THE PEOPLE'S COMMITTEE OF KIEN GIANG PROVINCE
THE SOCIALIST REPUBLIC OF VIETNAM

PREPARATORY SURVEY ON WATER SUPPLY AND SEWERAGE SYSTEM PROJECT IN PHU QUOC ISLAND IN THE SOCIALIST REPUBLIC OF VIETNAM

FINAL REPORT
VOLUME II
MAIN REPORT

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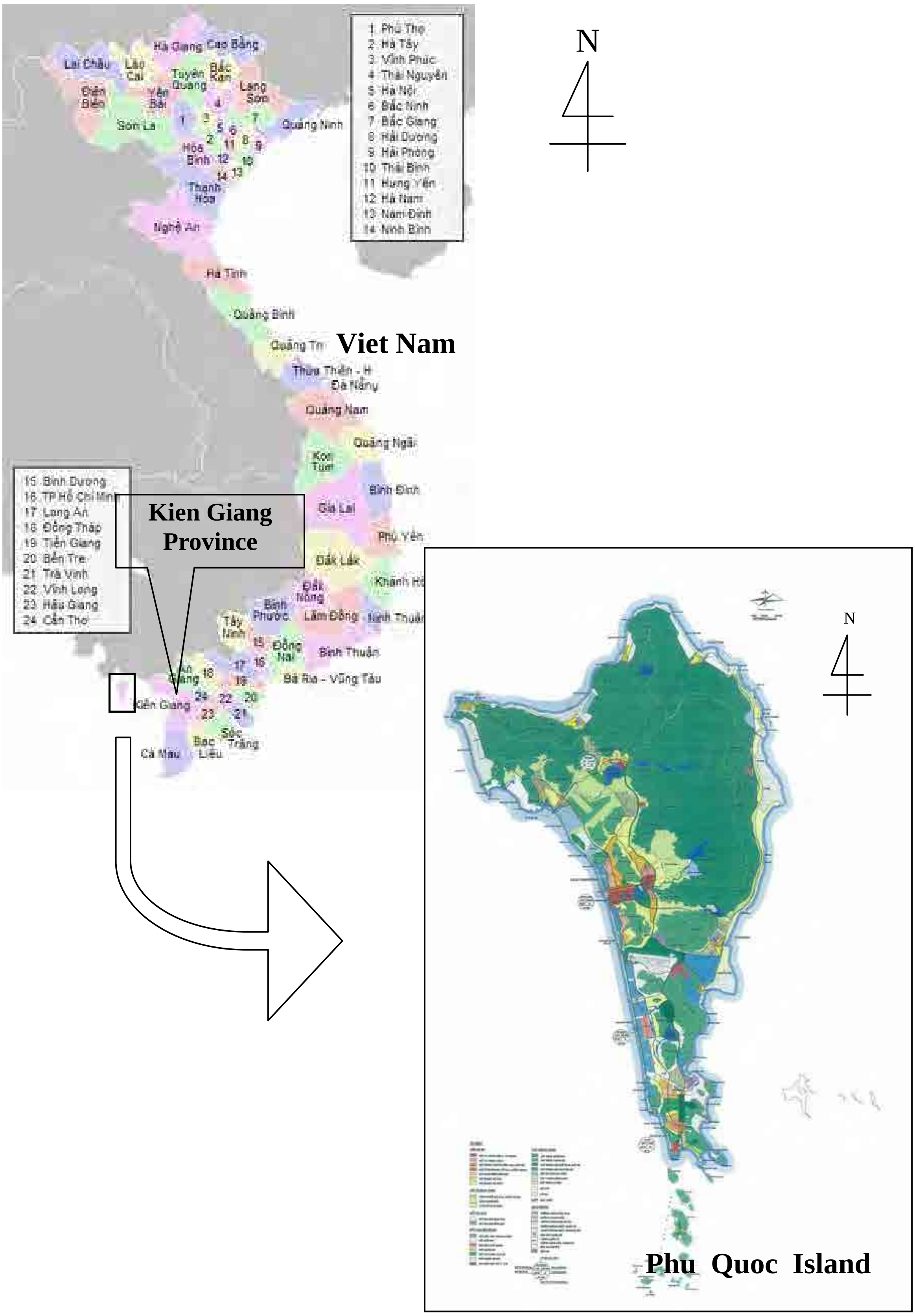
VOLUME I:	EXECUTIVE SUMMARY
VOLUME II:	**MAIN REPORT**
VOLUME III:	SUPPORTING REPORT (ANNEXES)

EXCHANGE RATE (data as of February 2012)

USD 1	=	JPY 76.6
USD 1	=	VND 20,703
VND 1	=	JPY 0.0037



Location Map of Survey Area

Preparatory Survey
on
Water Supply and Sewerage System Project
in Phu Quoc Island, Vietnam

FINAL REPORT

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List of Abbreviations

ABC	Advanced Biological Contactor
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BOD	Biochemical Oxygen Demand
BOO	Build, Operate and Own
BOT	Build, Operate and Transfer
CAS	Conventional Activated Sludge
CIA	Central Intelligence Agency
COD	Chemical Oxygen Demand
DARD	Department of Agriculture and Rural Development
D/D	Detailed Design
DIP (DCIP)	Ductile Cast Iron Pipe
DPC	District People’s Committee
DSCR	Debt Service Coverage Ratio
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
FC	Foreign currency
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
FS (F/S)	Feasibility Study
FY	Financial Year
GDP	Gross Domestic Product
GOJ	Government of Japan
GOV	Government of Viet Nam
GSO	General Statistics Office
HDPE	High Density Polyethylene Pipe
IMF	International Monetary Fund
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
JPST	JICA Preparatory Survey Team
KIWACO	Kien Giang Water Supply and Drainage One Member Limited Company
KGPPC	Kien Giang Provincial People’s Committee
LC	Local Currency
MP (M/P)	Master Plan
NRW	Non Revenue Water
OD	Oxidation Ditch
ODA	Official Development Assistance
O&M	Operation and Maintenance
PC	People’s Committee
PPC	Provincial People’s Committee

PPP	Public Private Partnership
PQDMB	Phu Quoc Development Management Board
PVC	Polyvinyl Chloride Pipe
ROA	Return on Asset
ROE	Return on Equity
SBR	Sequencing Batch Reactor
SPC	Special Purpose Company
SS	Suspended Solids
STP	Sewage Treatment Plant
S/V	Construction Supervision
UASB	Upflow Anaerobic Sludge Blanket
VAT	Value Added Tax
VDB	Vietnamese Development Bank
VNAT	Vietnam National Administration of Tourism
VND	Vietnamese Dong
WACC	Weighted Average Cost of Capital
WB	World Bank
WEF	World Economic Forum
WTP	Water Treatment Plant

CHAPTER 1 INTRODUCTION

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1.1 Background

Rapid economic growth and urbanization in the Socialist Republic of Viet Nam (hereinafter referred to as "Viet Nam") is worsening problems associated with environmental contamination. It is urgent for the country to improve the urban environment, including establishing well-functioning water supply and sewerage systems. Currently, the water supply coverage ratio is only 69% in urban areas. Non-revenue water ratio is high (33% on average in the whole country). There is insufficient water quality control. Water tariff is too low and there is too much dependence on subsidy. Improvement to the water supply service is needed. Concerning sewerage, while drainage system for domestic and industrial wastewater is expanding, sewerage treatment capacity is still limited. Untreated wastewater is flowing directly into the river or canal, causing serious water contamination.

