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

FINAL REPORT
VOLUME I SUMMARY

May 2012

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

METAWATER CO., LTD
TOKYO ENGINEERING CONSULTANTS CO., LTD
KUBOTA CORPORATION
PRICEWATERHOUSE COOPERS CO., LTD

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 investiment 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.

The Preparatory Survey on The Duong River Water Supply System Project
in The Socialist Republic of Viet Nam

Final Report
Summary

TABLE OF CONTENTS

List of Figures

List of Tables

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
SBV	State Bank of Vietnam

Abbreviation	
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 below.

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	18.6 billion USD (In 2010, 17.8% decrease compared to the previous year)

	foreign country (authorization amount)	
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)

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

2.2 Survey Contents

The followings show the contents of the analysis.

① Water Resource Survey
- Water quality survey for Hong River, Da River (including Hoa Bin Dam) and Lo River (including Tac Ba Dam).
- Water quality analysis (Turbididy etc., 12 items)

② Duong River Raw Water Quality Analysis
- Raw water quality tests near the proposed Water Treatment Plant site.
  - ✓ Daily examination of raw water (Everyday survey at the same time)
  - ✓ 24hours continuous sampling survey (Each hour survey for continuous 24 hours)
  - ✓ Consignment examination of raw water and treated water (Collecting sample water for each Team visit)
- Water Quality Analysis
  - ✓ Daily examination (Turbididy etc., 10 items)
  - ✓ 24hours continuous sampling survey (Turbididy etc., 6 items)
  - ✓ Consignment examination (28 standard items, 3 agricultural chemical items, 14 water treatment target items)

③ Duong River Raw Water Treatment Survey
- Settling Characteristics
  - ✓ Particle Size Distribution
  - ✓ Settling Time and Turbidity
- Jar-Tests
  - ✓ Coagulant types (11 types)
  - ✓ Dosing rate (Raw water turbidity etc.)
  - ✓ Mixing rate and time (Rapid mixing, Slow mixing)
  - ✓ Others (pH value, Aluminum Concentration, etc.)

- Chlorine Demand
  - ✓ Dosing rate of chlorine
  - ✓ Others (Supernatant test, etc.)

- Sludge Thickening Characteristics
  - ✓ Sludge concentration

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

(1) Doung River water resource survey

- Da River (including Hoa Bin Dam), Lo River (including Tac Ba Dam) and Hong River (before and after joining).
  - ✓ Hong River, begins in China's Yunnan province, and enters Viet Nam at Lao Cai Province. Then, Hong River (Thao River named before joint) joints Da River (downstream of Hoa Bin Dam) around Co Do City, and joints Lo River (downstream of Tac Ba Dam) around Viet Tri City.
- Da River, Lo River and Hong River analysis results.
  - ✓ Hong River (Thao River): Turbidity is high, but electrical conductivity is low.
  - ✓ Da River and Lo River: Turbidity is low but electrical conductivity is high. Pollution by human factors is small.
  - ✓ pH value was steady around 8 for all three rivers.
  - ✓ Duong River water, which is tributary of Hong River, has same characteristics of Hong River after joining two rivers.

(2) Duong River Water Quality survey

- Daily Sampling
  - ✓ Testing everyday during survey period.
  - ✓ Duong River water, which is tributary of Hong River, has same characteristics of Hong River after joining two rivers.
  - ✓ Rainfall is very small during the Dry season. Turbidity is low (maximum 50 degree). Electrical conductivity is 200 μ S/cm.KMnO4 consumption value is low.
  - ✓ Rainfall is large in the Rainy season. Turbidity is high (maximum 141 degree). Electrical conductivity is 170 μ S/cm.KMnO4 consumption value is high, and closely related to turbidity.
  - ✓ SS is about 1.8 times of turbidity (degree).
- 24 hours Continuous Sampling
  - ✓ Surveyed twice during the Dry season.
  - ✓ Water and ambient temperature, electrical conductivityand pH hardly changed.
  - ✓ Turbidity and KMnO4 consumption value difference were related to water level.
  - ✓ There is less chance of pollution by human factor in upstream.
- Consignment Examination
  - ✓ The items that are detected to have level over Japanese standards (8 items) are possible to treat with proper treatment process.
  - ✓ It is not necessary to introduce special treatment for other items.
  - ✓ Coagulo-sedimentaion and sand filtration will be suitable for Doung River water treatment.

(3) Water Treatment Survey

- Settling Characteristics
  - ✓ 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.
  - ✓ No matter what initial turbidity is, the turbidity becomes 20−40 degree after 12 hours.
  - ✓ 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.
- 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.
  - ✓ No relation to turbidity (40 to 140 degree), optimum dosing rate of PAC-4 (solution, 17% of Al_2O_3 content) was around 30 mgPAC/L.

- ✓ It may not need to acid for coagulation process.
- ✓ The best result is observed at the slow mixing rate of 70 RPM.
- ✓ 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.
- ✓ As the turbidity decrease by settling, the residual turbidity of supernatant becomes higher.
- ✓ It is recommended to introduce inclined plate clarifier or tube settler into sedimentation basin

➢ 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.
- ✓ 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.
- ✓ Intermediate chlorination is effective to reduce chlorine demand and thrihalomethane precursor.

➢ Sludge Thickening Characteristics

- ✓ Pre-sedimentated Sludge settling speed 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.
- ✓ Sedimentated Sludge settling speed is rather high and the concentration was about 7% (1.3% at starting point) and 9% after 24 hours.

.

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 S.1).

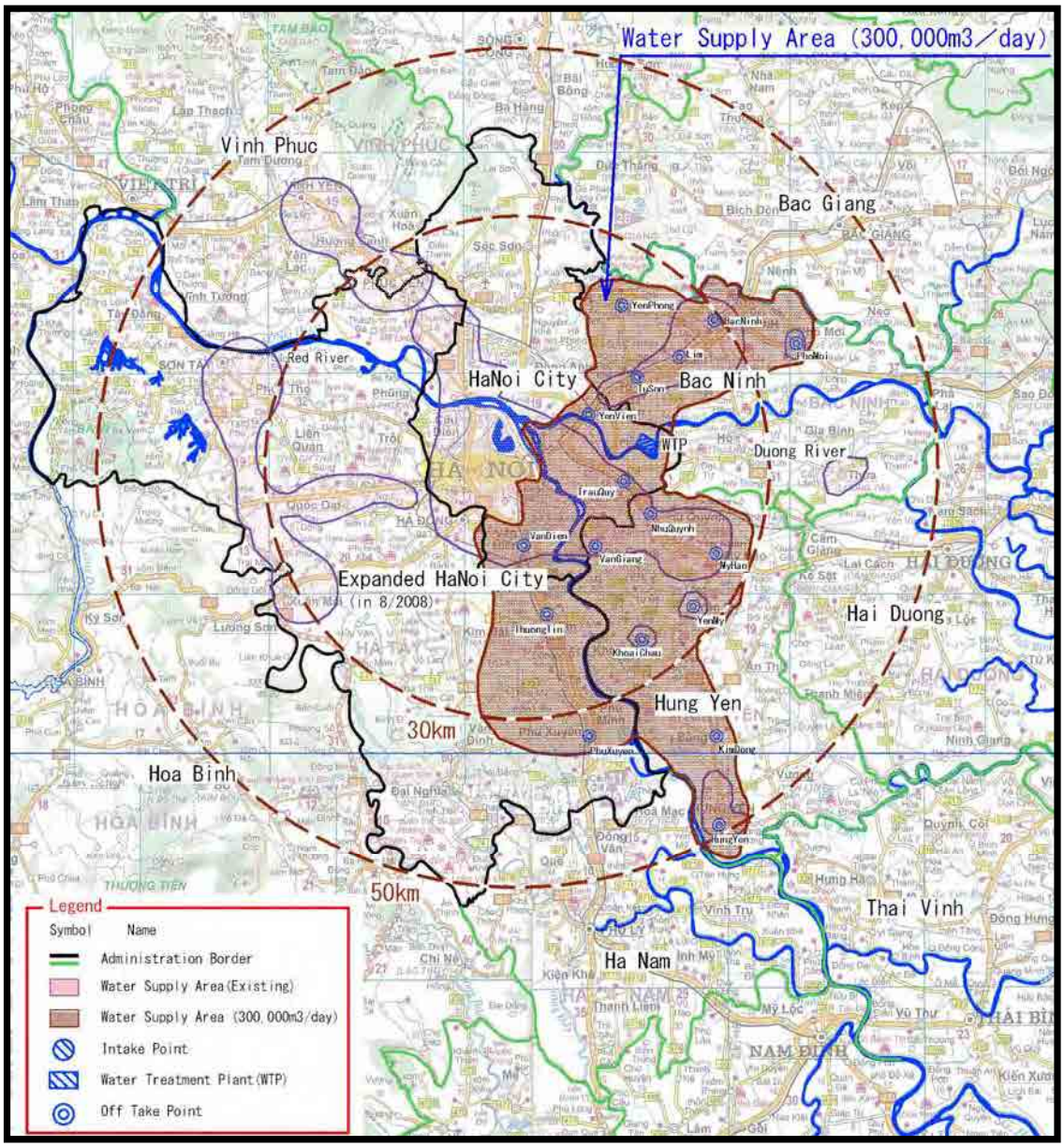


Figure S.1 Target Area

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 334,470 ha 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.

Ha Noi City Water Suply Area is shown in Figure S.2.

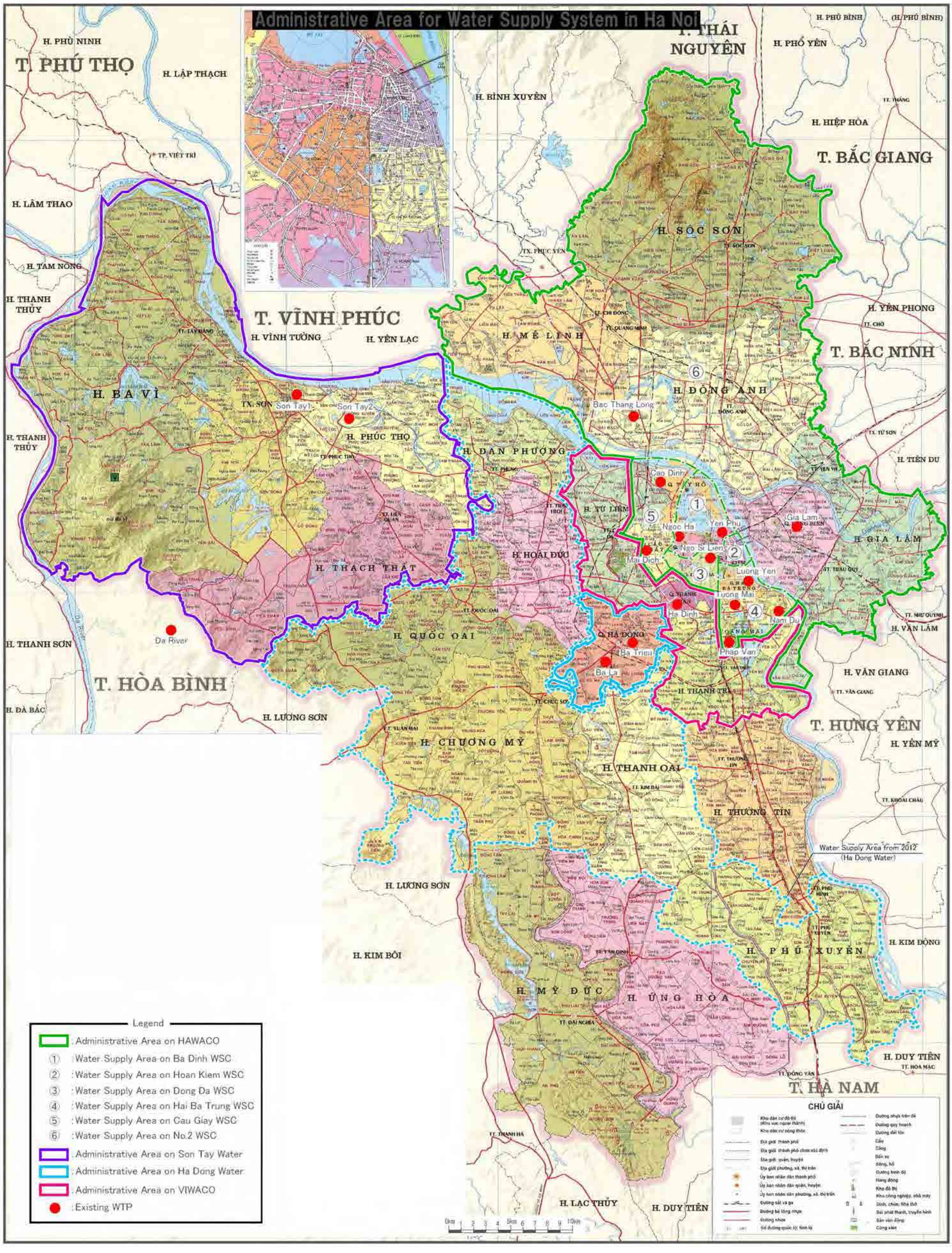


Figure S.2 Ha Noi City Water Supply Area

(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.

Overall view of Bac Ninh Province and its water treatment plants are shown in Figure S.3.

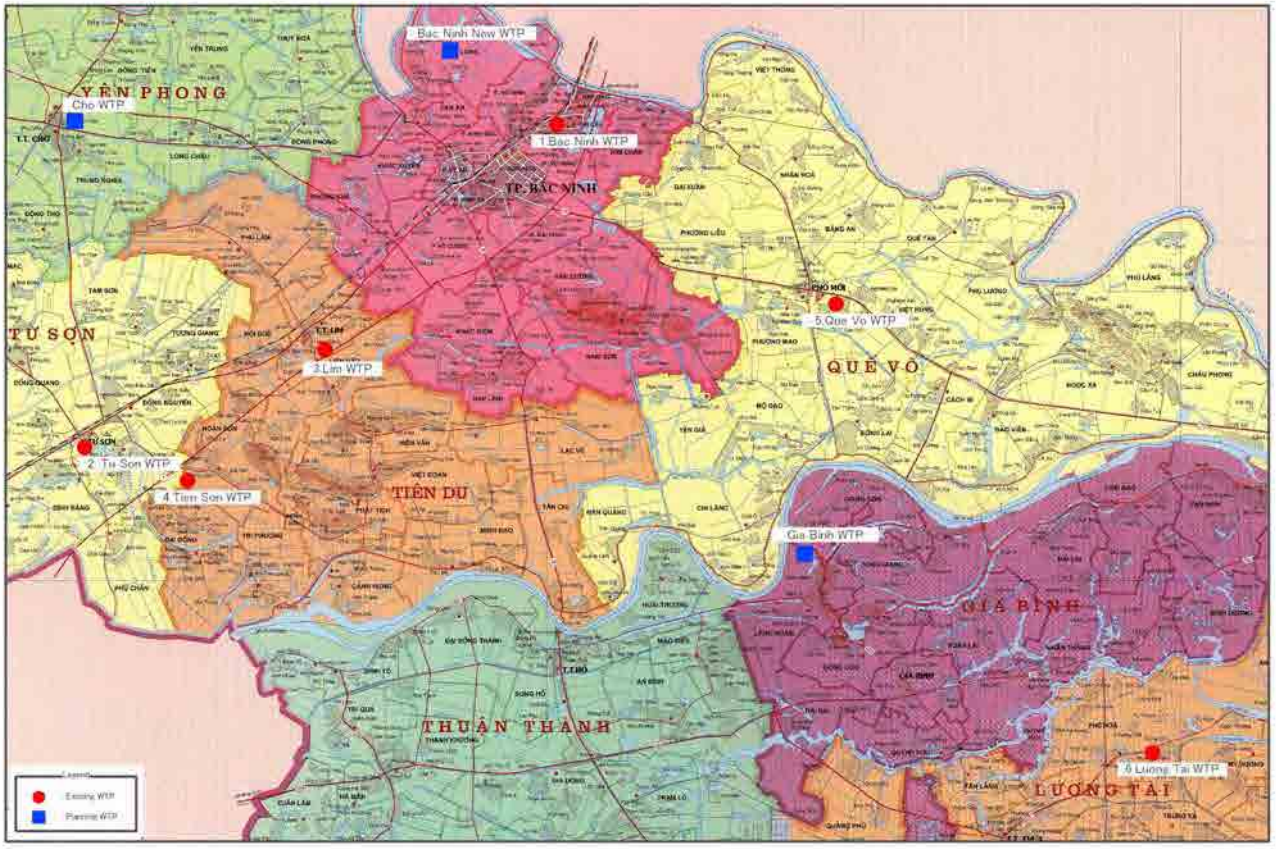


Figure S.3 Existing and planned Water Treatment Plants in Bac Ninh Province

(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. Therefore, at present, water supply business is mainly operated commune level by commune and there is no water supply business entity that would administrate the entire province.

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.

Overall view of Hung Yen Province and its Water Treatment Plants are shown in Figure S.4.

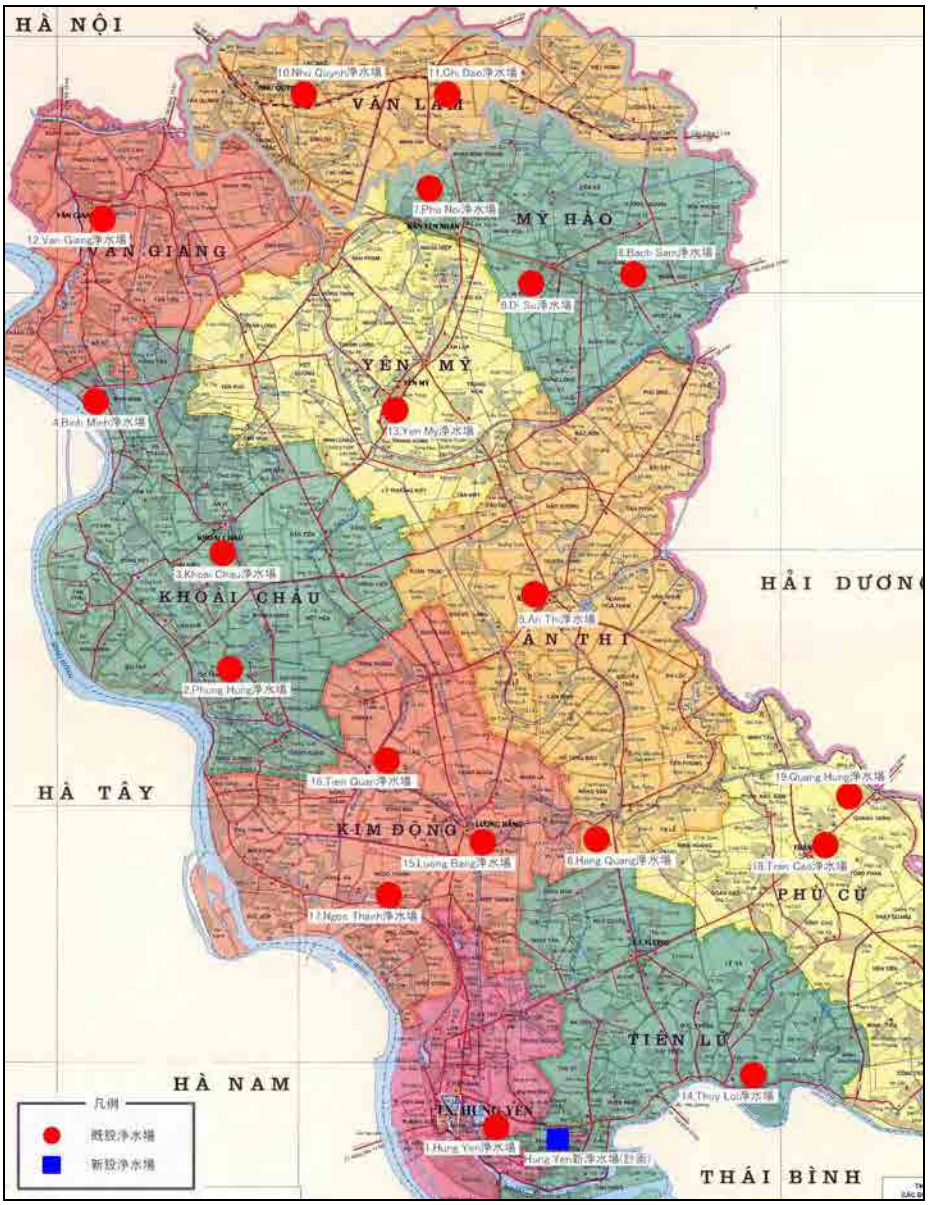


Figure S.4 Water Treatment Plants in Hung Yen Province

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 S.5.

