SOCIALIST REPUBLIC OF VIETNAM
CAN THO PEOPLE'S COMMITTEE
CAN THO WATER SUPPLY AND SEWERAGE COMPANY, LTD.

PREPARATORY STUDY ON CAN THO CITY WATER SUPPLY IMPROVEMENT PROJECT

FINAL REPORT (SUMMARY)

March 2013

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NIPPON KOEI CO., LTD.
SWING CORPORATION
MITSUBISHI CORPORATION
PRICEWATERHOUSECOOPERS CO.,LTD.

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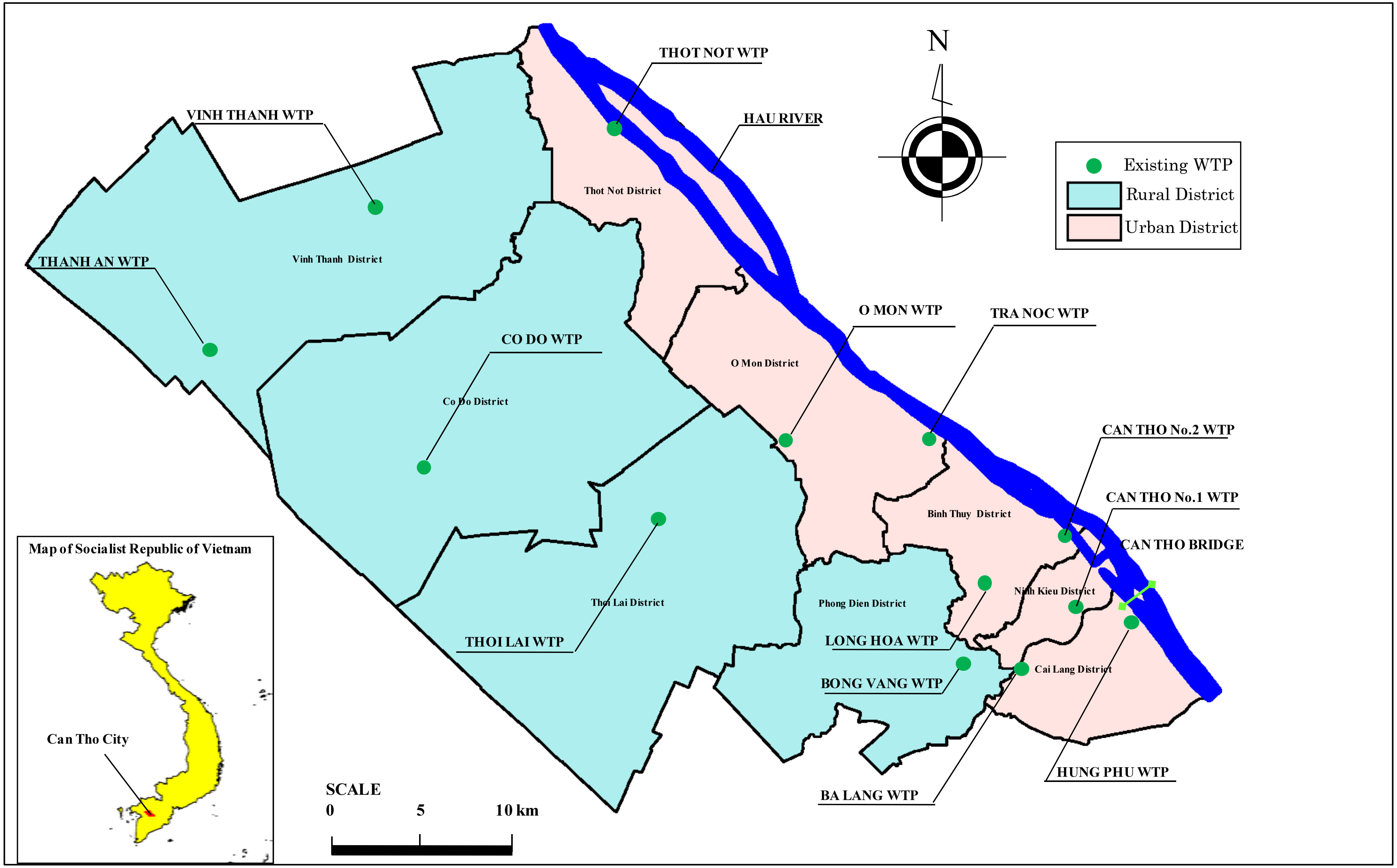
Exchange Rate

1 USD = 77.92 USD

1 Yen = 266.36 VND

1 USD = 20,890 VND

(As of End of May 2012)



Source : JICA Study Team

Location Map of Study Area

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AC	Accelator
AF	Aquazur Filter
AMSL	Above Mean Sea Level
ARP	Abbreviated Resettlement Plan
BOD	Biological Oxygen Demand
BOT	Build Operate Transfer
BTO	Build Transfer Operate
C/B	Cost-Benefit Ratio
Can Tho PC	the People's Committee of Cantho City
CAPEX	Capital Cost
CERWAS	Center for Rural Water Supply and Sanitation
CGF	Conventional Gravity Filter
CIF	Cost, Insurance and Freight
COD	Chemical Oxygen Demand
DARD	Department of Agriculture and Rural Development Can Tho City
DCI	Ductile Cast Iron
DF/R	Draft Final Report
DI	Ductile cast Iron
DO	Dissolved Oxygen
DOC	Department of Construction of Cantho City
DOF	Department of Finance of Can Tho City
DONRE	Department of Natural Resources and Environment of Cantho City
DOST	Department of Science and Technology of Can Tho City
DOT	Department of Transportation
DP	Displaced Person
DPI	Department of Planning and Investment of Cantho City-Vietnam
DSRA	Debt Service Reserve Account
EIA	Environmental Impact Assessment
EIRR	Equity Internal rate of Return
EPC	Engineering, Procurement and Construction
EVN	Vietnam Electric Corporation
F/R	Final Report
F/S	Feasibility Study
GDP	Gross Domestic Product
GLF	Green Leaf Filter
GSO	General Statistics Office
HM	Hydraulic Mixing
IC/R	Inception Report
IMF	International Monetary Fund
IRR	Internal Rate of Return
IZ	Industrial Zone

JICA	Japan International Cooperation Agency
LPEB	Land Pricing Evaluation Board
MM	Mechanical Mixing
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
NPV	Net Present Value
NRW	Non-Revenue Water
ODA	Official Development Assistance
O&M	Operation and Maintenance
OPEX	Operation and Maintenance Cost
PACl	Poly Aluminum Chloride
PF	Pressurized Filter
PPP	Public Private Partnership
PSIF	Private Sector Investment Fund
PU	Pulsator
PVC	Polyvinyl Chloride
RAP	Resettlement Action Plan
RRA	Replacement Reserve Account
SB	Sludge Blanket
SCF	Standard Conversion Factor
SEPIZA	Can Tho Export Processing & Industrial Zones Authority
SIWRPM	Sub-Institute of Water Resources Planning and Management
SPC	Special Purpose Company
SS	Suspended Solid
TOR	Terms of Reference
TSS	Total Suspended Solids
VAT	Value Added Tax
VND	Viet Nam Dong
VVVF	Variable Voltage Variable Frequency
WLG	Water Level Gauge
WSSC	Cantho Water Supply and Sewerage Company., Ltd
WTP	Water Treatment Plant

CHAPTER 1 INTRODUCTION

1.1 Background

Can Tho City was designated as a centrally-governed city under the decision of the national government. Can Tho City has an approximate area of 1390 km^2 and a population of 1.2 million as of 2011. The population is expected to increase to 1.5 million in 2020.

Due to the rapid increase in population and economic growth, water scarcity is becoming a critical problem. Furthermore, groundwater contamination in the surrounding areas of Can Tho City and salt water intrusion from the downstream of Hau River are among the critical issues in the water environment.

Under such condition, the Can Tho People's Committee (hereinafter referred to as Can Tho PC) has proposed in its general master plan to establish new water supply facilities in the upstream area of Hau River for the target year 2030. In addition, the Can Tho PC has planned to execute the water supply system improvement jointly with private sector participation.

To meet the abovementioned requirements of Can Tho PC, the Japan International Cooperation Agency (JICA) has decided to execute a technical assistance to carry out the preparatory study, namely, the Feasibility Study for Private Sector Participation in the Water Supply Project for the target year 2020 (hereinafter referred to as the “Study”). The Study will help in clarifying the necessity and sustainability of the project in view of its technical, financial, and environmental aspects, as well as proposing optimum implementation plan and operation and maintenance (O&M) schemes by utilizing private investment and foreign funds.

The Study commenced in the beginning of May 2012 and was carried out for about ten months until the end of February 2013 involving field works and home works in five stages. The major findings and analytical results carried out during the Study were summarized in this Draft Final Report.

1.2 Objective and Necessity of the Preparatory Study

In recent years, the Government of Vietnam has decided to expand project promotion utilizing public-private partnership (PPP) schemes. Pursuant to this decision, the Can Tho PC has decided to execute water supply and sewerage projects under PPP schemes in 2012.

Under such conditions, Nippon Koei Co., Ltd., Mitsubishi Corporation, and Swing Corporation proposed to implement water supply system improvement projects by establishing a special purpose company (SPC). These will be under the financial support of JICA’s Private Sector Investment Fund (PSIF), together with the implementation of this Study through grant aid.

1.3 Study Area

The Study area covers Can Tho City consisting of urban and rural districts. For the selection of priority projects to be carried out under the JICA's PSIF scheme, practically through build-operate-transfer (BOT) scheme, the core area of the city center was selected as the priority project area.

CHAPTER 2 GENERAL CONDITIONS OF THE PROJECT AREA

2.1 Natural Conditions

2.1.1 Topography

The total area of Can Tho City is 298,561 ha and the land is covered with fertile alluvial soil, which is suitable for agriculture. According to the 2010 report on the existing environmental conditions in Can Tho City, about 82% of the land is used for agriculture, 17% is allocated for non-agricultural purposes such as residential area and industrial zones, and the 1% remain idle.

The general topography of Can Tho City is relatively flat, and is gradually low from north to south and from east to west (from Hau River to the inner land). Can Tho City has an altitude of 0.2-1.5 m, and slightly declines from the Hau River bank to the inner land.

2.1.2 Meteorology

Can Tho City is located in a tropical and monsoonal region. It is hot and humid all year round. The annual mean temperature is around 27 °C and the mean annual humidity is 82%. The annual rainfall of Can Tho City varies from 1200 mm to 700 mm. The mean annual rainfall is 1500 mm. The rainy season lasts from May to November, while the dry season is from December to April.

During peak hours, heavy rain combined with high tide of the Hau River overflows and inundates the city, leading to traffic jam in the city area.

2.1.3 Hydrology

There are 158 tributaries and canals that intersect within the city. According to the Can Tho City Master Plan 2030, the total length of the rivers and canals in Can Tho City is 800 km. The largest river is the Hau River that runs to the northeast of the city. Generally, the flow ratio of the Hau River is about 200 billion m^3 per year, which is 41% of the total volume in the Mekong River.

The discharge of the Hau River in the dry season is approximately 1000 m^3/s. The water level of the Hau River is affected by the flow from the upstream and tidal level. The water level begins to rise in July and reaches the highest level in September or November, and then declines in February.

There was a serious flood in 2000 in the Lower Mekong River Delta, which was one of the biggest floods in decades. The observed water level at the Can Tho Hydrological Station during the flood was 1.9 m, which is the highest in the last 40 years. According to the Water

Supply and Sewerage Company (WSSC), the elevations of existing water treatment plants are relatively high and the plants have never experienced inundation.

2.1.4 Geology, Geography, and Hydrogeology

Can Tho City is located in the alluvial plains of the Hau River. According to Can Tho City General Master Plan 2030, the volume of sediment, which was transferred through the Hau River, is 35 million m^3 per year.

In the detailed design of the Can Tho Bridge Project, the standard penetration test yielded the following soil characteristics. The surface layer up to EL-50 m is composed of soft clay where the N-value is 1 to 5. Layer St/C-1, which is reddish light brown silty clay with a little sand, lies within El -40 m to El -50 m. The N-value for this layer varies from 13 to 60 in proportion to sand content. The layer from El -70 m to El -95 m consisting of brownish color fine sand revealed N-value of more than 60.

2.1.5 Water Quality

The water quality in Can Tho City is being monitored by the Center for Natural Resources and Environmental Monitoring under the Department of Natural Resources and Environment (DONRE). The monitoring is conducted through sampling and laboratory tests, which are normally made three to four times a year and 12 times at heavily polluted canals.

Profile surveys along the Hau River were conducted twice a year and the measurement was started in 2002 for items such as pH, salinity, and dissolved oxygen (DO). Water quality levels are classified into four classes, namely: A1, A2, B1, and B2, depending on water use and type of treatment.

The water quality of rivers and canals is evaluated under surface water quality standard. Some canals are classified as heavily polluted canals, where sampling is being conducted 12 times a year. In the 2010 report on the existing environmental conditions in Can Tho City, the testing results composed of surface water quality standard. The pH, F^-, Cr^{6+}, As, and Hg were below the A1 level, while the remaining items exceeded the A1 level.

(2) Site Survey

In the course of the Study, water quality sampling and testing were conducted by the JICA Study Team on May 29, 2012. The sampling and laboratory test results are shown in Table 2.1.1. Some of the test items are above the standard levels. Nevertheless, these items will be appropriately treated by the water treatment process.

Table 2.1.1 Summary of Water Quality Test at O' Mon Proposed Site

No.	Specification	Units	Test Results	Surface Water Quality Standard (QCVN 08: 2008/BTNMT)			
				A1	A2	B1	B2
1	Total Suspended Solid (TSS)	mg/L	39	20	30	50	100
2	COD	mgO_2/L	18	10	15	30	50
3	BOD_5 (20℃)	mgO_2/L	8	4	6	15	25
4	Ammonia Nitrogen (NH4)	mg/L	0.22	0.1	0.2	0.5	1
5	Iron (Fe)	mg/L	1.69	0.5	1	1.5	2
6	Total Oil and Grease	mg/L	2	0.01	0.02	0.1	0.3

Source: JICA Study Team

2.1.6 Saltwater Intrusion

Before the 1980s, agricultural areas in the Mekong Delta have been affected by saltwater intrusion every dry season. In the period between the 1980s and 1990s, a number of salinity control projects were implemented, such as construction of closure dams and sluice gates in the navigation canal network in the delta region.

Salinity measurements by boat along the Hau River have been conducted by DONRE twice a year since 2002. According to the Can Tho City General Master Plan 2030, saltwater intrusion was observed at 12 km downstream of the city in 2004 during the dry season, and it came closer at 8 km downstream of the city in April 2010.

From the interview with DONRE, several water quality meters have been recently installed around the city under the Water-related Information System for the Sustainable Development of the Mekong Delta (WISDOM) Project between Vietnam and Germany. The observation started in April 2012.

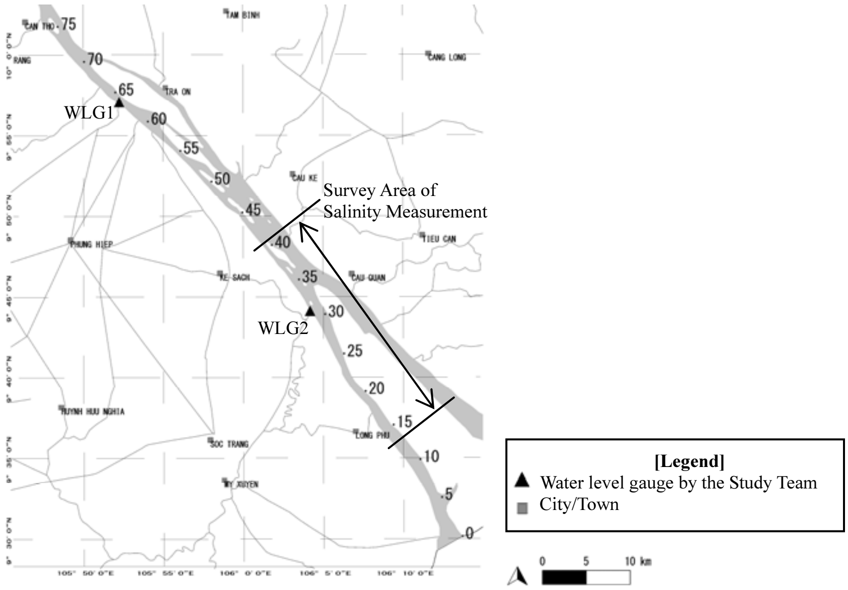
According to the description of the Mekong River Commission, the extension of saltwater intrusion was largely affected by the flow rate of the Hau River and the tide water level. Therefore, the magnitude of saltwater intrusion will be very much affected by the change of climate and river flow rate control in the upstream area such as by dam construction.

The commission predicted that the dam will be constructed in the upstream area even during climate change. Saltwater intrusion may be only up to 40 km from the estuary, since saltwater will be washed away to the estuary. While there will be no dam construction in the upstream area during climate change in 2020–2029, the saltwater intrusion will be 7 km downstream from Can Tho City. In the same manner, it will be 3 km downstream from Can Tho City in 2040–2049.

2.1.7 Saltwater Intrusion Survey in this Study

Salinity measurement was conducted using water quality meter (WQC-24) and boat during high tide. Temporary water level gauges were installed in the Hau River to know the time of high tide occurrence. The water level was measured manually at one hour interval.

The location of the survey is shown in Figure 2.1.1. The survey was conducted 15-40 km upstream of the Hau River mouth. Can Tho City is located 77 km upstream of the river mouth.



Source: JICA Study Team

Figure 2.1.1 Location of Saltwater Intrusion Survey

The survey was conducted at neap and spring tides. The period of the survey is shown in Table 2.1.2.

Table 2.1.2 Period of the Saltwater Intrusion Survey

Type of Survey	Period	Note
Salinity Measurement	June 12 to 13 and 19 to 20, 2012	Neap tide on June 11, 2012 Spring tide on June 29, 2012
Water Level Observation	June 8 to 14, 2012 at WLG1 June 14 to 22 2012 at WLG2	WLG was relocated on June 14, 2012

Source: JICA Study Team

Saltwater intrusion was found approximately 30 km upstream of the Hau River mouth, which was approximately 45 km downstream of Can Tho City. The condition of saltwater was found to be partially mixed.

The survey was conducted in the beginning of the rainy season. It was confirmed that saltwater intrusion was located only near the estuary. It can be estimated that the probability of saltwater intrusion to Can Tho City is extremely minimal all year round.

2.2 Socioeconomic Conditions

2.2.1 Administrative Area of Can Tho City

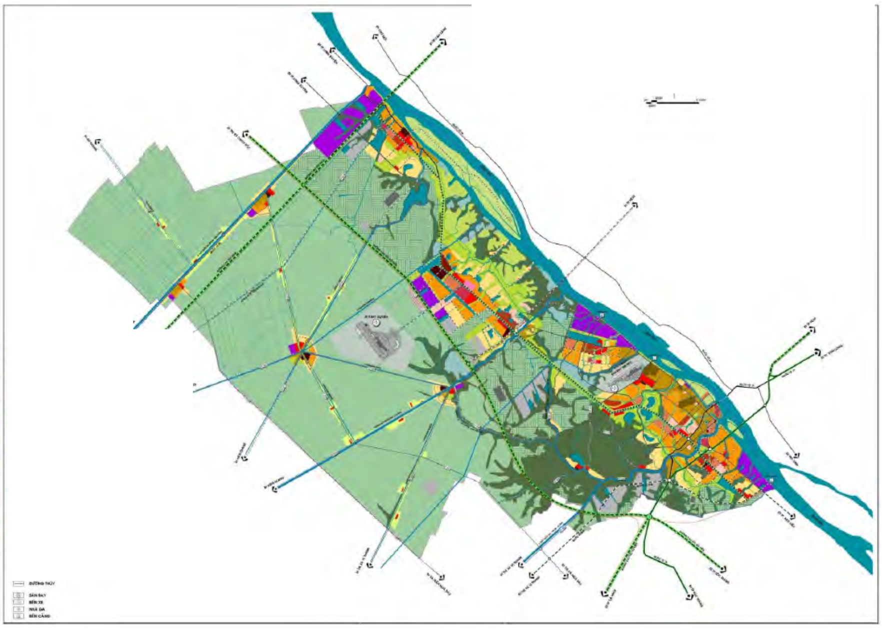
In 2004, Can Tho Province was divided into Can Tho City and Hau Giang Province under a goverment decision. Since then, Can Tho City was designated as a centrally-governed city. The administrative area of Can Tho City consists of five urban districts, namely: Ninh Kieu, O Mon, Binh Thuy, Cai Rang, and Thot Not; and four rural districts, namely: Vinh Thanh, Co Do, Phong Dien, and Thoi Lai.

2.2.2 Present Population and Population Projection

The population of Can Tho City was reported at 1.18 million according to the latest census data in 2009 surveyed by the General Statistics Office (GSO) under the Ministry of Planning and Investment. The population of Can Tho City was projected for 2010 to 2034 by GSO considering the historical trend from 1989 to 2009. The key factors such as mortality, migration, and fertility rates were set considering the past trend.