The current measures to stimulate the regional economy include developing tourism and other local industries, as stated in the Spatial Development Policy of the Vietnam's Socio-Economic Development Plan. There are negative impacts associated with rapid development of the tourism industry, if resource protection is not in place and the required infrastructure improvements are not implemented.

Phu Quoc Island, target area of this survey, is part of Kien Giang Province, about 18 km south of the Vietnamese and Cambodian coast. The district has a total area of 573 square kilometres and a permanent population of approximately 100,000. Tourism plays an important part of the economy with the white sandy beaches being the main attraction. The government targets tourist arrivals of 2 million per year by 2020 and 5 million by year 2030, and provides various preferential treatments for the development of the island, including the Prime Minister's approval to allow 15-day stay on the island without visa for foreign tourists (Decision No. 38). A new international airport opened in December 2012

The only water treatment plant in Duong Dong does not have the capacity to meet the increasing water demand resulting from the growth of the tourism industry. There is no sewerage treatment plant on the island. Wastewater from septic tanks is discharged to the river or sea. The water supply system must be improved and a sewerage system established if the tourism development is to continue without negative impacts on the natural environment.

1.2 Objective of the Survey

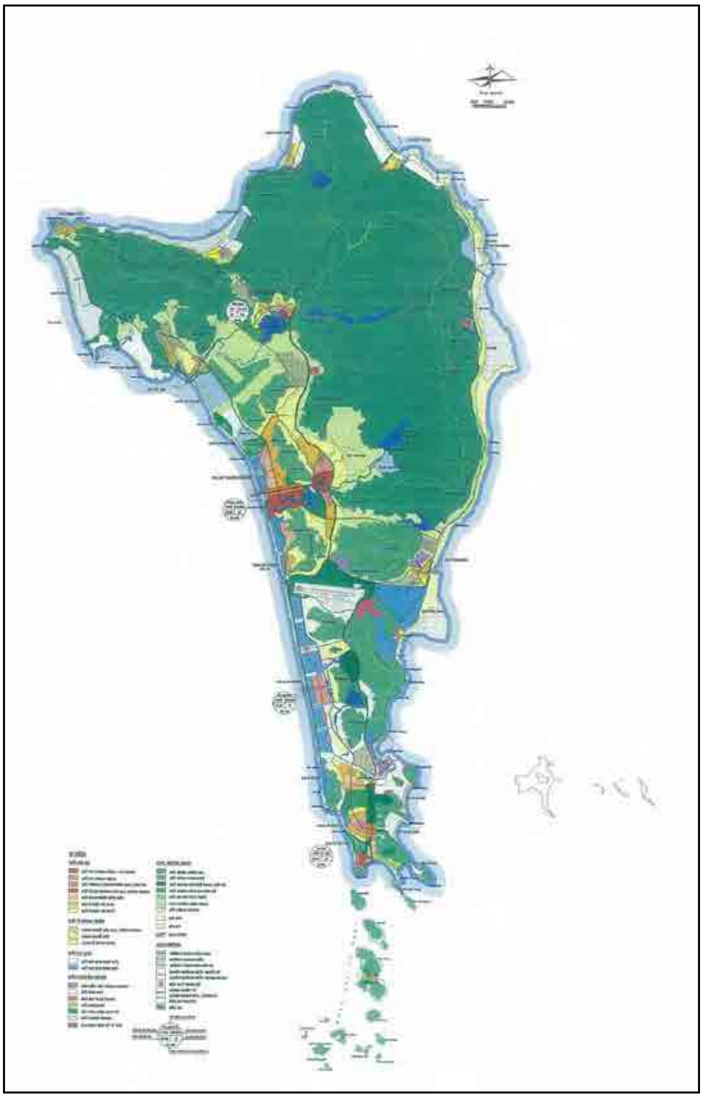
The objective of the survey is to confirm the priorities for developing water infrastructure of Phu Quoc Island and to design a public-private partnership to implement the project.

After analyzing the validity of water demand projections in the Phu Quoc Development Master Plan (Decision 633/QD-TTg), various conditions necessary for PPP project are considered and decided by confirming the following:

- Justifications for the project
- Water demand projections
- Preliminary design and general cost estimate of water infrastructure development
- PPP project implementation plan
- Project implementation schedule
- Environmental and social considerations
- Financial and economic analyses

1.3 Survey Area

Figure 1-1-1 shows a map of Phu Quoc Island, target area of this survey.



(Source：Decision No.633/QD-TTg, May 11, 2010)

Figure 1-1-1 Phu Quoc Island

1.4 Survey Outline and Schedule

Figure 1-1-2 shows the survey outline and general schedule. The survey confirms and describes the scope of the project in the Interim Report. Two assignments, one domestic and one overseas, were added to the original schedule.

Start	Survey Contents & Phasing	Reporting
Middle of Sept. 2011	**1. Preparation Work in Japan** - Analysis of existing data and information - Preparation of questionnaires and list of data to be collected - Preparation of Inception Report	**Inception Report**
End of Sept. 2011	**2. First Field Work in Viet Nam** - Explanation and discussion of Inception Report, data collection - Socio-economic conditions in Viet Nam - Conditions of water sector, problems and governmental policy - PPP related legal Framework in Viet Nam - Movement of foreign companies for related project - Natural condition near the survey area - Needs of the project (now and hereafter) - Project risks - Confirmation of environmental & social consideration - Objectives of the project - Water demand project for the project - Proposal of relevant projectr scope - Setting the design criteria - Preliminary design - Preparation of implementation plan	
Beginning of Jan, 2012	**3. First Home work in Japan** - Preliminary Cost Estimation - Preparation of project implementation schedule - Preparation, explanation & discussion of Draft Interim Report	**Draft Interim Report**
Middle of March 2012	**4. Second Field Work in Viet Nam** - Explanation & discussion of Draft Interim Report - Proposal of project implementation structure - Analysis of financial condition of implementation agency and finance plan of the project - Proposal of procurement packages - Financial analysis of private part of the project - Economic analysis of the entire project (EIRR) - Setting Operation and Effect Indicators - Proposal of organization for operation and maintenance - Assistance for preparation of EIA Report - Assistance for preparation of Resettlement Action Plan - Conclusion and recommendation - Explanation & discussion of the Results of 2nd Field Work	
Beginning of May 2012	**5. Second Home Work in Japan** - Preparation, submission & discussion of Interim Report	**Interim Report**