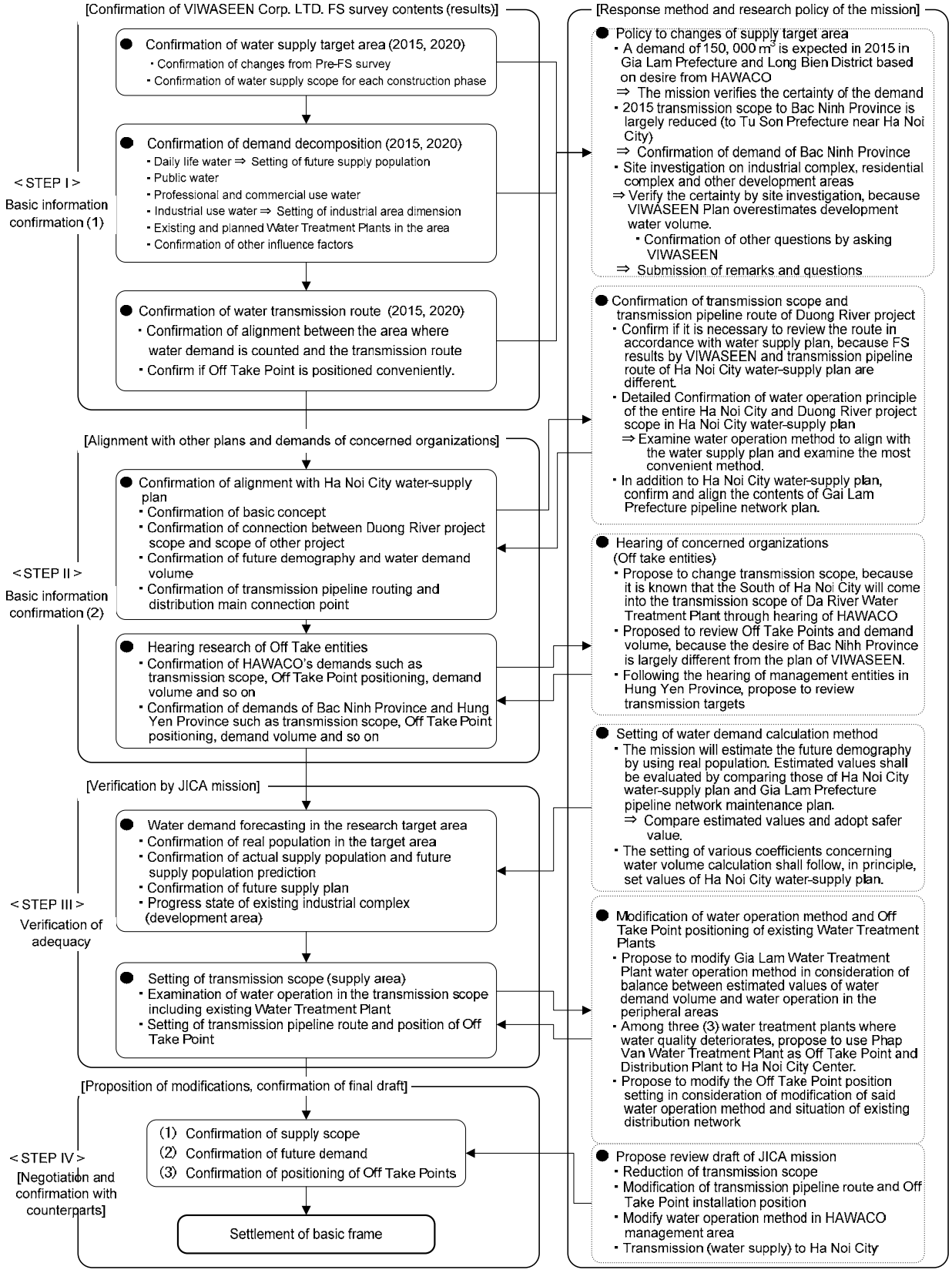


Figure S.5 Flow of Demand Forecasting and Basic Frame Setting

3.2.5 Project Demand Forecasting and Proposal of Basic Frame

In order to resolve the aforementioned issues, JICA Study Team examines below the water demand and transmission pipeline plan, based on FS survey of VIWASEEN, in consideration of Pre-FS evolution, and Ha Noi City water supply plan, proposes the most appropriate draft.

(1) Research Principles of Water Supply Scope

1) Ha Noi City

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 Figure S.6.

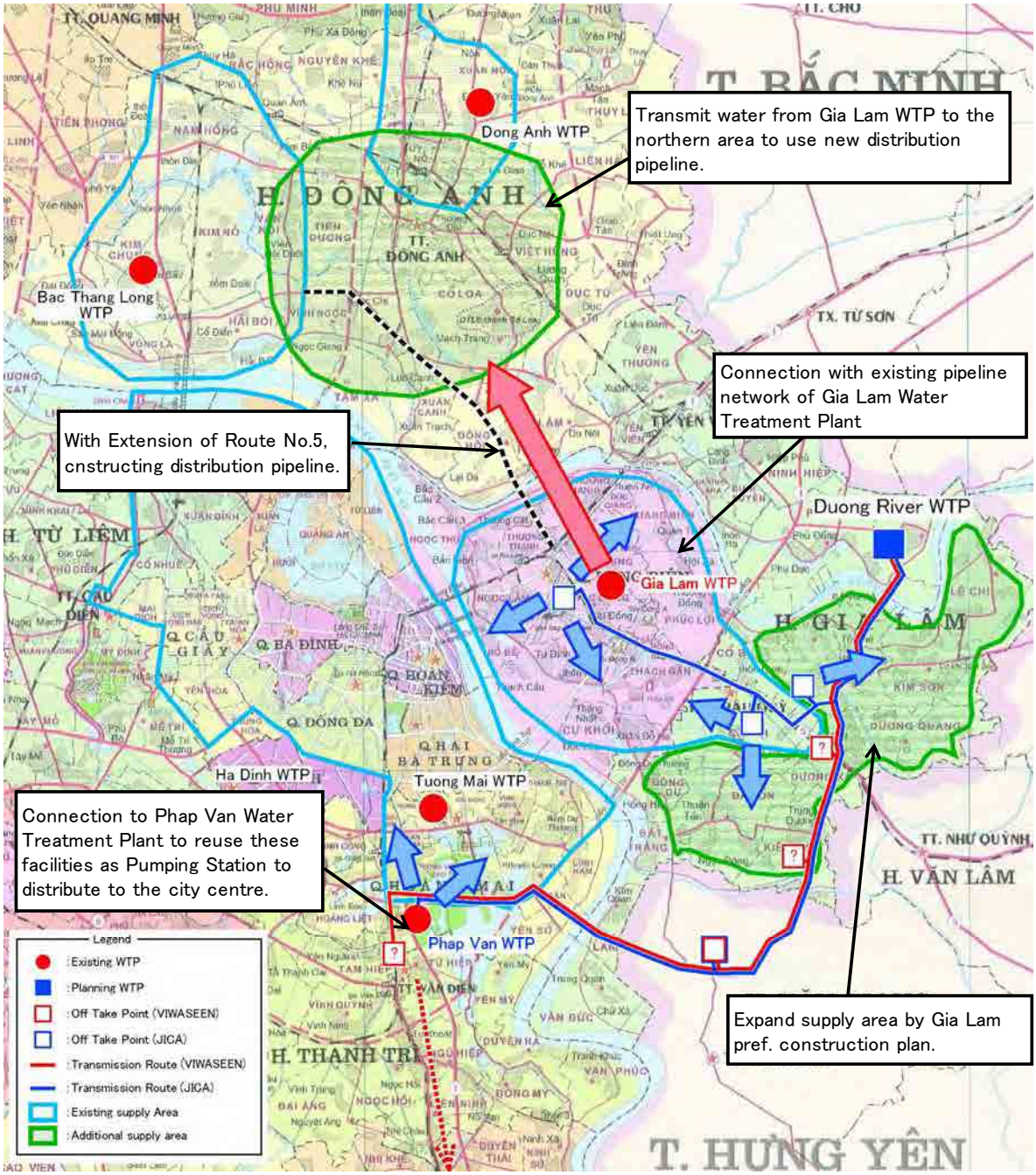


Figure S.6 Water Operation Principles in Duong River Water Treatment Plant and North of Hanoi

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.

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 S.7.

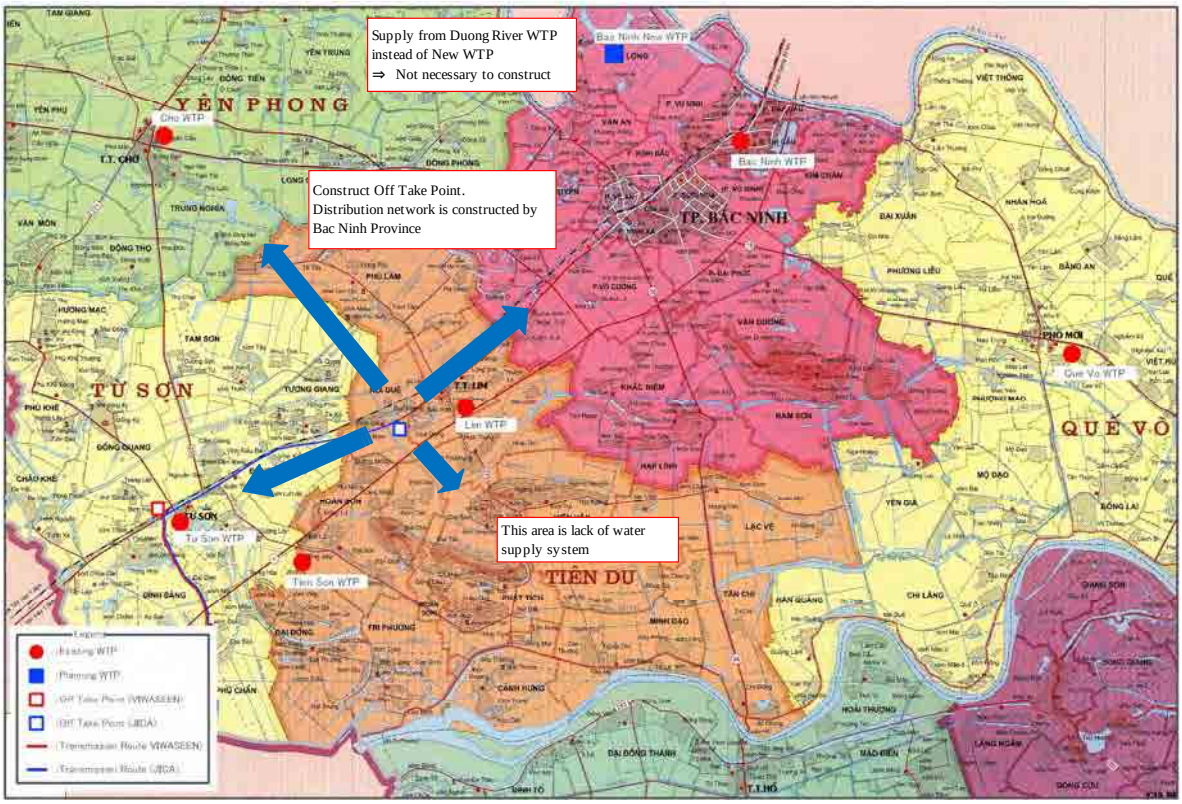


Figure S.7 Water Operation Principles of Bac Ninh Province in the Proposed Project

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 S.8.

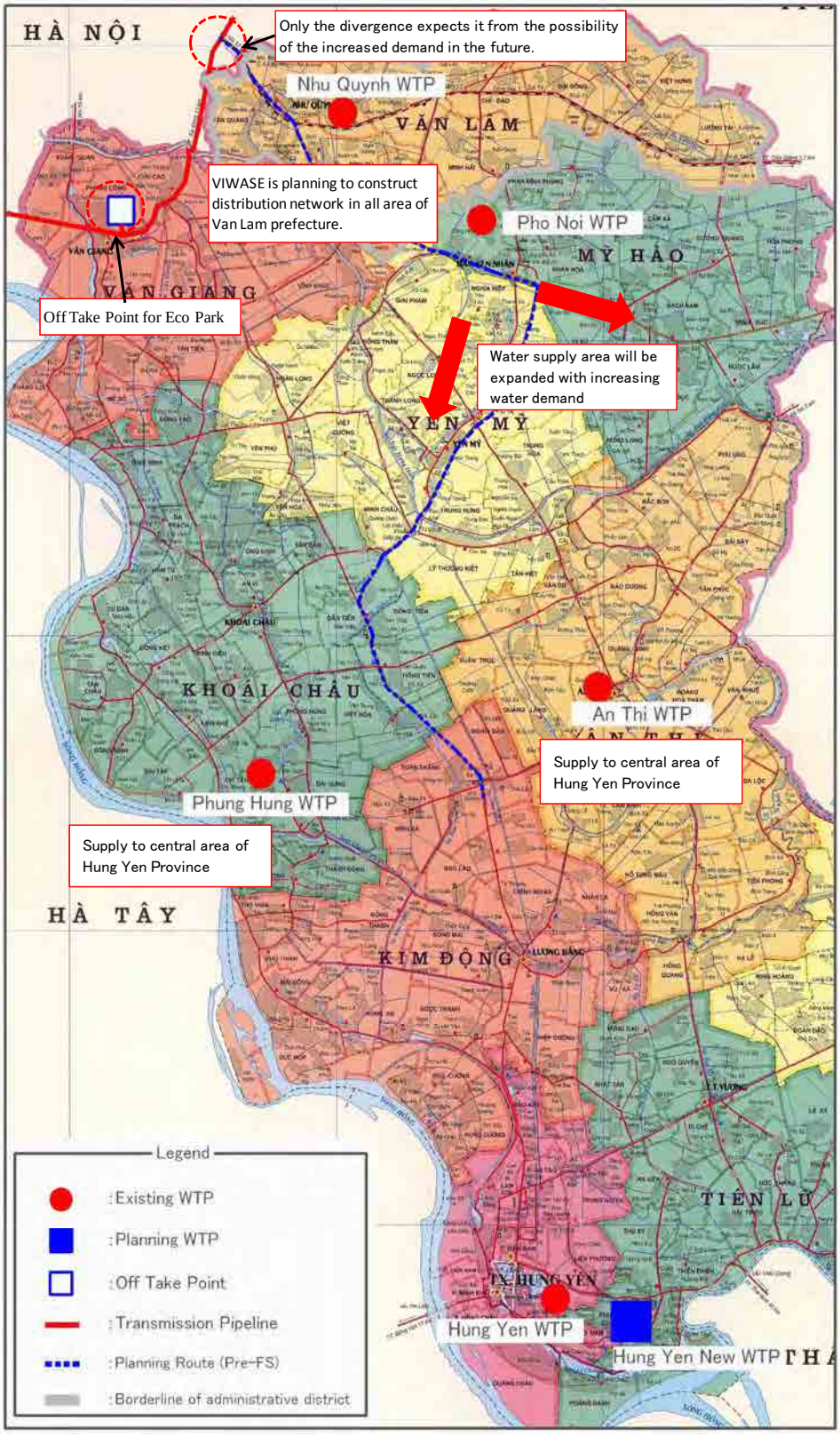


Figure S.8 Water Operation Principles of Duong River Water Treatment Plant and Hung Yen Province

(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.

The estimation of future population is shown in Table S.1.

Table S.1 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

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.

This estimation aims at 90% coverage ratio in 2015 and 2020.

Table S.2 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)

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.

Units and adopted values in the present Ha Noi City is shown in Table S.3.

Table S.3 Basic Unit Set Values (unit: Lpcd)

Area		2010		2015			2020		
		Existing	WS	GL	HN	WS	GL	HN	WS
Center 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 above mentioned 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 S.4 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

Development water volume for industrial and housing complex must be kept in consideration upon estimation..

6) Demand Forecast Results

Results of water demand calculation of each area for 2015 and 2020 based on settings discussed earlier are shown below. In case 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 S.5, 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 S.6, 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.

7) 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 S.7.

Moreover, transmission route chart including final review is shown in Figure S.9.

