Socialist Republic of Vietnam

Preparatory Survey
for
Da Nang City
Hoa Lien Water Supply Project
(PPP Infrastructure Project)

FINAL REPORT

March 2016

Japan International Cooperation Agency (JICA)

Kajima Corporation
Hitachi, Ltd.
Yokohama Water Company
Original Engineering Consultants Co., Ltd.
Global Water Recycling and Reuse System Association

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADB	Asian Development Bank
B&V	Black and Veatch
BOD	Biochemical oxygen demand
BOT	Build Operate Transfer
CIP	Cast Iron Pipe
DARD	Department of Agriculture and Rural Development
DAWACO	Da Nang Water Supply Company
DBO	Design Build and Operate
DCIP	Ductile cast-iron pipe
DHTP	Da Nang Hi-Tech Park
DNPC	Da Nang Peoples Committee
DOC	Department of Construction
DONRE	Department of Natural Resources and Environment
DOT	Department of Transportation
DPC	Da Nang People's Committee
DPI	Department of Planning and Investment
DSCR	Debt Service Coverage Ratio
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EVN	Vietnam Electricity
FIRR	Financial Internal Rate of Return
FS	Feasibility Study
GERUCO	Geruco-Song Con Hydro Power Joint Stock Company
GGU	Government Guarantee Undertaking
GPS	Geographic Positioning System
HDPE	High Density Polyethylene
HH	House Hold
IEE	Initial Environmental Examination
IPO	Initial Public Offering
IRR	Internal Rate of Return
ISO	International Standards Organization
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
LA	Loan Agreement
LSTK	Lump Sum Turn Key

MARD	Ministry of Agriculture and Rural Development
MCRHMC	Mid-Central Regional Hydro-Meteorological Center
MOC	Ministry of Construction
MOF	Ministry of Finance
MONRE	Ministry of Agriculture and Rural Development
MOT	Ministry of Transportation
MPI	Ministry of Planning and Investment
MDGs	Millennium Development Goals
NPV	Net Present Value
NRW	Non-Revenue Water
O&M	Operation and Maintenance
PAC	Poly Aluminum Chloride
PMU	Project Management Unit
PPIAF	Public-Private Infrastructure Advisory Facility
PPP	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PVC	Polyvinyl chloride
RAP	Resettlement Action Plan
SCADA	System Control and Data Analysis
SPC	Special Purpose Company
SAWACO	Saigon Water Corporation
TA	Technical Assistance
UPI	Urban Plan Institute
URENCO	Da Nag Urban Environment company Ltd.
VND	Vietnam Dong
WB	World Bank
WTP	Water, Sanitation and Environment (company)
WPA	Water Purchase Agreement

CHAPTER 1 PROJECT OUTLINES AND OBJECTIVES

1.1 Background

(1) Project Conformity to the Development Policy in the Water Supply Sector

The Government of Vietnam formulated the "10-Year Socio-Economic Development Strategy (2011-2020)" in January 2011, with the national goal to accelerate national industrialization and modernization to become an industrialized nation by 2020. The national goal for provision of water supply services are set in the "The Prime Minister Decision approving orientations for development of water supply in Vietnam's urban centers and industrial parks up to 2025, and a vision towards 2050 (No. 1929/QD-TTg)" in which Da Nang is categorized as Class I City and its relevant targets are shown in the table below.

Table 1.1 Development Targets of Water Supply for Class I City

	2015	2020	2025
Service Stability (hours)	24	24	24
Service Coverage (%)	90	90	100
Unit Water Demand (letter/person/day)	120	120	120
Non-Revenue Water (%)	Below 25%	Below 18%	Below 15%

Source: Decision No. 1929/QD-TTg dated November 20, 2009 of the Prime Minister approving orientations for development of water supply in Vietnam's urban centers and industrial parks up to 2025, and a vision towards 2050

In the Da Nang Socio-Economic Development Plan (SEDP) to Year 2020, Da Nang City has set out the general target of expanding Da Nang City to become one of the biggest cities in Vietnam with a population of about 1.5 million. The SEDP has some specific economic goals, which include economic growth rate to be 12-13 % per year, Da Nang's GDP per capital to reach 4,500-5,000 USD by 2020 and export turnover in 2011-2020 to increase by 22-25% per year on average. It also declares that Da Nang city will focus on the infrastructure development to improve urban public services, including development of lighting system, public transportation, environmental sanitation, parks, sewage treatment, as well as water supply.

In addition, according to the Da Nang City Spatial Master Plan, the main thrust of new development will be to the north-west in Lien Chieu district where the recently constructed large scale Industrial Development Zones (IDZs) will be further expanded. A 1,200 hectare area has been earmarked for a high tech industrial park in Hoa Lien very close to the proposed new water treatment plant, which induces further water demand increase in the future.

Striving to environmentally-friendly development, Da Nang City has made an Environmental City

Declaration in 2008 and has been awarded the title "ASEAN Environmentally Sustainable City" by ASEAN. Especially Da Nang is highly inclined to water protection which is one of the resources for tourism, and has expectation on support from Japan in this field. Da Nang has made MOU with Yokohama City for "technical cooperation for sustainable urban development."

Table 1.2 Outline of Technical Cooperation of Da Nang City and Yokohama City

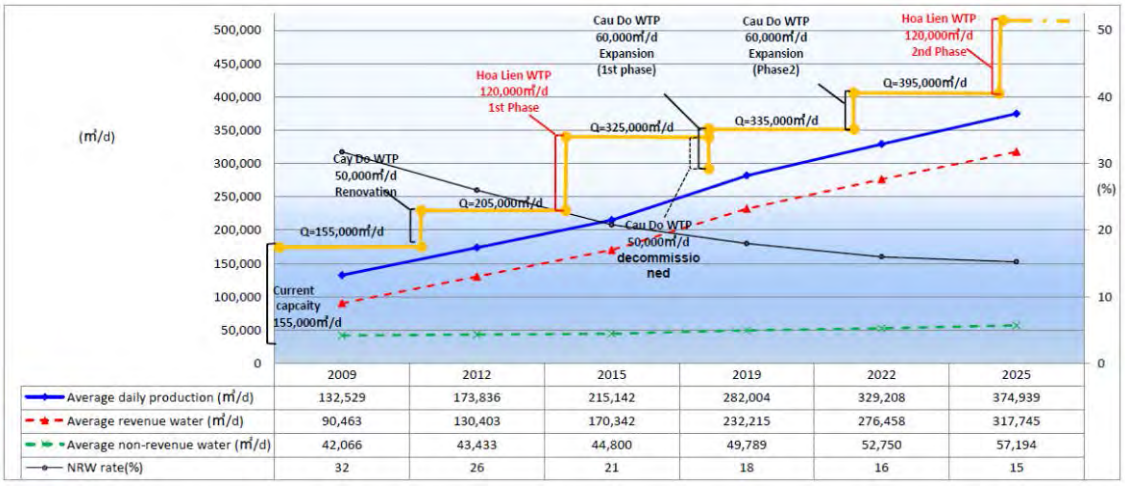
Name	Note on technical cooperation for sustainable urban development in Yokohama City and Da Nang City
Date of Signing	9th April, 2013
Outline	Yokohama have been promoting a international technical cooperation called for "Y-PORT" in order to contribute to solve problems in environmental filed which emerging and developing countries are facing business, taking advantage of the technology and know-how related to urban infrastructure development with the City of Yokohama and Yokohama city companies. As a part of technical cooperation, Da Nang City has signed the above mentioned note on technical cooperation, outline of the note are as follows.. (1) Yokohama City will provide technical advice to the Da Nang City which aims to become an environmental city. (2) Both cities will encourage participation of private organizations and academic institutions with the knowledge and experience on urban development that are friendly to the environment in order to achieve the objectives listed above. (3) Both cities urge government of both countries and international organizations to provide an appropriate support to the both cities when implementing the technical cooperation.
Action Plans	● In December 2014, Da Nang City Development Forum was established by JICA, Da Nang City and Yokohama City, and assisted to make a Da Nang City Development Action Plan. ● Small and medium enterprises in Yokohama City are feasibility studying and under implementation business in terms of energy conservation diagnostic service. ● In 2015, Yokohama City studied needs investigation in Da Nang City in order to impel an utilization of Joint Crediting Mechanism promoted by Ministry of Environment, and work at formation of business in terms of green gas emission reduction.

(2) Necessity of the Project

Da Nang city has been experiencing a rapid economic growth and massive urbanization, which causing severe water shortage and environmental issues. The City population is increasing by 2.5%

per year and is going on one million. It is one of the most urgent tasks in Da Nang City to have a stable water supply to meet the increasing water demand due to the population increase and expanding business operation

The figure below shows the growth in water demand (including both revenue water and non-revenue water) compared with water production capacity, which indicates the tight situation of water supply capacity in Da Nang City. It is clear that the existing infrastructure cannot produce enough water to meet the water demand in the near future, which should be promptly addressed.



	2009	2012	2015	2019	2022	2025
Average daily production (m³/d)	132,529	173,836	215,142	282,004	329,208	374,939
Average revenue water (m³/d)	90,463	130,403	170,342	232,215	276,458	317,745
Average non-revenue water (m³/d)	42,066	43,433	44,800	49,789	52,750	57,194
NRW rate(%)	32	26	21	18	16	15

Source：Prepared by the PS Team based on "The Draft Final Report for Da Nang Water Supply Project, ADB, Appendix 1. Population and Water Demand Projections"

Figure 1.1 Growth in Water Demand compared with Production Capacity

However, having a tight budget for infrastructure development, Da Nang water supply sector has to rely on financial and technical assistances from foreign aid and/or private sector.

Amid such a situation, ADB has developed the "Da Nang Water Supply Project (2010 – 2025)" that will expand the water treatment plants (hereinafter, referred to as "WTP") and decrease NRW in order to improve water production capacity to meet the future water demand. ADB has conducted the Feasibility Study (hereinafter, referred to as "ADBFS") for this project, and estimated that the water demand will reach 215,000m^3/day (225,000 m^3/day including treatment losses at WTP) in 2015 which is beyond the production capacity of the existing WTP (205,000 m^3/day). Therefore, this ADB established the plan to first upgrade the existing Cau Do WTP as a temporal solution, and then to construct the new Hoa Lien WTP as a cornerstone of the city's urban water supply development strategy. The new WTP will intake raw water from the dam to be constructed upstream of the Cu De River, which can provide a good quality of water. Moreover, Da Nang City has exclusive rights to use Cu De River water, which enables the Project to ensure stable supply of raw water for many years.

As mentioned above, Da Nang water supply sector has to rely on financial and technical assistance

from foreign aid and/or private sector due to a tight budget for infrastructure development. In addition to such financial condition, the Government of Vietnam has become very prudent for the new external public debt since increase of public debt in the Vietnam government has been becoming a problem. Under such background, ADB recognizes that out of the Da Nang Water Supply Project at least the new Hoa Lien WTP can be implemented under PPP.

The proposed Da Nang Hoa Lien Water Supply Project (hereinafter, referred to as "the Project") comprises of construction of a new Hoa Lien WTP (Phase 1), a water intake facility at water source and a raw water main from the water resource to WTP, as well as operation of the newly built WTP, which is the best needed water supply infrastructure project in Da Nang City.

ADB has already completed the Feasibility Study of the whole project. DAWACO is now preparing the documents which will be used to select a consultant that will prepare the tender documents for a consultant that will carry out the detailed design.

1.2 Project Objectives

The proposed Da Nang Hoa Lien Water Supply Project (hereinafter, referred to as "the Project") will implement a part of the Water Supply Project for the whole Da Nang City prepared by ADB. In the Project, several leading Japanese companies and Vietnamese companies form a consortium to construct water intake facility in the Cu De River, raw water main from the water source to the WTP and a new Hoa Lien WTP (only Phase 1 of the ADB project), and operate these facilities under the Private Public Partnership (PPP) or Build, Operate and Transfer (BOT) scheme. This Project aims to contribute to the achievement of the target for water supply development set in the "The Prime Minister Decision approving orientations for development of water supply in Vietnam's urban centers and industrial parks up to 2025, and a vision towards 2050 (No. 1929/D-TTg)" and the Master Plan of Da Nang City, and eventually to the healthy and sustainable development of Da Nang City.

1.3 Project Component

(1) ADB Water Supply Project

The Component of the ADB Da Nang Water Supply Project includes the followings:[1] And the following number is linked to number shown in Figure 1.2.

i. Upgrade of the existing Cau Do WTP to increase production capacity
ii. Construction of the new Hoa Lien WTP (Phase 1: 120,000m^3/day)
iii. Construction of a new 16km raw water main from a new dam to be constructed on the Cu De river to a new Hoa Lien WTP (This length of raw water pipeline has been reduced from 16 km to 7 km in this JICA survey)

[1] ADB Final report "TA No. 7144-VIE : DA NANG WATER SUPPLY PROJECT June 2010"

iv. Removal of the antiquated system in the existing Cau Do WTP and instruction of a new system
v. Construction of the new Hoa Lien WTP (Phase 2: 120,000m^3/day)
vi. Expansion of the network to serve all areas of the city and replacement of leaking pipes to reduce NRW
vii. Provision of new technology and facilities to strengthen Da Nang Water Supply Company's (hereinafter referred to as "DAWACO") management capacity and capability for operation and maintenance of the system, including installation of GIS, management information system, asset management, SCADA (for monitoring control and data collection) and new ICT (Information Communication Technology) equipment

Among the above components, this PS examined the feasibility of the involvement of the SPC in the construction and operation of t ii) the new Hoa Lien WTP (Phase 1: 120,000m3/day), and iii) the new 16km raw water main from a new dam to be constructed on the Cu De river to a new Hoa Lien WTP (This length of raw water pipeline has been reduced from 16 km to 7 km in this JICA survey).

(2) The Outline of the Proposed PPP/BOT Project

The Project is a part of the Da Nang Water Supply Project which ADB has developed and partially commenced. Therefore, the SPC comprised of the Japanese companies shall make a clear demarcation in responsibility between ADB and the SPC, and closely cooperate with ADB to construct and operate the target facilities to run a water supply system in the whole Da Nang City.

As mentioned above, among the components of the ADB's Da Nang Water Supply Project, this PS examined the feasibility of the involvement of the SPC in the construction and operation of t ii) the new Hoa Lien WTP (Phase 1: 120,000m^3/day), and iii) the new 16km raw water main from a new dam to be constructed on the Cu De river.

However, because the new dam on the Cu De River (stated in iii. of the ADB's project component) may not be constructed in line with the Project schedule, the PS Team has proposed to take the raw water directly from the Cu De River by constructing a movable weir in the Cu De River at Hoa Bac commune and installing pumps to carry the raw water to the WTP. This proposal has been approved by Da Nang City and DAWACO. And, by the changing of intake points, length of raw water pipeline has been reduced from 16 km to 7 km.

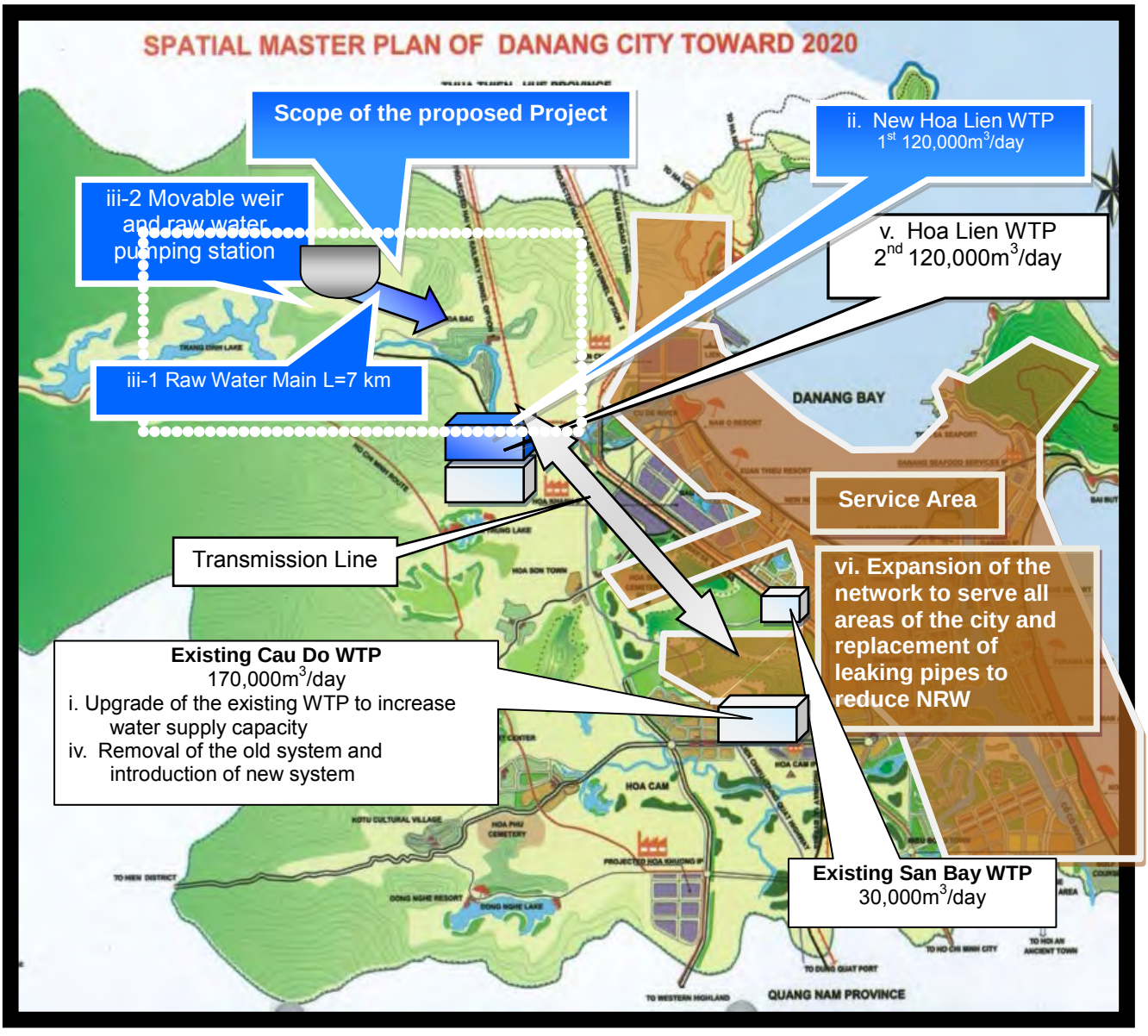
Therefore, the actual scope of the Project includes the construction, operation and maintenance of the following facilities as shown in Figure 1.2. The Figure 1.2 also shows demarcation of the proposed PPP project and Da Nang water supply project of ADB.

- ii. Hoa Lien WTP (Phase 1: 120,000m^3/day)
- iii-1. 7km long raw water main from the intake facility to be constructed on the Cu De River

to new Hoa Lien WTP

- iii-2. Water intake facilities (movable intake weir and raw water pumping station) to be constructed upstream of the Cu De River

The SPC will sell the treated water produced at the new WTP to DAWACO as bulk water.



(: Scope of the Proposed Project)

Figure 1.2 Demarcation of the Project Scope between ADB Water Supply Project and the Proposed Project

CHAPTER 2 BACKGROUND AND OBJECTIVES OF THE PREPARATORY SURVEY

2.1 Survey Purpose

This Preparatory Survey (hereinafter, referred to as "PS") aims to verify feasibility of the proposed Da Nang Water Supply Project under the PPP/BOT scheme to achieve development of water supply systems (e.g. New Hoa Lien WTP, Raw water main, Intake weir etc.in Hoa Lien commune and Hoa Bac commune in Hoa Vang district) through project cost estimation, financial analysis, examination of business scheme and contractual provisions, as well as socio-environmental assessment.

2.2 Survey Outlines

This PS will determine the detailed project plan in terms of technical and financial aspects, and carefully evaluate the profitability and feasibility of the business scheme under which the consortium will invest the water supply project including the construction, as well as operation and management with the cooperation from and appropriate risk allocation between the local governments.

The survey contents includes 1) technical examination, 2) determination of financial plan and profitability, 3) establishment of business implementation scheme, which can easily obtain stable governmental support, 4) appropriate risk allocation between public and private sector which directly affects cost estimation and project feasibility, and 5) development of draft contract in accordance with the Vietnamese laws.

The survey will be conducted under the following guidelines:

i. Make a fair disclosure of information about the survey to the local stakeholders (e.g. PC, DPI, DAWACO, etc.);
ii. Provide sufficient explanation on the possible business risks to the Vietnamese stakeholders, especially to the Vietnamese government who may bear some part of the risk, and make a steady effort to negotiate with them in order to achieve a realistic risk allocation between the stakeholders, with support from the Government of Japan, JICA and ADB;
iii. Execute an analysis of the current financial status of the water supply organizations in Da Nang to clarify direct and indirect assistance being provided from the local governments to reduce the business risks, to persuade the stakeholders that the water tariff offered by the SPC is realistic proposal.
iv. Accurately identify the decision-maker of the local government to make an efficient discussion for the business development
v. Make a close communication with JICA and ADB

vi. Discuss the most plausible business scheme to achieve a win-win situation with the local stakeholders from the early stage of the survey
vii. Try to obtain stakeholders' understandings of advantages of implementing the water supply project under PPP/BOT scheme instead of with ADB loan.
viii. Enhance solidarity among the PS Team, which is comprised of companies from the several industries needed to carry out this project, in order to efficiently conduct the survey to achieve the successful outcomes by making maximal use of each company's local resources.

Following the above guidelines, the PS Team conducted the following survey:

Table 2.1 Survey Items

Category	Survey Items
(1) Current Status and Future Plan of Water Works in Da Nang and Vietnam	a. Socio-economic condition and related policies in Vietnam, and position of Da Nag in Vietnam b. Current status of water supply sector in Vietnam and future development plan c. Current status of water supply sector in Da Nang City and future development plan d. Current status of urban development plan in Da Nang City and future development plan e. Financial condition of DAWACO and policy on water tariff of Da Nang City f. Other interested domestic and/or international private companies and/or donor agencies g. Outlines of the project being conducted by the other domestic and/or international private companies and/or donor agencies (incl. scope, schedule, influence to this project, etc.)
(2) Collection and Review of Basic Information	a. Water demand analysis b. Raw water sampling test c. Geotechnical investigation d. Topographic survey e. Identification of design standard f. Review of the existing documents
(3) Basic Design and Project Cost Estimate	a. Water demand analysis b. Development planning for water intake plant c. Development planning for water pipelines d. Development planning for water treatment plant e. Identification on the progress of land acquisition and water right f. Examination of design criteria g. Basic design and construction method/schedule plan h. Estimation of approximate construction cost, operating cost, maintenance cost and overall project cost
(4) Study on Environmental and Social Impacts	a. Environmental impact assessment (review of ADB report) b. Resettlement Plan (Review of ADB's plan)

Category	Survey Items
(5) Study of Business Scheme	a. Development of Business Scheme (Role allocation between public and private) b. Design of and Comparison between Several PPP/BOT Business Models c. Determination of Source of Initial Cost d. Profits and Costs e. Financial Analysis on PPP Business Model f. Service Contents and Loan Preconditions g. Role Allocation between Public and Private Sector in Business Operation h. Proposal of Operating Structure
(6) Financial Analysis for Business Model	a. Setting of framework for financial analysis b. Cash flow analysis c. Analysis of several financial indicators such as IRR (PIRR / EIRR) DSCR etc.
(7) Collection and Confirmation of Relevant Laws and Regulations	a. Regulations for water utility business b. Legislation on water tariff c. Investment laws and regulations d. Land related laws and regulations e. PPP/BOT related laws and regulations f. Corporate income tax regulations g. Business permits procedure
(8) Risk Analysis and Security Package Analysis	a. Determination of the possible risks in operation of the proposed project b. Examination of countermeasures against risks c. Examination of the contracts required for the running the project (e.g. PPP/BOT concession contract, loan agreement with SPC, water purchase agreement etc.) d. Security package
(9) Financial Analysis of Related Organizations	a. Financial Analysis of off taker b. Financial Analysis of investors
(10) Feasibility Analysis	a. Necessity of the Project b. Feasibility of business scheme

2.3 Policy of the Preparatory Survey

According to the scope of works in Table2.1, the study was executed in accordance with the following policies;

1) Development & Promotion the water supply project through BOT/PPP scheme

In order to enhance the feasibility of this Project to be implemented as BOT/PPP scheme, it is necessary to clarify the possible envisaged risks in the project operation and properly allocate those risks among the consortium and Da Nang City and design a business plan that can derive the maximum benefit from the investment, and carefully evaluate the profitability and feasibility of the business plan.

The PS team also implemented cash flow analysis of proposed business model and present the water tariff on early stage of the PS to negotiate regarding the water tariff with relevant organizations. In addition, the PS team ensured compliance with the related laws and regulations in Vietnam.

2) Environmental and social considerations

This project is classified on the environment category B of JICA Guidelines for Environmental and Social Considerations (hereinafter referred as to "New Environmental Guidelines"), therefore confirmation of environmental and social impact based on the guidelines is required.

Initial Environmental Examination and Resettlement Action Plan for the whole ADB project have already completed in the ADB FS, therefore in this study, the PS Team reviewed the ADB's findings comparing the Vietnamese requirements with the JICA guideline and execute the additional survey to supplement the insufficiency of ADBFS.

In addition, in order to materialize this project, the PS Team carried out the following items;

- To clearly identify the procedure to obtain the necessary environment study approval particularly for this project.
- Collection of relevant laws, regulations and guidelines.
- To associate these regulations with the approval procedure.

3) Sharing information with relevant agencies

In order for success of the Project as BOT/PPP scheme, it is essential that Vietnam government and DPC involve with this project. Therefore PS team shared information about the progress of this PS and exchange opinions with Vietnam government and DPC from the beginning stage of this preparatory study.

4) Adjustment & allocation of scope of Project with other donors

This project will not stand alone and its success is highly related to the construction of the distribution network of the water produced at the new Hoa Lien WTP, which will be constructed by the ADB loan. Close communications with these projects was tried during the PS to develop the project in the realistic manner.

2.4 Survey Schedule

The implementation schedule for the reparatory Survey is as shown below:

Table 2.2 Implementation Schedule for the Preparatory Survey

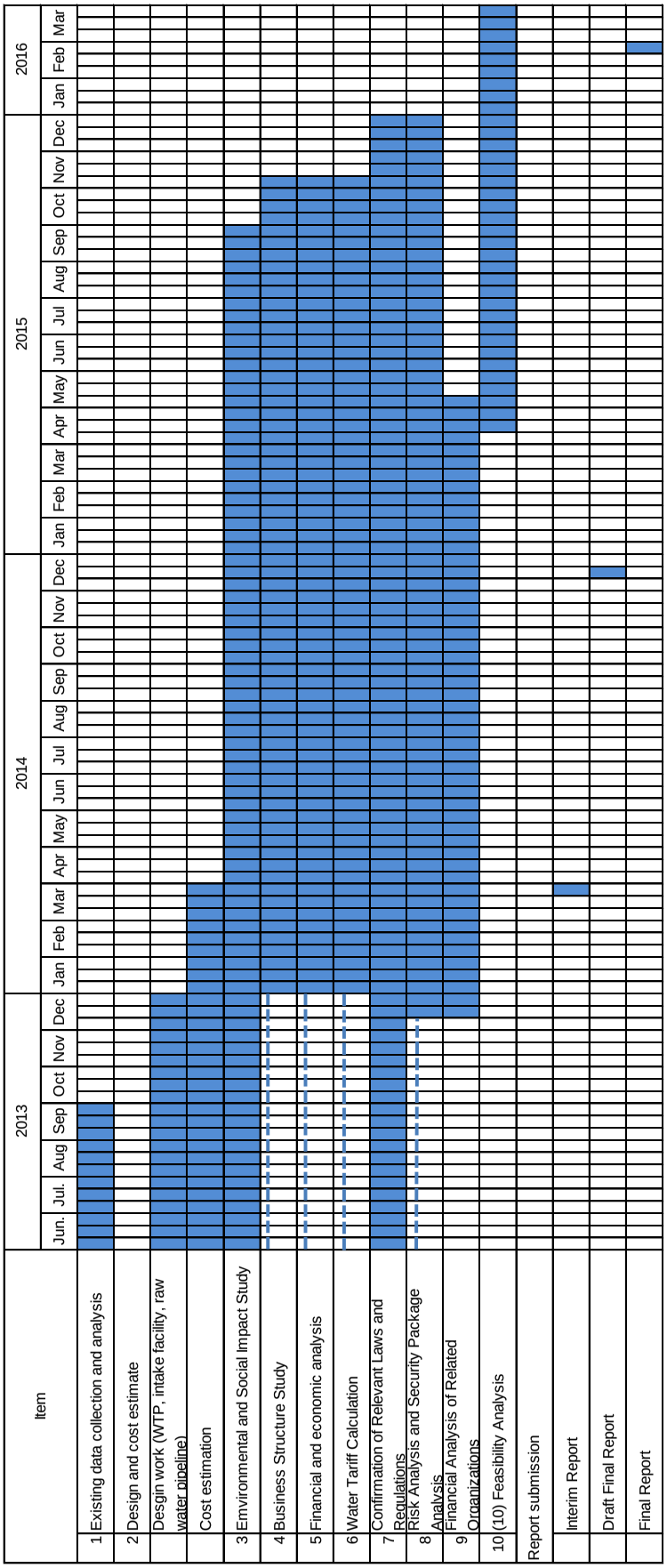
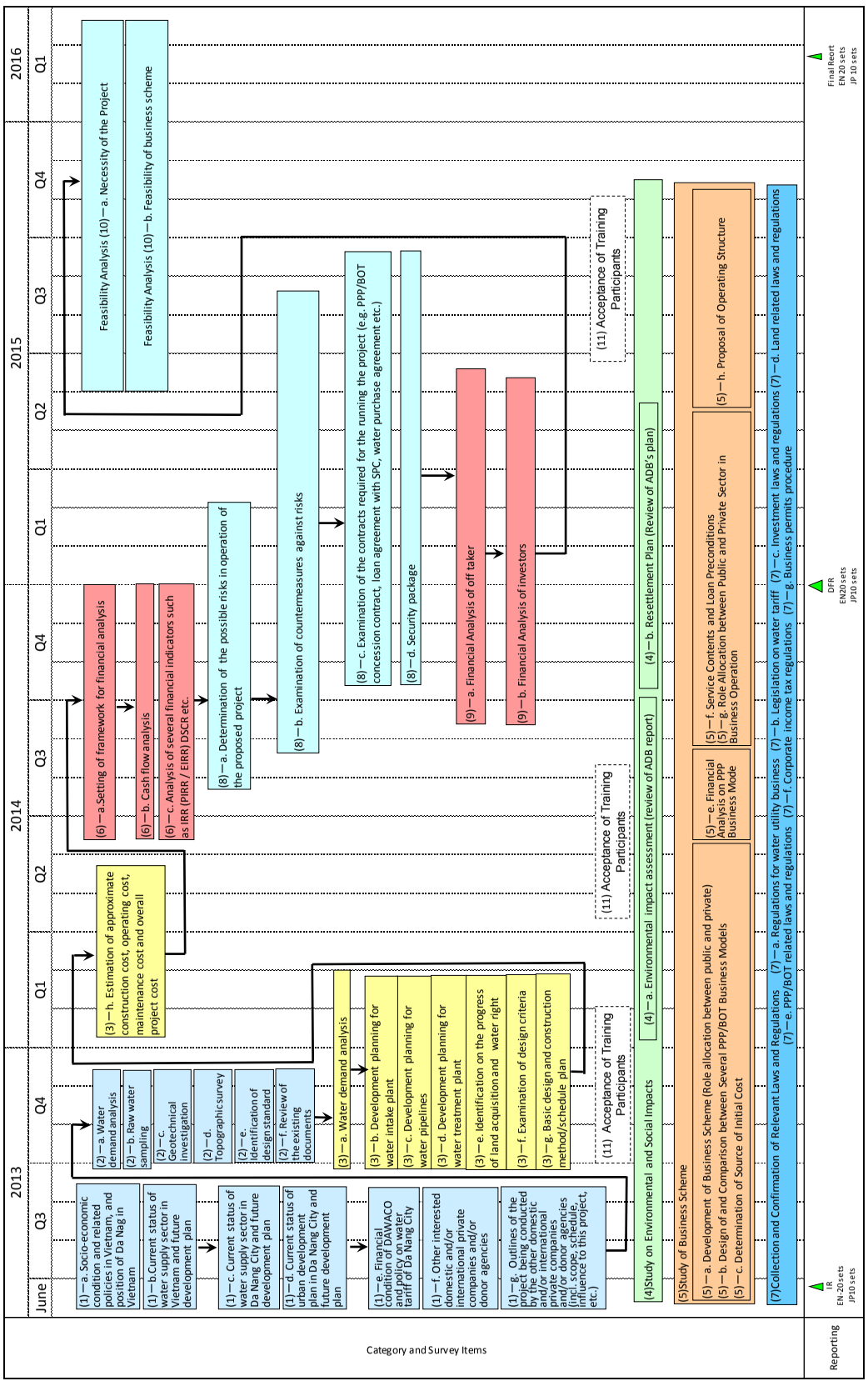


Table 2.3 Workflow Diagram for the Preparatory Survey



CHAPTER 3 BASIC INFORMATION OF DA NANG CITY

3.1 Socio-Economic Condition

(1) Geography and Climate

Da Nang is the fourth largest city of Vietnam with a total population of 970,000,000 (as of 2012) located in middle of Central Vietnam, between Hanoi and Ho Chi Minh City (HCMC). Da Nang was originally the capital city of Quang Nam province, but in 2003 it was separated to become one of the five city provinces in Viet Nam, together with HCMC, Hanoi, Haiphong and Kanto.

Situated on the east end of the East-West Economic Corridor which connects Myanmar and central Vietnam via Laos and Thailand, Da Nang is the important gateway to the Pacific Ocean and the economic center of Central Vietnam. Da Nang is surrounded by several UNESCO World Heritage Sites, such as Imperial City of Hue, the Old Town of Hoi An and the My Son ruins.

The City has a natural land area of 1,285.4 km^2 (as of 2014)[2] including Hoang Sa Island, divided into six administrative areas including six urban districts (Hai Chau, Thanh Khe, Son Tra, Lien Chiu, Ngu Hang Son and Cam Le), and two rural districts (Hoa Vang and Hoang Sa).

Figure 3.1 Location of Danang City

Da Nang has a typically tropical monsoon climate with two seasons, i.e., a dry season lasting from January to August, and a typhoon and rainy season lasting from September through December. Rainy season coincides with a hurricane season, which causes frequent flooding. Annual mean temperature is 26 ℃, the highest is 28-30℃ between June and August; the lowest is 18-23℃ between December and February. The mean annual rainfall is 2,523mm. Rainfall is typically highest between October and November (ranging from 550-1,000mm), and lowest between January and April (ranging from 23 to 40mm).

[2] General Statistics Office of Vietnam Website, <http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=14459> (accessed on 28 December 2015)

Table 3.1 Climate Data for Da Nang City

	2008	2009	2010	2011	2012	2013	2014	Average
Annual Mean Temperature (℃)	25.5	26.3	26.3	25.2	26.5	26.2	26.3	26.0
Annual Mean Humidity (%)	82.0	81.0	82.4	80.8	79.9	81.0	80.6	81.1
Annual Total Rainfall (mm)	2528.0	3017.8	2236.8	3647.8	1696.1	2,316.7	2,224.1	2,523.9

Source：General Statistics Office of Vietnam Website (28th December 2015) http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=14459 (accessed on 28 December 2015)

(2) Population

Population in Da Nang City has been increasing since 1995 to reach one million in 2014. With the target to become a city with population of 1.5 million people, Da Nang expects the population to further increase.

Table 3.2 Changes in Population in Da Nang

(Unit: thousand people)

1995	2008	2009	2010	2011	2012	2013	2014
637.3	868.8	894.5	926.8	946	966.3	986.8	1,007.7

Source：General Statistics Office of Vietnam Website (28th December 2015) <http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=14459> (accessed on 28 December 2015)

(3) Economic Status

As an economic and cultural center of the central Viet Nam, Da Nang City has experienced a continual and stable economic growth, and its GDP grew at an average rate of 11% in the period 2006-2010. Also, as shown in Table 3.3, Da Nang's GDP growth rate and per capita GDP are higher than the country's average.

In Da Nang City, industry and construction sector and service sector account for major share of GDP, constituting 36.5% and 53.5% respectively, while the share of agriculture, forest and fishery sector in GDP is as low as 2.7%. This resulted from the Da Nang's strategy executed in 1997 to 2000 to shift the city's major industry from agriculture to service, industry and construction. GDP share in Da Nang in 2020 is expected to be: 55.6% of service sector, 42.8% of industry and construction sector and 1.6% of agriculture, forest and fishery sector.

In line with its economic development policy, Da Nang City has been actively working to attract investment from domestic and foreign companies in a wide range of field.

The investment from Japan to Da Nang City has been increasing since 2005, which has mostly focused on the manufacturing sector. But recently there has been a growing trend toward the investment in the software development sector. There are six industrial parks in the city, of which Hoa Kahn and Hoa Cam Industrial Parks are the major investment destination for Japanese entities[3]. "The Japanese Business Association in Danang" was founded in October 2008, and 72 Japanese companies have advanced in Da Nang as of December 2013. Such a remarkable advancing of Japanese company have still been continuing as 11 new Japanese companies has been advancing in Da Nang city just from January to June 2015. Investment from Japan to Da Nang city has totaled a 378.5 million USD in October 2015.

Furthermore, Da Nang Hi-Tech Park with a total area of 1,129 ha has been newly constructed near the Hoa Lien WTP and three Japanese companies have already established their factories in the industrial park (as of October 2015).[4]

Table 3.3 GDP per Capita in Da Nang City and Viet Nam

	1997	2000	2005	2010	2012	2013	2014
1) GDP growth ratio (%)							
Da Nang City	12.7	9.9	13.8	11.5	9.1	8.1	9.3
Viet Nam	8.2	6.8	8.4	6.8	5.0	5.4	6.0
2) GDP per capita (USD)							
Da Nang City	420	460	950	2,016	2,294	2,800	2,487
Viet Nam	361	402	639	1,169	1,540	1,890	2,077

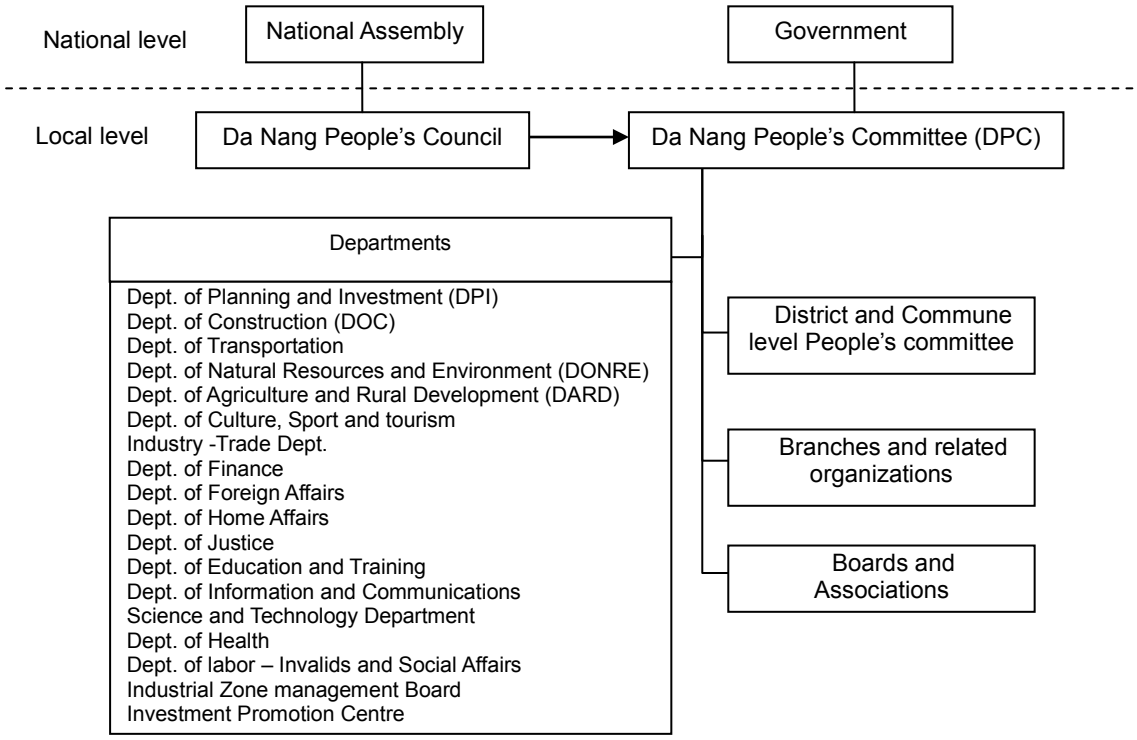
Prepared by the PS Team based on the information collected from the official website of the Da Nang Investment Promotion Center, and the Report on the "Current Status of Economy and Investment in Da Nang" published by Da Nang Representative Office in Japan in Jnuary 2014

(4) Administrative Structure of Da Nang City

Local administration system in Viet Nam is divided geographically into three levels, namely, including, provinces, districts, and communes. At all three levels there is a representative body (the people's council) and an executive body (the people's committee), under which many kinds of departments and district committees are established. The figure below shows the governmental institutional structure in Da Nang City. The agencies mainly concerning this project include Department of Planning and Investment (DPI), Department of Natural Resources and Environment (DONRE), Department of Construction (DOC), Department of Transportation (DOT) and Industrial Zone Management Board.

3 Da Nang Representative Office in Japan "Current Status of Economy and Investment in Da Nang," January 2014

4 Current Trends in Vietnam's Economy, October 2015



Source: Prepared by the PS Team based on the information collected from the official website of Da Nang City

Figure 3.2 Governmental Agencies under DPC

3.2 Current Water Supply Situation

(1) Existing Water Suppliers

Present water supply in Da Nang City has been carried out mainly by Da Nang Water Supply Company (hereinafter referred to as "DAWACO"), a one-member limited liability company owned by the City. Although DARD and other agencies have also been providing water supply services in some parts of the city, their water supply quantity is very limited and ownership of their facilities will be transferred to DAWACO in the future. Therefore, practically, DAWACO manages and operates almost entire water supply business in Da Nang City.

Table 3.4 Existing Water Suppliers in Da Nang City

Organization	Service Area
DAWACO	Lien Chieu District, Thanh Khe District, Hai Chau District, Hoa Vang District, Cam Le District, Son Tra District, Ngu Hanh Son District (covers almost all city area)
DARD and other agencies (however, all the services will be transferred to DAWACO in the future)	• Industries in Lien Chieu District • 915 households in the areas near the border with Quang Nam Province • 1,500 households in the South area of Hoa Vang District

In this regards, this section provides the study on the current situation of water supply services DAWACO has been providing in the seven districts.

Table 3.5 and Figure 3.3 show the outlines of DAWACO and DAWACO's organizational structure, respectively.

Table 3.5 General Information on DAWACO

Copany's Name		Da Nang Water Supply Company, DAWACO	
Service Area		Lien Chieu District, Thanh Khe District, Hai Chau District, Hoa Vang District, Cam Le District, Son Tra District, Ngu Hanh Son District	
Operating WTPs		Cau Do WTP, San bay WTP, Son Tra WTP	
Major Indicators		2010[1]	2013[2]
1	Sevice Area (km^2)	1,257.3	1,283.42
2	Production capacity (1,000m^3/d)	155	205
3	Population in service area	887,000	Year 2012: 967,000
4	Population served	524,000	Year 2012 : 736,000 As of July 2013 : 751,000
5	Water supply coverage ratio (%)	59%	Year 2012 : 75.70%
6	Number of connection	140,842	As of July 2013 : 217,704
7	Total distance of distribution network (km)	609	Distribution pipe: 3,579 Transmission pipe: 545
8	Service Stability (hrs/day)	24h	23.8h
9	NRW (Non revenue water) ratio (%) NRW = (Average daily production volume – Revenue water volumne) / average daily production volume	31.79	Seven months of 2013 : 18.85 As of July 2013 : 16.23

Source:
※1: The Project on the human resource development for promoting sound water supply management of Da Nang City Water Supply Company, Vietnam Socialist Republic, from the aspect of Water Safety Plans (MOHLW Japan, February 2012)
※2: Prepared by the PS Team based on interviews with DAWACO

Photo 3.1 Headquarter of DAWACO

Photo 3.2 Meeting among DAWACO and the PS Team

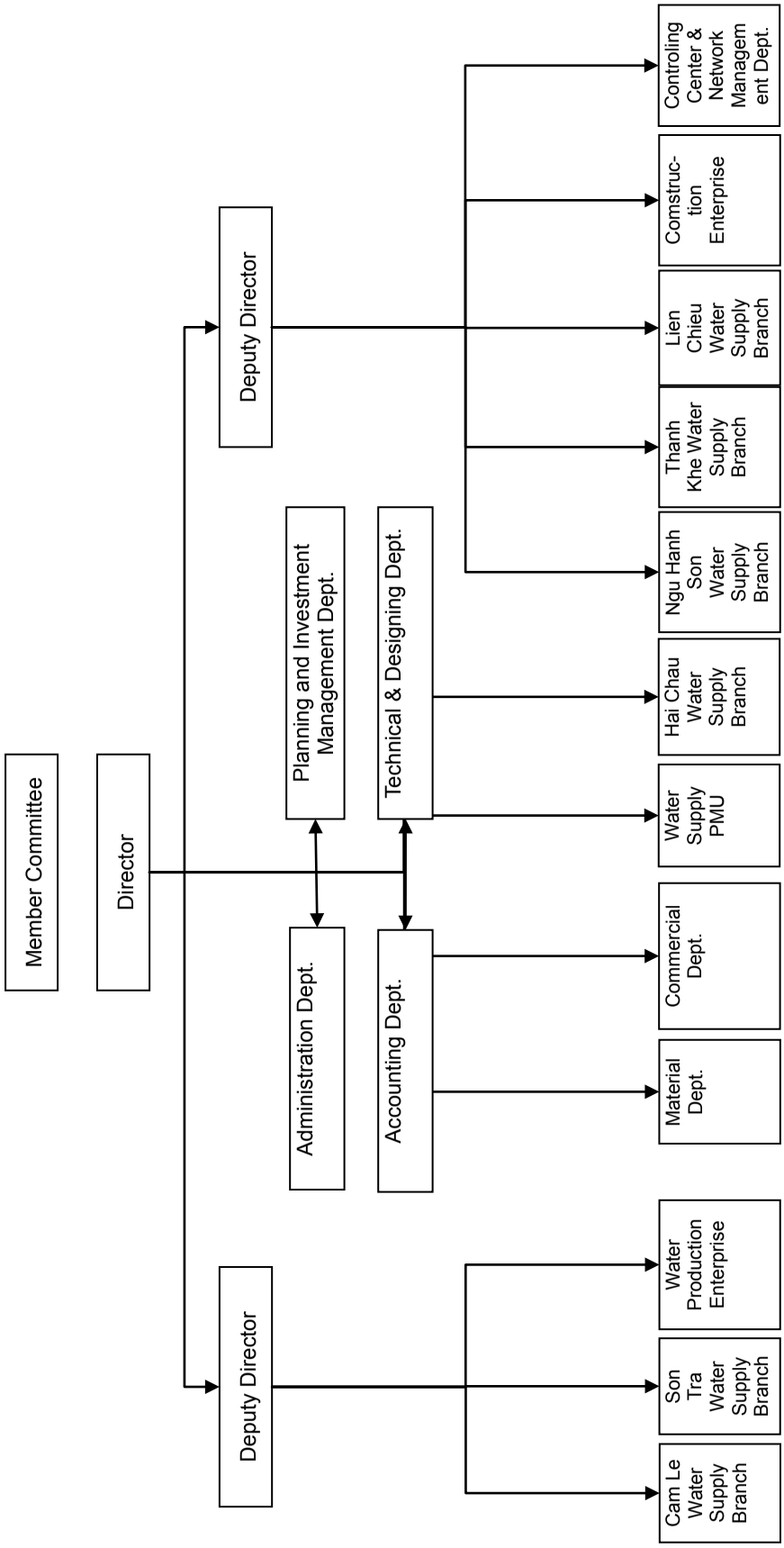


Figure 3.3 Organizational Structure of DAWACO

(2) Service Levels

As mentioned above, this chapter introduces service levels in the seven areas where DAWACO provides services.