Start	Survey Contents & Phasing	Reporting
End of Nov. 2012	**6. Third Field Work in Viet Nam** - Explanation and discussion of Interim Report	
Middle of Jan. 2013	**7. Third Home Work in Japan** - Preparation, submission & discussion of Draft Final Report	**Draft Final Report**
Middle of June 2013	**8. Fourth Field Work in Viet Nam** - Explanation and discussion of Draft Final Report	
End of July 2013	**9. Submission of Final Report** - Preparation and submission of Final Report	**Final Report**

Figure 1-1-2 Contents of the Survey and the Schedule

CHAPTER 2 CONFIRMATION OF PROJECT NEEDS

CHAPTER 2 CONFIRMATION OF PROJECT NEEDS

2.1 Socio-Economic Conditions in Viet Nam

Table 2-1-1 shows the basic socio-economic conditions of the country.

Table 2-1-1 Basic Socio-economic Data of Viet Nam

No.	Items	Value	Description
1	Population	86.93 million	Source: General Statistics Office (GSO)
2	Size	331,689 km^2	0.88 times of that of Japan
3	GDP	1,980.9 trillion VND	Current price, Year 2010, GSO
4	Per capita GDP	1,169 USD	Source:Statistical Handbook 2010, GSO
5	Inflation rate	9.2 %	Year 2010, Source: IMF
6	Interest rate	11.2 %	Deposit interest rate, World Bank
7	Population growth rate	1.054 %	2012 estimate, CIA
8	Infant mortality rate	20.24 persons	Among 1,000 live births, 2012 estimate, CIA
9	Life expectancy at birth	72.41 years	2012 estimate, CIA

Source: Prepared by JICA Survey Team

(1) Economy

In 1986, Viet Nam initiated socialist-oriented market economic reforms as part of the Doi Moi reform program. Private ownership and foreign investment was encouraged in industries, commerce and agriculture. By the late 1990s, the economy was growing at an annual rate of more than 7 percent, making Viet Nam one of the world's fastest growing economies. The growth rate slowed to 4 to 6% in the late 1990s during the Asian Financial Crisis but is still relatively strong in 2000s with the continuation of Doi Moi. **Table 2-1-2** shows the Gross Domestic Products at constant 1994 prices.

Table 2-1-2 Gross Domestic Product at Constant 1994 Prices by Economic Sector

Unit: trillion dongs

Year	Total		Agriculture, forestry & fishing		Industry & construction		Services		GDP growth rate
2005	393.1	100%	76.9	20%	157.9	40%	158.3	40%	8.4%
2006	425.4	100%	79.7	19%	174.3	41%	171.4	40%	8.2%
2007	461.3	100%	82.7	18%	192.1	42%	186.6	40%	8.4%
2008	490.5	100%	86.6	18%	203.6	42%	200.3	41%	6.3%
2009	516.6	100%	88.2	17%	214.8	42%	213.6	41%	5.3%
2010*	551.6	100%	90.6	16%	231.3	42%	229.7	42%	6.8%

Notes: *; Preliminary estimates
Source: 2010 Statistical Handbook, General Statistics Office of Viet Nam

After the year 2005, the GDP at constant price was increasing at around 7 to 8% per annum. Only in 2008 and 2009 the growth rate dipped to 6.3% and 5.3% because of global recession and the spike in crude oil and commodity prices. As shown in **Table 2-1-2**, the share of GDP for the industry, construction and service sectors increased from 40% in 2005 to 42% in 2009. GDP of the service sector has been increasing on average at 7.7% per year for the past 6 years, which was higher than that of the total GDP growth rate (7.2%). The GDP of the industry and construction sector is 7.9% per year on average for the same period. All the mentioned growth rates are real term not adjusted for inflation.

(2) Tourism and Service Sector

Table 2-1-3 shows the 2006-2010 breakdown of GDP of the service sector by General Statistics Office. Tourism is grouped with Transport in 2007, 2008, 2009. Average growth rates of tourism related sectors (hotel and restaurant, transport, post, tourism) were relatively higher than those of the other components of the service sector. All the growth rates in the table are in real term not adjusted for inflation.

Table 2-1-3 Gross Domestic Product at Constant 1994 Prices for Service Sector

Unit: trillion dongs

Year	Services Total		Trade		Hotel & Restaurant		Transport, Post, Tourism*		Others	
	Amount	Growth	Amount	Growth	Amount	Growth	Amount	Growth	Amount	Growth
2006	171.4	8.3%	69.4	8.4%	15.1	11.9%	16.9	10.5%	70	6.9%
2007	186.6	8.9%	75.4	8.7%	17.1	13.3%	18.6	10.1%	75.1	7.3%
2008	200.3	7.3%	80.4	6.6%	18.6	8.8%	21.3	14.5%	79.7	6.1%
2009	213.6	6.6%	86.8	8.0%	19	2.2%	22.8	7.0%	84.9	6.5%
2010	229.7	7.5%	93.9	8.2%	20.7	9.0%	24.8	8.8%	90.3	6.4%
Average	-	**7.7%**	-	**8.0%**	-	**9.0%**	-	**10.2%**	-	**6.6%**

Note: *; Tourism was calculated with Transport, in the year 2007, 2008, and 2009
Source: General Statistics Office of Viet Nam

Table 2-1-4 shows the number of international visitors to Viet Nam for the past 5 years.

Table 2-1-4 Number of International Visitors to Viet Nam

Unit: 1,000 persons

Year	Total		Tourism		Business		Others	
	Number	Growth	Number	Growth	Number	Growth	Number	Growth
2006	3,584	3.0%	2,069	1.5%	576	16.2%	939	-0.4%
2007	4,229	18.0%	2,606	26.0%	674	17.0%	949	1.1%
2008	4,254	0.6%	2,632	1.0%	845	25.4%	777	-18.1%
2009	3,746	-11.9%	2,241	-14.9%	743	-12.1%	762	-1.9%
2010	5,050	34.8%	3,110	38.8%	1,024	37.8%	916	20.2%
2011	6,014	19.1%	3,651	17.4%	1,003	-2.1%	1,360	48.5%
Average	-	**10.6%**	-	**11.6%**	-	**13.7%**	-	**8.2%**

Source: General Statistics Office of Viet Nam

On average the number of international visitors increased by 10.6% over the 2006 – 2011 period. Tourists made up 61% of international visitors in 2011 and the number is expected to increase rapidly.

Tourism in Viet Nam

Blessed with a ravishing coastline, emerald-green mountains, breathtaking national parks, outstanding cultural interests and world heritage sites, Viet Nam has great potential for tourism development.