Table S.7 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	

Table S.5 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 S.6 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)

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

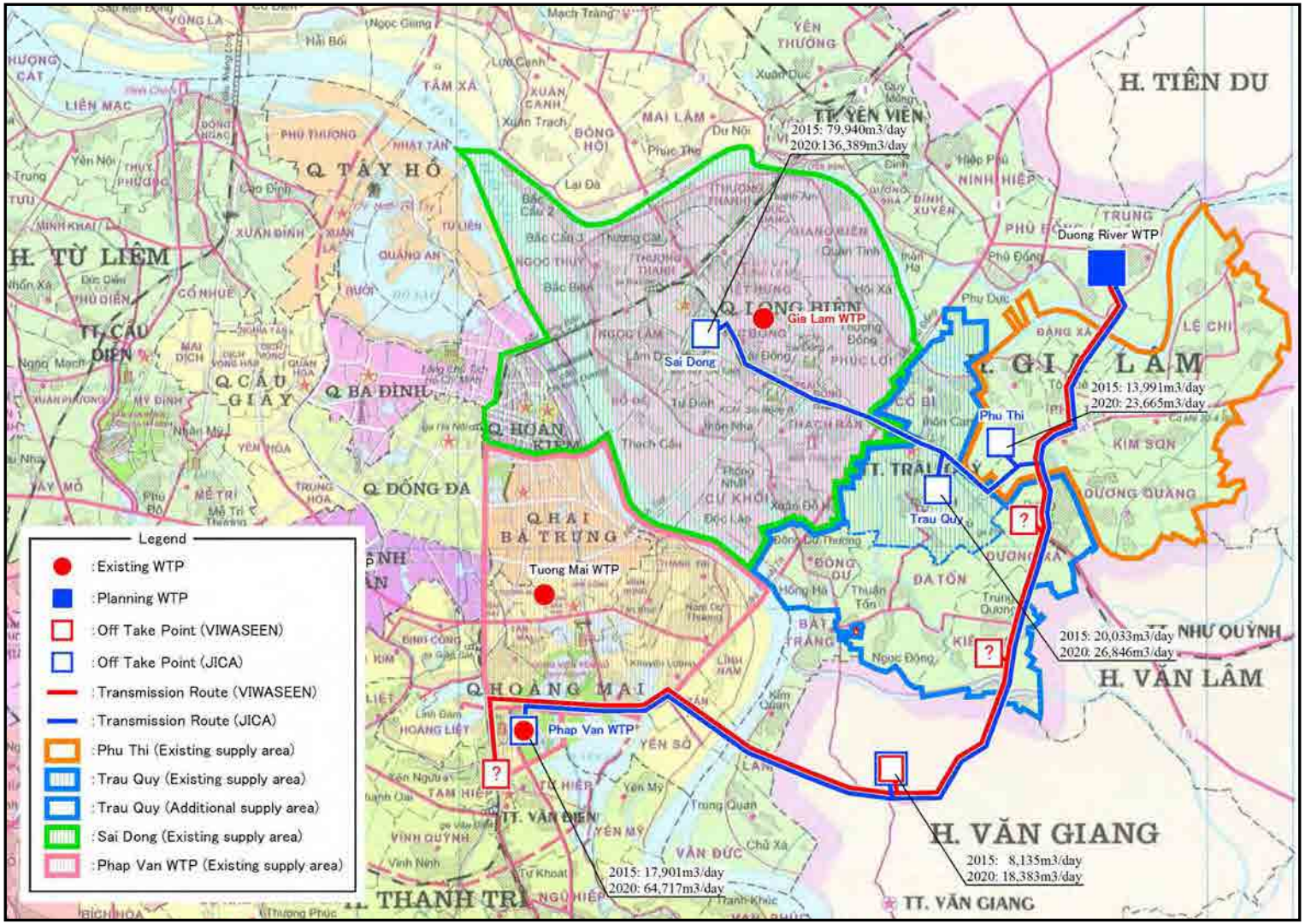


Figure S.9 Off Take Point and Distribution Area

3.2.6 Basic Frame of the Proposed Project

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.

Final target Supply Area of this research is shown in Figure S.10 and target water volume of Duong River Water Treatment Plant is presented in Table S.8. and Figure S 11.

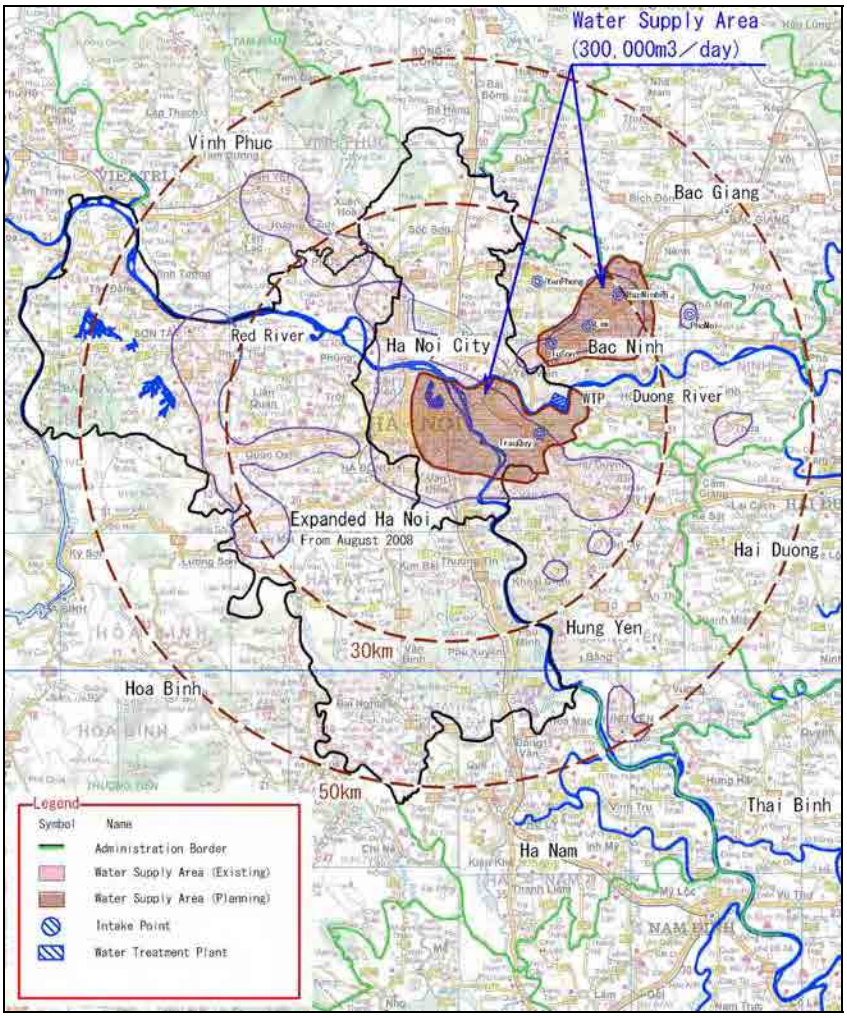


Figure S.10 Supply Area of the Proposed Project (Reviewed)

Table S.8 Target Water Volume of Duong River Water Treatment Plant

Item	2015	2020
Water demand (thousand m3/day)	162.1	829.7
Capacity of Other Water Treatment Plants (existing, planned, thousand m3/day)	0.0	438.0
Shortage in water available (thousand m3/day)	162.1	391.7
Duong River Water Treatment Plant (thousand m3/day) is proposed to provide	150.0	300.0
	Phase 1	Phase 2
Planned water volume (thousand m3/day)	150.0	300.0

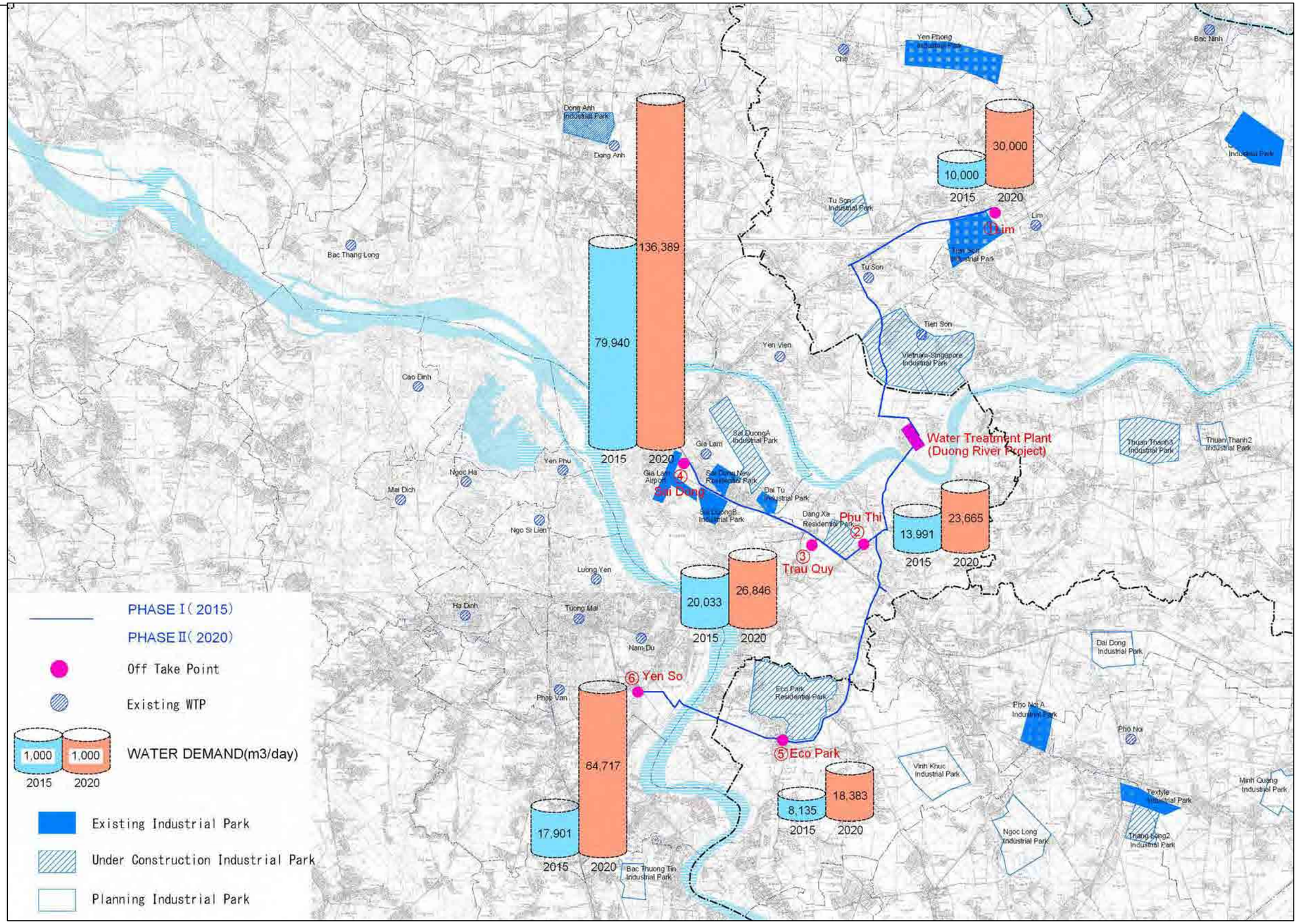


Figure S.11 Target Water Volume of Duong River

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 areas form part of the main water receiving locations.

3.3.2 Proposed Scope of Project

As shown in Figure S.12, 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.

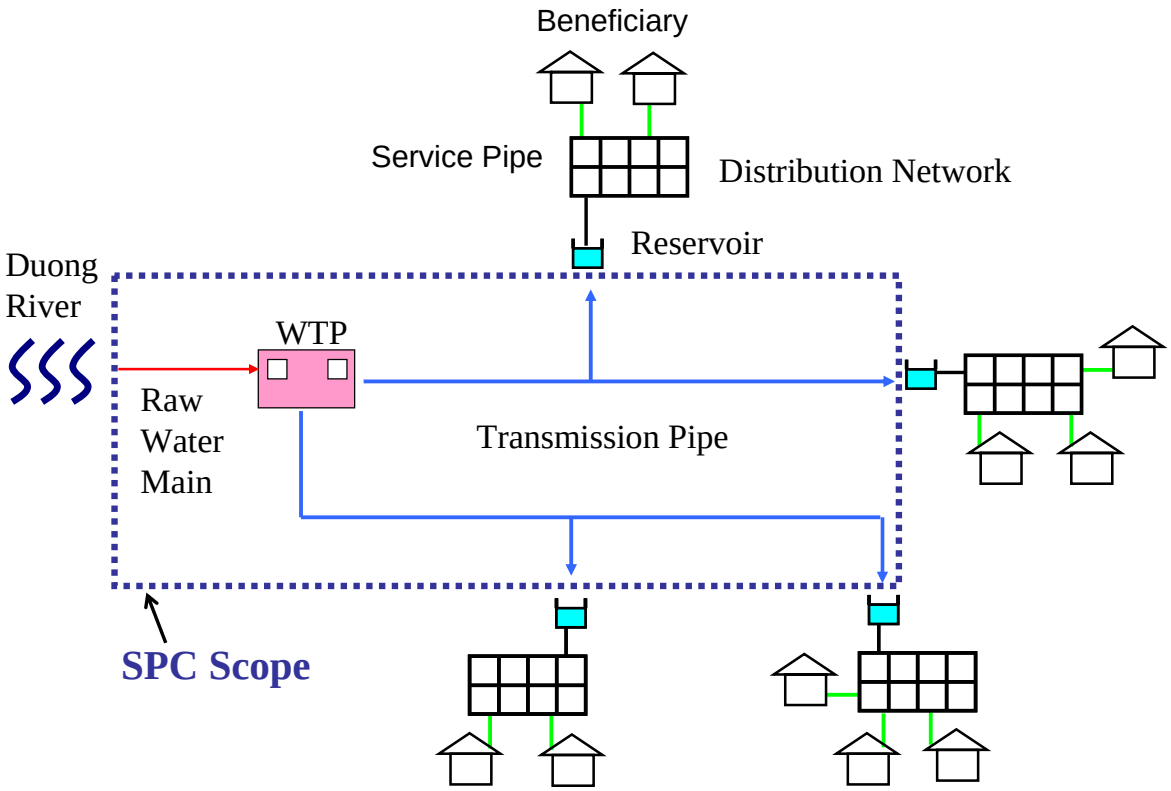


Figure S.12 Concept of the Proposed Project

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. 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 S.13.

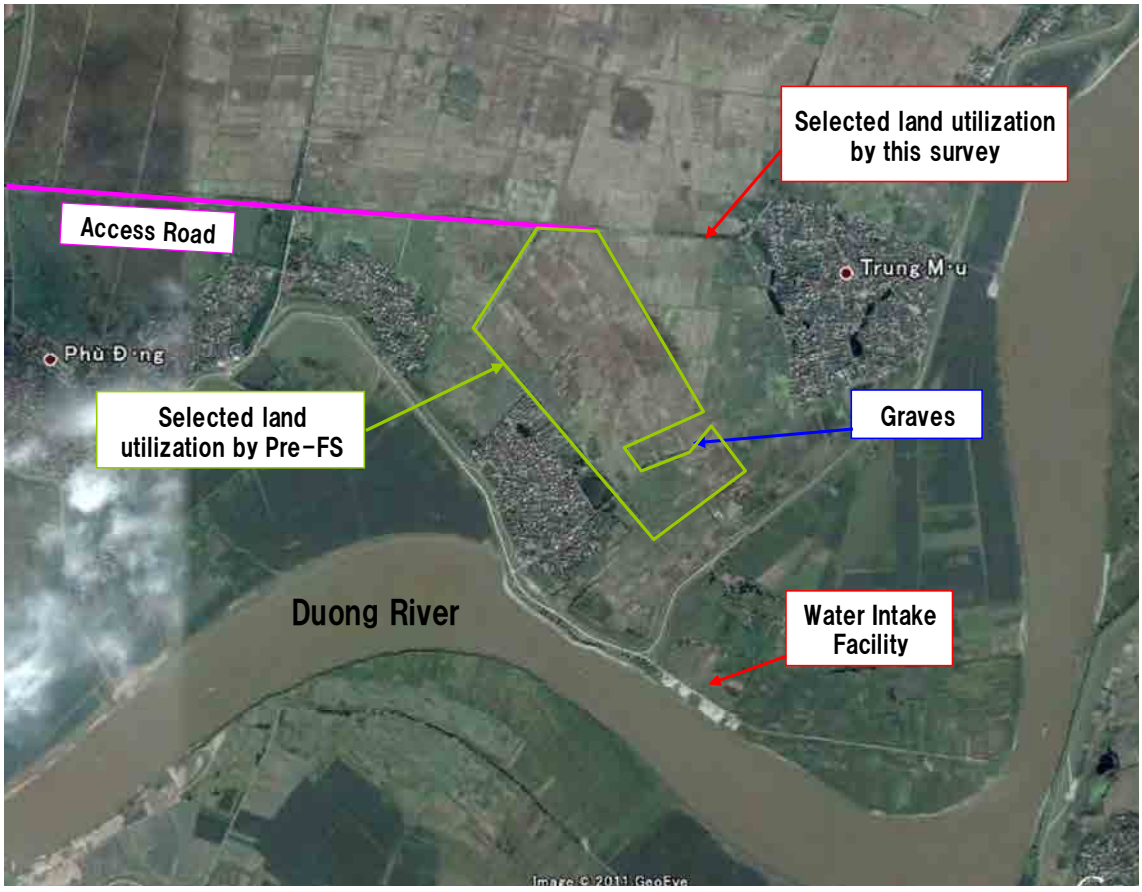


Figure S.13 Proposed Construction Sites for Water Treatment Plant and Intake Facilities

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 47 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 S.14 shows proposed alignment of the transmission pipeline routes.

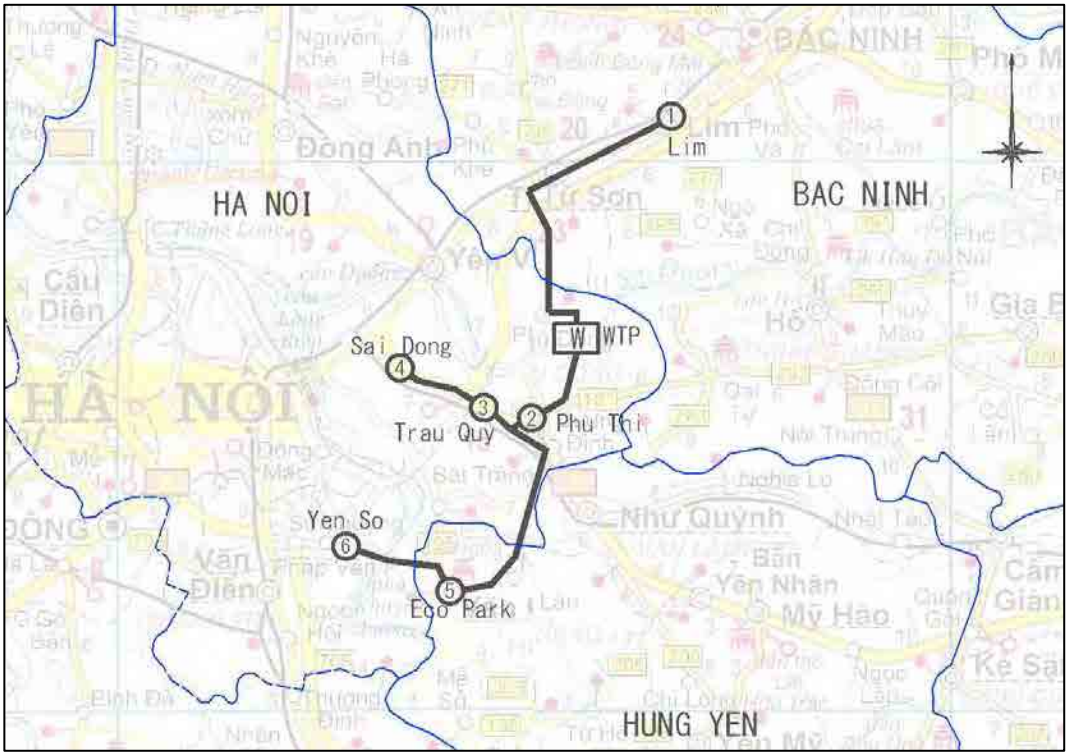


Figure S.14 Proposed Transmission Pipeline Routes in this Project

(2) 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.

