%	13.28%
	VND	19.98%	19.99%

Reference		Bank Loan 17	Bank Loan 18
Accrual of Interest		Yes	No
PIRR	VND	15.22%	15.66%
DSCR	Minimum	1.10	0.83
	Min DSCR Year	2017	2015
	Average	4.59	4.61
Minimum Cash at hand	in millions JPY	—	—
	in billions VND	27.49	27.49

Table 7.4.13 Results of Calculation of Interest, to Achieve EIRR 15% Denominated in JPY, after Improvement of Dividend Payout Ratio

Reference		Bank Loan 19	Bank Loan 20
Accrual of Interest		Yes	No
Unit Price in 2015		**11,025VND/m3**	**10,694VND/m3**
Unit Price in 2020		15,077VND/m3	14,625VND/m3
Unit Price in 2042		59,761VND/m3	57,967VND/m3
Interest Rate		**11.00%**	
EIRR	JPY	15.04%	15.02%
	VND	21.86%	21.84%
PIRR	VND	16.25%	16.78%
DSCR	Minimum	1.21	0.94
	Min DSCR Year	2017	2015
	Average	5.02	5.08
Minimum Cash at hand	in millions JPY	—	—
	in billions VND	27.49	27.49

7.5 Consideration of Direct Loan

Basically, Bank Loan financing is assummed in this project. However, analysis, based on Direct Loan to SPC, is studied.

For Cases 1 and 2, the unit price for selling water was calculated by classifying the cases into "Phase 1 only" and "Phase 1&2", and assuming an EIRR of 5%, 10% and 15% for each case, resulting in 12 cases (2 (by project scope)×2 (by Phase) × 3 (by Target IRR)).

Although the assumption for this project is earnings through the Payment Formula as described ("Fixed + Variable" method), the unit price for selling water that results in the same EIRR when inflation rate is added ("Fixed" method) has been specified together with all unit prices as reference.

7.5.1 For Case 1

(1) In Case of Phase 1 Only

Analysis will be conducted on a case where the SPC is engaged in the construction, possession, maintenance, control and operation of "purification plant, etc, facilities" and "water pipe, etc, facilities" during the project period of 22 years (loan period (25 years) - construction period (3 years)). Composition of the SPC's balance sheet at the time of completion will be as follows.

Table 7.5.1 Balance Sheet of SPC when the Construction Completed
(Case 1 with only Phase 1)

(Unit: millions in JPY)

Construction completed			
Investment		Funding	
Initial Investment	17,826	Senior Loan	14,349
Intake/ Raw water transmission point	*1,989*	Equity	3,577
Water purification plant	*7,628*	*Developer*	*3,006*
Water conveyance system	*6,401*	*JICA*	*571*
Other	*1,810*		

Cash at hand	100		
Total	17,926	Total	17,926

Results of the study regarding Case1 only with Phase 1 shall be shown by the chart designates the average water sales price, graph presents the transition of average water sales price and revenue amount during the project period and project cost summary.

1) EIRR 5%

Table 7.5.2 Average Water Sales Price
(Case 1 with only Phase1 targeted to EIRR 5%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	1,156,320,000 m3	39,973,992,504JPY	35JPY	15,186VND
Fixed (Reference)		41,447,497,240JPY	36JPY	16,426VND

* Average Unit Price =Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)
Although Study Team shall recommend the revenue stream by “Fixed + Variable” method, sales price which ensures 5% of EIRR in case “Fixed” method is added as reference information for comparison.

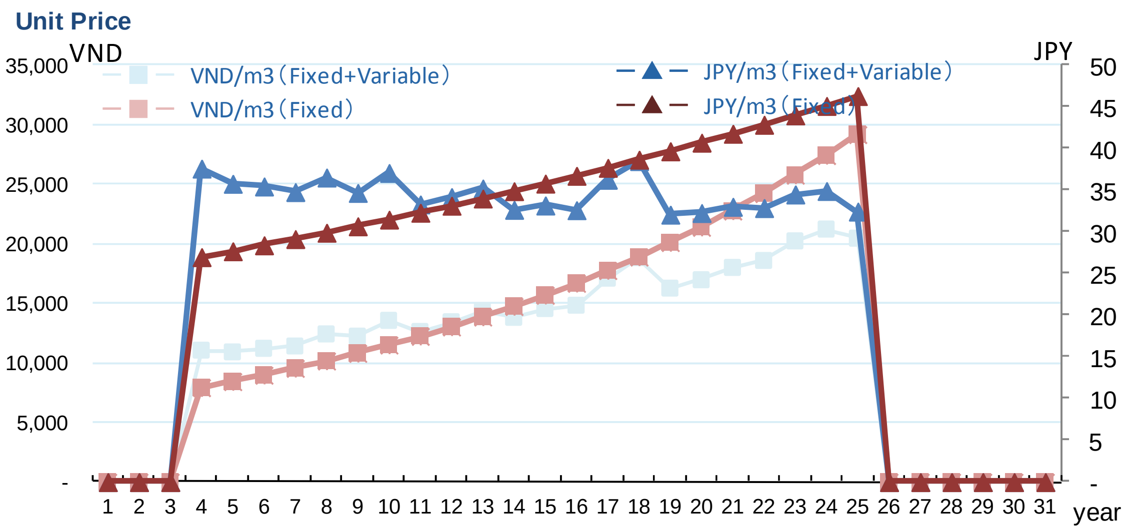


Figure 7.5.1 Transition of Average Water Sales Price
(Case 1 with only Phase 1 targeted EIRR 5%)

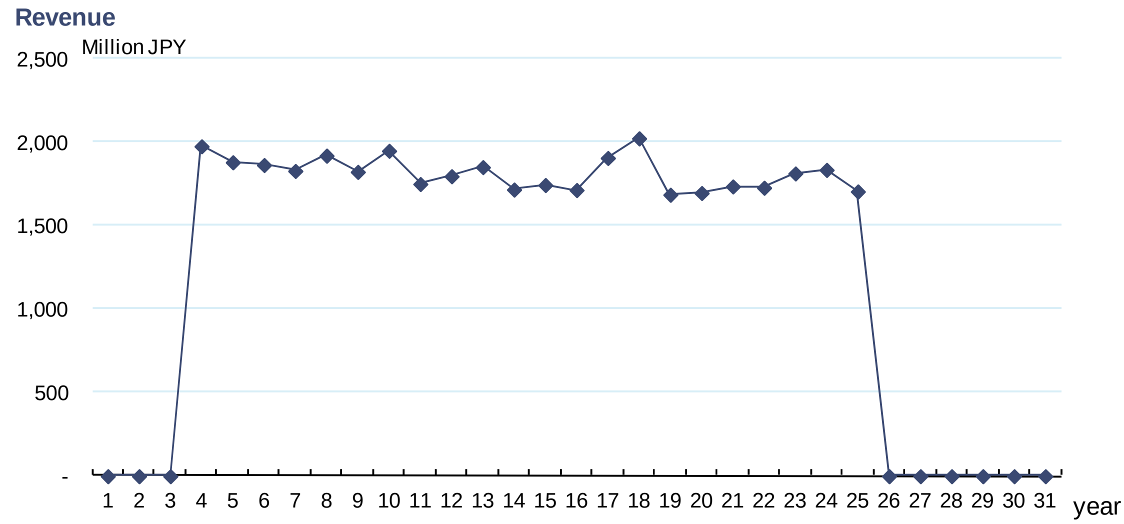


Figure 7.5.2 Transition of Revenue Amount
(Case 1 with only Phase 1 targeted EIRR 5%)

Table 7.5.3 Total Cash-in/Cash-out of the Project

(Case 1 with only Phase 1 targeted to EIRR 5%)

(Unit: millions in JPY)

Total project period			
Cash out		Cash in	
Initial Cost	17,826	Revenue	39,974
Renovation Cost	0		
Operating Cost	11,131		
Tax	411		
Interest	5,381		
Dividends	5,225		
Total	39,974	Total	39,974

2) EIRR 10%

Table 7.5.4 Average Water Sales Price

(Case 1 with only Phase 1 targeted to EIRR 10%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	1,156,320,000 m3	46,296,377,743JPY	40JPY	17,544VND
Fixed (Reference)		50,193,333,619JPY	43JPY	19,892VND

* Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by “Fixed + Variable” method, sales price which ensures 10% of EIRR in case “Fixed” method is added as reference information for comparison.

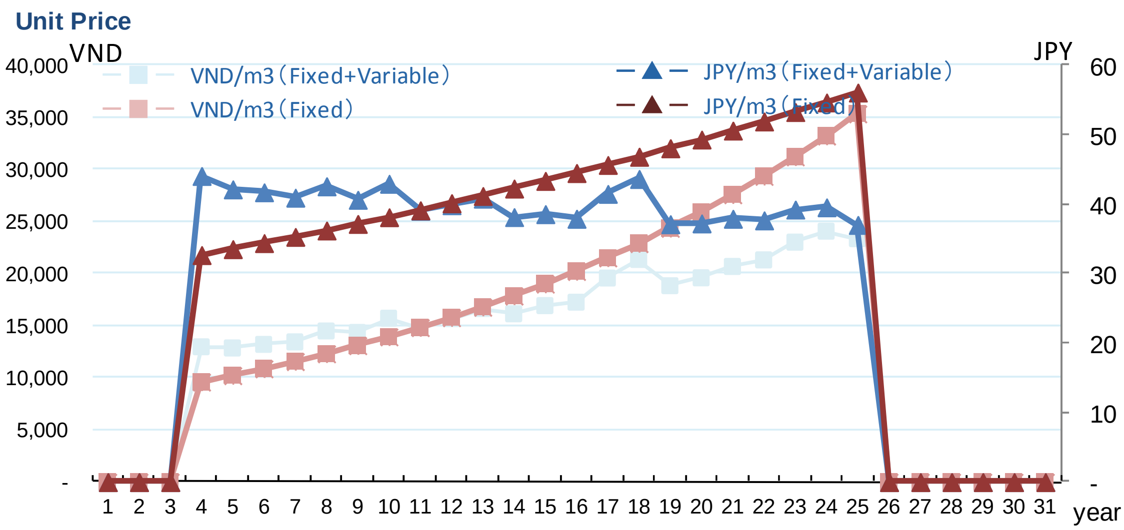


Figure 7.5.3 Transition of Average Water Sales Price
(Case 1 with only Phase 1 targeted EIRR 10%)

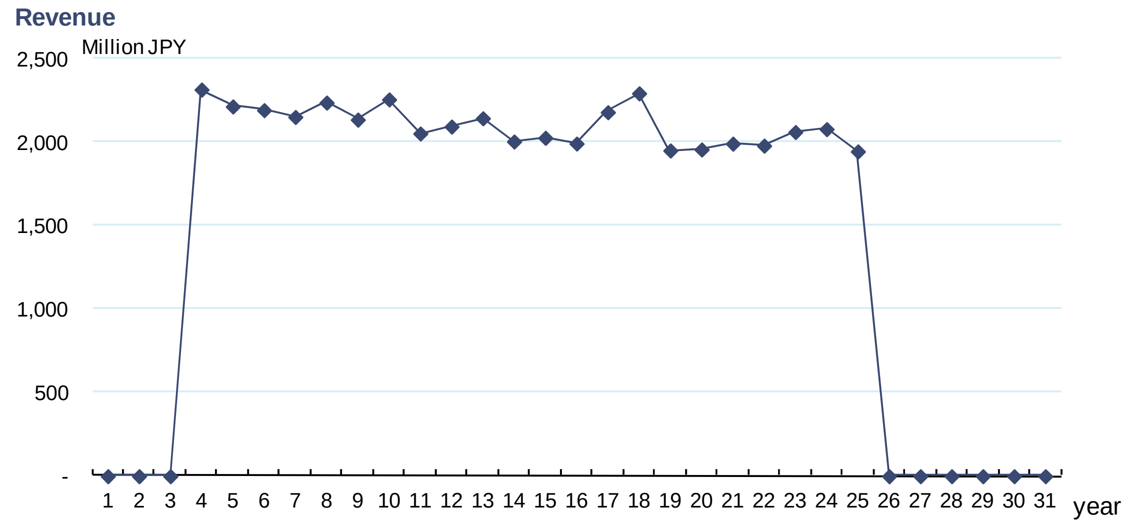


Figure 7.5.4 Transition of Revenue Amount
(Case 1 with only Phase 1 targeted EIRR 10%)

Table 7.5.5 Total Cash-in/Cash-out of the Project
(Case 1 with only Phase 1 targeted to EIRR 10%)

(Unit: millions in JPY)

Total project period			
Cash out		Cash in	
Initial Cost	17,826	Revenue	46,296
Renovation Cost	0		
Operating Cost	11,131		
Tax	776		
Interest	5,381		
Dividends	11,182		
Total	46,296	Total	46,296

3) EIRR 15%

Table 7.5.6 Average Water Sales Price
(Case 1 with only Phase 1 targeted to EIRR 15%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	1,156,320,000 m3	53,710,135,528JPY	46JPY	20,310VND
Fixed (Reference)		59,871,928,334JPY	52JPY	23,727VND

* Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)
Although Study Team shall recommend the revenue stream by “Fixed + Variable” method, sales price which ensures 15% of EIRR in case “Fixed” method is added as reference information for comparison.

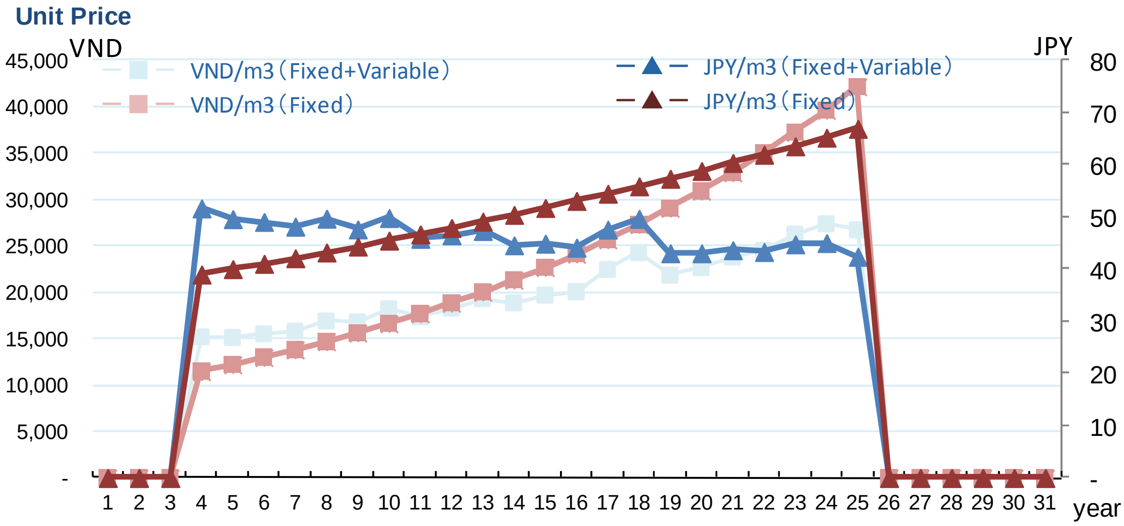


Figure 7.5.5 Transition of Average Water Sales Price
(Case 1 with only Phase 1 targeted EIRR 15%)