Table 3.6 and Figure 3.4 show the coverage of water supply system in each district and the location of district, respectively. As shown in the table below, DAWACO serves about 59% of Da Nang's population in 2009. However, the level of service is uneven with relatively high service levels of 75-90 % coverage in the central area of Hai Chau, Thanh Khe and Son Tra District, while the remaining three districts, Cam Le, Ngu Hang Son and Lien Chieu which are now undergoing rapid urban expansion have lower service level.

However, it should be noted that since 2009, there has been a big improvement in water supply service and number of connection to the distribution network in these areas has been increasing by 20,000 per year. For example, in Hoa Vang District, there were no distribution network and the service coverage was the lowest in the city until 2009, but now the construction of distribution network has been going on at high speed. The PS Teams confirmed the water supply coverage has increased from 59% in 2009 to about 75% in 2012 through the interview survey. The latest data in each district are being compiled by DAWACO.

Table 3.6 Coverage of DAWACO's Water Supply Service by District (2014)

No.	District	Average Population	Pop. Served	Households served	% Pop. Served
1	Hai Chau	205,380	204,045	49,567	99.4
2	Thanh Khe	187,766	184,292	46,791	98.2
3	Son Tra	149,212	139,349	32,289	93.4
4	Ngu Hanh Son	74,568	57,201	15,244	76.7
5	Lien Chieu	153,793	144,719	35,741	94.1
6	Cam Le	108,805	98,294	24,867	90.3
7	Hoa Vang	127,901	51,224	12,607	40.0
	Total	**1,007,425**	**879,124**	**217,106**	**87.3**

Source：Prepared by the PS team

Table 3.7 Water Supply and Consumption Pattern Since 2005

No.	Item	Unit	2005	2006	2007	2008	2009	2010	2011	2012
1	Production Water	(1000)m3/y	32,930	37,689	40,554	44,202	48,373	53,478	54,697	60,097
2	Domestic use	(1000)m3/y	14,994	16,488	17,781	20,640	24,263	28,820	31,247	35,222
3	Institutional use	(1000)m3/y	2,038	2,292	2,472	2,561	2,878	3,350	3,790	4,245
4	Industrial use	(1000)m3/y	2,047	2,186	2,652	2,866	3,056	4,112	4,487	4,616
5	Commercial use	(1000)m3/y	1,201	1,469	1,725	2,150	2,511	3,294	3,555	4,326
6	Other use	(1000)m3/y	23	67	87	232	291	–	–	–
7	Revenue water	(1000)m3/y	20,303	22,502	24,717	28,449	32,999	39,576	43,079	48,410
8	Flushing, fire fighting	(1000)m3/y	55	21	77	45	20	–	–	–
9	NRW	(1000)m3/y	12,572	15,166	15,759	15,706	15,354	13,902	11,618	11,688
		%	38	40	39	36	32	25.92	21.18	19.39
10	DaNang Population	people	779,019	792,572	806,744	822,178	887,070	926,018	959,575	967,790
11	Population that use DAWACO water	people	375,201	383,405	421,480	454,392	523,748	585,595	704,709	736,662
12	% of population that use DAWACO water	%	48	48	52	55	59	63	73	76
13	Average domestic consumption	lpcd	109	118	116	124	127	135	121	131

The following calculation formulas are used in the table above.

1. Production water = 7. Revenue water + 8. Flushing, firefighting + 9. NRW

7. Revenue water = 2. Domestic + 3. Institutional + 4. Industrial + 5. Commercial + 6. Other use

9. NRW (%) = 9. NRW / 1. Production water

13. Average domestic consumption = 2. Domestic use / 11. Population that use DAWACO water

Source : Data from 2005 to 2009: ADB Final report "TA No. 7144-VIE : DA NANG WATER SUPPLY PROJECT June 2010,
Data from 2010 to 2012: DAWACO

The above table clearly shows that water production has been increasing by about 10 % each year. At the same time, DAWACO has succeeded in decreasing NRW rate from 38% in 2005 to 19% in 2012, and simultaneously made a substantial increase in the water supply coverage from 48% in 2005 to 76% in 2012. This leap in supply level mainly attributes to the rapid development of the distribution pipelines for Hoa Vang, Ngu Hanh Son and Lien Chieu Districts.

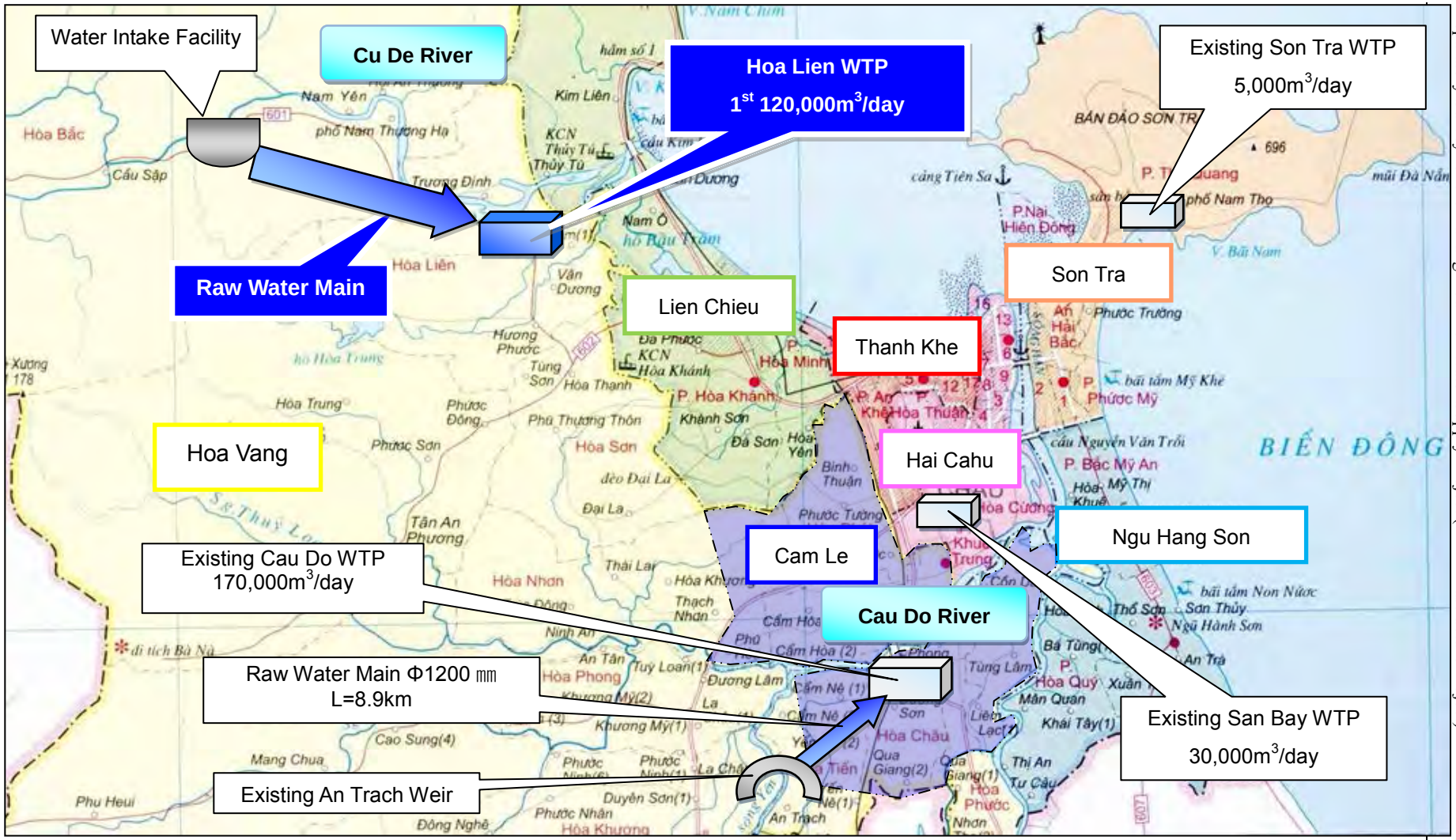


Figure 3.4 DAWACO's Service Areas and Operating Facilities (Seven Service Areas and Three WTPs)

(3) The Current Operation Status of the Existing WTPs

DAWACO now operates three WTPs throughout the city, namely, Cau Do WTP, san Bay WTP and Son Tra WTP to supply water to the seven districts including Lien Chieu, Thanh Khe, Hai Chau, Hoa Vang, Cam Le, Son Tra and Ngu Hanh Son Districts, with a combined capacity of 205,000 m^3/day (as of 2013). The locations of the WTPs are as shown in Figure 3.4, and the present operation status of the each plant is summarized below:

1) Cau Do WTP

Cau Do WTP is located at the left bank of Cau Do River where the river crosses with Highway No. 1 in Cam Le District, center of Da Nam City. The operation status of Cau Do WTP is summarized in Table 3.8.

In order to meet the increasing demand, DAWACO plans to expand the production capacity of this WTP by 60,000 m^3/day by 2015 and further expansion (60,000m^3/day) in 2022, and DAWACO is now working on developing a funding mechanism for the expansion. This expansion planned in 2015 has already been considered in the calculation of the future water demand on which the facility planning for the new Hoa Lien WTP is based. Therefore this expansion will have no impact on the operation condition of the proposed Hoa Lien WTP.

Table 3.8 Outlines of Cau Do WTP

Item	Description
Site area	Approx. 12ha
Water production/ water supply capacity	Maximum 170,000m^3/day Including: Old plant: 50,000 m^3/day (built in 1965, and upgraded in 2012) New plant: 120,000m^3/day (built in 2008)
No. of workers (as of 2013)	Day shift: 67 (incl. three leaders, 49 staff members and engineers, 15 laboratory operator), Night shift: 14 (incl. five laboratory operator)

The main problem of this WTP is the total dependence on Cau Do River for its water source.

Water of Cau Do River has relatively high turbidity, which would increase water treatment cost. And more serious issues in Cau Do River is tidal wave run up. Although the present water intake point is situated within the WTP site, when the water level of Cau Do River is lowered in dry season, tidal wave runs up to the intake point, which will increase the salinity of raw water. In case the salinity level increases to beyond the treatment capacity of the plant, plant is forced to halt water intake and/or water supply.

In addition, An Trach Weir built upstream of Cau Do River in 2009 has substantially increased the frequency of increase in salinity level. An Trach Weir was built to secure

agricultural water. As a result, water flow to downstream has considerably decreased, which increased the frequency of tidal water run-ups to the water intake point. Increase in salinity level is used to occur just several times per year, but after the construction of An Trach Weir, frequency has been increased to about 120 cases per year.

Therefore, a pumping station with transmission pipelines was developed on the right bank of An Trach Weir to transmit raw water to Cau Do WTP located 8.9m downstream of the weir. This addition of the facility has increased water production cost, and put more financial burdens on DAWACO's operation.

Detailed technical studies on the Cau Do WTP are provided in Chapter 5.

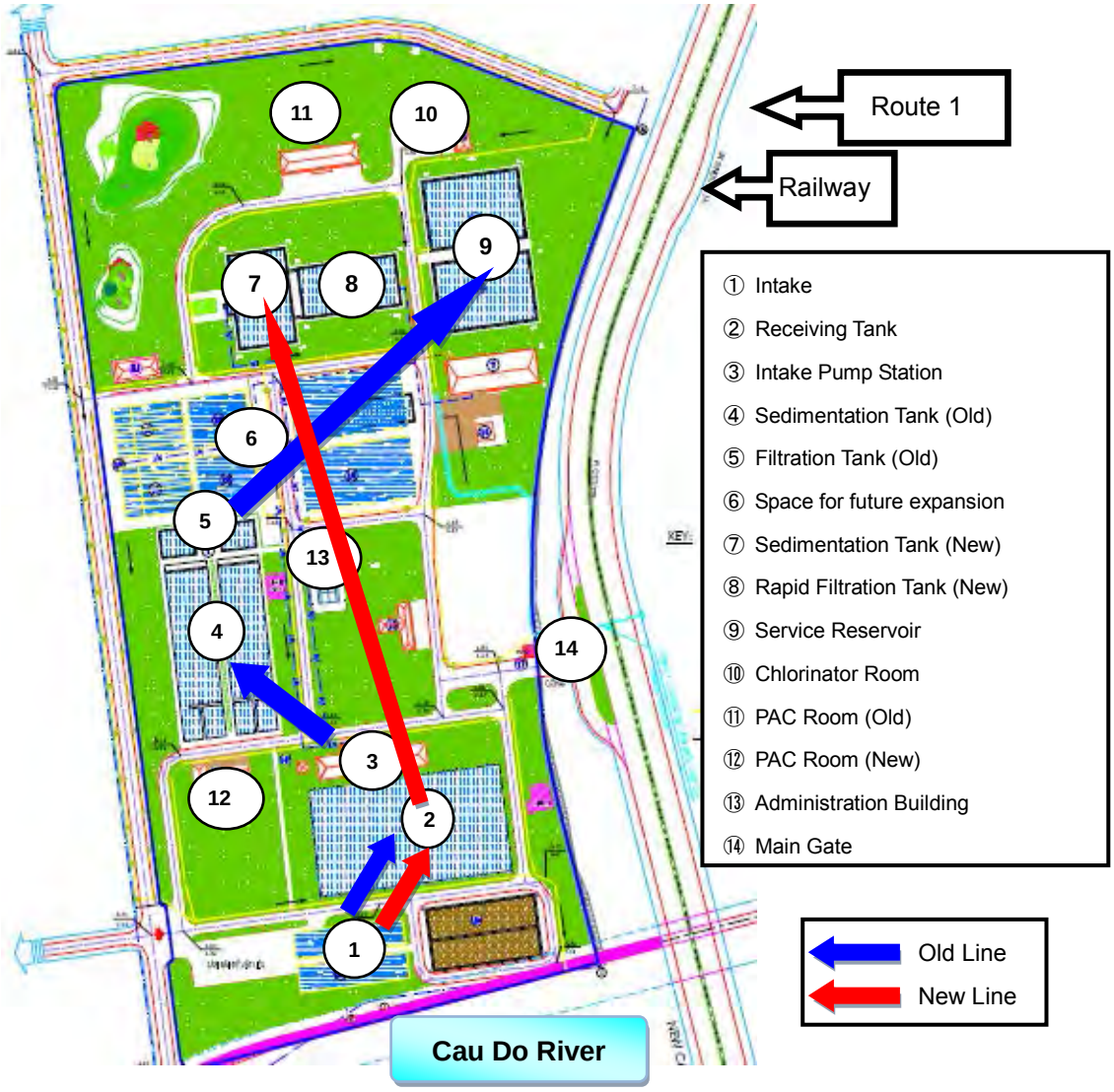


Figure 3.5 Layout of Cau Do WTP

Photo 3.3 An Trach Weir constructed upstream of Cau Do River (Left photo taken in September 2013) and water intake point at Cau Do WTP (Right photo taken in June 2013) High level of turbidity can easily be identified.

2) San Bay WTP

"San Bay" means "airport" in Vietnamese. As its name suggests, this WTP is located to the west of the airport situated in the center of Da Nam City, with the combined production capacity of 30,000 m^3/day. Except for employing a high speed coagulate precipitation method, there is no significant differences between San Bay and Cau Do WTP.

It is noteworthy that raw water for San Bay WTP is pumped from the raw water settling tank at Cau Do WTP, which means San Bay and Cau Do WTP share the same raw water. Therefore, San Bay WTP is also facing the problem of rise in water salinity level, which should be promptly addressed.

Other general information of San Bay WTP is summarized below:

- Design Capacity: 30,000m^3/day (Actual maximum capacity: 40,000 m^3/day)
- Two separate water treatment plants: (One is old build in 1973-1978 by the US, the other is new plant built in 2005 by the aids from France)
- Sedimentation pond: (old plant: accelerator, new plant: horizontal flow type mechanical stirrer, inclined tub) Flush mixer in the sedimentation pond of the new plant is currently not in use.
- Filter beds are semi-automatically cleaned. Backwash is carried out using one pump with the capacity of 1,190m^3/h×13m
- Powder PAC is used
- Liquid chlorine are used
- Operation status in 14th June (date of site survey):
  Turbidity of filtrate water: 0.6 NTU, residual chlorine: 0.78mg/l,
  water pressure in distribution pipe: 35m
- There are 19 workers and operators in day time, and three in night time (as of 2013)

Photo 3.4 Receiving well in San Bay WTP
Raw water is delivered from the receiving well in Cau Do WTP to this WTP

Photo 3.5 Rapid filtration Pond
Workers spray water to remove scum on a regular basis

Photo 3.6 Fast Coagulation Basin in San Bay WTP

3) Son Tra WTP

Son Tra WTP has two small plants with total capacity 5,000m^3/day, and uses two springs, Da Spring and Mo Spring rising in the foothills of the Son Tra Mountain to the North of the City as water source. It provides filtration and chlorination treatment. During the dry season Mo Spring sometimes dries up and then nearby Xanh lake becomes the alternative source.

Table 3.9 summarizes the outlines of the existing three WTPs, and future WTP development plan of Da Nang City. It shows that Da Nang City has made many plans for expansion and/or construction of WTPs by 2025, including the construction of Hoa Lien WTP Phase I which the PS Team proposes to develop under PPP/BOT scheme.

Table 3.9 WTPs in Da Nang City

	No.	WTP	Year of Est.	Capacity (m^3/day)		Treatment method	Water Source
				Each WTP	Total capacity		
Existing Facilities	1	Cau Do WTP	1965	120,000	120,000	Rapid filtration	Cau Do River
	2	San Bay WTP	1974	30,000	150,000	Rapid filtration	Cau Do River
	3	Son Tra WTP	1985	5,000	155,000	Chlorination	Spring water, and Xanh lake water in dry season
	4	Cau Do WTP (Old facilities to be upgraded)	2012	50,000	205,000	Rapid filtration	Cau Do River
Total Production Capacity (m^3/day)				205,000	630,000		

Source: Prepared by the PS Team based on the ADB FS Report and interview with DAWACO

(4) Issues in Water Supply Service in Da Nang City and Necessity of Hoa Lien WTP

As described above, the water supply service in Da Nang City has facing the following issues, which support the necessity of construction of Hoa Lien WTP.

1) Shifting of water source from ground water to surface water

Industries within Da Nang, partly purchase water from DAWACO, but rely heavily on groundwater and most major factories have their own private wells abstracting water from the underlying aquifers.

Thus, currently Da Nang City has having a several risks of : i) depletion of the groundwater, ii) pollution of groundwater due to untreated wastewater discharge from industry.

Therefore, the DPC intends to restrict the uses of groundwater and particularly by industry and will require new industry to connect to the DAWACO system, which is a factor to accelerate the demand of DAWACO water.

2) Turbidity of Cau Do River water

The water of Cau Do River, the water source of the Cau Do WTP, has high turbidity and requires large amount of flocculants for treatment, which increases the treatment cost.

On the other hand, the turbidity of Cu De River is rather low, being below 10 NTU in clear weather. Therefore, it is expected to decrease the treatment cost by constructing Hoa Lien WTP that uses Cu De River as the water source, and even by shifting the water treatment

operation from Cau Do WTP to the new Hoa Lien WTP.

3) Industrial wastewater from Hoa Cam Industrial Park

As of March 2012, there are six industrial parks in Da Nang City. Among these, Hoa Cam Industrial Park, in which 41 factories for machine, agricultural and fishery tools, construction materials and interior are operating, is located in the upstream of the raw water intake points for the Cau Do WTP.

If the wastewater treatment in the Hoa Cam Industrial Park is made inadequately, the water treatment should be carefully made and may have to be upgraded to remove all unhealthy matters, which certainly would lead to higher treatment cost and concerns on the health.

4) Water rights conflict between Da Nang City and Quang Nam Province

Cau Do River, the present major water source for Da Nang City, has two large tributaries, namely, Con River and Vu Gia River originate in Quang Nang Province adjacent to the South part of Da Nang City. Thus, since the watershed boundary of Cau Do River spans Da Nang City and Quang Nang Province, Da Nang city needs to negotiate with Quang Nang Province for water usage.

This may create a risk to the future water resources of Da Nang, since Da Nang City cannot freely control the intake water amount, and the possible development of dams in the future at connected rivers will reduce the flow of the Cau Do River.

On the other hand, the watershed boundary of Cu De River lies within Da Nang City, who has exclusive water rights. Therefore, in order to secure the stable water resources in the future, it is necessary to have a WTP which will utilize Cu De River as water source.

5) Conclusion

The issues set forth above have also been pointed out in the ADBFS Report, which was confirmed and approved by the DPC. The PS Team also confirmed through the discussion with DAWACO and Da Nang City that they have fully understood these issues. Furthermore, as shown in the previous chapters, the water demand in Da Nang City has been increasing at a much faster rate than the ADB projection.

The proposed Hoa Lien WTP is expected to improve the water supply capacity in Da Nang City, as well as to enable sustainable water supply for many years by taking raw water of good quality from Cu De River on which DPC has exclusive right to use water.

Therefore, the proposed project which will install the raw water main from the water intake

point to the WTP and construct new Hoa Lien WTP has been positioned as high priority project among the water supply infrastructure projects in Da Nang City.

(5) Water Tariff

The DPC has authority to decide and amend the water tariff in Da Nang City, and the Decree on No. 117/2007/ND-CP requires that water tariff should be set at adequate levels to allow water supply companies to reorganize with full cost recovery. Following this Decree, DPC enacted the Decision on Issue the domestic lean water tariff and approve the project of clean water tariff for other purposes in the Danang City Area (No. 46/2010/QD-UBND) in 2010 to set the water tariff for household and for other customer group. The Decision No.46/2010/QD-UBND stipulates as follows:

1) Set the clean water tariff as a responsible agency but must not exceed the maximum tariff approved by DPC as shown in the above table
2) Take responsibility and cost of making synchronous connection to connectors of people who utilize water (including the water meter)
3) Make a development plan of resource, water distribution network to meet demands
4) Make a plan to improve the quality of water supply services
5) Conduct a regular monitoring and testing of clean water
6) Charge water utility cost by the month based on a regulated tariff
7) Promptly implement remedial measures for the water loss situation and prevent the tariff losses
8) Promote the disseminating organization to raise public awareness
9) Take responsibility of the personals, organizations in the water supplying and preventing water loses

After this Decision was issued, DPC changed the water tariff at the end of 2011 and made another amendment in February 2014. Table 3.10 to Table 3.12 provides the water tariff including for Household, other customer group and a weighted average decided in 2011 and 2014 respectively.

Table 3.10 Water Tariffs for Household (including VAT)

	Used quantity/month	2011		2014	
		Rural area	Urban area	Rural area	Urban area
Tariff (Dong / m^3)					

Table 3.11 Water Tariffs for Other Customer Group

	Used quantity/month	2011	2014
Tariff (Dong / m^3)			

Table 3.12 Weighted Average Water Tariffs

Tariff (Dong / m^3)	2011	2014

The department of commercial affairs of DAWACO is responsible for the collection and billing of water tariffs. Customers are billed for water usage and wastewater services.

According to the ADB FS Report, most domestic customers pay in cash, which is collected monthly by a DAWACO bill collector, although they may also pay by ATM. Most non-domestic customers pay by bank transfer. Customers are required to pay within 30 days from receipt of the water bill. In the fourth quarter of 2008, 98.9% of DAWACO's customers paid on time, and about 99.4% within 90 days (Table 3.13). Unusually, collection rates are higher for domestic than for non-domestic customers. DAWACO will disconnect non-paying customers two months after payment is due. A reconnection fee of VND 40,000 applies.

Table 3.13 Collection rates by Customer Group, 2014

(Unit: Household)

Customer Group	Collected within 30 days			Collected within 90 days		
	Billed	Collected	% Collected	Billed	Collected	% Collected
Domestic	136,160	118,309	87	408,480	391,691	96
Non-Domestic	64,786	57,724	89	194,357	188,313	97
All Groups	200,946	176,032	88	602,837	580,003	96

Source: PS team

CHAPTER 4 PRELIMINARY TECHNICAL STUDY

4.1 Water Demand Prediction

(1) The Purpose of the Water Demand Prediction

Water demand prediction is very important and indispensable data to design water supply facilities both from technical and financial points of view. In order to maintain a sustainable water supply business, it is crucial to have as accurate water demand prediction as possible so that a project operator (an SPC) can develop facilities with the suitable capacity for the actual water demand and avoid overinvestment, which certainly should lead to a devastating business risk. For instance, underestimation of the future water demand will cause water supply shortages, while over-estimation of the demand will cause an excessive water production and make it extremely difficult for a project operator (an SPC) to recover the investment cost.

It should also be noted that a project operator (an SPC) will not be able to control the water demand in the City and is not able to take responsibility for any consequences caused by the differences between the water demand prediction and the actual demand. Therefore, the water demand prediction should be carefully studied and reviewed by both the SPC and Da Nang City, and should be mutually agreed.

(2) Methods of Water Demand Estimation

The analysis of future water demand was made by the following two methods:

1) Estimation based on the population forecast and water consumption per capita

This method was employed by DAWACO and ADB for their estimation. The PS Team also conducted the estimation in the same way, but using the updated data.

2) Time series analysis

To verify the projection made by DAWACO and ADB, the PS Team has also calculated the future water demand by the time series analysis. The analysis was conducted based on the actual data from 2003 provided by DAWACO. Because the detailed data in the sub-areas of the city were not available, the FS Team calculated the estimation for the entire city. The water demand was calculated for the following usages:

- Domestic use
- Commercial use
- Industrial use
- Institutional use
- Leakage water (the amount of water leakage was decided according to the leakage rate

plan by DAWACO)

The time-series trend estimation was carried out using the following equations, among which provided the best correlation was adopted.

- Annual average increase or decrease formula $y=a\times x+b$
- Annual average increase or decrease formula $y=y0\times(1+r)x-1$
- Modified exponential curve formula $y=K-a\times bx$
- Power-low curve formula $y=y0+A\times xa$
- Logistic curve formula $y=\{C+(K-C)\}/(1+ea-b\times x)$

  Legend: x : year, y : water demand, a, b, K, A : coefficient

The PS Team also tried water demand prediction by district. However, it was found to be difficult to make accurate prediction because the data by district has been recorded only since 2009 and there are only insufficient data available.

(3) Data used in Water Demand Estimation

The following data were obtained from DAWACO and used for water demand prediction.

Table 4.1 Data and Source used in Water Demand Estimation

Category	Data Items	Duration	Source
Annual water consumption (past data)	Water amount for domestic use, public use, industrial use, commercial use, and NRW	From year 2002 to 2013 (first half year of 2013)	DAWACO
Water demand prediction	Ditto	From year 2013 to 2020	DAWACO
Population (past data)	Population of whole city, and service population	From year 2002 to 2012	DAWACO
Population (projection)	Population of whole city, and service population	From year 2013 to 2020	DAWACO
Unit water consumption (past data)	Per capita water consumption for domestic use	From year 2002 to 2012	DAWACO
Unit water consumption (projection)	Per capita water consumption for domestic use	From year 2013 to 2020	DAWACO

(4) Projected Population in Da Nang City and DAWACO's Future Plan

Table 4.2 shows the estimation of future population in Da Nang City, and DAWACO's future plan for water supply coverage rate, daily per capita water consumption (domestic water) and non-revenue water rate.

The population of Da Nang City has been on the rise consistently since 1995 to reach 973,800 in

2012. According to the latest estimates on the population of Da Nang City, the population growth rate will remain at 3.2% to 3.3% even after 2013, the population of 2020 is estimated to be 1,256,000 people.

The water supply coverage rate was 75.3% in 2012, and is planned to be 81.0% in 2015, and 94.1 % in 2020. Da Nang City is classified as urban class I by "Vietnam Government 10 year national strategy (2011-2020 Years)" (1 January established 2011), the city aims 90% coverage of the water supply system in 2015 and is the target of urban class I, 100% by 2025.

The daily per capita water consumption (for domestic use), is 132 L/ person-day in 2012, 139 L/ person-day in 2015, it is predicted that 161 L/ person-day in 2020. It is higher than the 120 L / person-day in 2020 the target by the Vietnamese government.

The non-revenue water rate is 19.5% in 2012, and planned to be 16.6% in 2015, 13.8 % in 2020. It is greater than 18% in 2020 the target by the Vietnamese Government.

Table 4.2 Future Plans of DAWACO and Population Estimates of Da Nang

year	2012*	2013	2014	2015	2016	2017	2018	2019	2020
Population Increase Rate (%)	---	3.2	3.2	3.2	3.2	3.2	3.2	3.3	3.3
Estimated Population by DaNang City(thousand people)	973.8	1,005.0	1,037.3	1,070.9	1,105.0	1,140.6	1,177.5	1,216.0	1,256.0
Population Served (Person)	733.5	783.8	819.8	867.4	918.9	975.5	1,037.6	1,106.1	1,181.6
Water Suppply coverage Rate(%)	75.3	78.0	79.0	81.0	83.2	85.5	88.1	91.0	94.1
Daily per Capita Water Consumption (domestic Use)(L/person・day)	132	131	135	139	143	147	152	156	161
Nonreveue Water Rate (%)	19.5	18.8	17.7	16.6	16.0	15.5	14.9	14.4	13.8
Source: DAWACO	*: in 2012 actual value								

(5) Results

Table 4.4 shows the results of the water demand forecast by the time-series trend estimation. Estimation formula adopted for each prediction is as follows:

- Domestic Use: Power-low curve formula (y0=34,951, A=2,710.77347, a=1.3703985), correlation: 0.99103
- Public Use: Power-low curve formula (y0=4,763, A =170.57578, a=1.6868769), correlation: 0.99475
- Commercial Use: Power-low curve formula (y0=2,944, A =78.67498, a=2.1716777), correlation: 0.98048
- Industrial Use: Power-low curve formula (y0=4,332, A =601.90273, a=1.1629642), correlation: 0.98444

The calculation results suggested that there is no significant difference in water demand from those estimated by DAWACO using population growth ration and water consumption per capita.

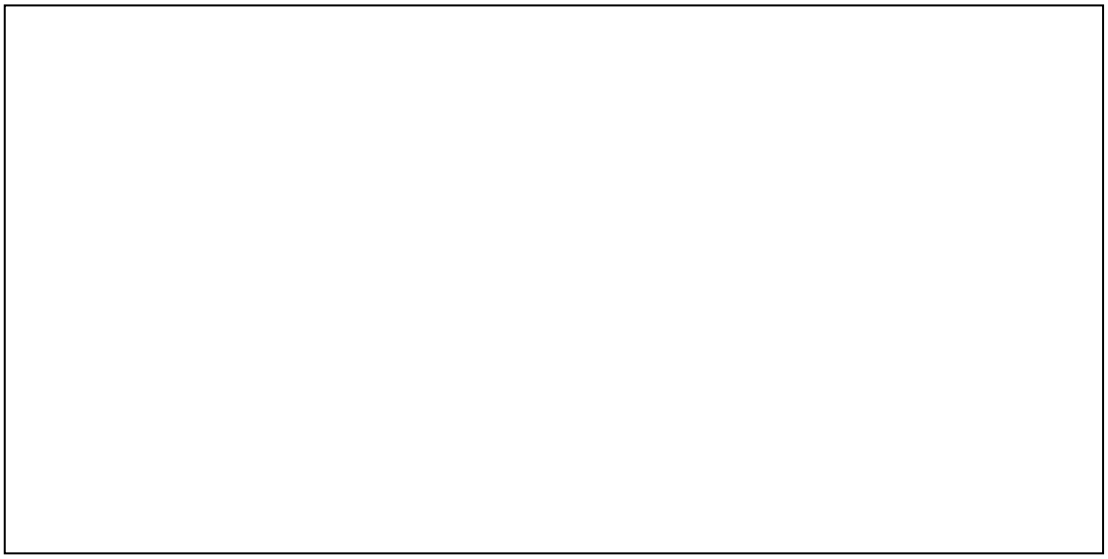


Figure 4.1 Water Demand Prediction

Table 4.3 Actual Water Demand

Table 4.4 Water Demand Prediction

Table 4.5 Water Demand Prediction by DAWACO

Table 4.6 Water Demand Prediction by ADB

(6) Conclusion

The analysis conducted in this PS confirmed that in 2019 when the Hoa Lien WTP will start operation, the water demand in the whole city is expected to be 272,000 m^3/day, therefore, if the existing WTPs will be operated at the rated capacity of 215,000 m^3/day, the water supply amount of the Hoa Lien WTP will be approximately 57,000 m^3/day. The Hoa Lien WTP is expected to reach its maximum capacity of 120,000 m^3/day by late 2022.

4.2 Analysis of Flood Data

Heavy rainfall followed by flooding on plant brings the plant operation to halt, and its recovery usually takes a long time, which cause a major economic loss. Therefore, it is crucial to estimate the possible flood scale in the planned project area (so called “design flood”) and to design the facilities by taking it into consideration.

The purpose of the flood data analysis is to study the flood history in the planned project area and to estimate the possible highest flood level, which is used to determine the ground elevation for the facilities.

It should be noted that a project operator (an SPC) is not be able to control the floods and is not

able to take responsibility for any consequences caused by the differences between the flood depth prediction and the actual flood depth. Therefore, the flood prediction should be carefully studied and reviewed both by the SPC and Da Nang City, and should be mutually agreed to confirm the ground elevation for of the facilities..

(1) Flood History in Da Nang City

Central Vietnam is prone to heavy rains and consequent flood damage, and Da Nang City has also been hit by large flood in 1964, 1999, 2007, to 2009. In particular, the great flood in 1999 is said to be one of the largest in 100 years. The situation of the great flood of 1999 is summarized below. (Source: Investigation and calculation of the highest annual design water level of the rivers in Da Nang city prepared by UPI)

- From 1st to 6th November 1999, Da Nang had as heavy as 600 ~ 900mm of torrential rains, which marked the record high in the last 100 years
- This heavy rain caused flooding in all the rivers in the city, which went far beyond the maximum warming water-level to reach 2-4m in the most of area.
- It resulted in a tremendous number of missing and dead, and enormous damage to the infrastructures including road and communication facilities, as well as agricultural infrastructure.
- Flood prone areas are the delta downstream of Thu Bon River and downstream of the Cu De River.
- Da Nang City center has also flood sometime, which appears to be caused by inability of the city drainage facilities.
- The flood in the downstream area of Cu De River is considered to be induced by the shortage of water flow capacity of the bridge built on the railway line of North-South Railway that runs parallel to the National Highway No.14.
- There are only three rainfall observation places in Da Nang city, and flood forecast area map (flood hazard map) has not been established.

(2) Analysis of the Past Records near the Planned Site for the Hoa Lien WTP

1) Collected Data for Analysis

The following data on the flood in the Hoa Lien WTP Site were collected, and used to determine the basic elevation of the Hoa Lien WTP Site.

i. ADB's Final report " TA No. 7144-VIE : DA NANG WATER SUPPLY PROJECT June 2010" &"PREFEASIBILITY STUDY OF WATER SOURCES AND WATER SUPPLY OPTIONS FOR DANANG CITY June 2010 "

ii. DAWACO's Report "Report on Cu De River Water Source & Water Reservoir Project for Da Nang City Water Project Phase 2 "

iii. UPI's Report "Investigation and calculation of the highest annual design water level of the rivers in Da Nang city "

iv. Flood Record Monuments

v. Information from interviewing to Residents at proposed WTP area

2) Analysis of Flood Data

i. ADB's Final report " TA No. 7144-VIE : DA NANG WATER SUPPLY PROJECT June 2010" &"PREFEASIBILITY STUDY OF WATER SOURCES AND WATER SUPPLY OPTIONS FOR DANANG CITY June 2010 "

This Report does not indicate the flood level but the attached drawings show the elevation for the facilities at the Hoa Lien WTP at 4.2 m.

ii. DAWACO's "Report on Cu De River Water Source & Water Reservoir Project for Da Nang City Water Project Phase 2"

This Report studies the precipitation of several reoccurrence periods based on the measurement at the Ba Na precipitation station, but does not mention the flood events.

iii. In other report in Da Nang city, the river water levels are calculated for four rivers in Da Nang to several occurrence probabilities as shown in the following Table 4.7, among which CD2 and CD3 is the nearest location from the proposed site for the Hoa Lien WTP.

Table 4.7 Calculation Results of the Design Water Level Hmax~P in Da Nang City

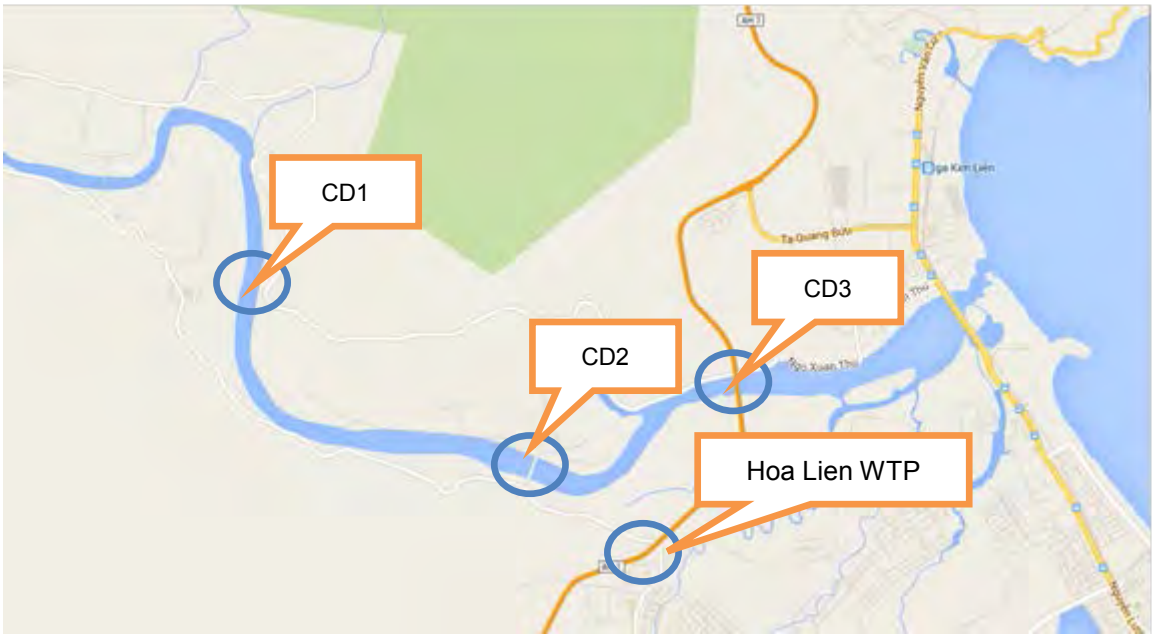


Figure 4.2 Water Level Measurement Points

iv. Flood Record Monuments

Along Cu De River, there are several flood monuments which had been built and are managed by DARD. The PS Team conducted an interview with DARD about the monuments, and obtained the following information;

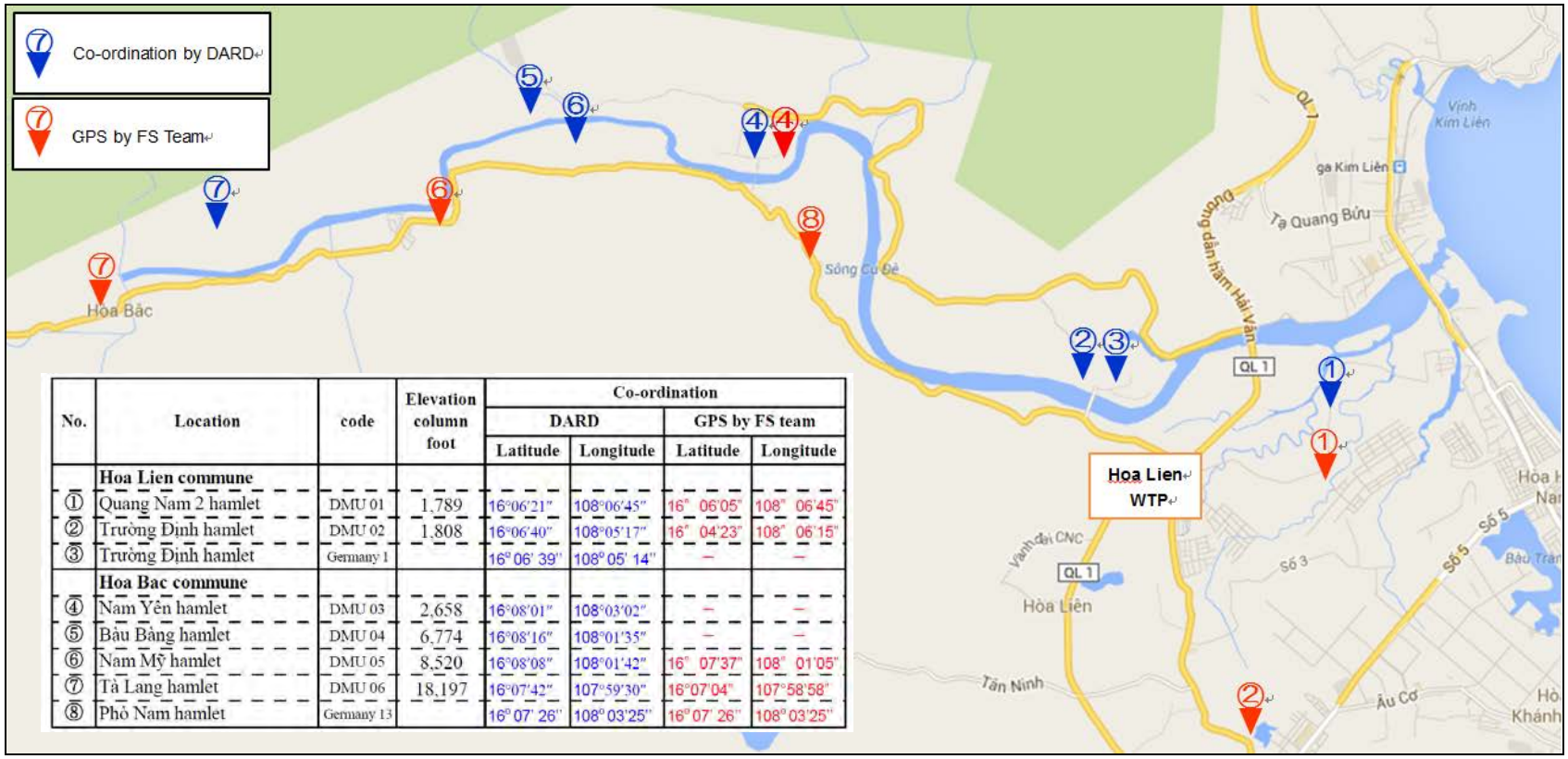
- There are seven flood monuments along Cu De River, of which two monuments are located near the planned construction site.
- These monuments were built with funds from the aid agencies such as German agency and UNDP, based on the data gathered through the interview survey conducted by the Mid Central Regional Hydro-Meteorological Center and DARD.
- There are no other flood records than the Flood Record Monuments

Table 4.8 is the summary of the date on Flood Record Monuments obtained from DARD.