Overview of the proposed locations of off take points is shown in Table S.9.

Table S.9 Overview of the Proposed Locations of Off Take Points

No.	Off Take Point	Province	Area	Remark (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 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.

3.3.5 Proposed Project Implementation Period

The scale of the project is large, and the cost of construction requires capital of 23,000 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 2014, 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 2019, 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 the maximum; the project implementation period divided into phases for financial model is shown in Table S.10.

Table S.10 Scope of Project Implementation and Estimated Period

Item	Project Scale	Concession Year	Year of starting Operation	Termination of the Concession
Phase 1	150,000m3/day	2012	2015	2042
Phase 2	150,000m3/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 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 S.11 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 CaCO3	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 (Fe2+ + Fe3+)	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 （KMnO4 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）

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

Table S.12 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

3.4.3 Off Take Point Water Receiving System

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.

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

Only the off take point No. 6 of Yen So will be directly connected to the water distribution main, and the water supplied from the Duong River water treatment plant will be taken as constant supply that does not consider time coefficients.

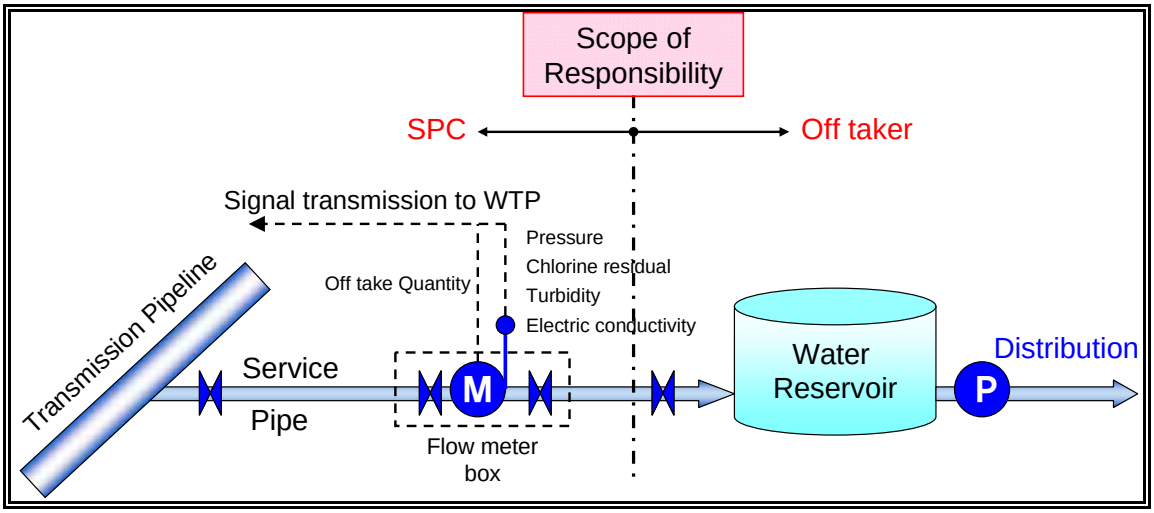


Figure S.15 Scope of Responsibility for the Proposed Project at Each Off Take Point

3.4.4 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).

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, 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.

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

3.4.5 Relevant Laws and Regulations and Permits and Licenses Required for Implementing 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 S.16.

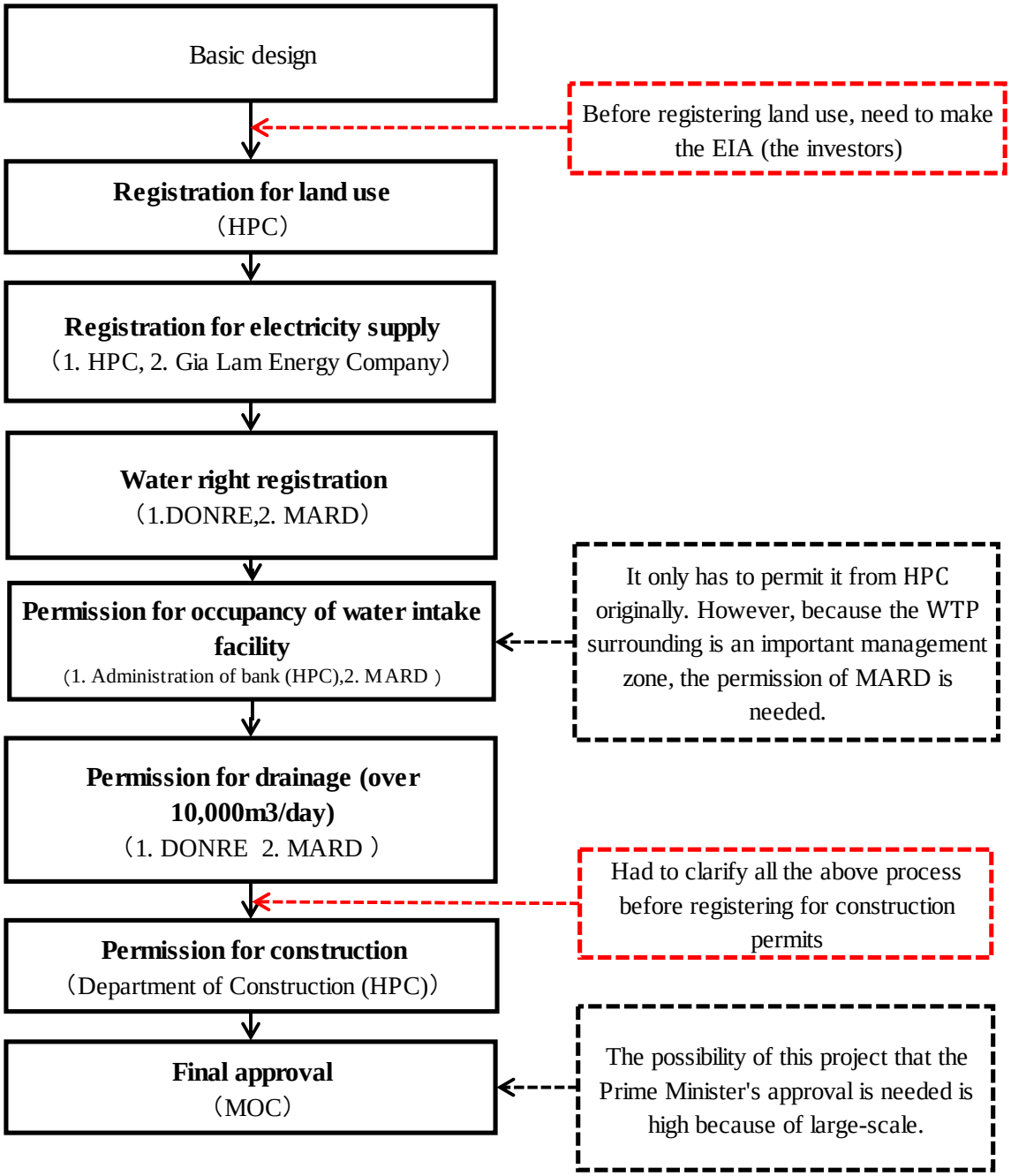


Figure S.16 Process for Obtaining Permits and Licenses Required up to the Final Approval of the Project

3.5 Design

3.5.1 Design Overview

An overview of design of facilities is given in Table S.13.

Table S.13 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=45.6km	―	
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 enterprise.

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

3.5.3 Transmission Pipeline Planning

Considering these policies, the basic items related to the intake facilities and water treatment plant are set and summarized in the form of Tables S.14-17.

Table S.14 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="5">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="4"></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="5">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="4"></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 S.15 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 S.16 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
Sludge settling percentage — Water intake: 40% of raw water (40%); Grit chamber: 60% of water intake (24%); Sedimentation basin: 100% of grit chamber (36%)
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/m^3</td></tr>
<tr><td>Rainy season average</td><td>2%</td><td>20 kg/m^3</td></tr>
<tr><td>Maximum</td><td>7%</td><td>70 kg/m^3</td></tr>
<tr><td rowspan="3">Sludge basin sludge</td><td>Annual average</td><td>3 %</td><td>30 kg/m^3</td></tr>
<tr><td>Rainy season average</td><td>2%</td><td>20 kg/m^3</td></tr>
<tr><td>Maximum</td><td>7 %</td><td>70 kg/m^3</td></tr>
<tr><td rowspan="3">Thickening tank sludge</td><td>Annual average</td><td>5%</td><td>50 kg/m^3</td></tr>
<tr><td>Rainy season average</td><td>5%</td><td>50 kg/m^3</td></tr>
<tr><td>Maximum</td><td>10%</td><td>100 kg/m^3</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 m^3/day x 1 system and the second phase is based on a rate of 150,000 m^3/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 m^3/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 S.17 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.	

(1) 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 S.17. 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 S.17 Shape of the Site and Conditions of Surrounding Roads

2) Facility Arrangement Plan

Figure S.18 shows the facility arrangement plan determined based on the aforementioned arrangement policy and constraints. Figure S.19 shows water level relationship.

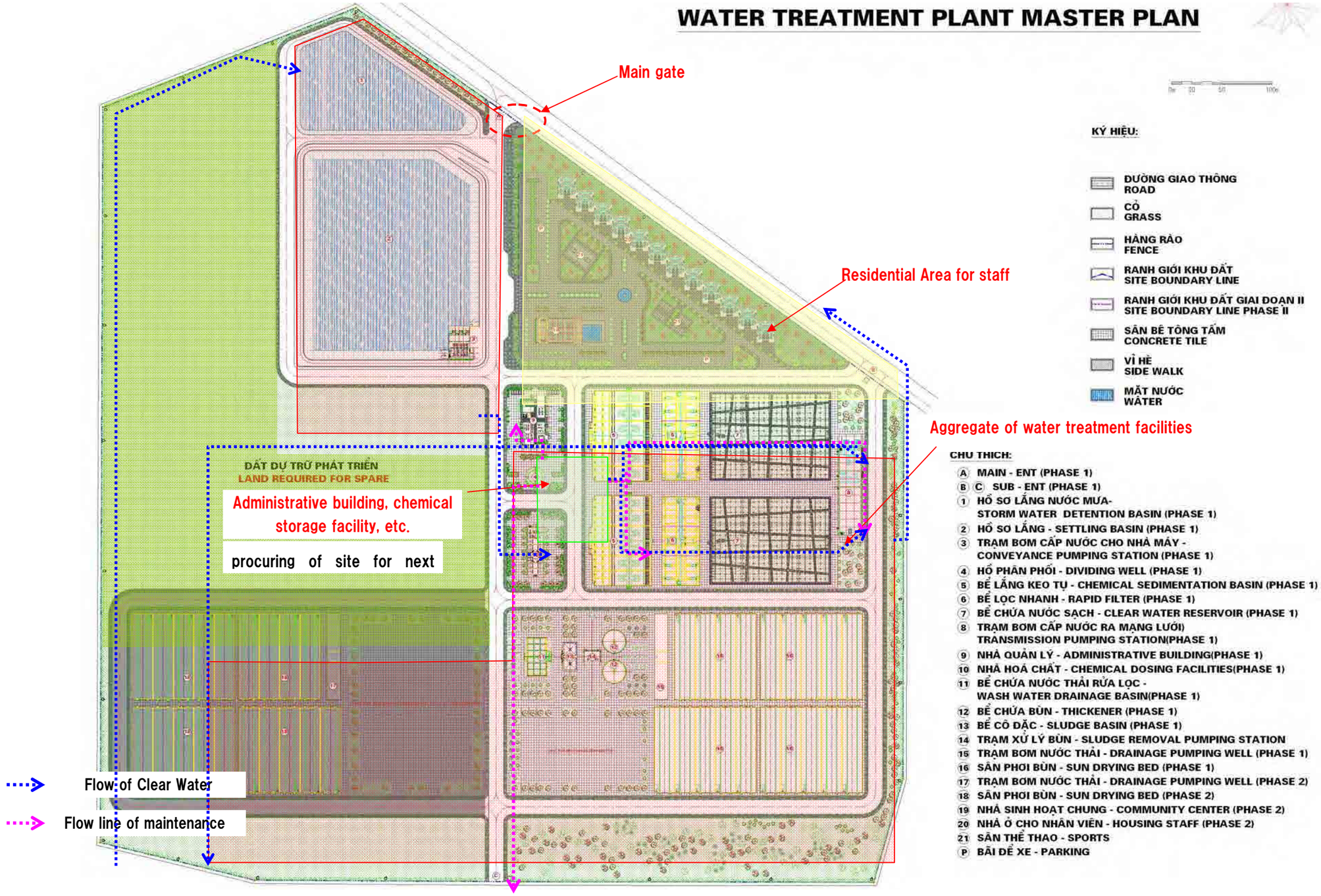


Figure S.18 Facility Arrangement Plan

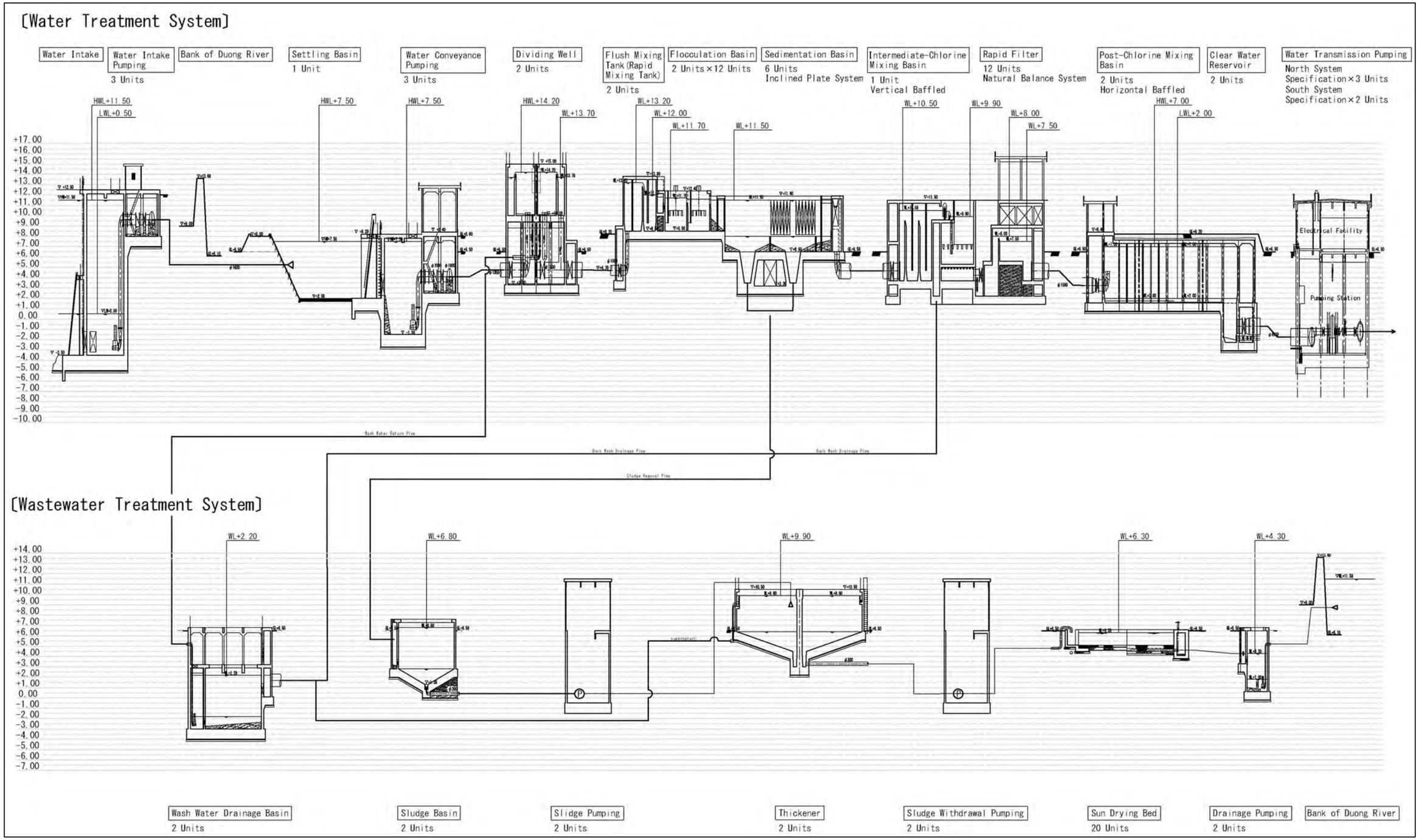


Figure S.19 Water Level Relationship (Phase 1: 150,000 m3/day)

(2) Outline Design of Water Intake Facility / Water Treatment Plant

Tables S.18-S.23 organize the results of outline design for water intake facility/water treatment plant

Table S.18 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 S.19 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 S.20 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 S.21 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 S.22 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 S.23 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	

3.5.4 Transmission Pipeline Planning

(1) Outline of Transmission Pipeline Route

The transmission pipeline routes, totaling about 46km, 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.

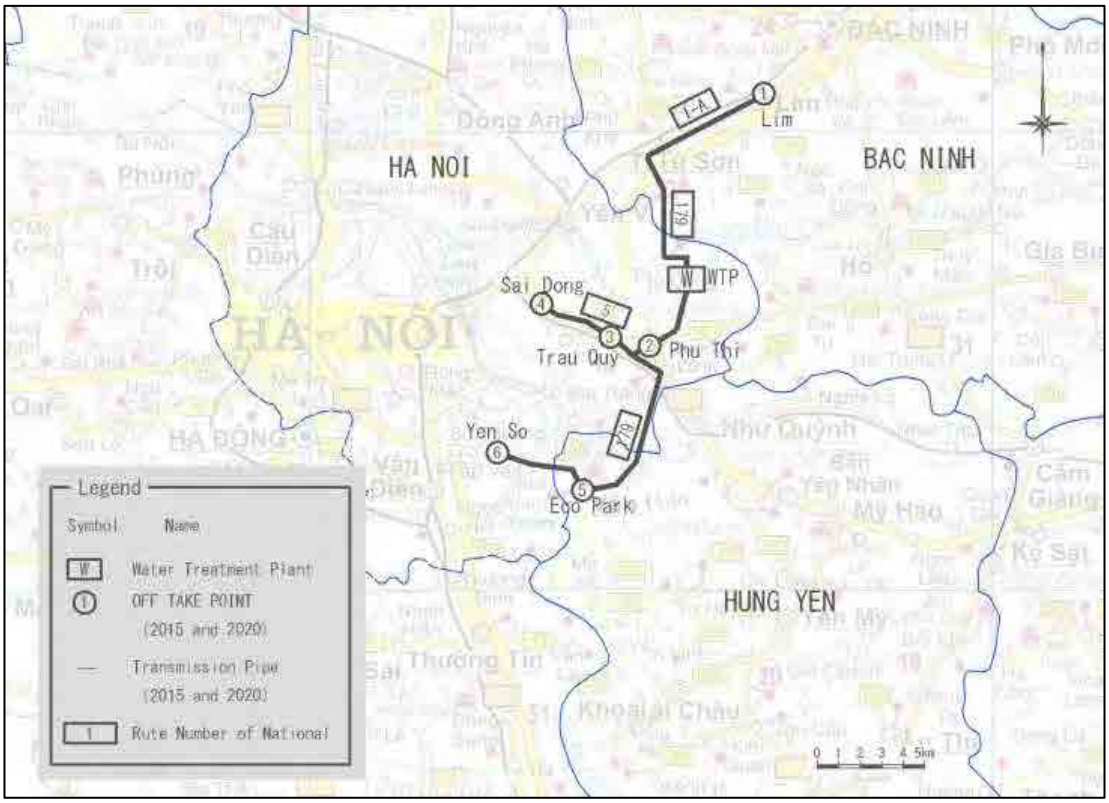


Figure S.20 Outline of Transmission Pipeline Route

(2) Pipeline Route and Plans

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.