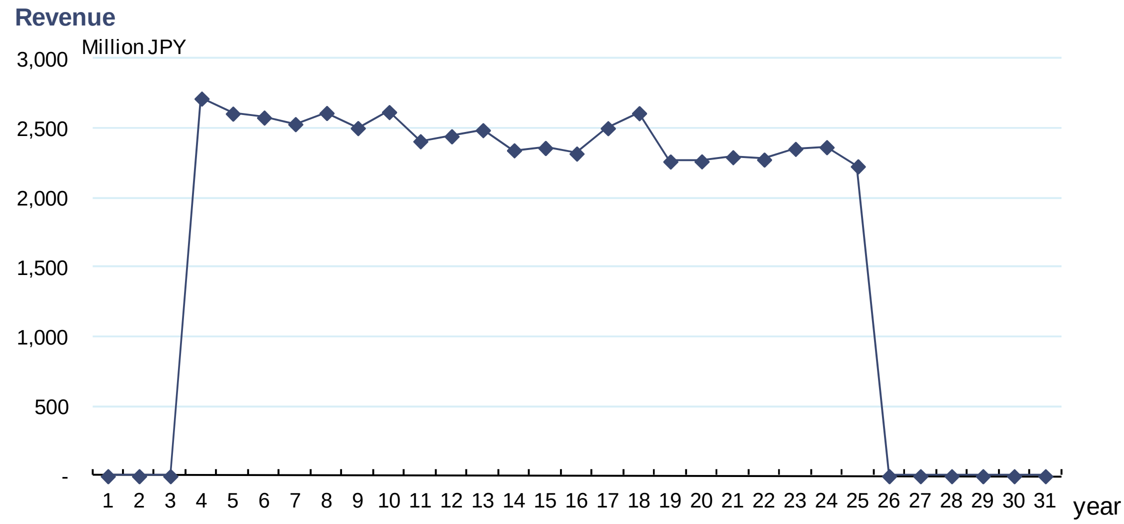


Figure 7.5.6 Transition of Revenue Amount
(Case 1 with only Phase 1 targeted EIRR 15%)

Table 7.5.7 Total Cash-in/Cash-out of the Project
(Case 1 with only Phase 1 targeted to EIRR 15%)

(Unit: millions in JPY)

Total project period			
Cash out		Cash in	
Initial Cost	17,826	Revenue	53,710
Renovation Cost	0		
Operating Cost	11,131		
Tax	1,205		
Interest	5,381		
Dividends	18,167		
Total	53,710	Total	53,710

(2) In Case of Phase 1&2

Continuing from the previous section, analysis will be conducted on a case where the SPC is engaged in the construction, possession, maintenance, control and operation of "purification plant, etc, facilities" and "water pipe, etc, facilities" during the project period of 31 years (6 years (number of years up to the start of Phase 2 construction) + JICA loan period (25 years)). Composition of the SPC's balance sheet at the time of completion will be as follows.

Table 7.5.8 Balance Sheet of SPC when the Construction Completed
(Case 1 with Phase 1 & 2)

(Unit: millions in JPY)

Construction completed			
Investment		Funding	
Initial Investment	24,542	Senior Loan	19,723
Intake/ Raw water transmission point	*2,657*	Equity	4,919
Water purification plant	*12,963*	*Developer*	*4,133*
Water conveyance system	*6,401*	*JICA*	*785*
Other	*2,522*		

Cash at hand	100		
Total	24,642	Total	24,642

1) EIRR 5%

Table 7.5.9 Average Water Sales Price
(Case 1 with Phase 1 & 2 targeted to EIRR 5%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	2,630,190,000 m3	66,635,937,265JPY	25JPY	13,067VND
Fixed (Reference)		68,988,058,119JPY	26JPY	14,215VND

* Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by "Fixed + Variable" method, sales price which ensures 5% of EIRR in case "Fixed" method is added as reference information for comparison.

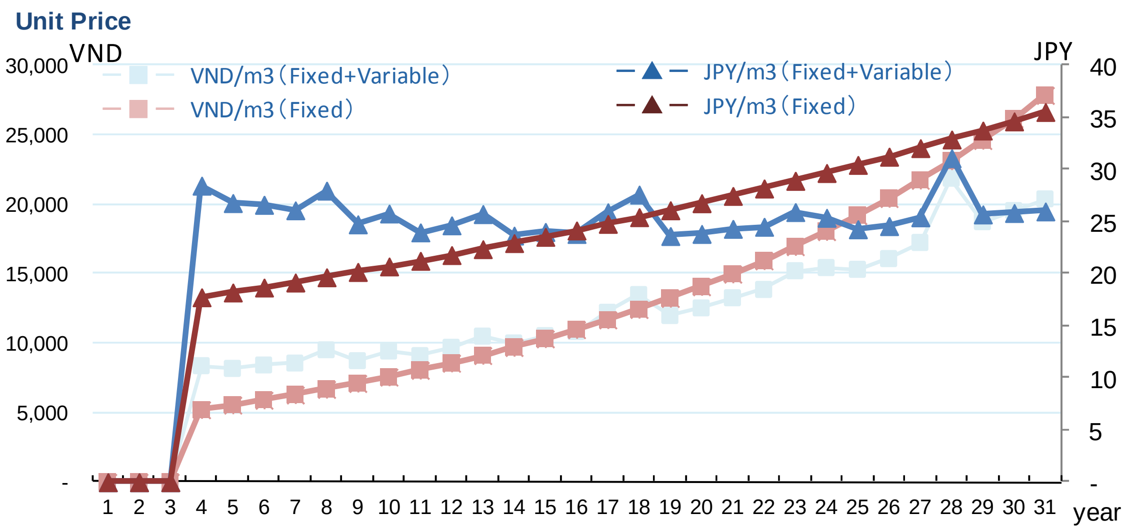


Figure 7.5.7 Transition of Average Water Sales Price
(Case 1 with Phase 1 & 2 targeted EIRR 5%)

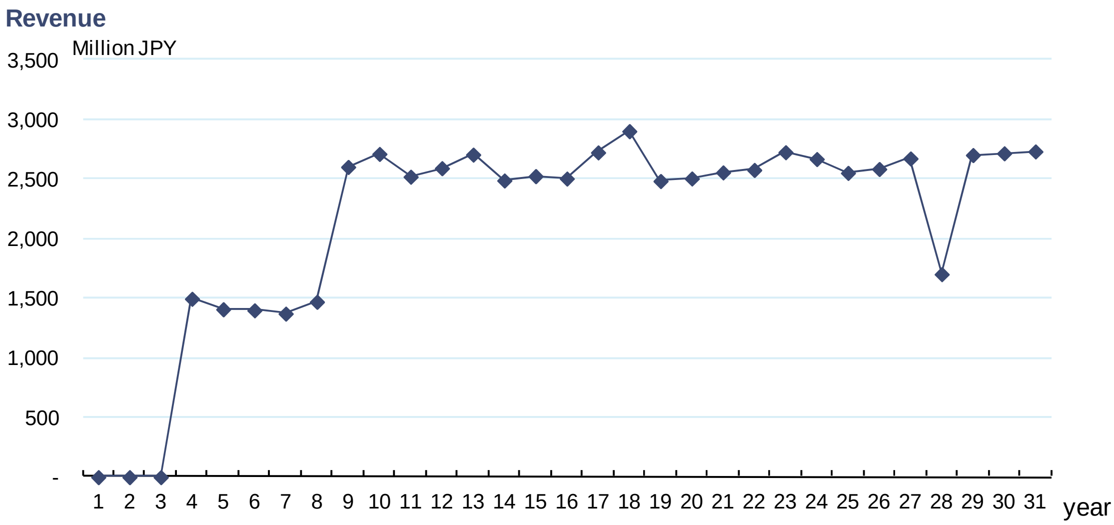


Figure 7.5.8 Transition of Revenue Amount
(Case 1 with Phase 1 & 2 targeted EIRR 5%)

Table 7.5.10 Total Cash-in/Cash-out of the Project
(Case 1 with Phase 1 & 2 targeted to EIRR 5%)

(Unit: millions in JPY)

Total project period			
Cash out		Cash in	
Initial Cost	24,542	Revenue	66,636
Renovation Cost	2,078		
Operating Cost	20,970		
Tax	1,008		
Interest	7,558		
Dividends	10,480		
Total	66,636	Total	66,636

2) EIRR 10%

Table 7.5.11 Average Water Sales Price
(Case 1 with Phase 1 & 2 targeted to EIRR 10%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	2,630,190,000 m3	80,016,464,814JPY	30JPY	15,601VND
Fixed (Reference)		90,284,218,317JPY	34JPY	18,601VND

* Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by "Fixed + Variable" method, sales price which ensures 10% of EIRR in case "Fixed" method is added as reference information for comparison.

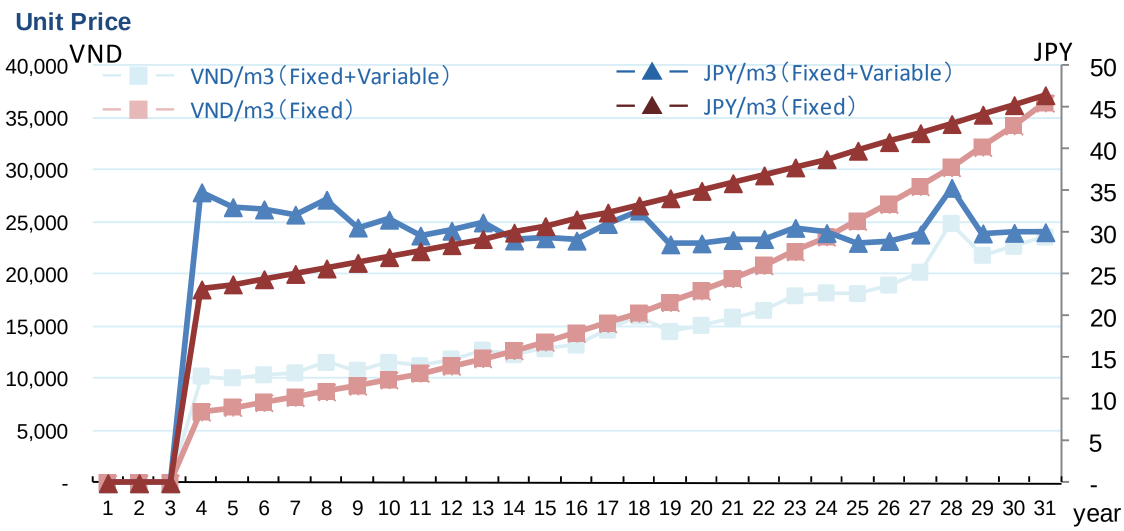


Figure 7.5.9 Transition of Average Water Sales Price
(Case 1 with Phase 1 & 2 targeted EIRR 10%)

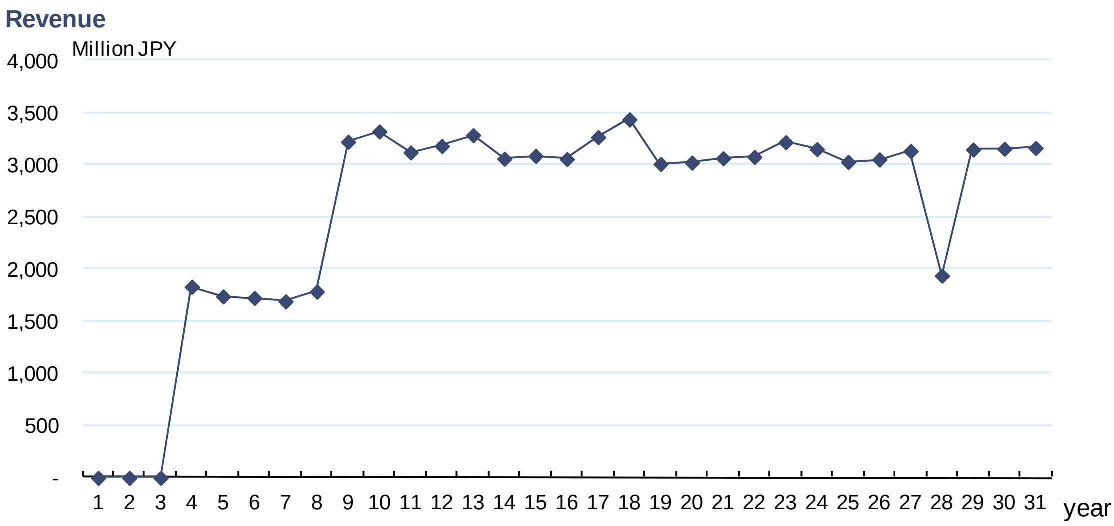


Figure 7.5.10 Transition of Revenue Amount
(Case 1 with Phase 1 & 2 targeted EIRR 10%)

Table 7.5.12 Total Cash-in/Cash-out of the Project
(Case 1 with Phase 1 & 2 targeted to EIRR 10%)

(Unit: millions in JPY)

Total project period			
Cash out		Cash in	
Initial Cost	24,542	Revenue	80,016
Renovation Cost	2,078		
Operating Cost	20,970		
Tax	1,996		
Interest	7,558		
Dividends	22,874		
Total	80,016	Total	80,016

3) EIRR 15%

Table 7.5.13 Average Water Sales Price
(Case 1 with Phase 1 & 2 targeted to EIRR 15%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	2,630,190,000 m3	94,416,957,728JPY	36JPY	18,329VND
Fixed (Reference)		114,421,888,117JPY	44JPY	23,577VND

※Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)
Although Study Team shall recommend the revenue stream by "Fixed + Variable" method, sales price which ensures 15% of EIRR in case "Fixed" method is added as reference information for comparison.