2.2.3 City Plan and Land Use Plan

Can Tho City was planned to be developed from an agricultural city into an industrial city according to the Decision 21/2007/QD-TTg. According to the land use plan for 2030 shown in Figure 2.2.1, urban districts are planned to be developed



Source: Can Tho City Master Plan 2030

Figure 2.2.1 Land Use Plan for 2030 in Can Tho City

2.2.4 Industries and Development Forecast

Presently, six IZs, namely: Tra Noc Industrial Parks (Nos. 1 and 2), Hung Phu Industrial Park (1, 2A, and 2B), and Thot Not Industrial Park (No. 1) are under operation, while three IZs are under the approval process by Can Tho City. The actual occupancy of settled factories is substantially lower than the registered ratio. This situation cannot be improved in a short period of time, because of the consecutive economic depression being experienced since 2007.

Regarding the water consumption in the IZs, some factories in Tra Noc Industrial Parks (Nos. 1 and 2) have exploited ground and surface water for their own use even though they can use the water from WSSC. The factories in Hung Phu Industrial Parks (1, 2A, and 2B) and Thot Not Industrial Park (No. 1) have exploited groundwater for their own use, because treated water from WSSC has not been supplied to these IZs.

2.2.5 National and Can Tho City's Economic Activities and Indices

(1) National Economic Activities and Indices

Currently, the credit ratings of Vietnam are below the investment grade (B1 by Moody's and BB- by S&P) due to account deficit and instability of financial system despite rapid economic growth in recent years. Inflation rate (expressed as "consumer price index") showed a historic increase of 23% in August 2011 and an annual increase of 18.10% as shown in Table 2.2.1 in the context of trade deficit, which evokes devaluation of VND. Table 2.2.2 shows the basic financial indicators of Vietnam.

Table 2.2.1 Macroeconomic Indicators

	2007	2008	2009	2010	2011
Consumer Price Index in Vietnam (*1)	12.60%	19.90%	6.50%	11.80%	18.10%
Producer Price Index in Vietnam (*2)	6.90%	21.80%	7.40%	12.60%	18.40%
VND/JPY (*3)	141.87	193.87	200.0509	239.7023	272.1126
USD/VND (*3)	16,003	17,486	18,479	19,498	21,049

Source: (*1) Producer prices, % each year, end of period (General Statistics Office)
(*2) Consumer price index, % each year, end of period (General Statistics Office)
(*3) Bloomberg

Table 2.2.2 Financial Indicators

	2006	2007	2008	2009	2010	2011
Increase Ratio of Real GDP (% change)	8.2	8.5	6.3	5.3	6.8	5.9
General Government Financial Balance/GDP (%)	-1	-0.7	-4.3	-5.9	-5.8	-4.1
General Government Debt/Revenue (%)	97.8	95.4	119.5	106.7	151.5	148.2
Current Account Balance/GDP (%)	-0.3	-9.8	-11.9	-6.8	-4	-4.5

Source: "Credit opinion on Government of Vietnam", February 14, 2012, Moody's

(2) Economic Activities and Indices in Can Tho City

The revenue of Can Tho City shown as "total revenue" of the local state budget in Table 2.2.3 increased by 17.8% per annum from 2010 to 2011, 32.7% from 2009 to 2010, and 29.8% from 2008 to 2009. The expenditure of Can Tho City shown as "total expenditure from state budget" in Table 2.2.3 increased by 19.2% per annum from 2010 to 2011, 27.7% from 2009 to 2010, and 26.4% from 2008 to 2009.

Table 2.2.3 Revenue and Expenditure of Can Tho City

(VND in millions)

	2008	2009	2010	2011
Total Revenue	**3,748,322**	**4,581,529**	**5,447,788**	**6,245,269**
Total Expenditure from State Budget	**3,309,681**	**4,182,531**	**5,339,737**	**6,367,016**

Source: "Statistical Yearbook 2011", May 2012, Statistical Office of Can Tho City

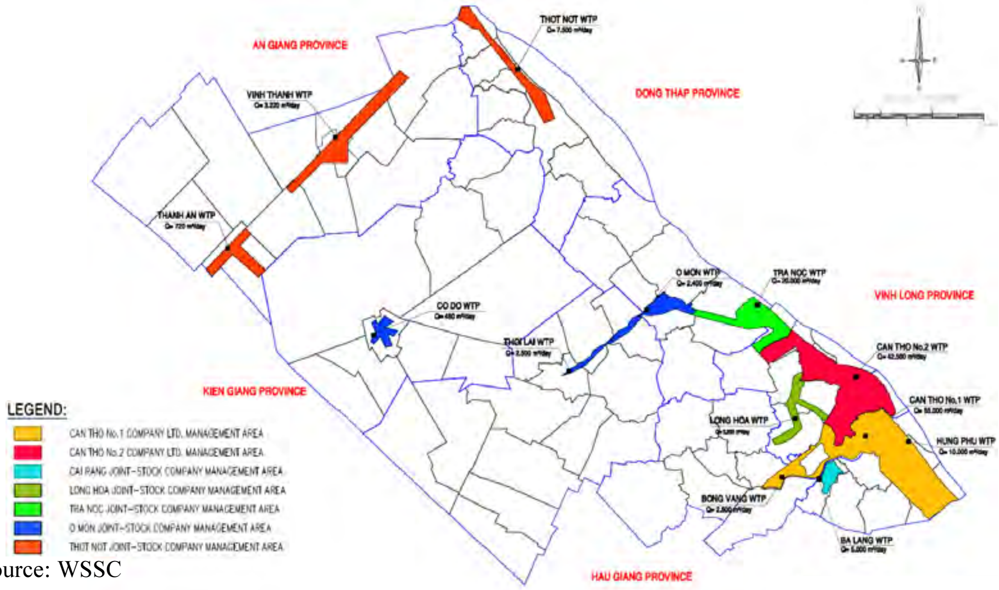
CHAPTER 3 EXISTING CONDITIONS OF THE WATER SUPPLY IN CAN THO CITY

3.1 Existing Water Supply System

3.1.1 Control and Management of Current Water Supply

According to the city plan, there are two other administrative classifications, namely, urban and rural area. The Can Tho Water Supply and Sewerage Co., Ltd. (WSSC) and its related companies currently manage the water supply system in the urban area. On the other hand, the Department of Agricultural and Rural Development (DARD) manages the water supply system in the rural area.

There are 13 water treatment plants (WTPs) with their service areas defined as urban water supply systems. These WTPs are managed by seven organizations, comprising WSSC, No. 2 Water Supply Limited Company (No. 2 LTC) and five joint stock companies (JSCs). The service areas of WSSC and its related companies (all are comprehensively called as Water Companies) are shown in Figure 3.1.1 and Table 3.1.1.



Source: WSSC

Figure 3.1.1 Service Areas of WSSC and its Related Companies

Table 3.1.1 Service Areas of WSSC and its Related Companies

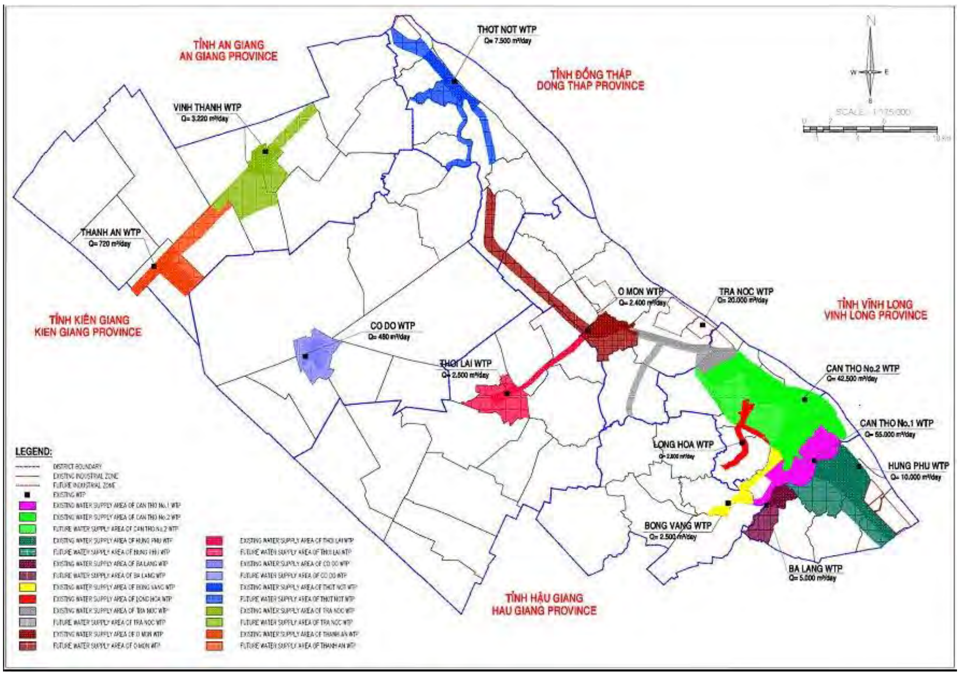
Water Managing Organization	WTP
Can Tho Water Supply & Sewerage Co., Ltd.	Can Tho No. 1 WTP, Bong Vang WTP, Hung Phu WTP
No. 2 Water Supply Limited Company	Can Tho No. 2 WTP
Thot Not Joint Stock Company	Thot Not WTP, Vinh Tanh WTP, Thanh An WTP
O Mon Joint Stock Company	O Mon WTP, Thoi Lai WTP, Co Do WTP
Tra Noc Joint Stock Company	Tra Noc WTP
Cai Rang Joint Stock Company	Ba Lang WTP
Long Hoa Joint Stock Company	Long Hoa WTP

Source: JICA Study Team

3.1.2 Current Water Demand and Consumption

(1) Water Supply Area and Service Area Population

The service area of the Water Companies is planned to be expanded based on the mutual agreement among DOC, WSSC, and DARD. The map of the water supply area for the target year 2020, as shown in Figure 3.1.2, was approved by the Can Tho PC in 2012.



Source: DOC

Figure 3.1.2 Water Supply Area Map for Target Year 2020

The total population, served population, and service ratio in the Water Companies' service area in 2012 are estimated and summarized in Table 3.1.2.

Table 3.1.2 Population in Each Service Area (as of 2012)

WTP	Population in Service Area	Served Population	Service Ratio
Can Tho No. 1	156,200	148,400	95%
Can Tho No. 2	159,100	140,700	88%
Tra Noc	28,600	14,300	50%
Hung Phu	48,900	16,500	34%
Thot Not	49,500	28,000	57%
Bong Vang	8,700	8,000	92%
Long Hoa	11,100	7,900	71%
Ba Lang	21,600	12,000	56%
O Mon	35,300	8,200	23%
Thoi Lai	14,600	6,200	42%
Co Do	11,600	5,700	49%
Vinh Thanh	20,300	15,200	75%
Thanh An	14,800	8,200	55%
Total	535,300	419,400	78%

Source: JICA Study Team

(2) Water Production

The water production in each WTP from February to May 2012 is summarized in Table 3.1.3. The water productions in Can Tho No. 1 and Can Tho No. 2 WTPs, where the largest population is served, are overloaded with more than 10% of their capacity. It showed that the capacities of WTPs in the center of Can Tho City are not enough and expansion plans are required as soon as possible.

Table 3.1.3 Water Production in Each WTP

WTPs	Urban /Rural	Capacity in 2012	February, 2012		March, 2012		April, 2012		May, 2012		Average	
			Water Production (m3/d)	Ratio per Capacity (%)	Water Production (m3/d)	Ratio per Capacity (%)	Water Production (m3/d)	Ratio per Capacity (%)	Water Production (m3/d)	Ratio per Capacity (%)	Water Production (m3/d)	Ratio per Capacity (%)
Can Tho-1 Bong Vang	Urban	57,500	77,921	136%	66,001	115%	72,291	126%	66,305	115%	70,433	122%
Can Tho-2	Urban	42,500	53,158	125%	43,265	102%	47,763	112%	46,977	111%	47,657	112%
Tra Noc	Urban	20,000	9,504	48%	9,738	49%	10,318	52%	10,498	52%	10,025	50%
Hung Phu	Urban	10,000	3,649	36%	3,652	37%	3,991	40%	3,820	38%	3,779	38%
Thot Not	Urban	7,500	7,969	106%	6,945	93%	7,323	98%	7,371	98%	7,388	99%
O Mon	Urban	2,400	2,995	125%	2,589	108%	2,779	116%	2,428	101%	2,690	112%
Long Hoa	Urban	2,000	1,882	94%	1,617	81%	1,728	86%	1,732	87%	1,736	87%
Ba Lang	Urban	5,000	3,997	80%	3,503	70%	4,037	81%	3,729	75%	3,810	76%
Thoi Lai	Rural	2,500	619	25%	476	19%	562	22%	487	19%	534	21%
Co Do	Rural	480	771	161%	606	126%	732	152%	654	136%	688	143%
Vinh Thanh	Rural	3,220	609	19%	550	17%	555	17%	625	19%	584	18%
Thanh An	Rural	720	1,123	156%	1,014	141%	1,000	139%	1,050	146%	1,045	145%
Total		153,820	164,196	107%	139,956	91%	153,077	100%	145,676	95%	150,370	98%
Can Tho-1,2		100,000	131,078	131%	109,266	109%	120,054	120%	113,282	113%	118,090	118%

Source: WSSC

(3) Water Consumption and Non-revenue Water Ratio

The billed water volume and non-revenue water (NRW) ratio from February to May 2012 are summarized in Table 3.1.4. The average NRW ratio was 33% in the service area of the Water Companies, and 37% in Can Tho No. 1 and Can Tho No. 2 WTPs.

Table 3.1.4 Billed Water Volume (Water Consumption)

WTPs	Urban /Rural	February, 2012		March, 2012		April, 2012		May, 2012		Average	
		Billed Volume (m3/day)	Ratio per Production (%)	Billed Volume (m3/day)	Ratio per Production (%)	Billed Volume (m3/day)	Ratio per Production (%)	Billed Volume (m3/day)	Ratio per Production (%)	Billed Volume (m3/day)	Ratio per Production (%)
Can Tho-1* Bong Vang	Urban	43,936	43.6%	38,477	41.7%	43,563	39.7%	41,135	38.0%	41,709	40.8%
Can Tho-2	Urban	34,511	35.1%	29,591	31.6%	33,704	29.4%	31,433	33.1%	32,243	32.3%
Tra Noc	Urban	8,634	9.2%	9,149	6.0%	9,642	6.6%	9,886	5.8%	9,342	6.8%
Hung Phu	Urban	3,452	5.4%	2,792	23.5%	3,202	19.8%	3,033	20.6%	3,111	17.7%
Thot Not	Urban	6,269	21.3%	5,180	25.4%	5,197	29.0%	5,680	22.9%	5,568	24.6%
O Mon	Urban	1,733	42.1%	1,491	42.4%	1,595	42.6%	1,552	36.1%	1,589	40.9%
Long Hoa	Urban	1,521	19.2%	1,143	29.3%	1,490	13.8%	1,377	20.5%	1,379	20.6%
Ba Lang	Urban	2,988	25.2%	2,737	21.9%	3,096	23.3%	3,067	17.7%	2,971	22.0%
Thoi Lai	Rural	507	18.1%	420	11.8%	510	9.3%	467	4.1%	475	11.0%
Co Do	Rural	685	11.3%	575	5.1%	660	9.8%	654	0.0%	642	6.7%
Vinh Thanh	Rural	516	15.2%	460	16.3%	448	19.3%	503	19.6%	481	17.7%
Thanh An	Rural	862	23.3%	781	23.0%	758	24.2%	801	23.7%	799	23.5%
Total		105,614	35.7%	92,798	33.7%	103,865	32.1%	99,588	31.6%	100,309	33.3%
Average of Can Tho-1,2		78,448	40.2%	68,069	37.7%	77,267	35.6%	72,569	35.9%	73,952	37.4%

Source: WSSC

(4) Unit Water Consumption

The five categories for water tariff setting in Can Tho City and the average water consumption in each category in 2011 are shown in Table 3.1.5. The ratio of non-domestic use in Can Tho City is 38% in total.

Table 3.1.5 Water Consumption in 2011

Water Company	WTP	Average Water Consumption in 2011 (Billed Volume) (m3/day)					
		Poor Households	Residential Households	Institution	Industry	Commercial	Total
WSSC	Can Tho No.1	136	18,718	4,116	623	6,553	30,144
An Binh	Bong Vang	7	6,099	1,208	266	972	8,551
Hung Phu	Hung Phu	3	1,898	223	236	285	2,645
Can Tho-2 JSC	Can Tho No.2	36	13,500	2,661	1,295	4,282	21,774
Binh Thuy		25	2,959	425	40	842	4,291
Tra Noc JSC	Tra Noc	22	1,630	71	5,440	569	7,732
Thot Not JSC	Thot Not	38	3,268	404	148	1,062	4,921
Vinh Thanh	Vinh Thanh, Thanh An	40	739	165	16	176	1,136
O Mon JSC	O Mon, Thoi Lai, Co Do	60	1,682	250	89	304	2,385
Long Hoa JSC	Long Hoa	8	816	110	6	91	1,031
Cai Rang JSC	Ba Lang	8	2,051	242	66	289	2,655
Total		**383**	**53,360**	**9,875**	**8,224**	**15,424**	**87,266**
			53,744				
Ratio			**61.6%**	**11.3%**	**9.4%**	**17.7%**	**100%**

Source: WSSC

The unit water consumption for domestic use differs depending on the urban classification. The average unit water consumption in 2011 in Can Tho City was estimated at 131 L/c/d as shown in Table 3.1.6.

Table 3.1.6 Unit Water Consumption for Domestic Use in 2011

Water Company	WTP	Domestic water consumption (m3/s)	Served Population (thousand)	Unit Consumption (L/c/d)
I. Urban Distict_ Urban Area				
WSSC	Can Tho No.1	24,960	145.5	142
An Binh	Bong Vang		7.8	
Can Tho-2 JSC	Can Tho No.2	16,521	138.0	
Binh Thuy				
II. Urban Distict_ Suburban Area				
WSSC_Hung Phu	Hung Phu	1,901	16.2	126
Tra Noc JSC	Tra Noc	1,652	14.0	
Thot Not JSC	Thot Not	3,306	27.5	
Long Hoa JSC	Long Hoa	824	7.8	
Cai Rang JSC	Ba Lang	2,059	11.8	
II. Rural District				
Vinh Thanh	Vinh Thanh	779	14.9	59
	Thanh An		8.1	
O Mon JSC	O Mon	1,742	8.1	
	Thoi Lai		6.1	
	Co Do		5.6	
Total in Can Tho City		53,744	411.3	131

Source: WSSC

(5) Non-revenue Water Ratio Reduction

The WSSC established the Water Loss Prevention Team to reduce the NRW ratio in March 2012. The team has four sub-teams as follows:

1) Distribution Network Management Team: 5 staffs
2) Water Leakage Detection Team: 11 staffs
3) Test Drilling Team: 5 staffs
4) Water Meter Management Team: 4 staffs

3.1.3 Laws and Regulations Related to Water Supply BOT Business[1]

This section summarizes the relevant Vietnamese laws and regulations for BOT water supply projects..

(1) Water Treatment Project and Water Tariff

1) Permission for Water Supply Services

To participate in the water supply business in Vietnam, one needs to obtain a permit for surface water abstraction which is issued either by MONRE or the people's committee. I

2) Price Setting of Water Tariff

The minimum price for water tariff applied in Can Tho City is VND 3500/m3, while the maximum price is VND 6400/m3.

The mechanism to determine the prices of water tariff is stipulated in the Joint Circular No.75/2012/TTLT-BTC-BXD-BNNPTNT (Joint Circular Guiding Principles and Method of Determination and Competence to Decide Water Consumption Price in the Urban Areas, Industrial Zones and Rural Areas).

The paragraph was omitted due to confidentiality.

(2) Investment Regulations

1) Permission for Investment Project

According to the Common Investment Law (Law No. 59-2005-QH11), those who want to start investment projects in Vietnam must obtain an investment certificate, which will be issued by the people's committee. First time foreign investors in Vietnam must have an investment project and undertake the necessary procedures for investment registration, so that foreign investment projects can obtain an investment certificate. When a project has invested a capital worth VND 300 billion or more, a project evaluation must be conducted by the people's committee prior to the issuance of an investment certificate. Application forms for the evaluation shall be submitted to DPI, which will make an evaluation report that will be submitted to Can Tho PC for approval.

(3) Land Use Regulations

In Vietnam, foreign organizations can only rent the land necessary for a project (land assignment is not applicable), and they need to have the land use certificate issued in

[1] Contents of this section are based on English-translated version of Vietnamese laws and regulations and information obtained through interviews with respective government authorities in Can Tho City.

accordance with the procedure stipulated in the Law on Land (Law No. 13/2003/QH11).

The paragraph was omitted due to confidentiality.

(4) BOT Regulations

The BOT projects in Vietnam are implemented in accordance with Decree 108/2009/ND-CP (Decree on Investment in the Form of Build-Operate-Transfer, Build-Transfer-Operate, or Build-Transfer Contract), or also known as "the BOT Law". The law articulates the following conditions for BOT projects in Vietnam.

1) Security for Obligation to Perform Project Contract

The amount of the security deposit for the obligation to implement the project contract must not be less than 2% of the total investment capital in case the project's total investment capital worth to VND 1.5 trillion.

2) Transfer of Project Facility

Upon expiry of the commercial operation of the project facility, the investor shall turn over the facility to the authorized state body without compensation.