Pipeline Route and Plans are shown in Figure S.21.

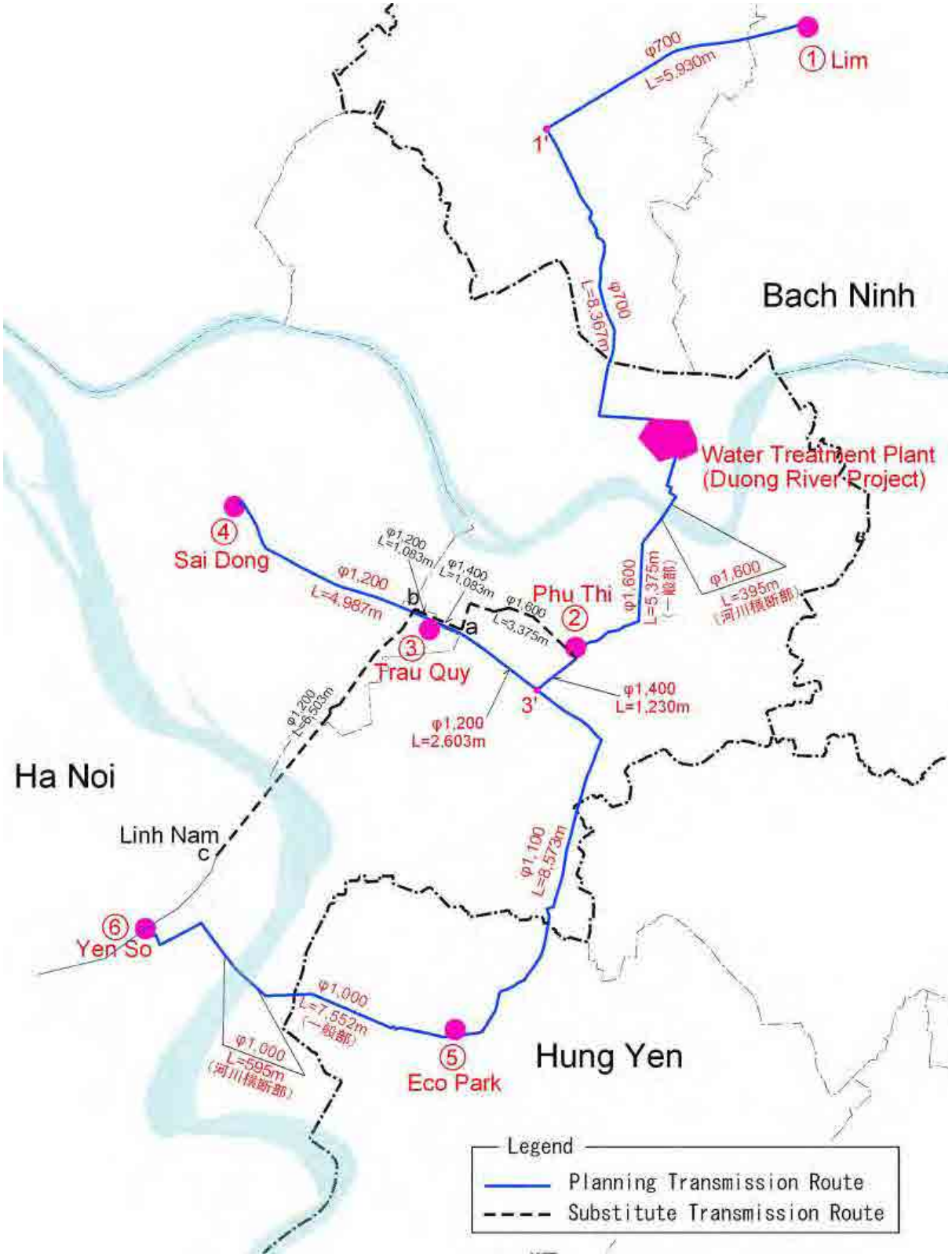


Figure S.21 Pipeline Route and Plans

(3) Survey of Underground Pipe

Underground pipe survey was carried out during field trips through hearing from the related Authorities. The following Table S.24 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 S.24 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

(4) Earth Covering of Pipeline

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.

(5) 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.

(6) 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 S.25.

Table S.25 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	

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, high adaptability to the future of the river circumstance change such as river bed reform, abundant experiences of construction technique and simple operation & maintenance.

(7) 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.

Table S.26 Objective Water 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	

3.5.5 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.

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.

Off take points to be covered by this examination are as specified in Table S.27.

Table S.27 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)	—

Development length is about 85.7km and it needs 25.9million USD for development cost at Phase 1. 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.

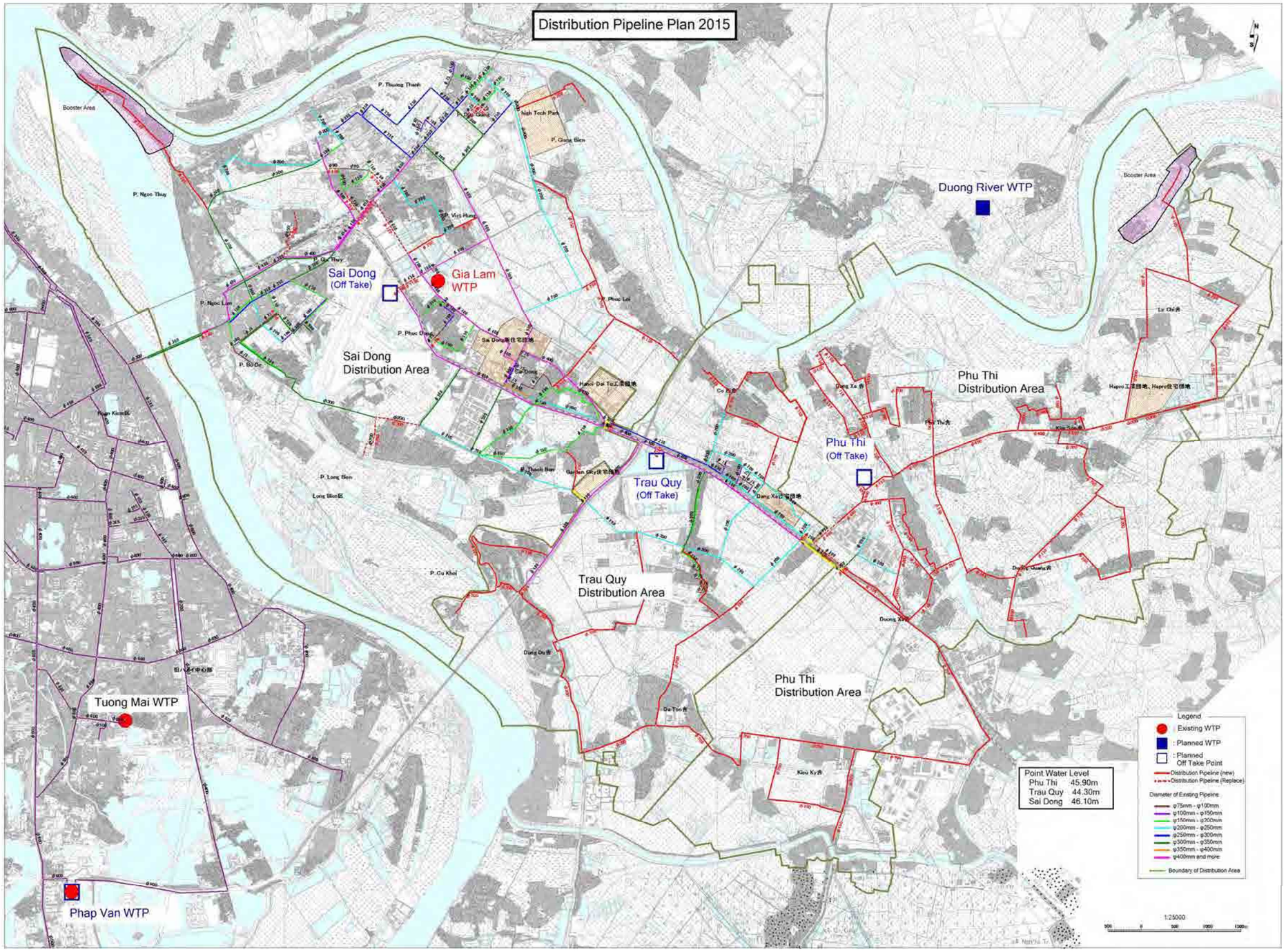


Figure S.22 Development Plan of Distribution Network at Phase 1

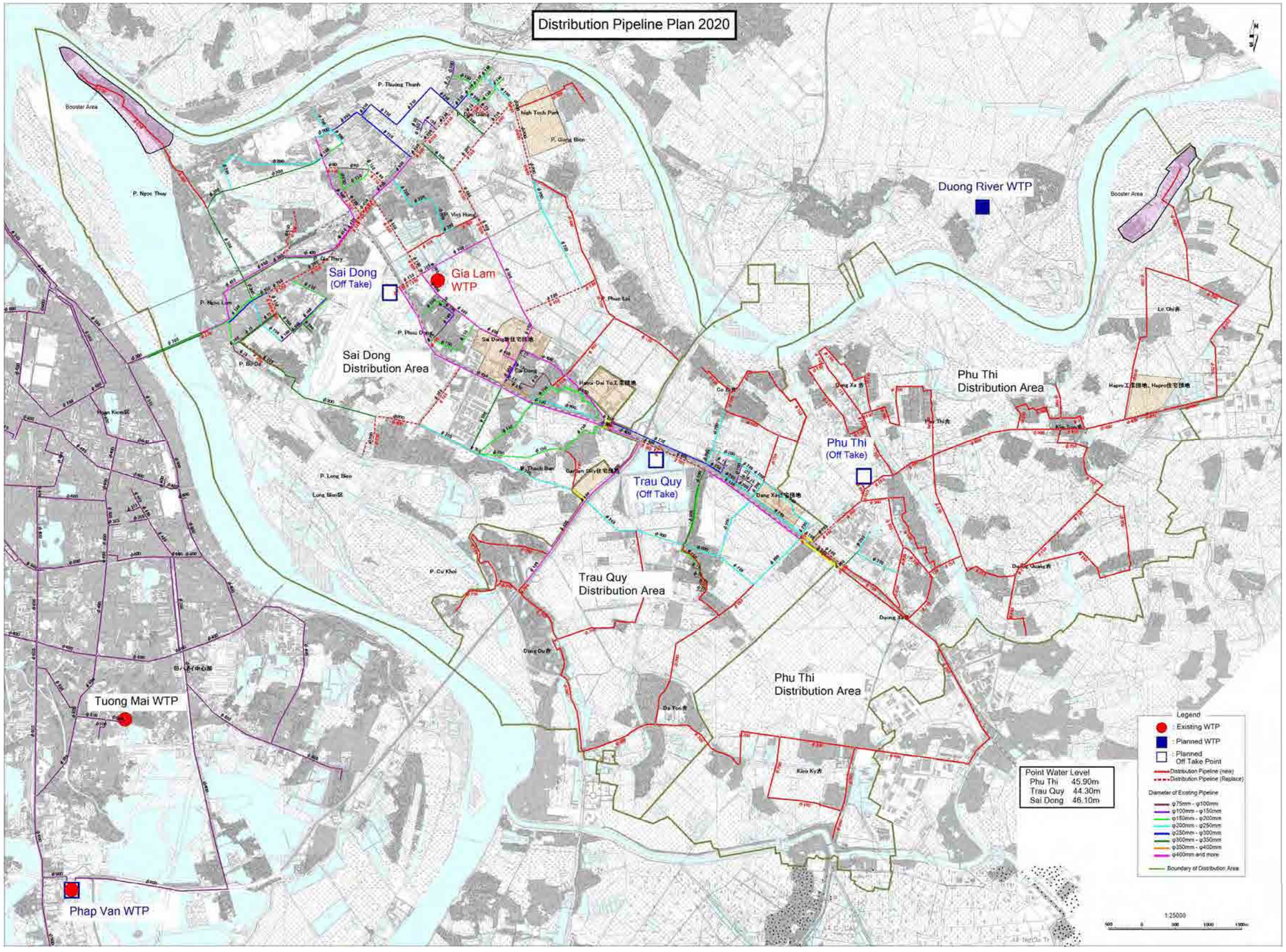


Figure S.23 Development Plan of Distribution Network at Phase2

3.6 Formulation of Work Execution Plan

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 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.

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.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 ϕ 700 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. Submerged pumps, on the other hand, are assumed 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 will also be 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) 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. Figure S.24 shows the approach roads for construction.

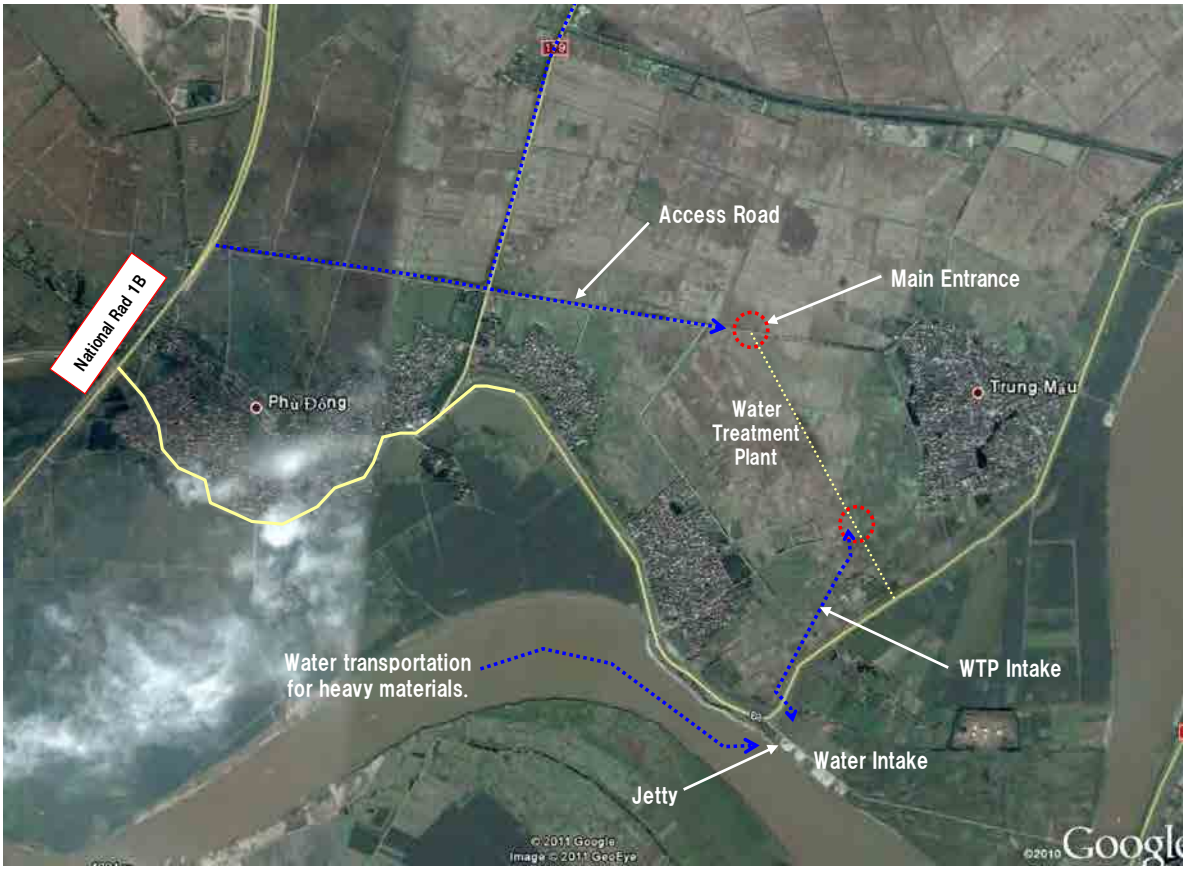


Figure S.24 Approach Roads for Construction

(2) Material Yards, Site Office, Warehouse and Others

The site office and its accompanying facilities will be located in the vicinity of the north gateway of the water treatment plant (Figure S.25).

Upon receipt of a permit for construction, the ground for these facilities will be immediately prepared and the office and others will be constructed.