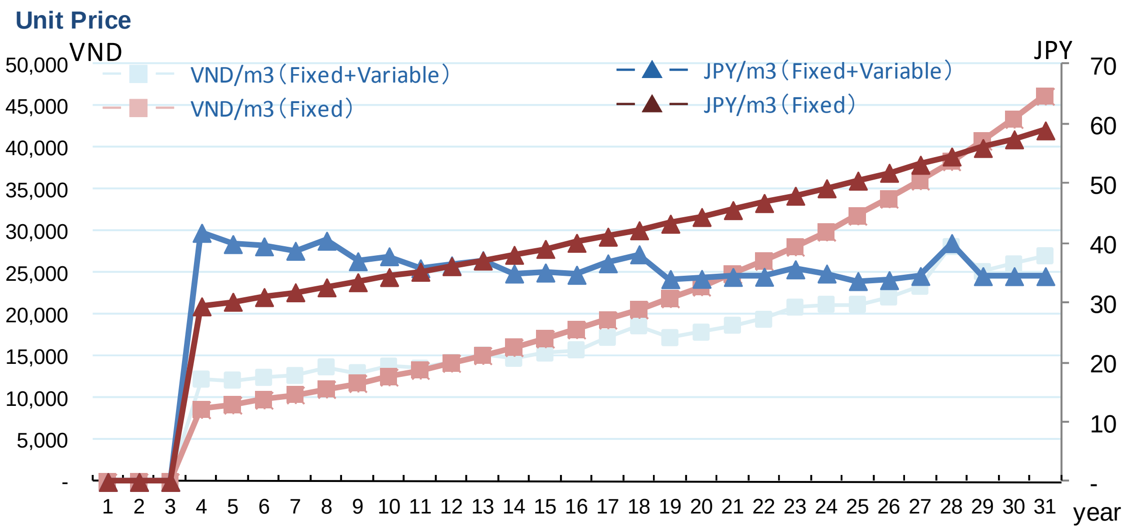


Figure 7.5.11 Transition of Average Water Sales Price
(Case 1 with Phase 1 & 2 targeted EIRR 15%)

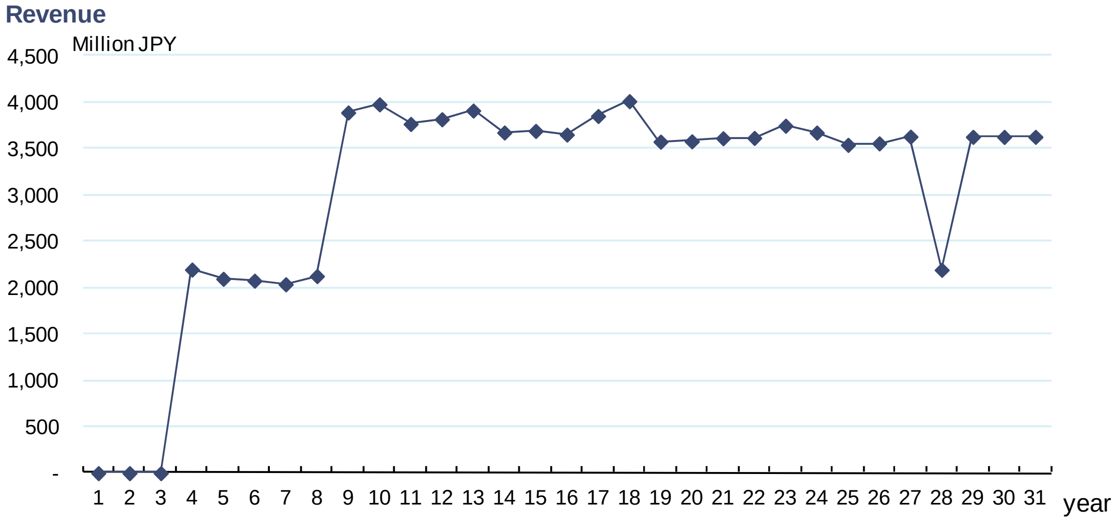


Figure 7.5.12 Transition of Revenue Amount
(Case 1 with Phase 1 & 2 targeted EIRR 15%)

Table 7.5.14 Total Cash-in/Cash-out of the Project
(Case 1 with Phase 1 & 2 targeted to EIRR 15%)

(Unit: millions in JPY)

Total project period			
Cash out		Cash in	
Initial Cost	24,542	Revenue	94,417
Renovation Cost	2,078		
Operating Cost	20,970		
Tax	3,025		
Interest	7,558		
Dividends	36,245		
Total	94,417	Total	94,417

7.5.2 For Case 2

(1) In Case of Phase 1 Only

Analysis will be conducted on a case where the SPC is engaged in the construction, possession, maintenance, control and operation of “purification plant, etc, facilities” and “water pipe, etc, facilities” during the project period of 22 years (loan period (25 years) – construction period (3 years)). Composition of the SPC’s balance sheet at the time of completion will be as follows.

Table 7.5.15 Balance Sheet of SPC when the Construction Completed
（Case 2 with only Phase 1）

(Unit: millions in JPY）

Construction completed			
Investment		Funding	
Initial Investment	11,042	Senior Loan	8,914
Intake/ Raw water transmission point	*1,989*	Equity	*2,229*
Water purification plant	*7,628*	*Developer*	*1,873*
Water conveyance system	*0*	*JICA*	*356*
Other	*1,426*		
Cash at hand	100		
Total	11,142	Total	11,142

1) EIRR 5%

Table 7.5.16 Average Water Sales Price
(Case 2 with only Phase1 targeted to EIRR 5%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	1,156,320,000 m3	29,136,846,878JPY	25JPY	11,144VND
Fixed (Reference)		30,081,561,722JPY	26JPY	11,921VND

※Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by "Fixed + Variable" method, sales price which ensures 5% of EIRR in case "Fixed" method is added as reference information for comparison.

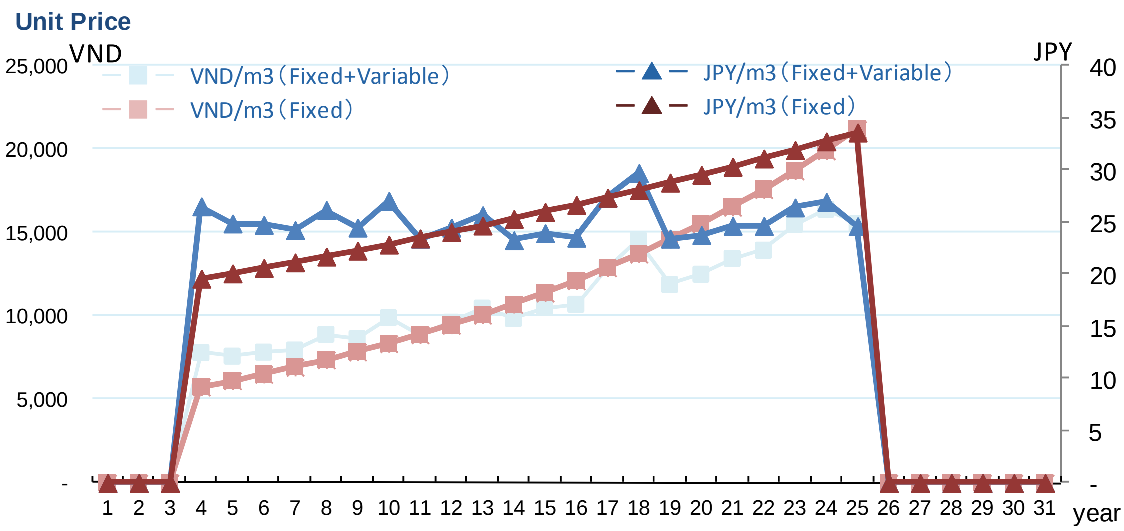


Figure 7.5.13 Transition of Average Water Sales Price
(Case 2 with only Phase 1 targeted EIRR 5%)

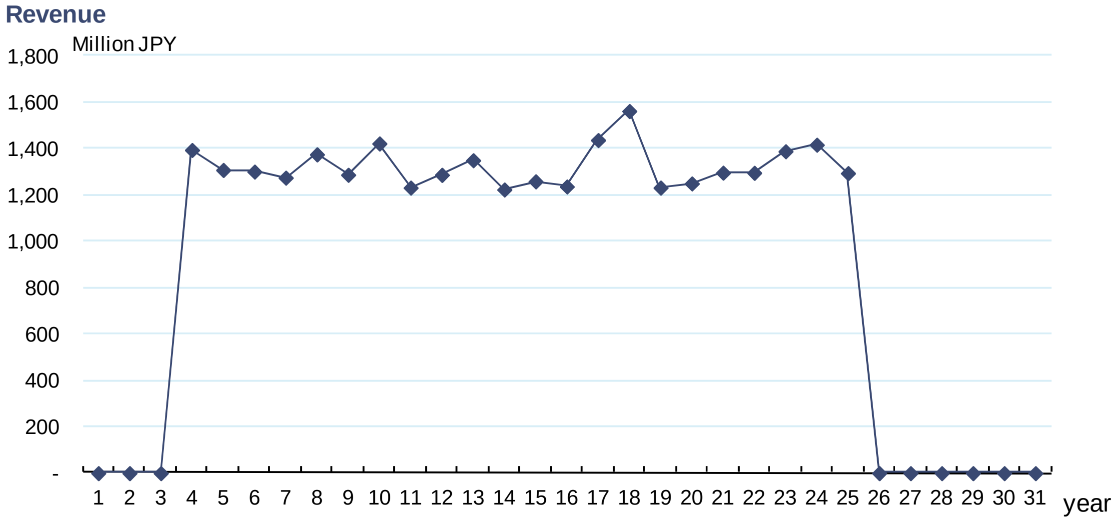


Figure 7.5.14 Transition of Revenue Amount
(Case 2 with only Phase 1 targeted EIRR 5%)

Table 7.5.17 Total Cash-in/Cash-out of the Project
(Case 2 with only Phase 1 targeted to EIRR 5%)

(Unit: millions in JPY)

Cash out		Cash in	
Initial Cost	11,042	Revenue	29,137
Renovation Cost	0		
Operating Cost	11,131		
Tax	289		
Interest	3,343		
Dividends	3,333		
Total	29,137	Total	29,137

2) EIRR 10%

Table 7.5.18 Average Water Sales Price

(Case 2 with only Phase1 targeted to EIRR 10%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	1,156,320,000 m3	33,225,999,070JPY	29JPY	12,669VND
Fixed (Reference)		35,948,504,632JPY	31JPY	14,246VND

※Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by "Fixed + Variable" method, sales price which ensures 10% of EIRR in case "Fixed" method is added as reference information for comparison.

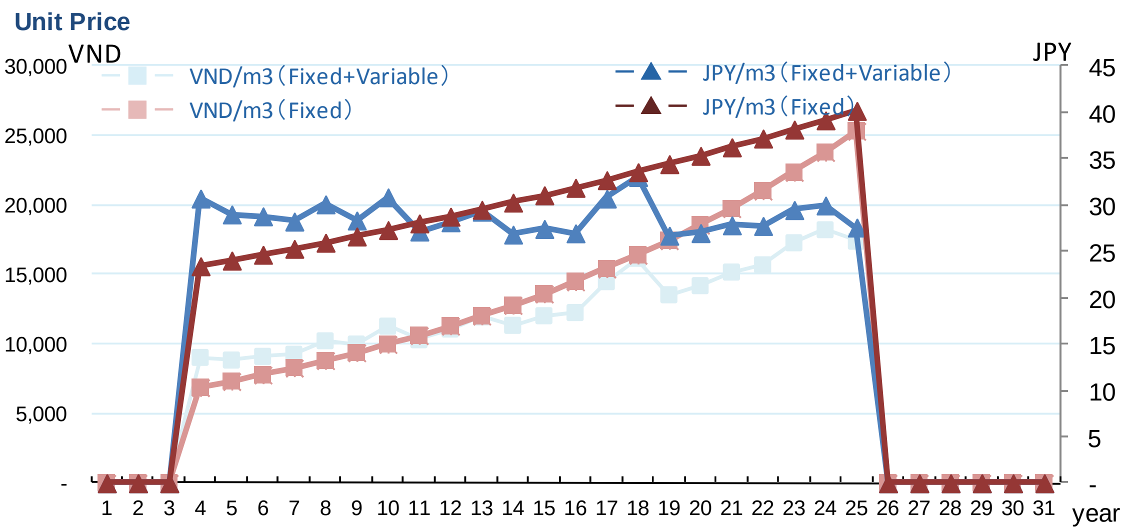


Figure 7.5.15 Transition of Average Water Sales Price

(Case 2 with only Phase 1 targeted EIRR 10%)

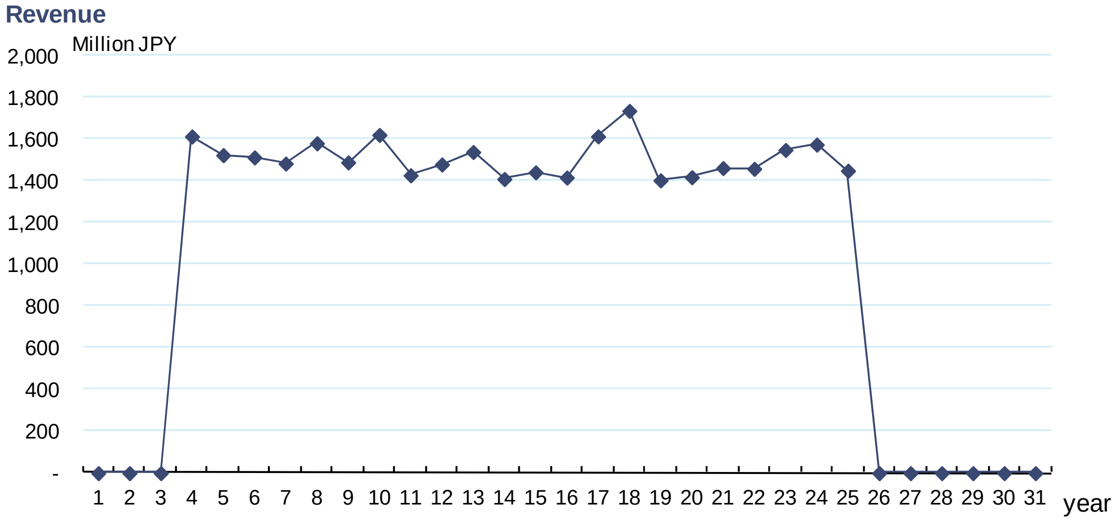


Figure 7.5.16 Transition of Revenue Amount
(Case 2 with only Phase 1 targeted EIRR 10%)

Table 7.5.19 Total Cash-in/Cash-out of the Project
(Case 2 with only Phase 1 targeted to EIRR 10%)

(Unit: millions in JPY)

Cash out		Cash in	
Initial Cost	11,042	Revenue	33,226
Renovation Cost	0		
Operating Cost	11,131		
Tax	525		
Interest	3,343		
Dividends	7,185		
Total	33,226	Total	33,226

3) EIRR 15%

Table 7.5.20 Average Water Sales Price
(Case 2 with only Phase1 targeted to EIRR 15%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	1,156,320,000 m3	37,857,352,587JPY	33JPY	14,397VND
Fixed (Reference)		42,193,941,501JPY	36JPY	16,722VND

※Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by "Fixed + Variable" method, sales price which ensures 15% of EIRR in case "Fixed" method is added as reference information for comparison.

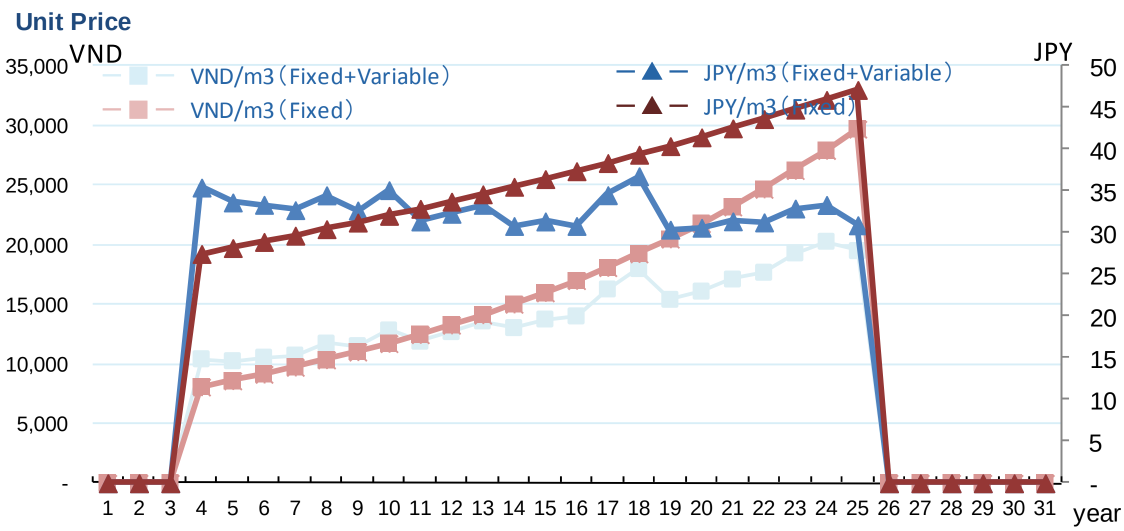


Figure 7.5.17 Transition of Average Water Sales Price
(Case 2 with only Phase 1 targeted EIRR 15%)

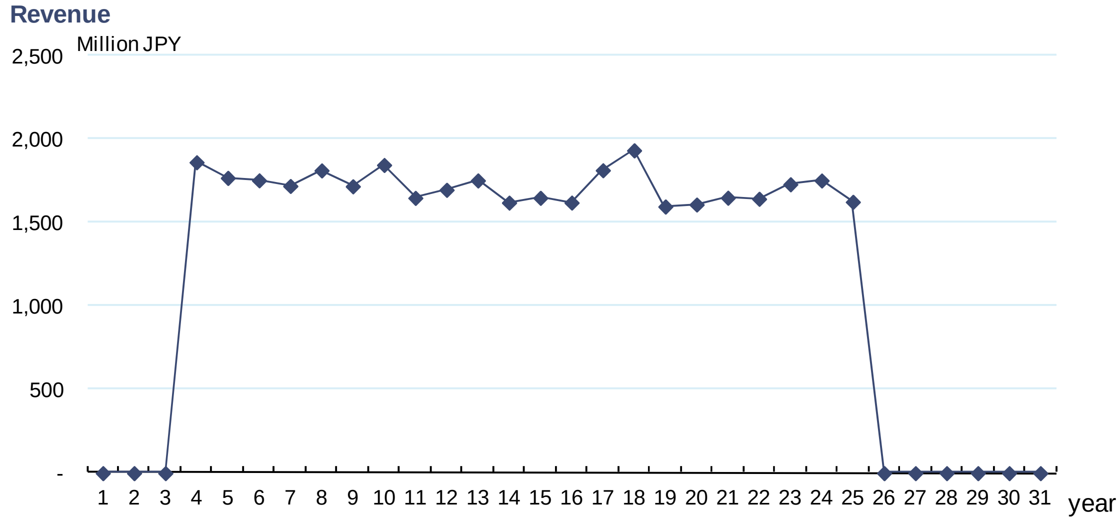


Figure 7.5.18 Transition of Revenue Amount
(Case 2 with only Phase 1 targeted EIRR 15%)

Table 7.5.21 Total Cash-in/Cash-out of the Project
(Case 2 with only Phase 1 targeted to EIRR 15%)

(Unit: millions in JPY)

Cash out		Cash in	
Initial Cost	11,042	Revenue	37,857
Renovation Cost	0		
Operating Cost	11,131		
Tax	793		
Interest	3,343		
Dividends	11,549		
Total	37,857	Total	37,857

(2) In Case of Phase 1&2

Analysis will be conducted on a case where the SPC is engaged in the construction, possession, maintenance, control and operation of “purification plant, etc, facilities” and “water pipe, etc, facilities” during the project period of 31 years (6 years (number of years up to the start of Phase 2 construction) + JICA loan period (25 years)). Composition of the SPC’s balance sheet at the time of completion will be as follows.