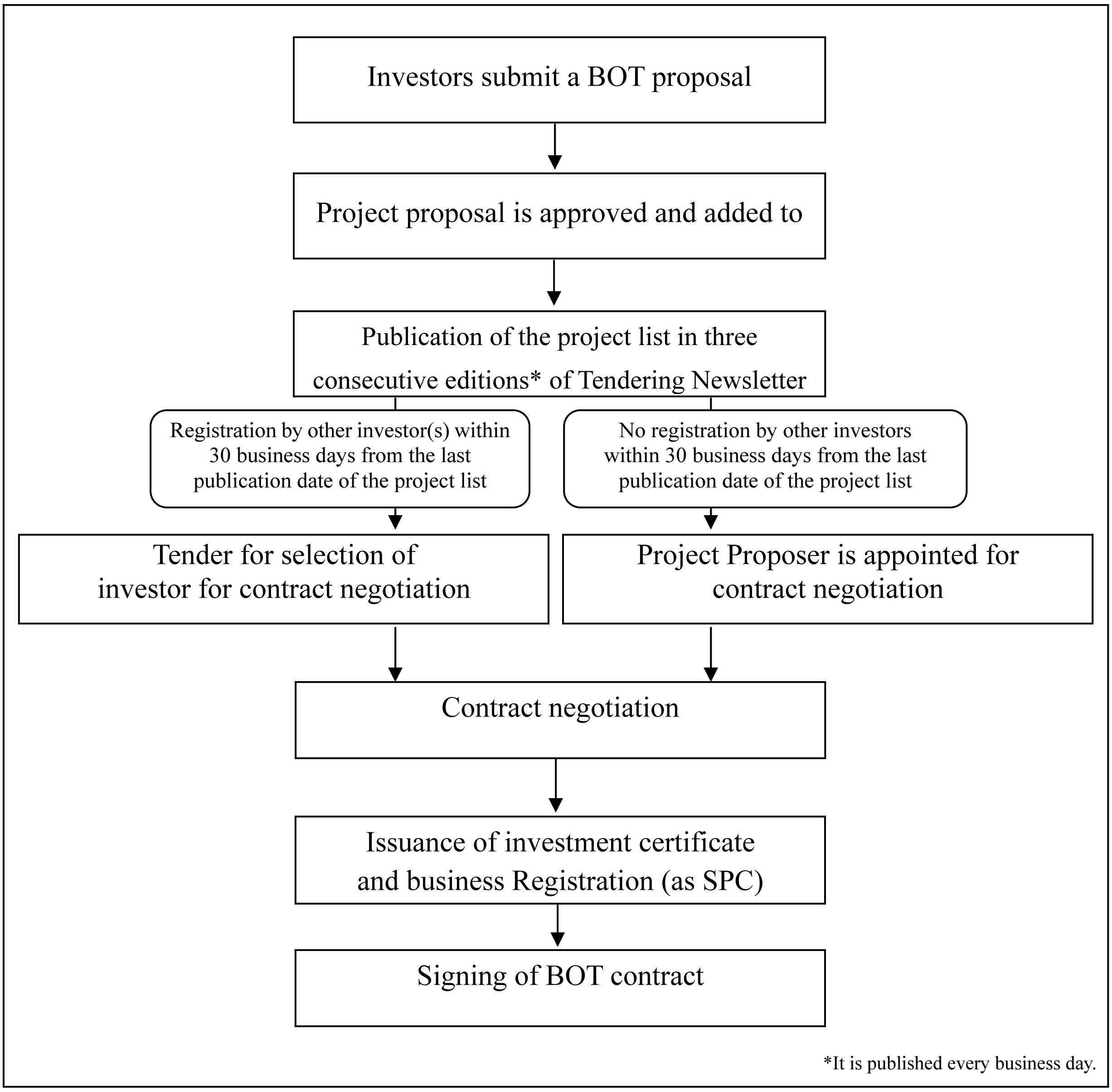
3) Incentives for BOT Projects

According to the BOT Law, the Common Investment Law, and Decree 124/2008/NC-DP (*Decree Detailing and Guiding the Implementation of a Number of Articles of the Law on the Enterprise Income Tax*), water supply BOT projects could potentially be entitled to the following investment incentives. However application of incentives must be approved by relevant agencies and written on the investment certificate.

- Right to mortgage assets
- Right to obtain governmental guarantees for the obligations, including loans, provision of raw materials, sale of products, etc., of the SPC, investors, and other enterprises participating in the implementation of the project.
- Exemption from payment of land levies and land use rents for the project land
- Incentive tax rate on enterprise income as well as investors' income (dividends)
- Exemption from payment of import duty on equipment, materials, means of transportation, and other goods necessary for the implementation of projects
- If an investor suffers losses after the calculation of income tax for a fiscal year, it shall be permitted to carry its losses forward to the subsequent fiscal years, and the amount of such losses shall be set off against taxable income of each year, and
- Accelerated depreciation of fixed assets.

4) Procedure for Approval of BOT Project and Selection of Contractor

The development procedure for a BOT project which involves the investor's project proposal are outlined in Figure 3.1.3.



Source: JICA Study Team

Figure 3.1.3 Procedures on Project Development for BOT Scheme

3.1.4 Financial Status of WSSC and Relevant Organizations.

(1) Corporate Profile

1) Business

The WSSC provides not only water production and sales services but also several different types of services, such as consulting services for water supply business, production and sales of water supply facilities, etc.

2) Structure

The paragraph is omitted due to confidentiality.

3) History

The WSSC started its history in1932. After the foundation of Can Tho City in 1970, the Can Tho PC developed the No. 1 WTP (Lot 1) in1973 and this was handed over to WSSC in 1975. Since then, several other major WTPs with over 10,000m3/day capacity have been established.

(2) Financial Status

Table 3.1.7, 3.1.8, and 3.1.9 show the financial statements of WSSC.

Table 3.1.7 Profit and Loss Statement of WSSC

(VND in billions)

The table was omitted due to confidentiality.

Source: WSSC

Table 3.1.8 Cash Flow Statement of WSSC

(VND in billions)

The table was omitted due to confidentiality.

Source: WSSC

Table 3.1.9 Balance Sheet of WSSC

(VND in billions)

The table was omitted due to confidentiality.

Source: WSSC

(3) New Tariff Application

The proposed new tariffs are shown in Table 3.1.10.

Table 3.1. 10 Financial Index of WSSC

The table was omitted due to confidentiality.

Source: No. 165/STC-QLG-CS Proposal for Adjustment of Clean Water Tariff applied in Can Tho City (January 24, 2013)

3.2 Existing Water Supply Facilities

3.2.1 Existing Water Treatment Plants

The WSSC is currently managing 13 WTPs in Can Tho City, including Can Tho No.1 and No. 2, Tra Noc, Thot Not, and Hung Phu with a total plant capacity of 135,000 m^3/day.

The WSSC also manages eight WTPs in rural areas with capacities of 480 to 5000 m^3/day. The total capacity in the rural area is 18,920 m^3/day. The details are shown in Table 3.2.1.

(1) Can Tho No. 1 WTP

Can Tho No. 1 WTP has three sub-units with production capacities of 30,000 m^3/day, 20,000 m^3/day, and 5000 m^3/day.

The quality of the treated water has met the drinking water standards of Vietnam in all the test items. However, it is recommendable that the plant should be operated considering the following:

i) Turbidity of settled water seems slightly higher, since the dosing rate of PAC is insufficient;

ii) Interval of backwash of filters is one day. It is usually two to three days where flocculation is properly carried out with sufficient coagulant dosage and sedimentation tank is properly functioning. The plant operation should be reviewed and improved;

iii) Sludge scraper in the accelerator was not operating when the JICA Study Team visited the plant. It should not be stopped unless otherwise required for maintenance and repair, because the scraper has an important role to collect and drain sludge from the tank properly and sufficiently. A scraper that has been stopped for a long time could cause damage due to overloading by accumulated sludge;

iv) According to the operator, sludge in the pond is periodically removed and dumped to a disposal site by tanker trucks. However, no evidence of such work was found in the site survey; and

v) Algae growth was found on the settling plates in the steel sedimentation tanks. It disturbs the removal of sludge from the inclined plates. Therefore, more frequent pre-chlorination should be carried out.

Table 3.2.1 Summary of the Existing Water Treatment Plants

No.	Name	Design Capacity ($\times 1000m^3$/day)	Current Production ($\times 1000m^3$/day)	Location (District)	Water Source	Intake Pump Spec./Qty	Water Treatment System	Distribution Spec./Qty	Sludge Treatment Method	Commissioned Year
1	Can Tho No.1	55	60	Ninh Kieu	Can Tho River	Vertical Shaft 650 m^3/h*45kW*3 900 m^3/h*55kW*3 Submerged 120 m^3/h*11kW*3	HM+AC+CGF HM+AC+CGF PS+PF	Vertical Shaft 850 m^3/h*132kW*3 850 m^3/h*160kW*2 400 m^3/h*100kW*1	Sludge Pond	1973/2004/2011
2	Can Tho No.2	42.5	47	Binh Thuy	Hau River/Khai Luong Canal	Vertical Shaft 950 m^3/h*75kW*3 840 m^3/h*55kW*2	HM+PU+AF PS+PF	Vertical Shaft 840 m^3/h*132kW*1 840 m^3/h*200kW*2	Sludge Pond	1998/2010
3	Tra Noc	20	10.1	O Mon	Hau River	Vertical Shaft 480 m^3/h*37kW*2 450 m^3/h*37kW*1	HM+PU+AF	Vertical Shaft 600 m^3/h*110kW*1 600 m^3/h*110-126.5kW*2	Lagoon	2004/2011
4	Hung Phu	10	4	Cai Rang	Hau River	Vertical Shaft 450 m^3/h*37kW*2	HM+PU+AF	Vertical Shaft 600 m^3/h*110kW*2	Lagoon	2005
5	Thot Not	7.5	7.1	Thot Not	Hau River	Submerged 110 m^3/h*11kW*2 210 m^3/h*11.5kW*2 Centrifugal 180 m^3/h*22.5kW*1	HM+SB+AF TS+PF	Vertical Shaft Centrifugal 120 m^3/h*22kW*1 72－165 m^3/h*22kW*4	Sludge Pond	2005/2009
6	Long Hoa	2	1.9	Binh Thuy	Cam Canal	Centrifugal 54－132 m^3/h*7.5kW*2	PS+PF	Centrifugal 54－144 m^3/h*22.5kW*2	N/A	2010
7	Ba Lang	5	4	Cai Rang	Can Tho River	Submerged 390 m^3/h*11kW*2	PS+PF	Centrifugal 208 m^3/h*22kW*2 50－120 m^3/h*22kW*1 54－144 m^3/h*22.5kW*1	Sludge Pond	2009/2011
8	Vinh Thanh	3.22	0.5	Vinh Thanh	Cai San Canal	Centrifugal 10 - 28.8 m^3/h*2.2kW*1 9 - 42 m^3/h*7.5kW*2 Submerged 18－252 m^3/h*13.6kW*2	TS+PF SB+GF	Centrifugal 10－36 m^3/h*4kW*1 40 m^3/h*5.5kW*1 54－144 m3/h*22.5kW*2	N/A	2003/2008
9	Thanh An	0.72	1	Vinh Thanh	Cai San Canal	Submerged 3－120 m^3/h*7.5kW*2	PS+GF SB+GF	Centrifugal 21－78 m^3/h*7.5kW*2 12－42 m^3/h*3.0kW*1	Sludge Pond	1999
10	O Mon	2.4	2.4	O Mon	O Mon River	Centrifugal 250 m^3/h*30kW*1 180 m^3/h*18.5kW*1	PS+GF	Centrifugal 150 m^3/h*30kW*1 110 m^3/h*11kW*1	N/A	
11	Thoi Lai	2.5	0.5	Thoi Lai	O Mon River	Centrifugal 180 m^3/h*7.5kW*1 200 m^3/h*11kW*1	HM+SB+AF	Centrifugal 60 m^3/h*11kW*2 180 m^3/h*18.5kW*1	Sludge Pond	2006
12	Co Do	4.8	0.7	Co Do	Groundwater	Well Pump*3	PF	Centrifuga*2	N/A	
13	Bong Vang	2.5	1.8	Phong Dien	My Khanh River	Submerged 110 m^3/h*11kW*2	PS+PF	Centrifugal 110 m^3/h*22.5kW*2	Sludge Pond Under Construction	2012

Source: JICA Study Team

Note: HM: Hydraulic Mixing, MM: Mechanical Mixing, AC: Accelator, PU: Pulsator, SB: Slurry Blanket, PS: Steel tank with plate settler, TS: Steel tank with tube settler, CG: Conventional Gravity Filter, AF: Aquazur Filter, GLF: Green leaf Filter, PF: Pressurized Filter

(2) Can Tho No. 2 WTP

The Can Tho No. 2 WTP has two sub-units with production capacities of 40,000 m^3/day and 2500 m^3/day.

The findings and recommendations regarding the facilities and operations are summarized as follows:

i) The water turbidity after settling is still very high. To identify the cause, the JICA Study Team conducted a jar test, and it was found out that PAC dosing rate is insufficient. The backwash interval is one day; thus, improvement of plant operation is necessary in the same way as in Can Tho No. 1; and

ii) Sludge treatment is not properly carried out.

(3) Tra Noc WTP

The Tra Noc WTP consists of two sub-units with a total production capacity of 20,000 m^3/day.

The findings and recommendations regarding facilities and operations are summarized as follows:

i) The turbidity of water after settling is high. The reason is the same as explained in Can Tho No. 2 WTP;

ii) Vacuum pumps of the pulsator were not operating when the JICA Study Team visited the plant. The operation of vacuum pump is indispensable for proper operation of pulsator and it should not be stopped; and

iii) The sludge treatment is not properly done, same as in Can Tho No. 1 WTP.

(4) Hung Phu WTP

This plant uses almost the same system as Tra Noc Plant. Its treatment capacity is 10,000 m^3/day. The operation status, performance, and problems encountered are also the same as with Tra Noc WTP.

(5) Thot Not WTP

The plant consists of two sub-units with production capacities of 5000 m^3/day and 2500 m^3/day.

The findings and recommendations regarding facilities and operations are summarized as follows:

i) A part of the upper end of tube settling in the package sedimentation is exposed, thereby degrading the settling efficiency of the plant. The tube settling should be rearranged so that the top of all tube settlings is fully submerged in water; and

ii) Most of the sludge in the lagoon returns to the river without sufficient treatment.

(6) Treated Water Quality of Existing WTPs

The treated water quality of existing WTPs has cleared all items in the drinking water standards of Vietnam.

The treated water quality of four large plants is summarized in Table 3.2.2.

Table 3.2.2 Summary of Treated Water Quality

					Can Tho 1 WTP			Can Tho 2 WTP			Tra Noc WTP			Hung Pho WTP		
	Item		Unit	Allowable limit	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
1	Color		mg/l Pt	15	1	6.3	10	1	7.1	12	1	5.3	10	2	6.8	15
2	Odour				-	-	-	-	-	-	-	-	-	-	-	-
3	Turbidity		NTU	2	0.15	0.5	0.9	0.17	0.2	0.25	0.24	0.4	0.5	0.23	0.6	1.8
4	pH		mg/l	6.5-8.5	7	7.0	7.1	6.9	7.0	7.1	6.7	6.9	7	6.8	7.0	7.1
5	Hardness		mg/l	300	52	59.3	66	50	56.8	65	50	57.8	66	50	55.8	60
6	Crome	(Fe)	mg/l	0.3	0.01	0.0	0.04	0.01	0.0	0.03	0.01	0.0	0.02	0.01	0.0	0.08
7	Chromium	(CrVI)	mg/l	0.05	0	0.0	0.01	0	0.0	0.01	0	0.0	0.01	0	0.0	0
8	Chloride	(Cl^-)	mg/l	250	18	21.9	26	18	21.1	26	18	21.6	26	18	21.2	26
9	Nitrate	($N\text{-}NO_3^-$)	mg/l	50	0	0.1	0.8	0	0.3	0.8	0	0.2	0.7	0	0.1	0.4
10	Nitrite	($N\text{-}NO_2^-$)	mg/l	3	0.001	0.0	0.09	0.006	0.0	0.02	0.007	0.0	0.012	0.001	0.0	0.02
11	Residual Chlorine		mg/l	0.3-0.5	0.4	0.5	0.5	0.4	0.5	0.5	0.4	0.5	0.5	0.3	0.4	0.5
12	Sulfide	(SO_4^{2-})	mg/l	250	1	5.0	15	1	4.8	11	1	5.2	11	1	6.3	15
13	Manganese	(Mn)	mg/l	0.3	0.1	0.1	0.2	0.1	0.2	0.2	0	0.2	0.3	0.01	0.1	0.2
14	Ammonia	($NH4^+$)	mg/l	3	0	0.0	0.1	0	0.1	0.2	0	0.1	0.13	0	0.0	0.1

Source: JICA Study Team

3.2.2 Distribution Facilities

(1) Distribution Pipe

The diameter, length, and material of distribution pipes managed by WSSC are shown in Table 3.2.3. Distribution pipes with DM 250 mm or less are mainly made of polyvinyl chloride (PVC) and pipes with over DM 250 mm are made of DCI. The total length of the distribution pipes managed by WSSC is approximately 500 km, and the diameter ranges from 34 to 700 mm.

Table 3.2.3 Summary of the Existing Distribution Pipes Managed by WSSC

Diameter (mm)	Length (m)	Material
Less than 150 (34～114)	302,475	PVC
	6,220	DCI
150	71,690	PVC
	2,157	DCI
200	45,909	PVC
	8,777	DCI
250	4,515	PVC
	19,347	DCI
300	9,209	DCI
314	4,135	PVC
375	4,621	DCI
400	6,341	DCI
600	13,886	DCI
700	500	DCI
Total	499,782	PVC, DCI

Source: WSSC

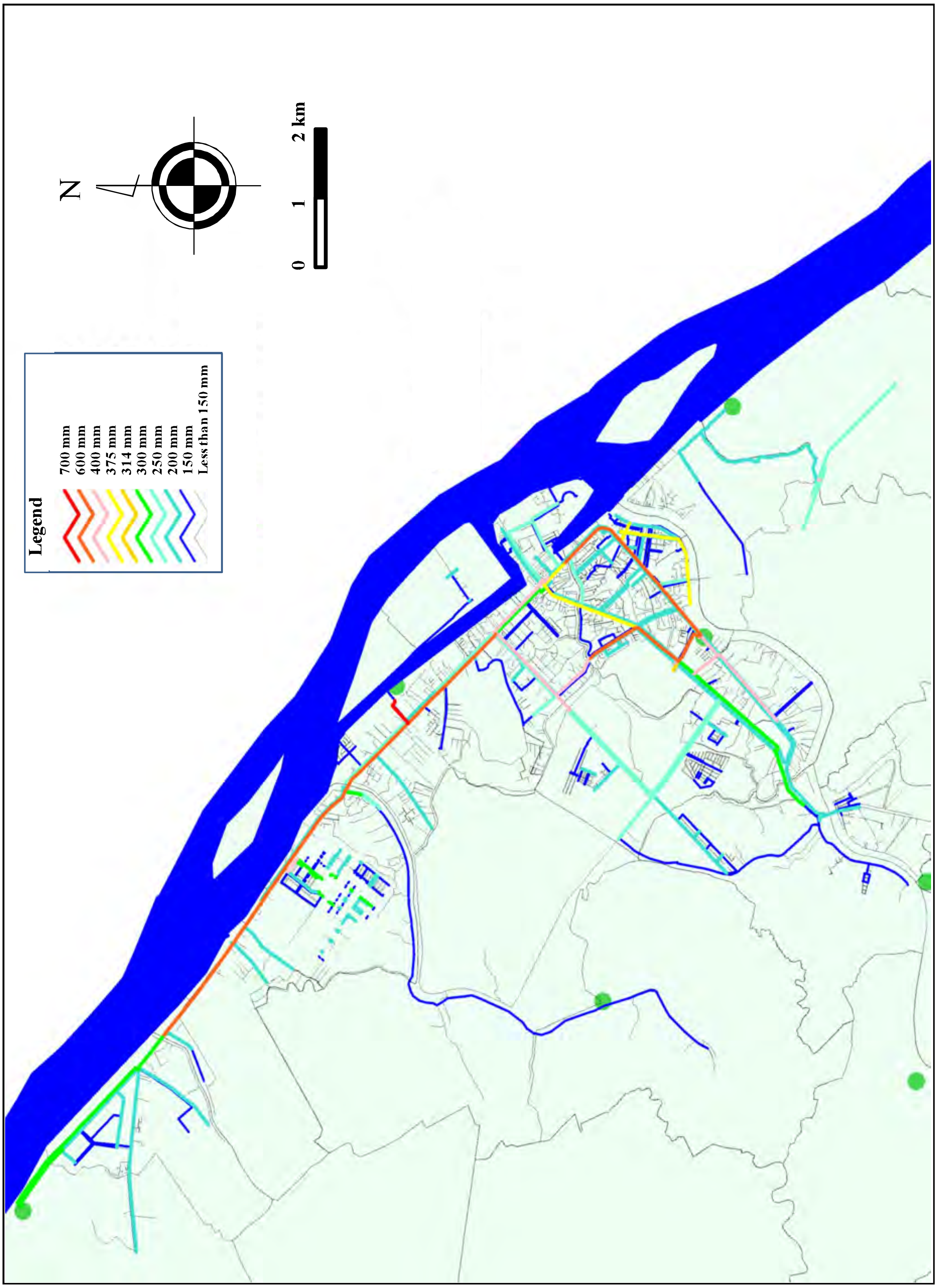
The installation year of distribution pipes above DM 300 mm is shown in Table 3.2.4. Over 70% of the distribution pipes were installed in the past 15 years.