Table 4.8 List of the Flood Record Monuments Prepared by DARD

STT	Location	code	Number of (column)	Elevation column foot	Co-ordination		Water level (cm)		Comparision	Note
					Latitude	Longitude	2007	2009		
I	**Hoa Vang district**		**8**							
E	**Hoa Lien commune**		**3**							
1	Quang Nam 2 hamlet	DMU 01	1	1.789	16°06′21″	108°06′45″	-200	-34	comparision with flood in1999	
2	Trường Định hamlet	DMU 02	1	1.808	16°06′40″	108°05′17″		-30	comparision with flood in1999	
3	Trường Định hamlet	Germany 1	1		16° 06' 39"	108° 05' 14"			New 2010	New 2010
F	**Hoa Bac commune**		**5**							
1	Nam Yên hamlet	DMU 03	1	2.658	16°08′01″	108°03′02″	-18	-40	comparision with flood in1999	
2	Bàu Bàng hamlet	DMU 04	1	6.774	16°08′16″	108°01′35″			Khó xác định	
3	Nam Mỹ hamlet	DMU 05	1	8.520	16°08′08″	108°01′42″	-132	-120	comparision with flood in1999	
4	Tà Lang hamlet	DMU 06	1	18.197	16°07′42″	107°59′30″			Khó xác định	nearby market
5	Phò Nam hamlet	Germany 13	1		16° 07' 26"	108° 03'25"				New 2010

Based on the list from the DARD, the PS Team conducted the filed survey for location of the monuments and recorded flood level, which are shown in Figure 4.3 and Table 4.9, respectively.



No.	Location	code	Elevation column foot	Co-ordination			
				DARD		GPS by FS team	
				Latitude	Longitude	Latitude	Longitude
	Hoa Lien commune						
①	Quang Nam 2 hamlet	DMU 01	1,789	16°06'21"	108°06'45"	16° 06'05"	108° 06'45"
②	Trường Định hamlet	DMU 02	1,808	16°06'40"	108°05'17"	16° 04'23"	108° 06'15"
③	Trường Định hamlet	Germany 1		16° 06' 39"	108° 05' 14"	–	–
	Hoa Bac commune						
④	Nam Yên hamlet	DMU 03	2,658	16°08'01"	108°03'02"	–	–
⑤	Bàu Bàng hamlet	DMU 04	6,774	16°08'16"	108°01'35"	–	–
⑥	Nam Mỹ hamlet	DMU 05	8,520	16°08'08"	108°01'42"	16° 07'37"	108° 01'05"
⑦	Tà Lang hamlet	DMU 06	18,197	16°07'42"	107°59'30"	16°07'04"	107°58'58"
⑧	Phò Nam hamlet	Germany 13		16° 07' 26"	108° 03'25"	16° 07' 26"	108° 03'25"

Figure 4.3 Location of Flood Record Monuments

Blue spots in the Figure show the monument locations plotted based on the coordination data from DARD's list, and Red spots are the monument locations plotted based on actual GPS measurement by the PS Team. Obviously, there are considerable discrepancies between them. However, it was confirmed that GPS location is more consistent with topographic map obtained from the site survey, therefore it can be considered that GPS measurement is more accurate.

Table 4.9 shows the comparison results between DARD and the PS Team's survey.

Taking into account proximity to the proposed WTP site, the following 2 monuments are selected to determine the flood water level.

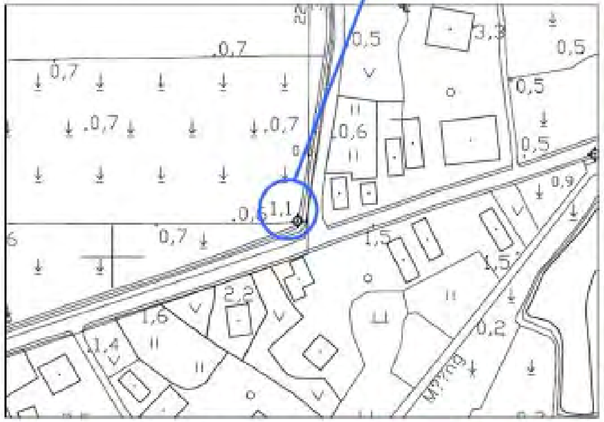
1. Quang Nam 2 hamlet (DMU01) : 3.789m
2. Truong Dinh hamlet (DMU02) : 3.730m

Table 4.9 Comparison between the DARD's Data and Output from PS Team's Survey

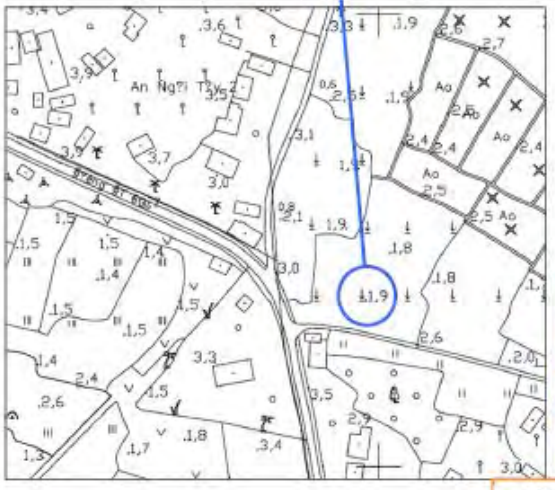
No.	Location	code	Elevation column foot (GL)				Co-ordination				Water level						
											DARD		Site Survey results				
			DARD	From Map	Actual Survey	Highest Value	DARD		GPS by Fs Team		2007	2009	1998	1999	2007	2009	Highest Value
1	Hoa Vang district		(m)	(m)	(m)	(m)	Latitude	Longitude	Latitude	Longitude	comparision with flood		(m)	(m)	(m)	(m)	(m)
E	Hoa Lien commune																
①	Quang Nam 2 hamlet	DMU 01	1,789	1.100	1.276	1.789	16°06'21"	108°06'45"	16° 06'05"	108° 06'45"	-2.00	-0.34	3.289	3.789	-	3.389	3.789
②	Trường Định hamlet	DMU 02	1,808	1.900	2.080	2.080	16°06'40"	108°05'17"	16° 04'23"	108° 06'15"	-	-0.30	3.130	3.730	-	3.280	3.730
③	Trường Định hamlet	Germany 1					16° 06' 39"	108° 05' 14"	—	—	-	-	-	-	-	-	-
2	Hoa Bac commune																
④	Nam Yên hamlet	DMU 03	2,658	-	2.870	2.870	16°08'01"	108°03'02"	16°08'01"	108°03'02"	-1.80	-0.40	-	6.960	-	-	6.960
⑤	Bàu Bàng hamlet	DMU 04	6,774	-	-	6.774	16°08'16"	108°01'35"	—	—	-	-	-	-	-	-	-
⑥	Nam Mỹ hamlet	DMU 05	8,520	9.600	8.540	8.540	16°08'08"	108°01'42"	16° 07'37"	108° 01'05"	-1.32	-1.20	10.530	11.560	10.140	10.270	11.560
⑦	Tà Lang hamlet	DMU 06	18,197	21.500	-	21.500	16°07'42"	107°59'30"	16°07'04"	107°58'58"	-	-	-	-	-	-	-
⑧	Phò Nam hamlet	Germany 13	-	-	3.100	3.100	16° 07' 26"	108° 03'25"	16° 07' 26"	108° 03'25"	-	-	5.531	6.100	-	5.751	6.100

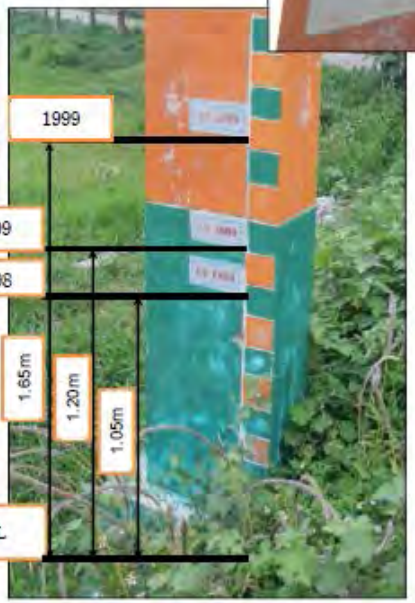
No.	Location	Code	Elevation column foot (GL)				Co-ordination				Water Level		
			DARD	From Map (1:5,000)	Site Survey	Higher one	DARD		GPS by FS team		Site Survey results Elevation of GL + Water level (Results of site survey)=Flood level		
①	Quang Nam 2 hamlet	DMU 01	1.789m	1.10m	1.276m	1.789m	16°06'21"	108°06'45"	16°06'05"	108°06'45"	1998	2009	1999
											1.789+1.50m=3.289m	1.789+1.6m=3.389m	1.789+2.0m=3.789m

Quang Nam 2 Hamlet (DMU01): 3.789m



No.	Location	Code	Elevation column foot (GL)				Co-ordination				Water Level		
②	Trường Định hamlet	DMU 02	DARD	From Map (1:5,000)	Site Survey	Higher one	DARD		GPS by FS team		Site Survey results Elevation of GL + Water level (Results of site survey)=Flood level		
			1.808m	1.90m	2.08m	2.08m	16°06'40"	108°05'17"	16°04'23"	108°06'15"	1998	2009	1999
											2.08+1.05m=3.13	2.08+1.2m=3.28m	2.08+1.65m=3.73m





Truong Dinh Hamlet (DMU02):3.730m

v. Interview survey with the residents living near the planned site for Hoa Lien WTP

The PS Team conducted a survey in June 2013 on the past floods by interviewing seven (7) residents living near the proposed site for the Hoa Lien WTP. The results are shown in the table below. It is readily observed that the flood level in the vicinity is estimated to be about 3.9m at the highest.

Table 4.10 Summary of Interview Survey

No.	Name Of Owner	A: Ground Height (m)	B: Depth of Inundation (m)	Inundation Level (A+B) (m)	Duration of Inundation/ Frequency (hr/year)	When did inundation happen	how long live in there (since)
1	Ngo Quang Man	+2.83	1.00	+3.82	4.0hr	—	1989
2	Ngo Van Da	+2.72	1.00	+3.72	Cause by rain	—	-
3	—	+4.55				—	
4	Ngo Mot	+2.60	0.60	+3.20		—	1988
5	—	+3.10	0.50	+3.60		—	1994
6	Ngo Quang Truong	+3.20	0.60	+3.80	Approx. 1 time/ every 5 year	—	1978
7	Nguyen Van Tiin	+2.50	1.40	+3.90		1999	1998


Photo 4.1 The PS Team Conducting Interview Survey to Residents

3) Summary of Flood Analysis Results

The existing study results can be summarized as follows:.

- ✓ 100-year re-occurrence flood indicated by the UPI Report is as high as 4.97 m.
- ✓ The highest flood level recorded in Flood Record Monument is 3.8 m.
- ✓ The highest flood level remembered by local residents is 3.9 m.

Table 4.11 Summary of Flood Analysis

4.3 Evaluation the Water Resources of Cu De River for Hoa Lien WTP

(1) Objectives

The water intake method for the Hoa Lien WTP was changed from the reservoir to be created by the planned hydro-power dam to the Cu De River stream by constructing a movable weir. Since the function of the movable dam is only collection of the river water without capacity of water storing, how much water can be taken from the Cu De River is one of the most crucial information to the feasibility of the proposed Project.

It should be noted that a project operator (an SPC) is not able to control the available raw water quantity at the water intake location of the Cu De River and will not be able to take responsibility for any consequences caused by the differences between the available water quantity prediction and the actual water quantity. Therefore, the analysis of the available water quantity should be carefully studied and reviewed by both the SPC and Da Nang City, and should be mutually agreed.

(2) Estimation Methods

The best method to estimate the river discharge is to analyze it based on a long term water discharge measurement in the Cu De River. However the measurements made were not long enough for the statistical analysis. The second choice could be estimation by the long term rainfall measurements with the correlation between the discharge data and the rainfall data during relatively short period in the Cu De River Area. Unfortunately, these preferable methods were not able to be taken, because the necessary data for these analyses were unavailable. Therefore, the estimation was made by the following methods, and the results by these methods were professionally and collectively studied to conclude the estimation.

a. Review of existing studies

b. Analytical study by using correlation among hydrological information

c. Direct measurements in the Cu De River

(3) Review of Existing Study regarding Water Resources of Cu De River

Because the following previous reports regarding Water Resources of Cu De River have been obtained during the FS survey, the PS team has reviewed its existing study and summarized the analysis results in these report;

1) ”PREFEASIBILITY STUDY OF WATER SOURCES AND WATER SUPPLY OPTIONS FOR DANANG CITY Da Nang Water Supply Project TA No. 7144-VIE(Jan 2010)” prepared by ADB

2) ”2003 Report of Cu De River Source Assessment & Water Reservoir Project for Da Nang City

Water supply Project Phase 2" prepared by DAWACO

3) "PLANNING OPTIONS FOR USING WATER RESOURCE OF TUY LOAN AND CU DE RIVER BASIN" prepared by Da Nang University

4) "Documents of the investment project for Nam River – Bac River Hydroelectricity Construction" prepared by Hydroelectric Power Centers

Sustainable flow yielded from Cu De River described in each report is summarized below

1) "PREFEASIBILITY STUDY OF WATER SOURCES AND WATER SUPPLY OPTIONS FOR DANANG CITY, DA NANG WATER SUPPLY PROJECT TA NO. 7144-VIE(JAN 2010)" prepared by ADB

The ADBFS suggests that there is a possibility of delay and uncertainties about GERUCO's dam project due to a political argument for keeping the hydropower and water supply facilities separate, and financial problem, etc. Therefore Da Nang City had been considering an alternative weir and intake facilities to provide them with an independent source even though the Song Bac 2 dam has some technical advantages.

Since the contents of this report have been confirmed and approved by Da Nang City and DAWACO, some intake locations suggested in the ADB report would become the basis for determining candidate sites as an alternative water intake site to the planned dam. Locations of water supply options suggested by the ADB Report are shown in Figure 4.4 below.

Figure 4.4 Locations of Water Supply Options suggested in the ADB Report

(Location D has selected as a raw water intake point in the PS. Please see evaluation of each candidate site in "5.3 Raw water intake facility")

On this ADB report, five (5) intake points, A to E, are proposed a candidate site for water sources, including the dam site by GERUCO, weir at another site, and etc. The hydrologic calculation results of each intake option described in the ADB report are outlined in Table 4.12.

Table 4.12 Summary of the Candidate Site for Water Source Selected by ADB

Location	Water Source and Location	Advantage	Disadvantage
A	Direct abstracting from the Song Bac 2 Reservoir to be built by GERUCO. However, the dam construction has been halt due to financial problem	· Sustainable yield of 6.44 m^3/s with 95% reliability	· 16 km of pipelines required to deliver water to the WTP · Long storage period, which may cause algal growth and require pre-chlorination treatment · Dam construction has been halt
B	A small independent weir to be built by DAWACO	· Sustainable flow more than 1.39 m^3/s · Good water quality	· Need to be constructed by DAWACO's own resource · Expensive construction cost for building a dam and 15.4 km of water main
C	Intake Weir to be built at Na My, 5. 5km down- stream from Song Bac 2 dam	· Good water quality	· Need to be built by DAWACO · Require 10.5 km pipeline length · Require a pump station · Mining in Song Nam could cause high turbidity and pollution
D (Location selected in the PS)	Intake Weir in the Middle of Cu De Site near Pho Nam Bridge (8. 5km downstream from Song Bac 2 dam Site)	· Shorter pipeline length (7.5km) · Good water quality	· Require a pump station · Mining in Song Nam could cause high turbidity and pollution
E	A new dam (HT3) to be constructed and utilized in combination with the existing Hoa Trung Dam (HT1), and Hoa Trung 2(HT2). Figure 4.5 shows location of HT1, HT2 and HT3.	· Can supply total 1.39 m^3/s water to WTP	· Necessary to build reservoir by DAWACO · DAWACO will have to share the resource with MARD

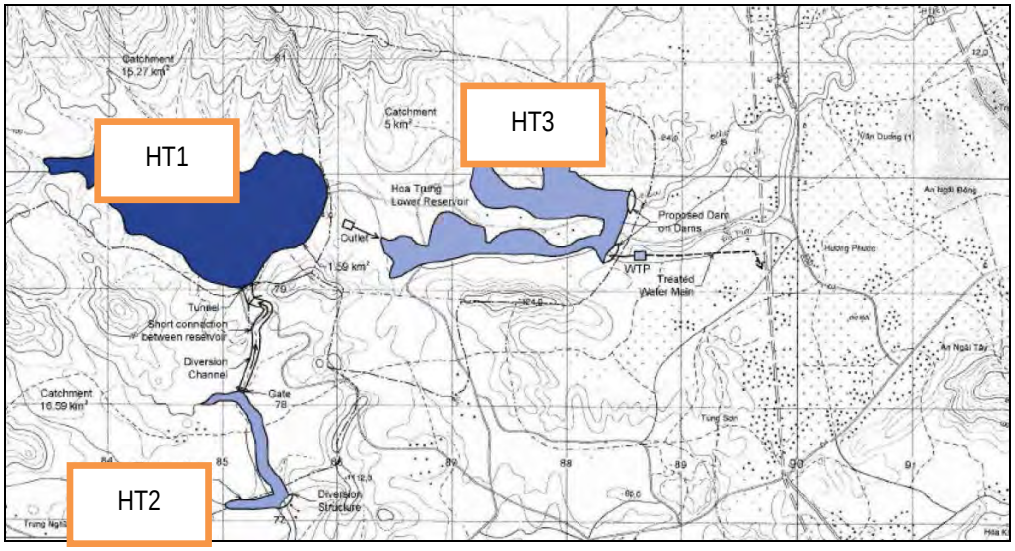


Figure 4.5 Location of Raw Water Intake Points of location E

In the ADB report, RRMOD model (Rainfall Runoff Model) & HEC-HMS is applied to calculate the sustainable water flow. The sustainable yield from each location each intake point is shown in the following table.

Table 4.13 Results of Sustainable Water Flow Calculation in the ADB Report

Location	Catchment Area (km2)	Flow in Main report (m3/s)
A GERUCO Song Back 2 Dam	191.9	6.44
B Weir but no S. Bac Dam	140.5	1.46
C Weir at Nam My village	280.7	2.91
D Rubber dam at D site (Location selected in the PS)	306.7	3.11
E Location E1 + Hoa Trung 2 Dam	31.86	1.39

Based on the above calculation results, the ADB Report concluded that each location could supply raw water of 1.39 m^3/s (120,000 m^3/day). However, this report also recommends that a more detailed survey for assessment of potential water source components must be executed in the next stage by collecting more sufficient hydrological data such as rainfall data, river discharge flow necessary to enhance the reliability.

2) ”2003 Report of Cu De River Source Assessment & Water Reservoir Project for Da Nang City Water supply Project Phase 2” prepared by DAWACO

This report summarized the study on the possible yield from Cu De River conducted by

DAWACO.

The sustainable flow was calculated based on the discharge data in the Cu De River made at the Nam My Gauging Station from 1978 to 1993, and statistically evaluated the minimum discharge with a certain probability.

In order to confirm the contents of report and study methodology, the PS team has conducted not only review of this report and interview survey to the report author.

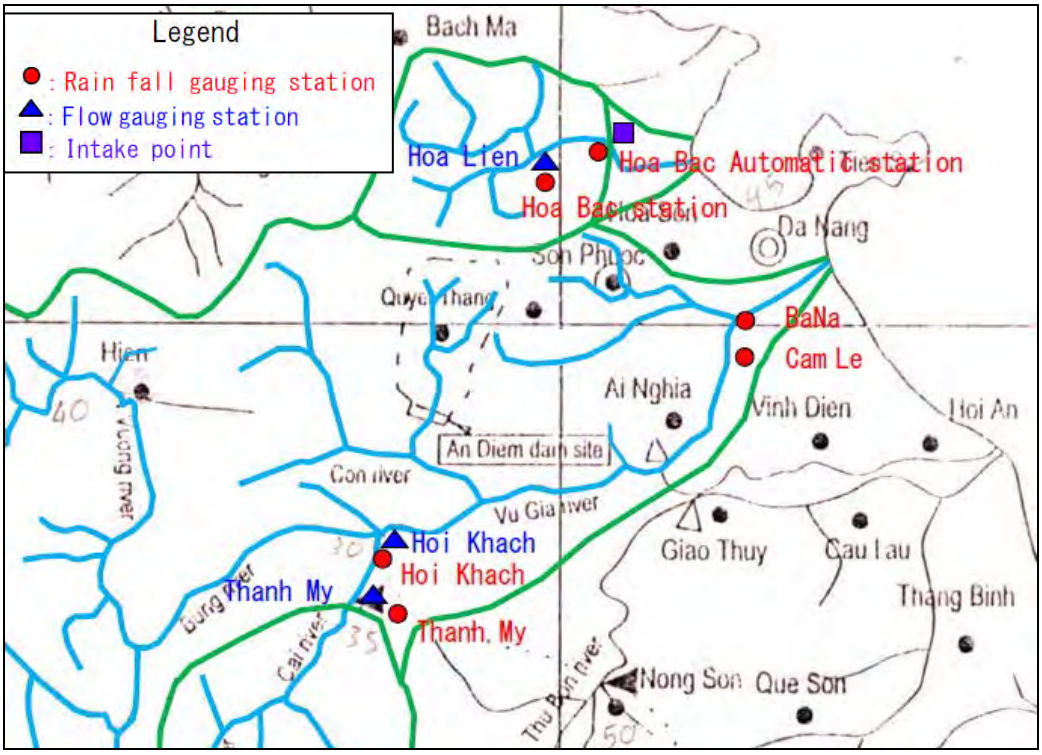


Figure 4.6 Location of Rainfall & River Flow Gauging Station

3) ”PLANNING OPTIONS FOR USING WATER RESOURCE OF TUY LOAN AND CU DE RIVER BASIN” prepared by Da Nang University

It is learned from Black & Veatch Inc. which prepared the ADB FS report, that this report have been prepared by Da Nang University by the request from them to ensure the reliability of evaluation of the sustainable river flow. This report evaluated the river flow discharge by using the MITSIM model and concludes that the Cu De River has enough water to supply the raw water for the Hoa Lien WTP. However, since, it was found that the university's survey is just a reviewing report of both previous survey of ADB and DAWACO, the university's survey report was used as just a reference.

4) ”Documents of the investment project for Nam River – Bac River Hydroelectricity Construction” prepared by Hydroelectric Power Centers

This report was prepared by Hydroelectric Power Centers to evaluate water resources of Cu De River for GERUCO's Hydropower Project. This report include considerable hydrological data as for candidate dam sites such as each catchment area, annual/monthly rainfall data, evapotranspiration, total annual runoff, and the storage capacity at candidate dam sites calculated from upstream hydrological data. However there is not detail description on the water flow from Cu De River, so PS team has decided to use this report as just for reference.

(4) Evaluation on Amount of Raw Water in Cu De River Available for Hoa Lien WTP

From the above reviews on the existing studies, it can be concluded that sustainable river flow of approximately 120,000m3/day can be ensured for Hoa Lien WTP.

However, as for ADB and DAWACO's report, data used for calculating sustainable river flow has not included the rainfall date in the recent years.

Therefore, in order to make sufficiently accurate judgment, the amount of the water in Cu De River stably available for the Hoa Lien WTP was estimated by the well-established method using the collected data. The results from the estimation in addition to the review and assessment of the existing studies were carefully studied.

1) Hydrological Data collected for the estimation

i. Mid-Central Regional Hydro-Meteorological Center

How much water can be taken from the Cu De River is one of the most crucial information to the feasibility of the Proposed Project. Therefore, at first, the PS Team tried to collect detailed hydrological data as much as possible.

Through the interviews with stakeholders, it was found that Mid-Central Regional Hydro-Meteorological Center (hereinafter referred to as MCRHMC) which is administrated by nation, has and manages all the hydrological data such as rainfall, river flow, water level measured at all existing hydrological gauging station in Da Nang city. These hydrological data include a lot of rain fall data which is not used for the ADB's & DAWACO's report.

And, through negotiation with MCRHMC, the PS Team was able to obtain all the daily and monthly rainfall data, river flow data, at the five (5) rain falls and three (3) river flow gauging station.

Photo 4.2 Mid-Central Regional Hydro-Meteorological Center（MCRHMC）

ii. Hydrological Data

Locations of the hydrological gauging station administered by MCRMC are as shown on Figure below;

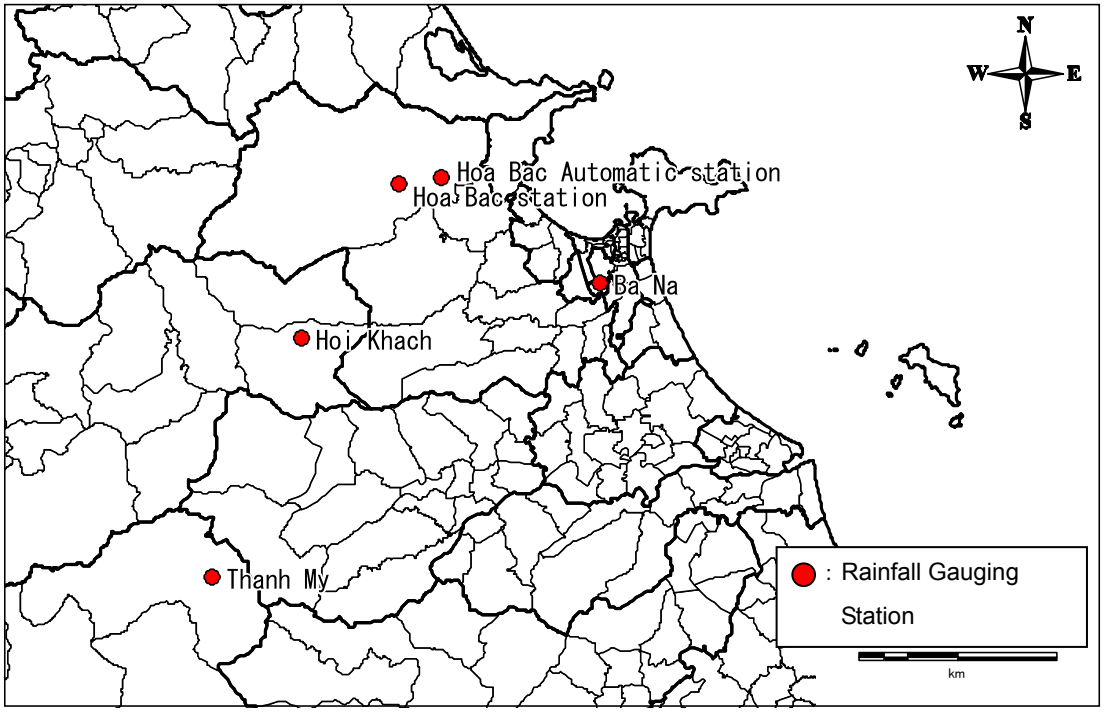


Figure 4.7 Rainfall Gauging Station managed by MCRHMC

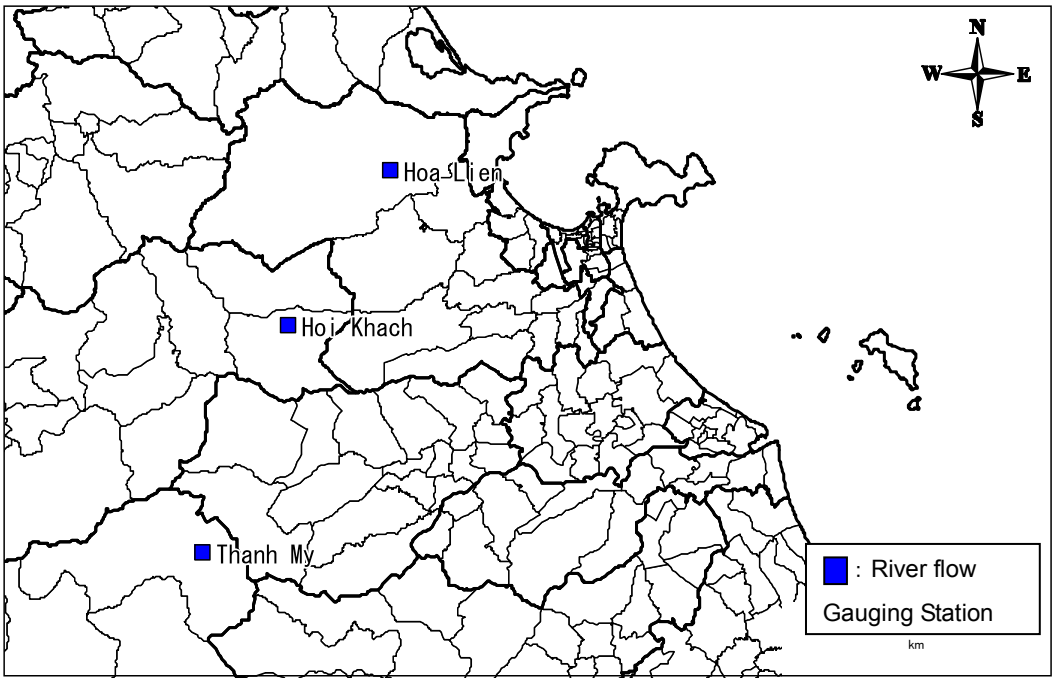


Figure 4.8 Flow Gauging Station Managed by MCRHMC

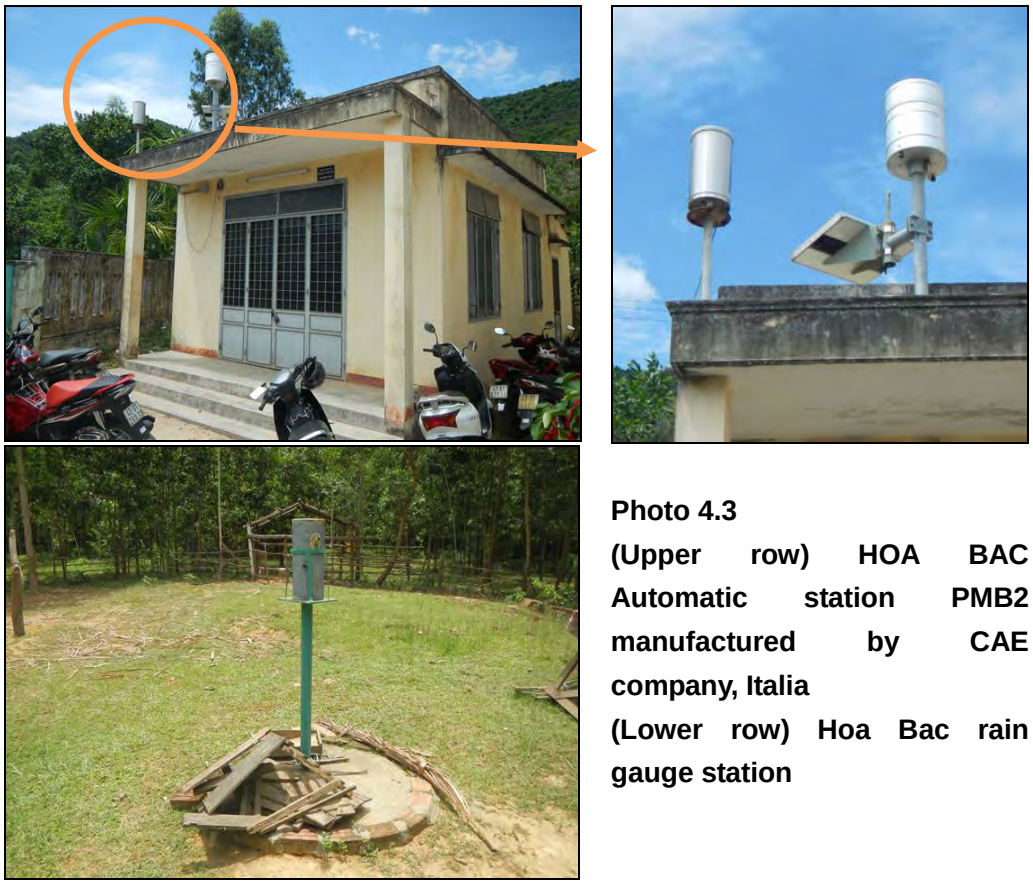


Photo 4.3
(Upper row) HOA BAC Automatic station PMB2 manufactured by CAE company, Italia
(Lower row) Hoa Bac rain gauge station

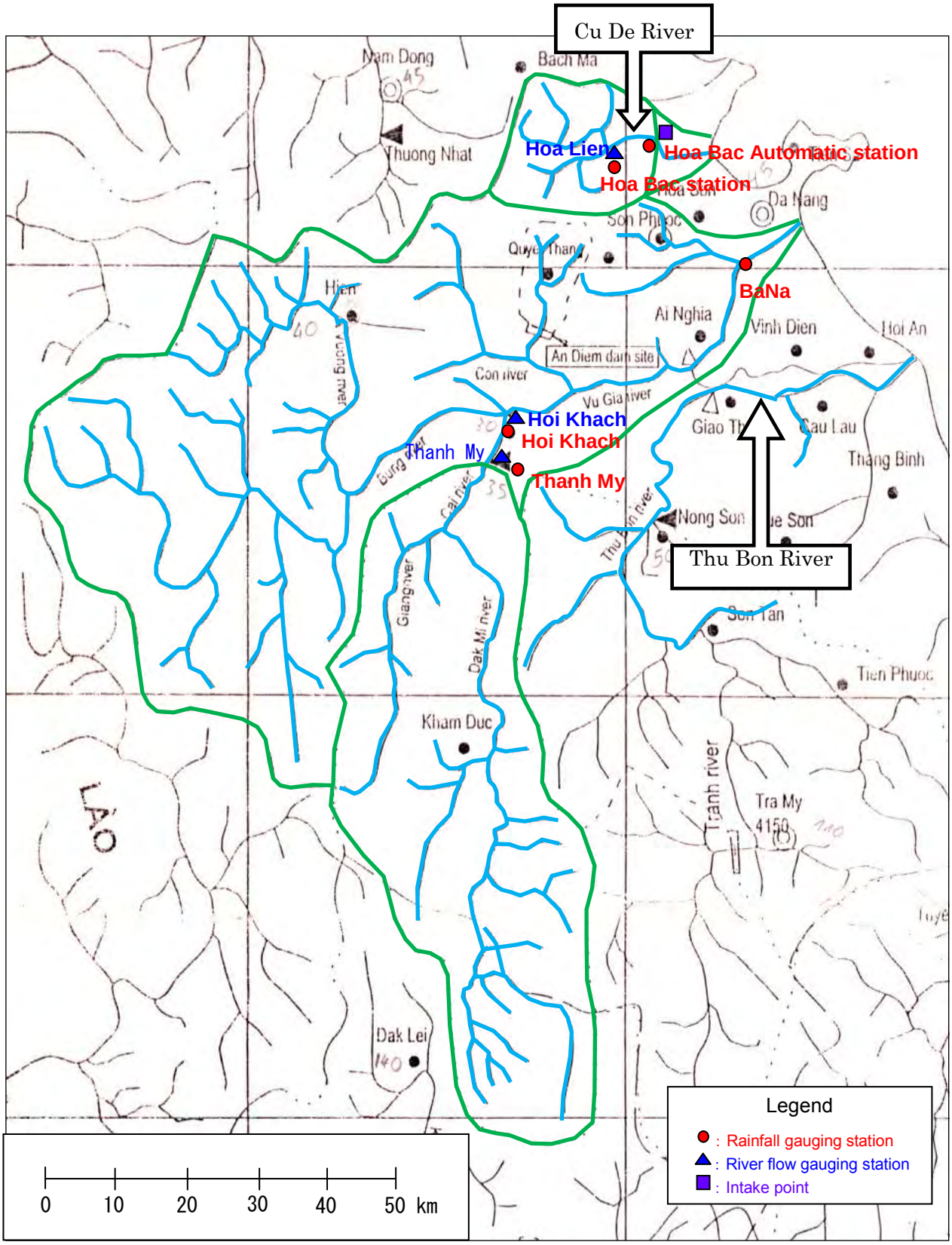


Figure 4.9 Catchment Area of Each Gauging Station

Outlines of each station are as shown in the table below.

Table 4.14 Information of Rainfall Gauging Station

No	Name of station	Longitude	Latitude	Type of data	Measurement period
1	Ba Na	108°12'E	16°02'N	Daily rainfall	1977 - 1995
2	Hoa Bac station	108°00'33"E	16°07'27"N	Daily rainfall	2009 - Present
3	Hoa Bac Automatic Station	108°03'00"E	16°07'47"N	Daily rainfall	2010 - Present
4	Hoi Khach	107°55'E	15°59'N	Daily rainfall	1977 - 1989 1995 - Present
5	Thanh My	107°50'E	15°46'N	Daily rainfall	1976 - Present

Table 4.15 Information of River Flow Gauging Station

No	Name of station	Longitude	latitude	Type of data	Measurement Period	Catchment Area（km^2）
1	Hoa Lien	108°1'5.96"E	16°7'47.51"N	Dry season discharge	1977 - 1992	257
2	Hoi Khach	107°55'E	15°59'N	Dry season discharge	2003 - Present	3,993
3	Thanh My	107°50'E	15°46'N	Daily river flow	2008 - Present	1,850

2) PS team's water sources modeling method for sustainable water yield & potential water sources

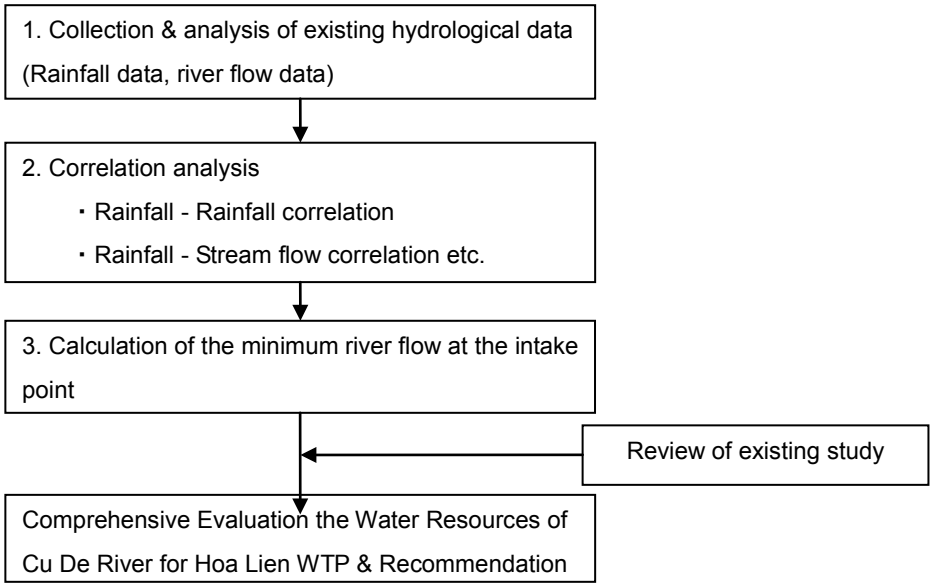


Figure 4.10 PS Team's Water Sources Modeling Flow

The report of ADB and DAWACO concluded that the required capacity will be 120,000 m3/day, which is equivalent to 1.39m3/s. However, in the PS study, the required water yield quantities at the intake location is calculated to be 132,000 m3/day (=120,000m3/day × 1. 10, equivalent to 153m3/s), taking into consideration the 10% of losses at the treatment plant.

3) Results of water source modelling

i. Collection & analysis of existing hydrological data (Rainfall data, river flow data)

Results of Collection & analysis of existing hydrological data are summarized as follows;

Table 4.16 Annual Rainfall Data (Total of daily rainfall data) (mm)

年	BaNa	Hoa Bac station	Hoa Bac Automatic	Hoi Khach	Thanh My	(Hoi Khach + Thanh My) / 2
1977	1,573	–	–	1,437	1,311	1,374
1978	3,377	–	–	2,757	2,897	2,827
1979	2,161	–	–	1,720	2,057	1,888
1980	3,104	–	–	2,575	2,279	2,427
1981	2,394	–	–	3,051	2,948	2,999
1982	1,300	–	–	1,628	2,061	1,845
1983	2,555	–	–	2,319	2,216	2,268
1984	2,419	–	–	2,265	2,507	2,386
1985	2,351	–	–	2,367	2,561	2,464
1986	2,402	–	–	1,785	2,018	1,901
1987	1,932	–	–	2,095	1,774	1,934
1988	938	–	–	1,386	1,651	1,519
1989	1,586	–	–	1,697	1,596	1,646
1990	2,800	–	–	–	2,449	2,449
1991	2,208	–	–	–	1,099	1,099
1992	2,614	–	–	–	1,819	1,819
1993	2,665	–	–	–	1,663	1,663
1994	3,699	–	–	–	2,073	2,073
1995	2,826	–	–	974	2,609	2,609
1996	–	–	–	2,502	2,641	2,572
1997	–	–	–	1,787	1,840	1,814
1998	–	–	–	2,442	2,853	2,648
1999	–	–	–	3,897	3,975	3,936
2000	–	–	–	2,762	2,857	2,809
2001	–	–	–	2,224	2,350	2,287
2002	–	–	–	2,266	2,282	2,274
2003	–	–	–	1,736	1,834	1,785
2004	–	–	–	1,803	2,150	1,977
2005	–	–	–	2,001	1,998	2,000
2006	–	–	–	1,999	1,926	1,963
2007	–	–	–	3,183	3,244	3,214
2008	–	–	–	2,240	2,377	2,308
2009	–	3,654	–	2,801	2,641	2,721
2010	–	3,532	1,764	2,474	2,341	2,408
2011	–	4,603	4,431	2,374	2,495	2,435
2012	–	2,116	1,945	1,650	1,768	1,709
2013	–	634	423	951	1,158	1,055

*Red letters indicate the year with missing data

Source: MCRHMC

Table 4.17 Total Annual River Flow, Minimum Flow and Maximum Flow

(Unit: m3/s)

	Total Annual River Flow			Annual minimun River flow			Annual maximun River flow		
Year	Hoa Lien※	Hoi Khach※	Thanh My	Hoa Lien※	Hoi Khach※	Thanh My	Hoa Lien※	Hoi Khach※	Thanh My
1978	31	-	-	2.51	-	-	7.65	-	-
1979	12	-	-	2.36	-	-	4.02	-	-
1980	7	-	-	1.73	-	-	3.53	-	-
1981	3	-	-	2.95	-	-	2.95	-	-
1982	7	-	-	2.23	-	-	2.68	-	-
1983	11	-	-	1.81	-	-	3.85	-	-
1984	12	-	-	2.26	-	-	3.67	-	-
1985	21	-	-	3.78	-	-	8.57	-	-
1986	17	-	-	2.38	-	-	5.23	-	-
1987	-	-	-	0.00	-	-	0.00	-	-
1988	9	-	-	1.50	-	-	3.25	-	-
1989	26	-	-	3.71	-	-	8.44	-	-
1990	38	-	-	2.66	-	-	8.42	-	-
1991	34	-	-	2.24	-	-	11.80	-	-
1992	18	-	-	1.50	-	-	4.10	-	-
1993	24	-	-	2.47	-	-	6.34	-	-
1994	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-
2008	-	981	53,820	-	35	31	-	105	1,870
2009	-	859	64,530	-	49	35	-	82	4,540
2010	-	548	50,673	-	14	29	-	68	1,610
2011	-	1,476	68,816	-	68	10	-	105	2,660
2012	-	1,244	21,823	-	58	7	-	98	614
2013	-	548	5,689	-	14	5	-	68	131

※:These values ,river flow at Hoa Lien and Hoi Khach gauging station, are computed from results of observations just only from March to August with 1 to 4 times /month.
Source: MCRHMC

Monthly & daily flow and monthly & daily rainfall are omitted here in this report since the data is too huge.

ii. Correlation analysis

In order to determine the rainfall runoff characteristics, PS team has executed the following correlation analysis.

- Daily river flow - Daily river flow correlation
- Daily Rainfall - Daily Rainfall correlation
- Daily river flow - Daily Rainfall correlation
- Annual total rainfall - Annual total rainfall correlation

➢ Annual minimum river flow - Annual total rainfall

As shown in the followings, correlation analysis with rainfall a week ago of the previous year has been carried out.

River flow（T) - Rain fall（T）
River flow（T)— Rainfall（T）＋Rainfall（T-1）
River flow（T)— Rainfall（T）・・＋Rainfall（T-2）
River flow（T)— Rainfall（T）・・・＋Rainfall（T-3）
River flow（T)— Rainfall（T）・・・・・＋Rainfall（T-4）
River flow（T)— Rainfall（T）・・・・・・＋Rainfall（T-5）
River flow（T)— Rainfall（T）・・・・・・・＋Rainfall（T-6）
River flow（T)— Rainfall（T）・・・・・・・・＋Rainfall（T-7）

Analysis of correlation revealed that correlation between rainfall and the river flow of the other basin is poor so it is difficult to apply it for calculation of river flow yield of Cu De River. From the results of analysis of correlation, the only following 14 patterns as shown in the following table have good correlation with R ＞0.8;

Table 4.18 Correlation Patterns with R>0.8

	Gauging Station		correlation formula	coefficient of correlation: R
Daily Rainfall correlation	Rainfall（Hoa bac station）	Rainfall（Hoa bac automatic station）	Y=0.8671x	0.9
	Rainfall（Hoi Khach）	Rainfall（Thanh My）	Y=0.8144x	0.83
River flow correlation	River flow (Hoi Khach)	River flow (Thanh My)	Y=0.9175x	0.8
Annual total rainfall	Annual total rainfall（BaNa）	Annual total rainfall（Hoi Khach）	Y=1.0298x	0.98
		Annual total rainfall（Thanh My）	Y=1.1335x	0.96
	Annual total rainfall（Hoa Bac Station）	Annual total rainfall（Hoa Bac Automatic Station）	Y=1.05x	1.0
		Annual total rainfall（Hoi Khach）	Y=1.5442x	0.98
		Annual total rainfall（Thanh My）	Y=1.4983x	0.97
	Annual total rainfall（Hoa bac automatic Station）	Annual total rainfall（Hoi Khach）	Y=1.5254x	0.96
		Annual total rainfall（Thanh My）	Y=1.4019x	0.94
	Annual total rainfall（Hoi Khach）	Annual total rainfall（Thanh My）	Y=0.9663x	1.0
Annual minimum river flow - Annual total rainfall	Annual minimum river flow (Thanh My)	Annual total rainfall (Thanh My)	Y=0.0096x	0.91
	Annual minimum river flow (Hoi Khach)	Annual total rainfall (Hoi Khach)	Y=0.0184x	0.9
	Annual minimum river flow (Hoi Khach)	((Annual total rainfall Thanh My + Annual total rainfall Hoi Khach)/2)	Y=0.0185x	0.9

iii. Calculation of the minimum river flow at the intake point

Catchment area of the proposed intake point is set as follows;

(A) Catchment area of the intake points; 294.2km^2 = 257km^2 (B) +37.2km^2 (C)

(B) Catchment area of Hoa Lien river flow gauging station: 257km^2

(C) Catchment area from gauging station to proposed intake point: 37.2km^2

This area of 37.2km^2 is set by study using topographic map as shown Figure below;

Catchment area from gauging station to proposed intake point: 37.2km^2

Figure 4.11 Catchment Area from Gauging Station to Proposed Intake Point）

The Calculation of the minimum river flow at the intake point has executed as the following steps using the correlation of the annual minimum river flow - annual total rainfall which exist all the data in recent years.