Table 7.5.22 Balance Sheet of SPC when the Construction Completed
(Case 2 with Phase 1 & 2)

(Unit: millions in JPY)

Construction completed			
Investment		Funding	
Initial Investment	17,758	Senior Loan	14,286
Intake/ Raw water transmission point	*2,657*	Equity	3,572
Water purification plant	*12,963*	*Developer*	*3,002*
Water conveyance system	*0*	*JICA*	*570*
Other	*2,138*		
Cash at hand	100		
Total	17,858	Total	17,858

1) EIRR 5%

Table 7.5.23 Average Water Sales Price
(Case 2 with Phase1 & 2 targeted to EIRR 5%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	2,630,190,000 m3	54,231,268,134JPY	21JPY	10,717VND
Fixed (Reference)		56,052,964,632JPY	21JPY	11,500VND

※Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by “Fixed + Variable” method, sales price which ensures 5% of EIRR in case “Fixed” method is added as reference information for comparison.

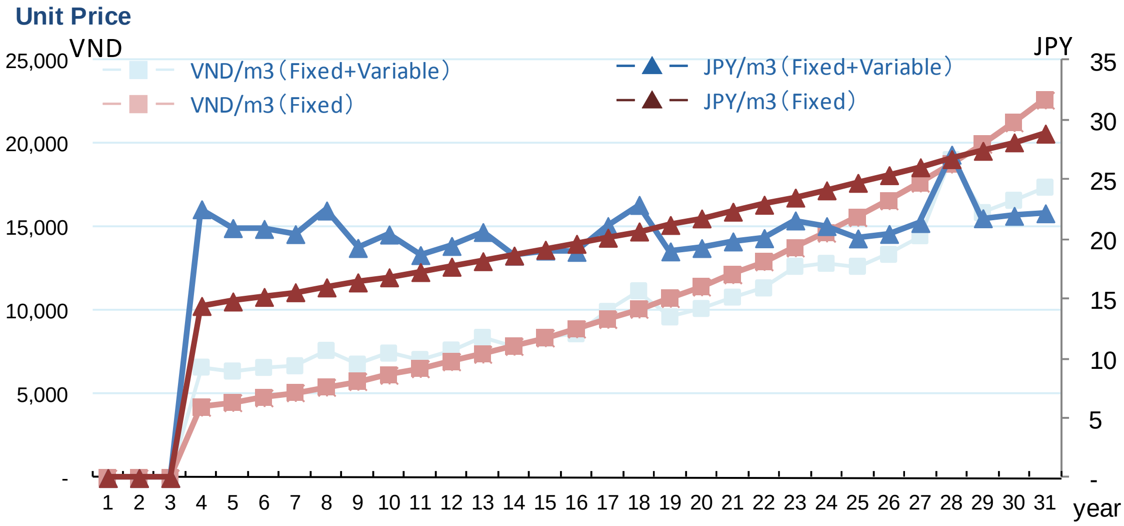


Figure 7.5.19 Transition of Average Water Sales Price
(Case 2 with Phase 1 & 2 targeted EIRR 5%)

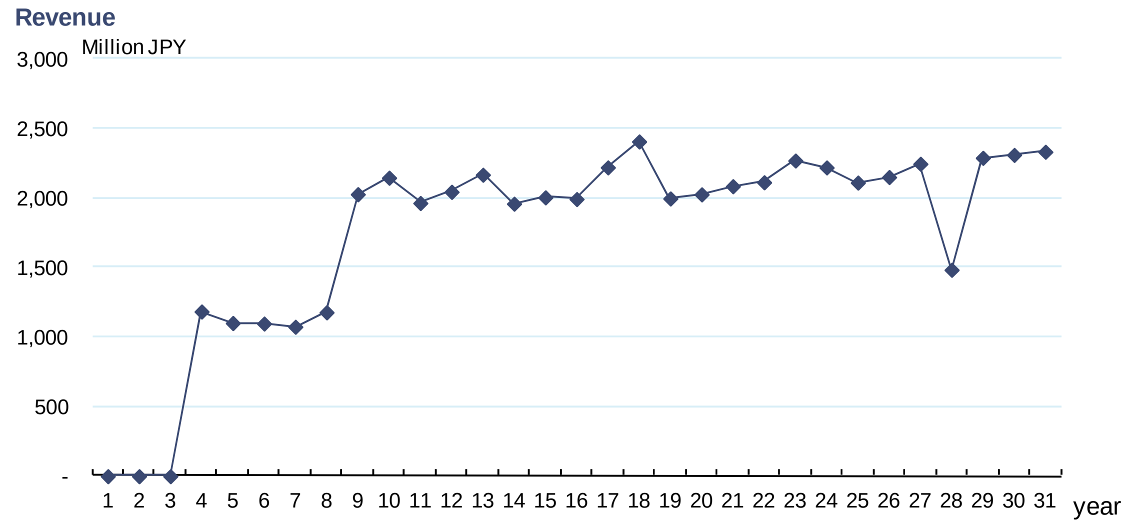


Figure 7.5.20 Transition of Revenue Amount
(Case 2 with Phase 1 & 2 targeted EIRR 5%)

Table 7.5.24 Total Cash-in/Cash-out of the Project
(Case 2 with Phase 1 & 2 targeted to EIRR 5%)

(Unit: millions in JPY)

Cash out		Cash in	
Initial Cost	17,758	Revenue	54,231
Renovation Cost	1,794		
Operating Cost	20,970		
Tax	730		
Interest	5,518		
Dividends	7,461		
Total	54,231	Total	54,231

2) EIRR 10%

Table 7.5.25 Average Water Sales Price
(Case 2 with Phase1 & 2 targeted to EIRR 10%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	2,630,190,000 m3	63,311,599,515JPY	24JPY	12,437VND
Fixed (Reference)		70,301,028,842JPY	27JPY	14,486VND

※Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by “Fixed + Variable” method, sales price which ensures 10% of EIRR in case “Fixed” method is added as reference information for comparison.

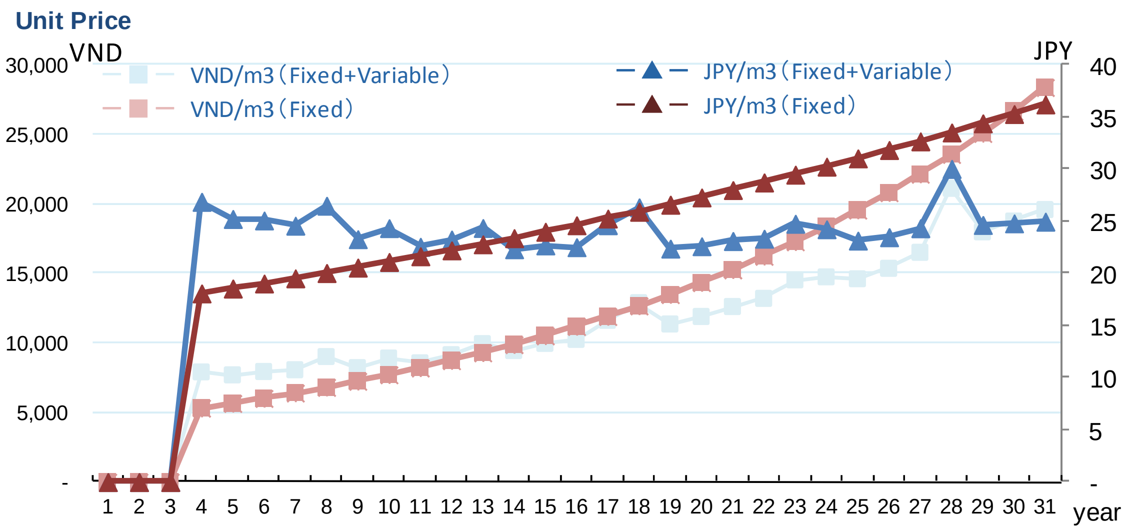


Figure 7.5.21 Transition of Average Water Sales Price
(Case 2 with Phase 1 & 2 targeted EIRR 10%)

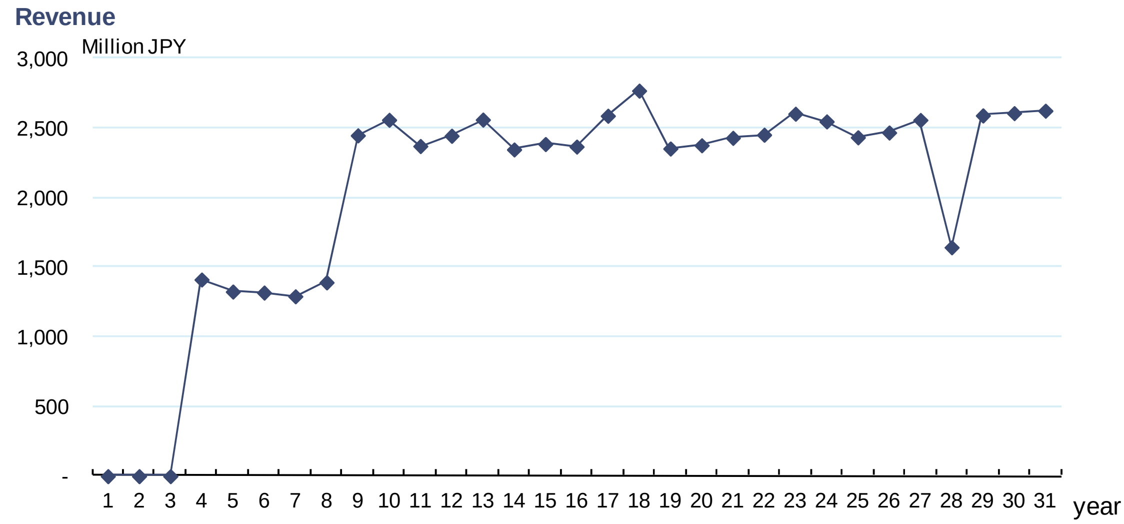


Figure 7.5.22 Transition of Revenue Amount
(Case 2 with Phase 1 & 2 targeted EIRR 10%)

Table 7.5.26 Total Cash-in/Cash-out of the Project
(Case 2 with Phase 1 & 2 targeted to EIRR 10%)

(Unit: millions in JPY)

Cash out		Cash in	
Initial Cost	17,758	Revenue	63,312
Renovation Cost	1,794		
Operating Cost	20,970		
Tax	1,390		
Interest	5,518		
Dividends	15,881		
Total	63,312	Total	63,312

3) EIRR 15%

Table 7.5.27 Average Water Sales Price
(Case 2 with Phase1 & 2 targeted to EIRR 15%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	2,630,190,000 m3	72,684,983,133JPY	28JPY	14,213VND
Fixed (Reference)		72,684,983,132JPY	33JPY	17,842VND

※Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)

Although Study Team shall recommend the revenue stream by “Fixed + Variable” method, sales price which ensures 15% of EIRR in case “Fixed” method is added as reference information for comparison.

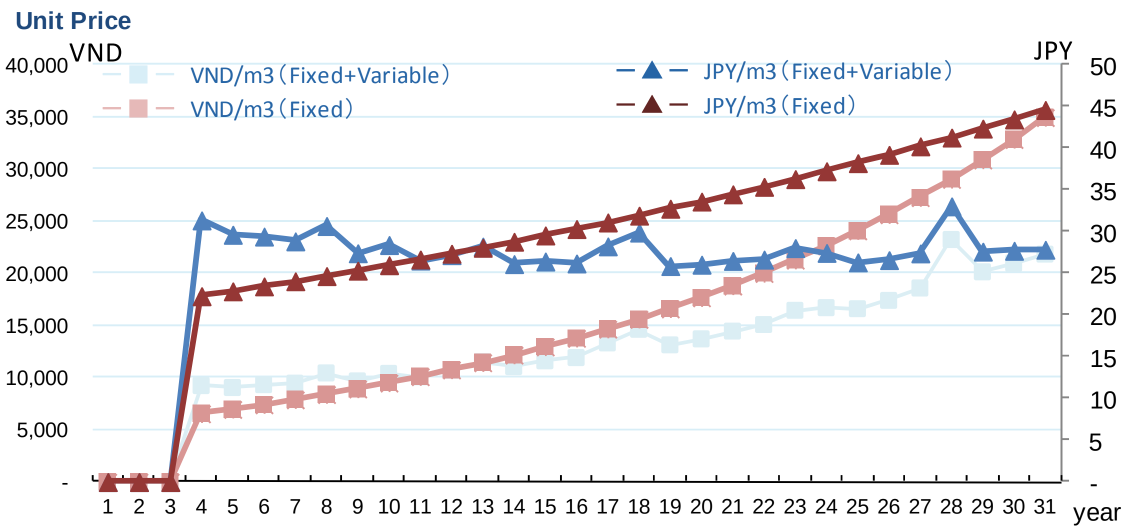


Figure 7.5.23 Transition of Average Water Sales Price
(Case 2 with Phase 1 & 2 targeted EIRR 15%)

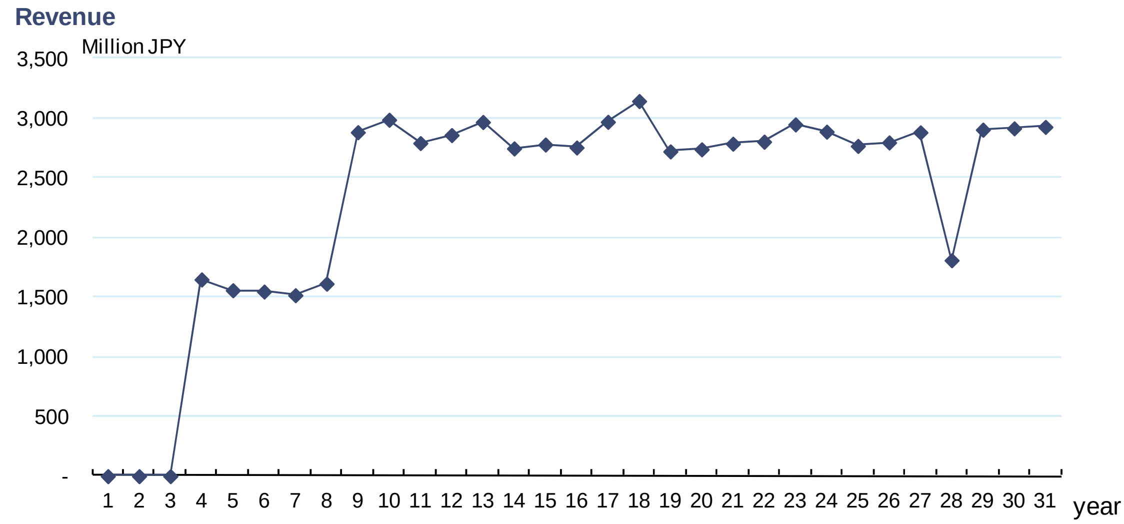


Figure 7.5.24 Transition of Revenue Amount
(Case 2 with Phase 1 & 2 targeted EIRR 15%)

Table 7.5.28 Total Cash-in/Cash-out of the Project
(Case 2 with Phase 1 & 2 targeted to EIRR 15%)

(Unit: millions in JPY)

Cash out		Cash in	
Initial Cost	17,758	Revenue	72,685
Renovation Cost	1,794		
Operating Cost	20,970		
Tax	2,060		
Interest	5,518		
Dividends	24,584		
Total	72,685	Total	72,685

7.5.3 Selection of Base Case

Based on the analyses so far, base case for the negotiation between stakeholders shall be decided as described herein below.