Table 3.2.4 Installation Year of Distribution Pipes of Over DM 300 mm

Installation Year	%
Under 5	11
5-10	18
11-15	45
Over 15	26

Source: WSSC

The overall view of the existing distribution pipes managed by WSSC is shown in Figure 3.2.1. The distribution pipes are installed densely in the center of the urban area.



Source: WSSC

Figure 3.2.1 Existing Distribution Pipelines in the Urban Area Managed by WSSC

(2) Other Facilities

1) Distribution Reservoir

There are three large elevated tanks in the urban district as follows:

- Elevated tank with a capacity of 2250 m^3 in Can Tho No. 1 WTP service area;
- Elevated tank with a capacity of 500 m^3 in the premises of WSSC Head Office; and
- Elevated tank with a capacity of 300 m^3 in Tra Noc IZ.

However, these tanks are not currently used. In the urban district, water is distributed directly by the distribution pumps.

2) Pressure Measurement Facility

There are 70 pressure measurement points installed on the distribution pipes managed by WSSC.

Water pressure check has been carried out by the NRW reduction team of WSSC once a month to detect the water leakage point. The results of the water pressure measurements are shown in Figure 3.2.2.

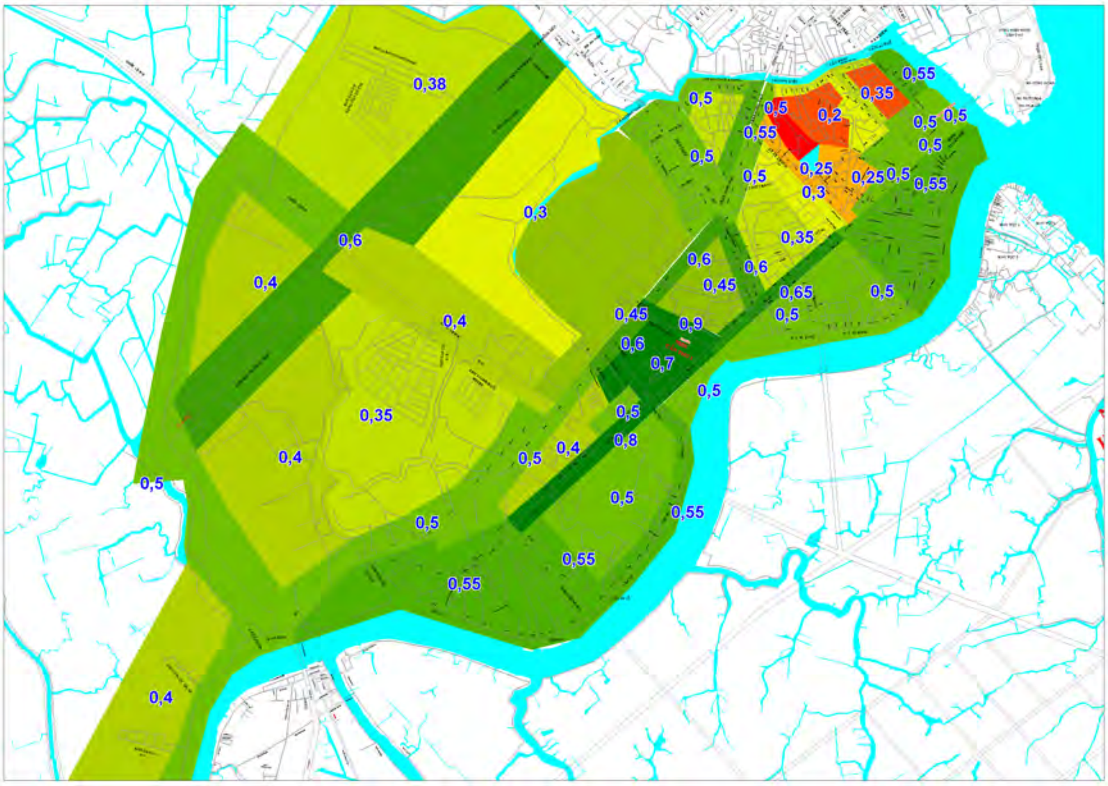
Based on the pressure measurement results, WSSC plans to improve the water pressure situation by increasing the capacity of distribution pumps in Can Tho Nos. 1 and 2 WTPs. The current minimum water pressure at the WTPs is 0.2 kgf/cm^2 (0.020 MPa). Hence, the WSSC plans to increase the water pressure up to 0.5 kgf/cm^2 (0.049 MPa) until 2015, and 1.0 kgf/cm^2 (0.098 MPa) until 2020.

3) Fire Hydrants

There are 326 fire hydrants that are installed on the distribution pipelines managed by WSSC. The fire hydrants are inspected twice a year, and the location is recorded in GIS data. Due to the lack of water pressure in the distribution pipelines, fire trucks use booster pumps.

4) Valve

There are 345 valves that are installed on the distribution pipelines managed by WSSC. The valves are inspected twice a year, and the location is recorded in GIS data. The valves are used for interruption of water flow at the time of an accident, and for the division of water supply area of Can Tho No. 1 and No. 2 WTPs.



Note: Unit of water pressure is kgf/cm^2 in this figure.

Figure 3.2.2. Results of the Water Pressure Measurements

3.2.3 Major Problems on Water Supply Facilities

(1) Insufficient Capacity of WTP

There are lots of problems for the operation and maintenance of WTPs such as shortage of injection amount of coagulation agent, unfixed and non-operating sedimentation pond, and evacuation of non-treated sludge.

(2) Water Leakage

According to the report of the NRW reduction team of WSSC, water leakage in the existing distribution pipes occur especially in small PVC pipes. This is possibly caused by inadequate pipe construction. In addition, there is insufficient number of staff and equipment in the NRW reduction team.

(3) Insufficient Water Pressure of Distribution Pump in WTP

In the distribution network managed by WSSC, the water pressure is very low due to the insufficient water pressure of distribution pump in Can Tho No. 1 and No. 2 WTPs.

CHAPTER 4 DEVELOPMENT PLAN OF FUTURE WATER SUPPLY SYSTEM

4.1 Basic Framework for Future Water Supply System

The basic framework for the future water supply system in Can Tho City is summarized as follows:

i) The target year for the future water supply system in Can Tho City was set at 2020;

ii) The future water supply plan was basically formulated in accordance with the Can Tho City Master Plan 2030. However, the detailed water demand for each ward or commune was not projected in the said master plan. The JICA Study Team carried out the projection for each ward or commune to identify the future water deficit covered by each water treatment plant in 2020;

iii) A partial new water supply area for the target year 2020 was proposed by DOC, DARD, and WSSC in 2012;

iv) The target area for the priority project was selected in urban areas, particularly from the distribution areas of Can Tho No. 1 and No. 2 WTPs; and

v) Hau River was selected as the water source of the proposed WTPs in consideration of the water quality. The salt water intrusion problems were assessed and found to be not a critical issue.

4.2 Related Plans and Projects

4.2.1 Can Tho City Master Plan 2030

The Can Tho City Master Plan 2030 as shown in Table 4.2.1 was approved by Can Tho PC.

4.2.2 Precedent and Ongoing Projects

(1) Con Khuong Project (AFD Project)

The Con Khuong Project is loaned by the French government and is under the evaluation of AFD as of February 2013. Based on the F/S report prepared for this project, the project aims to supply water to 1) Phong Dien, My Khanh, and Giai Xuan communes in Phong Dien District; and 2) Long Tuyen Ward in Binh Thuy District. The total water demand in the project area including the second phase of the project is approximately 20,000 m^3/day

(2) Hau River Project

The Hau River Project is the one proposed by the Ministry of Construction (MOC) for the water supply system with the target year of 2020 in Mekong Delta Key Economic Zone. The project was approved in Decision No. 2065/QD-TTg on November 12, 2010. However, the Can Tho City Master Plan 2030 does not comply with this plan.

Table 4.2.1 Summary of Can Tho City Master Plan 2030

Item	Contents
(1) Target Year	Phase I (2020), Phase II (2030)
(2) Population Forecast	1.04 million (2020), 1.5 million (2030)
(3) Water Demand	302,788 m^3/d in 2020, 485,664 m^3/d in 2030
(4) Development Plan of the WTP	(see below)

No.	WTP	Design Capacity for 2020 (m^3/day)	Design Capacity for 2030 (m^3/day)	Water Source (River and Canal)	Notes
1	Can Tho 1	50,000	50,000	Can Tho	
2	Can Tho 2	50,000	60,000	Hau	Extension
3	Con Khuong	30,000	40,000	Hau	New
4	Hung Phu	15,000	15,000	Hau	Extension
5	Hung Thạnh	10,000	20,000	Can Tho	New
6	Ba Lang	5,000	5,000	Can Tho	
7	Long Hoa	4,000	4,000	Binh Thuy	
8	Tra Noc	40,00	60,000	Hau	Extension
9	O Mon 1	2,500	2,500	O Mon	
10	O Mon 2	30,000	50,000	Hau	New
11	Thot Not 1	20,000	40, 00	Hau	Extension
12	Thot Not 2	30,000	50,000	Hau	New
13	Thạnh Quoi	3,000	7,000	Cai San	Extension
14	Thạnh An	3,000	6,000	Cai San	New
15	Co Do	3,000	7,000	Thot Not	Extension
16	Thoi Lai	3,000	6,000	O Mon	Extension
17	Song Hau 1	-	50 000	Hau	New
Total		298,500	472,500		

Note :WTPs described above are for urban areas and IZs.
Rural areas will be covered by groundwater supply system.

Source: Can Tho City Master Plan 2030

4.3 Water Demand Projection

4.3.1 Parameters for Water Demand Projection

(1) Basic Concept for Water Demand Projection

The water demand projection for the target year 2020 was basically carried out based on the Vietnamese Design Criteria QCVN 07: 2010, QCVN 01: 2008, and TCXDVN 33/2006 issued by the MOC.

(2) Parameters for Water Demand Projection

1) Unit Water Demand for Domestic Use

The unit water demand and service ratio for domestic use in the urban district, which are stipulated in the Vietnamese Standard TCXD VN 33: 2006, were applied as the parameters for water demand projection in this Study. Moreover, the unit water demand in rural district was slightly modified from 100 L/c/d to 80 L/c/d in consideration of the current water consumption in rural districts.

2) Water Consumption Ratio for Non-domestic Use

The average ratio of non-domestic water consumption as against domestic water consumption are presented in Table 4.3.1. The ratio derived from the actual record is more realistic and is applied in this Study.

Table 4.3.1 Water Consumption Ratio in 2011

Categories in Billed Water Record in Can Tho City		Water Consumption in 2011		QCVN 07:2010	Categories in Vietnamese Standard
		Can Tho 1 & 2	Another Area		
Domestic		100%	100%	100%	Domestic
Non-Domestic	Institutional	20%	15%	10%	Public works and services
				8%	Plantation, road maintenance, and fire fighting
	Industrial	5%	0%	8%	Commercial and urban services
	Commercial	30%	20%		
	Total	55%	35%	26%	

Note: The water consumption in IZs is excluded in the above calculation.
Source: JICA Study Team

3) Unit Water Demand in Industrial Zone

The standard stipulates that 40 m^3/ha/day is the industrial water demand for a service ratio of 60%. This unit water demand is applied in this Study, and the service ratios of IZs in 2020 were proposed in consideration of the current occupancy rate and development of IZs.

4) Conclusion

In conclusion, the parameters for the water demand projection for this project were decided based on the following: i) parameters used in the Can Tho City Master Plan 2030; ii) actual water consumption based on the billed volume data in 2011; and iii) unit water demand stipulated in the Vietnamese criteria and standard as shown in Table 4.3.2.

Table 4.3.2 Planning Criteria for Water Demand Projection

Category	Item	Unit	Can Tho Master Plan (2020)	Actual in 2011	Criteria in the study for 2020					Note
					QCVN 07: 2010	QCVN 01:2008	TCXD VN 33: 2006	Adopted for 2020		
I	**Urban Class I (Urban District)**									
	a. Domestic water use									
	Unit water consumption									
	(Urban area)	l/c/d	150	140	-	≧150	200	**200**		
	(Sub-urban area)	l/c/d	120	125	-	≧120	150	**150**		
	(Industrial zone)	m^3/ha/d	30	-	40	20	- *1	**40**		*1: Some industries uses both treated water and groundwater.
	(Industries for food, paper, and textile)	m^3/ha/d			-	-	45	-		
	(Other industries)	m^3/ha/d			-	-	22	-		
	Service Ratio									
	(Urban area)	%	100	<99	-	≧80	99	**99**		
	(Sub-urban area)	%	100	<95	-	≧80	95	**95**		
	(Industrial zone)	%	70	5～65	≧60	≧60		**90, 60**		Tra Noc: 90%, Others: 60%
								CT-1,2	Others	Ratio of water consumption for each category are decided based on the water consumtionusase record in 2011.
	b. Public works and services	%	10	12, 10	≧10	≧10	10	**12**	**10**	
	c. Plantation, road maintenance and fire fighting	%	8	8, 5	≧8	≧8		**8**	**5**	
	d. Commercial and urban service	%	-	35, 28	≧8	≧8	10	**35**	**20**	
	e. Non-revenue water									
	(Upgraded system)	%	15	34	≦20	≦30	<20	**20**		
	(New system)	%	15		≦15	≦25	<20			
	f. Water loss at treatment plant	%	-	6.1 - 12.1	≧4	≧4	5 - 8	**7**		
	g. Daily peak factor	-	-		-	-	1.1 - 1.2	**1.15**		
V	**Urban Class V (Rural District)**									Thoi Lai WTP Co Do WTP Vinh Thanh WTP Than An WTP
	a. Domestic water use									
	Unit water consumption	l/c/d	80	60	-	≧80	100	**80**		
	Service Ratio	%	100	<90	-	≧80	90	**90**		
	b. Public works and services	%	10	10	≧10	≧10	10	**10**		
	c. Plantation, road maintenance and fire fighting	%	8	5	≧8	≧8		**5**		
	d. Commercial and urban service	%	-	20	≧8	≧8		**20**		
	e. Non-revenue water									
	(Upgraded system)	%	15	16	≦20%	≦30	≦15	**15**		
	(New system)	%	15		≦15%	≦25				
	f. Water loss at treatment plant	%	-	6.1 - 12.1	≧4%	≧4	10	**7**		
	g. Daily peak factor	-	-		-	−	1.1 - 1.2	**1.15**		

Note: *1: QCVN 07: 2010/BXD, Vietnam Building Code Urban Engineering Infrastructures (Criteria)
*2: QCVN 01: 2008/BXD Vietnam Building Code Regional and Urban Planning and Rural Residential Planning (Criteria)
*3: TCXDVN 33:2006 Water Supply- Distribution System and Facilities Design Standard (Standards)

Source: JICA Study Team

4.3.2 Water Demand Projection for 2020

The water demand for 2020 in each WTP's distribution area was projected based on the above definition and procedure, and summarized in Table 4.3.3.

Table 4.3.3 Water Demand Projection for 2020 in Each WTP's Distribution Area

	Population (thousand)	Served Population (thousand)	Domestic Water Demand (m^3/d)	Non-domestic Water Demand: Institutional (m^3/d)	Non-domestic Water Demand: Public (m^3/d)	Non-domestic Water Demand: Commercial (m^3/d)	Water Demand in IZ (m^3/d)	Total Water Demand (m^3/d)	NRW (m^3/d)	Water Demand (Daily Ave) (m^3/d)	Water Demand (Daily Max) (m^3/d)
Can Tho No.1	173	171	33,932	4,072	2,715	11,876	0	52,595	13,149	65,744	75,606
Can Tho No.2	176	174	34,162	4,099	2,733	11,957	0	52,951	13,238	66,189	76,117
Tra Noc	32	30	5,132	513	257	1,026	10,512	17,440	4,360	21,800	25,070
Hung Phu	54	52	8,883	888	444	1,777	1,852	13,844	3,461	17,305	19,901
Thot Not	55	52	7,800	780	390	1,560	2,496	13,026	3,257	16,283	18,726
O Mon	39	38	6,909	691	345	1,382	0	9,327	2,332	11,658	13,407
Bong Vang	10	9	1,020	102	51	204	0	1,377	344	1,721	1,979
Long Hoa	12	12	1,753	175	88	351	0	2,367	592	2,959	3,403
Ba Lang	24	24	4,736	474	237	947	0	6,394	1,599	7,993	9,192
Thoi Lai	16	14	1,159	116	58	232	0	1,565	276	1,841	2,118
Co Do	13	12	927	93	46	185	0	1,251	221	1,472	1,693
Vinh Thanh	22	20	1,615	161	81	323	0	2,180	385	2,564	2,949
Thanh An	16	15	1,176	118	59	235	0	1,588	280	1,868	2,148

Note: As described in Figure 3.1.3 in Section 3.1.2, the distribution area of Can Tho No. 1 WTP will not be expanded, and remaining WTP's distribution areas will be expanded based on the water supply area map for target year 2020, which was established by DOC, DARD, and WSSC.
Source: JICA Study Team

4.4 Can Tho City Water Supply Improvement Plan

4.4.1 Water Supply Area

The water supply area in this plan for the target year 2020 was decided in accordance with the water supply area map decided among DOC, DARD, and WSSC in 2012.

4.4.2 Capacity Deficit of the WTPs

The deficit of the WTP's capacity is summarized in Table 4.4.1. The incremental capacity of WTP is about 87,000 m^3/day in total. Most of the incremental capacity in 2020 will be required in the WTPs in urban districts, such as 21,000 m^3/day in Can Tho No. 1 WTP and 24,000 m^3/day in Can Tho No. 2 WTP.

Table 4.4.1 Deficit of WTP Capacity in 2020

(unit: m^3/day)

WTP	Daily Average Water Demand			Daily Maximum Water Demand	Capacity of WTPs (Daily Maximum)		
					Existing WTPs	On-going Project	Incremental Capacity
	Non IZ	IZ	Total	Total			
Can Tho No.1	65,744	0	65,744	75,606	55,000		**20,606**
Can Tho No.2	66,189	0	66,189	76,117	42,500	10,000	**23,617**
Tra Noc	11,288	10,512	21,800	25,070	20,000		**5,070**
Hung Phu	15,453	1,852	17,305	19,901	10,000		**9,901**
Thot Not	13,787	2,496	16,283	18,726	7,500	2,500	**8,726**
O Mon	11,659	0	11,659	13,407	2,400		**11,007**
Bong Vang	1,721	0	1,721	1,979	2,500		**0**
Long Hoa	2,959	0	2,959	3,403	2,000		**1,403**
Ba Lang	7,993	0	7,993	9,192	5,000		**4,192**
Thoi Lai	1,841	0	1,841	2,117	2,500		**0**
Co Do	1,472	0	1,472	1,693	480		**1,213**
Vinh Thanh	2,565	0	2,565	2,949	3,220		**0**
Thanh An	1,868	0	1,868	2,148	720		**1,428**
Total	**204,540**	**14,860**	**219,400**	**252,308**	**153,820**	**12,500**	**87,163**

Source: JICA Study Team

4.4.3 Water Supply Improvement Plan

(1) Improvement of the WTPs

The water supply system in Can Tho City needs to be upgraded in accordance with the increase in water demand. The basic concepts for the improvement of the water supply system in Can Tho City are prsented in Table 4.4.2.

(2) Improvement of Pipelines (Actions for NRW Reduction)

1) Current Situation of NRW Reduction

The NRW ratio in Can Tho City is 33% in 2012, whereas the target NRW ratios in these areas in 2013, 2015, and 2020 are 26 %, 25%, and 20%, respectively. However, there is no detailed action plan for NRW reduction in WSSC.

The NRW reduction team in WSSC carried out the water leakage investigation with the use of acoustic bar and electronic water leakage detector. The investigation is planned to be carried out further for the assessment of the current condition of NRW.

2) Proposal for NRW Reduction

Temporal treatment of water leakage and replacement of water meter will be partly effective for NRW reduction in the area of high NRW ratio, such as the service area of Can Tho No. 1 WTP. Prompt completion of water leakage investigation under a subcontract is required, because the volume of the survey is massive and it requires experienced engineers. In addition, the measures for illegal connections and non-detective water flow shall be implemented in parallel.

Table 4.4.2 Water Supply Improvement Plan for 2020

Service Area and WTP	Improvement Plan for 2020
Can Tho No. 1	Incremental demand shall be covered by the new WTP with the incremental capacity of 21,000 m^3/day.
Can Tho No. 2	The service area of Can Tho No. 2 WTP shall be expanded to Long Hoa Ward. Due to the expansion of the service area, the new WTP with the incremental capacity of 24,000 m^3/day will be constructed in the premises of the existing WTP.
Tra Noc	The incremental demand highly depends on the efficiency of the prohibition of groundwater use in Tra Noc IZ and development of O Mon IZ. The additional WTP with a capacity of 6000 m^3/day will be constructed in the premises of the existing WTP.
Hung Phu	The service area of Hung Phu WTP has a huge potential for urbanization because of the development of Hung Phu IZs. In accordance with the progress of urbanization, the additional WTP with a capacity of 10,000 m^3/day will be required.
Thot Not	A new WTP with an incremental capacity of 9000 m^3/day will be constructed. The incremental demand will be affected by the occupancy and development of the Thot Not IZs. Therefore, the incremental capacity will be examined in collaboration with CEPIZA.
O Mon	The service area of O Mon WTP has to be expanded and the new WTP with incremental capacity of 12,000 m^3/day will be required. In addition, the water supply plan will be reformulated when the North O Mon IZ is developed.
Bong Vang	The capacity of Bong Vang WTP will be enough for 2020.
Long Hoa	The capacity deficit is about 1400 m^3/day in 2020. The incremental demand shall be covered by the Con Khuong WTP or Can Tho No. 2 WTP.
Ba Lang	The expanded WTP with a capacity of 5000 m^3/day for 2020 will be required.
Thoi Lai	The capacity of Thoi Lai WTP will be enough for 2020.
Co Do	The incremental demand is expected to be covered by the new WTP constructed under the Hau River Project.
Vinh Thanh	The capacity of Vinh Thanh WTP will be enough for 2020.
Thanh An	The incremental demand is expected to be covered by the new WTP constructed under the Hau River Project.