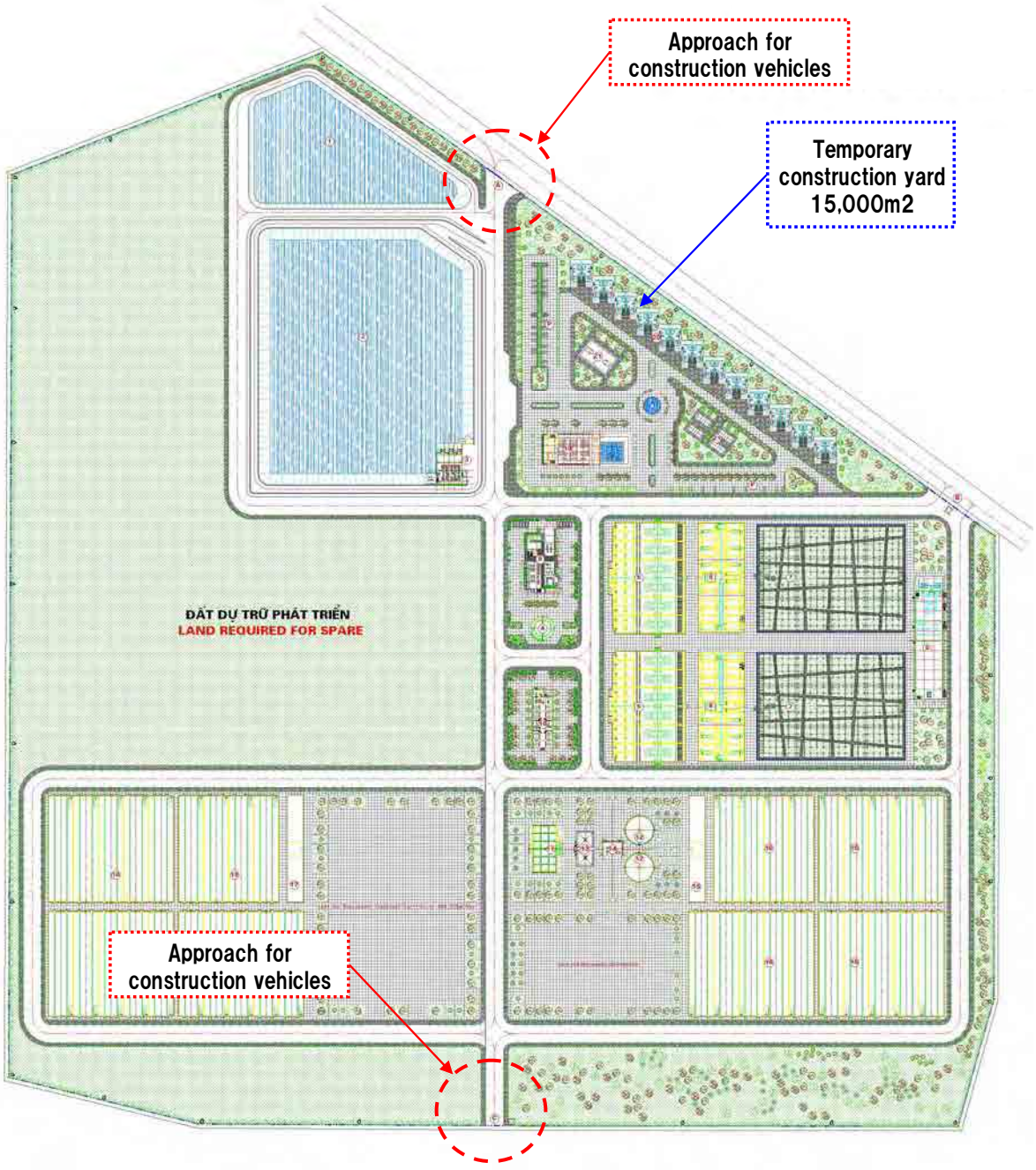


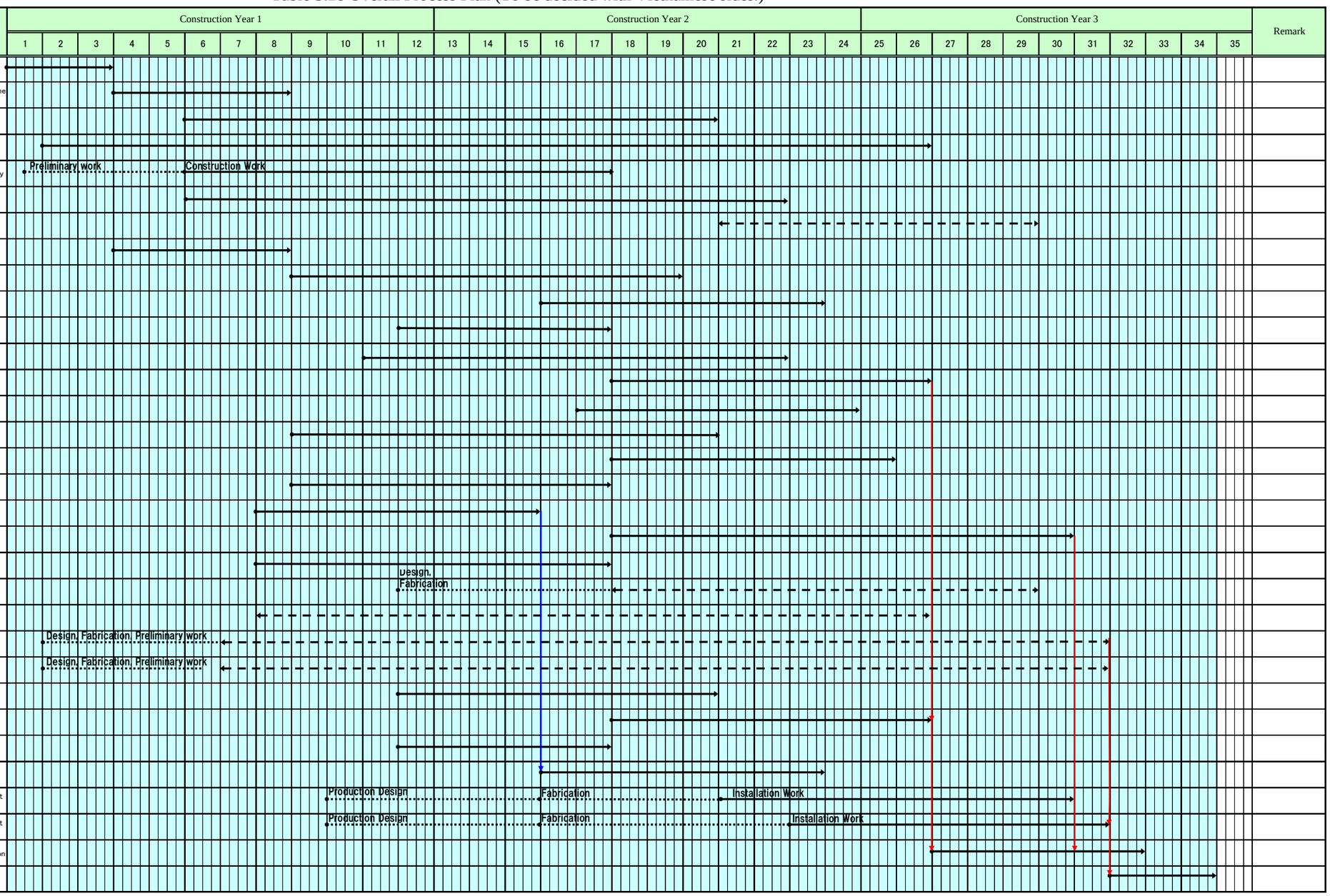
Figure S.25 Location of Yard for Temporary Construction

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 S.28. The actual overall process plan shall be decided with Vietnamese sides.

Table S.28 Overall Process Plan (To be decided with Vietnamese sides.)

Section	No.	Work Item	Description of Work	Remark
Preliminary Work	1	Preliminary Work	Topographical survey, Temporary road, Temporary fence, etc.	
	2	Construction of Temporary Facili	Site office, warehouse, and the others	
Civil Work	3	Fabrication of Foundation Pile		
	4	Land Development		
	5	Intake Pumping Station	including pump electric facility	
	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		
	22	Drain Pipeline		
	23	Water Transmission Pipeline	Normal	
	24		River Crossing	
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	
	28	Electrical Installation Work	Equipment of water treatment and pumping facility	
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 Project Cost

As for the expenses on this project, the initial investment (cost of construction) is estimated at about 22.7 billion yen. Phase 1 and Phase 2 initial costs are as below (Table S.29).

Table S.29 Initial Cost According to Period

Item	L. C.	F. C.		Total (JPY: ¥1,000)
	VND (Mil. VND)	JPY (¥1,000)	USD ($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

(Using Excahange Rate as of 2010)

3.7.2 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 Table S.30 and S.31.

Table S.30 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	Operate1st Year	2nd Year	3rd Year	4th Year	5th Year
Labor Cost	0 (0)	0 (0)	101,600 (24,892)	208,700 (51,132)	120,700 (29,572)	97,500 (23,888)	53,000 (12,985)	52,600 (12,887)
Chemical Cost	0 (0)	0 (0)	0 (0)	53,100 (13,010)	53,100 (13,010)	53,100 (13,010)	53,100 (13,010)	53,100 (13,010)
Electric Power Cost	0 (0)	0 (0)	0 (0)	95,900 (23,496)	95,900 (23,496)	95,900 (23,496)	95,900 (23,496)	95,900 (23,496)
Cost of Maintenance Check	0 (0)	0 (0)	0 (0)	34,600 (8,477)	43,800 (10,731)	57,300 (14,039)	82,500 (20,213)	169,900 (41,626)

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 (26,632)	108,700 (26,632)	108,700 (26,632)	108,700 (26,632)	108,700 (26,632)
Cost of Procurement of Equipment	0 (0)	0 (0)	0 (0)	17,800 (4,361)	17,500 (4,288)	17,300 (4,239)	17,500 (4,288)	17,300 (4,239)
Cost for Office Establishment	68,300 (16,734)	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 (16,930)	58,600 (14,357)	160,200 (39,249)	577,400 (141,463)	498,300 (122,084)	488,400 (119,658)	469,300 (114,979)	556,100 (136,245)

Table S.31 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 (19,865)
Chemical Cost	106,100 (25,995)	106,100 (25,995)	106,100 (25,995)	106,100 (25,995)	106,100 (25,995)	106,100 (25,995)
Electric Power Cost	182,900 (44,811)	182,900 (44,811)	182,900 (44,811)	182,900 (44,811)	182,900 (44,811)	182,900 (44,811)
Cost of Maintenance Check	64,500 (15,803)	193,500 (47,408)	70,400 (17,248)	140,000 (34,300)	263,700 (64,607)	146,420 (35,873)
Security Cost	800 (196)	800 (196)	800 (196)	800 (196)	800 (196)	800 (196)
Cost for Sludge Disposal	217,300 (53,239)	217,300 (53,239)	217,300 (53,239)	217,300 (53,239)	217,300 (53,239)	217,300 (53,239)
Cost of Procurement of Equipment	18,400 (4,508)	18,300 (4,484)	18,400 (4,508)	18,300 (4,484)	18,400 (4,508)	18,360 (4,498)
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)	880,500 (215,723)	712,300 (174,514)	781,800 (191,541)	905,600 (221,872)	810,760 (198,636)

(*Average of the 6th – 10th year)

- 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 through 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.

＜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

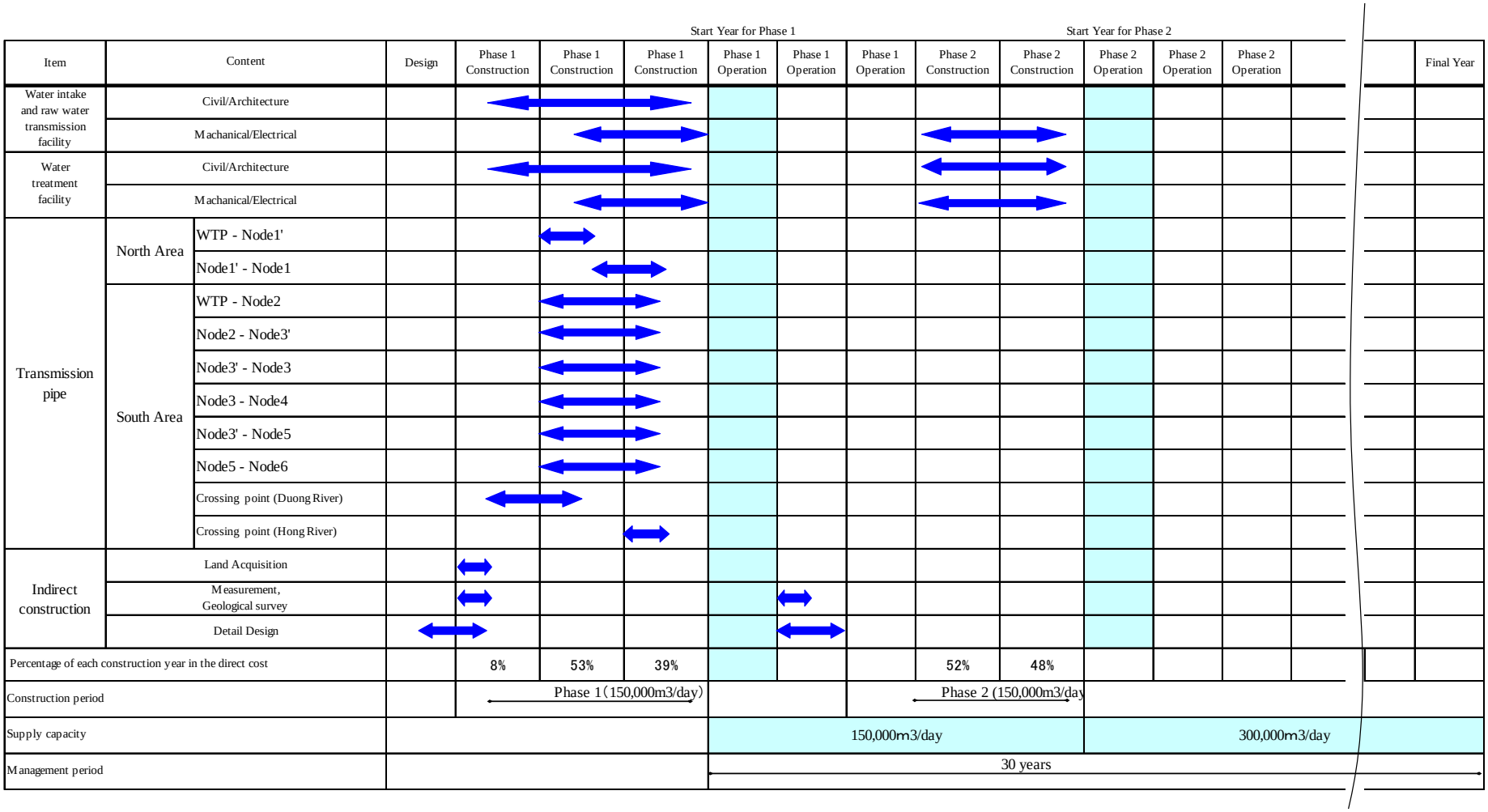
The construction cost of this project is large. Also, the construction period is longer and huge investment to the scale of 22.7 billion yen (Phase 1 and Phase 2) has to be made for long duration.

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 proposed 28 years with Phase 1 and Phase 2. 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 S.26 shows the execution schedule of the project in different phases.

Figure S.26 Execution Schedule (Agreement is needed between Japanese and Vietnamese sides.)



3.9 Proposal for Operation Management

At the present stage, EPC is considered as Figure S.27. 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.

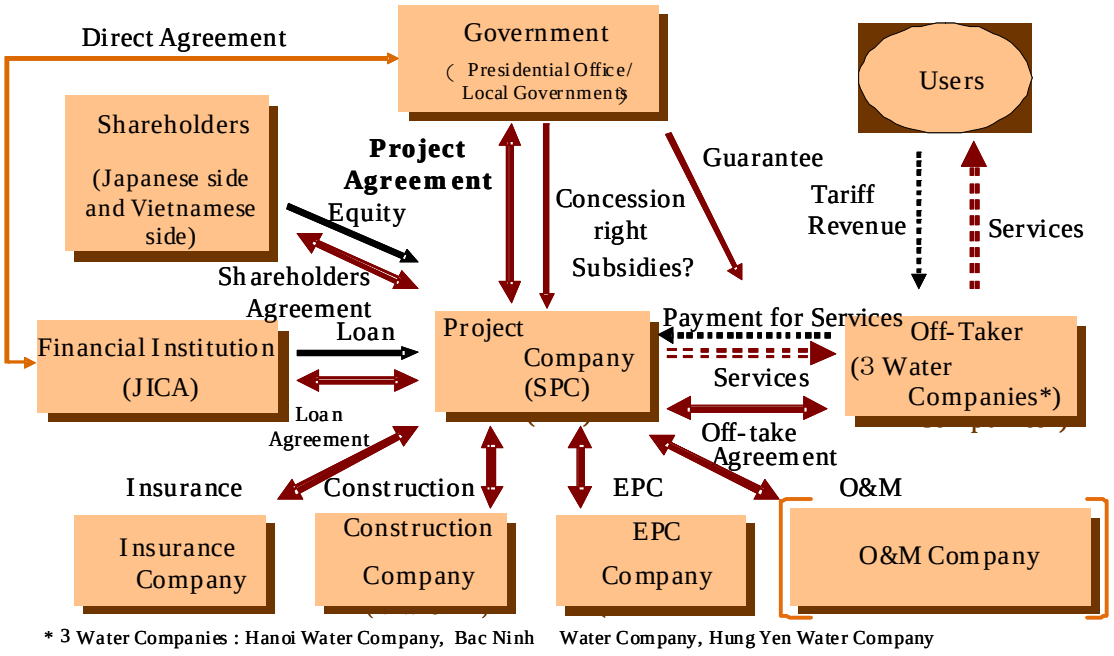


Figure S.27 Proposed Project Structure

3.10 Investigation Into the Operation and Maintenance Management System

3.10.1 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.

3.10.2 Investigation Into the Local Maintenance Management System

Therefore, we propose the following personnel system (Figure S.28).

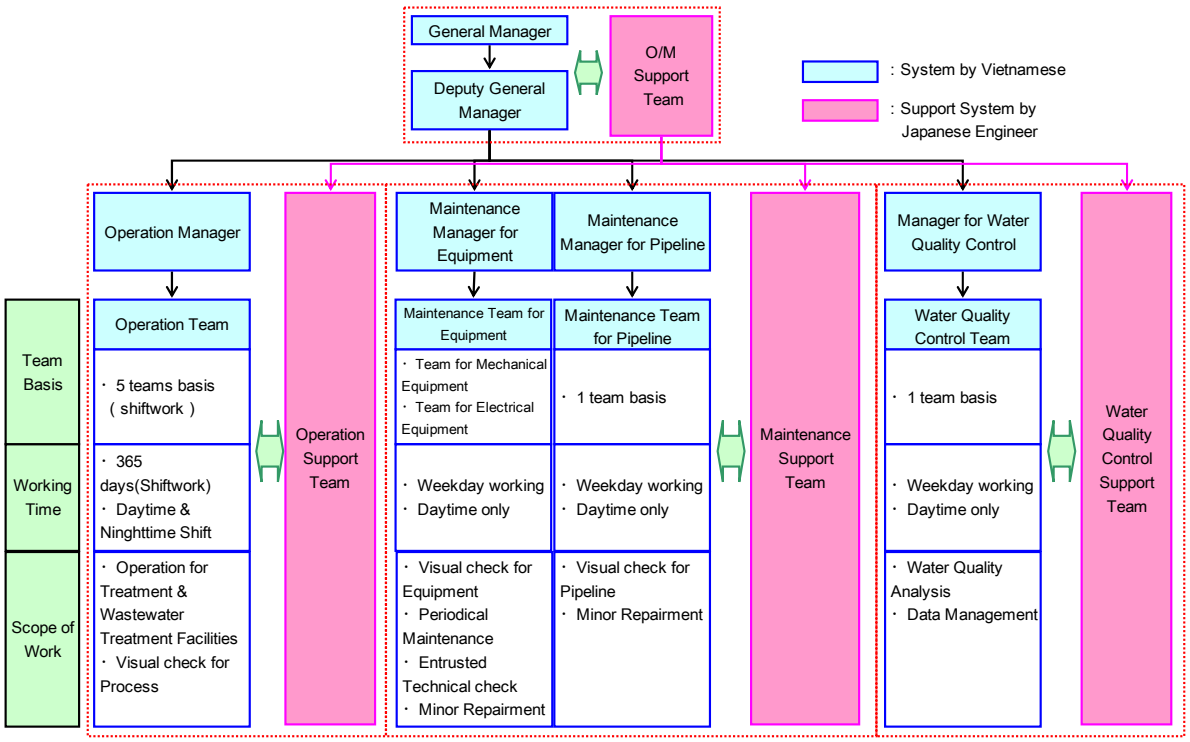


Figure S.28 Vietnamese Operating System and Japanese Support System

3.10.3 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
- 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

(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.