(1) Alternatives for the Base Case

EIRR, Minimum Cash, Minimum DSCR and average water sales price are abstracted from the above analyses from the standpoint of project feasibility to select the base case.

Table 7.5.29 Alternatives for the Base Case (Case 1)

Phase 1 only			
Target IRR	5%	10%	15%
Average water sales price(VND/m3)	15,816VND	17,544VND	20,310VND
Minimum Cash (millions in JPY)	100	100	100
Minimum DSCR	1.19	1.48	1.77
Phase1&2			Base Case
Target IRR	5%	10%	15%
Average water sales price(VND/m3)	13,067VND	15,601VND	18,329VND
Minimum Cash (millions in JPY)	100	100	100
Minimum DSCR	0.79	1.07	1.38

Table 7.5.30 Alternatives for the Base Case (Case 2)

Phase 1 only			
Target IRR	5%	10%	15%
Average water sales price(VND/m3)	11,144 VND	12,669VND	14,397VND
Minimum Cash (millions in JPY)	100	100	100
Minimum DSCR	1.13	1.43	1.77
Phase1&2			
Target IRR	5%	10%	15%
Average water sales price(VND/m3)	10,717 VND	12,437VND	14,213VND
Minimum Cash (millions in JPY)	100	100	100
Minimum DSCR	0.84	1.15	1.48

Results regarding the case 2 has been included here as reference information because there is high uncertainty for case 2 from the viewpoint of possibility of the project as previously described and thus study Team shall take into account the case 1 results only below to select the base case.

In case the “Fixed + Variable” method is applied for the unit price for selling water, this cannot be shown in a price for a certain fiscal year as “Variable” method. Thus, it is calculated by dividing the earnings for selling water for the project period by the water supply amount during the project period. It has been confirmed that when the “Fixed + Variable” method and the “Variable” method were compared, the unit price for selling water was more expensive under the “Variable” method.

As can be seen from the graph “Unit Price” attached in “7.5.1”, the unit price for selling water under the “Fixed + Variable” method immediately after starting to supply water is higher than the “Variable” method for all calculation results, but as such unit price does not rise greatly in later fiscal years under the “Fixed + Variable” method, it was also confirmed that the unit price under the “Fixed + Variable” method will be less expensive after approximately 10 years from the start of the project. This is mainly because by applying the payment formula previously described, the “Fixed + Variable” method which does not consider the inflation factor regarding the amount equivalent to “charges for collecting invested amounts” (“Debt services + Investment Return + Corporate Tax, etc”) and the appreciation rate of the unit price for selling water remains gradual. Compared to the “Fixed” method where the inflation rate is applied to all charge receipts, this indicates that the “Fixed + Variable” method becomes less expensive as the fiscal years proceed.

For the water companies, off taker, all calculation results seem expensive if they compare with the current unit price for selling water, but it is important that the more time passes and the more unit price get much cheaper compared with the price calculated by “Fixed + Variable” method.

In the calculation, the funding is set so that the cash and deposit in hand at the time of start of the operation period is 100 million yen. As such, the fact that the minimum cash and deposit in hand in the above table is shown as 100 million yen indicates that cash and deposit in hand has increased from the initial level after the start of the operation period and cash and deposit in hand remains to be free of issues in all cases.

In terms of minimum DSCR, it is said that project cash flow should be reviewed so that the minimum would be 1.2-1.5 in general (JICA Research Institute (2005), ‘PPP (Public-Private Partnership)’). For this simulation, it has been confirmed that in order to achieve this, the unit price for selling water must be set at a level of EIRR of 10% or more.

However, it could not be concluded that the range between 1.3 and 1.5 is appropriate for DSCR referring general case because this project has high public interest. Putting much value on LLCR (Loan life coverage ratio) than DSCR is one option as well.

There are various kinds of views on the minimum EIRR for investors. One is the method in which EIRR shall exceed the amount calculated by adding up financing cost including equity and interest gap between domestic and international. Following formula shows the result using weighted average capital cost (WACC) of listed companies on the Tokyo Stock Exchange for financing cost including equity and average of international interest-spread between JPY and VND during the last 5 years.

9.2% (WACC of listed companies on the Tokyo Stock Exchange) + 8.3% (8.9%(average interest rate of VND during the last 5 years) – 0.6%(average interest rate of JPY during the last 5 years)) = 17.5%

Table 7.5.31 Trends in Interest Rate of JPY and VND
(JPY：TIBOR 3month, VND：Policy rate by Central Bank, Unit：%)

	2007	2008	2009	2010	2011	5 years average
JPY	0.71	0.82	0.60	0.38	0.34	0.6
VND	8.3	12.0	7.0	8.0	9.0	8.9

In one scenario, Return of Investment (ROE) which exceeds minimum DSCR determined considering project risk and country risk could be set as minimum return for investors. On the other hand, some says low EIRR is acceptable in the case with low risk in domestic PFI project. The level of EIRR depends on the project scheme and Study Team tentatively sets 15% as target EIRR because project structure for this project is under discussion.

The table below shows that EIRR should be more than 11 % at least because the average ROE in the past 3 years in Japan is 11% (excluding negative data) and spread to cover the project risk and country risk shall be consider.

Table 7.5.32 Average ROE of Listed Company in Japan

	Year 2008	Year 2009	Year 2010	Average
ROE	11%	12%	10%	11%

Based on the above prerequisite, alternatives shall be narrowed down to the cases with “Phase 1 targeted to EIRR 10%”,”Phase 1 targeted to EIRR 15%”, and “Phase 1&2 targeted to EIRR 15%” from the table 7.5.29 and either the case with “Phase 1 targeted to EIRR 15%” or “Phase 1&2 targeted to EIRR 15%” shall be realistic option because ROE exceeds 11%. Furthermore, the case with “Phase 1&2 targeted to EIRR 15%” is the most preferable option taking account into the sales price level.

7.5.4 Assumptions and Results of the Base Case

Followings are the assumptions and results of the base case which are previously described.

(1) Project Scheme

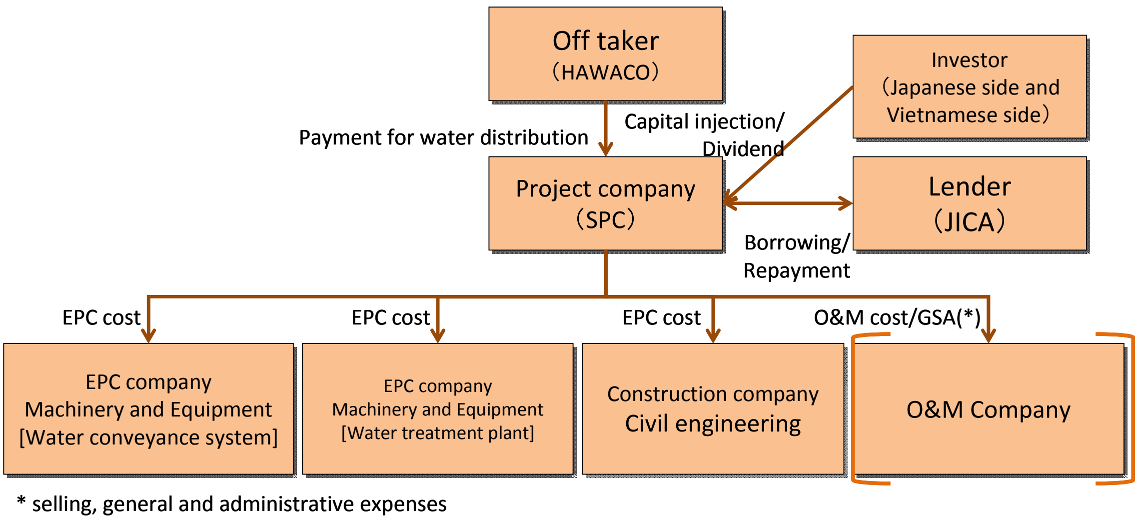


Figure 7.5.25 Project Cash Flow of Case1

(2) Project Period

Table 7.5.33 Main Project Schedule

Items	Assumptions
Project Anniversary	1 January 2012
Foundation of SPC	6 months prior to Signing day of LA
Signing day of LA	6 months prior to Construction Period
Construction Period	Phase 1 : 2012 to 2014（3 years） Phase 2 : 2018 to 2019（2 years）
O&M・Revenue Commencement	The day from which operation shall be commenced and tariff shall be charged. Phase1 : 1 January 2015 Phase2 : 1 January 2020
O&M Period	<u>Phase 1 only:</u> 22years （JICA Loan Period（25 years）－Construction Period（3 years））
	<u>Phase1 & 2:</u> 28 years （3 years (years until construction of phase 2 shall be commenced)＋JICA Loan Period（25 years））
End of Concession Period	<u>Phase 1 only:</u> End of 2036 （2012＋JICA Loan Period（25 years）－1）
	<u>Phase 1 & 2:</u> End of 2042 （2012＋｛6 years(years until construction of phase2 shall be commenced)＋JICA Loan Period（25 years）｝－1）
Liquidation of SPC	A year later after the end of O&M Period <u>Phase 1 only:</u> End of 2037 <u>Phase 1 & 2:</u> End of 2043

(3) Initial Investment Costs

Table 7.5.34 Estimates of Direct Costs and Indirect Costs as of 2010 Price

(Unit: billions in VND)

Items	Phase1	Phase2	Total
Intake and raw water transmission facilities	483.0	160.6	643.6
water treatment plant	2,038.4	1178.6	3,217.0
water conveyance system	1,563.9	-	1,563.9
Start-up costs	115.6	101.4	217.0
Total	4,200.9	1,440.6	5,641.5

(Figures are originally estimated with several kinds of currencies and exchanged into JPY by the rate as of 2011. Each figure was adjusted that total amount of each item equals to the figure shown in total.)

(4) Cash-in/Cash-out Total of Project Period

Table 7.5.35 Balance Sheet of SPC when the Construction Completed
(Case 1 with Phase 1 & 2)

(Unit: millions in JPY)

Construction completed			
Cash out		Cash in	
Initial Cost	24,542	Revenue	94,417
Renovation Cost	2,078		
Operating Cost	20,970		
Tax	3,025		
Interest	7,558		
Dividends	36,245		
Total	94,417	Total	94,417

(5) Average Sales Price

Table 7.5.36 Average Water Sales Price
(Case 1 with Phase 1 & 2 targeted to EIRR 15%)

	Water Purification Capability during the project period (m3)	Sales revenue of water supply during the project period (JPY)	Average Unit Price (JPY/m3)	Average Unit Price (VND/m3)
Fixed + Variable	2,630,190,000 m3	94,416,957,728JPY	36JPY	18,329VND

※Average Unit Price = Sales revenue of water supply during the project period ÷ Water Purification Capability during the project period

(Reference)
Although Study Team shall recommend the revenue stream by “Fixed + Variable” method, sales price which ensures 15% of EIRR in case “Fixed” method is added as reference information for comparison.

(6) Target EIRR(Dividend base)/Minimum Cash /Minimum DSCR

1) Target EIRR : 14.97%
2) Minimum Cash : 1 million JPY
3) Minimum DSCR : 1.38

(7) Financing Plan

1) Equity
   - Assumption that 20%, of total financing amount

2) Loan
   - Assumption that 80%, of total financing amount
   - Borrowed in Yen and swapped into USD
   - Interest rate for Yen loan of 2.0%
   - Swap cost 1.0%
   - Repayment period of 25 years,
   - Grace period of 5 years for Phase 1
   - Other fees: Upfront fee 1.5%, Commitment fee 1%, Lawyer/Agent fee etc.
   - Set up Debt Service Reserve Account（allocate debt service amount for one year for each tranche）

Shareholders’ loan will be considered in the future.

7.6 Sensitivity Analysis

In this subchapter, Study Team shall quantify the risk analyzed in the chapter 5 assuming the base case. Further suggestion from the results shall be developed in the chapter 8.

7.6.1 Quantification of the Risk

(1) Risks to be Quantified

There are 16 risks scored as “3” in “Table 5.4.2 Risk Allocation” and each risk are examined whether it could be quantified and how it could be in the following

The risks categorized in the project scheme which Study Team assuming can be quantified regarding the above 16 risks. The other hand, the risks extend beyond the assumed project scheme, such as No.7 & 8 which means calculation with different payment formula, No.10 & 11 which means the lack of preconditions for the project, can not be quantified. In other words, there would be the risk uncontrollable by private sector in the case these risks arise and investor shall decide not to proceed with the project. No.16 is spared as well because it means non dividend.

Given these facts, 11 risks abstracted from the 16 risks scored “3” in risk matrix eliminating No.7,8,10,11 and 16 are selected to be quantified.