Viet Nam is one of the most popular tourist destinations in the Asia-Pacific region. Currently, Vietnam ranks fifth among ASEAN countries in terms of the number of international tourists and revenue from tourism. Viet Nam's travel sector was ranked 14th in the Asian Pacific region last year and 80th in the world, up nine places from the last assessment in 2009, according to the recent "Travel & Tourism Competitiveness Report 2011" by the World Economic Forum (WEF).

Viet Nam's high ranking in the tourism industry can be attributed to its rich cultural background (ranked 36th), its world heritage sites, international fairs and exhibitions. Another attraction is its natural resources, placing Viet Nam in the 24th position in terms of its world heritage natural sites and diverse fauna. These attributes are reinforced by the country's price competitiveness (16th), the report stated. In 2011, Viet Nam's Hạ Long Bay was voted one of the World's Seven New Natural Wonders. This will open up a huge opportunity to boost the country's tourism development.

The tourism industry in Viet Nam has been growing rapidly over the past few years. According to the Viet Nam Administration of Tourism (VAT), Viet Nam welcomed only 250,000 international tourists in 1990 but the number reached 6 million in 2011, a 24 fold increase. Domestic tourists are also up more than 25 times, reaching 30 million. Tourism has created many jobs. In 2010 alone, 450,000 direct workers and nearly one million indirect workers were recruited in the sector, contributing to hunger elimination and poverty reduction.

The tourism sector has always attracted foreign direct investment (FDI) in Viet Nam. In 2009, 8.8 of the 22.48 billion USD total FDI was for tourism.. Viet Nam earned nearly 6.5 billion USD from the tourism sector in 2011 which contributed around 5 percent of the country's GDP. This is a positive impact on economic restructuring and development in different locations throughout the country.

According to a report "Tourism Viet Nam Industry Forecast to 2012", the tourism sector of Viet Nam is projected to post a double-digit growth rate in near future, owing to a rise in private sector investments. As the country attracts tourists from all over the world, many private players have started investing in the country's hospitality sector.

The industry expects to welcome 6.5 million international tourists and 32 million local visitors in 2012, for an estimated turnover of 150 trillion VND (7.1 billion USD), according to the Vietnam National Administration of Tourism (VNAT).

The above estimate by VNAT would help the industry realize targets of receiving 10-15 million foreign tourists and 47-48 million domestic tourists and obtaining total revenues of about 18-19 billion USD, contributing from 6.5 - 7% of GDP by 2020 ("Development Strategy for Viet Nam Tourism to 2020, Vision 2030"). The Development Strategy calls for continued promotion and sustainable development of tourism with an average yearly growth rate at 11.5 - 12% between 2011 and 2020.

(3) State Budget

Table 2-1-5 shows the revenue and expenditure (current price) of the central government in Viet Nam. The average increase in total revenue from 2005 and 2009 is about 18% per annum. The average increase in total expenditure is about 22% per annum for the same period. Both revenue and expenditure include inflation at 8.7% per annum, for 2005 - 2008.

Table 2-1-5 State Budget Revenue & Expenditure

Unit: billion VND

	2005	2006	2007	2008	2009
Total revenue	228,287	279,472	315,915	416,783	442,340
1. Domestic revenue (exc. Oil revenue)	119,826	145,404	174,298	229,786	269,656
2. Oil revenue	66,558	83,346	76,980	88,800	60,500
3. Custom duty revenue	38,114	42,825	60,381	90,922	105,664
4. Grants	3,789	7,897	4,256	7,275	6,520
Total expenditure	262,697	308,058	399,402	494,600	584,695
1. Expenditure on development investment	79,199	88,341	112,160	135,911	179,961
2. Expenditure on social and economic services	132,327	161,852	211,940	258,493	320,501
3. Addition to financial reserve fund	69	135	185	152	100
4. Others	51,102	57,730	75,117	100,044	84,133
Balance (revenue - expenditure)	-34,410	-28,586	-83,487	-77,817	-142,355

Source: prepared by the JICA Survey Team, based on the data of General Statistics Office of Viet Nam

Table 2-1-6 shows the ratio of state budget deficit in the current price of GDP of each year. In the year 2009, the ratio reached as high as 8.6% caused by the implementation of a large economic stimulus package against the economic downturn. Excluding the year 2009, the average of the ratios of state deficit among GDP is calculated at 5.1%. Increasing fiscal deficit is one of the major problems for the government.

Table 2-1-6 Proportion of Annual State Deficit in GDP at Current Price

Unit: billion VND

Year	GDP (current price)	Deficit	%
2005	839,211	34,410	4.1%
2006	973,790	28,586	2.9%
2007	1,144,014	83,487	7.3%
2008	1,477,717	77,817	5.3%
2009	1,658,389	142,355	8.6%

Source: prepared by the JICA Survey Team, based on the data of General Statistics Office of Viet Nam

"Five-year National Development Plan 2011-2015" was approved on 8 November 2011 by the National Assembly. Main targets of the 5-year National Social-Economic Development Plan 2011 - 2015 are as follows:

- **Economic targets:**
  1. Average GDP growth rate of 6.5 - 7%/year
  2. Total investment 33.5 - 35% GDP
  3. Budget deficit below 4.5% by 2015
  4. Public debt not exceed 65% of GDP
  5. Consumer price index to increase to 5 - 7% by 2015
- **Social targets:**
  1. Job creation for 8 million people
  2. Trained labor to reach 55%
  3. Population to increase by 1% by 2015

The government plans to bring the budget deficit to below 4.5% by the year 2015. Controlling inflation is also one of the major targets.

The government publicly indicated its intention to pursue "tight and prudent monetary and fiscal policy" and to cool an overheated economy in approving "Resolution 11 On key solutions for controlling inflation, stabilizing macro-economy, and ensuring social welfare", which included a wide range of monetary, fiscal and structural policy reforms, summarized in the following:

- ministries, agencies and local governments to proactively re-organize their responsibilities to save 10% of the total expenditure in the year 2011
- additional state budget not be allocated, except relating to natural disasters and epidemics
- reduce 2011 state budget overspending to less than 5% of the GDP
- closely supervise state own enterprises (SOEs), foreign loans and debt payments
- review the government's debt, limit incremental debts, not to expand the list of borrowers and scopes of debts that require government guarantees.
- make sure that the government, public, and foreign debts are within the limit of national financial security

- inspect and review investment activities, submit to the PM measures to reject unnecessary or ineffective projects, including overseas investments.

In order to control inflation and budget deficit, not only budget expenses but also loans and investments shall be checked and reviewed in detail; and rejected if necessary.