STEP1 : Set of correlation formula of annual minimum river flow - Annual total rainfall at Hoi Khach and Thanh My gauging station (2008 or later)

STEP2 : Plug in the minimum rain fall at Hoi Khach and the Thanh My gauging station during 1977 to 2013 for the STEP 1 formula

STEP3 : Conversion of the value calculated at STEP 2 according to area ratio of catchment area by using the following formula ; Catchment area of intake point / Catchment area of Hoi Khach or Thanh My gauging station

Results of calculation are given as table below.

Table 4.19 Results of Calculation of Minimum River Flow at the Intake Point (Annual Minimum River Flow – Total Annual Rainfall)

	Correlation formula	Annual minimum rainfall	Calculated minimum river flow	Catchment area of gauging station	Minimum river flow at the intake point (294.2km^2)
Annual minimum river flow- Annual total rainfall at Thanh My	Y=0.0096X	1,099.4mm (1991) Thanh My	10.55m^3/s Thanh My	1,850km^2 Thanh My	1.67m^3/s
Annual minimum river flow-Annual total rainfall at Hoi Khach	Y=0.00184X	1,386mm (1988) Hoi Khach	25.50m^3/s Hoi Khach	3,993km^2 Hoi Khach	1.88m^3/s
Annual minimum river flow-Annual total rainfall at Hoi Khach*	Y=0.0185X	1,519mm (1988) (Hoi Khach + Thanh My)/2	28.10m^3/s Hoi Khach	3,993km^2 Hoi Khach	2.07m^3/s

*Annual total rainfall is set the following formula; (Hoi Khach + Thanh My)/2

From the table above, the minimum river flow at the intake point is calculated to be 1.67m^3/s ~ 1.88m^3/s. Therefore it can be determined that intake points at Cu De River could ensure the sustainable water yield required for Hoa Lien WTP of 132,000 m^3/day (≒1.53m^3/s).

(5) Actual River Flow Measurement by the PS Team

As summarized so far, from the calculation by water source modelling which processes the rainfall data into river flow, it can be concluded that that Cu De River could supply reliable water yield for the Hoa Lien WTP.

However, this evaluation is to review the existing report and desk study using existing topographic mapping, satellite imagery to identify possible water supply options, therefore in order to enhance the accuracy and ensure the trust and safety intake points can supply a sufficient water yield for required capacity of WTP, the PS Team conducted an actual flow measurement at Cu De River.

1) Method of river flow measurement

On the actual measurement of river flow, the PS team has adopted ADCP method, Acoustic Doppler Current Profiler, which has a higher accuracy than a general measurement method using a current meter.

The summary of measurement method using ADCP is outlined as below.

i. Principle of ADCP measurement

ADCP is the device used to measure flow by the ultrasonic energy. A pulse of the energy emitted is called "Ping" is transmitted into the water, this energy is dispersed suspended in water, part of it will come back ADCP equipment. ADCP measure the intensity change of echo sound in the cells, thereby determining the average flow rate of their cells, multiplied by the area of the cell, there will be the cell discharges. The total flow of all the cells, plus the water flow of the cross sections are extrapolated, will calculate full flow of cross section.

The Figure below shows the system and the conceptual figure of ADCP method.

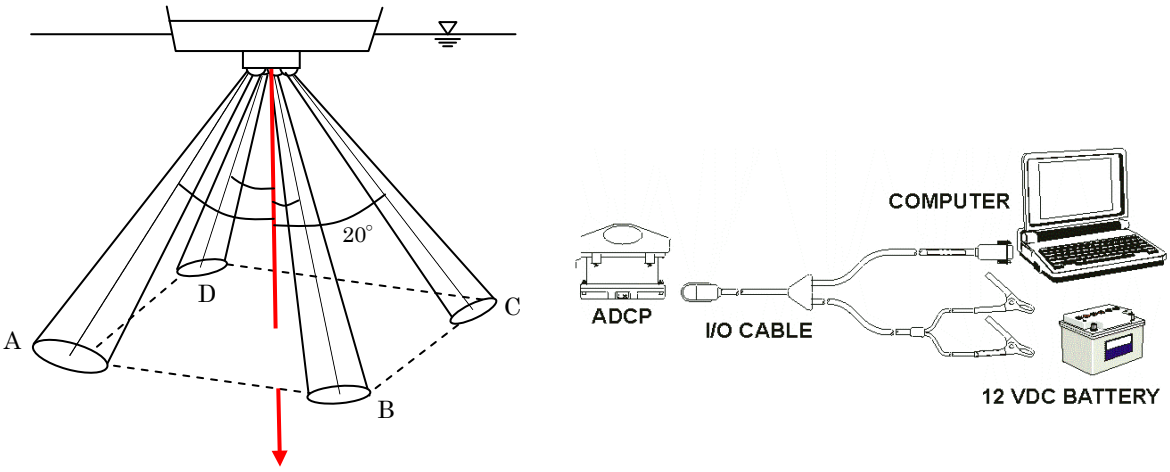


Figure 4.12 System and Conceptual Figure of Measurement by ADCP

ii. Steps of ADCP measurement

Measurement using ADCP device is executed according the following steps;

Step1: launch ultrasound, read, record water level

Step2: Move the machine slowly until the off-shore deep enough to make a value flow between the top two layers deep, determine the distance from start side to depart ADCP measurements, enter values into the distance to identified side

Step3: Move the cross-river machine with appropriate speed, movement speed does not exceed 1.5 m/s

Step4: Continue to move across the river until reaching a depth that can only flow value is in the top two layers of depth, stop at this location to determine the distance from the side end ADCP measurement, enter values into the distance to identified side. Stop broadcasting ultrasonic measurements end. Remember to record data on water flow measurements by ADCP

The Figure below is the velocity magnitude which can be displayed when ADCP was put in the observation ship which was moved with appropriate speed.

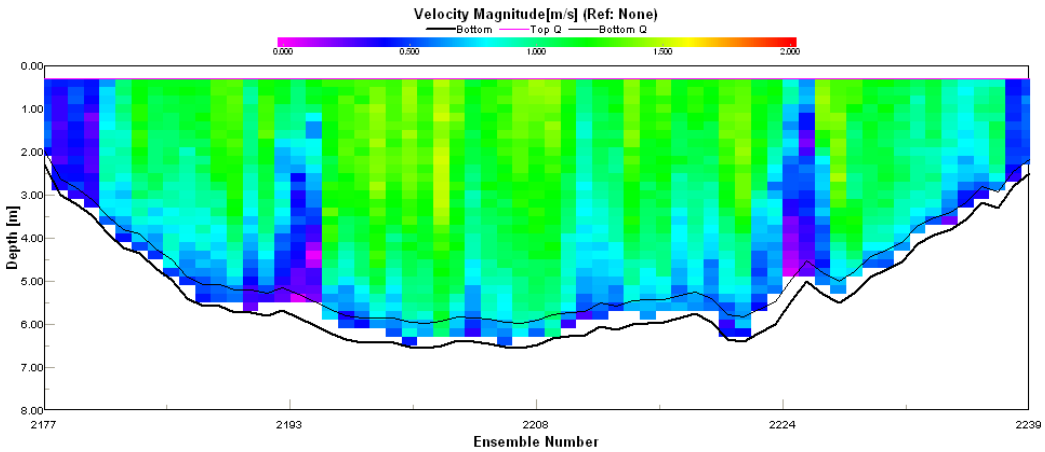


Figure 4.13 Example of Velocity Magnitude Display

In parallel with ADCP measurement, the PS Team has conducted a general measurement using a current flow meter for the purpose of enhancing the accuracy of the results measured by ADCP.

This typical method is measuring the flow velocity using current flow meter, which is able to measure the flow velocity by counting a number of rotations of propeller in response to the river flow.

First, velocity are measured drawing the current meter along the center line of the cross section which was measured in advance as described In such a manner as the right figure below.

And in the second step, velocity obtain in first step and area the river cross-section measured

are multiplied to calculate the river flow, and finally by summing up the river flow at each points, total river flow in the section can be calculated.

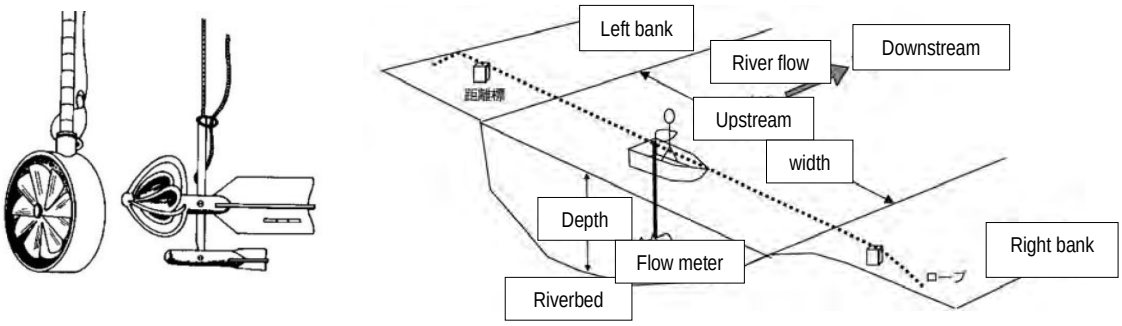


Figure 4.14 Current Flow Meter & Conceptual Figure of Measurement

2) The Actual measurement at Intake point

Summary of the actual flow measurement conducted by PS team in this time is as follows.

i. Location of measurement point

The location is selected at downstream of Pho Nam bridge about 100m, in geographic coordinates 16°07'20,7" at northern latitude; 108°03'05,9" at east longitude. This location is in Pho Nam village, Hoa Bac ward, Hoa Vang District, Da Nang City.

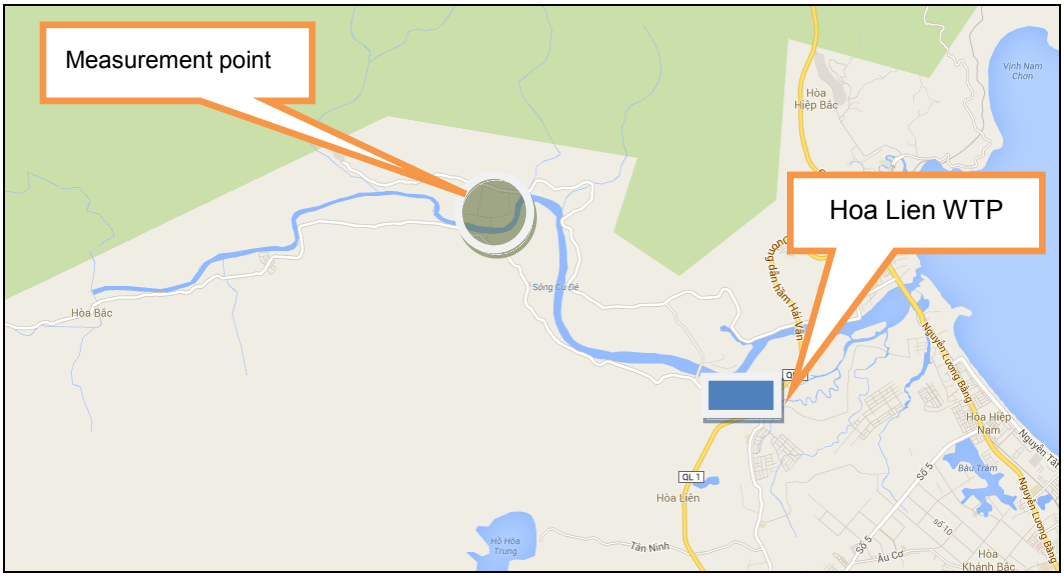


Figure 4.15 Locations of Measurement and the WTP

ii. Contents of measurement

The measurement method shall be ADCP basis. However, in the initial measurement, the result of the flow velocity used ADCP shall be checked by Current Meter to secure the measurement accuracy.

iii. Frequency of flow measurement

The actual measurement will be carried out at seven (7) times from November 2013 to March 2014.

Table 4.20 Frequency of Flow Measurement

Measurement method	2013		2014		
	November	December	January	February	March
ADCP	1	1	1	2	2
Current flowmeter	1	-	-	-	-

3) Measurement Results

The measurement results are as follows. In Da Nang, dry season is lasting from January to August, and a typhoon and rainy season is lasting from September through December. Only 1st and 2nd time measurements were done in rainy season.

Table 4.21 Results of Flow Measurement

No.	Date	Time	Weather	Water flow	Cross-sectional area	Average flow	Maximum flow	Width of the river	Average depth	Maximum depth
				Q (m^3/s)	F (m^2)	V (m/s)	V (m/s)	B (m)	Htb (m)	hmax (m)
1st (Current meter)	29/Nov/2013 (Rainy season)	9:30	Slightly rain	76.1	242.00	0.31	0.36	118.00	2.05	3.01
1st				81.9	239.00	0.34	0.71	114.00	2.09	2.93
2nd	25/Dec2013 (Rainy season)	8:30	Cloudy	14.0	149.00	0.09	0.50	101.00	1.48	2.09
3rd	24/Jan/2014 (Dry season)	14:30	Light sunny	21.7	203.30	0.11	1.21	106.17	1.91	2.56
4th	15/Feb/2014 (Dry season)	14:40	Light sunny	9.14	170.00	0.05	0.20	100.89	1.69	2.28
5th	22/Feb/2014 (Dry season)	14:30	Light sunny	18.4	209.20	0.09	0.32	107.00	1.95	2.51
6th	9/Mar/2014 (Dry season)	9:10	Drizzle	7.74	181.00	0.04	0.249	108.00	1.68	2.36
7th	22/Mar/2014 (Dry season)	14:30	Windy	24:50	227.71	0.11	0.51	112.2	2.03	2.75

The actual measurement of the river flow revealed the following information:

- There was no significant margin between the results of flow measurement using ADCP and the results measured using a current meter, which indicated that the ADCP method have a high reliability.
- The minimum river flow among the seven (7) times measurement occasions is 7.74m^3/s, which is certainly larger than the necessary flow, approximately 1.53 m^3/sec, required for Hoa Lien WTP of 132,000 m^3/day. However, since period of this actual measurement is short, results of the actual measurement is used for one of the references for determining the validity of the river flow value calculated in the PS.

Photo 4.4 Actual Measurement Situation（November 2013）

(6) Comprehensive Evaluation the Water Resources of Cu De River for Hoa Lien WTP

Results of evaluation the Water Resources of Cu De River from the previous & the PS team's study are summarized below.

Table 4.22 Summary of Results from Previous & the Study by the PS Team

Study Name	The minimum river flow		Remarks
	m^3/s	m3/day	
ADB FS	2.91	251,424	Location C
	3.11	268,704	Location D
DAWACO Study			Location C
			Location D
Da Nang University Study	Concluded that 120,000m^3/day is possible by studying the analyses by ADB and DAWACO		
PS			Location D
Actual Measurement	7.74	668,000	Measurement period was too short and only for reference

4.4 Analysis on the Water Quality of Cu De River

(1) Geographical Condition of Cu De River Basin

The Cu De River basin consists of three rivers which are Son Nam River, Son Bac River and Cu De river. As the water resource of Hoa Lien Water treatment Plant, Cu De River basin has areas of 280.7 Km2 and length of 47km. The length of Cu De River is 20km distance from the confluence of Son Nam and Son Bac River to the estuary. There are many villages and agricultural fields along the road beside Cu De River. Since the river is low-gradient, it is always relate to the retention of brackish water at the midstream in river.

(2) Weather Condition of Cu De River Basin

The weather condition of Da Nang is two season of rain season and dry season. The period of dry season is January to August and rain season is September to December. Annual average precipitation at the coastal zone is gauged 2,000mm and West Mountain zone is 3,500mm. The amount of precipitation in rain season is triple in dry season. In Typhoon season, storm rain had been happened as 650mm/d sometimes. During the study period in October 2013, the PS Team had encountered inundations at Route 601 on riverside of Cu De River, because of approaching Typhoon.

(3) Benchmark Data of Existing Quality Analysis of Cu De River Water

Water analysis of Cu De River had been executed three (3) times under ADB FA Project in 2009. Analyzed parameters were 42 items which was regulated by the Surface Water Standards (QCVN 08:2008/BTNMT) of Vietnam.

1) Surface Water Standards (QCVN 08:2008/BTNMT) of Vietnam.
   The standard is for classifying in common term of public usage water and of protecting the water quality of public water body in each municipality. The standard is regulated by four (4) criteria; i: A1 is for domestic use, ii: A2 is for domestic use with treatment and protection of aquatic organism, iii: B1 is for irrigation use, and iv: B2 is for water of canal and equivalents.

2) Review on existing annualized data in 2009 by QCVN 08:2008/BTNMT
   a. The analyzed parameters are shown in Table 4.23. The water quality at three (3) points (S1~S3) had been keeping the rank-A of this standard.

   b. The point S4 is in brackish zone of 7,000mg/l as Chloride compound. It is unable to use for drinking water and irrigate.

Table 4.23 Existing Whole Analysis Record by Surface water Standard of Each Water Sampling Points in Cu De River in 2009 (ADB Data)

No	Parameter	Unit	Max. Limit	Nam River B Point (S1)	Bac River A Point (S2)	Middle Cu De C Point	Tidal Cu De D Point (S4)
1	pH	—	6.0～8.5	6.74/6.32	6.80/6.53	6.70/6.46	7.65/6.54
2	DO	mg/L	≧5	6.8/6.2	6.8/6.2	6.5/6.0	3.8/5.0
3	TSS	mg/L	30	3.0/3.0	2.0/3.0	3.0/2.0	3.0/3.0
4	COD	mg/L	15	8/16	8/12	10/12	260/60
5	BOD_5（20C）	mg/L	6	2/3.6	2/3.0	4/2.6	68/10
6	$N\text{-}NH_3$	mg/L	0.2	0.04/0.13	0.02/0.13	0.06/0.15	0.12/0.18
7	F^-	mg/L	1.5	ND/ND	0.16/ND	ND/ND	0.2/ND
8	$N\text{-}NO_2^-$	mg/L	0.02	0.01/0.01	0.01/0.01	0.01/0.01	0.03/0.03
9	$N\text{-}NO_3^-$	mg/L	5	1.1/1.2	0.5/1.2	1.0/1.4	12/3.1
10	$P\text{-}PO_4^-$	mg/L	0.2	0.0/0.01	0.0/0.01	0.02/0.02	0.08/0.06
11	CN^-	mg/L	0.01	ND/ND	ND/ND	ND/ND	ND/ND
12	As	mg/L	0.02	ND/0.0022	ND/0.0017	ND/0.0019	ND/0.0033
13	Cd	mg/L	0.05	ND/ND	ND/ND	ND/ND	ND/ND
14	Pb	mg/L	0.02	ND/ND	ND/0.0027	ND/ND	ND/0.0046
15	Cr^{3+}	mg/L	0.1	ND/ND	ND/ND	ND/ND	ND/ND
16	Cr^{6+}	mg/L	0.02	ND/ND	ND/ND	ND/ND	ND/ND
17	Cu	mg/L	0.2	ND/ND	ND/ND	ND/ND	ND/ND
18	Zn	mg/L	1	ND/ND	ND/0.014	ND/ND	ND/ND
19	Ni	mg/L	0.1	ND/ND	ND/ND	ND/ND	ND/ND
21	Hg	mg/L	0.001	ND/ND	ND/ND	ND/ND	ND/ND
22	Surface active detergents	mg/L	0.2	ND/ND	ND/ND	ND/ND	0.18/ND
23	Total oils & grease	mg/L	0.02	ND/ND	ND/ND	ND/ND	ND/ND
24	Phenol(total)	mg/L	0.005	0.14×10^{-3}/ 0.3×10^{-3}	0.38×10^{-3}/ 0.3×10^{-3}	0.45×10^{-3}/ 0.17×10^{-3}	ND/ 0.2×10^{-3}
25	Aldrin +Dieldrin	mg/L	0.004	ND/ND	ND/ND	ND/ND	ND/ND
26	Endrin	μg/L	0.012	ND/ND	ND/ND	ND/ND	ND/ND
27	BHC	μg/L	0.1	ND/ND	ND/ND	ND/ND	ND/ND
28	DDT	μg/L	0.002	ND/ND	ND/ND	ND/ND	ND/ND
29	Endosunfan	μg/L	0.01	ND/ND	ND/ND	ND/ND	ND/ND
30	Lindan	μg/L	0.35	ND/ND	ND/ND	ND/ND	ND/ND
31	Chlordance	μg/L	0.02	ND/ND	ND/ND	ND/ND	ND/ND
32	Heptachlor	μg/L	0.02	ND/ND	ND/ND	ND/ND	ND/ND

No	Parameter	Unit	Max. Limit	Nam River B Point (S1)	Bac River A Point (S2)	Middle Cu De C Point	Tidal Cu De D Point (S4)
33	Parathion	µg/L	0.2	ND/ND	ND/ND	ND/ND	ND/ND
34	Malation	µg/L	0.32	ND/ND	ND/ND	ND/ND	ND/ND
35	2,4D	µg/L	200	ND/ND	ND/ND	ND/ND	ND/ND
36	2,4,5T	µg/L	100	ND/ND	ND/ND	ND/ND	ND/ND
37	Paraquat	µg/L	1200	ND/ND	ND/ND	ND/ND	ND/ND
38	Total Radioactivity α	Bq/L	0.1	0.005±0.001/ 0.0041 ±0.001	0.004±0.001/ 0.0032 ±0.001	0.0025±0.001/ 0.0018 ±0.001	0.0025± 0.005/ND
39	Total Radioactivit β	Bq/L	1	0.006±0.005/ 0.0050±0.005	0.055±0.005/ 0.042±0.005	0.0064±0.005/ 0.0047±0.005	0.0064± 0.007/ND
40	E.Coli	MPN/ 100mL	50	7/93	7/21	7/9	ND/4
41	Coliform	MPN/ 100m L	5000	2.4×10^2/ $2.4X10^2$	2.4×10^2/ $4.6X10^2$	2.4×10^2/ $4.3X10^2$	23/ $9.3\ X10^2$

Note: N1/N2： N1 is Data in July 2009. N2 is Data in Dec 2009.

Source: Partly Data, FS report of Hoa Lien Water Treatment Plant in 2011 by ADB

3) Review on existing record of Water analysis based on 16 parameters

These parameters are like a daily test of water inspection at Water Treatment Plant, and are mostly included in Vietnam Drinking water standard(QCVN 01：2009/BYT).

The water quality (Table 4.24) was able to evaluate good quality as drinking water source because any parameter didn't exceed the criteria.

Table 4.24 Existing Record of Water Analysis based on the Requirement Level of Daily Test for Water Treatment Plant (Drinking water Standard)

No	Parameter	Unit	Max. Limit	S1 Nam River	S2 Bac River	S3 Middle Cu De	S4 Tidal Cu De
1	Conductivity	μ S/cm		38	35	36	1451
2	Turbidity	NTU		3.10	3.20	5.2	8.5
3	Color	Co		5	6	8	10
4	Oder			0	0	0	0
5	pH		6.0～8.5	7.17	7.06	6.97	6.83
6	T-Hardness	$Mg/CaCo_3$		6	6	6	140
7	Consumed O_2	mg/l		2.0	1.4	1.0	1.6
8	N-NH3	mg/l	0.12	0.12	1.0	0.03	0.09
9	$N\text{-}NO_2$	mg/l	0.02	0.02	0.03	0.02	0.03
10	$N\text{-}NO_3$	mg/l	5	1.9	0.02	1.8	2.2
11	SO_4^{2-}	mg/l		0	10	0	62
12	Coliform	MPN/100ml	5000	$4.6X10^2$	$4.6X10^2$	$4.6X10^2$	$1.1X10^2$
13	E-Coli	MPN/100ml	50	24	21		15

Source: ADB, September 2009

(4) Water Analysis conducted in the PS

Since there has been little progress in the construction project of multipurpose dam which should be constructed by Vietnamese private company, the PS Team, based on the discussion with DPC, decided to seek the alternative way to intake water, that is, construct a new intake facility for water supply from Cu De River directly.

Locations for the water quality analysis include the four (4) points selected as candidate intake point by ADB, and another five (5) points newly selected by the FS Team. The location of each point is shown in Table 4.25 and Figure 4.16

Table 4.25 Sampling Points for Water Analysis in Cu De River Basin

Sampling Point		Location of Sampling Point	Remarks
1	A Point (S2 Point)	16°07'25.2"N, 107°59'00.6"E Bac -Hoa Bac Commune、Hoa Van district	BM:S2 2009 ADB TA
2	B Point (S1 Point)	16°07'10.6"N, 107°59'00.2"E Nam -Hoa Bac Commune、Hoa Van district	BM:S1 2009 ADB TA
3	C Point	16°07'34.2"N, 108°00'10.6" Middle Cu De-Nam My Hamlet-Hoa Bac Commune	BM:S3 2009 ADB TA Candidate Intake D Point
4	C-1 Point (S3 Point)	16°07'46.9"N, 108°01'05.9"E Cu De-Nam My Hamlet-Hoa Lien Commune	
5	C-2 Point	16°08'15.3"N, 108°01'56.9"E Middle Cu De-Nam My Hamlet-Hoa Lien Commune	
6	D Point	16°07'55.3"N, 108°02'50.8"E Cu DE-Nam My Hamlet-Hoa Lien Commune	BM:S4 2009 ADB TA
7	D-1 Point	16°07'53.3"N, 108°03'03.2"E Nearby Pho Nam bridge	Candidate Intake D Point
8	E Point	16°06'44.7"N, 108°03'55.2"E Cu DE-Nam My Hamlet-Hoa Lien Commune	
9	F Point	16°06'28.2"N, 108°05'12.0"E At Second bridge from Estuary of Cu De	

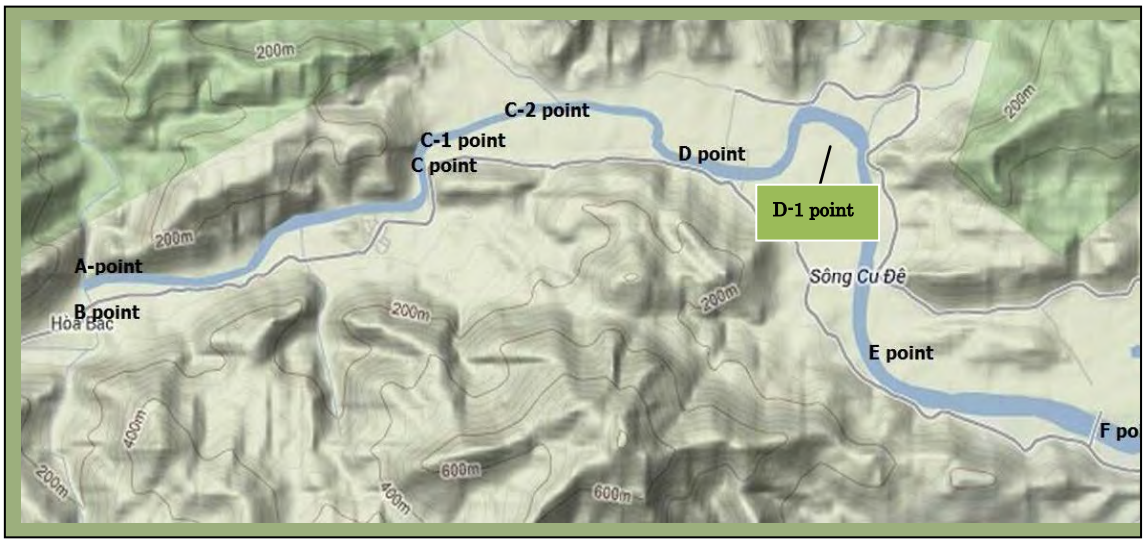


Figure 4.16 Water Sampling Point of Cu De River Basin

(5) The Contents of Water Analysis

The water analysis was conducted according to the Vietnam Surface Water Standard (QCVN 08:2008/BTNMT) and National Drinking Water Standard (QCVN 01: 2009/BYT). The items studied in each sampling point are as described below:

1) A Point and B point

- 42 parameters in line with the QCVN 08:2008/BTNMT (SWS)

- 5 parameters under QCVN 01: 2009/BYT (NDWS)
- Elution analysis of toxic metals in the river sediment in June 2013.

2) C Point
   - 121 parameters according to QCVN 08:2008/BTNMT and QCVN 01: 2009/BYT
   - Electro conductivity and 50 parameters under both standards.
3) D Point-1: Beside Pho Nam Bridge:
   - One of alternative place of raw water intake, located at downstream of C point, where village and branch stream nearby. Therefore, its water quality can be influenced by sewage and polluted by inorganic and organic substance.
4) Overall:
   - Turbidity: Turbidity of Cu De River water and Cau Do River water are analyzed for comparison.
   - Concentration of Suspended Solid in dry and rainy season to decide the design loading and capacity of the WTP

(6) Conducting of Water Analysis

Sampling and analysis in dry season were conducted on 27th June, and those in rain season were conducted in 20th September and 18th December 2013.

(7) Results of Analysis

1) Results of A B C Point and D-1 regarding parameters of Surface water Standard

At C and D-1 Points, increase in nutrient salts was observed in rainy seasons, which may be caused by the runoff of domestic wastewater and agricultural fertilizer during heavy rains. Therefore, Hoa Lien Water Treatment Plant will be required to stabilize the both component. .

Table 4.26 Water Quality of Candidate Water Intake Points (Surface Water Standard)

Potential assessment of Eutrophication of the water by Intake Weir Construction

The ADB report shows that the water taken from the weir would have odd smell and taste by algae.

The nutrient N and P in raw water at rainy season gave 5~100 times higher concentration than at dry season. It could be caused by nutrient salts runoff from the river basin with rain. These facts indicate a slight possibility of eutrophication.

Table 4.27 Judgment of Possibility for Eutrophication at A, B and C Point in Dry Season

Table 4.28 Judgment of Possibility for Eutrophication at C and D-1 Point in Rain Season

Table 4.29 Index of Nutrient Salts as N and P on Each Trophic State, Lake water

2) Evaluation of the water quality at C and D-1 points based on the National Drinking Water Standard

Table 4.30 shows the quality of water taken at the both alternative intake points, C and D-1 points. The observed values are below the standard for the most of parameters.

The analytical results show low turbidity, hardness and permanganate kalume consumption, it is indicating the good water quality. The turbidity is relatively low during this analysis, even when

the river discharge is very high because of stormy weather, which indicates that turbidity is less affected by rainfall amount.

Table 4.30 Water Quality of Candidate Water Intake Points (Drinking Water Standard)

3) Characteristics on Sedimentation of Turbid Particle in Cu De River Water

i. Turbidity in Dry season and Rain season (Table 4.31, Figure 4.17).

Table 4.31 Relation of Turbidity and TSS Concentration at the Candidate Water Intake Locations

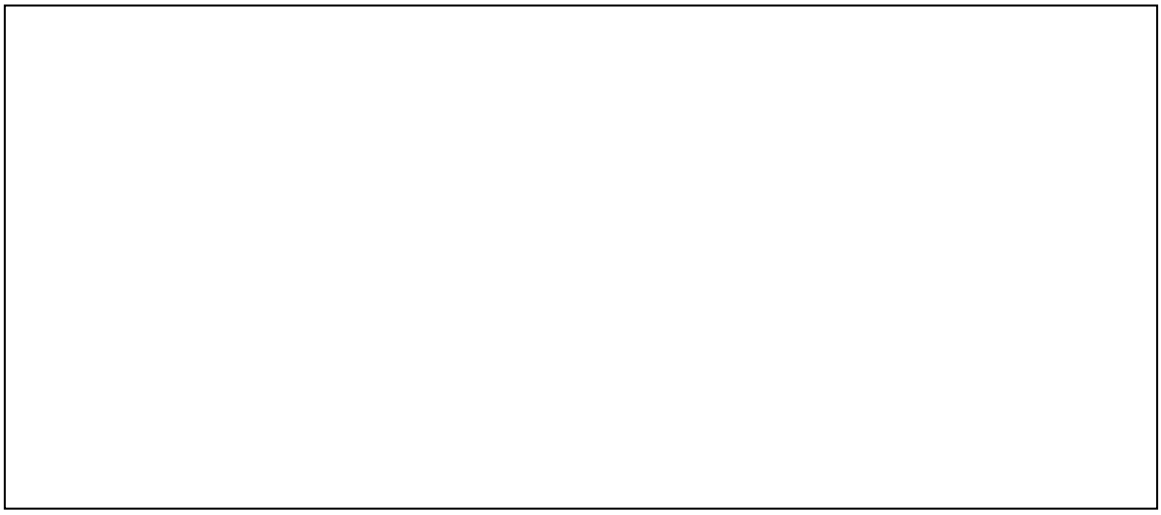


Figure 4.17 Correlation between Turbidity and Total Suspended Solid at Candidate Intake Points of C and D-1

ii. Characteristic on turbidity and suspended solid between Cu De and Cau Do River

The suspended solid consists of fine sand, silty sand, clay and organic matter normally. The difference in the turbidity between Cu De River and Cau Do River attributes to the different characteristics of sediment composition and surface electric charge of suspended solid.

To find the sedimentation characteristics of the water in both the rivers, the gravity sedimentation and the concentration of supernatant after 10 minutes were compared in a graduated cylinder. (Photo 4.6)

Table 4.32 Comparison on Characteristics of Kinetic Assay on Turbidity for Cu De and Cau Do River Water

4) Coagulation sedimentation test of raw water (Jar Test)

Jar Test was conducted six (6) times during this study. However, the turbidity in river water was always low, and the relation between the amount of chemical dosing and removal ratios of turbidity was not clear. Complete tests were made for the samples on 15th October. The results of the tests are shown in Table 4.33, Table 4.34 and followings.

Table 4.33 Sample Water Quality of Jar Test

Table 4.34 Sample Water Quality after Jar Test

5) Conclusion

a) According to the survey results of water quality in Cu De River as water source, the analysis value of each parameters were mostly under the limits value of the surface water standard (QCVN 08:2008/BTNMT) or drinking water standard (QCVN 01:2009/BYT). In order to decision of treatment process flow finally, it is need more additional survey for the fluctuation of water quantity and qualities in next stage.

b) Selecting factors in water treatment process are: turbidity, THM precursor, and musty odor substance including 2-MIB and Geosmin.

- Turbidity (NTU) is usually low at less than 5. Although NTU was measured at 100 during the typhoon in October 2013, it returned to low value within 24 hr.
- THM precursor was not detected by this analysis.
- Analysis for 2-MIB and Geosmin was not conducted in this study, because oscillatoria as occurrence material of both materials cannot be thought the existence in Cu De river water.

c) In consideration with the results of this water analysis, the sequential process of coagulation, sedimentation and rapid filtration is recommended. In addition, dosing of chlorine into coagulation tank, filtration tank and distribution tank is recommended in order to remove Algae.

d) In order for the optimal and efficient operation of the WTP, it is essential to conduct treatment tests on removal of Turbidity, sufficiently in the operation stage.

CHAPTER 5 PRELIMINARY DESIGN OF WATER TREATMENT FACILITIES

5.1 Basic Design Concept

A top priority in the facility design is given to the facility's capability of the sustainable supply of safe water over the entire operation period, which should be achieved by applying an appropriate cost-efficient technology and optimized operation.

In order to achieve the sustainable supply of safe water, the SPC especially considers:

- Selection of optimum treatment process accommodating the local conditions
- Economical construction, equipment and operation/ maintenance

Table 5.1 summarizes the design principle applied in the facility design of the Hoa Lien Water Treatment Plant, which is in compliance with QCVN 01: 2009/BYT NATIONAL TECHNICAL REGULATION ON DRINKING WATER QUALITY. The preliminary design was also made in accordance with the design standard listed in Table 5.2.

Table 5.1 Design Principal of Hoa Lien Water Treatment Plant

Target	Design Principal
Sustainable supply of Safe water	Compliance of QCVN 01 : 2009/BYT NATIONAL TECHNICAL REGULATION ON DRINKING WATER Secure clean water source ➢ Obtain raw water with low-turbidity from the Cu De River to supply safe water Sufficient quantity for stable water supply. ➢ Intake facility shall be designed to ensure a required intake design volume based on detailed hydrological analysis Provide safety countermeasure of emergency ➢ Standby facility and equipment for measure facilities such as rapid filter, pumps etc. ➢ Sufficient distribution tank volume as a countermeasure for blackout and polluting of raw water ➢ Emergency power generator

Minimization of project cost to maintain reasonable water tariff	<u>Design facilities to be suitable to the local conditions without over-investment</u> ➢ With local needs to safe water, design facilities with optimized specification ➢ Carefully select proven and trusted processes for water treatment and appropriate equipment in Da Nang. ➢ System depending not only mechanized system but also actively utilizing the gravity function without electricity <u>Functional Layout Plan for effective operation and Cost reduction</u> ➢ Carefully study of the location of the raw water intake to minimize the raw water intake facilities, intake pumping station and raw water main. ➢ Take full advantage of the ground condition to reduce construction cost <u>Equipment selection by based on estimates of LLC</u> ➢ Selection of machines and equipment based on a comprehensive comparison including not only the initial cost but also life cycle cost since this project deals with management and operation of the facilities for 20 years ➢ Effective and economical centralized comprehensive control systems (SCADA) which is able to control facilities and equipment by a computer in the operation management center
Introduction of Japanese Technology & Environmental Consideration.	<u>Introduction of energy-saving technology</u> ➢ Inverter control system for Pump ➢ Chemical and Chlorine Injection control system relay on instrumentation equipment ➢ Study on possibility of introduction of solar power generation system <u>Technology transfer of effective O & M methods</u> ➢ Transfer of technology by skilled Japanese engineer ➢ Participation in JICA training program such as leakage detection and other technical program <u>Installation of wastewater & sludge treatment facility</u> ➢ Since QCVN 24:2009/BTNMT and QCVN 40:2011/BTNMT for National Technical Regulation on Industrial Wastewater have been executed in recent years, wastewater treatment facility and sludge treatment facility are new in Da Nang and are still rare even in Viet Nam. Therefore, the wastewater treatment facility and sludge treatment facility for the Hoa Lien WTP, which is designed in the PS, will contribute substantially to the aqua environment in Da Nang. <u>Layout taking account of the impact on the traffic situation of surrounding residential area</u> ➢ Design taking into consideration environmental condition surrounding WTP ➢ Layout taking account of the impact on the traffic situation of surrounding residential area ➢ WTP Design harmonizing surrounding landscape and plantation at WTP

Table 5.2 Design Standard

No	Design Standard
1	QCVN 01 : 2009/BYT NATIONAL TECHNICAL REGULATION ON DRINKING WATER QUALITY
2	Vietnamese Standard TCVN 33: 2006 : "Water Supply Pipeline Network Construction –Design standards", issued under Decision No. 06/2006/QÑ-BXD on 17th March 2006 by Ministry of Construction.
3	Sector Standard: Drainage – External Network and Construction. Design standards 20 TCN – 51 – 84 by Ministry of Construction promulgated in 1989.
4	Viet Nam construction standards (volume 1, 2, 3).
5	Design criteria TCVN 2737 – 1995: loading capacity and impacts.
6	Design criteria TCXD VN 356 – 2005: steel reinforced concrete structure.
7	Steel Structure Design Criteria: TCXD VN 338 – 2005.
8	Pile Foundation Design Criteria: TCVN – 205 – 1998
9	Foundation Work Design Criteria: TCXD – 45 – 78
10	Highway Design Criteria: TCVN – 4054 - 2005
11	Design Criteria TCVN 5573 – 1991: stone, brickwork and steel reinforced masonry.
12	Foundation Lining Design Criteria: 22 TCVN – 211 – 06.
13	Electrical installation procedures part 1: General regulations: 11TCVN – 18 – 2006.
14	Electrical installation procedures part 2: Network system: 11TCVN – 19 – 2006.
15	Installation of electric wiring and equipment for indoors and public works: TCXD 27 - 91
16	Exterior artificial lighting for public works and urban infrastructure engineering: TCXD VN333 – 2005
17	Earthing procedures for electric equipment: TCVN 4756 – 1989.
18	QCVN 07:2010/BXD Vietnam Building Code Urban Engineering Infrastructures
19	National Technical Regulation on Noise QCVN 26:2010/BTNMT
20	Fire prevention and protection for buildings and structures -Design requirements
21	Calculation Regulation for Hydraulics of Weir.
22	Drainage and sewerage - External Networks and Facilities - Design Standard TCVN 7957:2008
23	Qcvn40:2011/BTNMT National Technical Regulation On Industrial Wastewater
24	Indoor and public works: TCXD 25 - 91

5.2 Hoa Lien Water Treatment Plant

(1) Design Conditions

Table 5.3 summarizes the basic design conditions were agreed upon between DAWACO and the PS Team.

Table 5.3 Design Basic Condition

Item	Design Standard
Proposed Daily Maximum Supply water	Phase1：120,000m3/day (This project) Phase2：240,000m3/day (In Future)
Treatment Process	Raw water receiving tank→Mixing tank→Flocculation tank→ Sedimentation tank → Rapid filter → Clear water Tank
Treated Water quality	Applied on Vietnam Drinking Standard
Distribution Tank	Phase1：30,000m3 (This Project) Phase2：60,000m3 (In future)
Distribution system	Pump
Sludge treatment	Wash water recovery tank, sludge balancing tank, sludge thickener and sludge drying Bed

(2) Layout Plan of the Plant

Proposed site is located at Hoa Lien village in a direction toward southwest of Route 1 and Route 601 crossing point. The site location is provided condition of good traffic ability for transportation of construction and maintenance work, and can be expect good access on all-weather because of front onto Route 1.

1) Concept of layout planning

- The workability of maintenance and operation shall be kept on smooth.
- For avoiding of a pipe trouble such as clog and detachment, piping length shall be shortened by consider in layout.
- In view of results of Soil condition, the layout shall be planning of manner to be reducing the construction cost.

2) Requirement of construction site

- Boundary of northern part shall be keeping out 20m distance from present edge of Route 1.
- The entrance gate shall be set 3 gates at north, east and southeast.
- Storm drainage shall be discharge into drainage channel of constructing by Da Nang city.
- An area of the site is 8.4 ha.

3) Soil Condition

The soil investigation is very important to conduct preliminary study of this project. The PS Team had been done boring test of 13 bore holes, penetration test, grain size test, rate of water content and density. The results of test were utilized to determine type of foundation, structural design and cost estimation. Location of bore holes are shown in the Figure 5.1, B/Q of Soil Test is shown in Table 5.4.

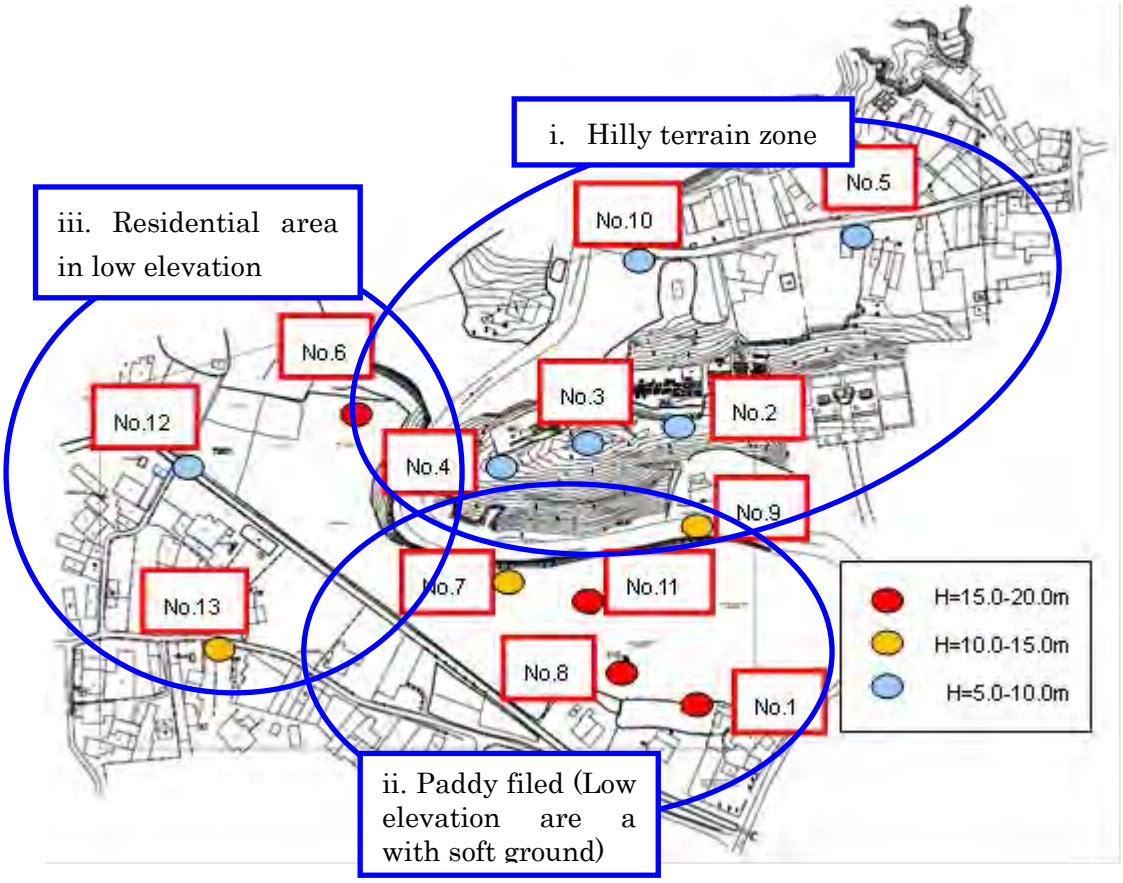


Figure 5.1 Location of borehole in WTP site

Table 5.4 B/Q of Soil Test

	Borehole ϕ 66	penetration test	Grain size test,	Water content test	Density. test
Paddy field	20m x 4sites 15m x 4sites	20m x 4sites 15m x 4sites	Total 60 samples Vertical Compression test 4 samples		
Hilly terrain zone	10m x 5sites	10 times x 5sites			

Photo5.1 Conducting of During Borehole

Photo5.2 Laboratory Test of Sample Soil

4) Outline of soil condition

According to the results of Soil test, the soil characteristic can be separated to the following three types; i) Hilly terrain zone , ii) Paddy field in the eastern area of the low ground, and iii) Residence area in the western area at the low ground. Each characteristic is as follows.

i) Hilly terrain zone (Borehole No 2,3,4,5,10)

The hill area is occupying the northern part of WTP site with elevation of 7 to 15 m. The area is mainly composed rock.

ii) Paddy field in the eastern area of the low ground (Borehole No.1,7,8,9,11)

The low ground with elevation of 0 to 3 m was used for rice field, therefore this soil condition is soft which is be composed of sand, sandy clay, clay, mud etc. Especially, the thick soft clay is distributed in this area.

iii) Residence area in the western area at the low ground. (Borehole No.6, 12, 13)

The residence area in the western area of the low ground is relatively stiff.