Table 7.6.1 Quantification of Major Risks and Means for Them

No.	Project Stage	No. in Table 5.4.3	Category 1	Category 2	Category 3	Risk	Risk Details	Quantification	Means for quantification
1	General	2	External Factor	Law/ Regulation	Approval	SPC can't obtain necessary approvals.	・ Necessary measures are not taken for the approvals required by SPC (concession rights, water rights, water supply licenses etc.) Concession rights provided to VIWASEEN cannot be maintained and assigned to SPC.	○	・ Delay in project schedule (Delay in revenue stream)
2	General	11	Financial	Interest rate		Interest rate	・ Cost increase due to rising interest rates.	○	・ Rising interest rate

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No.	Project Stage	No. in Table 5.4.3	Category 1	Category 2	Category 3	Risk	Risk Details	Quantification	Means for quantification
3	General	12	Financial	Financing		Financing - SPC	・ SPC cannot raise funds at appropriate term/currency. Interest.	○	・ Shortening of the borrowing period ・ Borrowing in VND ・ Rising interest rate
4	General	15	Commercial	Revenue	Demand	Demand lower than demand projection	・ Demand is lower than 150k ton/day for Phase 1 and 2.	○	・ Reduction in water sales amount.
5	General	16	Commercial	Revenue	Demand	Contract with appropriate size	・ Plan is changed during the project period and affects the size of facility.	○	・ Reduction in water sales amount.
6	General	18	Commercial	Revenue	Demand	Competitor	・ Take or pay contract is not introduced aiming to avoid competitive environment.	○	・ Reduction in water sales amount.
7	General	25	Commercial	Revenue	Tariff revision	Payment Method	・ Inappropriate formula for payment to SPC.	×	・ Calculation with different payment formula is necessary but difference between payment methods is not comparable.
8	General	26	Financial	Fluctuation in exchange	Currency	Currency	・ Mismatch between the currency of payment and currency received.	×	・ Calculation with different payment formula is necessary but difference between payment methods is not comparable.

No.	Project Stage	No. in Table 5.4.3	Category 1	Category 2	Category 3	Risk	Risk Details	Quantification	Means for quantification
9	General	28	Commercial	Revenue	Off-Taker Risk	Default in paying service payment	・ Default in paying service payment for the reason attributed to Off-Taker.	○	・ Reduction in revenue.
10	General	31	Commercial	Cost	Development plan	Government Subsidy/ Capital Injection/ Development as public work	・ Necessary government subsidy, capital injection, or development of related infrastructure is not provided.	×	・ Reduction in revenue.
11	General	32	Commercial	Cost	Infrastructure	Delay in GOV's work	・ Delay in construction by delay in Government work (i.e. land acquisition, land lease and marginal infrastructure (power, road and telecommunication).	×	・ Could not be quantified the prerequisite for the project.
12	Construction	47	Commercial	Cost	Inflation	Increase in Inflation	・ SPC's EPC costs will increase due to inflation.	○	・ Increase in the inflation rate of EPC cost(Fixing the inflation factor in revenue formula).
13	Construction	48	Finance	Forex		changes in fore	・ Cost increase in changes in forex.	○	・ Decrease in the forex volatility of VND/JPY of EPC cost(EPC cost is composed by VND and JPY).
13	Operation	55	Commercial	Cost	Inflation	Inflation rate increase	・ SPC's O&M costs will increase due to inflation.	○	・ Increase in the inflation rate of O&M cost(Fixing the inflation factor in revenue.

No.	Project Stage	No. in Table 5.4.3	Category 1	Category 2	Category 3	Risk	Risk Details	Quantification	Means for quantification
									formula).
15	Operation	56	Finance	Forex		changes in forex	・ Cost increase in changes in forex.	○	・ Decrease in the forex volatility of VND/JPY of O&M cost(O&M cost is composed by VND and JPY).
16	Operation	57	External Factor	Country risk	Forex	Overseas remittance	・ Breakdown of overseas remittance system through which SPC repay debt service and distribute dividend. ・ Stop of clearing function by decrease of foreign currency reserves.	×	

(2) Categorization Criteria and Setting the Conditions for Quantification

Besides above abstracted 11 risk factors for quantification, the impact by the change in D:E ratio from 80:20 to 70:30 and 75:25 shall be quantified. Detailed conditions for the calculation are set as below.

Table 7.6.2 Setting the Conditions for Calculation

No	No. in Table 7.6.1	Means for quantification	Conditions for calculation	Remarks
1	1	・ Delay in project schedule (Delay in revenue stream).	・ Delay in O&M period by 1 year. ・ Delay in O&M period by 2 years.	
2	3	・ Shortening of the borrowing period	・ Change in the borrowing period of 25 years to 20 years.	・ Project period shall be shortening as well.
3	3	・ Borrowing in VND	・ Compared borrowing in JPY with the assumption of base case to borrowing in VND with interest rate 11%. ・ Compared borrowing in JPY with the assumption of base case to borrowing in VND with interest rate12%.	
4	2,3	・ Rising interest rate	・ Change in the interest rate of 3% to 4% including swap cost of 1%. ・ Change in the interest rate of 3% to 5% including swap cost of 1%.	
5	4,5,6,9	・ Reduction in water sales amount/revenue	・ Reduction in water sales amount by 25%. ・ Reduction in water sales amount by 50%.	・ Cost incurred as projected although the amount of the water sales declines.
6	12,14	・ Increase in the inflation rate of O&M cost(Fixing the	・ Increase in inflation rate by 1% for cost side. ・ Increase in inflation rate	・ Inflation rate for cost side increases fixing

No	No. in Table 7.6.1	Means for quantification	Conditions for calculation	Remarks
		inflation factor in revenue formula).	by 2% for cost side.	the inflation factor in revenue formula.
7	13,15	· Decrease in the forex volatility of VND/JPY of EPC and O&M portion revenue(EPC and O&M cost is composed by VND and JPY).	· Decrease in the forex volatility of VND/JPY of O&M cost by 1% · Decrease in the forex volatility of VND/JPY of O&M cost by 2%.	· Forex volatility for cost side increases fixing the forex factor in revenue formula.
8		· The change in D:E ratio	· D:E ratio = 75:25 · D:E ratio = 70:30	

(3) Calculation Results

Each major risk scored as “3” was quantified through the EIRR, Minimum Cash, Minimum DSCR and EIRR elasticity shown in Table 7.6.3.

Table 7.6.3 Results of Risk Quantification

No	No. in Table 7.6.2	Base case	Stress case		EIRR in JPY (Dividend base)	Minimum Cash (Millions in JPY)	Minimum DSCR	EIRR Elasticity
Base case					14.97%	100	1.38	
1	1	O&M service shall be commenced from the year 2015 and terminated in the year 2042	Delay in project schedule because of delay in permission (Delay in revenue stream).	O&M service shall be commenced from the year 2016 and terminated in the year 2042.	13.26%	-330	0（*1）	-3.21
2	1			O&M service shall be commenced from the year 2017 and terminated in the year 2042.	12.26%	-761	0（*1）	-2.54
3	2	Borrowing period for 25 years (Operation shall be ended with the year 2042)	Borrowing period for 20 years (Operation shall be ended with the year 2037).		13.79%	100	1.14	-0.40
4	3	Borrowing in JPY (Borrowing period for 25 years, Grace period for 5 years, Interest rate for	Borrowing in VND	Compared borrowing in JPY with the assumption of base case to borrowing in VND with interest rate 11%.	9.81%	-617 （-209,800,000,000VND (*2)）	0.75 (*3)	N/A (Not comparable)

					EIRR in JPY (Dividend base)	Minimum Cash (Millions in JPY)	Minimum DSCR	EIRR Elasticity
5	3	3%(including swap cost for 1%), D:E ration 80:20).		Compared borrowing in JPY with the assumption of base case to borrowing in VND with interest rate 12%.	9.14%	-1,114 （-378,600,000,000VND (*2)）	0.71 (*3)	N/A (Not comparable)
6	4	Interest rate for 3%	Increase in interest rate	4% (+1%)	13.39%	100	1.21	-0.32
7	4			5% (+2%)	11.80%	100	1.07	-0.32
8	5	water sales amount 54,750,000 m3/year	Reduction in water sales amount/revenue	Reduction in water sales amount by 25% (41,063,000 m3/year)	14.07%	100	1.31	-0.24 (*3)
9	5			Reduction in water sales amount by 50% (27,375,000 m3/year)	13.15%	100	1.25	-0.24 (*3)
10	6	Inflation rate in the payment formula described as “Fixed with inflation” and “Variable with inflation” JPY0%,VND 6.4%, USD3.5%	Increase in the inflation rate of O&M cost(Fixing the inflation factor in revenue formula).	Inflation rate for cost side (+1%) JPY1%,VND 7.4%, USD4.5%	13.95%	100	1.35	N/A (From the point of JPY)
11	6							-0.44 (From the point of VND)
12	6							-0.24

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					EIRR in JPY (Dividend base)	Minimum Cash (Millions in JPY)	Minimum DSCR	EIRR Elasticity
		Inflation rate for cost side JPY0%,VND 6.4%, USD3.5%						(From the point of USD)
13	6			Inflation rate for cost side (+2%) JPY2%, VND 8.4%, USD5.5%	12.82%	100	1.3	N/A (From the point of JPY)
14	6							-0.46 (From the point of VND)
15	6							-0.25 (From the point of JUSD
16	7	Base Case VND/JPY 3.70% VND/USD2.00% JPY/USD -1.64%	Stress Case Decrease in the forex volatility of VND/JPY of EPC and O&M cost.(EPC and O&M cost is composed by VND and JPY)	Decrease in Forex volatility (-1%) VND/JPY 2.70% VND/USD2.00% JPY/USD -1.64%	13.62%	100	1.34	-0.33
17	7			Decrease in Forex volatility (-2%) VND/JPY 1.70% VND/USD2.00% JPY/USD -1.64%	11.55%	100	1.29	-0.42

					EIRR in JPY (Dividend base)	Minimum Cash (Millions in JPY)	Minimum DSCR	EIRR Elasticity
18	8	D:E ratio = 80:20	Change in the proportion of D:E ratio	D:E ratio = 75:25(*4)	13.16%	100	1.48(*5)	-0.48
19	8			D:E ratio = 70:30(*4)	11.80%	100	1.59(*5)	-0.42

*1 : Debt services proceed without revenue if the commencement year delays because the grace period could not be extended.

*2 : Converted JPY into VND with the exchange rate of the year with minimum cash.

*3 : Calculated the elasticity per 1,000m3 because the elasticity per 1m3 is too small to consider.

*4 : Unit price left unchanged to compare the base case with the stress case although the unit price for “Charges for collecting invested amounts” which include debet repayment should be recalculated because total borrowing amount should be changed.

*5 : Decrease in borrowing amount contributes to the increase of DSCR although EIRR decreases.

7.6.2 Analysis for the Calculation Results

(1) Elasticity of EIRR

Table 7.6.3 shows that the elasticity of EIRR by "Delay in project schedule (Delay in revenue stream)" (No.1 and 2) is much lower than others and it suggests that "Delay in project schedule (Delay in revenue stream)" could be high risk in the project. The value of elasticity is largely over – 0.5 and there is not much difference between them.

(2) EIRR

Table 7.6.3 shows that the EIRR in case of the "Borrowing in VND" (No.4 and 5) declined into 9% and "Borrowing in VND" could have a considerable impact on the project. This is mainly because the managed float system in Vietnam's foreign exchange market in which interest-rate arbitrage can't fully work and the interest cost in case of borrowing in VND is relatively higher than in case of borrowing in JPY.

"Decrease in the forex volatility of VND/JPY of EPC and O&M cost(EPC and O&M cost is composed by VND and JPY)(-2%)" (No.16 and 17), "Increase in interest rate to 5%(+2%)" (No.7) and "Change in the proportion of D:E ratio to 70:30" (No.19) follow "Borrowing in VND" (No.4 and 5) in terms of the reduction of EIRR.

EIRR of 15% could be considered enough for the risk "Decrease in the forex volatility of VND/JPY of EPC and O&M cost (EPC and O&M cost is composed by VND and JPY)(-2%)" (No.16 and 17) because the risk shall occur on a single year basis although the result shown in Table-7.6.3 has been quantified assuming the occurrence of the risk throughout the total project period.

As for "Change in the proportion of D:E ratio to 70:30" (No.19), EIRR of 15% could be considered because its impact to EIRR is not so large.

(3) Overall

Followings could have the considerable impact on EIRR according to the quantification of the major risks analyzed above.

- "Delay in project schedule (Delay in revenue stream)" (No.1 and 2)
- "Borrowing in VND" (No.4 and 5)

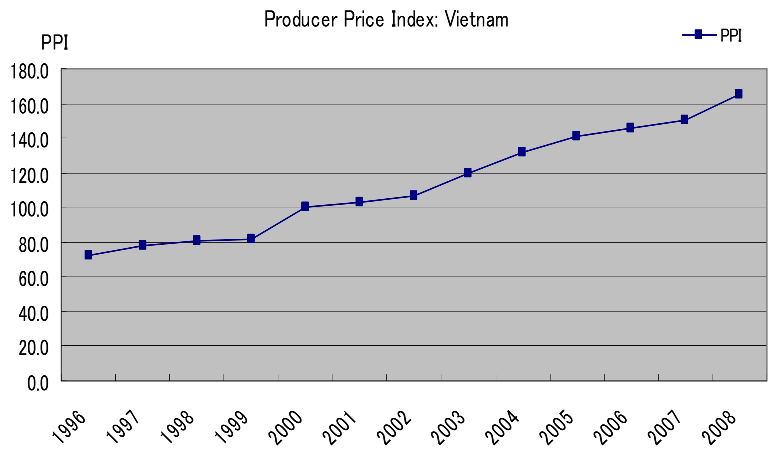
- "Decrease in the forex volatility of VND/JPY of O&M cost (O&M cost is composed by VND and JPY)" (No.16 and 17)
- "Increase in interest rate to 5%" (No.7)
- "Change in the proportion of D:E ratio to 70:30" (No.19)

To ensure the stable cash flow, thorough countermeasures should be taken especially for the above risks.