(4) Socio-Economics of the Kien Giang Province and Phu Quoc Island

General History of Kien Giang Province

Kien Giang, formerly a wilderness of the Chenla Kingdom (Dynasty of Cambodia), was explored and opened up by Mac Cuu from Guangdong, China. He migrated to this area, developed trade routes and made the region affluent in the late 17th and early 18th century. The King of Cambodia conferred Oknha (governorship) to Mac Cuu to govern this land. However, Cambodia did not have the military power to protect the area from the frequent confrontations with the Siam (Thai) military. In 1708, Mac Cuu pledged his allegiance with Lord Nguyen Phuc Chu of Viet Nam for protection. From then on, the area belongs to Viet Nam and is called Ha Tien. Later, his son Mac Thien Tich extended this area.

In 1774, Lord Nguyen Phuc Dang Khoat divided South Viet Nam into 12 places, but still left the town of Ha Tien, for Mac Thien Tich to rule as Admiral.

By the reign of Minh Mang, in 1832, Ha Tien is one of six provinces of south Viet Nam.

In 1876, French divided south Viet Nam (Cochinchina) into 4 large administrative regions, each administrative region to split into sub-areas or administrative counties. Ha Tien was divided into two administrative counties, called Ha Tien and Rach Gia. From 1 January, 1900, the two administrative counties (Ha Tien and Rach Gia) became provinces.

When the Republic of Vietnam was established, Ha Tien and Rach Gia merged to become Kien Giang province. Kien Giang provincewith 7 districts, one of which is Phu Quoc.

Now, Kien Giang province is divided into one city (Rach Gia), one town (Ha Tien), and thirteen districts (Phu Quoc, and the other 12 districts).

General History of Phu Quoc Island

The discovery and development of Phu Quoc started earlier than other places in the Mekong Delta. Late 17th century, Mac Cuu from Ha Tien recruited wandering people in Phu Quoc and other places to set up communes and villages. In 1708, Mac Cuu pledged allegiance to Lord Nguyen and merged Ha Tien (also consisted of Phu Quoc at that time) into Dang Trong (the southern region). Since then, Phu Quoc became part of Viet Nam.

Socio-economic condition of Kien Giang Province

Table 2-1-7 shows the basic socio-economic conditions of the Kien Giang Province.

Table 2-1-7 Basic Socio-economic Data of Kien Giang Province

No.	Items	Value	Description
1	Population	1,703,500	Source:Statistical Handbook 2010, GSO
2	Size	6,346 km^2	More than 2 times of Awaji Island, source: GSO
3	Regional GDP	44,104 billion VND	Current price, Year 2010, GSO
4	Per capita GDP	1,251 USD	Year 2010, JICA Survey Team estimate
5	Population density	268 $/km^2$	Source:Statistical Handbook 2010, GSO
6	FDI projects licensed	29 cases 2,832.9 million USD	For the period 1988 – 2010, GSO, Ranked 16th among 63 provinces

Source: Prepared by JICA Survey Team

Kien Giang Province is located in southern Viet Nam near the Cambodia border. Main industries are the fishing and rice farming. The province is also famous for the tourism industry on the Phu Quoc Island. **Table 2-1-8** shows the regional GDP of the province at constant prices.

Table 2-1-8 Regional Gross Domestic Product of Kien Giang province at Constant 1994 Prices by Economic Sector

Unit: billion VND

Year	Total		Agriculture, forestry & fishing		Industry		Construction		Services		GDP growth rate
2005	10,829	100%	5,173	48%	2,837	26%	380	4%	2,440	23%	12.8%
2006	11,916	100%	5,322	45%	3,197	27%	497	4%	2,900	24%	10.0%
2007	13,487	100%	5,965	44%	3,707	27%	524	4%	3,291	24%	13.2%
2008	15,183	100%	6,621	44%	4,145	27%	576	4%	3,841	25%	12.6%
2009	16,792	100%	6,841	41%	4,584	27%	720	4%	4,647	28%	10.6%
2010	18,781	100%	7,315	39%	5,091	27%	910	5%	5,465	29%	11.8%

Source: Kien Giang Trade Promotion Center, website: www.kitra.com.vn/

Compare to the GDP by economic sector of the whole country in **Table 2-1-2**, the share of the 'Agriculture, forestry & fishing' in Kien Giang Province (39% - 48%) is much higher than that of the whole country (16% - 20%). On the other hand, the share of GDP for the service sector has been increasing from 23% to 29% over the 2005 to 2010 period. GDP growth rate of the province (10% - 13%) is higher than that of the whole country (5% - 8%). Kien Giang Province has the potential to lead the economic growth of the whole country. Furthermore, the service sector including tourism has been growing rapidly in this period.

Socio-economic conditions of Phu Quoc Island

Phu Quoc island is located in the Gulf of Thailand, covering a total area of approximately 580

km^2, close to the major Asian cities, such as; Singapore, Bangkok, Hong Kong and Kuala Lumpur. It is closer to Cambodia than to the closest mainland town of Ha Tien in Viet Nam in the Kien Giang Province, which is 46 km away. Major industries on the island are fishing, marine product processing, and tourism. Nuoc mam (fish sauce) and black pepper are the famous products of the island.

Phu Quoc is blessed with favorable natural environment like the virgin forest of over 37,000 hectares, white sandy beaches, coral gardens offshore, varieties of wildlife, so it is not hard to see why the island has great tourist potential.

The government has formulated a master plan to develop the island into a high quality eco-tourism destination by 2020. As investment starts to flow into Viet Nam, the infrastructure on the island is slowly being improved, along with new developments. The Prime Minister has offered the best conditions possible for domestic and foreign investors to encourage the development of the island, to an international standard tourism and trade center by 2020.

In the year 2008, officials planed to start the construction of an international airport that can accommodate large passenger jets such as the Boeing 767 (250 – 350 passengers) and Airbus A321 (220 passengers). The airport was opened at 2nd of December 2012. Duong Dong old airport was closed at 11:59 pm, 1st of December 2012. In January 2013, though international airplane was not available in the airport yet, several airplanes were available every day with connecting Ho Chi Minh, Ha Noi, and so on, with Phu Quoc by Vietnam Airline and Air Mekong.

Phu Quoc's existing seaport facilities are planned to be upgraded and expanded as follows:

- Duong Dong seaport: upgraded to accommodate international and local passenger ships with a capacity of up to 2,000 passengers.
- A port at Dat Do Cape: to accommodate international ships with a capacity of 2,000 passengers and to serve as a cargo port for the west side of Phu Quoc Island.
- Dam Bay port: a passenger and cargo port, to accommodate ships with a capacity of 2,000 passengers and cargo ships up to 30,000 deadweight tons.
- An Thoi port: a wharf for cargo ships up to 3,000 deadweight tons and coastal passenger ships with a capacity up to 300 passengers.

As Phu Quoc Island has the great potential of tourism and tourist numbers has increased rapidly, the central government announced the development of the island as tourism and trade center. Expansion of transportation infrastructure has started to support the development plan.