Source: JICA Study Team

CHAPTER 5 SELECTION OF PRIORITY SCHEME FOR BOT PROJECT

5.1 Establishment of Conditions for Priority Project

5.1.1 Selection of Service Area

In order to identify the feasibility of the project, the service areas of Can Tho No. 1, Can Tho No. 2, Hung Phu, and Tra Noc WTPs were selected as the target areas for the project in consideration of the following aspects:

- The area where high incremental water demand will be required;
- The area with high population density; and
- The area where minimum investments for additional transmission and distribution network from WTP are required.

In addition, the service area of O Mon WTP was selected as a conditional target area, and will be chosen only as a target area when the selected WTP is located at the O Mon area.

5.1.2 Selection of the Proposed Site for WTP

In the selection of the proposed site for the WTP, WSSC's premises is more preferable than private land because neither payment of land acquisition fee nor resettlement of residents is required. However, WSSC's premises, which can be utilized as a construction site of WTP, does not have sufficient space to accommodate the project. Therefore, both private land and WSSC's premises were examined for the selection of the proposed site of the new WTP in this study.

As for the WSSC's premises, the Study Team chose the proposed sites for the new WTPs at the premises of Can Tho No. 2, Hung Phu, and Tra Noc WTPs.

In addition, private lands along the Hau River in Binh Thuy and O Mon districts[1] were surveyed for the new WTPs.

5.1.3 Case Study for Optimum System

The alternatives for the case study for optimization were selected as shown in Table 5.1.1 in consideration of the efficiency of the project.

[1] According to the city development plan approved in October 2012, the private land in O Mon area, which was proposed as a WTP site in this study, was decided as a housing development land. This private land is considered as a proposed site of WTP in this report as when the case study was conducted in the study.

Cases 1 and 2 are alternatives in which one new WTP will be constructed at the private land near the Hau River. New WTPs will be constructed in the premises of the existing WTPs in Cases 3 to 5.

Table 5.1.1 Case Study Setting for Optimum System

Case	Location of WTP	Capacity of WTP (m^3/day)	Length of Pipeline (km)	Service Area				
				O Mon	Tra Noc	CT-1	CT-2	Hung Phu
Case 1	O Mon (New)	70,000	46.5	○	○	○	○	○
Case 2	Binh Thuy (New)	60,000	18.2		○	○	○	○
Case 3	Premises of Can Tho No. 2	50,000	14.8		○	○	○	
	Premises of Hun Phu	10,000	-					○
Case 4	Premises of Can Tho No. 2	45,000	11.0			○	○	
	Premises of Tra Noc	5,000	-		○			
	Premises of Hung Phu	10,000	-					○
Case 5	Premises of Can Tho No. 2	45,000	11.0			○	○	

Source: JICA Study Team

5.1.4 Preliminary Cost Estimate for the Case Study

In order to select the priority scheme and conduct preliminary financial assessment of the schemes, the project cost for each case was estimated as shown in Table 5.1.2.

Table 5.1.2 Estimated Cost of Each Case

Scheme	Item	Cost (VND Billion)
Case 1 (70,000 m^3/day)	1) Capital Investment Cost	1,477
	2) Operation and Maintenance Cost (Present value of 22 years)	566
	Total	2,043
	VND 30.2 million/m^3	
Case 2 (60,000 m^3/day)	1) Capital Investment Cost	804
	2) Operation and Maintenance Cost (Present value of 22 years)	261
	Total	1,065
	VND 18.8 million/m^3	
Case 3 (60,000 m^3/day)	1) Capital Investment Cost	748
	2) Operation and Maintenance Cost (Present value of 22 years)	314
	Total	1,062
	VND 18.7 million/m^3	
Case 4 (60,000 m^3/day)	1) Capital Investment Cost	782
	2) Operation and Maintenance Cost (Present value of 22 years)	353
	Total	1,135
	VND 20.0 million/m^3	
Case 5 (45,000 m^3/day)	1) Capital Investment Cost	570
	2) Operation and Maintenance Cost (Present value of 22 years)	220
	Total	790
	VND 18.3 million/m^3	

Note: Discount rate for the conversion from each annual cost to present value in this case study was set at 6% per year with reference to similar projects in Vietnam.
Source: JICA Study Team

5.1.5 Selection of Optimum System

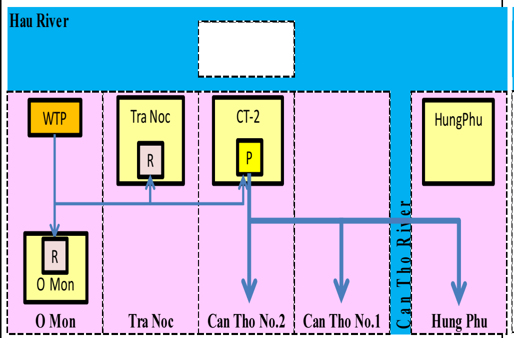
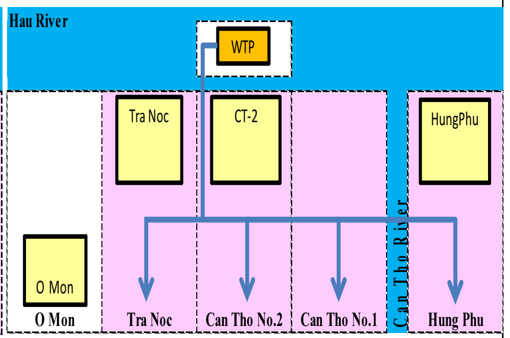
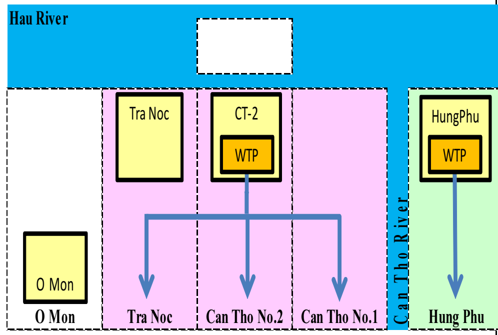
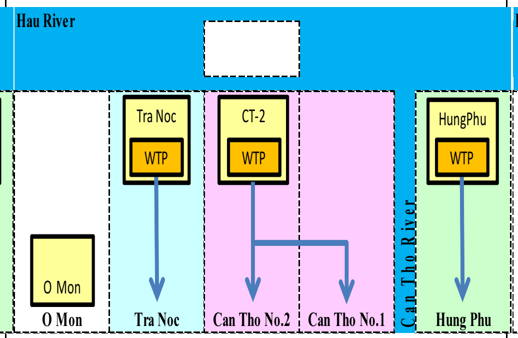
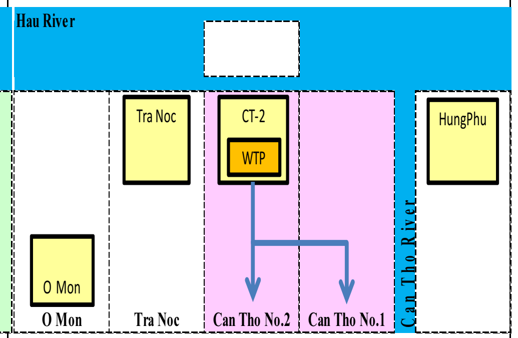
Based on the detailed comparison as shown in Table 5.1.3, Case 5 was selected as the optimum system of the priority project considering the following aspects:

i) The index of "total cost/capacity" was calculated to compare the financial efficiency of each case. As a result of this financial evaluation, Case 5 was selected as the best among the five alternatives.

ii) The new WTP in this case is proposed at the premises of Can Tho No. 2 WTP, and land acquisition and resettlement of residents will not be required.

iii) There is not much demand risk because the IZs in the service areas of Hung Phu and Tra Noc WTPs were not included in this case.

Table 5.1.3 Comparative Chart for the Selection of Optimum Water Supply System

		Case 1	Case 2	Case 3	Case 4	Case 5
Schematic Model						
Brief Summary		New WTP will be constructed in O Mon District and treated water will be served to O Mon, Tra Noc, Can Tho No. 2, Can Tho No. 1, and Hung Phu WTPs' planned area. The length of pipeline is very long; the cost of pipeline is relatively expensive; and the land acquisition process will take long time.	New WTP will be constructed in Binh Thuy District (near Can Tho No. 2 WTP) and treated water will be served to Tra Noc, Can Tho No. 2, Can Tho No.1, and Hung Phu WTPs' planned area. The length of pipeline is relatively short, but the pipe bridge across the Can Tho River is required.	New WTPs will be constructed in the premises of Can Tho No. 2 and Hung Phu WTPs. Treated water of the new WTP in Can Tho No. 2 will be served to Tra Noc, Can Tho No. 2, and Can Tho No. 1 WTPs' planned area. The length of pipeline is relatively short.	New WTPs will be constructed in the premises of Tra Noc, Can Tho No. 2, and Hung Phu WTPs. Treated water of the new WTP in Can Tho No. 2 will be served to Can Tho No. 2 and Can Tho No. 1 WTPs' planned area. The length of pipeline is relatively short.	New WTPs will be constructed in the premises of Can Tho No. 2 WTP. Treated water of the new WTP in Can Tho No. 2 will be served to Can Tho No. 2 and Can Tho No. 1 WTPs' planned area. The length of pipeline is relatively short.
Service Area and Incremental Demand in 2020	O Mon	11,000 m^3/d	-	-	-	-
	Tra Noc	5,000 m^3/d	5,000 m^3/d	5,000 m^3/d	5,000 m^3/d	
	CT-1	20,600 m^3/d	20,600 m^3/d	20,600 m^3/d	20,600 m^3/d	20,600 m^3/d
	CT-2	23,600 m^3/d	23,600 m^3/d	23,600 m^3/d	23,600 m^3/d	23,600 m^3/d
	Hung Phu	9,900 m^3/d	9,900 m^3/d	9,900 m^3/d	9,900 m^3/d	-
	Total	70,100 m^3/d	59,100 m^3/d	59,100 m^3/d	59,100 m^3/d	44,200 m^3/d
Location and Capacity of the WTPs		O Mon (new): 70,000 m^3/day	Binh Thuy (new): 60,000 m^3/day	Can Tho No.2: 50,000 m^3/day Hung Phu: 10,000 m^3/day	Can Tho No.2: 45,000 m^3/day Hung Phu: 10,000 m^3/day Tra Noc: 5,000 m^3/day	Can Tho No.2: 45,000 m^3/day
Land for WTP		3.5 ha	2.5 ha	3.0 ha	3.5 ha	2.5 ha
Area (ha)		WTP: 30,000 m^2 Booster PS: 5,000 m^2	WTP: 25,000 m^2	WTP(CT2): 10,000 m^2 WTP (Sludge area for CT2): 15,000 m^2 WTP (Hung Phu): 5,000 m^2	WTP(CT2): 10,000 m^2 WTP (Sludge area for CT2): 15,000 m^2 WTP (Tra Noc): 5,000 m^2 WTP (Hung Phu): 5,000 m^2	WTP(CT2): 10,000 m^2 WTP (Sludge area for CT2): 15,000 m^2
Land Acquisition		Required (3.5 ha)	Required (2.5 ha)	Approx. 1.5 ha	Approx. 1.5 ha	Approx. 1.5 ha
Current Land Use		Private land/ Agricultural use	Private land/ Agricultural use	WSSC's land/ Land for WTPs Private land/ Agricultural use	WSSC's land/ Land for WTPs Private land/ Agricultural use	WSSC's land/ Land for WTPs Private land/ Agricultural use
Compensation		Required	Required	Expected to be in small amount	Expected to be in small amount	Expected to be in small amount
Pipeline	Transmission	D300 – D800 L=32.5 km	-			-
	Distribution	D400 – D900 L=14 km	D400 – D900 L=18.2 km	D400 – D800 L=14.8 km	D400 – D800 L= 11.0 km	D400 – D800 L=11.0 km
	Total	Total = 46.5 km	Total = 18.2 km	Total = 14.8 km	Total = 11.0 km	Total = 11.0 km
Cost (in Billion VND)	Intake and WTP	483	429	454 (367 (CT2)+ 87 (Hung Phu))	504 (345 (CT2)+72 (Tra Noc)+ 87 (Hung Phu))	345
	Booster PS	76	-	-	-	-
	Pipeline	647	201	137	107	107
	Engineering	167	95	70	72	54
	Renewal	104	79	87	99	64
	O&M	566 (22 years)	261 (22 years)	314 (22 years)	353 (22 years)	220 (22 years)
	Total	2,043	1,065	1,062	1,135	790
Total Cost / Capacity		VND 30.2 million/m^3	VND 18.8 million/m^3	VND 18.7 million/m^3	VND 20.0 million/m^3	VND 18.3 million/m^3
Evaluation		Rank fifth (5th)	Rank third (3rd)	Rank second (2nd)	Rank fourth (4th)	Rank first (1st)

Source: JICA Study Team

5.2 Design of the Proposed Water Treatment Plant

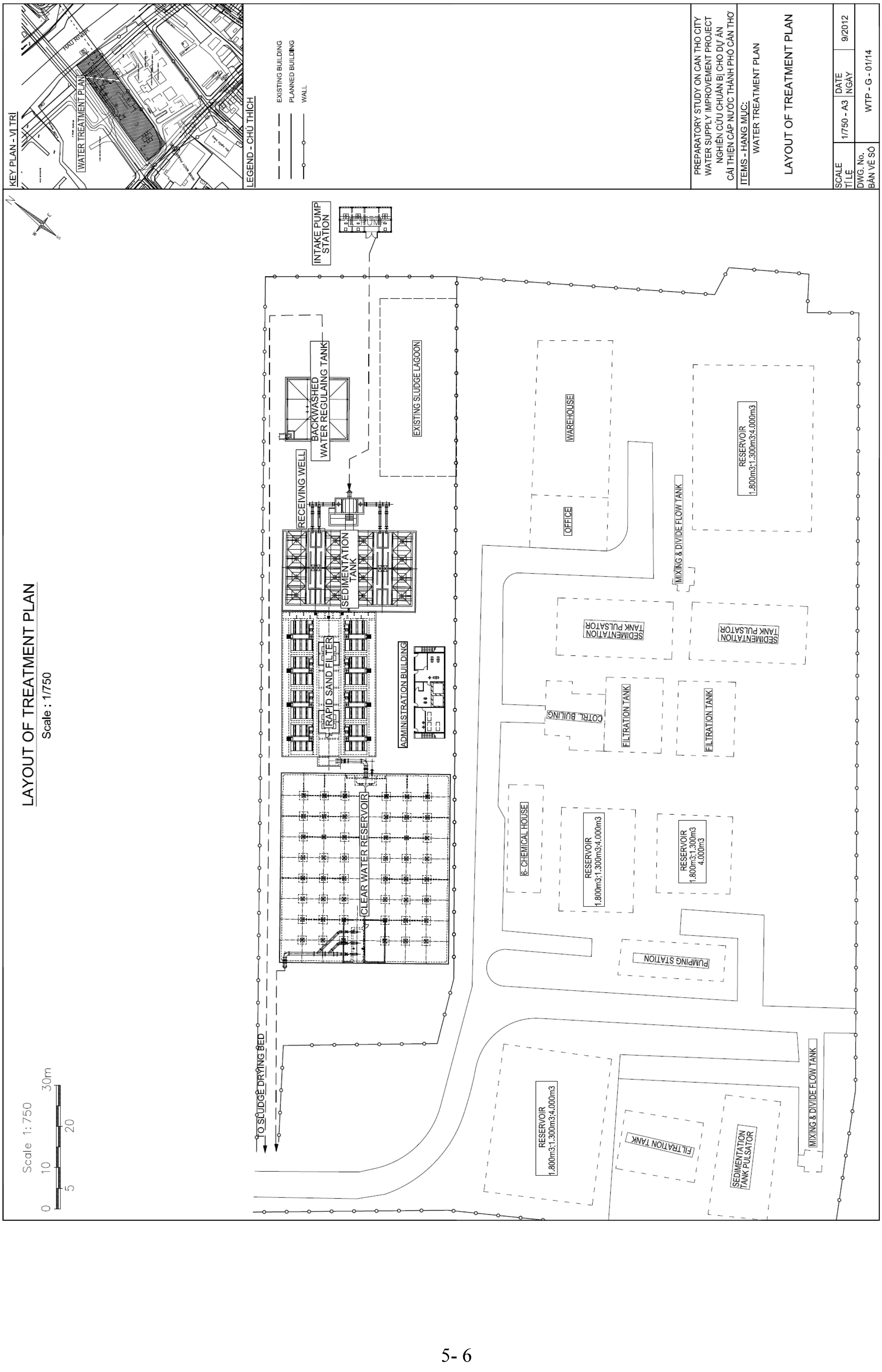
5.2.1 Outline of the Design

The components of the water treatment plant are shown in Table 5.2.1 below. The layout is shown in Figure 5.2.1.

Table 5.2.1 Major Components of the Proposed Water Treatment Plant

No.	Name of Facilities	Unit	Remarks
	Intake Pump	3	Pump: Q=16.5 m^3/min (2 + 1 standby, variable speed type)
	Receiving Well	1	Rapid mixing by weir flow
	Flocculation Chambers	4	Hydraulic mixing by zigzag flow channels
	Sedimentation Tanks	4	Vertical upflow type with tube settling, hopper bottomed
	Chlorination Chamber	1	Hydraulic mixing by zigzag flow channels
	Rapid Sand Filter Beds	8	Constant flow, natural equilibrium, and self washing type
	Clear Water Reservoirs	2	Flat slab type V=7,500 m^3
	Distribution Pumps	3	Pump: Q=23.5 m^3/min (2+1standby)
	Backwater WR Tank	1	V=400 m^3
	Sludge Regulating Tank	1	V=35 m^3
	Sludge Drying Beds	10	Concrete structure, 30 m x 45 m x 1.2 m x 10 beds
	Administration Building	1	Office, Laboratory, Blower Room. Meeting Room, Other Rooms, PAC, Chlorine

Source: JICA Study Team



Source: JICA Study Team

Figure 5.2.1 Layout Plan of the Proposed WTP

5.2.2 Topographic and Soil Conditions

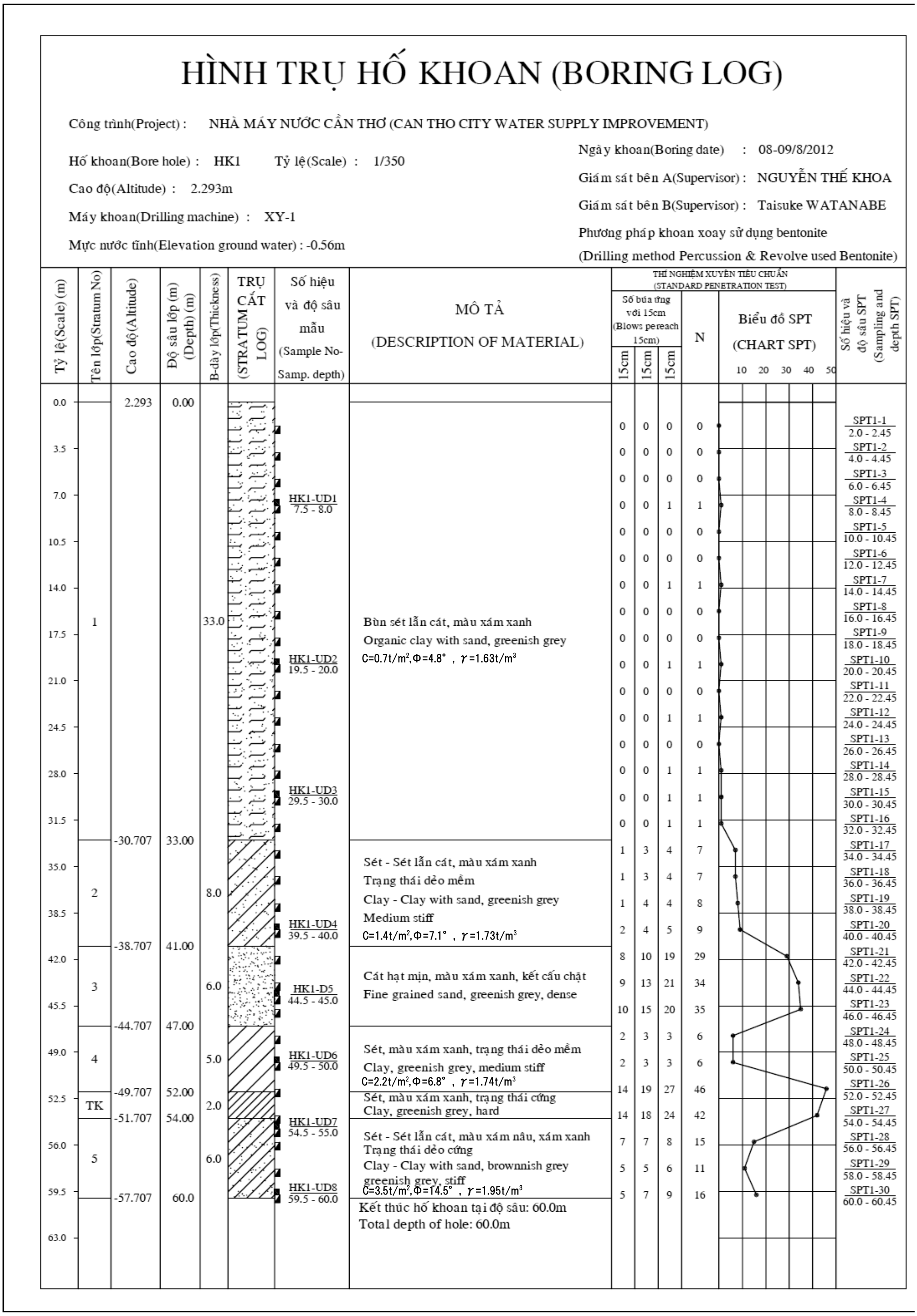
Hau River is a tidal river. The highest high water level reaches El +2.05 m and the lowest low water level reaches El -1.55 m. The ground height in the site varies from El 0.75 m from the bottom of the sludge pond to El 3.18 m. The formation level is set at El 2.2 m which is almost the average ground height.