5) Setup Condition of Proposed Ground Height

In accordance with the existing flood record, the ground height was decided on higher than the flood level.

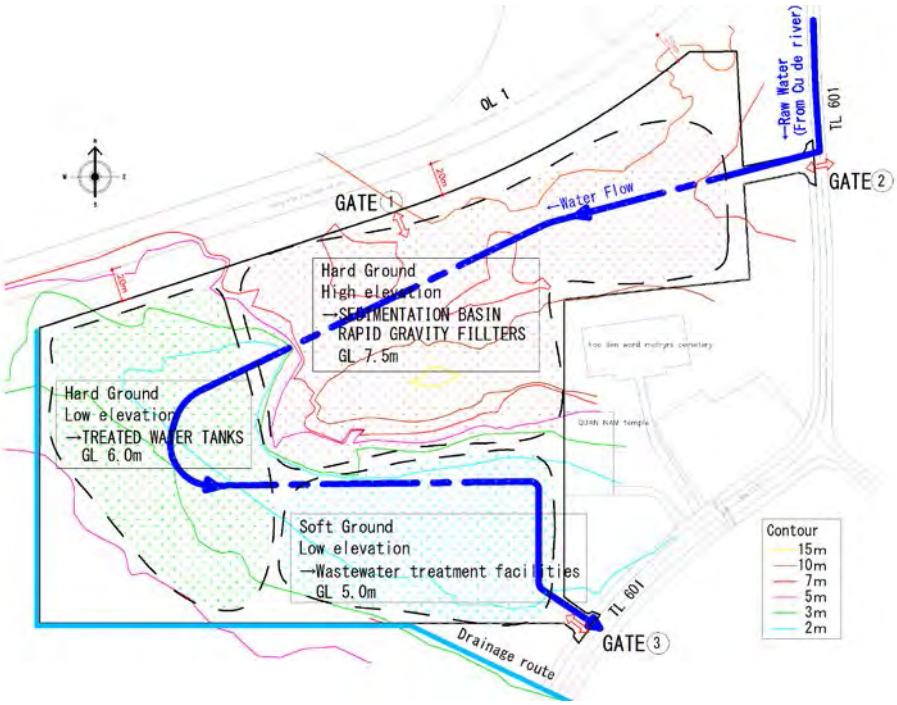


Figure 5.2 Present Land Form and Soil Condition

6) Layout Plan of Water Treatment Plant

The layout design was prepared of considering several requirement for surrounding habitants, workability of O/M, optimum functional condition, and also expanding work of 2nd facilities. And then it determined finally on consultation with DAWACO.

Figure 5.3 Final Layout Plan

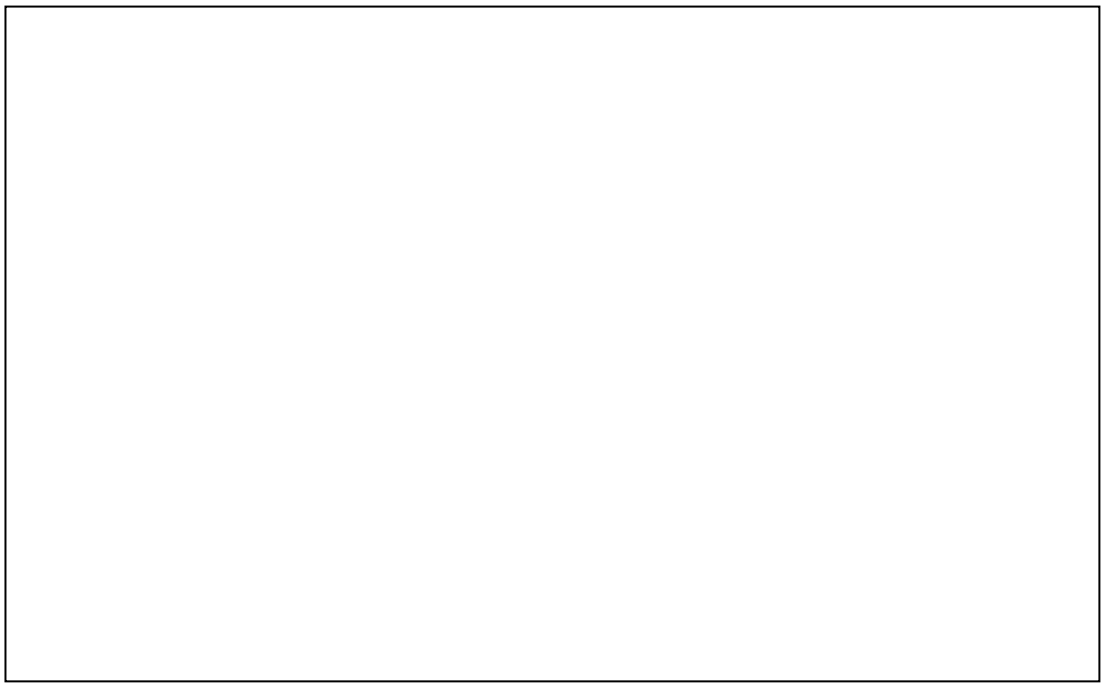


Figure 5.4 Rendering of Water treatment Plant (simplified Bird-eye -view)

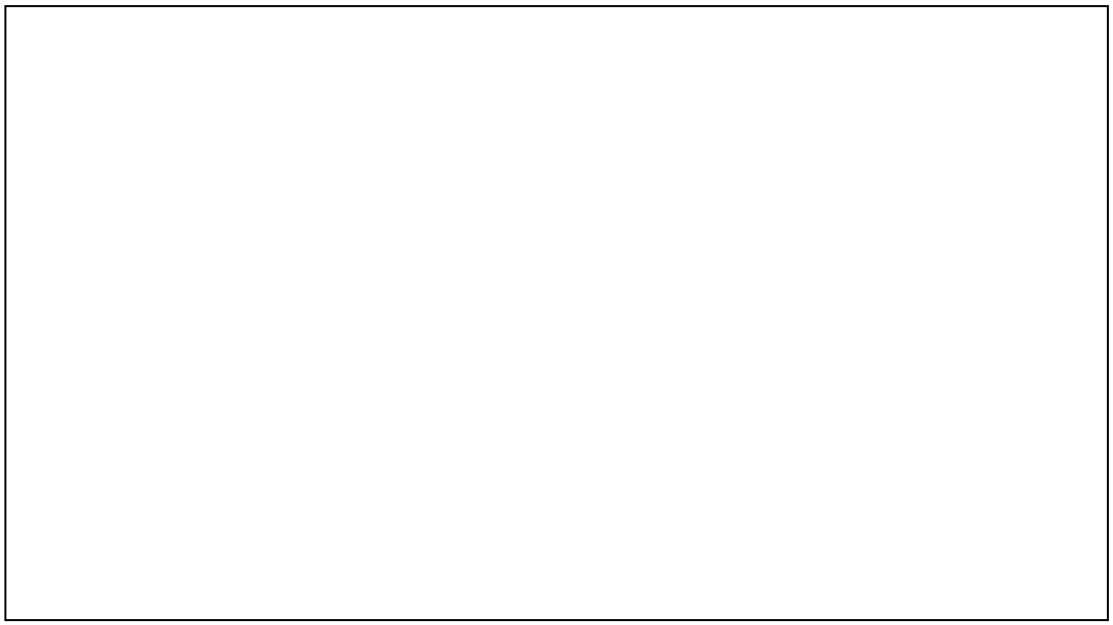


Figure 5.5 Hydraulic Profile

(3) Hydraulic Profile of Water Treatment Plant

1) Flood Level

Refer to "4.2. Analysis of Flood Data"

2) Setup of the formation level

Confidential information

3) Hydraulic profile of each Facilities

Table 5.5 Classification of Facilities according to Top Slab Height

4) Flood Hazard Identification

The followings are the major flood-related risks that could affect the water treatment plant's operation:

Actual Flood Smaller Than Design Flood

In case that actual food would be smaller than the design flood of +5.00m above sea level, the water treatment plant would be safety. However, since the whole area of Da Nang city is located at low elevation, the surrounding area of WTP would be submerged as shown in the Figure 5.6.

Figure 5.6 Flood Hazard Map at Water Level +5.00m

(4) Basic Design of the WTP

Since water quality of Cu De River is clean, therefore it is expected that the Hoa Lien WTP could save the amount of chemicals less than existing Cau Do WTP.

In addition, the Hoa Lien WTP is equipped wastewater treatment facilities which are able to treat Wastewater & sludge from the WTP properly in accordance with the relevant law, which existing Cau Do WTP does not have this wastewater facilities.

Comparing to the existing Cau Do WTP, specifications of the Hoa Lien WTP are summarized as follows.

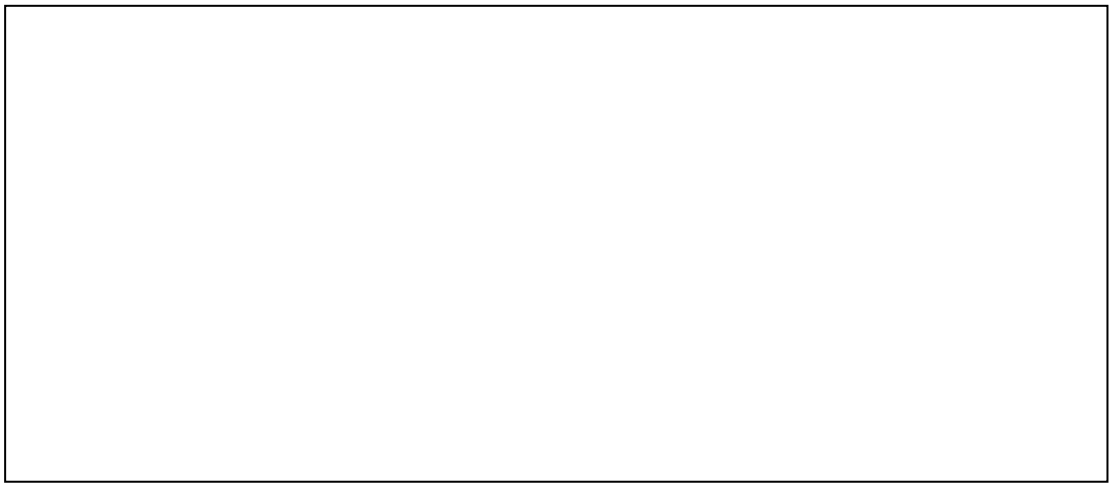


Figure 5.7 Layout of Hoa Lien WTP and Cau Do WTP

Table 5.6 Data Comparison of the Two WTPs

	Hoa Lien WTP	Cau Do WTP
Treatment Capacity	Phase 1 120,000m3/day (Phase 2 120,000m3/day Total 240,000m3/day)	System 1 50,000m3/day System 2 120,000m3/day Total 170,000m3/day
Area	8.79ha	14.03ha
Water Source	Cu De river	Cau Do river
Treatment Method	Rapid filtration	Rapid filtration
Wastewater Treatment	Sludge Thickerner + Sludge Drying Bed	Sludge Pond only
Measures against Power Failure	Stanby Generator	Nothing
Electrical fee	Hoa Lien ≒ Cau Do	
Chemical fee	Hoa Lien ≦ Cau Do	
Treatment fee	Hoa Lien ≦ Cau Do	

5.3 Raw Water Intake Facility

(1) Circumstances of Surface water Intake and Proposed Intake Volume

Since Som Bac Dam construction project has been suspended until now, the meetings regarding necessity of alternative intake facility were held often between DAWACO, PC, DPI and the PS Team. As for surface water intake from Cu De River, these were described detail including contents of ADB FS report in this report on section 4.3. This study was conducted a site selection and type of intake facilities comprehensively with newly information concerning with water use, water quality and hydrological aspect.

(2) Selection of Candidate Locations

Based on review and analysis on existing report and newly collected data such as rainfall records, candidate intake points were selected by the following criteria,

i. Be able to keep good quality;
ii. Be able to obtain targeted water quantity sustainably in dry season;
iii. Should be the point having least influence of environmental aspect in water body and ecology and also socio-economic;
iv. Have favorable shape of channel form; recommended shapes are; i. straight line, ii.narrow for reduction of weir, iii less segment generation
v. Have recommendable type of intake facility, i.easy construction, ii. easy O & M
vi. Be able to avoid confliction with surrounding habitants by full consideration of measure for flood and land scape

The candidate intake point where is satisfying the above five conditions, are show in Figure 5.8.

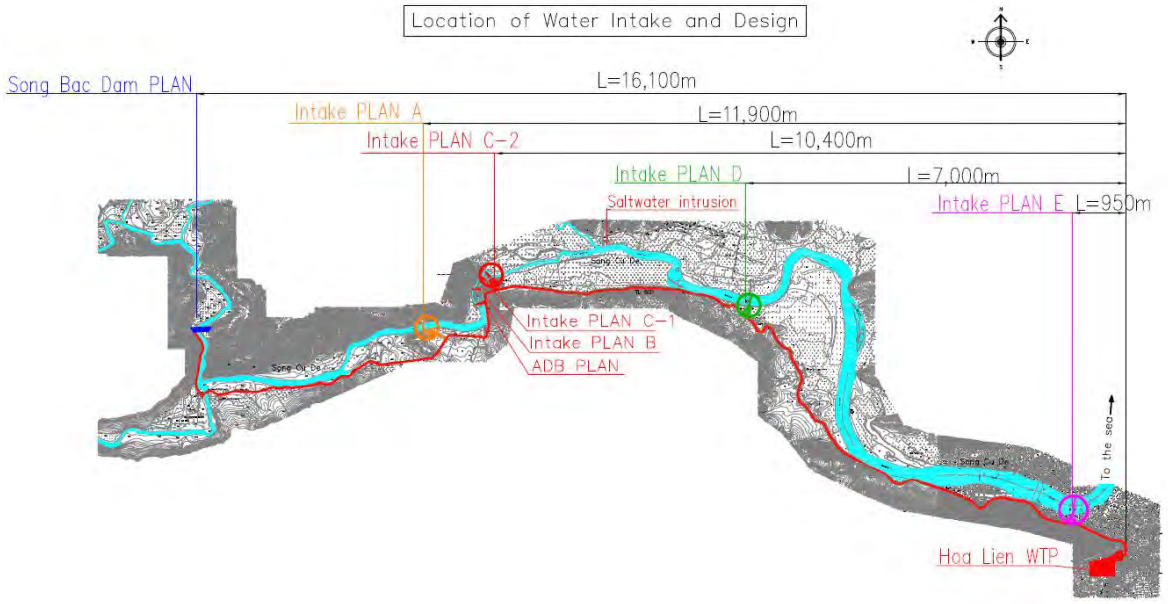


Figure 5.8 Candidate Intake Points

The characteristic of each sites are outlined as follows,

PLAN A

This location satisfies the requirements to be the intake point, having a straight channel form, little change of inclination, narrow channel width and so on.

However, this location will need a long water transmission pipe, and there are some places where it is difficult to install the pipe due to a narrow road and rock hills, which will require costly construction. Therefore, the Plan A cannot be selected as an intake point because of costly construction cost and traffic issues.

Photo 5.3 Location A (arrow point show the direction of the river stream)

PLAN B

ADB had selected this point as the intake point at their FS study. According to ADB report and meeting with DAWACO on this Plan, it seems to be selected by judgment of compatibility of construction condition. Their reason is followings; i: both mountains wall on right and left basin can be used for retaining the wing of Dam, ii: it can be constructing gradually at each stage. Through the site investigation in this Project, the PS Team observed the bending of river course was observed, as well as hydrological phenomenon in upper stream of Intake dam. It has an assumption that sediment amount will be increasing at upper stream of Intake Dam.

Photo 5.4 Location B

PLAN C-1

Since this site is at the end of curved river, the water route is stable and the shoal is formed on the right bank.

The elementary schools site is located on right bank, so it will be easily affected by rising water level and surface flow by installation of the weir.

Photo 5.5 Location C-1

PLAN C-2

C-2 is located at the downstream point nearby C-1 position. Since the river is blocked by sedimentation at the downstream of weir, it naturally has a function as a dam to store the water and from this point the water route made the shift to the right bank, and that River-channel morphology is stable. Although there is sedimentation at the river bed and transition to water route, amount of sedimentation is low

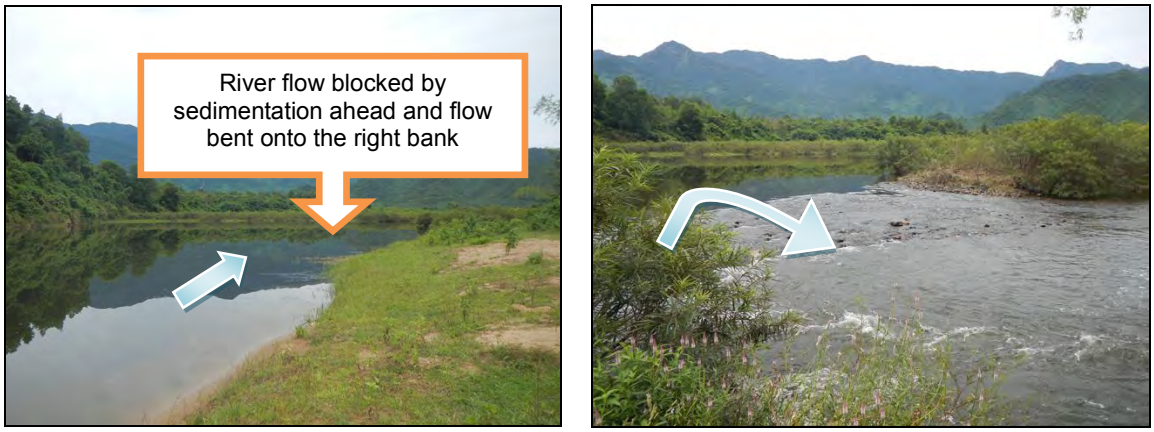


Photo 5.6 Location C-2

PLAN D

The site for Plan D is located at 50m downstream from Pho Nam Bridge. Since the river course is straight and stream line is stable, little river bed change is expected in flooding events.
Regarding weir installation, it is optimum location because of equivalent width of river at upper and downstream. Since the branch river is joining to Cu De River in this area, it will be able to reserving proposed intake quantity sustainable.

Photo 5.7 Location D

PLAN E

The site is located at near of Truong Dinh Bridge. Possible intake volume of this point can be increasing a lot because the location is 6km downstream from D point. And also can be shortening of raw water transmission pipe and deducting initial investment.
It is difficult to obtain a permission and approval of water right, and approval of EIA for installation of tide gate by related government organization shortly.

Photo 5.8 Location E

Table 5.7 Evaluation of Each Candidate Point as Intake Weir

Candidate location	Result of Evaluation
A	Eliminated from possible options for the following reasons: i). Length of transmission pipe between beginning and WTP is maximum ii). Costly pipe installation due to the existence of a narrow road with 4m of width and rock hill on route.
B	Eliminated from possible options for the following reasons: i). Difficult to analysis on hydrological action ii).Possibility of obstruction of intake water by sedimentation of Gravel and sand
C-1, C-2	Since it naturally has a function as a dam to store the water and from and that River-channel morphology is stable, this point is suitable for installation of weir. However the option are deselected by following reason; i). Possibility of inundation of housing at upper stream by back water ii).Possibility occurring resettlement at same area
D	D point is most optimum site for installation of intake weir because it can be deducting of length transmission pipe, preventing of inundation of houses at upper stream. However impacts on the environment of water body and ecology shall be evaluated.
E	Possible intake volume of this point can be increasing a lot because the location is 6km far at D point. And also can be shortening of raw water transmission pipe and deducting initial investment. However It is very difficult to obtain an approval of taking raw water from the intake point, by related government organization. Also it is difficult to obtain an approval of EIA from related government organization since environmental adverse impact is huge.

As shown in Table 5.7, the Location D is evaluated to be the best location to have the water intake facility.

Based on the study results described above and professional discussions with DAWACO, DPI, DARD, DONRE and other related agencies, location D was selected as the intake facility location. This selection was proposed to the DPC, who has approved the selection.

(3) Raw Water Intake Weir (at Location D)

1) Selection of the Intake Weir Type

The selected intake location D (near the Pho Nam Bridge) has the following river channel morphology and geological formation:

- The river channel is straight.

- The river width is narrow at both upstream and downstream, which enables to shorten the weir length.
- A tributary joins to the river at the between location of C and D, which is expected to increase the river water flow, and consequently to secure stable water quantity.

From the above conditions, the weir in this zone should be satisfied with the following conditions:

- The weir should be a "movable gate-controlled weir" with a crest height adjustment function, instead of a "fixed weir" which cannot change the weir height after installed.
- The weir gate should be open during the time of flood to prevent backwater to the upstream region.
- A wash-out gate should be installed to prevent river bed elevation rise caused by sedimentation at the upstream side of the weir.

2) Design Condition

Table 5.8 Proposed Water Level at Location D of Cu De River Water based on the Past Record and Mathematical Analysis (Data by DAWACO/ MCRHCM)

Requirement of installation for movable tidal gate at D Point

- install a withdrawal facility of preventing sediment of gravel and sand
- install grit chamber for prevention of incoming a grits and sand
- shall be clear of soil condition for Basement and Wing concrete at detailed design

3) Type of Movable Gate

Movable weir has some types as shown in Figure 5.9.

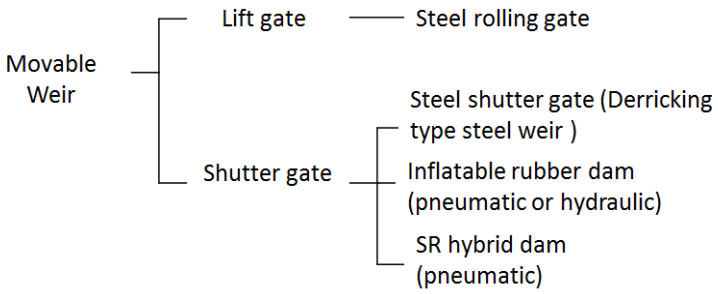


Figure 5.9 Type of Movable Gate

Among those, a steel rolling gate type is usually employed at large rivers to divert river flow and to prevent seawater intrusion. However, this type requires complicated operation which requires continuous control by the resident operators. Therefore, this type is not adopted for this project because of expensive construction and operation cost.

The characteristics of the other types of weirs are as described below.

i. Inflatable Rubber Dam

This type was recommended in the ADB report. But as the disadvantage of this type is costly of material, and is difficult of procurement in Viet Nam.

Photo 5.9 Past Example

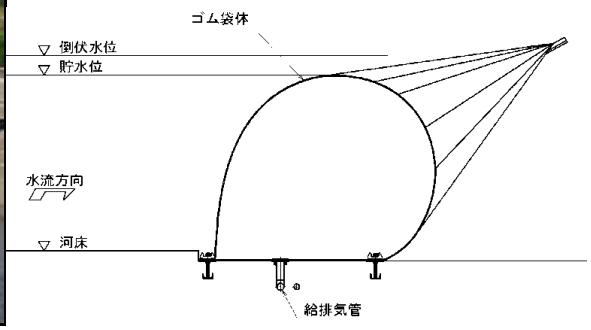


Figure 5.10 Schematic Diagram of Rubber Dam

ii. SR Hybrid Weir

SR Hybrid Weir on the base concrete can be adjusting crest level by air bag ejection and injection. The gate installed on riverbed is raised/ lowered by inflating/ deflating the rubber bladder placed at the gate bottom on the downstream side.

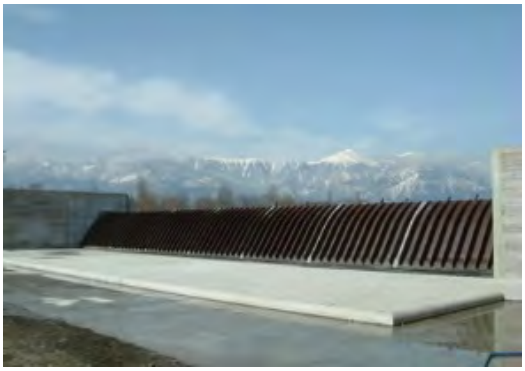


Photo 5.10 Past Example (Upstream side)

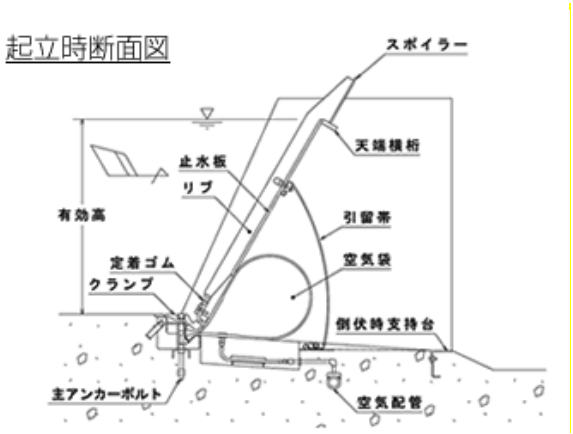
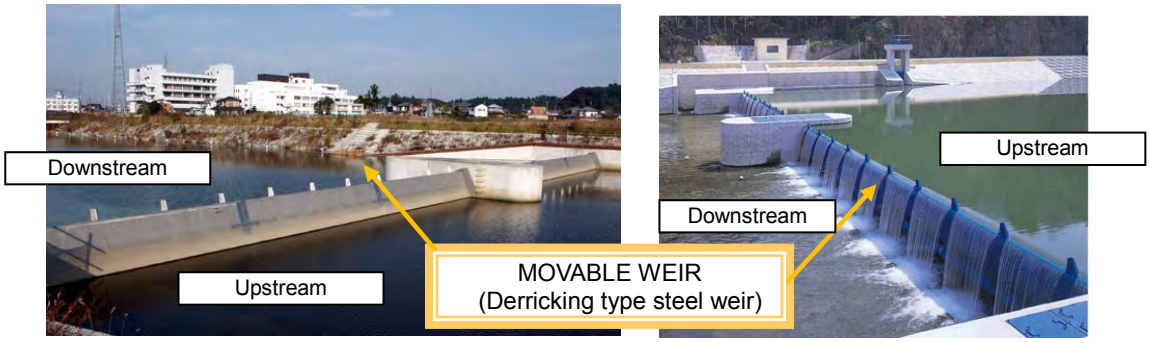


Figure 5.11 Schematic Diagram of the SR Weir

iii. Steel Shutter Gate (Derricking Type Steel Weir)

The weir is raised/ lowered by rotating the torque shaft attached to the gate bottom, with the hydraulic cylinder placed between the end pillar and middle pillar. The weir width is able to adjusting by number of unite required.



View from Upstream View from downstream

Photo 5.11 Past Example (from Upstream)

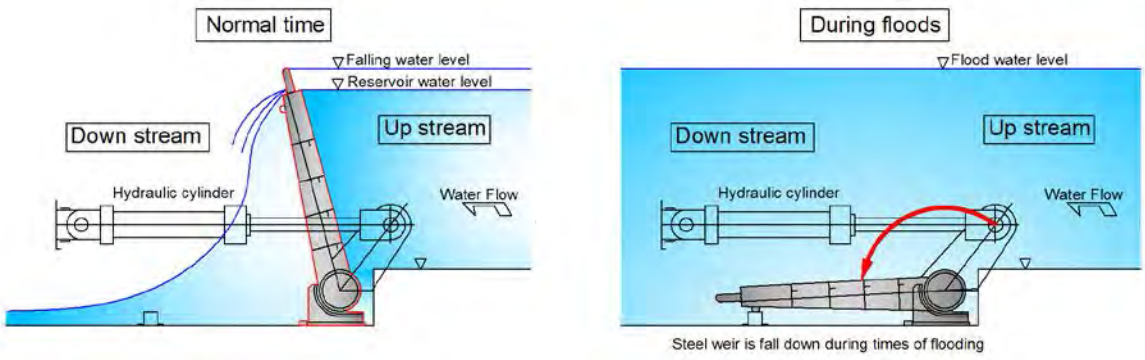


Figure 5.12 Schematic Diagram of Derricking Type Steel Weir

iv. Results on Comparison and Selection of the Weir type

Table 5.9 compares the above mentioned three types of movable weir

Table 5.9 Comparison of Movable Weir Type

(4) Design Criteria of Intake Facility

The specification of the movable weir is shown in Table 5.10. Figure 5.13 and Figure 5.14 show drawings of the intake facility.

Table 5.10 Design Criteria of Movable Weir at Pho Nam Bridge

Figure 5.13 Cross section of gate

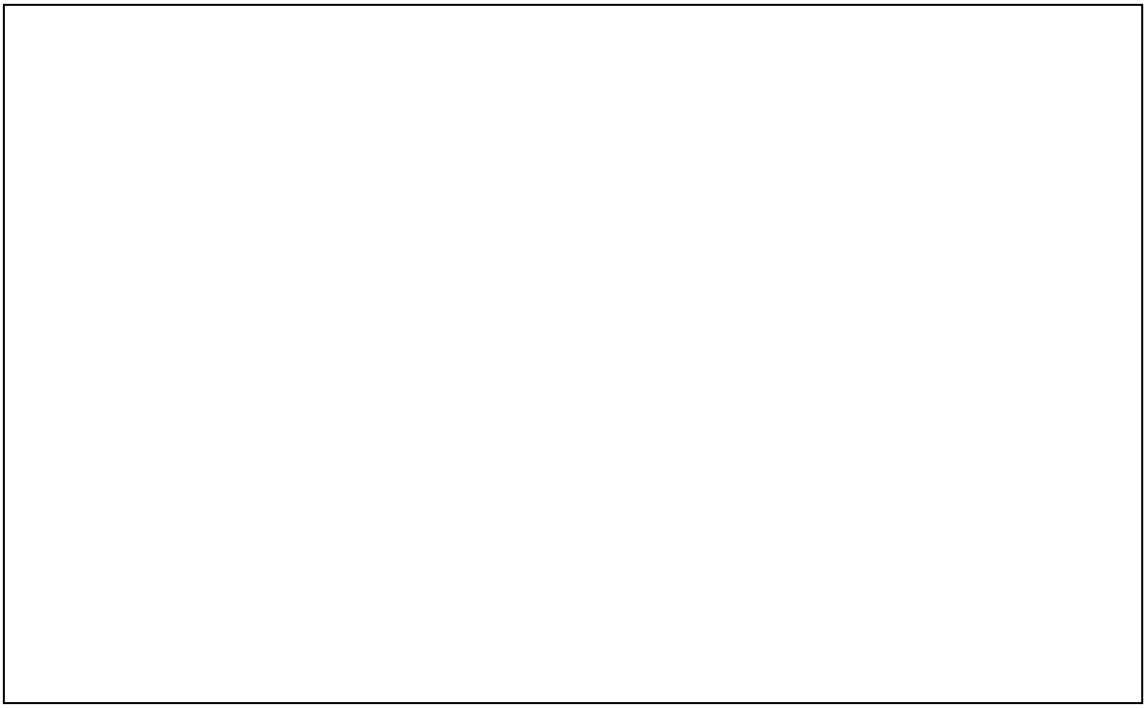


Figure 5.14 Layout Plan of Intake Facility

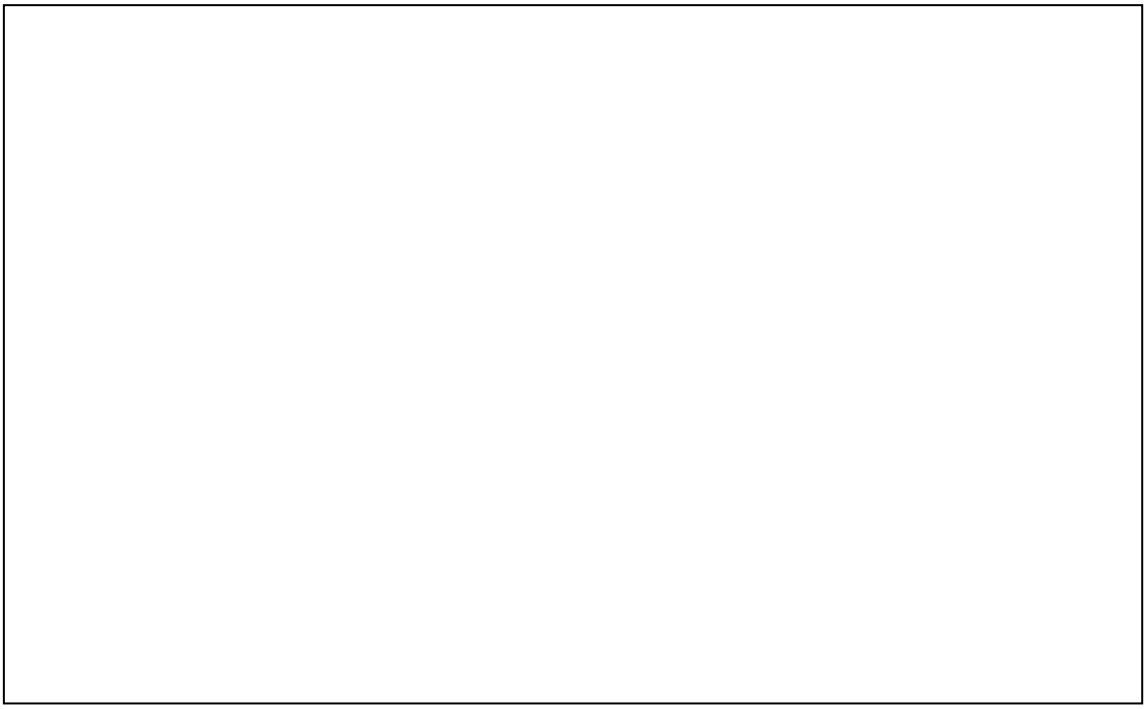


Figure 5.15 Elevation of Intake Facility

(5) Pumping station

Although gravity flow is desirable for raw water pipeline, it is not possible under the present site conditions, and pumping station should be installed due to the higher elevation at the WTP than at the intake facility location.

Basic design conditions of the intake pumping station are summarized as follow:

- Location : The right bank of Cu De River at 50m downstream from the Pho Nam bridge (The location shall be finalized through the meeting with Da Nang City at detailed design stage)
- Main facilities : electric house, generetor house, control room
- The proposed ground elevation : EL +7.00m, tentatively determined based on the Flood Record Monument situated on the opposite bank. This elevation could be determined at the next detailed design stage after the additional boring and topographic survey and final elevation shall be approved by Da Nang City.
- Sand basin is installed between the intake facility and intake pumping station to prevent the entry of sediment the pump well of the pumping station.

In addition to the basic design conditions of intake pumping station, it is important to examine the necessary total head of the intake pump installed at the pumping station.

The specification of the pumping station is provided in Table 5.11. Figure 5.16 and Figure 5.17 show the layout of the intake pumping station. Note that the more additional soil investigative survey around the intake pumping station shall be executed in the detailed design stage in order to finally decide the ground elevation and basement structure.

Table 5.11 Specification of Intake Pumping Station

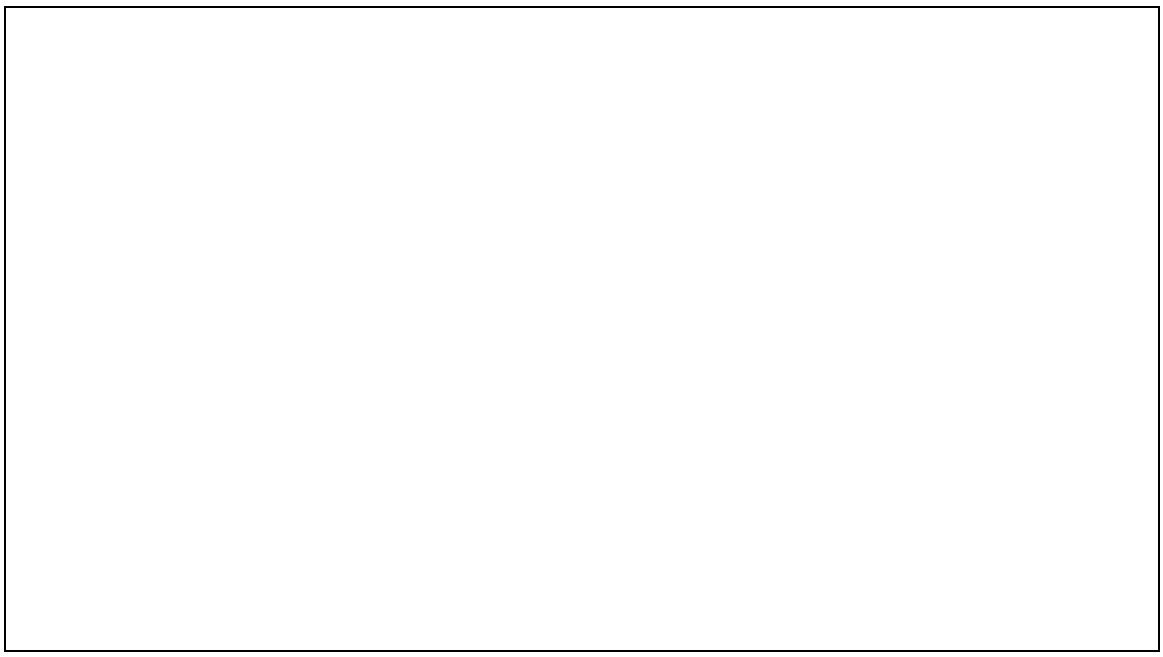


Figure 5.16 Layout of Intake Pumping Station

Figure 5.17 Cross Section of Intake Pumping Station

5.4 Raw Water Transmission Pipeline

(1) Basic Design Condition of Raw Water Transmission Pipeline

In this section, design of raw water transmission pipeline from Intake point to WTP is examined based on the following basic design conditions.

As for conveyance of raw water, gravity flow is desirable. However this conveyance of raw water requires a pumping station due to the relationship between the elevation of intake point and the WTP.

- Design required quantity to intake of raw water
  Phase1 : 132,000 m3/day
  Phase2 : 264,000 m3/day (Future)
- Method of conveyance : Pump station
- Length of Raw Water Pipeline : approximately 7km

(2) Route of Raw Water Pipeline

The ideal route for the raw water main is having as less undulating and short distance as possible. In addition, land acquisition will usually be difficult with tough negotiations with affected people. Therefore, through the meetings with DAWACO, it was decided to install the raw water main under Road 601. Road 601 is an only community road in this hamlet, which runs along the right (southern) bank of the Cu De River and passes through Hoa Bac hamlet which is the district administrative center. Topographic characteristics of Road 601, under which the raw water main is installed, are summarized in Table 5.12 and Figure 5.18.

Table 5.12 Characteristics of Provincial Road 601

Section	Distance (m)	Elevation (m)	Topographic characteristics
a-b	570	+6.3~+11.2	There is a bridge crossing the Cu De river named Pho Nam bridge and some homesteads, hospitals along both sides of this road. In this section, the road is rising while meandering.
b-c	630	+3.7~+11.2	Road becomes a downward slope, there is a village on both sides of the road.
c-d	830	+3.7~+27.3	There are a junior high school, prison, and hamlet. Road is becoming steeply uphill with the highest elevation of +27.3m during this raw water pipeline route.
d-e	690	+3.6~+27.3	There is no village along the road. The topography of the road is still undulating and becoming down slope.
e-f	620	+3.6~+7.6	There is no village along the road. The topography of the road is not undulating but in some sections the vertical right bank of the river is only a few meters from the road.
f-g	780	+2.8~+9.5	The topography of the road is still undulating, however is not so large. There is a small hamlet on the right side of the road.
g-h	1,030	+2.8~+7.9	There are some households on both sides of the road, and the lowest elevation of +2.8m in the section.
h-i	1,660	+3.0~+11.9	Going away gradually from Cu de river, there is still undulating but is not so large and route is almost straight.
i-j	190	+3.0~+6.0	The topography of road is flattens and the road underpasses the Hay Vang Route connecting to the WTP. Houses, shops are concentrated so properties become denser.
Total	7,000		

The other features commonly seen in the all areas of Road 601 are:

- Mostly asphalted and have width of about 4 to 6 m
- Crossing some side streams and small rivers.

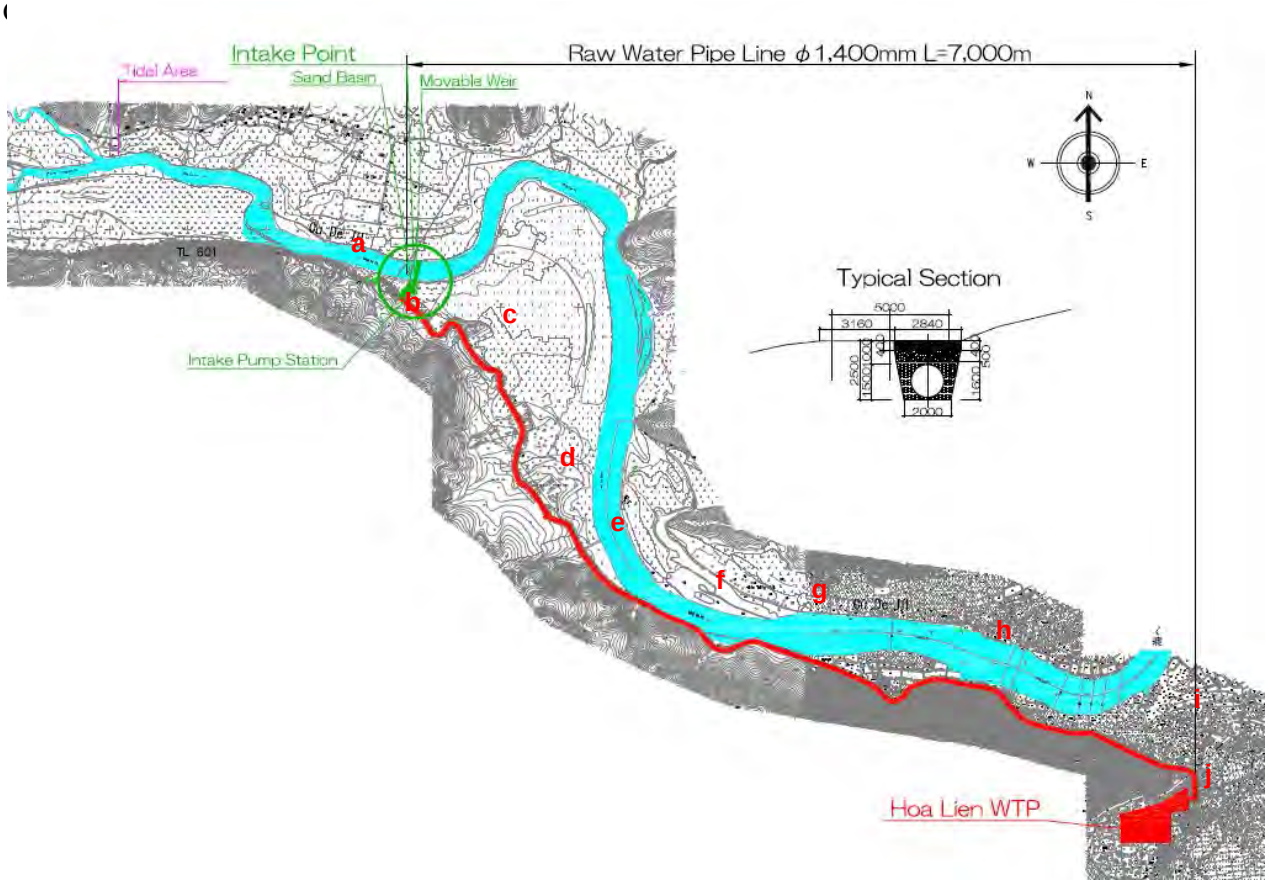


Figure 5.18 Route of Raw Water Transmission Pipe

Photo 5.12 Crossing a channel (left), Section C-D, slow ascent (right)

Photo 5.13 Bac River looking upstream. Song Bac 2 dam is planned to be built backside

Photo 5.14 Nam River, which is tributary of Cu De river, looking upstream from Confluence

Photo 5.15 Existing Girder bridge at Nam My , 4km downstream from Song Bac 2

Photo 5.16 Flood monuments at Nam My, 4.5km downstream from Song Bac

Photo 5.17 Typical view of road, Section a-b

Photo 5.18 Typical view of road, Section b-c Flow direction of Pipeline is the front side to the over there of photo

Photo 5.19 Typical view of road, Section c-d. Flow direction is the over there to the front side

Photo 5.20 Side stream in Section d-e. Pipe crosses under the stream right to left.

Photo 5.21 Typical view of road, d-e. Flow direction is the over there to the front side

Photo 5.22 View of Section e-f. Right bank of the river is only a few meters from the road

Photo 5.23 Truong Dinh bridge crossing Cu De river in Section h-i. Pipe lies left to right

Photo 5.24 Typical view of Section i-j Flow direction is the front side to the over there

(3) Diameter and Material of Pipe

In Viet Nam, large diameter of water supply pipes with D ≥ 1000 mm generally adopts the following materials: steel, ductile cast iron, HDPE and GRP (Glass-fiber Reinforced Plastic).