Table 2-1-9 shows the regional GDP of the Phu Quoc Island at constant prices. Since the island is famous for tourist resorts, the service sector has a higher share (50%) of the regional

GDP than that of the Kien Giang Province (29%) and the share of the sector has increased over the 2005 to 2009 period . The regional GDP growth rate of Phu Quoc Island of the period is as high as 16% to 23%. Therefore, it is considered that high GDP growth is led by service sector especially by tourism.

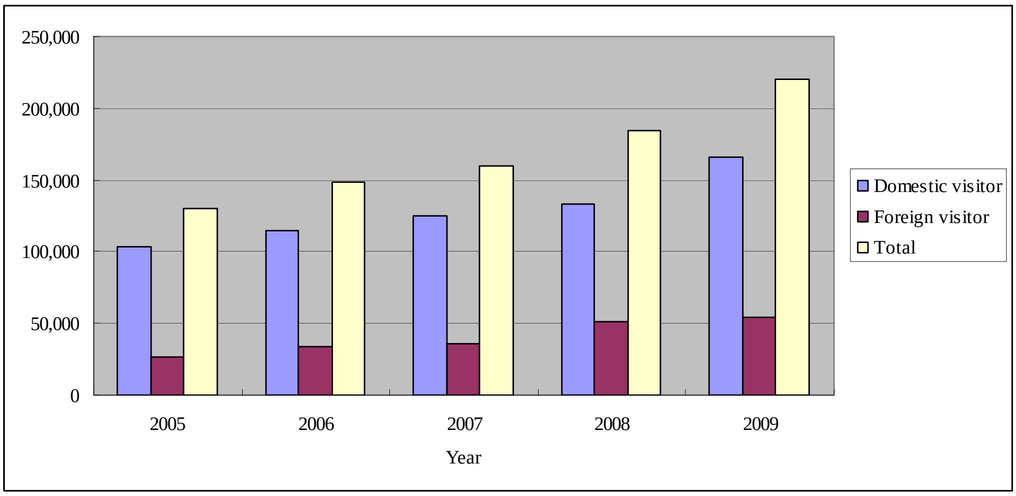
Table 2-1-9 Regional Gross Domestic Product of Phu Quoc Island at Constant 1994 Prices by Economic Sector

Unit: billion VND

Year	Total		Agriculture, forestry & fishing		Industry & construction		Services & others		GDP growth rate
2005	486.9	100%	138.0	28%	133.2	27%	215.7	44%	-
2006	566.4	100%	130.0	23%	184.5	33%	252.0	44%	16.3%
2007	682.8	100%	154.2	23%	202.3	30%	326.4	48%	20.6%
2008	838.9	100%	185.9	22%	250.7	30%	402.3	48%	22.9%
2009	1,030.6	100%	207.4	20%	303.6	29%	519.7	50%	22.8%

Source: Statistic Yearbook 2008 & 2009, Phu Quoc Island

Figure 2-1-1 shows the trend of tourist visits to Phu Quoc Island over the 5 years. Tourist number has steadily increased for the 2005 to 2009 period. Currently, there are about 800 direct workers and about 1.500 indirect workers working in more than 150 hotels and tourism bases.



Source: Statistic Yearbook 2008 & 2009, Phu Quoc Island

Figure 2-1-1 Trend of Tourist Visits to Phu Quoc Island

Table 2-1-10 shows the status of the 82 foreign as well as domestic investment projects granted certificate by the end of 2011 on Phu Quoc Island. These projects represent an investment of 57,220 billion VND (approximately, 2.76 billion USD) in tourism and transportation developments which would contribute to the economic growth of the island.

Table 2-1-10 Number of Certified Investment Projects in Phu Quoc Island

No.	Process of Project	No. of projects	AREA (ha)	Total Investment (billion VND)
PROJECTS GRANTED INVESTMENT CERTIFICATE				
1	Operational	9	18.46	713.26
2	Under construction	14	1,347.39	5,687.73
3	Preparing for construction	33	2,329.44	49,643.71
4	**Total Number of Projects**	**56**	**3,695.29**	**56,044.70**
PROJECTS GRANTED CERTIFICATE WITHOUT ADDITIONAL LAND				
5	All process	26	39.67	1,175.61
6	**GRAND TOTAL**	**82**	**3,734.96**	**57,220.30**

Source: prepared by JICA Survey Team, based on the data of Phu Quoc Development Management Board

(5) Budget of the Phu Quoc District People's Committee (DPC)

Table 2-1-11 shows the budget condition of Phu Quoc DPC for 2006, 2007, 2009, and 2010 (projection).

Table 2-1-11 Budget Revenue - Expenditure of Phu Quoc Island

Unit: million VND

Items	2006	2007	2009	2010*
Revenue	**74,336**	**87,544**	**219,157**	**249,300**
Revenue in local area	63,714	61,312	212,281	242,700
Revenue from non-state sector	32,392	32,980	58,023	77,000
Land use revenue	11,000	10,383	122,340	120,000
Land use right assignment tax	16,600	1,289	7,134	8,500
Others	3,722	16,660	9,435	37,200
Subsidies from Provincial budget	4,612	15,612	-	-
Others	6,010	10,620	6,901	6,630
Expenditure	**69,724**	**87,544**	**328,108**	**228,133**
Expenditure on economic services	2,386	10,450	156,109	122,670
Expenditure on education, health care and culture	25,085	49,452	35,410	35,805
Expenditure on general public administration	5,869	11,580	10,658	8,538
Expenditure on commune budget	6,898	8,989	12,670	11,270
Other expenditure	28,990	2,890	102,110	41,356
Management expenditure through budget	496	4,183	11,151	8,494

Note: *; Projection
Source: Statistic Yearbook 2008 & 2009, Phu Quoc Island

Phu Quoc DPC received subsidies from the province to cover their budget deficits in 2006, and 2007. Generally speaking, according to Article 4 of State Budget Law, the province would provide subsidy to District People's Committee in the following circumstances:

- to enable the local administration to proactively perform assigned tasks, and to strengthen the commune budget;
- to enable the local administration to execute new policy and programs which require increase in spending, must be supported by a financing solution appropriate with balancing capability of the budget concerned;

- In case an upper-level state management agency authorizes a lower-level state management agency to carry out a spending task that comes under the former's responsibility, funds must be transferred from the upper-level agency budget to the lower-level agency budget for performing such a task;
- Additional allocation from the upper-level agency budget to the lower-level agency budget shall be made to ensure equality, balanced development among the regions and local administrative authorities;
- During a period of stable budget, local administrative authorities may utilize increased annual revenue to which they are entitled for local socio-economic development. After each period of stable budget, the local administrative authorities must improve their capability to balance their budgets, increase the local budget, and reduce additional allocation from the upper-lever budget.