Borings were carried out in two locations. The field boring log of the proposed site is shown in Figure 5.2.2.

The ground layer down to El -50m is composed of soft clay layer with N value of 0-1, as a whole. The possible bearing layer should be at the first hard layer at El -38.7 m with N=30. The soil condition will also require sheet pipes for earth retaining works especially for deep structures such as the clear water reservoir and backwash wastewater regulating tank.

5.2.3 Flow Diagram

Figure 5.2.3 shows the flow diagram of the proposed treatment plant including chemical dosing points, water level in the tanks and filters, and major valves and siphons.



Source: JICA Study Team

Figure 5.2.2 Boring Logs at the Proposed Plant Site

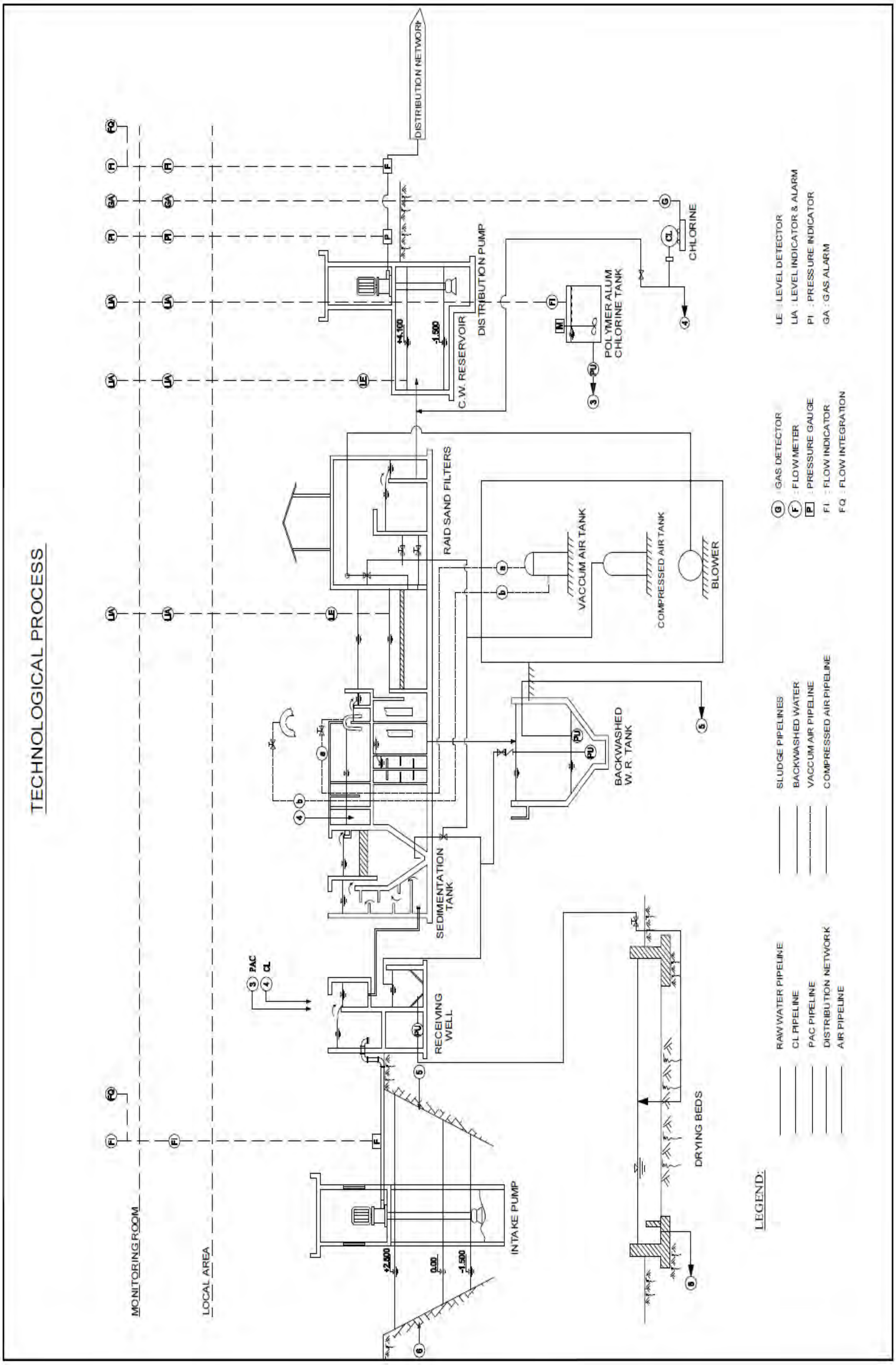


Figure 5.2.3 Flow Diagram of the Proposed Treatment Plant

Source: JICA Study Team

5.2.3 Treatment Process

(1) Intake Pump and Station

The proposed intake pumping station will be located in the Khai Luong Canal and at the immediate upstream of the existing pumping station. Three pumps (one standby) will be installed at the station together with their control panels. Each pump will have the same pumping capacity of Q=16.5 m^3/min and head of 15 m. The motor of the pump will be controlled by an electric device called variable voltage variable frequency (VVVF). This system was selected based on the result of a comparative study in which a conventional fixed speed pump system with a butterfly valve and a VVVF system were compared from both technical and economical points of view.

The summary of the comparative study is shown in Table 5.2.2 below.

Table 5.2.2 Comparison of Variable and Fixed Speed Pumps (Intake Pumps)

Items to be Compared	Variable Speed Pump	Fixed Speed Pump
Initial cost of control system	VND 2.23 billion	VND 850 million
Power required	86.1 kWh to 110.3 kWh	112 kWh
Electricity consumption	897,700 kW/year	984,500 kW/year
Unit price of electricity	VND 2,600/kW	VND 2,600/kW
Annual electricity cost	VND 2.33 billion	VND 2.56 billion
Breakeven point of cost	6 to 7 years (See Figure 5.2.4)	

Source: JICA Study Team

(2) Raw Water Transmission Pipeline

A raw water pipeline with diameter of 700 mm will be installed between the intake and the receiving well. The pipe material is ductile cast iron. An ultrasonic flow meter will be provided in the raw water pipeline. The flow rate will be monitored at a monitoring room in the administration building. Poly Aluminum Chloride (PAC) dosing will be controlled according to the flow rate.

(3) Receiving Well

The retention time of the receiving well will be 1.5 minutes. The PAC coagulant will be applied to the water that flows over the weirs, and rapid mixing will be carried out by using the energy of falling water. Chlorine will also be applied occasionally to prevent algae growth.

(4) Flocculation Chambers

Four flocculation chambers are proposed. Each chamber will have a long channel which has several baffle walls in it. These walls will make the channel a horizontal zigzag channel. The retention time will be about 15 minutes. The flow velocity in the channel will be 10-25 cm/sec. The drain water and sludge will be sent to the backwash wastewater regulating tanks.

(5) Sedimentation Tanks

Due to the limited space, an upflow sedimentation tank with tube settler was selected. An advantage of this sedimentation tank is easy operation and maintenance (O&M).

(6) Intermediate Chlorination Tank

The tank will be provided between the sedimentation tanks and the rapid sand filter. The retention time will be 15 minutes. Mixing of water and chlorine will be carried out hydraulically by the horizontal zigzag channels with baffle walls. It will prevent algae growth and remove manganese due to oxidation by chlorine.

(7) Rapid Sand Filters

The rapid sand filter will be a constant rate, natural equilibrium and self-washing type, usually called as "green leaf filter". The filtration and backwash rates will be 150 m^3/m^2/day and 0.8 m^3/m^2/minute, respectively.

(8) Clear Water Reservoir

The clear water reservoir is a flat slab type divided into two sub-tanks by a partition wall. The retention time and the capacity will be 4 hours and 7500 m^3, respectively. The minimum retention time was set at 3.5 hours.

(9) Distribution Pumps

Three distribution pumps (one is standby) will be installed in the pump house, all of which are variable speed type. The capacity and maximum head of each pump are 23.5 m^3/min and 40 m, respectively. The pump is of vertical shaft and mix flow type. The motor of the pump will be controlled by VVVF system. The distribution pumps will be controlled so that the water pressure in the distribution network is kept at 0.1 MPa constantly throughout the day.

(10) Backwash Wastewater Regulating Tank

The regulating tank receives backwash wastewater from the rapid sand filter and decants the water. The tank capacity is 400 m^3 which is equivalent to the volume of wastewater produced by one backwashing. The tank will hold the water for several hours until it is separated into supernatant and sludge. Two submersible pumps will be installed in the tank. One pump will be located in the middle of the tank and will discharge the supernatant to the river. The other pump will be located at the bottom of the tank and will discharge sludge to the sludge regulating tank by manual operation.

(11) Sludge Regulating Tank

This tank receives sludge drained at the sedimentation tank. The tank is a compound structure with a receiving well. It has a capacity of 35 m^3. The drained sludge will enter this tank at pulse interval. Two progressive cavity pumps (one is standby) will be installed in a pump house situated under the receiving well.

(12) Sludge Drying Beds

The sludge drying bed receives the sludge from the sludge regulating tank. The sludge will be dewatered using natural energy, such as sunlight and wind. The sludge drying bed is a concrete structure and is divided into some beds by partition walls.

5.2.4 Chemical and Storage

(1) Coagulant

Although existing WTPs use powder PAC with an aluminum oxide concentration of 30%, the proposed WTP will use liquid PAC with an aluminum oxide concentration of 10%. Two PAC storage tanks with a capacity of 20 m^3 each will be provided in the chemical room in the administration building. It is equivalent to 15 days of storage during the wet season and 45 days of storage during the dry season.

(2) Disinfectant

Liquid chlorine will be used in the proposed WTP. It will be supplied by one ton cylinder to the site. A chemical room will be provided in the administration building. The floor will be lowered by about 0.5 m than the other areas so that the lowered floor retains chlorine gas when it is leaked.

5.2.5 Administration Building

The administration building accommodates the following rooms: 1) monitoring room, 2) laboratory, 3) office, 4) meeting room, 5) machinery room, 6) workshop, 7) chemical room, 8) chlorination room, and 9) other rooms. The blower for air scouring of the rapid sand filter and compressor for pneumatic valves will be installed in the machinery room.

5.2.6 Electrical and Mechanical Works

(1) Pumping Facilities

Intake and distribution pumps are variable speed types. For the backwashing of the filter, two root type blowers will be installed in the machinery room in the administration building. The capacity is 10.8 m^3/min x 60 kPa x 18.5 kW.

The backwash wastewater tank has two submersible pumps; one for sludge and the other for supernatant. The sludge regulating tank will be equipped with progressive cavity pumps, which will discharge 2% or higher concentration sludge to sludge drying beds.

(2) Power Receiving Transformer

The electricity for the WTP will be supplied by Can Tho Power Corporation. The maximum electric load of the WTP is 700 kW. The electricity will be supplied from existing 22 kV lines to a power receiving transformer to be installed in the proposed WTP where the voltage will be stepped down to 380 V.

(3) Backup Power Supply

For plant operation during power outage, a generator will be installed. An uninterrupted power supply system consisting of batteries will be provided in the monitoring room. The system will supply electricity to the instrumentation system and computer including the logging system.

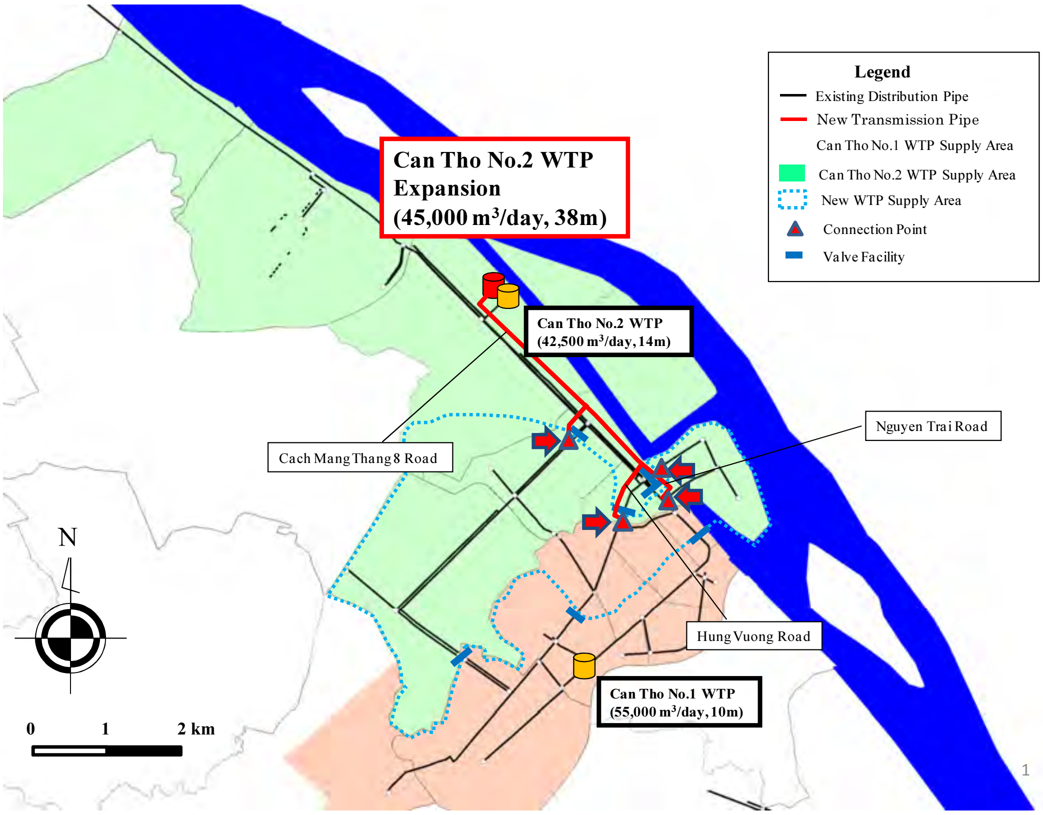
(4) Control and Monitoring System

The proposed WTP will be composed of the following facilities: 1) intake pumps, 2) receiving well, 3) sedimentation tanks, 4) rapid sand filter, 5) distribution pumps, 6) sludge treatment facility, and 7) chemical dosing facility. Operational information from these facilities will be transmitted to the monitoring room, and displayed on the VDUs.

5.3 Transmission Systems

5.3.1 Outline of the Transmission System

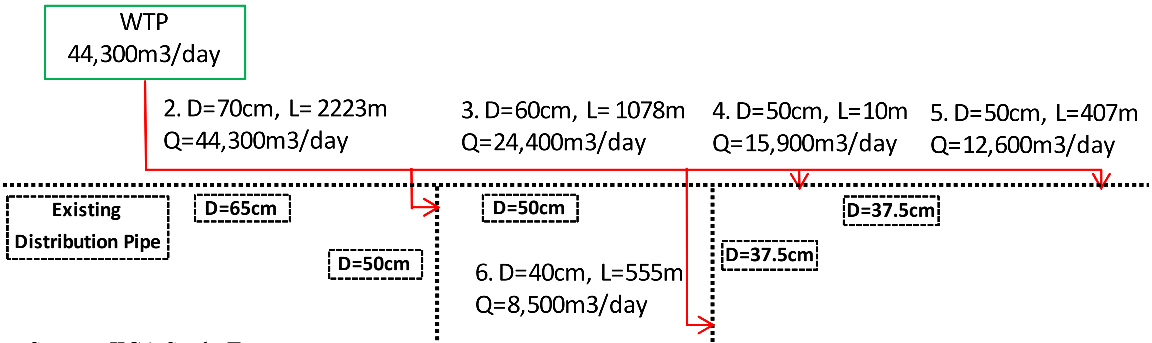
The treated water from the new WTP will be transmitted to the existing distribution pipeline network.. Figure 5.3.1 shows the outline of the proposed transmission system.



Source: JICA Study Team

Figure 5.3.1 Outline of the Proposed Transmission and Distribution Systems

The new water supply area is divided by valve facilities. The proposed transmission pipeline is designed with minimal pipe length and diameter to reduce the water head loss and construction cost. Figure 5.3.2 shows the schematic diagram of the proposed transmission pipeline.



Source: JICA Study Team

Figure 5.3.2 Schematic Diagram of the Proposed Transmission Pipeline

5.3.2 Pipeline Alignment

(1) Pipeline Route

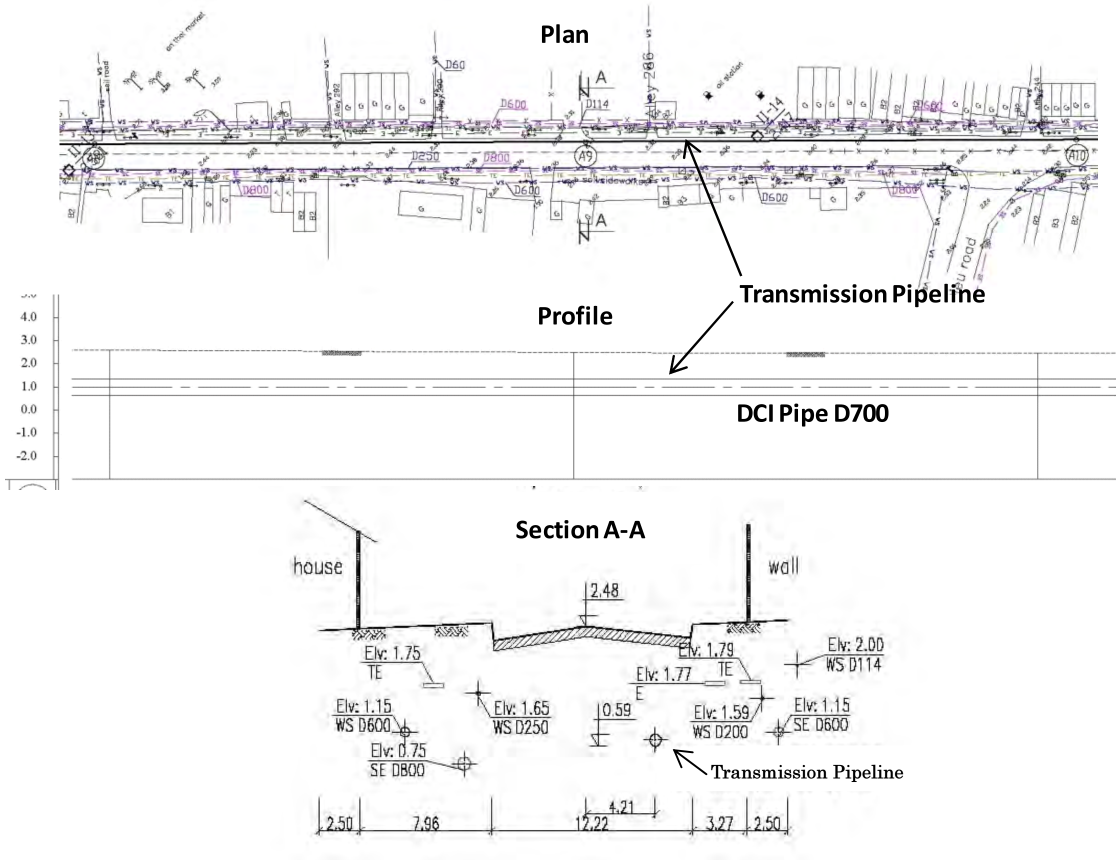
The transmission pipeline starts from the WTP and runs along the national road. The general layout map of the pipeline is shown in Drawing G-1/1.

(2) Existing Underground Utility

The width of the above national road is 13-18 m and the sidewalk is 5 m. Telephone cable, water distribution pipe, sewer pipe, and electrical cable are buried under the road with bedding depth of 1.0-1.2 m, 0.7-1.5 m, 0.3-2.0 m, and 1.0-1.2 m, respectively. Therefore, new pipeline is planned to be installed under the edge of the roadway.

5.3.3 Plan and Profile of the Transmission Pipeline

The transmission pipe is planned to be placed at the edge of the roadway, which is about 4 m to 5 m from the centerline of the road, with earth coverage of 1.2 m. The typical layout of the transmission pipeline is shown in Figure 5.3.3.