(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.

3.10.4 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.

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) 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.

4) 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.

3.10.5 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 (approx. 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.

3.10.6 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.

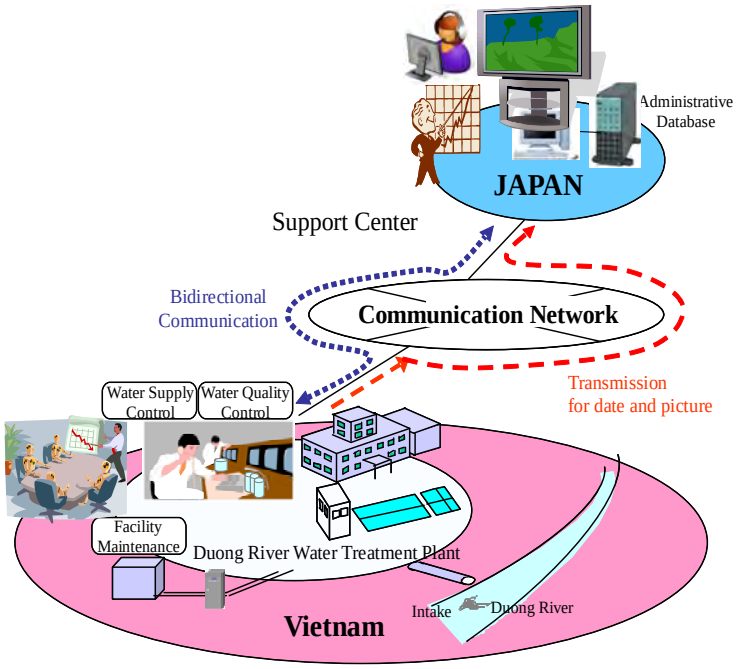


Figure S.29 Image of the Support System by the Remote Surveillance System

(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.

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.

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 Hung 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 S 32). 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 S.32 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 – 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) 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 S.33.

Table S.33 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 m3 per day. – Project exploiting surface water greater than 500,000 m3 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 m3 per day are required to prepare EIA report.
Circular No. 05/2008/TT-BTNMT; Guiding Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment	– Elaboration and appraisal of strategic environmental assessment reports – Elaboration, appraisal and approval of EIA; Implementation, Examination and certification of the implementation of EIA – 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 m3/day or higher for purposes other than agriculture, and for wastewater discharge into water sources at a rate of 5000m3/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

(3) Legal Framework of Environmental and Social Consideration

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.

This Project is categorized in B.

- *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 (Category B)

- 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.

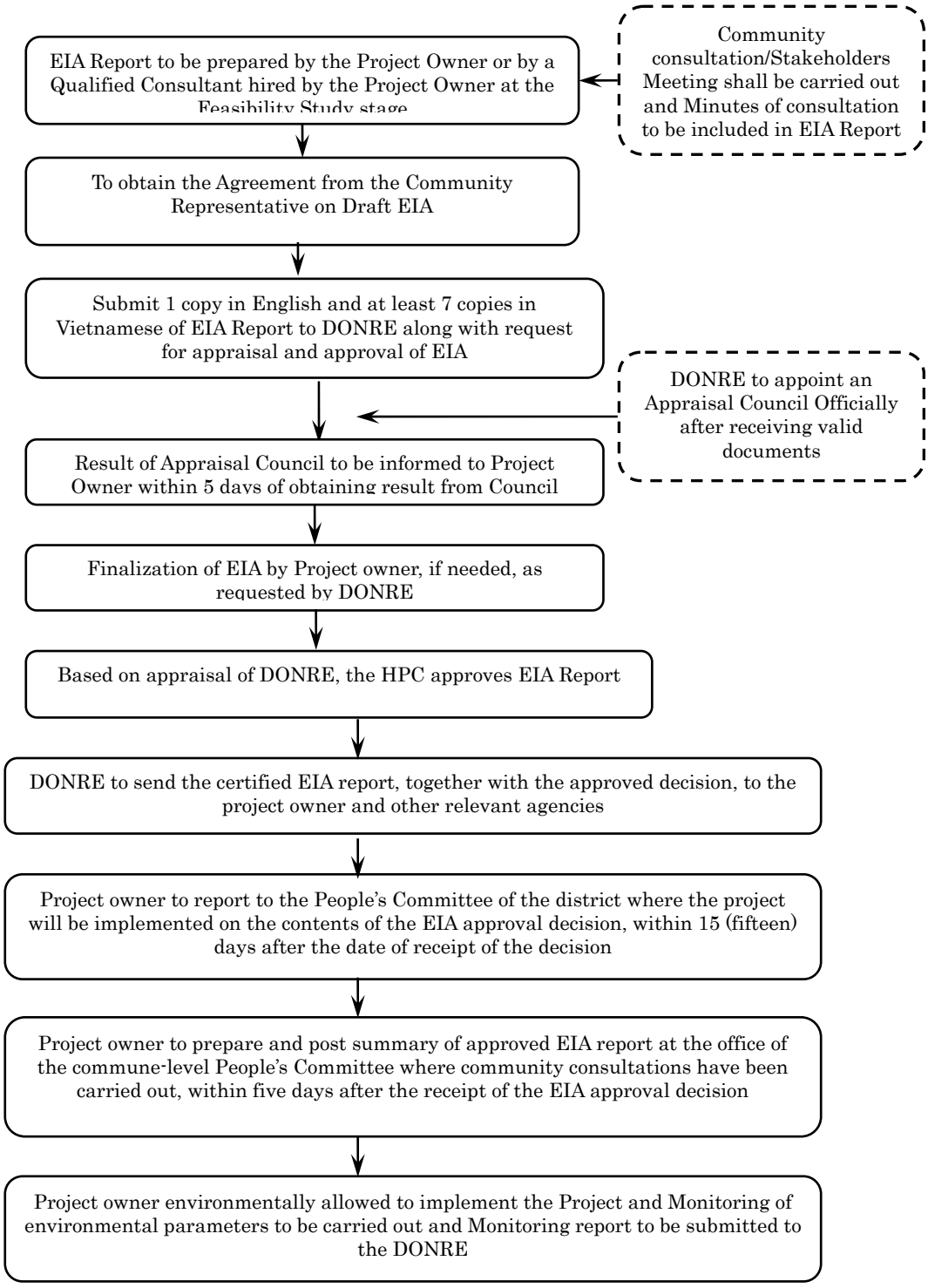
(4) Environmental and Social Considerations Needed for Projects

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.

(5) Environmental Impact Assessment according to Regulations in Viet Nam

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 related laws, 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).



Source: Based on the interview with the Hanoi Environment Protection Agency and Circular No. 05/2008/TT-BTNMT

Figure S.30 Law-based EIA Appraisal and Approval Procedure

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 S.34 and S.35 below. Location map of main facilities in this Project is presented in Figure S.31.

Table S.34 Project Proposal

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 300,000m3/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

Table S.35 Project Location Proposal

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)

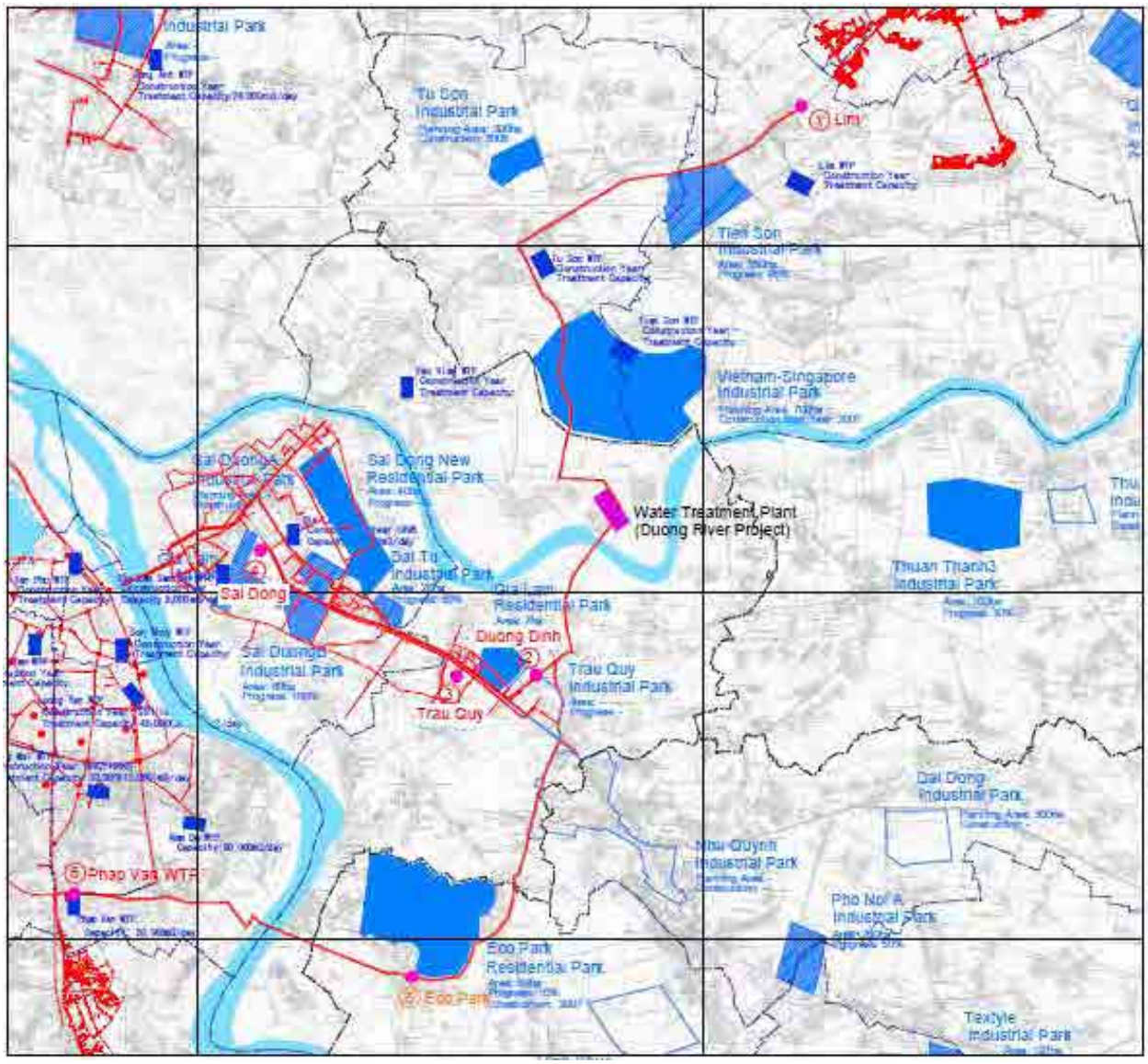


Figure S.31 Location Map of Main Facilities Proposed in this Project

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.

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

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.
- The sites proposed for alignment of transmission pipelines and off take points.

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.

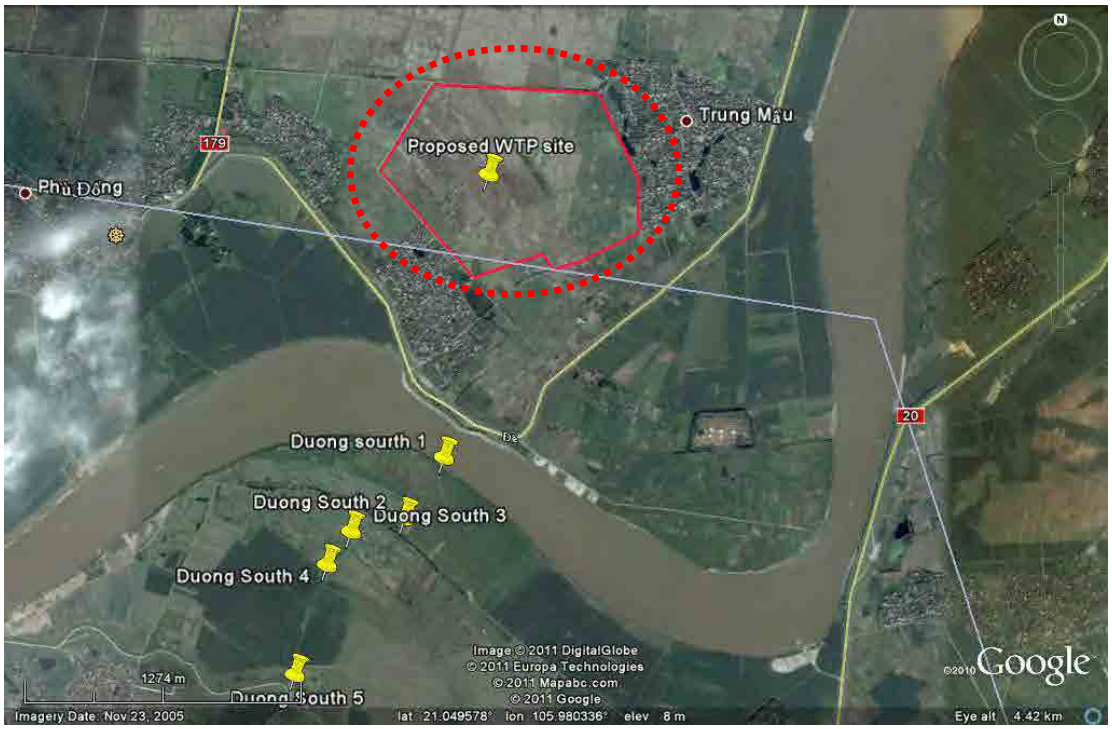
(3) Topography

(A) Topographical Feature

– 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:

- 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 S.32 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.

– 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.

– 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.

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 S.36 and Figure S.33. 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 S.36 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

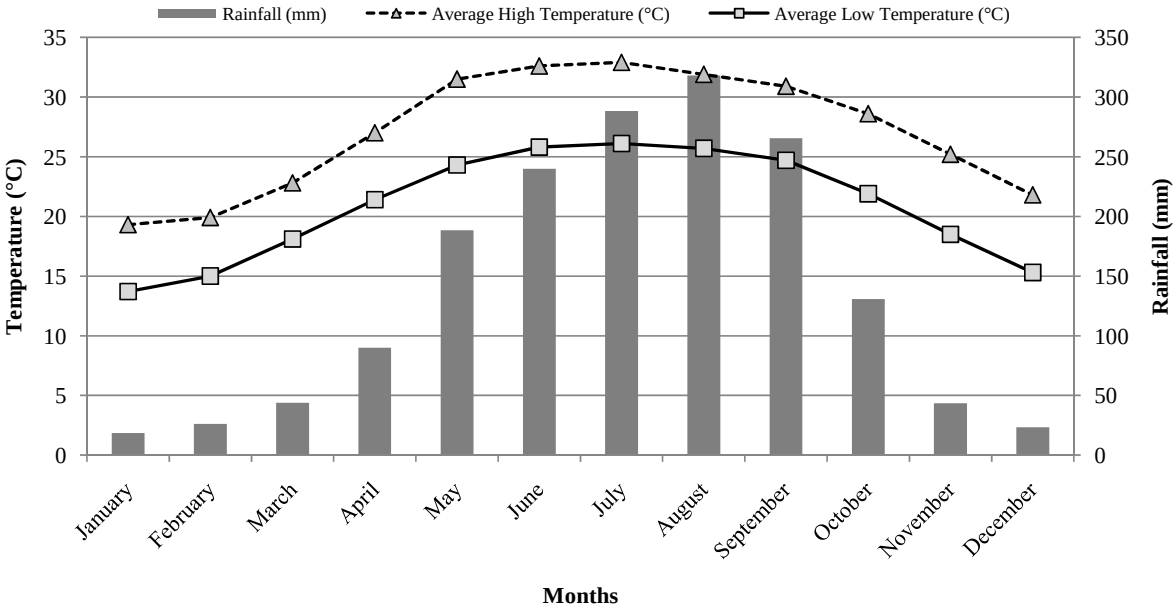
Source: World Meteorological Organization webpage

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, 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 S.33 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.

(4) 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 S.36. 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 S.37 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: PPP Project Study Team for the Greater Hanoi Water supply System

(5) 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 S.38 including the hourly average concentration of air quality parameters. However, during the congestion in streets of Hanoi, the air quality becomes worse.

Table S.38 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, Vietnam, Phd Thesis, Ngo Tho Hung

(6) 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.

(7) 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 S.34.

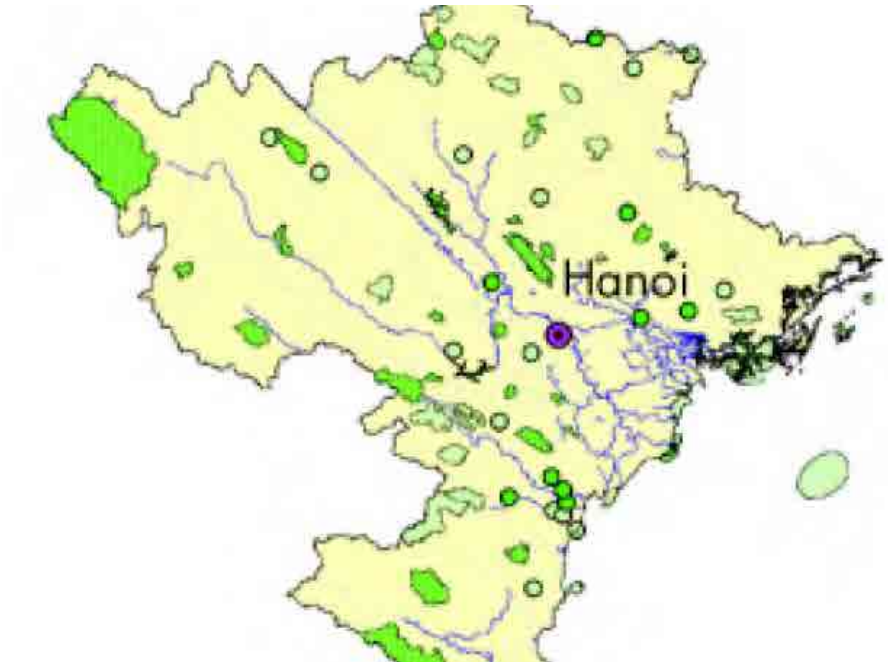


Figure S.34 Protected Areas in around Hanoi

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

(A) 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.

(B) 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.