In the year 2009, Phu Quoc DPC expended much more than previous year for economic services and other expenditures (refer to **Table 2-1-11**). "Expenditure on economic services" means economic non-business activities. According to Decree No. 60/2003/ND-CP on guiding implementation of State Budget Law, economic non-business activities managed by local administrative authorities are as follows:

- communications activities: consolidation, maintenance and repair of bridges, roads and other communications works;
- Agricultural, irrigation, fishery, salt-making and forestry activities: consolidation and maintenance of dyke systems, irrigation works, agricultural, forestry and fish farms;
- Municipal administration activities: consolidation and maintenance of public-lighting systems, street sidewalks, water supply and drainage systems, intra-municipal traffic, parks and other municipal administrative activities;
- Making cadastral measurement and maps and archiving cadastral dossiers, and other cadastral activities;
- Basic surveys;
- Environment-related activities;

A large revenue increase in 2009 was caused by the jump in land use revenue (1,078% added from 2007) (refer to **Table 2-1-11**). Land use revenue increased because land prices were hiked in the year 2008 as described in the "Decree 41/2008" concerning the land price of each area, issued by Kien Giang Province. This land price hike was caused by purchasing of land by developers.

In the budget projection for 2010, expenditure is expected to be 30% lower than the previous year, within the amount of the projected revenue. For 2011 to ensure a balanced budget, the Phu Quoc DPC has to carefully set the maximum on investment expenses and the priorities of the investment targets. Private sector financing for infrastructure development projects would take much pressure off the expenditure side of the budget scheme.

"The Five-Year Socio-Economic Development Plan 2006-2010" prepared by the Ministry of Planning and Investment, refers to the development policy of Phu Quoc Island, including its tourism industry:

- Develop aquaculture, fishery and seafood processing industry as the targeted export sectors in the Mekong Delta. Preserve and develop coastal mangrove forests, and Phu Quoc primitive forests;
- Make stepwise investments in the Phu Quoc economic zone, building it into a large, modern world class center for tourism, recreation and international trade;
- Continue targeted investment in coastal industrial parks which would be involved in off shore and island eco-tourism ventures.

From October 2004 to February 2006, the Prime Minister enacted several decisions for Phu Quoc to provide a variety of preferential policies for domestic and foreign investors (Decision No. 178/2004, Decision No. 229/2005, Decision No. 38/2006, Mekong Delta Development - Decision No. 344/2005). According to these decisions, Phu Quoc is entitled to apply the highest preferential policies permitted by the Government of Viet Nam. The goal is to transform Phu Quoc Island into a world-class eco-tourism center while conserving its valuable environmental resources.

This project for water supply and sewerage services in Phu Quoc Island conforms with the central government's economic development policy. The PPP scheme will reduce the initial investment by the public sector which is particularly important under the present strict budgetary conditions.

2.2 Phu Quoc Development Mater Plan

The Phu Quoc Development Master Plan was prepared by KGPPC and revised in 2004 and 2009, and approved as Adjusted Master Plan for the construction of Phu Quoc Island, Kien Giang, in 2030 by Prime Minister Decision No. 633/QD-TTG in May 2010. (The adjusted master plan is hereinafter referred to as Master Plan).

The Master Plan objective is to sustainably develop Phu Quoc Island into an international tourism destination and a science and technology hub in the Southeast Asian region, balancing economic development with the protection of the environment and preservation of historic monuments and cultural heritage. The developments would take place in 2 stages with the first stage completion targeted for 2020 and the final stage for 2030.
The projected populations for 2020 and 2030 are shown in **Table 2-2-1**.

Table 2-2-1 Population Forecast by Master Plan

Year	Total Population	Urban Population	Rural Population	Number of tourists in terms of equivalent population	Number of Tourists per year
2020	340,000 – 380,000	200,000 - 230,000	80,000 – 90,000	50,000 – 65,000	2 – 3 million
2030	500,000 – 550,000	320,000 – 370,000	90,000 – 100,000	80,000 – 85,000	5 – 7 million

Duong Dong, An Thoi and Cua Can townships are designated as urban development areas, and their development goals are summarized in **Table 2-2-2**.

Table 2-2-2 Development Policies of Three Designated Urban Areas

Urban Area	Urban Function	Target Population (Y2030)	Development Area (ha)
Duong Dong Urban Center	government services, public services, business center, tourist service center	240,000	2,502 ha
An Thoi	international port, tourist services, light industry, cultural center	71,000	1,020 ha
Cua Can	forest/marine protection, agriculture, tourist center	26,500	329 ha

The development goals for the entire island are summarized as follows:

- Duong Dong urban area: center of tourist industry
- Northern area: nature and forest reserve, eco-tourism, villages showcasing cultural features for the tourist industry, sustainable agriculture
- Southern area: international airport, tourist industry complex, eco-tourism, urban port area, forest reserve, internment prison monument area
- Western area: eco-tourism, villages showcasing cultural features for the tourist industry
- Eastern area: sustainable agriculture, nature reserve

Table 2-2-3 shows population forecasts and technical standards according to the Master Plan.

Table 2-2-3 Population Forecast and Technical Standards by Year 2030

No	Description	Unit	By Y2020	By Y2030
I	Phu Quoc Island population	Person	340-380,000	500-550,000
1	Urban population	Person	200-230,000	320-370,000
	Rural population	Person	80-90,000	90-100,000
2	Staying tourists	Person	50-65,000	80-85,000
3	Tourist visitors	Person/year	2-3 million	5-7 million
II	Total land area	Ha		58,922
1	Urban construction land use	Ha		3,852
2	Tourism land use for:	Ha		3,477
	- Eco-tourism	Ha		2,637
	- Mixed tourism	Ha		810
3	Land for tourism complex, services, residential area	Ha		1,235
4	Special land use	ha		1,489
5	Land for landscape, water surface and open space	ha		3,399
6	Land use for technical infrastructural head works	ha		1,567
7	Silviculture land	ha		37,802
8	Agricultural land	ha		5,381
9	Land use for security and national defenses	ha		750
III	Technical infrastructural			
1	Water supply for domestic use	L/capita/day	120	150
2	Power supply	Kwh/capita/day	750	1,500

Source: The Amended General Construction Master Plan for Phu Quoc Island by year 2030, prepared in 2010.

According to the Master Plan, the following technical infrastructure development is proposed up to 2030:

2.2.1 Water Supply Plan in Master Plan

The water demands on the main island of Phu Quoc for 2020 and 2030 are estimated to be 70,000 and 120,000 m^3/d respectively. Four new water impounding reservoirs would be required to meet these water demands. The water supply system to be developed would provide 68,000 m^3/d by 2020 and 103,000 m^3/d by 2030 (equivalent to 65% and 85% of the projected demands), with the balance to be supplemented by rain water and reclaimed water.