Note: TE: Telephone Line, WS: Water Distribution Pipe, SE: Sewer Pipe, E: Electrical Cable, Elv: Invert Elevation
Source: JICA Study Team

Figure 5.3.3 Typical Layout of Transmission Pipeline

5.3.4 Selection of Pipe Material

The comparison of pipe materials is carried out for the planned transmission pipeline. The comparison results are shown in Table 5.3.1.

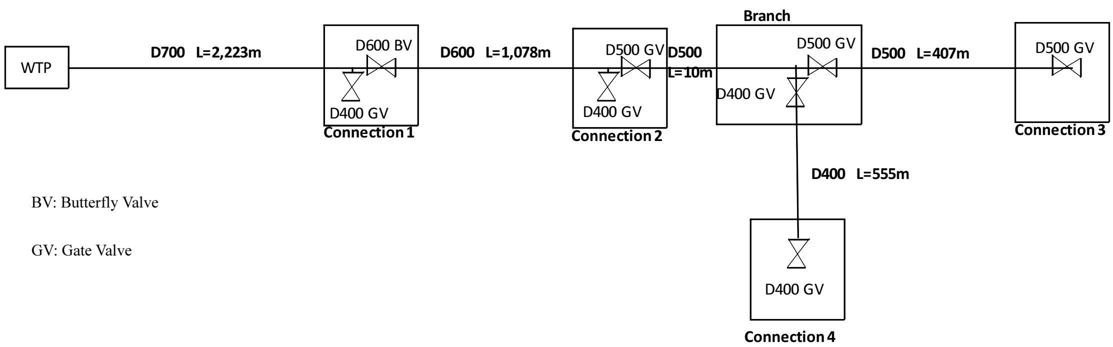
Table 5.3.1 Comparison of Pipe Materials

	DCI Pipe	Steel Pipe
Work Efficiency	- High work efficiency - No need for special skill and equipment	- Needs special skill - Needs strict quality control - Difficult in wet condition
	◎	△
Material Cost (DM 400)	VND 2,600,000/m	VND 1,600,000/m
	○	◎
Construction Cost (DM 400)	VND 1,200,000/m	VND 2,100,000/m
	◎	△
Durability	- High durability	- Needs measure to prevent electrical corrosion
	◎	△
General Practice in WSSC	Applied in WSSC as a standard material for pipelines with diameter of 250 mm or larger.	Not generally used in Vietnam except for special locations such as high working pressure section, river crossing section, etc.
	◎	△
Overall judgment	◎	△

Source: JICA Study Team

5.3.5 Valve Facilities

Valve facilities are planned to be installed at the connection points and branch point. The schematic diagram of the valve locations is shown in Figure 5.3.4.

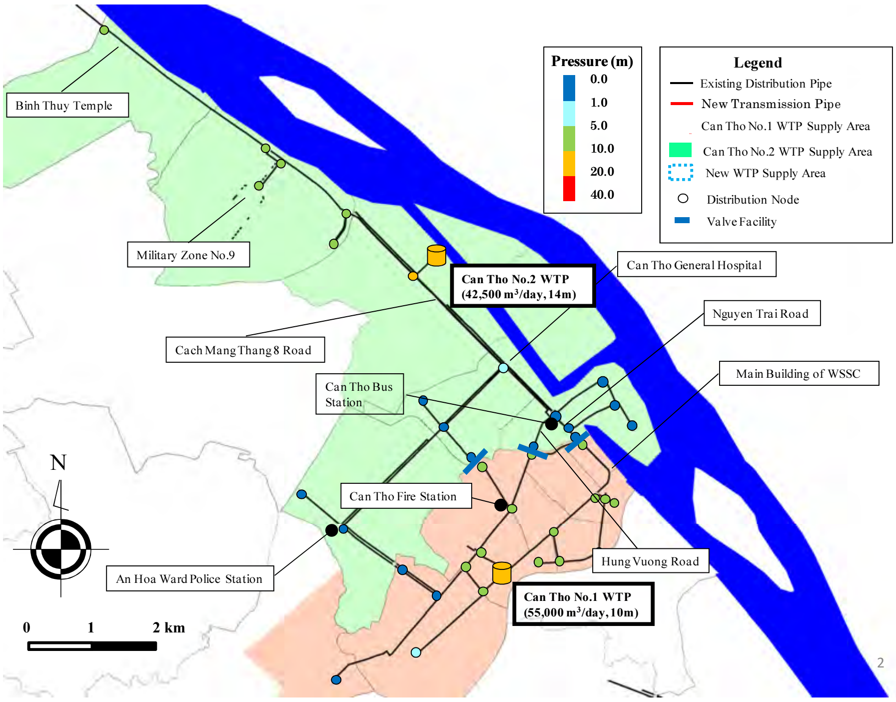


Source: JICA Study Team

Figure 5.3.4 Schematic Diagram of the Valve Locations

5.3.6 Flow Analysis

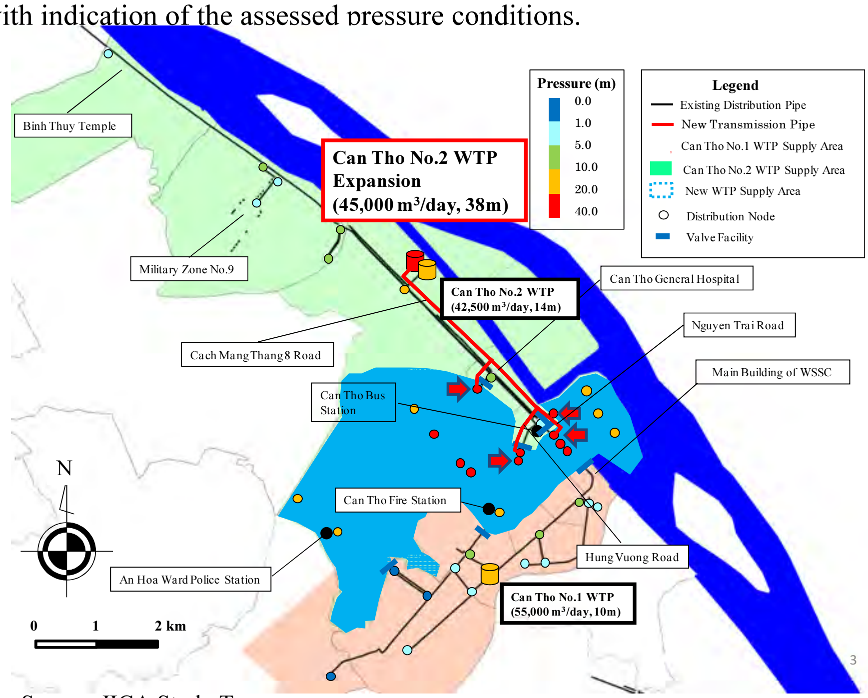
A flow analysis was perfomed to check the effect of the inflow of large amount of water from the new water treatment plant in the existing distribution network, to determine the connection point of the transmission pipeline with the existing distribution pipeline. Figure 5.3.5 shows the result of flow analysis in the existing distribution network.



Source: JICA Study Team

Figure 5.3.5 Existing Situation in the Existing Distribution Network

Figure 5.3.6 shows the proposed division of the water supply areas and connection points with indication of the assessed pressure conditions.



Source: JICA Study Team

Figure 5.3.6 Future Situation in Planned Distribution Network

The above figure shows that the water pressure still does not reach 10 m in areas remote from the existing WTP. Hence, it is recommended to increase the water pressure from the existing distribution pump.

CHAPTER 6 COST ESTIMATES AND CONSTRUCTION SCHEDULE

6.1 Cost Estimates

6.1.1 Project Facility

The outline of the project facility is shown in Table 6.1.1.

Table 6.1.1 Outline of the Project Facility

Facility	Outline
A. Intake Facility	Foundation: Pier foundation Pump house: RC and concrete block Intake pump: Vertical mixed flow, 16.5 m^3/min x 15 m x 60 kW, 3 nos.
B. Water Treatment Plant	
Sedimentation Facility	Vertical upflow type with tube settler, 4 lines
Rapid Sand Filter	Self washing type, 8 nos., Siphon system Backwash blower: Roots type, 10.8 m^3/min x 60 kPa x 18.5 kW, 2 nos.
Clear Water Reservoir and Pump	Volume: 7,500 m^3, 2 lines Distribution pump: Vertical mixed flow, 24 m^3/min x 40 m x 220 kW, 3 nos. Service water unit: Horizontal centrifugal, 0.2 m^3/min x 25 m x 1.5 kW, 1 no.
Sludge Treatment	Backwash wastewater tank: V=350 m^3 Wastewater discharge pump: Submersible, 1.25 m^3/min x 15 m x 5.5 kW, 2 nos. Sludge regulation tank: V=50 m^3 Sludge discharge pump: Progressive cavity, 0.23 m^3/min x 15 m x 0.75 kW, 2 nos.
Chemical Facility	PAC dosing system: Diaphragm type, 2.9 L/min x 0.75 kW, 2 nos. Chlorination system: 4 kg/h, 3 nos. Air compressor for valve actuator: 240 L/min x 0.83 MPa x 2.2 kW
Electrical Facility	Power receiving panel, Local control panel, Instrumentation, Cables Emergency generator: 3 phase, 4 wire, 750 kVA
Sludge drying bed	10,000 m^2 (50 m x 50 m, 4 nos.)
C. Water Transmission Pipeline	
Pipeline	DCI Pipe D700 – D400, L = 4.3 km

Source: JICA Study Team

6.1.2 Conditions of Cost Estimate

(1) Conditions of Project Cost Estimation

1) Price level : May 2012
2) Exchange rate : JPY 1 = VND 266
(May 31, 2012 Vietcombank Selling Rate)

(2) Composition of Project Cost

1) Capital Cost (CAPEX)

The CAPEX is estimated by the following items:

a) construction cost; b) equipment cost; c) compensation and resettlement assistance; d) project management cost; e) construction investment consultancy cost; f) other costs; and g) physical contingency.

2) Operation and Maintenance Cost (OPEX)

The OPEX is composed of the following items:

a) power cost; b) chemical cost; c) maintenance cost; d) personnel cost; and e) sludge disposal cost.

6.1.3 Capital Cost

(1) Construction Cost

The construction cost is shown in Table 6.1.2.

Table 6.1.2 Construction Cost

Item	Cost (VND in million)	Note
I. Direct Cost		
Intake	[redacted]	
Water Treatment Plant	[redacted]	
Water Transmission Pipeline	[redacted]	
Other Direct Costs	[redacted]	2.5% of above
Direct Cost	[redacted]	T
II. General Cost	[redacted]	C = T x 6.5%
III. Advance Calculated Taxable Income	[redacted]	TL = (T+C) x 5.5%
Before-tax Construction Cost	[redacted]	G=T+C+TL
IV. VAT	[redacted]	GTGT=G x 10%
After-tax Construction Cost	[redacted]	G+GTGT
V. Cost for Construction Administration	[redacted]	G x 2% x 1.10
Total	[redacted]	

Source: JICA Study Team

(2) Equipment Cost

The equipment cost is shown in Table 6.1.3.

Table 6.1.3 Equipment Cost

Item		Cost (JPY in million)
I.	Cost for Equipment Procurement	[redacted]
II.	Cost for Training and Technology Transfer	(included in Item III)
III.	Cost for Installing Equipment and Testing and Calibration	[redacted]
	Total (Before Tax)	[redacted]
	VAT (10%)	[redacted]
	Total	[redacted]

Source: JICA Study Team

(3) Breakdown of Construction Cost and Equipment Cost by Facility

The breakdown of construction and equipment costs is shown in Table 6.1.4.

Table 6.1.4 Breakdown of Construction Cost and Equipment Cost by Facility

	Construction Cost		**Equipment Cost**		**Total**	
	VND in billion	(JPY equivalent million)	VND in billion	(JPY equivalent million)	VND in billion	(JPY equivalent million)
A Intake (47,500 m³/day)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
B Water Treatment Plant (45,000 m³/day)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Sedimentation Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Sand Filter Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Distribution Reservoir and Pump Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Sludge Treatment Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Chemical Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Electrical Facility	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Site Preparation and Ancillary Work	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
C Water Transmission Pipeline	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Pipeline D700-D400 L=4.2 km	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Connection point: 4 nos.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Source: Study Team

(4) Overall Capital Cost

Overall capital cost is shown in Table 6.1.5.

Table 6.1.5 Overall Capital Cost

JPY 1 = VND 266

	FC Portion	LC Portion	Total		
	(VND in billion)	(VND in billion)	(VND in billion)	(JPY Equivalent Million)	
1. Construction Cost	[redacted]	[redacted]	[redacted]	[redacted]	including VAT
2. Equipment Cost	[redacted]	[redacted]	[redacted]	[redacted]	including VAT
3. Compensation and Resettlement Assistance	[redacted]	[redacted]	[redacted]	[redacted]	
4. Project Management					
5. Construction Investment Consultancy	[redacted]	[redacted]	[redacted]	[redacted]	7% of (1.+2.)
6. Other Costs					
7. Physical Contingency	[redacted]	[redacted]	[redacted]	[redacted]	5% of (1. – 6.)
Total Capital Cost	[redacted]	[redacted]	[redacted]	[redacted]	

Source: Study Team

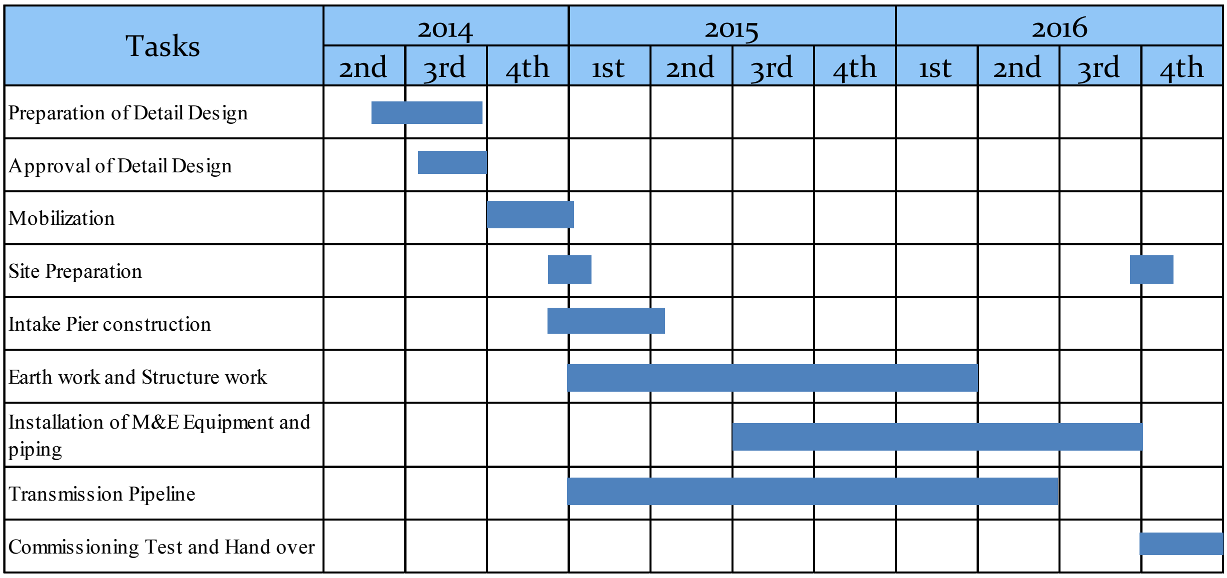
6.1.4 Operation and Maintenance Cost

Annual operation and maintenance cost was VND [redacted] billion.

6.2 Construction Schedule

The total construction work period including detailed design and commissioning test is intended to be 32 months. Construction is expected to be completed by the end of 2016.

The construction schedule is shown in Figure 6.2.1.



Source: JICA Study Team

Figure 6.2.1 Construction Schedule

CHAPTER 7 PROJECT IMPLEMENTATION PLAN

7.1 Overall Project Schedule

Figure 7.1.1 below outlines the overall schedule of this project.

The figure is omitted due to confidentiality

Source: JICA Study Team

Figure 7.1.1 Overall Project Schedule

7.2 Detailed Schedule

7.2.1 Project Development Period

The project development period contains three phases, namely: 1) project design; 2) project approval; and 3) negotiations and signing of contracts. Figure 7.2.1 outlines the main tasks under each phase and their specific timelines.

The figure is omitted due to confidentiality

Source: JICA Study Team

Figure 7.2.1 Project Development Schedule

7.2.2 Construction Period

The construction period, which includes the detailed design and construction phases, shall start in 2014. It will continue for three years until the commissioning by the end of 2016 (refer to Chapter 6.2 for details of the construction schedule).

7.2.3 O&M Period

The O&M period shall start in 2017 as shown in Figure 7.2.2. The operational period for this project is planned for 25 years, which will continue until 2041.

The figure is omitted due to confidentiality

Source: JICA Study Team

Figure 7.2.2 O&M Schedule

CHAPTER 8 RISK ANALYSIS

8.1 Risk Analysis and Design of Countermeasures

8.1.1 Risk Sharing

Designing appropriate risk sharing structure among related parties and mitigation measures to prevent risks from hindering the project is crucial in order to realize a feasible project. It is particularly important that each risk is borne by the party having the best ability to manage it because such party can handle the risk with the least risk management cost possible. When risks are borne by the party with best risk management ability, it benefits both the government and private enterprises through the reducing of project costs and thereby reducing the service (off-take) fees. Such risk sharing benefits the project also because, by clearly defining who is responsible for each risk, it facilitates the best efforts by each risk-bearing party to mitigate the risks.

8.1.2 Expected Risks and Risk Management Methods for the Proposed Project

Risks needed to be considered in BOT infrastructure projects are caused by commercial, financial, or external factors.

<u>The paragraph is omitted due to confidentiality.</u>

The insurances utilized in the analysis are those commonly purchased in BOT business, such as:

- Overseas investment insurance;
- Delayed start-up insurance;
- Construction insurance;
- Contractor's liability insurance; and
- Third party insurance.

The major risks expected in BOT infrastructure projects are shown in Table 8.1.1. (See the original version of this report for the detailed management methods for each of these risks.)

Table 8.1.1 Major Risks Expected in BOT Infrastructure Projects

The table is omitted due to confidentiality.

Source: JICA Study Team

8.2 Possible Project Scheme

8.2.1 Related Parties and Roles

In this study, the following parties are assumed to be involved in the project: (1) Can Tho City Government; (2) Off-taker; (3) Sponsors/SPC; (4) Lenders (financial institutions); (5) Insurance providers; and (6) Sub-contractors. Preliminary assumptions of role sharing among these parties are described below. The PSIF loan is assumed to be provided directly to the SPC.

The figure is omitted due to confidentiality.

Source: JICA Study Team

Figure 8.2.1 Possible Project Scheme

In this study, the Study Team has created lists of general contents for each of the following contracts expected to be signed in the proposed project.

- BOT Contract
- EPC Contract
- O&M Contract
- Shareholders' Agreement
- Off-take Contract

Among the above contracts, the currently expected Japanese investors has set the conditions indicated in Table 8.2.1 as necessary criteria for the BOT Contract as well as Off-take Contract in order for them to conduct this proposed project.

Table 8.2.1 Conditions Required by the Japanese Investors

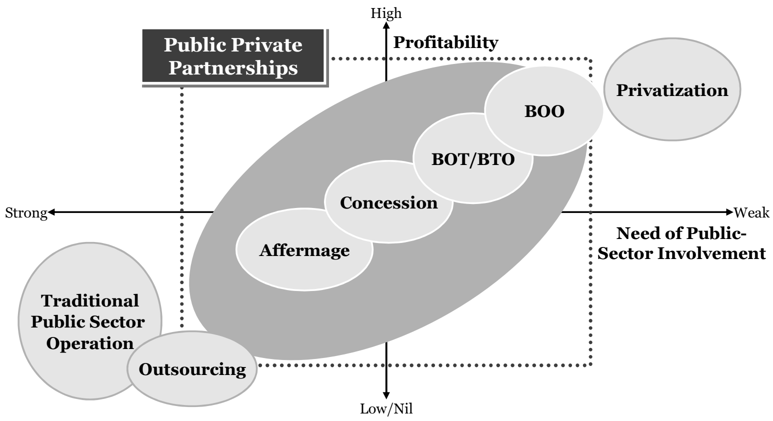
The table is omitted due to confidentiality.

Source: JICA Study Team

CHAPTER 9 PROJECT MODEL SCHEMES

9.1 Introduction of Public-Private Partnerships (PPP) for Public Investment

The term PPP covers a range of different structures where the private sector delivers a public project or service. build own operate (BOO) ,build Own Operate (BOT), build transfer operate (BTO), concession and affermage scheme the typical schemes of PPPs as shown in Figure 9.1.1.



Source: JICA Study Team

Figure 9.1.1 Various Models of Public-Private Partnerships

The BOT and concession schemes are preferred in the water sector from the viewpoint of public interest because high service outcomes and performance as well as cost-effectiveness could be expected under these schemes. However BOT scheme is much preferred to secure higher public interest leaving the right to make a decision on tariff level to the host government..

9.2 Financing Scheme

Generally, projects with low profitability need long-term financing, while projects with high profitability only need short-term financing. The financing source should be decided in relation to the profitability of the project, especially if the cost of the project affects the end users through tariff.

Only when the foreign investors have enough experience in the local area can they invest alone without receiving any financial assistance from a local company. Hence, an investment on the proposed project from WSSC by way of equity shall be recommended.