The pipe material shall be decided after careful evaluation of applicability of each pipe material based on characteristics such as strength, durability, price, workability, useful life, application record for site conditions.

Based on the comparison analysis among these materials as shown in Table 5.13, the PS Team has chosen the ductile iron pipes as the pipes for the raw water main.

Table 5.13 Evaluation of Materials for Raw Water Pipeline


Photo 5.25 (Left) Survey at the Glass-Fiber Reinforced Plastic factory, (Right) Performing of Laying Ductile Iron Pipe

The diameter of the raw water main shall be capable to transmit the planned raw water volume. In addition, the current water speed in the pipe line should be carefully studied, since the surface of the pipes could be badly worn by speedy water in the raw water main. In this regards, the PS team compared the raw water pipe with 1,100mm, 1,200mm and 1,400mm as shown in the table below, in order to determine the optimized diameter for the Project.

Table 5.14 Diameter Comparison of Raw Water Pipe

CHAPTER 6 ENVIRONMENTAL SOCIAL IMPACT ASSESSMENT

This project is classified as environmental category B according to the "GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (hereinafter, referred to as “JICA Guidelines”)" which was promulgated in April 2010.

However, the Initial Environmental Examination (hereinafter, referred to as “IEE”) was already completed in the "DA NANG WATER SUPPLY PROJECT (Final Report was prepared in June 2010),” which was submitted by ADB and approved by Da Nang City. This IEE concluded that the project would cause a limited impact on the environment, and classified this project as Category B.

In this PS, the existing IEE Report was reviewed in line with both the Vietnamese regulations and the JICA Guidelines, to make sure that all the required items are fulfilled.

In addition to the review, the detailed study on the procedures to obtain social and environmental permission in Viet Nam was conducted. The PS Team also took a careful attention for environment in developing a business plan and preliminary design so the project will be socially acceptable.

6.1 Summary

As stated above, the IEE of this project has already been conducted by ADB. Therefore, the PS Team first reviewed the ADB’s IEE Report to confirm whether there is any additional investigation required.

(1) Natural and environmental Conditions

The conditions of the natural environment surrounding the project area are described in the part of (1) Geography and Climate, 3.1 Socio-economic Condition, CHPTER3 BASIC INFORMATION OF DA NANG CITY.

(2) Social and environmental Conditions

The conditions of the social environment in the project area are described in the part of (2) Population and (3) Economic Status, 3.1 Socio-economic Condition, CHPTER3 BASIC INFORMATION OF DA NANG CITY.

(3) Scope

The following table summarized the study conducted by ADB in its IEE, and items to be investigated in this project.

Table 6.1 Assessments Done by the PS Team in Connection with ADB's IEE

Facilities name	Area of influence	IEE by the ADB	Works by the PS Team	Future Action
WTP	WTP site and environs	Conducted	Review of the ADB's IEE	EIA will be conducted before starting the project
Pipe line	Road Route 601 and neighboring houses	Conducted	Review of the ADB's IEE	
Water Intake & Pumping station	Area near Pho Nam Bridge & River near water intake facility	It is inoperative in the IEE of the ADB	Preliminary study	
＊Neither natural reserves nor cultural heritages are in the project area.				

6.2 The Law of Environmental Impact Assessment

In general, Vietnam's laws on environmental protection represent Law on Environmental Protection、No. 52/2005/QH11, executed in Dec. 2005. Based on the new law, EIA reports are presented in details in Circular No. 08/2006/TT-BTNMT, replaced with Circular No. 05/2008/TT-BTNMT and then with Circular No.26/2011/TT-BTNMT on 8th Dec. 2008.

In June 2014, the law was drastically amended and replaced with Circular No. 55/2014/QH13, executed in Jan. 2015. In line with this law, the item in which air environment and drainage are categorized has been changed from "Waste Management" to "Water, Soil and Air Environment Protection". In addition, regulations on climate changes are contained.

EIA reports sets to be evaluated under the new law, No. 55/2014/QH13, executed in 1st Jan. 2015.

The laws of EIA including new environmental protection and enforcement orders are summarized based on our surveys of new decrees introduced in Vietnam Environmental Society Friendliness Profile issued by JICA in Sep. 2011 and various reports.

(1) Laws

1) The Law on Environmental Protection, November 29th 2005, Decide No52/2005/QH11
（New environmental protection law: the 1st Revision;

This law is composed of 15 chapters and 134 provisions and covers environmental issues including EIA, SEA, water environment protection, waste management, environment monitoring, environment assessment, compensation for environmental damages and others. It is remarkable that new regulations on protection of the public water body like oceans and rivers are built in, and those regulations on waste management are beefed up.

The Law on Environmental Protection, Decision No. 55/2014/QH13
(Revised environmental protection law: the 2nd Revision);
In this law, a principle on measures against environmental pollution caused by various

factors is introduced. Measures against air environment, drainage, noise and vibration are included in the item of 'Waste Management' under the 1st revision but they are separated into 'Water, Soil and Air Environment Protection' and 'Waste Management' under the 2nd revision. Furthermore, new regulations on climate changes are included.

2) Law on Water Resources (January 1999):
Information is confidential.

(2) Decree

1) Decree No.80/2006/NĐ-CP August 9th 2006: Detailed regulations and guidelines for implementation of some articles of the Law on Environmental Protection;
This decree defines projects in which EIA and SEA reports should be prepared and authorities who should make appraisals and approvals for the reports.

2) Decree No.21/2008/NĐ-CP dated 28/02/2008 Decree on amendment and addition to a number of articles of the decree No. 80/2006/ND-CP on detailing and guiding the implementation of a number of articles of Law on Environmental Protection;
Decree No.80/2006/NĐ-CP was replaced with Decree No.21/2008/NĐ-CP, and the appendix along with the new decree shows a list of projects required to prepare EIA reports by classifying into162 categories. This project corresponds to the 70th category of "Development of surface water" with designed capacity of not less than 50,000m^3 per day.

3) Decree No. 29/2011/ND-CP dated 18 April 2011 on strategic environmental assessment;
This decree was prepared by amending Decree No.21/2008/NĐ-CP, and Appendix2 displays a list of projects required to prepare EIA reports. In line with Appendix2, this project needs EIA report.

4) Decree No.59/2007-ND on Solid Waste Management

5) Decree No.88/2007/NĐ-CP Decree on Urban and industrial-park water drainage

(3) Circular

1) Circular No. 16/2009/TT-BTNMT of October 07, 2009, defining national technical regulations on environment;
2) Circular No. 12/2011/TT-BTNMT of April 14, 2011, stipulating hazardous waste management;

3) Circular No. 26/2011/TT-BTNMT of July 18, 2011, detailing a number of articles of the Government's Decree No. 29/2011/ND-CP of April 18, 2011, on strategic environmental assessment, environmental impact assessment and environmental protection commit;

Based on the regulations in the new low on environmental protection, items composing EIA reports are displayed in details in Circular No. 08/2006/TT-BTNMT. This circulation was replaced with Circular No. 05/2008/TT-BTNMT in 8th Dec. 2008 and then done with Circular No. 26/2011/TT-BTNMT.

This new circulation defines 1) Verification and appraisal of strategic environmental assessment, 2) Assessment report on environmental impact, 3) Certification, registration appraisal of documents on environmental protection, and 4) Appraisal and approval of EIA reports and supplementary documents. In line with the circulation, EIA report for this project shall be evaluated and approved.

(4) Decisions

1) Decision 04/2008/QD-BTNMT Ministry of Natural Resources and Environment dated 18/07/2008 issuing national technical regulations on environmental;
2) Decision No.23/2010/QĐ-UB People's Committee of Da Nang city dated August 10th 2010 issuing the Regulations of Environmental Protection in Da Nang city:

(5) Applied regulations, standards in EIA report

Air Environment:

- QCVN 05: 2009/BTNMT - National technical regulation on ambient air quality
- QCVN 06: 2009/BTNMT - National technical regulation on hazardous substances in ambient air

Noise:

- 26:2010/BTNMT - National technical regulation on noise

Water quality:

- QCVN 08:2008/BTNMT - National technical regulation on surface water
- QCVN 09:2008/BTNMT - National technical regulation on underground water
- QCVN 14:2008/BTNMT - National technical regulation on domestic wastewater

Hazardous waste:

- QCVN 19:2009/BTNMT -National technical regulation on inorganic substance and smoke dust emission
- QCVN 20:2009/BTNMT -National technical regulation on organic substance
- QCVN 40:2011/BTNMT -National technical regulation on industrial wastewater

(6) Others:

- Decree No. 25/2013/ND-CP - Government degree on environmental protection tax levying on drainage
- Joint Circular No.107/2010/TTLT-BTC -BTNMT - Government internal circular on guideline to implement Decree No.67/2003/ND-CP（Revision of Joint Circular No.125/2003/TTLT-BTC-BTNMT）
- Decree No. 38/2011/ND-CP - Government degree on issuance of a permit for exploring, taking and using water resources and discharging into water resources. (Revision of Decree No. 149/2004/ND-CP)
- Decision No. 59/2006/QD-BTC – Decision on providing the regime of collection, remittance, management and use, and levels, of the evaluation charge and the fee for granting permits for exploring, taking and using water resources and discharging into water resources.

(7) Environmental standards

1) Air environmental standards

	Average per hour	Average per 8 hours	Average per 24 hours	Yearly average
SO2	350	—	125	50
CO	30, 000	10, 000	5, 000	—
NOX	200	—	100	40
O3	180	120	80	—
Total suspended dust (TSP)	300	—	200	140
PM10	—	—	150	50
Pb	—	—	1. 5	0. 5

Source：QCVN 05: 2013/BTNMT

2) National technical regulation on hazardous substances in ambient air

No.	Source Pollutants	Chemical formula	Guideline value (QCVN06:2009/BTNMT) ($\mu g/m^3$)			
			1 hour	8 hours	24 hours	1 year
1	arsenic	As	0.03	-	-	0.005
2	arsine	AsH_3	0.3	-	-	0.05
3	hydrochloric acid	HCl	-	-	60	-
4	nitrate	HNO_3	400	-	150	-
5	sulfuric acid	H_2SO_4	-	-	50	3
6	silica	50% to 90% of SiO_2	300	-	50	3
7	particles of asbestos	MgO.Si $O_2.H_2O$	-	1fiber/ m^3	-	-
8	cadmium	Cd	0.4	0.2	-	0.005
9	chlorine	Cl_2	100	-	30	-
10	chromium	Cr	0.007	-	0.003	0.002
11	hydrofluoric acid	HF	20	-	5	1
12	hydrogen cyanide	HCN	10	-	-	
13	manganese	Mn/MnO_2	10	-	8	0.15
14	nickel	Ni	-	-	1	-
15	mercury	Hg	-	-	-	0.3
16	acrolein		50	-	-	-
17	acrylonitrile	CH_2=CHCN	-	-	45	22.5
18	aniline	$C_6H_5NH_2$	50	-	30	-
19	ß-propiolactone	$C_3H_4O_2$	-	-	-	54
20	benzene	C_6H_6	22	-	10	-
21	benzidine	$NH_2C_6H_4$ $C_6H_4NH_2$	0	0	0	0
22	chloroform	$CHCl_3$	-	-	16	0.04
23	hydrocarbon		5,000	-	1500	-
24	formaldehyde	HCHO	20	-	-	-
25	naphthalene		-	500	120	-
26	phenol	C_6H_5OH	10	-	-	-
27	tetrachloroethylene	C_2Cl_4	-	-	100	-
28	vinyl chloride	$ClCH=CH_2$	-	-	26	-
29	ammonia	NH_3	200	-	-	-
30	acetaldehyde		45	-	-	30
31	propionic acid	C_2H_5COOH	-	300	-	-
32	hydrogen sulfide	H_2S	42	-	-	-
33	methyl mecarptan		50	-	20	-
34	styrene	$C_6H_5CH=CH_2$	-	-	260	190
35	toluene	$C_6H_5CH_3$	500	-	-	190
36	xylene		1,000	-	-	-

Note: 30 minutes, 1,000µg/m3 for toluene
Source: QCVN06 2009/BTNMT

3) Maximum allowable limit of noise

No	Area	From 6 pm to 21 hours dBA	From 21 am to 6 pm dBA
1	Special areas	55	45
2	Common area	70	55

Source: QCVN 26:2010/BTNMT

④ Water quality standards of surface water

No	Item	unit	Density			
			A1	A2	B1	B2
1	pH	-	6-8.5	6-8.5	5.5-9	5.5-9
2	Oxygen	mg/l	≧6	≧5	≧4	≧2
3	suspended solids	mg/l	20	30	50	100
4	COD Cr	mg/l	10	15	30	50
5	BOD5 (20℃)	mg/l	4	6	15	25
6	ammonium(NH+4)	mg/l	0.1	0.2	0.5	1
7	chlorine(Cl^-)	mg/l	250	400	600	-
8	fluorine(F^-)	mg/l	1	1.5	1.5	2
9	nitrate ($NO2^-$)	mg/l	0.01	0.02	0.04	0.05
10	nitrate nitrogen($NO3^-$)	mg/l	2	5	10	15
11	phosphate(PO_4^{3-})	mg/l	0.1	0.2	0.3	0.5
12	cyanide(CN^-)	mg/l	0.005	0.01	0.02	0.02
13	Arsenic	mg/l	0.01	0.02	0.05	0.1
14	Cadmium	mg/l	0.005	0.005	0.01	0.01
15	lead (Pb)	mg/l	0.02	0.02	0.05	0.05
16	trivalent chromium Cr3+	mg/l	0.05	0.1	0.5	1
17	hexavalent chromium Cr6+	mg/l	0.01	0.02	0.04	0.05
18	copper (Cu)		0.1	0.2	0.5	1
19	zinc (Zn)		0.5	1	1.5	2
20	Nickel(Ni)		0.1	0.1	0.1	0.1
21	iron (Fe)		0.5	1.0	1.5	2
22	mercury (Hg)	mg/l	0.001	0.001	0.001	0.002
23	Surfactant	mg/l	0.1	0.2	0.4	0.5

24	oil membrane	mg/l	0.01	0.02	0.1	0.3
25	phenol (C_6H_6O)	mg/l	0.005	0.005	0.01	0.02
26	Agricultural chemical					
	aldrin and dieldrin	μg/l	0.002	0.004	0.008	0.01
	endrin	μg/l	0.01	0.012	0.014	0.02
	BHC	μg/l	0.05	0.1	0.13	0.015
	DDT	μg/l	0.001	0.002	0.004	0.005
	endosulfan	μg/l	0.005	0.01	0.01	0.02
	lindane	μg/l	0.3	0.35	0.38	0.4
	chlordane	μg/l	0.01	0.02	0.02	0.03
	heptachlor	μg/l	0.01	0.02	0.02	0.05
27	Organic phosphors					
	parathion	μg/l	0.1	0.2	0.4	0.5
	marathion	μg/l	0.1	0.32	0.32	0.4
28	Herbicide					
	2,4D	μg/l	100	200	450	500
	2,4,5T	μg/l	80	100	160	200
	Paraquat	μg/l	900	1200	1800	2000
29	Alpha radiation	Bq/l	0.1	0.1	0.1	0.1
30	beta radiation	Bq/l	1.0	1.0	1.0	1.0
31	escherichia coli	MPN/100ml	20	50	100	200
32	number of colitis germ legions	MPN/100ml	2500	5000	7500	10000

Source: QCVN08 2008/BTNMT

Note: Standards of surface water are classified as 4 categories.

A1: Domestic water and purposes other than A2, B1, and B2.

A2: (1) Domestic water processed by appropriate technology, (2) conservation for water creature, and (3) purposes other

than B1 and B2

B1: (1) Irrigation water and water that requires equivalent quality of irrigation water, and (2) purposes other than B2

B2: Water that requires relatively low quality

5) Groundwater quality standards

No	Item	Unit	Standards
			Beach
1	pH	-	5.5-8.5
2	hardness (as CaCO3)		500
3	dissolved solid	mg/l	1500
4	COD Cr	mg/l	4
5	ammonium(NH+4)	mg/l	0.1
6	Chlorine		250
7	fluorine(F-)		1.0
8	nitrogen dioxide		1.0
9	Nitrate	mg/l	15
10	Sulfide	mg/l	400
11	cyanide(CN-)	mg/l	0.01
12	Phenol	mg/l	0.001
13	Arsenic	mg/l	0.05
14	Cadmium	mg/l	0.005
15	Lead	mg/l	0.01
16	hexavalent chromium Cr6+	mg/l	0.05
17	Copper (Cu)	mg/l	1.0
18	zinc (Zn)	mg/l	3.0
19	Manganese	mg/l	0.5
20	mercury (Hg)	mg/l	0.001
21	iron (Fe)	mg/l	5
22	Selenium	mg/l	0.01
23	alpha radiation	Bq/l	0.1
24	beta radiation	Bq/l	1.0
25	escherichia coli	MPN/100ml	0
26	number of colitis germ legions	MPN/100ml	3

Source: QCVN09 2008/BTNMT

6) Standard for industrial exhaust gas (sooty smoke and inorganic substance)(mg/ m3)

No.	Pollutants	permissive density (mg/ m^3)	
		standard A	standard B
1	Sooty smoke	400	200
2	Sooty smoke includes silica	50	50
3	Ammonia	76	50
4	Antimony	20	10
5	Arsenic	20	10
6	Cadmium	20	5
7	Lead	10	5
8	carbon monoxide	1,000	1,000
9	Chloride	32	10
10	Copper	20	10
11	Zinc	30	30
12	hydrochloric acid	200	50
13	Fluoride	50	20
14	hydrogen sulfide	7.5	7.5
15	sulfur dioxide	1,500	500
16	nitrogen compound	1,000	850
17	nitrogen compound at processing facilities	2,000	1,000
18	sulfuric acid or trisulphuration gas	100	50
19	nitrate gas includes nitrogen dioxide	1,000	500

Standard A will be applied for factories or facilities in operation.

Standard B will be applied for new factories or facilities

Source: QCVN 19:2009/BTNMT

7) Standard for exhaust organic substance (mg/m3)

No	Item	chemical formula	permissive density NEW standard (QCVN 20: 2009)	permissive density Old standard (TCVN 5940: 2005)
1	Acetone	CH3COCH3	-	2400
2	sym-tetrabromoethane	CHBr2CHBr2	14	14
3	acetaldehyde	CH3CHO	270	270
4	acrolein	CH2=CHCHO	2.5	1.2
5	amyl acetate	CH3COOC5Al	525	525
6	Aniline	C6H2NH2	19	19
7	Anhydride	(CH3CO)20	-	360
8	benzidine	NH2C6H4C6H4NH2	-	0

9	Benzene	C6H6	5	80
10	chlorobenzene	C6H5CH2Cl	5	5
11	butadiene	C4H6	2200	2200
12	Butane	C4H10	--	2350
13	butyl acetate	CH3COOC4H9	950	950
14	n-butanol	C4H9OH	—	300
15	n-butylamine	CH3(CH2)CH2NH2	15	15
16	cresol.(o-, m-, p-)	CH3C6H4OH	22	22
17	chlorobenzene	C6H5Cl	350	350
18	chloroform	CHCl3	240	240
19	ß-chloropyrene	CH2=CClCH=CH2	90	90
20	chloropicrin	CCl3NO2	0.7	0.7
21	cyclohexane	C6H12	1300	1300
22	cyclohexanol	C6H11OH	410	410
23	cyclohexznone	C6H10O	400	400
24	cyclohexene	C6H10	1350	3150
25	diethylamine	(C2H5)2NH	75	75
26	dibromodifluoromethane	CF2Br2	860	860
27	ortho dichlorobenzene	C6H12Cl2	300	300
28	1,1-dichloroethane	CHCl2CH3	400	400
29	1,2-dichloroethylene	ClCH=CHCl	790	790
30	1,2-dichloroethane	CCl2F2	-	4950
31	Dioxane	C4H8O2	360	360
32	dimethyl aniline	C6H5N(CH3)2	25	25
33	dichloroethyl ether	(ClCH2C2)20	90	90
34	diethylformamide	(CH3)2NOCH	60	60
35	dimethyl sulfide	(CH2)2SO4	0.5	0.5
36	dimethyl sulfide	(NH3)2NNH2	1	1
37	dinitrobenzene (o-, m-, p-)	C6H4(NO2)2	1	1
38	ethyl acetate	CH3COOC2H5	1400	1400
39	ethylamines	CH3CH2NH2	45	45
40	ethyl benzene	CH3CH2C6H5	870	870
41	ethyl bromide	C2H5Br	890	890
42	ethyl diamine	NH2CH2CH2NH2	30	30
43	ethyl dibromide	CHBr=CHBr	190	190
44	Ethanol	C2H5OH	-	1900
45	ethyl acrylate	H2=CHCOOC2H5	100	100
46	chlorohydrin	CH2ClCH2OH	16	16
47	ethylene oxide	CH2OCH2	20	20
48	ethyl ether	C2H5OC2H5	1200	1200
49	ethyl chloride	CH3CH2Cl	2600	2600
50	ethyl silicate	(C2H5)4SiO4	850	850
51	ethanolamines	NH2CH2CH2OH	45	45
52	furfural	C3H3OCHO	20	20
53	formaldehyde;	HCHO	20	6
54	furfuryl	C4H3OCH2OH	120	120
55	fluorotrichloromethane	CCl3F	5600	5600
56	n-heptane	C7H16	2000	2000
57	n-hexane	C6H14	450	450
58	isopropylamine	(CH3)2CHNH2	12	12
59	isobutanol	(CH3)2CHCH2OH	360	360
60	Methyl acetate	CH3COOCH3	610	610
61	methylacrylate	CH2=CHCOOCH3	35	35
62	methanol;	CH3OH	260	260
63	methylacetylene	CH3C=CH	1650	1650

64	Methyl bromide	CH3Br	80	80
65	methylcyclohexane	CH3C6H11	2000	2000
66	methylcyclohexanol	CH3C6H10OH	470	470
67	methylcyclohexanone	CH3C6H9O	460	460
68	Methyl chloride	CH3Cl	210	210
69	methylene chloride	CH2Cl2	1750	1750
70	Methyl chloroform	CH3CCl3	2700	2700
71	monomethylamine	C6H5NHCH3	9	9
72	methanol amine	HOCH2NH2	31	31
73	naphthalin	C10H8	150	150
74	nitrobenzene	C6H5NO2	5	5
75	vitroethane	CH3CH2NO2	310	310
76	nitroglycerin	C3H5(NO2)3	5	5
77	nitromethane	CH3NO2	250	250
78	2-nitropropane	CH3CH(NO2)CH3	1800	1800
79	nitrotoluenes	CO2C6H4CH3	30	30
80	octane	C8H18	-	2850
81	pentane	C5H12	-	2950
82	pentanone	CH3CO(CH2)2CH3	700	700
83	phenol	C6H5OH	19	19
84	phenylhydrazine	C6H5NHNH2	22	22
85	tetrachloroethylene	CCl2=CCl2	-	670
86	propanol	CH3CH2CH2OH	980	980
87	propyl acetate	CH2COOC2H7	840	840
88	propylene dichloride	CH3CHClCH2Cl	350	350
89	propylene oxide	C3H6O	240	240
90	propylene ester	C3H5OC3H5	-	2100
91	pyridine	C5H5N	30	30
92	pyrene	C16H10	15	15
93	quinone	C6H4O2	0.4	0.4
94	Styrene.	C6H5CH=CH2	100	420
95	tetrahydro	C4H8O	590	590
96	1,1,2,2-tetrachloroethane	C12HCCHC12	35	35
97	tetrachloromethane	CCl4	65	65
98	Toluene	C6H5CH3	750	750
99	tetranitromethane	C(NO2)4	8	8
100	toluidine	CH3C6H4NH2	22	22
101	Toluene 2,4-diisocyanate	CH3C6H3(NCO)2	0.7	0.7
102	triethylamine	(C2H5)3N	100	100
103	1,1,2 - trichloroethane	CHCl2CH2Cl	1080	1080
104	trichloroethylene	ClCH=CCl2	110	110
105	trifluoride methane	CBrF3	-	6100
106	xylene (o-, m-, p-)	C6H4(CH3)2	870	870
107	xylidine	(CH3)2C6H3NH2	50	50
108	vinyl chloride	CH2=CHCl	20	150
109	vinyltoluene	CH2=CHC6H4CH3	480	480
	mercaptan		-	15

Sources:QCVN20:2009,TCVN 5940: 2005

6.3 EIA Procedure in Viet Nam

The EIA procedure in Vietnam is stipulated in the Decree No. 29/2011/ND-CP and Circular No. 26/2011 TT-BTNMT as shown in the following figure.

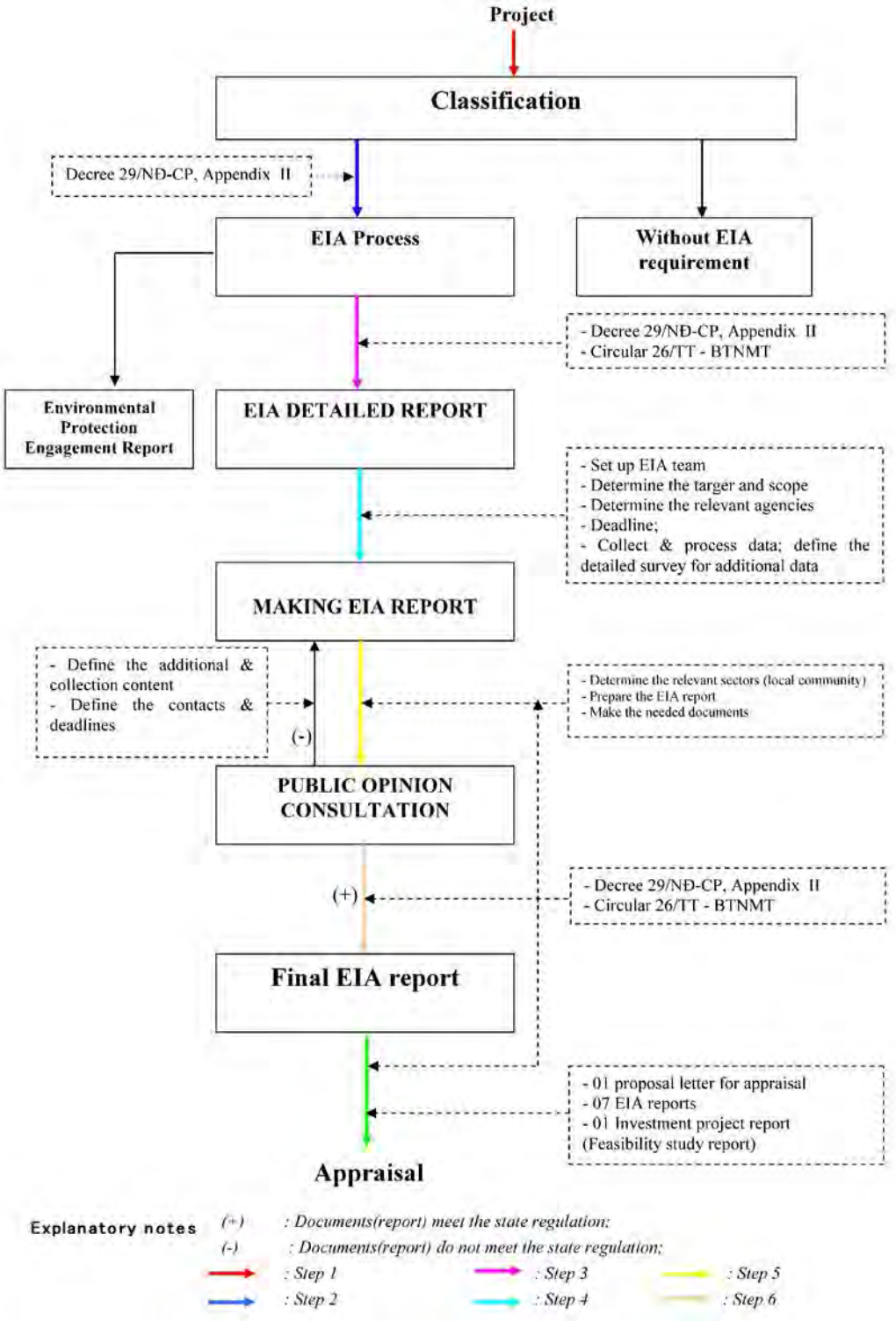


Figure 6.1 EIA Procedure in Viet Nam

Step 1. Categorization of project

In line with the Decree No29, appendix II, projects shall be classified into:

- Project that has small impacts to environment and do not need to implement the EIA report, or
- Project that needs to implement the EIA report.

Step 2. Preliminary EIA report

The preliminary EIA report is used as a step of determining the EIA scope. Its content includes:

- Examination of major impacts of project on the surrounding environment
- Study on major impacts and determination of EIA scope
- Determination of the necessity for detailed EIA report

Step 3. Implementation of a detailed EIA

Detailed EIA shall cover the following content as defined in Circular No.26/2011/ TT- BTNMT.

Introduction

- Project source
- Description of legal and technical documents serving as the basis for EIA implementation and report
- List of applicable EIA methods during EIA implementation and report
- EIA Implementation Organization

Chapter 1: BRIEF DESCRIPTION OF THE PROJECT

- Project Name
- Project Owner
- Geographical Location of the Project
- Main Components of the Project

Chapter 2: NATURAL, ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS

- Natural and Environmental Conditions: Geographical and geological condition; Meteorological and hydrographical/ marine hydro-meteorological condition; Existing Conditions of Natural Environment Elements; Biological resources condition.
- Socio-economic Conditions

Chapter 3: ENVIRONMENT IMPACT ASSESSMENT

- Impact Assessment: assess the project impacts on natural and socio-economic environment

in each stage (preparation, construction and operation); the assessment shall be made in detail for each specific impact source in terms of temporal and spatial aspects (detail quantitative and qualitative assessment for the project) and comparing with the existing standards and regulations.

- Comments on Detail and Reliability of Assessments

Chapter 4: PROPOSED MEASURES TO PREVENT, MITIGATE AND SOLVE NEGATIVE ENVIRONMENTAL IMPACTS AND INCIDENTS

- For Adverse Impacts: Measures to minimize, prevent and respond to environment incidents shall be prepared for each stage (preparation, construction and operation) of the project
- For Environment Incident: Measures to minimize, prevent and respond to environment incidents shall be prepared for each stage (preparation, construction and operation) of the project

Chapter 5: ENVIRONMENT MANAGEMENT AND MONITORING PROGRAMS

- Environment Management Program (EMP)
- Environment Monitoring program

CONCLUSION, RECOMMENDATION AND COMMITMENT

The following activities should be implemented for making an EIA Report:

Set up EIA group
Scope of data collection (area, subjects to be assessed)
Determine the relevant agencies
Deadline for finishing the EIA;
Collect & process data; define the detailed survey for additional data

After implemented these tasks, EIA Reporting Group amend the additional data and finalize the EIA report.

Step 4. Preparation of EIA Report

The main content of EIA report shall include:

Summary of project set up and conditions, in which indicating what type the projects are, new, additional, expanded or other projects; Description of legal and technical documents serving as the basis for EIA implementation and report; public opinion consultation of Commune-level People's Committee.

Listing and detailed description of works and items of projects with information on spatial and temporal scales and construction workloads; and technologies that would be applied to

operate each of works, items and projects as a whole;

General assessment of the current state of the environment at project sites and in the vicinity of sites; of the sensitivity and carrying capacity of local environments;

Comprehensive assessment of potential environmental impacts that are likely to be caused during the implementation of projects, and of environmental components and socio-economic factors that are likely to be directly affected by projects; and prediction of risks of environmental incidents that may be imposed by projects; Comments from the People's Committees at communal, quarter and/or township level (hereinafter called "Communal Level") and representatives from residential communities where the implementation of projects takes place

Specific measures for adversely environmental impact minimization; and environmental incident prevention and response

Lists of works and programs on the management and monitoring of environmental issues during the implementation of projects ;

Estimation of costs incurred in the construction of environmental protection works and/or facilities within the total estimated budget of projects;

Commitment of project proponent to implementation of the environment protection measures during the construction and the operation as described in EIA report and other related regulations in environmental protection activities .

Step 5. Public Opinion Consultation

During the EIA implementation, the project owner shall get the opinions from community

People's Committees at communal, quarter and/or township level (here in after called "Communal Level") in project location.

Representatives from residential communities where the implementation of projects takes place.

It is required that the project proponent includes the official written feedback from People's Committee (PC) and Fatherland Front at commune level in the EIA report. A chapter in the EIA report should describe the public consultation during the EIA process, including: the extent, timing, approach to, methods and techniques applied for PC

The public consultation from People's Committees at communal, quarter and/or township level (here in after called "Communal Level") in project location would be implemented as follow:

The project owner shall send to the People's Committee and the Fatherland Front Committee of the commune where the project will be implemented a document notifying project's principal investment items, environmental issues and environmental protection measures the;

The commune-level People's Committee and Fatherland Front Committee shall request in

writing the project owner, to collaborate in holding dialogue meetings, when necessary (within 10 days from receiving the document);

The dialogue between the project owner, commune-level People Committee, Fatherland Front Committee and stakeholders, shall be recorded in a minutes, which lists all attendants, and reflects all debated matters and contents accepted or unaccepted by the project owners. The minutes must bear the signatures (together with the full names and titles) of representatives of the project owner and attendants;

Within fifteen (15) working days after receiving a written request for opinions, commune level People's Committee and Fatherland Front Committee shall give their opinions in writing and make them public to local people. Past this time limit, if they issue no written replies, the commune-level People's Committees and community representatives shall considered having agreed with the project owner;

The pros and cons of the project proposed by the commune-level People Committee and Fatherland Front Committee and attendants to the dialogue meeting shall be summed up and truthfully expressed in the environmental impact assessment report.

The dialogue meeting's minutes and other documents on community consultations (if any) shall be duplicated and attached to the project's environmental impact assessment report.

Step 6. Final EIA Report

After public consultation for comments of people's committees, fathers' front committees and local residents; Modify, supplement and finalize EIA reports.

The content of final EIA has to follow the Decree No.29/2011/NĐ-CP & circular No.26/2011/ TT-BTNMT.

6.4 Vietnamese EIA Appraisal

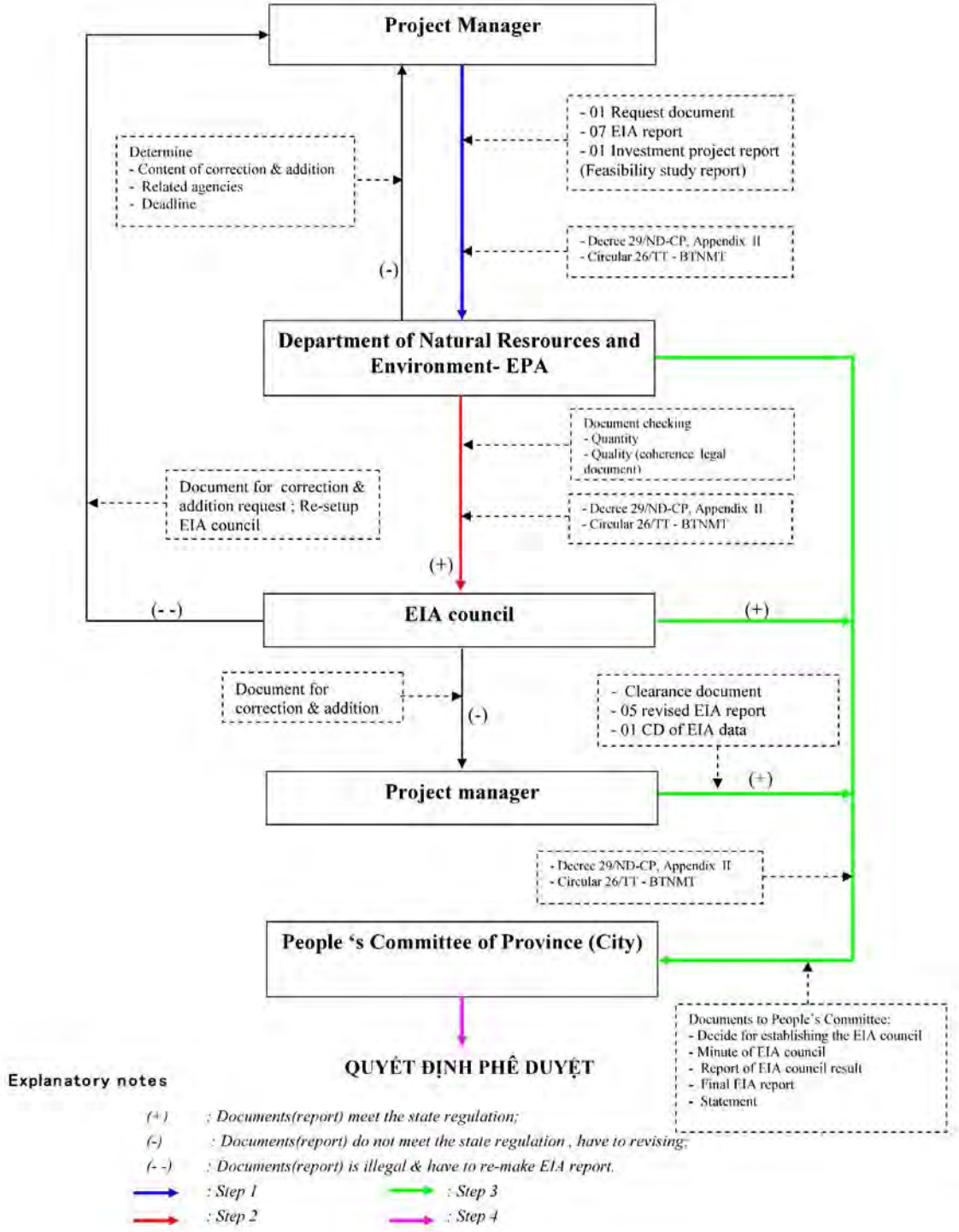


Figure 6.2 Vietnamese EIA Appraisal

Step 1. Project proponent summit document for authorities

After making the EIA report, project proponent submit these document (as follow) to authorities (Department of Natural Resources and Environment- Environmental Protection Agency):

- ✓ Request document
- ✓ EIA reports
- ✓ Investment project report (Feasibility study report)

Step 2. Set up EIA council

After receiving the documents from project proponents; the authorities (Department of Natural Resources and Environment- Environmental Protection Branch) checks the document due to legal material and announce by official document to project manager for correction & addition within 05 days.

After receiving the legal documents, due to Item 1, Clause 20- Decree 29 within 30-45days, the authorities have the responsibility of setting up the appraisal (establish the EIA council),announcing the project proponent with appraised fee and responding by official document to project proponents.

Step 3. Submit the document for approving the EIA report

Based on the announcement of EIA appraisal from authorities, project proponent has responsibility in:

- Re-making the EIA report in case of unapproved appraisal. Deadline and re-appraisal process are the same as the first time;
- Amending, addition the content of EIA and re-submit to the authorities in case of approved with amending & addition requirement. The time for addition is not included in EIA appraisal time;
- Re-submit the EIA report to authorities in case of approved EIA without amending & addition requirement; and got decision from authorities (DONRE & People's Committee).

Step 4. Decide the approved EIA

The authorities have responsibility in approving the EIA report in time due to item 2, clause 20 of Decree 29:

Appraisal time: 30 working days from receiving the document. In case of complex adverse environmental impact project, appraisal time is 45 working days.

Approving time for EIA report is 15 working days, from receiving the documents

6.5 Comparison of Requirements for EIA among Vietnam, World Bank and JICA

To ensure the compliance to the requirements for EIA, the PS Team studied the new Environmental Guideline and Safeguard Policy of World Bank, JICA Guidelines, as well as EIA related laws in Vietnam. Table 6.2 and Table 6.3 show the comparison and main different points among those guidelines. Overall, no significant differences observed among the three guidelines/laws.

Table 6.2 Comparison of New Environmental Guidelines/Safeguards of the World Bank and related Laws in Vietnam about EIA

	Response policy of comprising New Environmental Guidelines and Safeguard policy of the World Bank	EIA related laws in Vietnam	Main different points	Measures
Procedure system	It is confirmed if the projects comply with the law or standards related to the environment in the central and local governments of host countries. It is also confirmed that the projects do not deviate significantly from the World Bank's Safeguard Policies.	Environmental Impact Assessment system exists, which DONRE has formulated.(Decree NO.80/2006/ND-CP)	(There is not difference in particular.)	(There is not difference in particular.)
Language of Environmental Assessment Statement	Environmental Assessment Statements (their names may be different depending on systems) must be written in official language or language used widely in countries where the projects are implemented. Also, when explanating, document must be formulated in languages and forms that are understandable to local people.	It is written in Vietnamese or English.(Circular No.08/2006/TT-BTNMT)	(There is not difference in particular.)	(There is not difference in particular.)

	Response policy of comprising New Environmental Guidelines and Safeguard policy of the World Bank	EIA related laws in Vietnam	Main different points	Measures
Information disclosure of environmental and social considerations	In principle, host countries etc. disclose information about the environmental and social considerations of their projects. As needed, assist host countries etc. Encourage project proponents etc. to disclose and present information about environmental and social considerations to local stakeholders. So that information on environmental and social considerations be made public and provided	It is required to receive opinions of People's committee of commune, ward and township during formulating EIA report and they must be included in EIA report (Law on Environment Protection Article 20) Public hearing must be held and in addition, EIA report must be disclosed(Decree NO.80/2006/ND-CP). However details of disclosure procedure such as disclosure period, or the way of receiving comments are not decided.	Under the domestic legal system, detailed process of disclosing EIA report has not been decided.	Encourage project proponents to disclose and present EIA report to local stakeholders
Access/Copy	Environmental Assessment Statements are disclosed in countries where projects are implemented to local residents as well. It is required that they are accessible by stakeholders such as local people and permitted for copying.	EIA report is disclosed on project sites (Circular No.08/2006/TT-BTNMT)	(There is not a difference in particular.)	(There is not difference in particular.)
Consultation with stakeholders	In principle, host countries consult with local stakeholders as much as widely in a rational range, assist host countries as needed. In the case of Category A projects, encourage host countries to consult with local stakeholders about their understanding of development needs, the likely adverse	Residents are able to participate in the scoping and EIA report review steps. As for all projects of the State and in Category A, at the scoping step, consultation with stakeholders including residents is required. Also, at the EIA report review process, public hearing has to be	Currently, procedures, system of sanctions etc. are not fixed.	Encourage host countries to consult with local stakeholders about their understanding of procedures at an early stage of the

	Response policy of comprising New Environmental Guidelines and Safeguard policy of the World Bank	EIA related laws in Vietnam	Main different points	Measures
	impacts on the environment and society, and the analysis of alternatives at an early stage of the project.	held. (Circular No.08/2006/TT-BTNMT)		project, if possible.
Disclosure of monitoring results	Confirm monitoring results through host countries to confirm if host countries etc. implement environmental and social considerations. Host countries are required to report information needed to confirm monitoring results in an appropriate manner such as documentations. Also, it is required to disclose the monitoring results conducted by host countries etc. on the website to the extent that they are made public in host countries. On Website to the extent that they are made public.	Monitoring results are edited in the form of white paper, and the State stores them as archive. (At 3 levels of province , local and State)(Circular No.08/2006/TT-BTNMT)	(There is not a difference in particular.)	(There is not difference in particular.)

Source: New Environmental Guidelines, World Bank Safeguard policy, Related laws in Vietnam

Table 6.3 Comparison between EIA Procedures Required in Vietnam and JICA Guidelines

Step	Vietnam's requirement	JICA
Classification	2 types (Appendix II – Decree No. 29/2011/ND-CP	4 type (JICA Guidelines)
Implementation	Conducted for support making the EIA report (belong to project's component & consultants):	Implemented for support making Environmental & Social Consideration report (advices from Advisory Committee if necessary)
Appraisal	Project' component submit EIA report to EIA council & People's Committee will approve the decide through suggestion from DONRE	Project' component submit Environmental & Social Consideration report JICA council (Advisory Committee

6.6 Review of ADB's IEE (Water Treatment Plant, and Raw Water Main)

Summary of the IEE Report by the ADB

The contents of the IEE report of the ADB are arranged to a list shown below.

Table 6.4 Summary of the IEE Report by the ADB

Item	contents
Report-name	PPTA VIE No. 7144 Da Nang Water Supply Project FINAL REPORT APPENDIX 14. INITIAL ENVIRONMENTAL EXAMINATION
Publication organization	Asian Development Bank
Publication time	June, 2010
Implementation organization	- BLACK AND VEATCH, HONG KONG LTD. - The Environmental Protection Research Center of the University of Da Nang
Structure of the IEE	I. BACKGROUND II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK III. PROJECT DESCRIPTION IV. DESCRIPTION OF THE ENVIRONMENT A. Location, Climate and Geography B. Population and Land Use C. Surface Water Resources D. Existing Water Supply Source E. Water Demand F. Water Quality G. Catchment Condition H. Ecological Conservation Areas V. IMPACTS, ALTERNATIVES AND MITIGATION MEASURES A. Expected Benefits B. Pre-Construction Activities C. Construction Activities D. Project Operation VI. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION VII. GRIEVANCE REDRESS MECHANISM VIII.ENVIRONMENTAL MANAGEMENT PLAN A. Institutional Arrangement B. Impacts and Mitigation/Safeguard Measures to be Monitored C. Budget IX. CONCLUSION AND RECOMMENDATION Annex 1. Project Implementation Timetable Annex 2. Surface Water Quality Sampling Results for July 2009 Annex 3. Surface Water Quality Sampling Results for November 2009 Annex 4. Analysis of Drinking Water Samples from Present Water Supply Service Area

Project Outlines and Environmental and Social Situation in the Target Area

The local environmental and social situation in the proposed site for the ADB Project is as

described below.