【Attachment 1】Producer Price Index（PPI）:Viet Nam

① Viet Nam (Attachment1-1)

year	PPI
1996	72.524651
1997	77.498817
1998	80.998557
1999	81.211777
2000	100
2001	102.61872
2002	106.93823
2003	119.32365
2004	131.37022
2005	140.72252
2006	145.67195
2007	150.67457
2008	165.15771

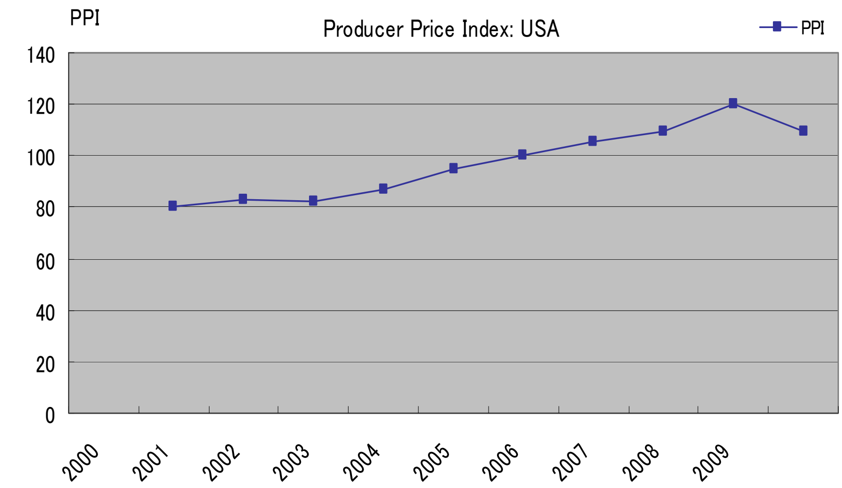


Based on year 2000 1.064725

Source: Viet Nam General Statistics

② USA (Attachment 1-2)

year	PPI
2000	80.00
2001	82.81
2002	82.40
2003	87.20
2004	95.20
2005	100.00
2006	105.40
2007	109.40
2008	120.00
2009	109.20

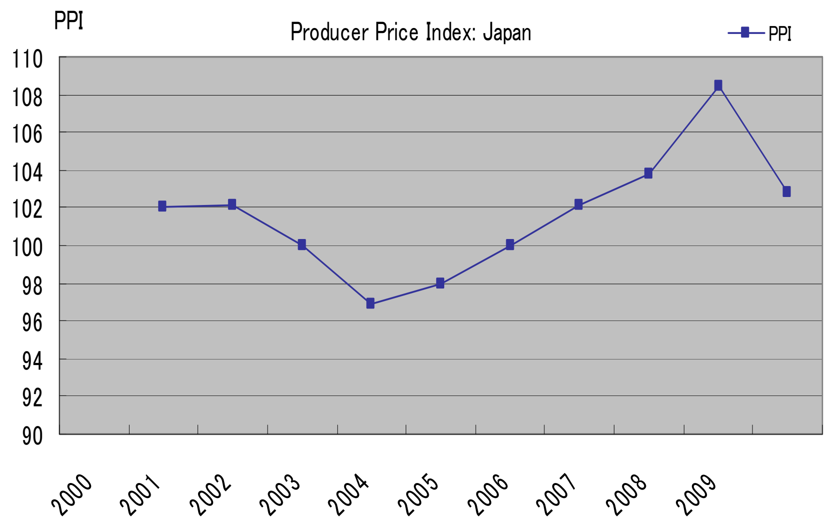


Based on year 2000 1.035177

Source: World Statistics

③ Japan（Attachment 1-3）

year	PPI
2000	102.04
2001	102.12
2002	100.00
2003	96.94
2004	97.96
2005	100.00
2006	102.10
2007	103.80
2008	108.40
2009	102.80



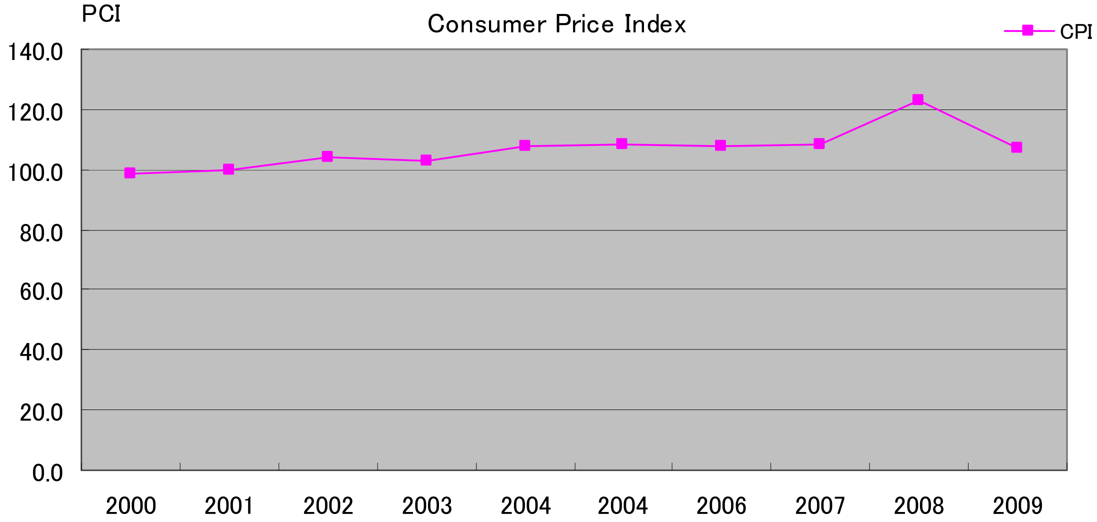
Based on year 2000 1.000824

【Attachment 2】Consumer Price Index: Viet Nam (Attachment 2-1)

year	2000	2001	2002	2003	2004	2004	2006	2007	2008	2009
CPI	98.4	99.8	103.9	103.1	107.8	108.3	107.5	108.3	123.0	106.9

Source: Viet Nam General Statistics

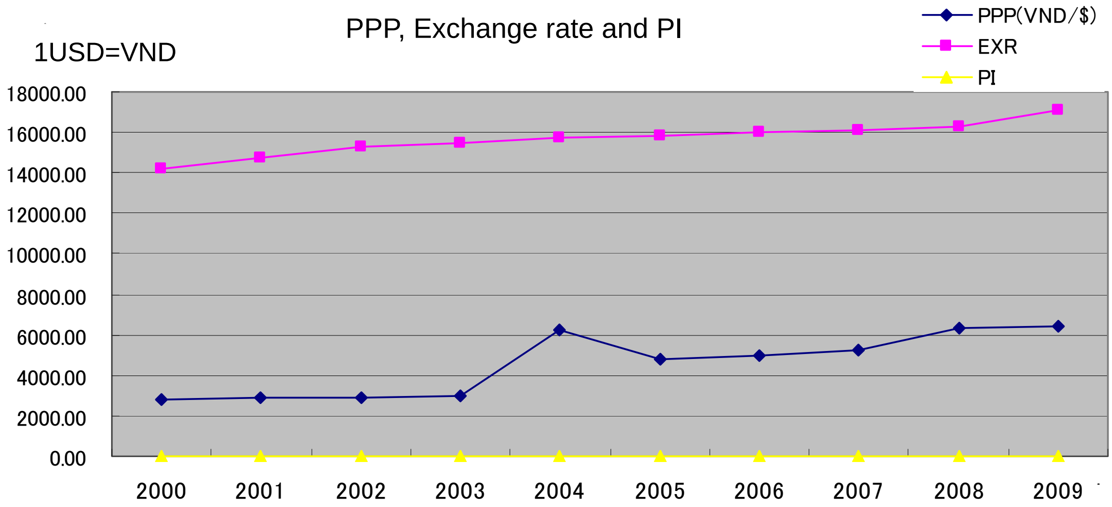
Based on year 2000：1.07517



【Attachment 3】Foreign Exchange Rate and Purchasing Power Parity (PPP)

① VND/USD（Source: Viet Nam General Statistics, IMF data）(Attachment 3-1)

PPP(VND/USD)	EXR	PI	year
2811.51	14168	0.1984406	2000
2913.65	14725	0.1978713	2001
2879.36	15280	0.1884396	2002
3004.42	15510	0.1937087	2003
6200.11	15746	0.393758	2004
4751.78	15859	0.2996264	2005
4956.05	15994	0.3098696	2006
5271.26	16105	0.3273056	2007
6314.74	16302	0.38736	2008
6455.40	17065	0.3782829	2009



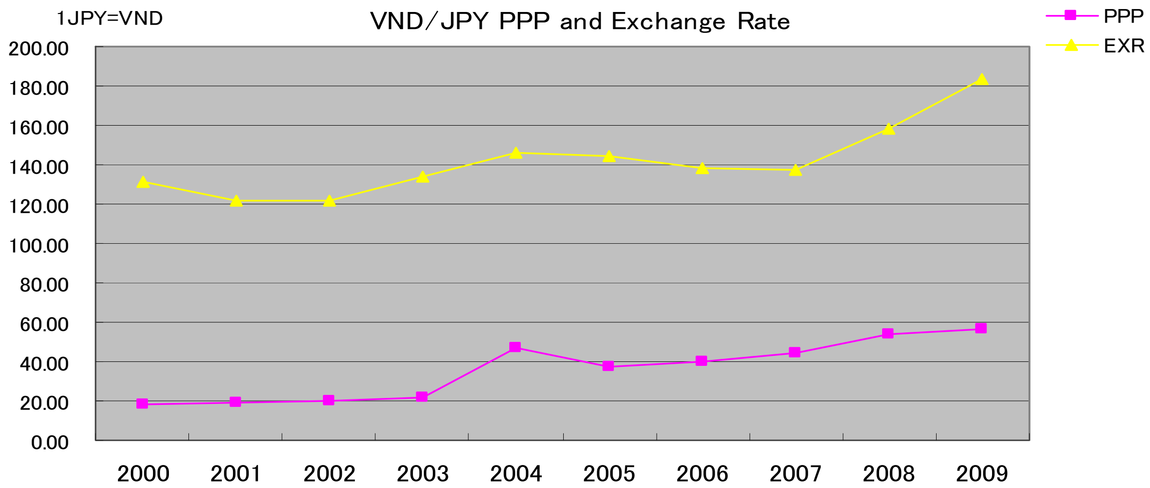
PI=Price Index

・Average change rate for year 2000 - 2009 : 1.0208867

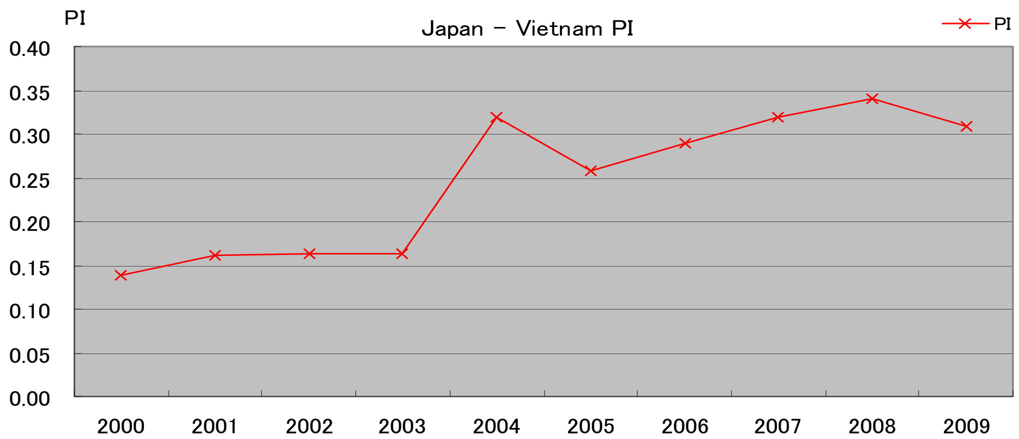
② VND/JPY (Attachment 3-2)

year	PPP	EXR	PI
2000	18.14	131.63	0.14
2001	19.55	121.56	0.16
2002	20.00	122.03	0.16
2003	21.77	133.75	0.16
2004	46.62	145.80	0.32
2005	37.12	144.17	0.26
2006	39.97	137.88	0.29
2007	43.93	137.65	0.32
2008	53.97	158.27	0.34
2009	56.63	183.49	0.31

Source: World Statistics

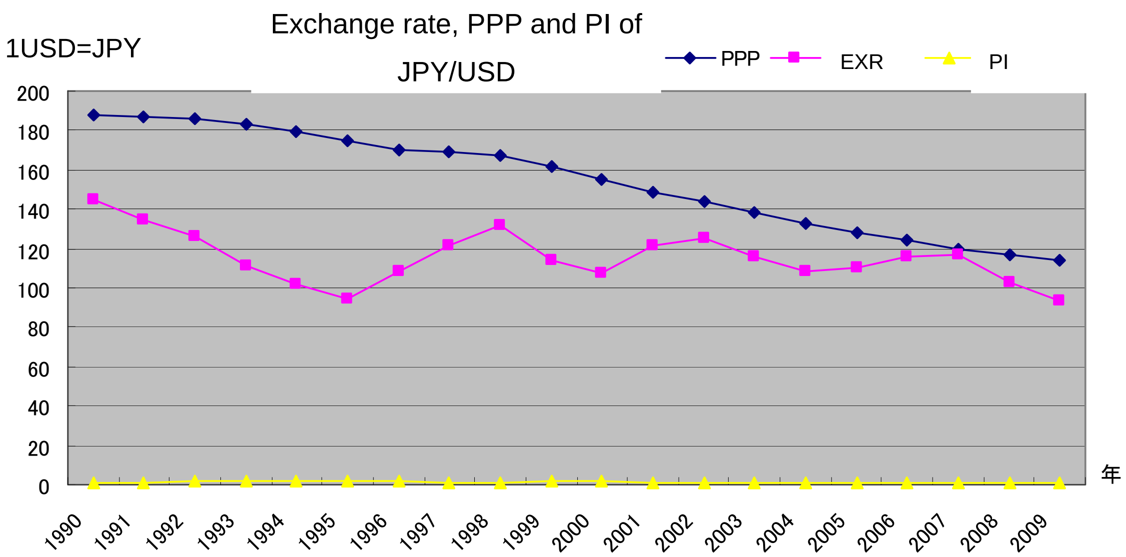


・Average change rate for year 2000 - 2009 : 1.0376038

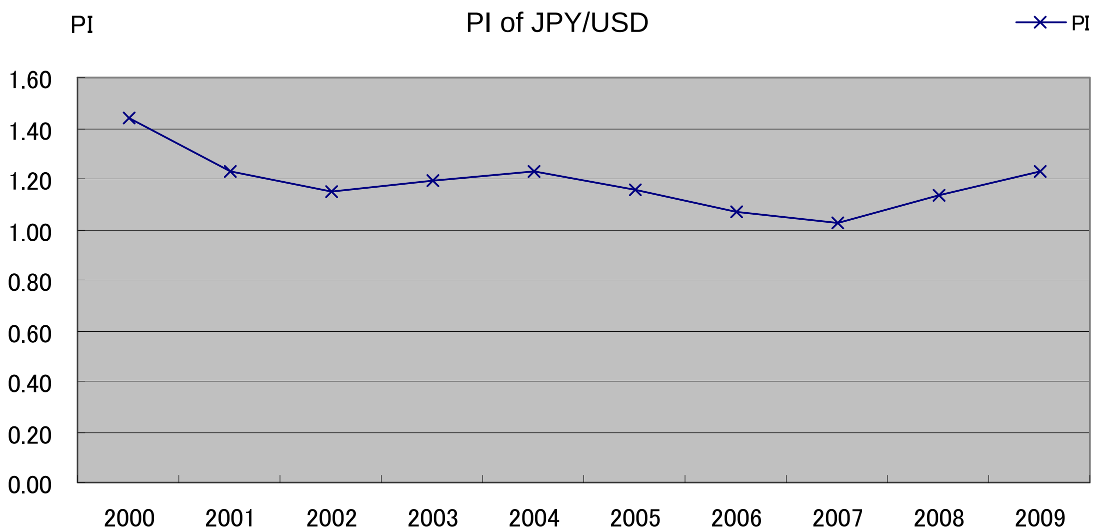


③ JPY/USD (Attachment 3-3)

year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
PPP	155	149	144	138	133	128	124	120	117	114
EXR	108	121	125	116	108	110	116	117	103	93
PI	1.44	1.23	1.15	1.19	1.23	1.16	1.07	1.03	1.14	1.23



PI＝Price Index



・Average change rate for year 2000 - 2009 : 0.9838887

8. Issues and Proposals on Management and System

This chapter proposes the appropriate risk bearing method under this project assuming the risk mitigation measures and other countermeasures, described in Chapter 5. It also proposes the requests to the Vietnamese and Japanese Governments in order to make feasible project structure.

8.1 Management

An appropriate level of profitability is a prerequisite for investors to carry out this project under PPP scheme for stable and long-term operation. From this viewpoint, this section will identify the open issues recognized in developing the project according to investors' action towards the realization of the project, and will also sort out matters to be proposed based on the concept of PPPs from the viewpoint of investors.

(1) Double Risk Control Measures

As described in Chapter 5, each risk could be controlled as long as the risk mitigation measures and countermeasures are taken by the player who can control the risk appropriately. However, investors have to secure the continuity of the project in case the risk mitigation measures and countermeasures are not taken for same reasons by having a margin to bear the financial damage.

Investors need to set a certain level of profitability including satficient margin against the risks scored as "3" in Table 5.4.4, which are highly likely to occur and presumed to give large impact on the project. On the other hand, from the viewpoint of off-taker, higher profitability for investors leads to higher level of the tariff and results in the difficulty for the off takers to accept the project. Study Team summarized countermeasures for the risks by analyzing the balance between the continuity of the project and high tariff level in Chapter 7 referring the base case, presuming EIRR for 15%.