9.2.1 Financing Source Options

Table 9.2.1 illustrates the comparison of the possible financing source options. In the table, the features of each financial source were evaluated item by item and colors were associated for each item according to favorability to the project. It should be noted that PSIF is divided into two categories, namely, direct lending and two-step loan.

Project financing under the PSIF program could be regarded as a favorable financing source. In particular, it is favorable in that its preparatory steps do not take such a long time compared to an ODA loan.

Considering the time frame, it is fair to say at this point in time that project financing under the PSIF program would be the most favorable financing source option.

Table9.2.1 Comparison of Possible Financing Source Options

Financial Source	ODA Loan	Long-Term Project Financing		WSSC's Own Borrowing (From Domestic Banks)
		PSIF (Direct Lending to SPC)	PSIF (Two-Step Loan)	
Tenor	Very Long (max: 40 years)	Long (max: 25 years)	Long (max:25 years but depending on the local bank)	Medium/Short (may be much shorter than the life of the project)
Currency of Loan	JPY	JPY	VND	VND
Interest Rate	Very Low	Low	Medium/High	High
Availability	Subject to project priority of the Vietnamese government	Available as long it is economically viable	Available as long it is economically viable and acceptable by local bank	May take longer time to find banks
Time Frame	Will take long time	Will take medium time	Will take medium time	Will take short/medium time
Other Remarks	The loan constitutes a debt of the Vietnamese government			

Source: JICA Study Team

Remarks: *Data obtained for ODA loan comes from JICA's homepage

*The above data are just estimates from the current financial market and may change through time. It is not certain that one can secure financial sources based on the above conditions.

* The colors in each item mean the following (based on the "trial" base evaluation):

Most favorable	Favorable	Neutral/Unable to evaluate	May not be favorable

9.3 Other Assumptions

Tax	Income Tax	1st~4th year from the beginning of the O&M Period: 0% 5th ~9th year from the beginning of the O&M Period: 5% 10th ~15th year from the beginning of the O&M Period: 10% 16th year and after: 25% The loss incurred after the calculation of income tax for a fiscal year shall be carried forward to the next five years to be set off against the taxable income of each year.
	Customs	Customs are exempted. (BOT Law Article 38)
	VAT	Since VAT for water business is reduced to 5% (regular rate is 10%), the VAT received can be lower than the VAT paid.
Fee	Right of Water Use	The law regulating royalty fee is currently being revised and the JICA Study Team has reviewed the details.
	Fee for Land Use	Fee for land use is exempted under the BOT law and is not included in the analysis, as stated in BOT Article 38.3.
Deposit on Construction Completion (BOT Law Article 23)		The amount of the deposit shall be the sum of the following items: - With respect to that portion of investment capital up to VND 1.5 trillion, 2% of such portion; - With respect to that portion of investment capital exceeding VND 1.5 trillion, 1% of such portion.
Inflation		The paragraph is omitted due to confidentiality.
Currency Devaluation		The paragraph is omitted due to confidentiality.
Depreciation		For accounting and tax calculation purposes, the construction cost and replacement cost are assumed to be booked as fixed assets at the completion of construction and replacement, and to be depreciated over the remaining years of the project period, so that the fixed assets so booked at the end of the project period become zero.

9.4 Project Organization

The SPC is expected to take the form of either a limited liability company or a joint-stock company. According to the Law on Enterprise (Law No. 60/2005/QH11), limited liability companies and joint-stock companies are required to have management structures. The detailed functions of each management body shall be stipulated in the company's charter. Table 9.4.1 presents the required management structure by company type with their corresponding major functions.

Table 9.4.1 Management Structures by Company Type

Company Type	Required Management Structure	Representative at law
Limited Liability Company	1) Members Council	
	2) Chairman of the Members Council	Qualified
	3) Director or General Director	Qualified
	4) Control Board (for a company with 11 or more members)	
Joint-Stock Company	1) Shareholders' Meeting	
	2) Management Board	
	3) Chairman of the Management Board	Qualified
	4) Director or General Director	Qualified
	5) Control Board (for a company with more than 11 individual shareholders or a shareholding organization which holds more than 50% of total shares)	

Source: Created by JICA Study Team based on the Enterprise Law (Law No. 60/2005/QH11)
Remarks: * In both limited liability company and joint-stock company, the company's representative-at-law must permanently reside in Vietnam. In case the representative is not in Vietnam for more than 30 days, he or she must authorize in writing another person to exercise the rights and perform duties as the legal representative.

CHAPTER 10 FINANCIAL ASSESSMENT FOR PRIORITY SCHEME

10.1 Financial Plan for Priority Scheme

In this section, an analysis of the financial plan for priority scheme was made. Note that the analysis is calculated based on the conditions expected by the prospective investors in this study.

10.1.1 Assumptions on the Financial Analysis

(1) Business Plan Assumptions

Table 10.1.1 Assumptions of Business Plan

Scheme	BOT
Schedule	Establishment of SPC: 2013 Construction Commencement: 2014 Completion of the Facility: 2016 Commencement of Operations: 2017 End of O&M Period: 2041(O&M period of 25 years)
Outline of the Facility	The intake and water treatment plant (WTP) with a capacity of 45,000 m^3 /day and transmission pipeline connecting the WTP and the existing distribution pipeline.
Operating Ratio	The WTP is expected to operate at full capacity from the first year of its operational period starting in 2017 (the expected average daily production volume is estimated at 39,000m^3/day)
Tax	Income tax: Assumed according to the tax rate described in Section 9 VAT : Assumed only for the construction costs Property Tax: Not assumed
Financing Source	70% of the required initial investment amount：JICA's PSIF 30% of the required initial investment amount：Equity

Type		PSIF
Currency		JPY
Tenor	Disbursement	3 years
	Grace	2 years
	Repayment	20 years
	Total	25 years

Source: JICA Study Team

(2) Funding Source and Its Usage during the Construction Period

Table 10.1.2 shows the funding sources and investment objectives of SPC during the construction period.

Table 10.1.2 Funding Source and Investment during the Construction Period

(VND in billions, Hundred million JPY)

The table is omitted due to confidentiality.

Source: JICA Study Team

(3) Cash-in and Cash-out during the O&M Period

Table 10.1.3 shows cash-in and cash-out of SPC during the O&M period.

Table 10.1.3 Cash-out and Cash-in During O&M Period for 25 years Operation

(VND in billions, JPY in hundred million)

The table is omitted due to confidentiality.

Source: JICA Study Team

(4) Assumptions for Revenues

The SPC shall earn its revenue from tariff and interest income from cash deposit to reserve accounts, and the details are presented in Table 10.1.4.

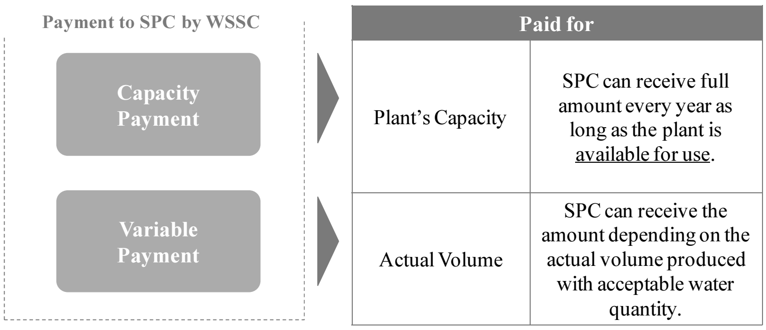
Table 10.1.4 Tariff Revenue

(VND in billions, Hundred million JPY)

The table is omitted due to confidentiality.

Source: JICA Study Team

The annual tariff revenues shown in Table 10.1.4 are calculated based on the payment formula of the "Take or Pay" method which is shown in Figure 10.1.1. The tariff price based on this formula consists of two components, namely, capacity payment and variable payments.



Source: JICA Study Team

Figure 10.1.1 Structure of the SPC's Revenue Formula "Take or Pay"

10.2 Financial Analysis on the Priority Scheme

10.2.1 The Results with the Assumptions Requested by the Prospective Investors

The paragraph is omitted due to confidentiality.

10.2.2 Other Financial Analysis

The analysis can provide different results by applying different values for the construction cost and the target economic internal rate of return (EIRR).

(1) Reduction in Construction Cost

Among the assumptions shown in Sub-section 10.1.1, the JICA Study Team changed the assumption for the construction cost to calculate the wholesale price.

<u>The paragraph is omitted due to confidentiality.</u>

(2) Decrease in Target EIRR

Among the assumptions shown in Sub-section 10.1.1, the JICA Study Team changed the assumption for target EIRR to calculate the wholesale price.

<u>The paragraph is omitted due to confidentiality.</u>

10.3 Economic Benefit-Cost Analysis

In this Study, the economic benefit-cost analysis was conducted by referring to the procedures provided in the Handbook for the Economic Analysis of Water Supply Projects (1999) published by the ADB (hereafter referred to as “ADB Handbook”). The purpose of the economic benefit-cost analysis is to verify the economic viability of the projects by calculating the potential economic benefits, which the project could bring about to the target community. In order to verify the economic viability of the project, the JICA Study Team calculated the project’s E IRR through the following procedure.

(1) Financial Costs of the Proposed Project

The estimated project costs (CAPEX and OPEX) are in market price. Such costs were converted into economic price for the purpose of economic analysis as shown in Table 10.3.1.

Table 10.3.1 Conversion of Financial Costs into Economic Costs

The table is omitted due to confidentiality.

(VND in billions)

Source: JICA Study Team

(2) Calculation of Economic Benefits

The total benefits derived from a water supply project can be estimated by identifying the its incremental and non-incremental benefits. The non-incremental benefit is the benefit obtained from a new water supply system that will replaces the existing water supply sources. For example, if the users who are currently using water from wells, rivers, or vendors, the new water supply output which replaces the current water sources is considered as non-incremental benefit. On the other hand, the incremental benefit is the output of the new water supply system that meets additional or induced demand for water.

The paragraph is omitted due to confidentiality.

In addition, the benefit from the use of NRW (non-technical loss) was also assumed. The NRW is caused by technical loss, such as leakage from the distribution pipes, and also non-technical loss, such as theft and malfunctioning of consumption meters. The amount of non-technical loss is included as economic benefit due to the fact that such amount is actually consumed by the people in the target community. In this Study, such benefit was calculated as follows:

The paragraph is omitted due to confidentiality.

(3) Calculation of EIRR

Applying the yearly economic costs and benefits calculated above, the EIRR was calculated.

The paragraph is omitted due to confidentiality.

The ADB Handbook suggests 12% as the minimum rate required for projects to be economically viable. Therefore, it is fair to conclude that the proposed project is expected to bring about sufficient benefits to the target community.

CHAPTER 11 PRELIMINARY ENVIRONMENTAL EXAMINATIONS

11.1 Social Baseline Survey

A social baseline survey was carried out from June to July 2012 with the goal of assessing the following: i) current water use patterns in Can Tho City; ii) availability of water from various sources; iii) satisfaction on and willingness to pay for piped water supplied by WSSC; and iv) sanitary conditions and water-related hazards. A total of 516 households in four urban districts were surveyed. Among these, 332 households are currently connected to the WSSC service. More than 60% of the samples were drawn from Ninh Kieu and Binh Thuy districts since the proposed project aims to supply water in these districts.

The samples vary greatly in terms of family size, income, and water consumption levels. On average, households using WSSC water earn higher income and use more water. However, this is primarily due to location rather than affordability. The survey found little correlation between income and the level of water consumption. Water-related expenditures among surveyed households represent only about 1% of their income regardless of their connection status. This is considerably low as compared with the benchmark indicated by the World Bank (3-5%) and the Asian Development Bank (5%)[1].

The survey also found that households in Can Tho City are willing to pay more for better and more reliable water services. On average, 332 households currently connected to WSSC services pay VND 85,500/month (1.1% of median monthly income) for piped water with median monthly consumption of approximately 16 m^3. For a better service that is more reliable, has good quality, and has higher water pressure, they are willing to pay, on average, VND 105,000/month (1.3% of median monthly income). This is nearly VND 20,000/month more than they are paying today. Assuming that the water consumption level is consistent, this figure translates into VND 6560/m^3 of water (VND 105,000 divided by 16 m^3), which is still well below the international benchmark discussed above. Meanwhile, the majority of not-connected households are interested in getting connected to WSSC service with the average willingness to pay of VND 5550/m^3 of water[2].

More than 80% of the surveyed households are satisfied with the service provided by WSSC, but the satisfaction level is quite low in areas where water pressure is low. The survey results

[1] Asian Development Bank. 2003. *Asian Water Suppliers - Reaching the Urban Poor,* Manila: Asian Development Bank

[2] The average willingness to pay is VND 50,000 per month, which is less than 1% of their average monthly income. The unit cost is estimated by dividing the willingness to pay value by the current water consumption level of these households (9 m^3). Although the figure is lower than those of existing users, this is mainly because of their low water usage, and not due to the limited affordability. Unconnected households tend to spend more on bottled water, meaning that they pay more in terms of per unit cost of water. Per unit cost of water may actually be lower if unconnected users start using WSSC water.

suggest that there is room for increasing water tariff. When considering an increase in water tariff, however, it is of critical importance to ensure that satisfactory water pressure is available across the entire service area in addition to providing enough volume of water.

11.2 Preliminary Environmental Impact Assessment (EIA)

The Law on Environmental Protection requires owners of projects with a potential risk of causing adverse impacts to the environment to carry out an EIA (Articles 18 and 19). As part of the preparatory study, a preliminary EIA was carried out at this stage. The preliminary EIA will facilitate the preparation of the official EIA report, which will be prepared by the project owner and submitted to DONRE for appraisal and approval at a later stage.

The proposed project will not trigger involuntary resettlement since the water treatment plant will be constructed on a vacant land next to Can Tho No. 2 WTP. The main environmental issues during the construction phase include noise and emissions from transport vehicles and machines, and solid waste. Sound management of sludge is a key environmental issue during the operation phase of the project. It is proposed that sludge will be disposed in an existing disposal site in Cai Sao, near Hung Phu Industrial Zone. This is where sludge from Can Tho No. 1 WTP is currently disposed. The Prime Minister’s Decision No. 1873/QD-TTg of October 11, 2010 requested Can Tho PC to review existing solid waste management plans, which may lead to consolidation or closure of existing sites once the new solid waste treatment and disposal facilities in O Mon site are developed. Should the site in Cai Sao be closed during the operation period of the BOT project, supplementary EIA will need to be carried out in order to assess the environmental and social impacts associated with the development of the new site, most likely in O Mon. Other environmental impacts during the operation phase are considered to be minor, and potential environmental risks can be minimized by proper management of the water treatment plant.

The assessment of alternatives also indicates that the proposed location is most favorable because of its proximity to a high demand area. Overall, the preliminary environmental examinations suggest that the proposed project will bring significant positive benefits to Can Tho City with limited adverse impacts.

CHAPTER 12 OVERALL EVALUATION AND CONCLUSION

12.1 Technical Evaluation

1) According to past investigation and analytical reports, as well as to the actual measurements carried out in this Study, confirmed that salt water intrusion up to Can Tho City area will not occur in the future. In addition, the raw water quality and flow rate of the Hau River even during the drought period will cause no particular problem in using river water for establishing the new water supply scheme.

2) In the central part of Can Tho City, No. 1 and No. 2 purification plants have been producing excessive water recently due to the lack of water production capacity. Therefore, it is urgently needed to rehabilitate or expand these plants, or to construct new plants in the neighboring sites. However, due to financial difficulties of WSSC, the development programs have not been achieved yet.

3) Another reason for excessive water production of No. 1 and No. 2 purification plants is the high NRW ratio. No. 1 plant has an NRW of 41%, while No. 2 plant has 32%. These high ratios are caused by leakages from the distribution networks, incomplete water charge collection, and lack of calibration of water meters. Although WSSC has a plan to reduce NRW down to 20% by 2020, leakage problem may still occur even if the BOT scheme is started in 2017 as planned.

4) The population and water demand projections in Can Tho City are summarized in the Can Tho City Master Plan 2030. However, these items were not projected for each district or for each ward. Therefore, the population was divided into categories of urban, rural, and administration, and water demand for 2020 in this Study was projected by multiplying the unit water demand given in the Vietnamese design standard. The division of unit water demand of Can Tho City is different from the Vietnamese design standard. Therefore, the Study Team derived the unit water consumption based on the actual water consumption record of Can Tho City. The water demand projection carried out in this Study has already been approved by Can Tho PC.

5) It was identified that the total water deficit to be procured was 87,000 m^3/day in the whole Can Tho City and 79,000 m^3/day in the urban area of the city. Above all, the city center where the No. 1 and No. 2 purification plants are situated needs a facility with capacity of 44,200 m^3/day (daily max. capacity of 45,000 m^3/day). The construction site of the new facilities was set up at the neighboring area of the existing No. 2 purification plant. The site for the construction of the purification plant has already been approved by the Can Tho PC.

6) The proposed purification facilities were designed with the same rapid sand filter method.

The intake pump facility was planned in the neighboring canal with 16.5 m^3/min (2 mains and 1 standby) using the variable speed type. In the sedimentation basin, the tube settler was applied. For the filter, constant flow, natural equilibrium, and self-washing type was selected. The wastewater from the sedimentation basin and rapid sand filter was planned to be pumped to the sludge drying bed to be constructed near the proposed purification plant yard.

7) The transmission line to the existing distribution networks currently covered by No. 1 and No. 2 purification plants consists of a 4.3-km long ductile iron pipe with diameters ranging from 400 mm to 700 mm. The connection points were planned at the boundary between No. 1 and No. 2 distribution areas. The current water pressure heads in these areas vary from 1 m to 5 m. Therefore, the water to be transmitted to these areas shall be able to recover the pressure up to 10 m or more. The construction of the transmission pipe is included in this BOT scheme due to the financial difficulty of WSSC and Can Tho PC.

12.2 Project Cost, Operation, and Economic and Financial Evaluation

1) For the project cost estimation, the exchange rate of Vietcom Bank as of May 2012 (JPY 1.0 = VND 266) was applied to the CAPEX and OPEX. The civil works were estimated at VND [redacted] billion (JPY [redacted] million), and the mechanical and electrical works were set at VND [redacted] billion (JPY [redacted] million) on the basis of the Japanese manufacturer's cost estimate. Thus, the total construction cost is VND [redacted] billion (JPY [redacted] million). Furthermore, the engineering service fee and physical contingency were added resulting to an overall project cost of VND [redacted] billion (JPY [redacted] million). The construction was planned to commence in 2014 and be completed by the end of 2016.

2) It is important for both government and private sector to share the risks appropriately and clearly. Subsequently, this will help reduce the cost of the project and also protect risk possession of the concerned parties. In order to carry out the project under the BOT scheme, the risk mitigation, risk transfer, risk sharing, countermeasure for risk actualization, application of insurances, and division of responsibility of each party were examined. For the BOT implementation scheme, the relationship among the relevant organizations was clarified. The contract documents necessary for the implementation of the scheme were also examined.

3) The overall procurement fund, which consists of VND [redacted] billion for construction cost and VND [redacted] billion (JPY [redacted] million) for other parameters such as inflation, interest during construction, cash reserves, and performance bond, amounted to VND [redacted] billion (JPY [redacted] million) in total. Based on the initial investment fund and cash dividend distribution to the three capital investors, the wholesale price of water in 2012 price level amounted to VND [redacted]/m^3. Meanwhile, Can Tho PC calculated the retail price as of 2012 at VND [redacted]/m^3, and wholesale price subsequently resulted to VND [redacted]/m^3 showing a large price difference

between both parties. There are two means of mitigating this difference. One is to reduce the construction cost and the other is to reduce the level of dividends to the investors.

4) Economic analysis was carried out based on cost benefit assumption by setting up "with project" and "without project" scenarios. Two types of economic benefit were considered. The first was the benefit resulting from the conversion of the existing water source into the new water source called as "non-incremental benefit". The second was the benefit brought about by the increase of water consumption after the new scheme has started, which was called as "incremental benefit". The total of the incremental and non-incremental benefit amounted to VND 119 billion/year. In addition to this, the benefit brought by non-technical loss out of the non-revenue water was added. Subsequently, the EIRR resulted to 17%, which is above the 12% EIRR stipulated in the ADB guidelines as the minimum level.

12.3 Evaluation on Social Environmental Aspects

The baseline survey was carried out from June to July 2012. The survey covered 516 households in the Study area. Among these, 332 households use WSSC piped water and approximately 85% of the residents were satisfied with the water service of WSSC. However, the residents in low pressure areas were not necessarily satisfied with the service. The willingness to pay for improved water service was revealed at VND [redacted] In the course of the Study, a preliminary EIA was implemented. In the later stages after establishing the SPC, an actual EIA should be carried out by the SPC implementation team.

12.4 Conclusion

During the Study period, several negotiations concerning the wholesale price between Can Tho PC with WSSC and the JICA Study Team were carried out, but no agreement was made so far. The JICA Study Team proposed the wholesale price of VND [redacted]/m^3 but Can Tho PC together with WSSC rejected this offer and presented VND [redacted]/m^3 as a counter proposal.

Can Tho PC announced that the agreement between the two parties should be settled as soon as possible since a lot of time has already been spent for the negotiation. The JICA Study Team should therefore provide an answer on how to proceed with this project.

However, the JICA Study Team could not find a suitable solution to solve the wholesale price issue, so that it is necessary to terminate the project in the near future. In this regard, it is indispensable for the JICA Study Team to officially propose the termination. Likewise, Can Tho PC should also state and provide their comments for the termination to the JICA Study Team and JICA as well.