(C) 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.

(8) 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 capital 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 An access road exists near the proposed site of the WTP. 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.

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 S.39. 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 S.39 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 S. 40. 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 S.40 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 WTP, 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 S.41 and S.42.

Table S.41 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 Construction of pipelines along busy roads can cause traffic problems and accidents	• 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 • Traffic management to be carried out appropriately with proper instruction near the site of construction. • Management of pipe laying works to be carried 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 S.42 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 S.43 and Table S.44.

1) Construction Stage

Monitoring program for construction stage is summarized in Table S.43 below.

Table S.43 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.

2) Operation Stage

Monitoring program required at operation stage is summarized in Table S.44.

Table S.44 Monitoring Program for Operation Stage

Object	Monitoring Location	Parameters	Frequency	Implementing Agency	Monitoring Cost*
Water Quality	– Intake	pH, Turbidity Hazardous Substances (Fluoride, Fe, Mn, NO2-N, NO3-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, NO2-N, NO3-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, BOD5, 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, Mercury, 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.
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.

(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.

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)

In this chapter, 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.

5.1 Project Risks Managed by Contracts

Public Private Partnership 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 which 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 Public Private Partnership projects 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 manage risks rather than who is responsible.

(1) Extraction of All Risks

It is important for risk management of projects to identify all key risks associated with the project at an early stage prior to detailed work on project documentation.

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).

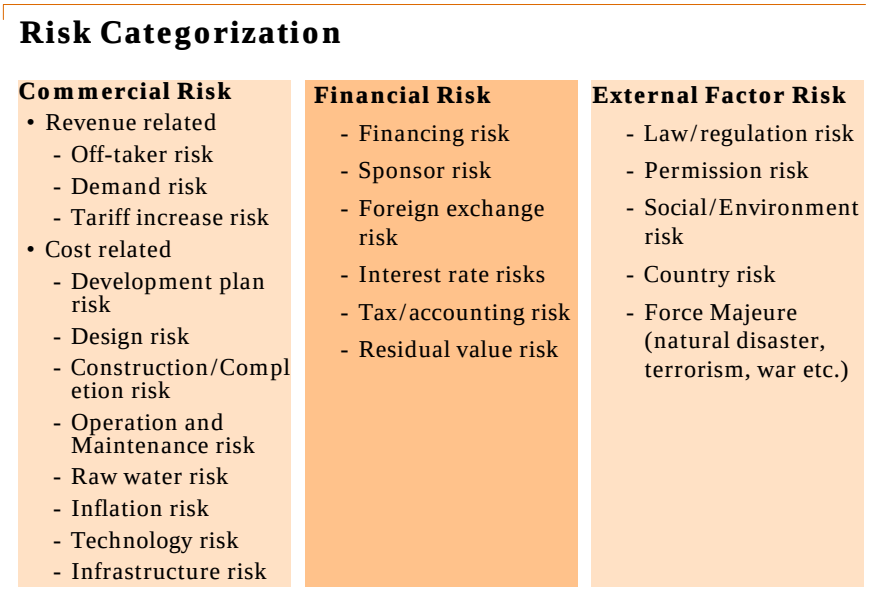


Figure S.35 Risk Categorization

(2) Risks Associated with the Project

Secondly, 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 to abstract risks scored with "3". Importance that is comprehensively determined based on impact and probability has been categorized in scores from 1 to 3.

Table S.45 Risk Matrix of the Expected Project

Project stage	Category 1	Category 2	Category 3	Risk
General	External Factor	Law/Regulation	Approval	SPC can't obtain necessary approvals.
	Financial	Interest rate		Interest rate
	Financial	Financing	Financing	Financing - SPC
	Commercial	Revenue	Demand	Demand lower than demand projection
	Commercial	Revenue	Demand	Contract with appropriate size
	Commercial	Revenue	Demand	Competitor
	Commercial	Revenue	Tariff revision	Payment Method
	Financial	Fluctuation in exchange	Currency	Currency
	Commercial	Revenue	Off-Taker Risk	Default in paying service payment
	Commercial	Cost	Development plan	Government Subsidy/ Capital Injection/ Development as public work
	Commercial	Cost	Infrastructure	Delay in GOV's work
Construction	Commercial	Cost	Inflation	Increase in Inflation
	Finance	Forex		changes in forex
Operation	Commercial	Cost	Inflation	Inflation rate increase
	Finance	Forex		changes in forex
	External Factor	Country risk	Forex	Overseas remittance

(3) Risk Mitigation Measures and Countermeasures

Measures and countermeasures for the above listed risk require discussions and agreements between parties relevant to the project and action items have been provided. Risks mentioned in the above list 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.

6. Economic Analysis

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").

In this 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 S.46 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%		

As above mentioned, 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 S.47 Maximum WTP Corresponding to EIRR (Economic IRR), and Project NPV

	EIRR	Maximum WTP		Project NPV	
Base Case	222%	2,000,000 VND/m3	(100.0%)	241 Trill. VND	9,403 100 Mill. Yen
Case 1	15%	34,500 VND/m3	(1.7%)	8,130 100 Mill. VND	32 100 Mill. Yen
Case 2	14%	32,500 VND/m3	(1.6%)	5,685 100 Mill. VND	22 100 Mill. Yen
Case 3	13%	30,000 VND/m3	(1.5%)	2,629 100 Mill. VND	10 100 Mill. Yen
Case 4	12%	28,000 VND/m3	(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 discuss 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 tons 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 tons of water per day and common facilities with the capacity of 300 thousand tons of water per day.

(2) Case study

Following case is analyzed. Note that “water treatment plant” includes water intake and raw water transmission facilities and “water conveyance system” includes booster pump and water pipe.

Table S.48 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.

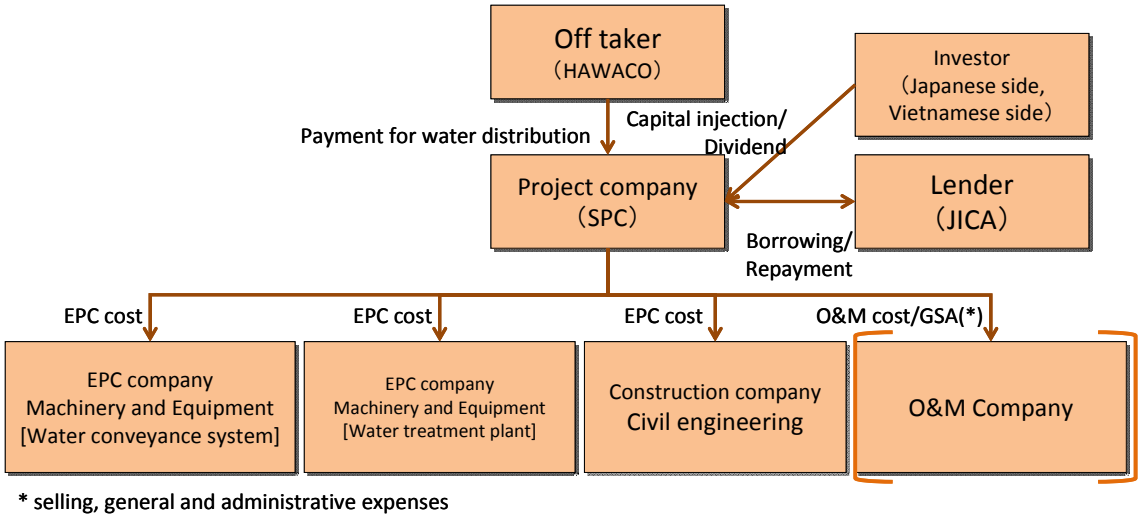


Figure S.36 Project Cash Flow of Case 1

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 investors 49% and Vietnamese investors 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 S.49 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	Phase 1 only: 22years （JICA Loan Period（25 years）－Construction Period（3 years））
	Phase1 & 2: 28 years （3 years (years until construction of phase 2 shall be commenced)＋JICA Loan Period（25 years））
End of Concession Period	Phase 1 only: End of 2036 （2012＋JICA Loan Period（25 years）－1）
	Phase 1 & 2: 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 Phase 1 only: End of 2037 Phase 1 & 2: 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%

(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.

Table S.50 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.)

(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.

(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 S.51 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.
2) Assets for rehabilitation investments are depreciated during the BOT project period.

(12) Inflation (Producer Price Index)

- Viet Nam : 6.4%/year
- The U.S. : 3.5%/year
- Japan : 0%/year

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
   - VND/JPY : 3.7％/ year
   - JPY/USD : -1.64%/ year

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.

(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 S.52 Outline of Payment Formula

Component		Paid for	Price Revision		Composed of
			Inflation	Forex	
Capacity Payment	Capacity-1	Availability (Water Purification Capability ×Availability Ratio)	×	○	• principal and interest + Additional Investment + Tax + Equity + Dividend
	Capacity-2 (Foreign Currency Portion)		○	○	• O&M Fixed cost
	Capacity-2 (Local Currency Portion)		○	×	• O&M Fixed cost
Variable Payment	Variable (Foreign Currency Portion)	Volume (Actual Purchased amount)	○	○	• O&M Variable cost
	Variable (Local Currency Portion)		○	×	• O&M Variable cost

Table S.53 Outline of the Payment Formula

Earnings Item		Description	Price Fluctuation
Capacity Payment	Charges for collecting invested amounts	• "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"	×
	Operation fixed charges (with inflation)	• 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)	○
	Operation fixed charges	• Book operation fixed costs (fixed portion of the O&M costs) for which no addition for inflation is	—

	(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	—

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.

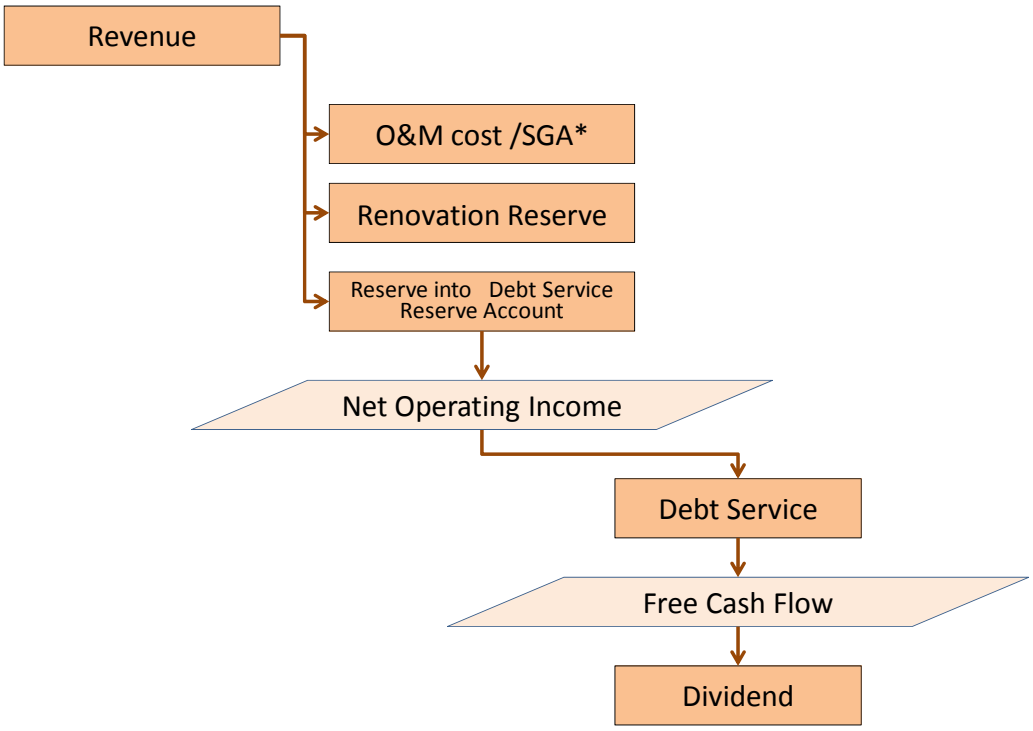


Figure S.37 Cash Water Fall

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.

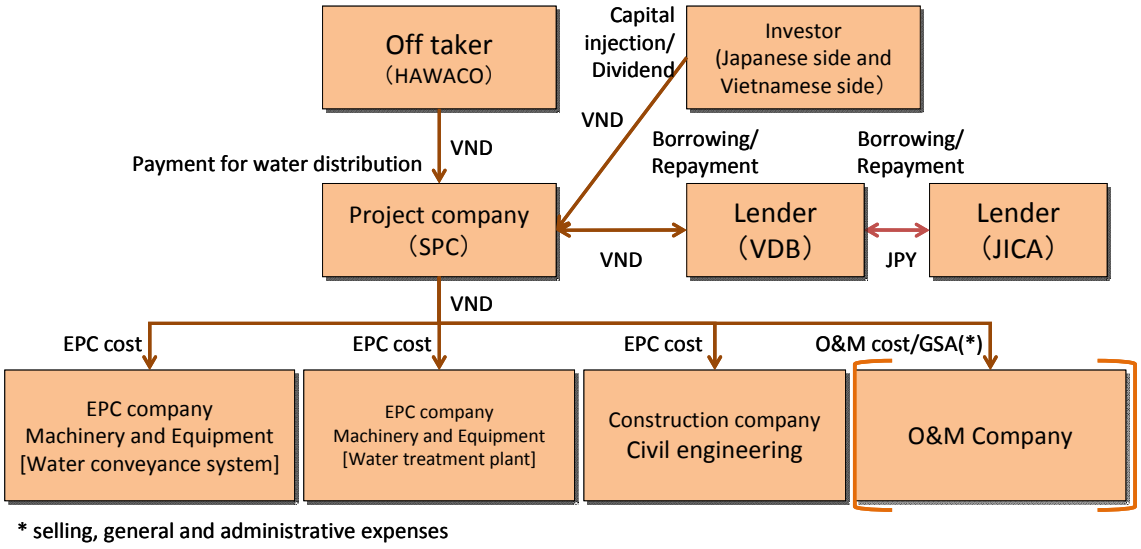


Figure S.38 Financial Scheme of Bank Loan

(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 S.54 Result of Calculation of Bank Loan by Sensitivity Analysis

No. in Table S.64		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 S.55 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.

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

Six (6) cases are analyzed for Case 1 (WTP and Transmission pipeline).

① Phase 1 only with 5% EIRR
② Phase 1 only with 10% EIRR
③ Phase 1 only with 15% EIRR
④ Phase 1&2 only with 5% EIRR
⑤ Phase 1&2 only with 10% EIRR
⑥ Phase 1&2 only with 15% EIRR

7.5.2 For Case 2

Six (6) cases are analyzed for Case 2 (WTP only).

① Phase 1 only with 5% EIRR
② Phase 1 only with 10% EIRR
③ Phase 1 only with 15% EIRR
④ Phase 1&2 only with 5% EIRR
⑤ Phase 1&2 only with 10% EIRR
⑥ Phase 1&2 only with 15% EIRR

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 S.56 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 S.57 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

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 S.58 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 S.59 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

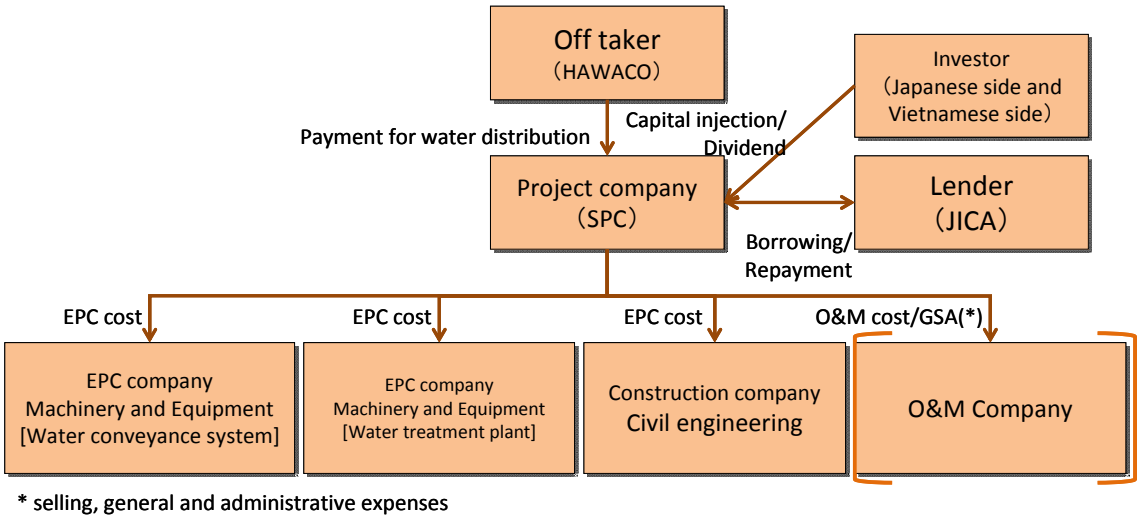


Figure S.39 Project Cash Flow of Case1

(2) Project Period

Table S.60 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	Phase 1 only: 22years （JICA Loan Period（25 years）－Construction Period（3 years））
	Phase1 & 2: 28 years （3 years (years until construction of phase 2 shall be commenced)＋JICA Loan Period（25 years））
End of Concession Period	Phase 1 only: End of 2036 （2012＋JICA Loan Period（25 years）－1）
	Phase 1 & 2: 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 Phase 1 only: End of 2037 Phase 1 & 2: End of 2043

(3) Initial Investment Costs

Table S.61 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.)

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 S.62 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

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 S.63 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 inflation factor in	・ Increase in inflation rate by 1% for cost side. ・ Increase in inflation rate	・ Inflation rate for cost side increases fixing the inflation

No	No. in Table 7.6.1	Means for quantification	Conditions for calculation	Remarks
		revenue formula).	by 2% for cost side.	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 S.64 Results of Risk Quantification

					EIRR in JPY (Dividend base)	Minimum Cash (Millions in JPY)	Minimum DSCR	EIRR Elasticity
Base case					14.97%	100	1.38	
No	No. in Table 7.5.2	Base case	Stress case					
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

					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.

8. Issues and Proposals on Management and System

(1) Assistance required from the Vietnamese Government and Japanese Government

1) Guarantee on the continuity of VIWASEEN's BOO concession right as a BOT concession right, following the transfer to a VIWASEEN-related SPC.

2) Guarantee on the purchase of the amount water purified (up to 300,000m3/day).

3) Adjustments between this project and the pilot projects under the PPP Law.

4) Adoption of a method to the payment system that combines the "Capacity Payment" and "Variable Payment"

5) Payment support for the off take price (VGF system based on the output).

6) Clarification on the position of the project in the metropolitan development plan and confirmation of the importance.

7) Encouragement the consensus building between the sponsors by governmental support for the Vietnamese sponsor.

8) Establishment and implementation of a monitoring agency for the project by the Vietnamese and Japanese governments.

(2) Assistance required from the Japanese Government

1) Payment support for the off take price (VGF system based on the output).
2) Establishment and implementation of a monitoring agency for the project by the Vietnamese and Japanese governments.