Table 8.1.1 shows that the risk mitigation measures and countermeasures for the risk scored "3". In the column, "Coping by the margin" "〇" means investors are highly likely to cope with the risks to the extent that project meets a profitability that Study team presumes, "△" means investors may cope with risks and "×" means investors will have difficulty in accepting the project because the impact of the risks is beyond the ability of the private sector. Private sector cannot carry out the project without strong commitment by the Government regarding the risk marked with “×” It is preferable for the Government to provide some measures to protect profits for investors.

Table 8.1.1 Risk Mitigation Measures and Countermeasures as Investor

No. in Table 5.4.2	Project Stage	No. in Table 5.4.2	Category 1	Category 2	Category 3	Risk	Risk Details	Coping by the margin
1	General	2	External Factor	Law/ Regulation	Approval	SPC can't obtain necessary approvals.	・ Necessary measures are not taken by centralor local government for the approvals required by SPC (concession rights, water rights, water supply licenses etc.). Concession rights provided to VIWASEEN cannot be maintained and assigned to SPC.	× (The risk could not been born by the private sector and indispensable to acquire the guarantee from the Vietnamese government.)
2	General	11	Financial	Interest rate		Interest rate	・ Cost increase due to rising interest rates.	△ (EIRR declines into the level to the extent sponsor can't inject the equity at the beginning of the project in terms of investor when interest rate increases by 1%. Sufficient discussion with JICA as lender is indispensable.
3	General	12	Financial	Financing		Financing - SPC	・ SPC cannot raise funds at appropriate term/currency. Interest.	Tenor: △ (Some allowance on EIRR as long as tenor exceeds 20 years although the tight condition on DSCR.)
3								Currency: × (EIRR declines into the level that sponsor can't inject the equity at the beginning of the project investors may not be able to make a choice of "VND borrowing".)
3								Interest rate: △ (Refer to No.2)
4	General	15	Commercial	Revenue	Demand	Demand lower than demand projection	・ Demand is lower than 150k ton/day for Phase 1 and 2.	△ (Decrease in the amount water purchased within 25% is acceptable for SPC because

No. in Table 5.4.2	Project Stage	No. in Table 5.4.2	Category 1	Category 2	Category 3	Risk	Risk Details	Coping by the margin
								of the payment formula which enables SPC to recollect the amount equivalent with its invested capital.)
5	General	16	Commercial	Revenue	Demand	Contract with appropriate size	・ Assumed demand (150,000m3/day for Phase 1 and Phase 2) at the beginning is no longer consistent with that of the latest.	△ (Decrease in the amount water purchased within 25% is acceptable for SPC because of the payment formula which enables SPC to recollect the amount equivalent with its invested capital.)
6	General	18	Commercial	Revenue	Demand	Competitor	・ Take or pay contract is not introduced aiming to avoid competitive environment.	△ (Decrease in the amount water purchased within 25% is acceptable for SPC because of the payment formula which enables SPC to recollect the amount equivalent with its invested capital.)
7	General	25	Commercial	Revenue	Tariff revision	Payment Method	・ Payment to SPC is not made based on an appropriate formula	× (Sponsors can't inject the equity at the beginning of the project in terms of investor because it means the application of the fixed method as payment formula which shall not work as countermeasures for the risk, No.15, 16, 18 and 28.)
8	General	26	Financial	Fluctuation in exchange	Currency	Currency	・ Mismatch between the currency of payment and currency received.	× (Sponsors can't inject the equity at the beginning of the project in terms of investor because it means the application of the fixed method as payment formula which shall not work as countermeasures for the risk, No.15, 16, 18 and 28.)
9	General	28	Commercial	Revenue	Off-Taker Risk	Default in paying service payment	・ Default in paying service payment for the reason attributed to Off-Taker.	△ (Decrease in the amount water purchased within 25% is acceptable for SPC because of the payment formula which enables SPC to recollect the amount equivalent with its invested capital.)
10	General	31	Commerci	Cost	Development	Government Subsidy/ Capital Injection	・ Necessary government	× (The BOT and off take contracts shall not

No. in Table 5.4.2	Project Stage	No. in Table 5.4.2	Category 1	Category 2	Category 3	Risk	Risk Details	Coping by the margin
			al		plan		subsidy, capital injection, or development of related infrastructure is not provided.	be concluded without VGF because 18,329VND/cubic meter assumed as the Average Consumption Price for the base case does not fall within the range of Average Consumption Price for filtered water for the “special urban district” that Hanoi corresponds to as stipulated under Decision No.100/2009/ TT-BTC by MOF in 2009 (minimum 3,000VND/ cubic meter, maximum 12,000VND/cubic meter)
11	General	32	Commercial	Cost	Infrastructure	Delay in commercial operation and increase in construction cost due to the delay in GOV's work	・ Delay in construction by delay in Government work (i.e. land acquisition, land lease and marginal infrastructure (power, road and telecommunication), change in the scope of the project or failure by the government for operation and maintenance.	× (Sponsors can’t inject the equity at the beginning of the project because development of the marginal infrastructures.)
12	Construction	47	Commercial	Cost	Inflation	Increase in Inflation	・ SPC's EPC costs will increase due to inflation.	△ (Increase in the CPI within 2% is acceptable for SPC because of the payment formula which enables SPC as both EIRR and DSCR are likely to stay in an acceptable range.)
13	Construction	48	Finance	Forex		changes in forex	・ Cost increase in changes in forex.	△ (Decrease in the foreign exchange volatility within 2% is acceptable for SPC as both EIRR and DSCR are likely to stay in an acceptable range.)
14	Operation	55	Commercial	Cost	Inflation	Inflation rate increase	・ SPC's O&M costs will increase due to inflation.	△ (Increase in the CPI within 2% is acceptable for SPC as both EIRR and DSCR are likely to stay in an acceptable

No. in Table 5.4.2	Project Stage	No. in Table 5.4.2	Category 1	Category 2	Category 3	Risk	Risk Details	Coping by the margin
								range.)
15	Operation	56	Finance	Forex		changes in forex	・ Cost increase in changes in forex.	△ (Decrease in the foreign exchange volatility within 2% is acceptable for SPC as both EIRR and DSCR are likely to stay in an acceptable range.)
16	Operation	57	External Factor	Country risk	Forex	Overseas remittance	・ SPC is unable to pay debit services and make dividend payments. ・ Stop of clearing function by decrease of foreign currency reserves.	× (Apparently, EIRR is negative)
N/A	General	N/A	Financial	Financing		Change in D:E ratio	・ Decrease in Debit ratio	△ (Change in D:E ratio up to 75:25 is acceptable for SPC. But equity over 25% of total project cost will invoke the heavy decrease in EIRR to the level that sponsor cannot inject the equity at the beginning of the project.)

(2) Appropriate Level of DSCR and EIRR for Investors

Investors estimates the level of return in making an investment decision by taking into consideration of the probability of occurrence and size of loss so that, even if a risk is realized, it can ensure the business opportunity of the project. This is the basic concept for such a project as PPP. Rating agencies also refer to DSCR (debt service coverage ratio; a ratio indicating the level of security of repayments) as one of their rating policies.

The DSCR is determined by financial institutions based on the probability of occurrence of a risk and the size of loss. Putting much value on LLCR (Loan life coverage ratio) than DSCR is one option because this project has high public interest although this project, as stated under Chapter 7, assumes around 1.3 in general terms. When borrowing funds externally, the debit service payments will be prioritized over dividend to be paid to investors, and the determination of the level of DSCR will naturally lead to the determination of the lower limit for the level of EIRR. From the investors' point of view, Study Team assumes the minimum conditions for this project as a level of 15% for EIRR in general terms as calculated in the analysis under realization of risk under Chapter 7, and considers the scheme to achieve such level. Following are the items to be discussed by study team for the realization of 15% for EIRR

2) Suggestion and consensus building on off-take price (unit price) which achieves 15% of EIRR under off-take contact with HAWACO.
3) Suggestion of financial terms for lenders to achieve 15% of EIRR and consensus building on it.

8.2 Necessary Support from the Governments

In this Chapter, Study Team would like to make the following proposals to the government of both countries as necessary measures to mitigate risks and ensure countermeasures discussed in Chapter 5 which is the precondition for realizing this project under the PPP scheme as previously described.

8.2.1 Governmental Support Required from the Vietnamese Government and Japanese Government

The following are the issues that need to be resolved for Japanese companies to invest in this project:

(1) Government Approval to the Conversion of VIWASEEN's BOO Concession Right into a BOT Concession Right, and the Transfer of the Rights to a VIWASEEN-related SPC

VIWASEEN, a state-owned enterprise (SOE), has obtained a concession right for this project as a BOO project from the Presidential Office. The project is currently positioned at a pre-F/S level. In order for Japanese companies to participate in this project, the project must be a BOT project instead of a BOO project in accordance with the Investment Law (Law No.59/2005/QH11). However, a BOT project must comply with Decree No.108/2009/ND-CP. Study Team has obtained approval from VIWASEEN to transfer the project into a BOT project upon participation by Japanese investors. Study Team proposes the governments to assist the presiding authority make a governmental decision to permit the conversion of the BOO concession right granted to VIWASEEN into a BOT concession right to this project of which VIWASEEN is the main party, in other words, and to apply this BOT construction right to the VIWASEEN-related SPC.

(2) Government Undertaking on the Volume Off-Take for Purified Water up to 300,000m3/day

The SPC in this project will need a Take or Pay Agreement with Water Company for the volume of purified water by 150,000m3/day and 300,000m3/day in oeder to secure the project feasibility. Study Team proposes a guarantee from the Ministry of Construction (or Ha Noi City) for purchasing the amount of water to be supplied.

(3) Adjustments between this Project and the Pilot Projects under the PPP Law

It was recently stated that the Red river water project in the northern part of Hanoi's metropolitan area was listed in the short list of pilot projects based on the PPP Law (Decision No.71/2010/QD-TTg) by the governmental authorities led by Ministry of Planning and Investing. It is also said that the excess portion of the Da river BOO water project that supplies water to the southern part of Hanoi's metropolitan area.

In the above case, the feasibility of this project could be negatively impacted depending on progress of the projects which are in a competitive position with this project. Thus, Study Team proposes that a guarantee be given to ensure this project.

(4) Adoption of a Method to the Payment System that Combines the "Capacity Payment" and "Variable Payment"

For the payment system for the off take price, Japanese companies that will be investing in the project assume combing method of the "Capacity Payment" and "Variable Payment" which is currently actually being adopted by the power generation IPP project in Vietnam.

The background of the adoption of this method is based on the concept of how to manage "inflation risk" and "foreign exchange risk" to which Japanese companies as overseas investors are exposed.

Under this project, funds that will be invested and loaned from Japan (loan amount is approximately 19.7 billion yen (80% of the total project cost) and investment amount is subject to discussion among Japanese investors) and mainly that compose the project's asset building portion, will be made in "Capacity Payment" on the assumption that the Japan side will bear the inflation risk and which is a fixed expense payment that does not consider inflation to secure the cash for repayment. The variable payment portion for which it is assumed that the off taker side will bear for Vietnam's inflation during the O&M period will be in "Variable Payment."

Next, for avoiding the "foreign exchange risk" that Japanese investors will be exposed to assuming Vietnam's macroeconomic situation under which it is experiencing high inflation caused by trade deficit, decrease in foreign reserves and the rise in import price. The Japanese investor side proposes the off take payment to be "denominated in USD and paid in VND."

Step up method is preferable in the case of bank loan to secure the project feasibility because traditional payment formula for project finance, "capacity payment", results in extremely expensive unit price. Unit price calculated with step up method increases every year with certain ratio defined in off-take contract as considered in 7.4 regardless actual inflation rate. VDB shall require spread because VDB bears forex risk and rate of appreciation for unit price in the case of step up method should be set to the extent that tariff covers the cost brought by forex risk.

(5) Payment Support for the Off Take Price (VGF system based on the output)

In Vietnam, water operators can propose an "Average Consumption Price" which is determined by the average cost to provide the purified water that includes a profit (3% of investment), based on the Inter-Circular No.95/2009/TTLT-BTC-BXD-BNN, issued by Ministry of Finance (MOF) in 2009 regarding both wholesale and retail water charges. As it would be difficult for this project to secure necessary profitability according to the level of current water charges (refer to the results of the financial analysis). The project define the off take price, which equals to water charges, based on this Average Consumption Price.

The Average Consumption Price which will be the base case for this project has been calculated as 18,329VND/m3. As this price does not fall within the range of Average Consumption Price for filtered water for the "special urban district" that Hanoi corresponds to as stipulated under Decision No.100/2009/ TT-BTC by MOF in 2009 (minimum 3,000VND/ cubic meter, maximum 12,000VND/cubic meter), Study Team proposes the Vietnamese government's measures on purchases to be applied to this difference in amount.

(6) Clarification on the Position of the Project in the Metropolitan Development Plan and Confirmation of the Importance

Arrangement for the marginal infrastructure system is prerequisite for the project by Government side. The risk at the project delay cannot be controlled by private sectors.

Therefore it is necessary to clarify the schedule assumed in the related governmental development plan, coordinate them and confirm its importance to consider the reasonable schedule of the project in the metropolitan development plan. Study Team proposes a governmental guarantee for the damages result from the delay in the project schedule due to Government side's delay.

(7) Encouragement the Consensus Building between the Sponsors by Governmental Support for the Vietnamese Sponsor

This project will be conducted and managed by SPC to be established by VIWASEEN that is a SOE that is granted BOO concession right by the Presidential Office, HAWACO who is a member of the off taker, Metawater and JICA who are expected as Japanese investors. Therefore, consensus building is required among investors through the common financial analysis results to structure the project scheme, including scopes of the project, investment structure, financing conditions, profit sharing, risk sharing, etc. Study Team would like to propose requesting cooperation from VIWASEEN that has been granted the BOO concession right from the central government agency and HAWACO who is a member of the off taker, for the realization of the project.

(8) Establishment and Implementation of a Monitoring Agency for the Project by the Vietnamese and Japanese Governments

When the SPC is making a direct borrowing for this project, JICA may collect various data as a right under the loan agreement from the SPC each time for drawdown during the construction period, on a monthly or annual basis, or regularly. Study Team proposes that both Vietnamese and Japanese Government may hold meeting to resolve issues for such cases as that off-take payment is not paid in accordance with Off-take Agreement and the case that outward remittance is actually prohibited. Study team propose that JICA requests the Vietnamese government for the establishment of a monitoring agency for the Vietnamese and Japanese governments to hold meetings each time a loan is disbursed during the construction period (quarterly, at minimum) and semi-annually after completion, and to engage proactively in actions to identify and rectify issues at an early stage, based on such data.

8.2.2 Assistance Required from the Japanese Government

Study team would like to propose the following items to the Japanese government.

(1) Payment Support for the Off Take Price (VGF system based on the output)
Study Team proposes the establishment of a fund through which the Japanese Government to provide fiscal assistance for the output-based VGF to the Vietnamese Government, as described above.

(2) Establishment and Implementation of a Monitoring Agency for the Project by the Vietnamese and Japanese Governments
As proposed in the section 8.2.1 "Governmental Support Required from the Vietnamese Government and Japanese Government", Study Team expects the Japanese Government a leading role to establish a monitoring agency, based on JICA's involvement. Study Team considers that fulfillment of obligation by Japan side and Viet Nam side defined in the contracts has the effect on the success and failure of the project. Therefore, it is important to establish the institution which guarantees the fulfillment of obligation which project members owe in the event of contractual failure of either party.