1) Environment, social condition around the water treatment plant

The proposed site for the WTP is located in the southwest of Hoa Lien Village, where Route 1 and Route 601 cross. The site location has a good access to transportation for construction and maintenance work, which is one of the reasons that ADB selected this site. The 8.4ha plot of land excluding the area where the war memorial stands was set as the project site, which was agreed by DPC. DPC has already agreed the land acquisition by DPC, and instructed to Hoa Vang PC and other related agencies to proceed land acquisition to complete by the end of 2014.

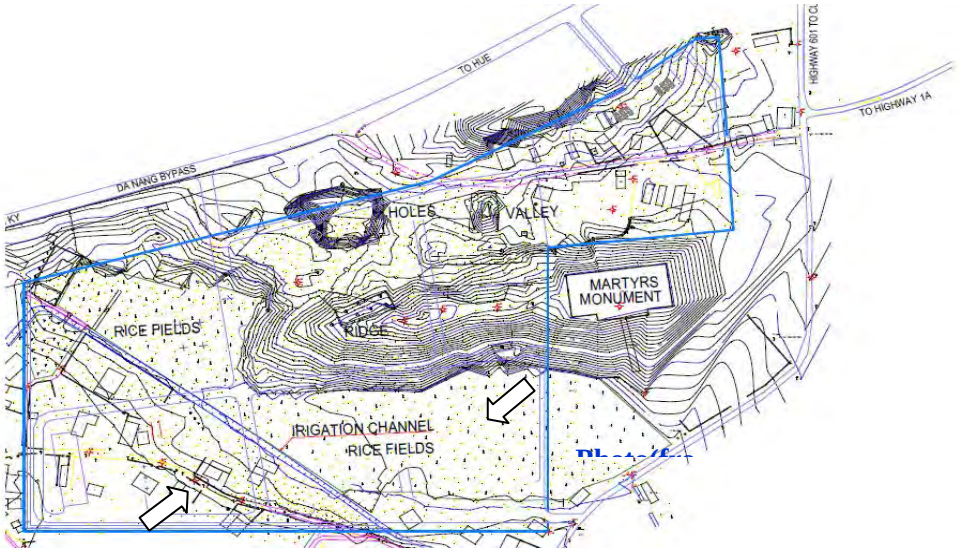


Photo (from southwest)

Figure 6.3 Water Treatment Plant Site Division and Landform

Photo 6.1 WTP site from northeast (the left) and WTP site from southwest (the right)

2) Society, environmental condition around the raw water main route

Since the raw water pipe will be laid under the Route 601 road, no resettlement is required for neither construction nor operation. The road width is around 5.0m on average, having 4.0m width at the narrowest, and the area adjacent to the housing areas is limited to part of the road. Therefore, little influence is expected on nearby houses during the construction.

Furthermore, there is much vacant along the road, which can be utilized to temporally stock excavated soils and/or to keep heavy equipment and pipe materials.

Results of EIA and Mitigation Measures

The ADB's IEE concluded that the environmental impacts in the stages of construction and operation of the WTP and raw water main would not be significant on the flora and fauna, and the project would not cause any destruction of the historical ruins nor require relocation of such historical ruins.

Main impacts which the project is likely to cause to the environment are summarized as follows:

Positive impacts

- It can contribute to the promotion of the citizens' health and sustainable growth of the Da Nang City by providing safe water supply to the households which are not presently serviced by tap water
- In the districts currently without tap water supply the people filter or boil the water taken from wells before using it. Now that the underground water is more contaminated than before due to the industrialization in the areas in the recent years, this Project is expected to substantially contribute to promoting people's health

Negative impacts

- Noise which may be caused at the time of construction of the raw water main and the air pollution due to the heavy traffic of construction vehicles, etc.
- Disposal of the sludge produced from the water purifying treatment process

These possible negative impacts listed above can be mitigated or avoided by taking appropriate measures such as installing wastewater and sludge treatment facilities. Other assumed negative influence and its mitigation measures are as listed in the table below.

Table 6.5 Negative Impact and Mitigation Measures

Construction	
Negative influence	Influence mitigation
Earth and sand increase to occur in excavation at the time of the pipe line installation	- As the temporal customs shed which secured enough space, a site for the second phase of the water treatment plant construction planned site is utilized.
The occurrence (the excavation earth and sand put temporarily on a road) of the traffic disorder	- The excavation earth and sand conjugate as backfill material of the pipe line effectively as far as they can do it. - In the water treatment plant planned site, the surplus earth is put temporarily, or conjugated by creation of the water treatment plant. Quantity of occurrence surplus earth is reduced as much as possible by the above-mentioned effort.
At a rainy day, muddy water flows out into the outskirts from the temporal customs shed of the excavation earth and sand	- It is divided into the temporal customs shed of the earth and sand with a fence or a silt trap, and a drainage is installed. Muddy water is considered to be structure not to flow out into the outskirts in the rainy day. - At the time of a flood, as for the temporal customs shed, the position that is not flooded is secured. - The surface water of the Cu de river is measured every three months by QCVN08:2008/BTNMT - The ground water of the construction range is measured twice a year by QCVN09:2008/BTNMT
Scattering of the excavation earth and sand at the time of the strong wind	- At the time of the fine weather, the earth and sand put temporarily are watered regularly and moderate water is kept.
Traffic disorder of a thing of local people at the time of the pipe line construction	- So that, about the point where width of street is narrow, securing of traffic is possible, small excavator and a damp truck for earth and sand transportation are used. - Traffic is secured by a road decking panel of the steel.
Air pollution with the exhaust gas from excavator and a damp truck(Increase of the traffic between an excavation spot and the temporal customs shed of the damp truck)	- Speed limit is established on a construction vehicle. - A check of the exhaust gas (in three spots along the pipe line route, carry it out every three months) by ambient air quality standard QCVN 05: 2009/BTNMT, QCVN 06: 2009/BTNMT - At fine weather, as for the unpaved part, water spray is carried out regularly.
Increase of the traffic accident (a child in particular and old man) and accident with relation to other pipe line construction	- Speed limit is established on a construction vehicle. - The construction planning avoids commuting, attending school time or time held the market. - The pipe line makes it restoration basically on the same day. When backfill is not completed out of necessity in the day, a road decking panel version, a fall prevention fence, a construction mark is installed in the excavation ditch of the pipe line and lighted up by illumination.
Unexploded ordnance (along the neighborhood of water treatment plant, the pipe line route)	- Before the construction, an unexploded ordnance study is carried out. - The unexploded ordnance study is carried out by management by Project Management Board.

in operation	
Negative influence	Influence mitigation
Leak accident of chlorine for sterilizing in the water treatment plant	- The facilities such as chlorine neutralization facilities, the chlorine gas leak-detector are established to cope at the time of a leak. - When chlorine is treated, the worker is obliged to carry out the wearing of the protective suit. - A safe manual is made when chlorine gas is made to handle and the urgent countermeasure at the time of a practical class of the handling and the leak of the chlorine gas is made enforcement. - The facilities relative to the chlorine room are checked regularly.
Discharge to the public water areas of sewage occurring in a water treatment process	- As introduction of facilities to handle clean water sludge appropriately, a drainage pond, a sludge pond, thickener tank, a sludge drying bed are introduced. - About the quality of the water of the effluent, monitoring is carried out regularly along QCVN40QCVN 40:2011/BTNMT and Circular 47/2011/TT-BTNMT. - In addition, this Vietnamese industrial waste water standard wants to be established newly in 2009 (revised in 2011 by these laws and ordinances), as well as existing Cau Do water treatment plant, it is the only PPP water project in water treatment plant of Hue which Yokohama-city government office performs technical cooperation and Vietnam. - There is not the effluent treatment facility in the water treatment plant of the Binh An province either. - As far as this investigating group researched it, effluent treatment facility of this Hoa Lien water treatment plant is water treatment plant having the country's first real effluent treatment facility substantially.
Sludge occurs in a water treatment process	- A drainage pond, a sludge pond, thickener tank, a sludge drying bed is installed, and sludge is handled appropriately. - The sludge left in the sun drying is delivered to DONRE which is a local waste disposal treatment company, and right final disposal is carried out. - A property of the sludge is monitored regularly by QCVN 07:2009/BTNMT（National Technical Regulation on Hazardous Waste Thresholds）.
Support at the time of the water treatment plant trial run	- The treated boiler feed water is thrown away until process water quality becomes less than the standard value, and water supply is started if it becomes less than the standard value. - And, before a trial run, washing of a water tank, the water supply plumbing, sterilization and a trial run of the machine electric installation must complete it.

Table 6.6 displays relevant aspects and impacts which could be caused in the stages of construction and operation of the WTP and Vietnam’s guidelines and standards.

Table 6.6 Relevant Aspect/Impact and Vietnam Guidelines/Standards

Relevant Aspect/Impact	Vietnam's Guidelines/Standards
Dust emission	TCVN 5937:2005
Air emission from construction equipment and transport vehicles	TCVN 5947-1; TCVN 6438; TCVN5939; TCVN 5940
Noise	TCVN 5948:1998; TCVN 5949:1999
Vibration	TCVN 7210:2002
Traffic obstruction	TCVN 4054:1998
Excavation heaps and spoil storage areas	TCVN 5299:1995
Effluent/discharge standards	TCVN 6984:2001
Hazardous substances	TCVN 5938:2005

Source：PPTA VIE No. 7144 Da Nang Water Supply Project FINAL REPORT Appendix 14 －Initial Environmental Examination, page 39

Public Opinion Consultation

The project operator should hear public opinions and views on the project and environmental preservation measures by having public hearings attended by the people's committees on the village community level as well as the community representatives, and include their opinions in the EIA Report for the purpose of reflecting people's opinions on the project.

When IEE was done by ADB, interviews were conducted with the residents and the representatives of eight communities near the WTP and along the raw water main in order to collect their opinions and views. As a result of these interviews and public hearings there was no objection to the implementation of the Project.

Table 6.7 shows a summary of local residents' perceptions towards the potential effect of the project on their lives and social environment.

Table 6.7 Perceptions of Persons Interviewed during Environmental Consultations

Activity Affected	Percent of 55 Respondents along the Cu De River			Percent of 45 Respondents near Pipeline Route and WTP site		
	Serious Adverse Effect	Moderate Effect	Low or None	Serious Adverse Effect	Moderate Effect	Low or None
Farming, fishing or forest resource exploitation	0	4	96	7	15	78
Trading and business activities (including aquaculture)	2	4	94	11	18	71
Cooking, drinking and washing	0	0	100	13	20	67
Living habits	0	0	100	18	29	53
Entertainment	0	0	100	0	13	87

Source: ADB PPTA No.7144-Da Nang Water Supply Project Final Report: Appendix 14 － Initial Environmental Examination

In parallel to the interview, public hearings were carried out in Hoa Bac and Hoa Lien Commune. Overall, there was no opposition raised against the proposed project as the most of the potential negative impacts can be mitigated by taking appropriate measures.

1) Public consultation meeting in Hoa Bac (construction of raw water pipeline route)

Site：Meeting house of Pho Nam hamlet, Hoa Bac Commune

Time and Date： 14:00 – 17:00, 11th June, 2010

Participants：

- The members in support group of EPRC and the collaborators
- Rep. of CPC：Mr. Ho Tang Phuc, Vice Chairman of Hoa Bac Commune
- Rep. of Commune Fatherland Front Committee：Mr. Huynh Dung, Chairman of Hoa Bac Commune
- Rep. of Farmers Association：Mr. Truong Thanh Tam, Chairman
- Rep. of Women Association：Ms. Ba Bui Thi Ga, Ms. Chu Tich Hoi
- Plus about 50 local people in both Pho Nam Village and Nam My Village, Hoa Bac Commune

2) Public consultation meeting in Hoa Lien (construction area of WTP)

Site：Meeting house at Quan Nam3 hamlet, Hoa Lien Commune.

Time and Date：14:00 – 17:00, 10th June, 2010

Participant：

- The members in support group of EPRC and the collaborators
- Rep. of CPC：Mr. Nguyen Thu, Chairman of Hoa Lien Commune
- Rep. of Farmers Association：Mr. Nguyen Thanh Xuan, Chairman
- Rep. of Women Association：Ms. Le Thi Dao, Chairman
- Plus about 50 local people in Quan Nam hamlet, Hoa Lien Commune (see list attached in the appendix)

For details on the public hearing, it is described in 'ANNEX 5 RESULTS OF PUBLIC CONSULTATION ON RAW WATER PIPELINE CONSTRUCTION AND HOA LIEN WTP' in the ADB Report entitled 'PPTA VIE No. 7144 - Da Nang Water Supply Project DRAFT FINAL REPORT APPENDIX 14 INITIAL ENVIRONMENTAL ASSESSMENT'

In case that any complains arise in the stage of construction and operation, it will be dealt with in the following procedures: first complaints shall be collected to the Commune People's Committee, then brought up to the District People's Committee, and third to the Provincial People's Committee to be discussed. When no agreement is reached in these processes, the complaint shall be brought into court for final decision. DAWACO shall bear all the cost incurred in handling complaints.

Environment Management and Monitoring Plan

The IEE by ADB mentioned that noise, surface stream water quality, underground water quality and air during the construction, and wastewater from the WTP and hazardous waste during the operation would be monitored.

The Project Management Board (hereinafter referred to as "PMB") is responsible for the monitoring of the environment. The PMB manages to ensure that the mitigation measures for the negative environmental impacts and monitoring plans, which are written in EIA report, the detailed design documents and the construction contracts, will be implemented by the project operator. In addition, this PMB is in charge of responding to the complaints and inquiries from the residents regarding the Project. During the construction period, The Environmental Protection Research Center of the University of Da Nang will conduct interviews with local residents to identify any concerns in a regular basis. Budget for EMP and monitoring are summarized in the table below.

Table 6.8 Budget for EMP and Monitoring

Activities	Frequency	Budget (USD)	Source of Budget
Construction safeguards	Throughout the construction period, incl. commissioning of the WTP	To be incorporated in the implementation contract	Loan
Sampling and testing of surface water, groundwater and ambient air quality along the pipeline construction corridor	3 times per year during the 2-year construction period	20,000	Loan
Perception survey and follow-up consultations with local residents	3 times per year during construction	15,000	Loan
Survey of pipeline corridor for unexploded ordnance	Once, prior to the start of construction	1000,000	Loan
Local environment specialists	Intermittent input: 8 person-months over 2 years	32,000	Loan
Training and orientation for PMB and community leaders	Once, (Before the construction)	4,000	Loan
Environmental audit	Once (After completion)	30,000	Loan
Contingency (in case of construction delay)		29,000	Loan
	Total	230,000	

Source： PPTA VIE No. 7144 - DRAFT FINAL REPORT on "Da Nang Water Supply Project, Appendix 14 －Initial Environmental Examination, page 54

Conclusion

The ADB's IEE concluded that the Project can contribute to the promotion of the citizen's health by supplying safe tap water to the households who are now using ground water due to no access to the water supply system.

Also, the Project activities including construction and operation of the WTP and the raw water main will neither have a significant impact on the environment (flora and fauna), landscape nor will require any relocation and demolition of historical relics.

However, it is necessary to take appropriate measures against the possible noise problem at the time of raw water main construction, air pollution problem due to a heavy traffic of the construction vehicles and disposal of sludge generated from the water treatment process at the WTP.

6.7 Assessment of Impacts by the Water Intake Facility

(1) The raw water will be taken from the location downstream of the Pho Nam Bridge over the Cu De River and a pump station is constructed near the water intake facility in this Project. This PS made a preliminary assessment of the possible impact on the environment of those sites, their vicinity and the Cu De River, which was not included in the IEE by ADB. The results are summarized below. Outline of the Facilities which may Impact the Environment

The followings are the components which may cause impact on the environment.

- Construction of a pump station and connection pipe to the raw water main
- Operation, maintenance and management of the movable weir and the pump station.
- Water intake from the Cu De River at the rate of 132,000m^3/day.

The movable weir for collecting raw water is proposed located in Hoa Bac Commune, Hoa Vang district, Da Nang city at coordinates: 16.131505N & 108.051671E, downstream of Pho Nam bridge. (Figure 6.4)

Figure 6.4 Proposed Position of the Movable Weir in Cu De Basin

(2) The Social and Environmental Conditions along the Cu De Basin

The Cu De River has the whole watershed area of 462km^2, all of which lies in the Da Nang City, and is 47km long. The Cu De River flows through the villages of Hoa Bac and Hoa Lien, passes down the Nam O Bridge, and enters into the Da Nang Bay.

The residential areas and the social economic activities are made mostly in the middle and lower parts of the watershed area of the Cu De River between the Pho Nam Bridge and the Nam O Bridge. This area is mostly mountainous with some scattered farm lands.

Photo 6.2 The Current Status of Traffic and Land use along Cu De River

There is a flat land composed of alluvial deposited sand, which is mostly used as farm land along the Cu De River. The principal crops produced in the area are rice, sugar canes and corns.

Other than agricultural activities in the floodplain of the Cu De River near the Hoa Bac Village, eleven families are engaged in the fish culture industry. The area of the aquaculture pond is approximately two (2) hectors, producing about two (2) tons of cultured fish every year including grass carps, tilapia, a kind of butterfish.

(3) The Possible Environmental Impacts

On this ADB report, five (5) intake points, A to E, are proposed as a candidate site for water sources, including the dam site by GERUCO, weir at another site, and etc. Information on five intake points suggested by the ADB Report is described in Chapter 4 from page 4-17 to 4-19.

Figure 6.5 Locations of Water Supply Options suggested in the ADB Report

The PS Team made a comparison with the five candidate sites respectively and summarized the result in Table 6.9.

Table 6.9 Result of Comparison

Item	Point-A	Point-B	Point-C	Point-D	Point-E	Remarks
Dam construction	×	△	―	―	×	Cost
Securable quantity of water intake	◎	◎	○	○	○	
Intake weir building	―	―	○	○	―	
Pumping station	―	―	△	△	―	
Likelihood of mercury pollution	―	―	△	△	―	Preliminary study
Pipe line construction	×	×	△	△	△	Cost
Ecosystem	△	△	△	△	△	EIA
Land use	―	―	―	―	―	EIA
Involuntary relocation	―	―	―	―	―	EIA
Result	Not selected	Not selected	Not selected	Selected	Not selected	
Main reasons	Dam construction has been suspended.	Expensive construction cost for dam and 15.4km of pipeline	Expensive construction cost for 10.5km of pipeline	Shorter pipeline (7.5km) construction	Need to be built reservoir by DAWACO	

【Explanatory notes】

― : No impact, × : Quite negative impact, △ : Negative impact, ○ : Positive impact, ◎ : Quite positive impact

Preliminary survey to find out possible environmental impacts was conducted given that Point-D was selected as the intake point for WTP. Screening on the impacts of raw water intake with a movable weir is as summarized in Table 6.10.

Table 6.10 Screening on the Impacts of Raw Water Intake with a Movable Weir

Notes: I : Impact , D : Direct , ID : Indirect
Impact: (-) negative impact ; (0) : unknown ; (+) : Positive impact
Level: 1: Negligible; 2. Average, 3. Strong

The main possible environmental impacts, which may be caused by the movable weir and pump station, are summarized as follows:

- There may be some negative impacts on agriculture, fish culture and fishery due to possible turbid water during construction. However, the operation of the weir itself is expected to have little impacts on agriculture, fish culture and fishery, as the weir will be built in estuarine basin, water for agricultural use is taken from groundwater, spring, or lake, and also fish culture is carried out mainly in the estuarine region.

Since the detailed design for the movable weir and the pumping station has not yet been completed at the PS stage, EIA will be conducted when this proposal is accepted and the detailed design is prepared. The above mentioned possible impacts shall be carefully studied in conducting a detailed EIA.

6.8 Scoping and Determination of TOR

(1) Scoping

Scoping is the process to evaluate a range and items of significant and potentially significant impacts. The PS Team conducted scoping for the project activities taking into consideration the results of review on the ADB's IEE. The result of scoping is presented in Table 6.11.

Table 6.11 Result of Scoping

Category		Outline	Impact evaluation		Reason
			Pre- and during the construction	Operation	
Counter-measure for pollution	1	Air pollution	B-	D	**Construction:** Air pollution with the exhaust gas from excavator and a damp truck due to increase of the traffic between an excavation spot and the temporal customs shed of the damp truck. **Operation:** It is not expected that air pollution to lead adverse impact for surrounding area would occur.
	2	Water pollution	B-	D	**Construction:** Waste water flows out into the outskirts from the temporal customs shed of the excavation earth and sand, construction site. **Operation:** Wastewater generated in a water treatment process would be treated appropriately by installing of waste water treatment facilities such as a drainage pond, a sludge pond, thickener tank, a sludge drying bed.
	3	Waste	B-	D	**Construction:** Earth and sand increase in excavation at the time of the WTP & pipe line installation. **Operation:** It is not expected that increase of waste to lead adverse impact for surrounding area would occur.
	4	Soil pollution	B-	D	**Construction :** There is possibility of soil contamination by the outflow of oil used for construction. **Operation :** It is not expected that soil contamination to lead adverse impact for surrounding area would occur.
	5	Noise and vibrations	B-	D	**Construction:** Increase of noise and vibration by excavator and a damp truck. **Operation :** Although noise is generated by the pumping station, appropriate soundproofing measure would be taken.
	6	Ground subsidence	D	D	There is not construction and operation works to lead ground subsidence.
	7	Offensive odors	D	D	It is not expected that generation of offensive odors would occur.
	8	Bottom sediment	D	D	There is not construction and operation works to lead adverse impact for bottom sediment.

Category		Outline	Impact evaluation		Reason
			Pre- and during the construction	Operation	
Natural environtment	9	Protection area	D	D	There are no national parks, protection areas designated by the government around project site.
	10	Ecologically important habitats	D	D	There are no ecologically important habitats, habitats of endangered species for which protection is required under local laws and/or international treaties.
	11	Hydrological conditions	D	C	**Construction:** There is not construction and operation works to lead adverse change for hydrological condition of river. **Operation:** There would be some possibility to change trend of water quality due to development activities in the estuarial area when taking raw water in the minimum river flow in 10 to 20 years. So it is not expected that change to lead adverse impact for water quality of river would occur.
	12	Geographical features	D	D	There would be no adverse impact for geographical features because massive volume excavation & back filling works is not planned.
Socio-economy	13	Involuntary resettlement	B-	D	**Pre-construction :** Involuntary resettlement is required to construct the WTP.
	14	Poor people	D	D	It is not expected that adverse impact for poor people would occur because concrete measure of compensation, the support for site acquisition, resettlement have been approved between Da Nang city and affected people.
	15	Indigenous, or ethnic people	D	D	There would be no adverse impact for indigenous, ethnic people.
	16	Local economies, such as employment, livelihood, etc.	B+	B+	**Construction :** Employment opportunity for local community would be increase by hiring local people for construction works. **Operation :** Some employment opportunity for local community would be generated by hiring local people as operation workers for WTP & pumping station.
	17	Land use and utilization of local resources	D	D	Since land acquisition and resettlement plan have already been approved by DNPC, and the land acquisition and resettlement plan have already commenced. Therefore, additional land use and utilization of local resources would not be expected.

Category		Outline	Impact evaluation		Reason
			Pre- and during the construction	Operation	
	18	Water usage	C	C	It is not expected that adverse impact for existing water usages, because water for irrigation to agricultural land are currently abstracted from small mountain runoff, underground water and Hoa Trung lake not surface water from Cu de River because downstream than intake point is located in tidal area. However, it is necessary to clarify potentiality of changing the water quality for domestic and agricultural irrigation, affecting aquaculture in the estuaries in the detailed EIA.
	19	Existing social infrastructures and services	B-	D	**Construction :** Adverse impact for the traffic of local people is limited because detour can be ensured during construction phase.
	20	Social institutions incl. social infrastructure and local decision-making institutions	D	D	There would be no adverse impact for Social institutions such as social infrastructure and local decision-making institutions.
	21	Misdistribution of benefits and damages	D	D	There would be no adverse impact for Misdistribution of benefits and damages.
	22	Local conflicts of interest	D	D	There would be no adverse impact for local conflicts of interest.
	23	Cultural heritage	D	D	There are no cultural heritages round project site.
	24	Landscape	D	D	There would be no adverse impact for landscape.
	25	Gender	D	D	There would be no adverse impact for landscape for Gender.
	26	Children's rights	D	D	There would be no adverse impact for landscape for children.
	27	Infectious diseases such as HIV/AIDS	C-	D	**Construction :** Since the increase of construction workers possibility of infection is considered.
	28	Working environment	C-	D	**Construction :** Appropriate measure to ensure safety of construction workers should be determined and taken. **Operation :** Appropriate measure to ensure safety of operation workers should be determined and taken.
The Others	29	Accidents	B-	D	**Construction :** Appropriate measure to ensure safety of construction workers should be determined and taken. **Operation :** Appropriate measure to ensure safety of operation workers should be determined and taken.
	30	Global warming	D	D	There would be no adverse impact for landscape for global warming.

As previously mentioned, the project is expected to have no significant impacts on the environment during both the construction and the operation. Some possible negative impacts will occur only for a limited period of the construction, which can be mitigated or prevented by taking appropriate measures.

(2) Assessment of Projected Negative Environmental Impact by Scoping

Table 6.12 Assessment of Projected Negative Environmental Impact

Pre-Construction, ・construction/	
Air pollution	• Air pollution with the exhaust gas from excavator and a damp truck due to increase of the traffic between an excavation spot and the temporal customs shed of the damp truck.
Water pollution	• Waste water flows out into the outskirts from the temporal customs shed of the excavation earth and sand, construction site.
Waste	• Earth and sand increase in excavation at the time of the WTP & pipe line installation.
Soil pollution	• There is possibility of soil contamination by the outflow of oil used for construction.
Noise and vibrations	• Increase of noise and vibration by excavator and a damp truck.
Involuntary resettlement	• Involuntary resettlement is required to construct the WTP.
Local economies, incl. employment, livelihood, etc.	• Employment opportunity for local community would be increase by hiring local people for construction works.
Water usage	• It is not expected that adverse impact for existing water usages, because water for irrigation to agricultural land are currently abstracted from small mountain runoff, underground water and Hoa Trung lake not surface water from Cu de River because downstream than intake point is located in tidal area. However, it is necessary to clarify potentiality of changing the water quality for domestic and agricultural irrigation, affecting aquaculture in the estuaries in the detailed EIA.
Existing social infrastructures and services	• Adverse impact for the traffic of local people is limited because detour can be ensured during construction phase.
Infectious diseases such as HIV/AIDS	• Since the increase of construction workers possibility of infection is considered.
Working environment	• Appropriate measure to ensure safety of construction workers should be determined and taken.
Accidents	• Appropriate measure to ensure safety of construction workers should be determined and taken.

(3) Preliminary EIA Projected by Scoping

Table 6.13 Comparison between Scooping Results and Preliminary EIA

Category		Outline	Scoping Results		Preliminary EIA		Reason
			Pre- and during construction	Operation	Pre- and during construction	Operation	
Counter measure for pollution	1	Air pollution	B-	D	B-	D	**Construction:** Air pollution with the exhaust gas from excavator and a damp truck due to increase of the traffic between an excavation spot and the temporal customs shed of the damp truck. **Operation:** It is not expected that air pollution to lead adverse impact for surrounding area would occur.
	2	Water pollution	B-	D	B-	D	**Construction:** Waste water flows out into the outskirts from the temporal customs shed of the excavation earth and sand, construction site. **Operation:** Wastewater generated in a water treatment process would be treated appropriately by installing of waste water treatment facilities such as a drainage pond, a sludge pond, thickener tank, a sludge drying bed.
	3	Waste	B-	D	B-	D	**Construction:** Earth and sand increase in excavation at the time of the WTP & pipe line installation. **Operation:** It is not expected that increase of waste to lead adverse impact for surrounding area would occur.
	4	Soil pollution	B-	D	B-	D	**Construction :** There is possibility of soil contamination by the outflow of oil used for construction. **Operation :** It is not expected that soil contamination to lead adverse impact for surrounding area would occur.
	5	Noise and vibrations	B-	D	B-	D	**Construction:** Increase of noise and vibration by excavator and a damp truck. **Operation :** Although noise is generated by the pumping station, appropriate soundproofing measure would be taken.
	6	Ground subsidence	D	D	D	D	There is not construction and operation works to lead ground subsidence.

Category		Outline	Scoping Results		Preliminary EIA		Reason
			Pre- and during construction	Operation	Pre- and during construction	Operation	
	7	Offensive odors	D	D	D	D	It is not expected that generation of offensive odors would occur.
	8	Bottom sediment	D	D	D	D	There is not construction and operation works to lead adverse impact for bottom sediment.
Natural environ-ment	9	Protection area	D	D	D	D	There are no national parks, protection areas designated by the government around project site.
	10	Ecologically important habitats	D	D	D	D	There are no ecologically important habitats, habitats of endangered species for which protection is required under local laws and/or international treaties.
	11	Hydrological conditions	D	C	D	C	**Construction :** There is not construction and operation works to lead adverse change for hydrological condition of river. **Operation :** There would be some possibility to change trend of water quality due to development activities in the estuarial area when taking raw water in the minimum river flow in 10 to 20 years. So it is not expected that change to lead adverse impact for water quality of river would occur.
	12	Geographical features	D	D	D	D	There would be no adverse impact for geographical features because massive volume excavation & back filling works is not planned.
Socio-economy	13	Involuntary resettlement	B-	D	B-	D	**Pre-construction :** Involuntary resettlement is required to construct the WTP.
	14	Poor people	D	D	D	D	It is not expected that adverse impact for poor people would occur because concrete measure of compensation, the support for site acquisition, resettlement have been approved between Da Nang city and affected people.
	15	Indigenous, or ethnic people	D	D	D	D	There would be no adverse impact for indigenous, ethnic people.

Category		Outline	Scoping Results		Preliminary EIA		Reason
			Pre- and during construction	Operation	Pre- and during construction	Operation	
	16	Local economies, such as employment, livelihood, etc.	B+	B+	B+	B+	**Construction :** Employment opportunity for local community would be increase by hiring local people for construction works. **Operation :** Some employment opportunity for local community would be generated by hiring local people as operation workers for WTP & pumping station.
	17	Land use and utilization of local resources	D	D	D	D	Since land acquisition and resettlement plan have already been approved by DNPC, and the land acquisition and resettlement plan have already commenced. Therefore, additional land use and utilization of local resources would not be expected
	18	Water usage	C	C	C	C	It is not expected that adverse impact for existing water usages, because water for irrigation to agricultural land are currently abstracted from small mountain runoff, underground water and Hoa Trung lake not surface water from Cu de River because downstream than intake point is located in tidal area. However, it is necessary to clarify potentiality of changing the water quality for domestic and agricultural irrigation, affecting aquaculture in the estuaries in the detailed EIA.
	19	Existing social infrastructures and services	B-	D	B-	D	**Construction :** Adverse impact for the traffic of local people is limited because detour can be ensured during construction phase.
	20	Social institutions incl. social infra-structure and local decision-making institutions	D	D	D	D	There would be no adverse impact for Social institutions such as social infrastructure and local decision-making institutions.
	21	Misdistribution of benefits and damages	D	D	D	D	There would be no adverse impact for Misdistribution of benefits and damages.

Category		Outline	Scoping Results		Preliminary EIA		Reason
			Pre- and during construction	Operation	Pre- and during construction	Operation	
	22	Local conflicts of interest	D	D	D	D	There would be no adverse impact for local conflicts of interest.
	23	Cultural heritage	D	D	D	D	There are no cultural heritages round project site.
	24	Landscape	D	D	D	D	There would be no adverse impact for landscape.
	25	Gender	D	D	D	D	There would be no adverse impact for landscape for Gender.
	26	Children's rights	D	D	D	D	There would be no adverse impact for landscape for children.
	27	Infectious diseases such as HIV/AIDS	C-	D	C-	D	**Construction :** Since the increase of construction workers possibility of infection is considered.
	28	Working environment	C-	D	C-	D	**Construction :** Appropriate measure to ensure safety of construction workers should be determined and taken. **Operation :** Appropriate measure to ensure safety of operation workers should be determined and taken.
The Others	29	Accidents	B-	D	B-	D	**Construction :** Appropriate measure to ensure safety of construction workers should be determined and taken. **Operation :** Appropriate measure to ensure safety of operation workers should be determined and taken.
	30	Global warming	D	D	D	D	There would be no adverse impact for landscape for global warming.

Notes: A+/- : Quite positive or negative impact B+/- : Possible positive or negative impact

C+/- : Unknown for degree of positive or negative impact D : No impact

(4) Environmental Impacts caused by the Project and the Mitigation Measures

As stated above, the project is expected to have no serious impacts on the environment during both the construction and the operation. It is projected that most of the negative impacts will be limited and caused during a short period of the construction. Thus, the environmental management plan presented in the ADB's IEE Report includes mitigation and safeguard measures to be monitored. The EIA monitoring plan is displayed in the following table.

Table 6.14 EIA Monitoring Plan

	Monitoring Item	Monitoring Site	Frequency	Standards
Construction Stage				
Noise	Noise(max. level)	・ Access road ・ WTP ・ Water receiving point	Arbitary frequency during the period when it is very noisy at the construction stage	QCVN 26:2010/BTNMT
Air quality	Particle	・ Access road ・ WTP ・ Distribution pipe ・ Water receiving point	Arbitary frequency during the period when air pollution is very heavy at the construction stage	QCVN 06: 2009/BTNMT
Requests, claims from residents	The number and content of requests and claims	・ Access road and vicinity of the construction site	At the time when requests and claims reach to the construction site	
Operation Stage				
Water quality	・pH、turbidity ・Toxic substance(F-、Fe、Mn、No2、 No3-)	・ Intake facilities	・Daily ・Semiannually	QCVN 08: 2008/BTNMT
	・pH、turbidity、residual chlorine ・Escherichia coli ・Toxic substance(F-、Fe、Mn、No2、No3-)	・ Distribution facilities including water receiving points	・Daily ・Weekly ・Semiannually	
	・pH、temperature、BOD、COD、SS、escherichia coli、residual chlorine ・Oil membrane、As、Cd、Pb、Cr、Cu、Zn、Mn、Ni、organic phosphorus、total phosphorus、Fe、CCl2、Sn、Hg、N2、CLCH=CCL2、ammonia nitrogen、F-、C6H5OH、sulphide、Cyan heavy metal(Fe/Pb/Cd/Cu/ Cr)/escherichia coli	・ Inflow and outflow of drainage pipes	・Monthly ・Quarterly	
Noise	Noise(max. level)	Outside of the following facilities ・ Pump ・ Power generator ・ Blower Site boundary of WTP	・Monthly	QCVN 26:2010/BTNMT
Sludge density	Zn、Cu、Ni、Cd、Pb、Hg、Cr、Mo、Se、As	Sludge from drying beds	・Semiannually	QCVN 20: 2009,TCVN 5940：2005

(5) TOR for EIA

In order to proceed the implementation of the project when the project by the PPP scheme is decided, it has been arranged that EIA would be carried out by DAWACO, who will be an implementation unit for the project financed by ADB. The TOR for the EIA will be determined through discussions between DAWACO and the proponent.

6.9 Forthcoming Challenges for the Project Implementation

Forthcoming challenges for the implementation of the project to be formed by the PPP scheme are summarized as below:

- This project is classified as environmental category B according to JICA Guideline promulgated in April 2010.
- Decree No.80/2006/NĐ-CP was replaced with Decree No.21/2008/NĐ-CP, and the appendix along with the new decree shows a list of projects required to prepare EIA reports by classifying into162 categories. This project corresponds to the 70th category of "Development of surface water" with designed capacity of not less than 50,000m^3 per day.
- The comparison and main different points between EIA related laws in Vietnam and JICA Guideline were prepared, and necessary measures to resolve the differences were proposed. At the stage of project implementation, further studies on the comparison will be indispensable.
- This report was prepared by studying the existing IEE Report prepared by ADB and conducting additional EIA. In order to obtain an approval for the project implementation, full-scale EIA should be conducted by the project proponent.
- The formal EIA is expected to be done efficiently because fine relationships with the local partners have been established through this preliminary EIA.

CHAPTER 7 RESETTLEMENT AND SITE ACQUISITION

7.1 Summary of the Study on Resettlement and the Site Acquisition

This project is classified as environmental category B according to the "GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (hereinafter, referred to as “JICA Guidelines”)" which was promulgated in April 2010.

However, the Initial Environmental Examination (hereinafter, referred to as “IEE”) was already completed in the "DA NANG WATER SUPPLY PROJECT (Final Report was prepared in June 2010),” which was submitted by ADB and approved by Da Nang City. This IEE concluded that the project may cause a limited impact on the environment, and so classified this project as Category B.

Therefore, based on JICA guidelines, existing RAP is reviewed, and, about deficient mention and contents, an additional study (including the update of data) is performed. In addition, in the review of RAP, what the contents of JICA guidelines are included in is confirmed.

In addition, after study completion (after the detailed design end), and in before implementation of the business, the factor of the environmental influence change is researched. Field work is performed and is reported a correction afterwards.

7.2 The Law to Resettlement and Site Acquisition

(1) Law and Decree

i. Law on Land Amended in 1998,2001 and 2003 :
ii. Decree 181/2004/ND-CP of October 29, 2004 providing for implementation of Law on Land:（As follows “Decree 181”）
iii. Decree 197/2004/ND-CP of December 3, 2004 on compensation, support and resettlement when land is recovered by the State：
iv. Circular 14/2009/TT-BTNMT of October 1, 2009 detailing the compensation, support and resettlement and order of and procedures for land recovery, allocation and lease :
v. Circular 57/2010/TT-BTC on making cost estimates, using and settling funds for organizing the compensation, support and resettlement when the state recovers land :
vi. Decree 188/2004/ND-CP of November 16, 2004 on price determination methods and price frameworks for all types of land :

vii. Circular 145/2007/TT-BTC of December 6, 2007 providing guidelines for implementation of Decree 188/2004/ND-CP of the government dated 16 November 2004 (as amended by decree 123 dated 27 July 2007) on land price determination methods and price frameworks for all types of land

viii. Decree 69/2009/ND-CP of August 13, 2009 making additional regulations on land use plan, land price, land acquisition, compensation, assistance and resettlement : （As follows "Decree 69"）

(2) Decision with the Da Nang PC

i. Decision 35/2009/QD-UBND of December 24, 2009 on issuance of compensation price for land when the Government acquires land in Da Nang province/City.

ii. Decision 62/2012/QD-UBND of December 20, 2012 determining land prices in Da Nang City in 2013.

iii. Decision 63/2012/QD-UBND of December 20, 2013 on promulgating regulations on compensation, support and resettlement when the state conducts the land recovery within territory of Da Nang City.

7.3 Procedures for Resettlement and Site Acquisition

1) The competed authorities of site acquisitions

When a site is acquired by a group, religious buildings, a Vietnamese resident in foreign countries and a foreign group, individual, PC at province level has discretion of the site acquisition (land law Article 44).

When a site is acquired by foreign countries residence Vietnamese having a right to purchase a right of using land house in family, individual, community and Vietnam with, PC at municipal level has discretion of the site acquisition each (land law Article 44).

2) Procedures for site acquisitions

a) Parties involved in the procedures

- 「People's committees of provinces and cities 」
- 「People's committees of districts, towns and provincial cities 」
- 「DONRE」（「Department of Natural Resources and Environment」）
- 「Council for Compensation, Assistance and Resettlement」
- 「Land Fund Development Organization」

- 「Investor」

b) Procedure of the site acquisition

The procedure of the site acquisition is prescribed by land law Article 39 and 69 Decree Article 27 to Article 31.

The summaries are as follows.

- Study, review by presentation of the investment-related document (investment documentations) to People's committees of provinces and cities by Investor, People's committees of provinces and cities and People's committees of districts, towns and provincial cities

- Publication of the notice of site acquisition by People's committees of provinces and cities (People's committees of districts, towns and provincial cities which or caught the handover of power)

- The establishment (about the district which Land Fund Development Organization has already established, the mechanism concerned may play a role as the council mentioned above.) of Council for Compensation, Assistance and Resettlement by People's committees of districts, towns and provincial

- Making of a plan for compensation, assistance and resettlement by Council for Compensation, Assistance and Resettlement or Land Fund Development Organization
  【Contents】
  Full name, address of inhabitants for the site acquisition
  Range of the target site, category of land, the location
  Calculation basis of the amount of compensation (land prices, value such as houses, the number of the people of working, the number of the social welfare subject)
  Compensation, supporting sum
  Arrangement content to depend on resettlement

- Publication of A plan for compensation, assistance and resettlement, opinion offer (more than at least 20 days)
- A review of a plan for compensation, assistance and resettlement by DONRE, making of a land recovery file and presentation to People's committees of provinces and cities

(or People's committees of districts, towns and provincial cities)

- Site acquisition decision by People's committees of provinces and cities (or People's committees of districts, towns and provincial)
- Notice to target inhabitants

【Contents】

Compensation, supporting sum

Arrangement content to depend on resettlement (when necessary)

Time of payment of the compensation

Time of the delivery

- Arrangement of payment of the compensation and the resettlement by Council for Compensation, Assistance and Resettlement or Land Fund Development Organization
- Transfer by target inhabitants (after payment of the compensation less than 20 days. When inhabitants do not accept transfer, by decision of PC and decree, execution of the transfer is carried out).
- It is established by People's committees of provinces and cities,
- Mechanism (69 Decree Article 35) that it is intended that an auction of the right of using land is carried out, and, in addition, a land fund of social economy development, the education welfare is run.

7.4 Comparison of JICA New Environmental Guidelines and Related Laws about Land Acquisition and People Resettlement in Vietnam

The comparison between JICA guidelines and Viet Nam system was summarized in Table 7.1.

Table 7.1 Comparison between JICA Guidelines and Viet Nam System

Items	Relevant laws in Vietnam	Requirement of JICA	Main different point	Measure
Minimize involuntary resettlement and adverse social impacts	Impacts should be minimized by giving priority to resettlement of nearby area from the actual residential place. (Decree197 Article 34)	Involuntary resettlement and loss of livelihood should be avoided by exploring all viable alternatives. When, after such an examination, avoidance is provided unfeasible, effective measures must be taken to minimize impacts and to compensate loss in consultation with affected people.	priority of involuntary resettlement	JICA Guidelines
Resettlement Plan	Institutions in charge of people Resettlement formulate. (Local people resettlement committee/Land Fund Development organization)(Decree197 Article 40). In addition, Decree 69 issued in October 2009 has enlarged assistance for people to be displaced. Assistance for living and productivity is decided based on actual level by Provincial-level People's Committee (e.g. plant seed, animal breeds for agricultural production crop, agricultural promotion, forestry promotion, plan protection, veterinary services, cultivation, and husbandry. Supports for creating some trades and occupations in resettlement areas(Deree197 Articles 36,37)	All projects which result is involuntary resettlement, resettlement action plan must be formulated and compensation for affected people must be considered. Particular attention must be payed to the poor and the vulnerable. Resettlement action plan includes timely assistance, budget, cost for relocation, contents of compensation and rehabilitation of means og livelihood.	Vietnam's laws are prioritized.	Proper compensation should be considered rather than legal observations
Compensation for affected people	Land price brackets (Khung Gia Dat) are established. "Basing on the actual land use right transfer price in localities, the provincial-level People's Committees can decide on the specific land prices within the permitted limits of increase of not more than 20 % compared with the maximum price level and decrease of not more than 20 % compared to the minimum price level of the bracket of prices of land of the same category.(Decree188/2004/ND-CP Article6-2).	Full replacement cost must be provided to affected people as compensation for loss of land and other assets.	Vietnam's laws are prioritized.	Proper compensation should be considered rather than legal observations

Items	Relevant laws in Vietnam	Requirement of JICA	Main different point	Measure
	" When the common land use right transfer prices fluctuate for 60 consecutive days or more as compared with the maximum land price or decrease by 30 % or more as compared with the minimum land price, the Finance Ministry shall formulate new land price brackets and submit then to the Government for proper adjustment. (Same as above: Article 7) Also, land price brackets of special cities (Hanoi and Ho Chi Minh are not clearly specified) are set at the highest level. There were several supplements in Decree188/2004/ND-CP in 2007, by which, land price brackets were segmentalzed by Delta commune, Midland commune, Mountain commune. Currently, 123/2007/ND-CP is the latest			
Stakeholder participation, grievance redress mechanism	Disclose provisional resettlement plan, receive comments and is discussed publicly (Article 34 of Decree197)A redness of grievance is able to be submitted under Article 138 of the Land Law, Articles 162,163,164 of Decree 181.	Consult affected people, host community and NGO etc. at an appropriate time, then provide them opportunities to participate in the planning, implementation and monitoring of resettlement plan. Grievance mechanisms must be established for the affected people and their communities	Vietnam's laws are prioritized.	Proper compensation should be considered rather than legal observations
Livelihood rehabilitation assistance	Assistance for living and productivity at resettlement sites is decided based on the actual status by the Provincial-level People's committees. Example: (Plant seeds, animal breeds for agricultural production crop, agricultural promotion, forestry promotion, plant protection, veterinary services, cultivation, and husbandry. Supports for creating some trades and occupations in resettlement areas	Efforts should be made to improve the levels of living, income opportunity and productivity or at least restore them to the same as before resettlement. level The levels of living, productivity	Vietnam's laws are prioritized	Proper compensation should be considered rather than legal observations

Items	Relevant laws in Vietnam	Requirement of JICA	Main different point	Measure
	(Deree197 Articles 36,37)			
Monitoring	Decree197 does not stipulate clearly monitoring. As for projects implemented by donors, donors arrange independent institutions themselves and monitoring is carried out.	The borrower is responsible for implementing adequate monitoring & evaluation on resettlement. The borrower monitors whether any unforeseeable situations occur and the performance and effectiveness of mitigation measures. Also monitoring is implemented by external institution. In addition, monitoring statement is made public.	Vietnam's laws do not stipulate clearly monitoring.	Donors arrange independent institutions themselves and monitoring is carried out.

Source: New Environmental Guidelines, World Bank Safeguard policy, Related laws in Vietnam

7.5 Review of the IEE on the Project

The PS Team reviewed the Resettlement Action Plan (hereinafter referred to as "RAP") prepared by ADB in the DA NANG WATER SUPPLY PROJECT (June, 2010). The RAP is reported in detail in the "APP 16.3- Resettlement Plan" of the Final Report of ADB Project, and has been approved by the Da Nang PC.

(1) Summary of the RAP report by the ADB

The contents of the RAP report by the ADB according to the list shown below.

Table 7.2 Summary of the RAP Report by the ADB

Item	Contents
Report-name	PPTA VIE No. 7144 Da Nang Water Supply Project FINAL REPORT APPENDIX 16.3 RESETTLEMENT PLAN
Publication organization	Asian Development Bank
Publication time	June, 2010
Implementation organization	BLACK AND VEATCH, HONG KONG LTD.
Structure of RAP	1. EXECUTIVE SUMMARY 2. INTRODUCTION 3. LEGAL AND POLICY FRAMEWORK 4. PROJECT POLICIES 5. LAND ACQUISITION AND RESETTLEMENT IMPACTS 6. PROJECT ENTITLEMENTS 7. CONSULTATION AND DISCLOSURE 8. RESETTELEMENT PLAN UPDATING AND IMPLEMENTATION 9. IMPLEMENTATION ARRANGEMENTS 10. MONITORING & EVALUATION 11. GRIEVANCE REDRESS MECHANISM 12. INDICATIVE IMPLEMENTATION SCHEDULE 13. RESETTLEMENT PLAN BUDGET

(2) Project Outlines and the Necessity of the Site Acquisition

This Project is a part of "DA NANG WATER SUPPLY PROJECT" planned than support of the ADB with the goal of" halving a ratio of population that safe drinking water and sanitation are not available" to which is MDGs of the United Nations.

The diffusion rate of the waterworks in the Da Nang city increases, a citizen becomes able to use safe service-water and promotes civic health promotion and sustained development of Da Nang City, and a big effect is provided.

This business intends for water treatment plant, pipe line, intake weir, raw water transmission pumping station among "DA NANG WATER SUPPLY PROJECT". And site expropriation of 8.4ha is performed for a construction site of the water treatment plant, and the Resettlement with it arises, the number of the people affected by the business surpasses 200 people, but it becomes clear as a result of study that it is less than 200 that Resettlement is necessary.

In addition, in RAP by the ADB, the expropriation of the site of 2.88ha including the garden, orchard, farmland, mongrel place is required with pipe line construction partially (the Resettlement does not arise).

However, there is not the influence evaluated at these ADB report writing because all the pipe line was changed to the route to lay underground under a public road of Route 601.

(3) Scope of the Site Acquisition and the Resettlement

Table 7.3 summarizes the scope and the range of site acquisition, resettlement arranged in RAP of the ADB

Table 7.3 Summary of Land Acquisition and Resettlement Impacts

Component	Impact on Households		
	Loss of house and other assets	Loss of Land34 and other assets	Total
Water Treatment Plant	32HH 130 persons	20HH 218 persons	52HH 218 persons
	Impact at Commune Level		
	・Relocation of 12 clan burial sites (317 graves) and 1 clan worship house on commune land		
	・Loss of Access Road		
	・Submergence of Irrigation Canal		
	Impact on Public Utilities		
	・Electrical poles and house connections, telephone connections		
	Loss of Land – Total 8.2ha		
	Residential/Garden	Agricultural	Forest/other
	2.9ha	2.8ha	2.5ha
Raw Water Pipeline	Number of structures/assets affected	Loss of private land (m2)	Households/persons affected
	・23 houses ・15 shops • 3610 trees • 1 well	• 14,823 –residential land • 3,426 agricultural land • 10,548 forest land	• 195 Households • 710 people

Source: New : ADB PPTA No.7144-VIE:Da Nang Water Supply Project Final Report: VOLUMEI-MAIN REPORT June 2010

The affected assets by the construction of the pipe line are partial influence, and the removal does

not arise. As a result that a route was reviewed, all the pipe line was laid under the ground in a road of Route 601. There is not the influence evaluated at ADB report writing, and the influence on inhabitants along the pipe line route is largely reduced.

In addition, the boundary line of the planned site of the water treatment plant is measured, and a coordinate point has been established. It is confirmed that there is not the change.

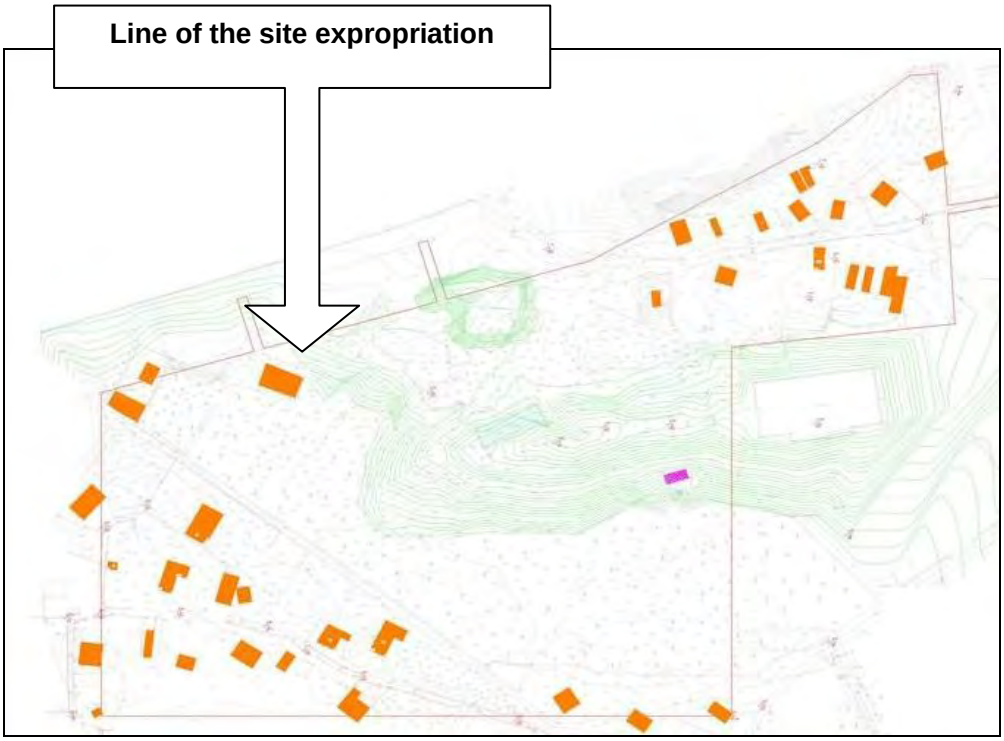


Figure 7.1 The Houses subjected to Demolition within the Planned WTP Site

In addition, scope and the range of the site acquisition in conjunction with the raw water transmission pumping station which is not researched in RAP of the ADB as follows.

Table 7.4 Land Purchase in Conjunction with the Raw Water Transmission Pumping Station

	Item	Contents
Raw water transmission pumping station (settling basin is included)	Resettlement	-
	The household which is affected	-

In the raw water transmission pumping station and the planned site of the settling basin, the house does not exist, and the Resettlement does not arise. In addition, there are not the assets that compensation such as the farmland is required. Discussion with Da Nang City is required after this.

This site is settled as intake point, and a range of the final land expropriation is decided when a

detailed design is carried out afterwards.

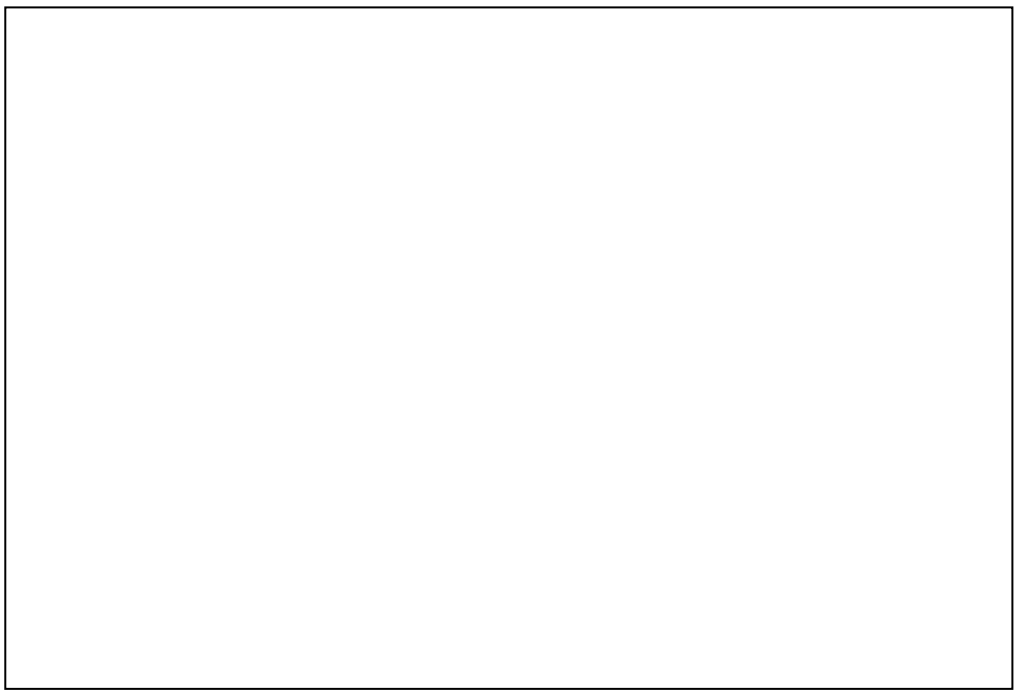


Figure 7.2 Planned Site for Raw Water Transmission Pumping Station

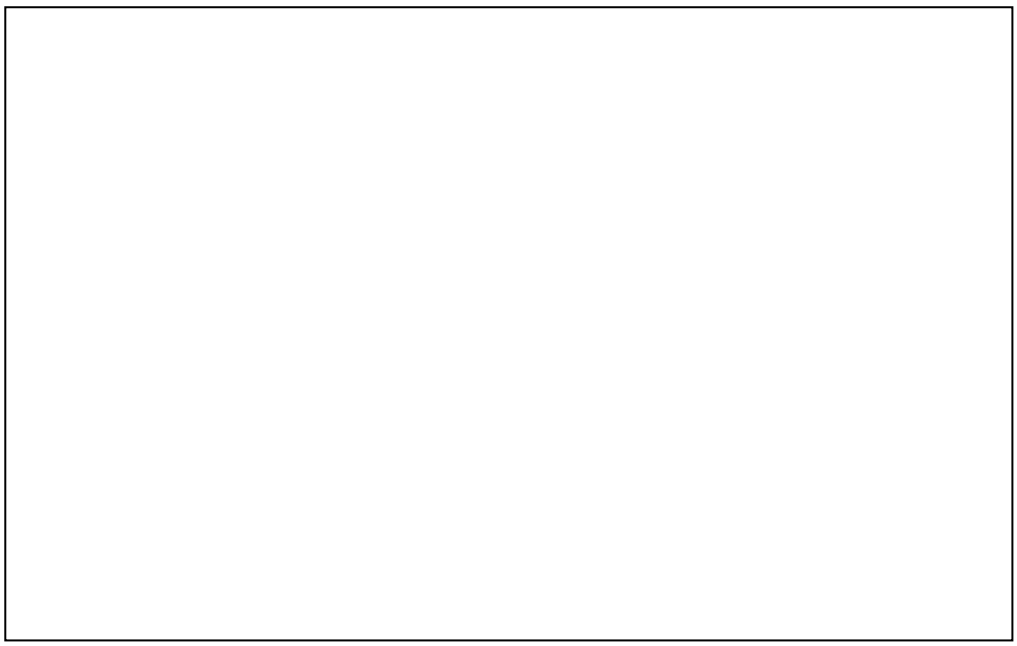


Photo 7.1 Planned Site for Raw Water Transmission Pumping Station (View from Pho Nam bridge)

(4) Household Survey

It is judged that the influence evaluated at ADB report writing will not affect households along the pipe line route because all the pipe line are laid under the ground in a road of Route 601 according to the result that a route was reviewed in the FS. There is no house within the premises of the raw water transmission pumping station and settling basin to be constructed, resulting in no need for resettlement. In addition, there is no asset like farmland for which compensation is required. Thus, the survey was conducted to find out family budget of residents in the planned site of WTP.

1) Job structure of household heads who answered the survey questionnaire

HH heads' main jobs	Number of surveyed household	Percentage (%)
Agriculture	33	63,5
Business, service	2	3,8
Government official	2	3,8
Worker	3	5,8
Handicraft	1	1,9
Employee	2	3,8
Self-employee	1	1,9
Retired, being elderly	7	13,5
Jobless	1	1,9
Total	52	100,0

[Source：PPTA VIE No. 7144 Da Nang Water Supply Project FINAL REPORT
APPENDIX 16.1 SOCIO-ECONOMIC SURVEY FOR HOUSEHOLDS AFFECTED
BY HOA LIEN WATER TREATMENT PLANT page06;and
Socio-economic survey, Hoa Lien WTP, Hoa Lien Commune, September 2009]

2) Average Income and expenditure of household relying on pure agriculture and non-agriculture

		HH Income/month (1,000 VND)	HH Expenditure (for eating, drinking, daily use)/month (1,000 VND)
Non-agriculture	Average	3586.00	3588.92
	Number of HHs	25	25
Pure Agriculture	Average	3696.17	4350.68
	Number of HHs	25	25
Household with elderly HH head who cannot work anymore	Average	1073.75	770.00
	Number of HHs	2	2
Total	Average	3542.34	3846.73
	Number of HHs	52	52

[Source： PPTA VIE No. 7144 Da Nang Water Supply Project FINAL REPORT
APPENDIX 16.1 SOCIO-ECONOMIC SURVEY FOR HOUSEHOLDS AFFECTED
BY HOA LIEN WATER TREATMENT PLANT page06; and
Socio-economic survey, Hoa Lien WTP, Hoa Lien Commune, September 2009]

3) Sources of Income of surveyed households

Jobs	Number of jobs creating cash for earnings	Percentage (%)
Rice planting	44	84.6
Crops	11	21.2
Orchard	7	13.5
Industrial trees	3	5.8
Cattle breeding	31	59.6
Aquaculture	1	1.9
Fishing		
Paid work/employee	16	30.8
Retirement pension/salary	29	55.8
Small business/service	6	11.5
Handicraft	2	3.8
Forestry	5	9.6
Others (self-employed, vendor, etc.)	8	15.4
Total	52	313.5

[Source： PPTA VIE No. 7144 Da Nang Water Supply Project FINAL REPORT
APPENDIX 16.1 SOCIO-ECONOMIC SURVEY FOR HOUSEHOLDS AFFECTED
BY HOA LIEN WATER TREATMENT PLANT page07; and
Socio-economic survey, Hoa Lien WTP, Hoa Lien Commune, September 2009]

4) Income Distribution of surveyed households

Types of households, classified based on level of income per capita per month (1,000 VND)	Number of HHs	%
< 400	13	25.0
401 - 600	12	23.1
601 - 800	3	5.8
801 - 1000	6	11.5
> 1000	18	34.6
Total	52	100.0

[Source： PPTA VIE No. 7144 Da Nang Water Supply Project FINAL REPORT
APPENDIX 16.1 SOCIO-ECONOMIC SURVEY FOR HOUSEHOLDS AFFECTED
BY HOA LIEN WATER TREATMENT PLANT page07; and
Socio-economic survey, Hoa Lien WTP, Hoa Lien Commune, September 2009]

5) Number of households relying on pure agriculture and non-agriculture

Types of works	Number of HHs	Percentage (%)
Non-agriculture	25	48.1
Pure Agriculture	25	48.1
Non-working (by old age, relying on a relative' s assistance	2	3.8
Total	52	100.0

[Source： PPTA VIE No. 7144 Da Nang Water Supply Project FINAL REPORT
APPENDIX 16.1 SOCIO-ECONOMIC SURVEY FOR HOUSEHOLDS AFFECTED
BY HOA LIEN WATER TREATMENT PLANT page07; and
ocio-economic survey, Hoa Lien WTP, Hoa Lien Commune, September 2009]

(5) Resettlement Assessment and Measures

The concrete measure of compensation, the support for site acquisition, the Resettlement is settled in detail in RAP. The main measures as follows.

- Cash compensation for land and structures at replacement cost (free from taxes and transaction costs).
- Cash assistance for permanent loss of production equivalent to market value of produce on affected land per year multiplied by 3 years.
- For temporary use of land - rental in cash which will be no less than the net income that would have been derived from the affected property during disruption.
- Restoration of the land within 3 months after use. Repair allowance not less than 20% of replacement cost of the affected portion or equivalent to the actual cost of repair.
- For perennial crops trees, cash compensation at replacement cost equivalent to current market value given the type, age and productive value (future production) at the time of compensation.
- All costs of excavation, relocation and reburial will be reimbursed in cash to the affected family.
- Graves to be exhumed and relocated in culturally sensitive and appropriate ways
- Transition subsistence allowance of not less than 24 months per household. This will cover living expenses and costs of rebuilding lifestyles.
- Business disruption allowance of not less than 6 months VND 6,000,000/household to cover the loss of income during re-establishing of shops which is reckoned to take six months.
- Additional support allowance of not less than VND 1,200,000 per household for 12 months to cover for additional human resources to help them rebuild their houses and re-establish their livelihood.
- Entitled to take part in Income Restoration Program and vocational programs.

(6) Entitlement Matrix

The entitlement matrix is prepared with the aim to summarize damage, recipients eligible for compensation and support, type of compensation, accountable agency, and others when considered

possible influences caused during project preparation phase and construction phase. A sample of the entitlement matrix is presented in the part of 'Resettlement Policy Framework' in ADB report entitled 'PPTA VIE No. 7144 - Da Nang Water Supply Project DRAFT FINAL REPORT APPENDIX 14, INITIAL ENVIRONMENTAL ASSESSMENT'.

(7) Grievance Redress Mechanism

Grievances related to any aspect of the DNWSP will be handled through negotiation aimed at achieving consensus. Complaints will pass through three stages before they can be elevated to a court of law as a last resort. DAWACO will shoulder all administrative and legal fees that might be incurred in the resolution of grievances and complaints.

- First Stage, Commune People's Committee: An aggrieved affected household may bring his/her complaint before any member of the Commune People's Committee, either through the Village Chief or directly to the CPC, in writing or verbally. It is incumbent upon said member of CPC or the village chief to notify the CPC about the complaint. The CPC will meet personally with the aggrieved affected household and will have 15 days after the lodging of the complaint to resolve it. The CPC secretariat is responsible for documenting and keeping a record of all complaints that it handles.

- Second Stage, District People's Committee: If after 15 days the aggrieved affected household does not hear from the CPC, or if the affected household is not satisfied with the decision taken on his/her complaint, the affected household may bring the case, either in writing or verbally, to any member of the DPC or the District CRC. The DPC in turn will have 15 days following the lodging of the complaint to resolve the case. The District CRC is responsible for documenting and keeping a record of all complaints that it handles.

- Third Stage, Provincial People's Committee: If after 15 days the aggrieved affected household does not hear from the District CRC, or if the affected household is not satisfied with the decision taken on his/her complaint, the affected household may bring the case, either in writing or verbally, to any member of the PPC or the Provincial CRC. The PPC has 15 days within which to resolve the complaint to the satisfaction of all concerned. The Provincial CRC is responsible for documenting and keeping a record of all complaints that it handles.

- Final Stage, the Court of Law Arbitrates: If after 15 days following the lodging of the complaint with the PPC, the aggrieved affected household does not hear from the Provincial CRC, or if he/she is not satisfied with the decision taken on his/her complaint, the case may be brought to a court of law for adjudication. Under no circumstance will the

affected household be evicted from his/her property or will the Government to take over his/her property without the explicit permission of the court. Moreover, CRC will deposit in a project area account to be designated by the court the proffered replacement cost of the subject property. Within 30 days following the adjudication of the expropriation case, CRC will pay the affected household the amount the court decides.

(8) Implementation Arrangements (organization having responsibility and a duty in Resettlement)

The responsibility organization about a plan, the implementation of the Resettlement becomes the Da Nang PC. In addition, as for the thing of the control of the Hoa Vang PC, Compensation and Resettlement Committee (the following, "CRC") is established. A Resettlement plan is carried out as scheduled or is monitored.

The CRC is constructed by the following member.

- The Da Nang Resettlement Support Unit
- The Project PMB
- Hoa Vang District Department of Finance
- Hoa Lien PC
- CSO (Fatherland Front, Women's union, Farmer's union etc.)

(9) Implementation schedule

After due discussion with Da Nang City, it was agreed that the DPC will proceed the necessary land expropriation. The DPC has given instruction to the related agencies such as Hoa Vang PC to accelerate the process to complete by the end of 2014.

Under the control of the DNPC and DPI, Land Acquisition & Compensation Committee was established to oversee the implementation of RAP.

The latest number of RAP updated by the latest data is as follows:

- Total number of people required resettlement: 185 peoples (70 households)
- Total number of people whose house has already been removed: 45 people (15 households)

(10) Cost

Regarding the value of compensation expense, DAWACO is the responsibility organization to update the budget plan of RAP. The cost necessary for land expropriation and resettlement updated

by DAWACO is as follows.

Table 7.5 Compensation Costs and the Actual Budget Spent at May 2014 (VND)

No.	Items	Approved Compensation value	Actual spending to 9/5/2014
(1)	Estimated value of compensation for property damage:	23.367.042.376	11.101.282.590
a.	Land	4.329.068.040	1.597.833.726
b.	House	11.976.282.090	5.781.283.254
c.	Without house including: fish tank, yard, garden, etc	2.852.759.440	2.044.797.820
d.	Plants, farm produce	1.269.113.260	683.112.350
e.	Policy support	1.647.095.160	273.930.180
f.	Allowances	1.292.724.386	720.325.260
(2)	Budget for compensation and site clearance	53.900.000	
	Total (1) + (2)	23.420.942.376	11.101.282.590
Note: The cost is not incurred in acquiring the site of about 0.95 ha for the raw water transmission pumping station because the planned land belongs to Da Nang City. However, it will be reviewed in cooperation with Da Nang City to make the project implementation go smoothly.			

(11) Monitoring Form

It is recommended that monitoring be conducted in order to continuously review the project implementation schedule, possible payment for compensation and other issues. Table 7.6 displays a tentative monitoring form.

Table 7.6 RAP Monitoring Form

Preparation of Resettlement Site (where necessary)

No.	Explanation of site (e.g. Area, No of resettlement HH,etc)	Status (Completed(date)/not compleated)	Deatails (Site Selection, identification of candidate site, discussion with PAPs, Development of the Site, etc)	Expected Date of Completion
1				
2				

Public Consultation

No.	Date	Place	Contents of the consultation/ main comments and answer
1			
2			

Resettlement Activity

Resettlement Activity	Planned/ total	Unit	Progress in Quantity			Progress in %		Expected Date of Completion	Responsible Organization
			During the Quarter	Till the Last Quarter	Up to the Quarter	Till the Last Quarter	Up to the Quarter		
Preparation of RAP									
Employment of Consultants		Man-month							
Implementation of Census Survey									
Approval RAP			Date of Approval;						
Finalized PAPs List		No.of PAPs							
(i)Progress of Compensation Payment									
Lot 1		No.of HH							
Lot 2		No.of HH							
Progress of Land Acquisition									
Lot 1		ha							
Lot 2		ha							
Progress of Assets Replacement									
Lot 1		No.of HH							
Lot 2		No.of HH							
Progress of Relocation People									
Lot 1		No.of HH							
Lot 2		No.of HH							
(ii) Progress of Information dissemination and public Meeting									
Lot 1									
Lot 2									
(iii) Grievance Redness									
Member of Grievance Redness		Nos.							
Receiving complain									
Disposing off complain									
Assist HH in replacement									
(iv) adjust a schedule with construction									
Lot 1									
Lot 2									

(12) Conclusion and Recommendation

- About the land expropriation of the water treatment plant as for the thing of Da Nang PC, in the control of the Hoa Vang PC, Compensation and Resettlement Committee and DAWACO stimulate site expropriation and resettlement.
- A coordinate is set in the range of the water treatment plant by actual survey, it was

confirmed in an RAP plan of the ADB and the execution plan that there was not the change.

- The route of the pipe line is laid under the ground under a road site expropriation and the resettlement does not arise.
- About the raw water transmission pumping station (include settling basin), site expropriation is necessary. For a mongrel place, resettlement and the compensation duties are not caused. After final decision of the intake point, an area and a cost of the site expropriation are calculated.
- In the event where resettlement and land expropriation are necessary to implement the project, it is considered that PAPs might require preparation of reciprocal sites, not compensation in money. It is necessary to confirm whether acquisition cost of the reciprocal sites is included in financial backing for their resettlement.
- In the event where preparation of reciprocal sites is already done, it is recommended to confirm through DAWACO whether their standard of living is equal to or higher than that before their resettlement.

CHAPTER 8 ESTIMATION OF PROJECT COST

This Chapter provides the estimation of construction cost based on the preliminary design of Hoa Lien WTP, raw water main, and water intake facility.

8.1 Method and Condition of Cost Estimation

Construction cost account for a considerable portion of the total cost of project implementation, and is a basis to determine water price. With this in mind, detailed cost estimation was carried out in accordance with the following policies:

- Collaborate with experienced local consultants to make accurate quantity survey and to make a reasonable cost estimation based on the local condition
- Create a budget estimation using a Capital Cost Estimation, instead of using unit rates and/or by multiplying the cost for main facilities by the total expense ratio without studying the cost for each attachment member, in order to increase calculation accuracy
- Examine the unit price for the civil works based on the Vietnamese standard listed below. In parallel, for the purpose of reflecting the current market price, detailed reviews on these standard prices were conducted by Kajima, the local consultant and Da Nang-based contractors.
  - Construction Unit Price - Construction Portion. Issued pursuant to Decision No.324/UBND-QL§T dated 16th January 2008 of Da Nang People's Committee
  - Construction Unit Price - Installation Portion. Issued pursuant to Decision No.325/UBND-QL§T dated 16th January 2008 of Da Nang People's Committee
  - Cost Estimate Quota of Construction Works - Construction Portion No.24/2005/BXD-VP dated 29th July 2005 of MOC
  - Cost Estimate Quota of Construction Works - Installation Portion No.33/2005BXD-VP dated 29th July 20075of MOC
  - Labor cost table, construction machine cost and labor cost adjusting coefficient. Issued pursuant to Decision No.11/TB-UBND dated 15th January 2013 of Da Nang People's Committee

- Collect quotations for all the necessary equipment from several companies to compare and study appropriate price
- Use the primary criteria for selecting supplier and/or machinery equipment
  - ✓ Availability of machinery and equipment with necessary function
  - ✓ Price of machinery and equipment
  - ✓ Nationality of manufacturer (domestic or international):

In order to minimize the initial and maintenance cost, the basic policy of the FS Team is to procure the necessary equipment within Viet Nam whenever possible. In parallel, imported options including from Japan were also studied for the better choice

- ✓ Running cost of equipment:
  Specifications that affect running cost was carefully studied, including required electricity consumption and frequency of major maintenance and/or replacement. However, actual running cost will be affected by the operation condition. Thus, the PS Team conducted the study in a qualitative manner.

- Carry out a review of quotes together with DAWACO to validate the accuracy of quantity survey and reasonability of selected unit price for each equipment
- Use the most recent exchange rate, the exchange rate applied for this FS Report presently is; USD 1 = VND 21,150 = JPY 103.6
- Project cost includes construction cost, preliminary expenses, interest payment and escalation.
- As for the other conditions to calculate water price including customs duty are provided in "13.1 Principal Conditions" in the Chapter 13.

8.2 Estimated Cost

Based on the preliminary design and the above-mentioned conditions, construction and operation cost were estimated as provided in Chapter 13.

CHAPTER 9 RISK ANALYSIS

9.1 Risk Identification and Risk Allocation

(1) Principle for Risk Allocation

A particular risk of a PPP/BOT infrastructure project should be borne by a party most suited to deal with it, in terms of control or influence and costs.

Main players of the Project, who may take some risks, include the SPC which will be established by the project sponsors to build and operate the water treatment plant, Da Nang City which concludes the BOT/PPP Contract with the SPC, DAWACO which purchases treated water from the SPC, and lenders who provide nonrecourse project financing.

The Governments of Vietnam and Japan, JICA and ADB are also very important main players, who could mitigate some of the major risks by providing appropriate measures such as guarantees and watching the relevant parties' compliance with the contracts.

The SPC, which undertakes infrastructure development: water supply, and finances much of initial development costs by project financing, should involve no other business than water supply and be managed transparently. The SPC gains revenue only by providing water to Da Nang City, but cannot at its discretion increase water tariff or supply water quantity without the consent of Da Nang City. The SPC owing heavy debt for initial development has to repay that by the tariff income. Therefore the SPV is financially a vulnerable company. If the payment from DAWACO is delayed for example, the SPC could fall into default on a loan agreement, which means that risks in the project borne by the SPV should be disaggregated, quantified and limited.

The SPC will bear the risks in the Project according to the following principle:

- In the stage of planning, design and construction, the SPC bears all the risks to the extent, which can be guaranteed by the SPC investors based on its technologies, expertise and experiences in water supply sector.
- In the stage of maintenance and operation, the SPC delivers the water supply service economically and efficiently with technical skills and abilities provided by the SPC investors and bears all of usually acceptable risks except that mentioned below
- In principle, the SPC cannot take risks beyond its control, such as regulatory and institutional risk, macroeconomic risk, risks associated with force majeure, delay in approval, delay in land acquisition and any disputes by local residents arising from unfounded complaints.

Details of risk allocation, including a distribution of risks among SPC, Da Nang City and lenders,

financial supports by government entities of Japan and Viet Nam, are described in contracts, e.g. a bulk water supply agreement, a sales purchase agreement, a loan agreement and an EPC contract etc.

(2) Risk Identification and Allocation

Information is confidential.

9.2 Risk Countermeasure

Information is confidential.

9.3 Water Pricing Method

Water price should be determined taking into consideration the following three points:

- The SPC needs to make a structure to secure the payment to the project cost and the profit each year during the entire Project period as a commercial operator.
- DAWACO can purchase the treated water from the SPC with securing its own profitability.
- DAWACO can finance water supply operation and management by the collected water tariff.

In consideration of these factors and the study results on the future water demand prediction, it has been agreed that the fixed amount of the treated water from the Hoa Lien WTP will be delivered to DAWACO according to the schedule below. The payment from DAWACO to the SPC will be calculated and paid by DAWACO by multiplying this fixed amount of the treated water by the water sale price at that time.

60,000 m^3/day in 2019
80,000 m^3/day in 2020
100,000 m^3/day in 2021
120,000 m^3/day in 2022 and after

9.4 Financial Condition of the Related Organizations

Information is confidential.

CHAPTER 10 PROJECT IMPLEMENTATION SCHEME

10.1 Determination of Project Implementation Scheme

The Project is originally a part of the project planned and supported by ADB as Da Nang Water Supply Project. The PS Team is planning to implement this project as a PPP/BOT project to supply bulk water to DAWACO.

10.2 Process of Project Implementation

In Vietnam, Decree No.15/2015/ND-CP is legal framework that may be applied to this project. This Decree was enacted on 14th February 2015 and enforced from 10th April 2015, which was made by integration of BOT law (Decree No.108/2009/ND-CP) enacted in November 2009 and Prime Minister Decision on PPP project approved in November 2010 (Decision No.71/2010/QD-TTg). According to Decree No.15/2015/ND-CP, detail such as process of evaluation and approval on investor's proposal, contents of feasibility study seems to follow guidelines or circulars. But basically, this project will be implemented within the framework of Decree No.15/2015/ND-CP. Therefore we make a study to implement this project based on Decree No.15/2015/ND-CP.

The process to implement a BOT project based on Decree No.15/2015/ND-CP is as follows. Since there is some detail procedure to be determined later in guideline etc. and there are no example which were already implemented based on Decree No.15/2015/ND-CP, following procedure is our understanding on current legal framework.

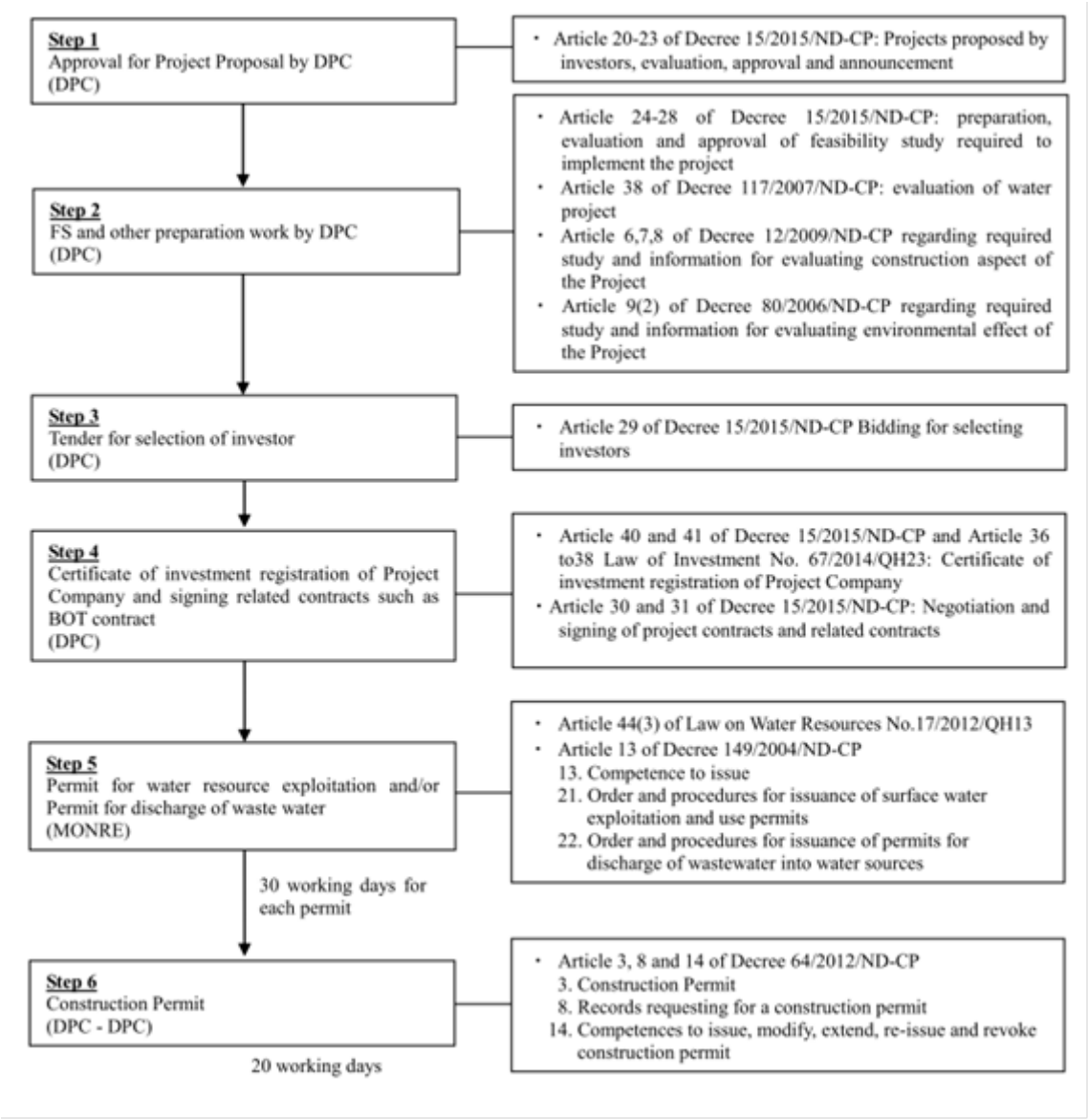


Figure 10.1 Procedure to Implement BOT Project

Step 1: Approval for Project Proposal by DPC

As the Project has not been included in the list of approved BOT projects of Da Nang City, the Investors will need to submit a Project Proposal for the DPC's approval to include the Project into the list of Da Nang City's BOT projects as per Article 21 of Decree 15/2015/ND-CP.

Step 2: FS and other preparation work DPC

It is provided under Article 24 (1) of Decree 15/2015/ND-CP that: "*Ministries, branches and provincial-level People's Committees shall organize the formulation of the feasibility study report*

of projects which shall be the basis to formulate the request for proposals for the investor selection and project contract negotiation.", and it is provided under Article 27 (2) of Decree 15/2015/ND-CP that: *"Ministers, Heads of the ministerial-equivalent bodies and Chairmen of the provincial-level People's Committees shall approve the feasibility study report of group A and group B projects".* Therefore DPC and its Chairman will be involved in preparation and approval of feasibility study report.

It is also provided that the fund to carry out the FS will be arranged from the Vietnamese state budget or other fund and the investor winning the tender in the next step will need to reimburse such expenses to the Vietnamese authorities.

Article 38 (3) of Decree 117/2007/ND-CP requires that project to invest in water treatment plants in urban zones (except for urban zones of special grades i.e. Hanoi, Ho Chi Minh City) with capacity of 10,000 m3/day must be approved in writing by the MOC before being licensed.

Step 3: Tender for selection of investor by DPC

Tender for selection of investor is a compulsory procedure, even in case the Project is proposed by the Investors. After the Project is approved to be performed under the BOT framework, DPC must publish the tender request on their website.

According to Article 22 (4) of Law on Bidding No. 43/2013/QH13 and Article No.22 (4) of Decree No. 30/2015/ND-CP, tender procedure can only be replaced by appointment of investor in case:

- Only one investor registers and satisfies requirements of the pre-qualification; or
- Only one investor is capable of executing the project; or
- Some conditions are satisfied such as Prime Minister approves that the project proposed by the investor is most efficient if the investor implant the Project.

Step 4: BOT Contract Signing

After an investor is selected, selected investor and DPC negotiate a draft of BOT contract and sign investment agreement to confirm the agreed contents (Article 30 of Decree 15/2015/ND-CP). Then, based on Article 40 and 42 of Decree 15/2015/ND-CP and Article 36-38 of Law on Investment No. 67/2014/QH13, investor will establish Project Company to implement the project after getting approval of DPC. Then, BOT contract will be signed between the Project Company and DPC according to Article 31 of Decree 15/2015/ND-CP.

According to Article 31 (1) and (3) of Decree 15/2015/ND-CP, two ways to agree on right and obligation of the Project Company is provided; one is the project company signs the BOT contract to join with the investor and the other is investor and the Project Company sign the separate document to take over the rights ad obligation of the investors.

Step 5: Permit for water resource exploitation and/or Permit for discharge of waste water by MONRE

In accordance with Article 44(3) of Law on Water Resources No. 17/2012/QH13, a permit for water resource exploitation must be obtained before the investors can start project company licensing procedures.

Permits for water resource exploitation are within the authority of the MONRE in case of "*exploiting, using surface water for other purposes with flow of **5,000 m3/day and night** or more*". MONRE will also decide to grant permits for discharge of waste water for projects "*discharging wastewater into water sources with the flow of **5,000 m3/and night** or more*".

Step 6: Construction Permit

Construction permit might be exempt if the construction works of the Project is considered to fall *into "construction works by lines not passing through urban areas but in accordance with the construction plans which have been approved by the competent State agencies*" or *"Works under construction investment projects decided on the investment by the Prime Minister, ministers, heads of ministerial-level agencies, the presidents of People's Committees at all levels".*

Otherwise, a construction permit must be obtained from Da Nang DOC before the start of construction work.

10.3 Parties Involved in the Project and Their Contractual Relationships

(1) Parties Involved

The following parties are expected to be involved in the Project covered by the survey. [1] The Vietnamese government, [2] Off-takers, [3] Investors/SPC, [4] Lenders (Financial institutions), [5] Insurance companies, [6] Subcontractors

Information is disclosed.

Figure 10.2 Parties Involved in the Project and Their Main Contractual Relationships

(2) Contracts

At this time, the following contracts are being discussed to be concluded for the project:

1) Investment Agreement and BOT contract (among DPC, investors and SPC)

Investment Agreement is an agreement between DPC and investor to confirm the contents of draft of BOT contract agreed in negotiation after selection of investor. In addition to the basic items of the business contract prescribed in Article 32 (1) of Decree 15/2015/ND-CP and guideline to be enacted in the future , we will include conditions (risk allocation, guarantee, etc.) that prospective investors expect to have for the Project, and other general points to note. The details on these will be decided through further discussions. An example of the term sheet for this Project is provided in Attachment 1. However, it should be noted that: the attached term sheet is only a draft which has not been agreed upon with the DPC; it is highly likely that the draft term sheet to be discussed will be prepared by the DPC themselves; and some amendments and additions will be required by contractual lenders.

2) Water purchase and sales contract (between DAWACO and SPC)
A water purchase and sales contract should cover the conditions provided in Circular No. 01/2008/TT-BHD. The PS Team will consider conditions such as risks in the Project, which shall be discussed and agreed with DAWACO. The example of the water purchase and sales contract for this Project is provided in Attachment 2. However, it should be noted that: the attached term sheet is only a draft which has not been agreed upon with the DPC; it is highly likely that the draft term sheet to be discussed will be prepared by the DPC themselves; and some amendments and additions will be required by contractual lenders.

3) Shareholders agreement (among shareholders)
Provisions will be discussed among prospective investors.

4) EPC agreement (between EPC contractor and SPC)
As an EPC agreement generally required for the BOT infrastructure project, we intend to conclude a Lump Sum & Turnkey Contract based on FIDIC Conditions of Contract for EPC / Turnkey Projects First Edition 2008 (commonly known as FIDIC Silver Book).

5) O&M agreement (between SPC and company in charge of operations, maintenance and management)
It is also considered that SPC will be engaged in operations, maintenance and management. In this case, this agreement will not be necessary. This matter will be discussed along with the SPC organizational structure.

6) Power supply agreement (between electric power company and SPC)

7) Material (drug, etc.) supply agreement (between material maker and SPC)

8) Insurance contract (between insurance company and SPC)

9) Financing agreement (between JICA and SPC)

10) Guarantee or Undertaking from Vietnamese Government

10.4 Business Company (SPC)

(1) Legal procedure, form, and management of SPC

The Enterprise Law (Law No. 60/2005/QH11) stipulates the legal framework for companies in all forms including those stated below to be set up and be operated in Viet Nam:

- Limited liability company with a single member
- Limited liability company with two or more members
- Joint-stock company
- Partnership company
- Private-sector enterprise

When the investors establish an SPC for this project, it is expected that the SPC will be a joint-stock company or a limited liability company with two or more members.

In the case of a joint-stock company, the chairman of the board of directors or the president, and in the case of a limited liability company with two or more members, the chairman of the general meeting of employees or president should be registered as the legal representative of the company. Whether for a joint-stock company or for a limited liability company with two or more members, the legal representative should live in Viet Nam during his/her tenure. If the legal representative stays outside of Viet Nam for more than 30 days, he/she should grant the authority of the legal representative to another person in writing.

In addition, investors and SPC for the BOT project should comply with the following obligations described in Decree 15/2015/ND-CP:

- When the BOT agreement expires, this project should be given over to the Vietnamese government with no payment.
- A minimum financial contribution is required. (15% of the total investment value up to VND1,500 billion (about USD75 million), or 10% of the total investment value exceeding VND1,500 billion)
- The PS Team considers that budget for cost of compensation, site clearance and resettlement will be allocated by DPC and paid by Da Nang City, since implementation of this Project is urgent considering water demand prediction.
- SPC can agree on the form, value and effective term of security for performance of project contract in accordance with the laws on public procurement.
- Collateral for SPC's assets should be used to get approval from Vietnamese government agencies and should not affect the goal, progress, or operations of the project.

(2) Organizational Structure of SPC

Information is disclosed.

Figure 10.3 Organizational Structure of SPC

CHAPTER 11 PROJECT IMPLEMENTATION SCHEDULE

Information is confidential.

CHAPTER 12 FINANCING ARRANGEMENT

12.1 Possibilities and Strategies of Financing Arrangements

The Project is aimed for PPP/BOT project, in which SPC will be established and will raise funds. In general, there are two ways for PPP/BOT projects to raise funds: one is equity from sponsors and the other is loan from financing institutions such as JICA, banks, etc.

This Survey focuses on the latter and considers possibilities and strategies of loan from various financing institutions as below.

Information is confidential.

12.2 Optimization of Fund Raising

Information is confidential.

12.3 Funding Cost

Information is confidential.

CHAPTER 13 ECONOMIC ANALYSIS

13.1 Preconditions

Economic Analysis will assess the profitability of the Project based on the construction costs estimated in session 8 and the operation costs such as the major maintenance costs and operation expenditures. The terms and conditions of the Project are to be supposed as mentioned below.

Table 13.1 Project Outlines

Information is confidential.

(1) Project Cost

Information is confidential.

Table 13.2 Project Cost

Information is confidential.

(2) Financing

Table 13.3 Financing

Information is confidential.

(3) Operation Expenditure

SPC is supposed to operate the water plant with the following expenses, such as the SPC‘s operation expenses, the labor costs for the water plant and raw water conveyance, the cost of power and the chemicals costs. Maintenance costs include the medium and large maintenance / repairs. The following maintenance cost is the average of the whole maintenance cost for 20 years.

Table13.4 Operation Expenditure

Information is confidential.

(4) Major Maintenance Cost

Information is confidential.

Table 13.5 Major Maintenance Cost (JPY million)

Information is confidential.

(5) Tax Assumption

Information is confidential.

Table 13.6 Tax

Information is confidential.

(6) Depreciation

Information is confidential.

Table 13.7 Durable Years for Mechanic/Electrical Equipment

Information is confidential.

13.2 Sensitivity Analysis

Based on the terms and conditions mentioned above, the economic analysis will be implemented on the cash flow model. In order to evaluate the performance of the Project, Debt Service Coverage Ratio ("DSCR") and Loan Life Coverage Ratio ("LLCR") are calculated, which are often employed for the financial covenants, Internal Rate of Return ("IRR") for the profitability of the Project. Discount factors are to be calculated from the lending interest rates.

Information is confidential.

13.3 Proposed Water Price

In accordance with the preconditions and sensitivity analysis mentioned above, we made a proposal based on Main Scenario (Assumption 1) to DAWACO about the water price on the project.

Information is confidential.

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