Table 2-2-1-1 summarizes storage capacities of the four new water reservoirs and one existing reservoir (Duong Dong) together with planned water supply capacity from each reservoir.

Table 2-2-1-1 Storage and Supply Capacities of Water Impounding Reservoirs identified in Master Plan

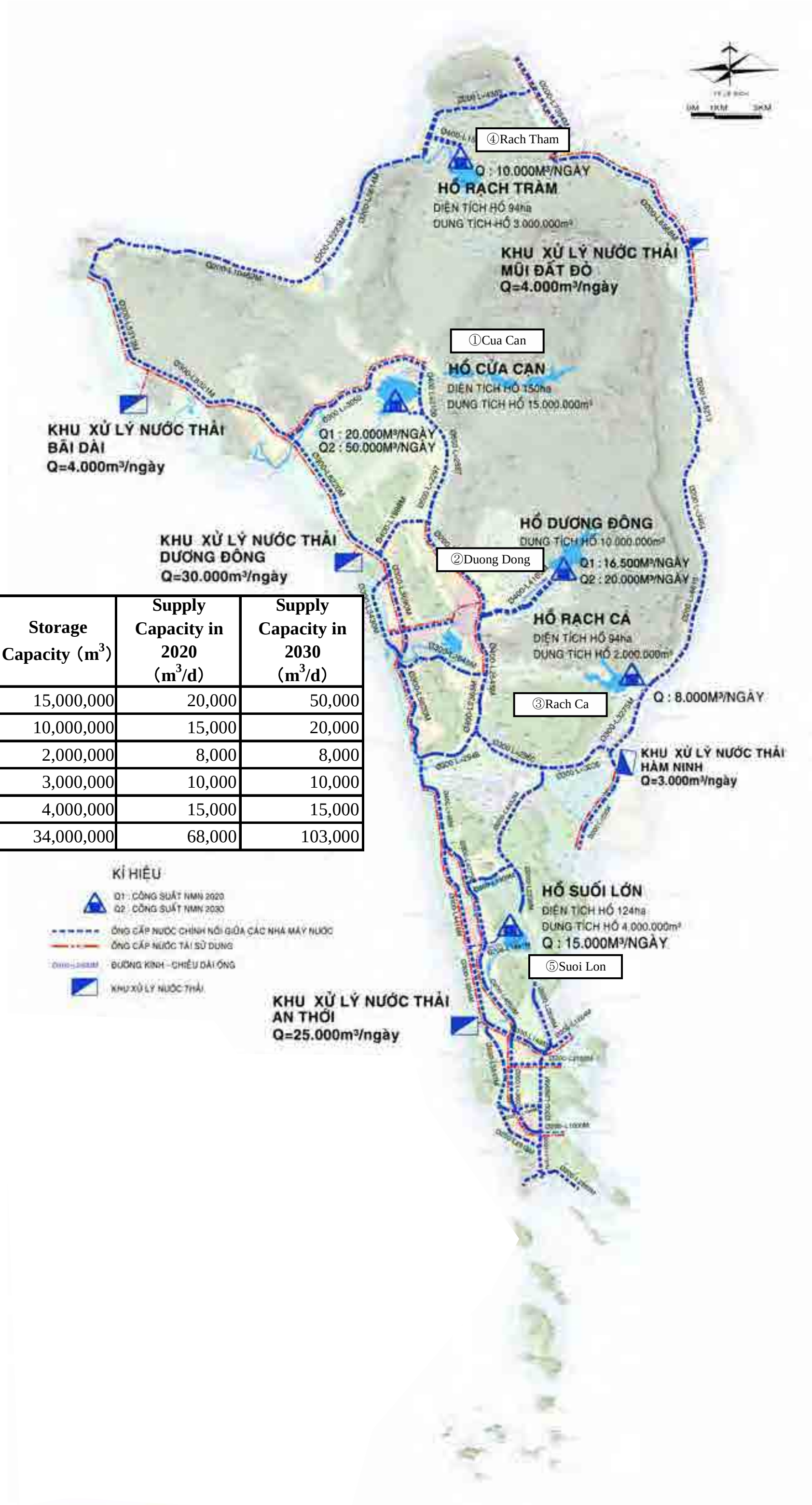
No.	Name of Reservoir	Storage Capacity (m^3)	Supply Capacity in 2020 (m^3/d)	Supply Capacity in 2030 (m^3/d)	Remarks
1	Cua Can	15,000,000	20,000	50,000	The largest capacity on the island
2	Duong Dong	10,000,000	15,000	20,000	Expansion of the existing reservoir
3	Rach Ca	2,000,000	8,000	8,000	
4	Rach Tram	3,000,000	10,000	10,000	
5	Suoi Lon	4,000,000	15,000	15,000	
	Total	34,000,000	68,000	103,000	

Source：Decision No.633/QD-TTg May 11, 2010

Figure 2-2-1-1 illustrates the five water supply systems. Raw water extracted from the reservoirs would be treated and distributed to customers on the island as potable water.

By the year 2020 Mater Plan indicates that the entire water supply capacity of the island becomes 68,000 m^3/d.

Water demand projected in year 2030 in Master Plan is 120,000 m^3/d, of which 85% (103,000 m^3/d) will be secured by the planned water supply systems. It is expected that the balance be fulfilled by the use of rainwater and reclaimed water.



No.	Name of Reservoir	Storage Capacity (m³)	Supply Capacity in 2020 (m³/d)	Supply Capacity in 2030 (m³/d)
1	Cua Can	15,000,000	20,000	50,000
2	Duong Dong	10,000,000	15,000	20,000
3	Rach Ca	2,000,000	8,000	8,000
4	Rach Tram	3,000,000	10,000	10,000
5	Suoi Lon	4,000,000	15,000	15,000
	Total	34,000,000	68,000	103,000

Source: Master Plan

Figure 2-2-1-1 Water Supply Plan Identified in Master Plan

2.2.2 Sewerage Plan in Master Plan

(1) Projected Sewage Quantity

Sewage quantities of the urban areas in 2020 and 2030 are estimated as shown in **Table 2-2-2-1**.

Table 2-2-2-1 Planned Sewage Quantity

No	Wastewater	Urban Population (People)		Formula		Sewage Quantity (m^3/day)	
	Year	2020	2030	2020	2030	2020	2030
1	Domestic(Q)	220,000	350,000	120*1×80%	150*1×80%	21,120	42,000
2	Public	-	-	10%Q	10%Q	2,112	4,200
3	Tourist	60,000	85,000	300*2×0.8	300*2×0.8	14,400	20,400
	Sub-total					37,632	66,600
4	Industrial	173(ha)	243(ha)	25m^3/ha*3×0.8		3,460	4,860
	Total					41,092	71,460
	Rounded					41,000	72,000

Source：Master Plan
*1: Daily water consumption per capita for domestic use
*2: Daily water consumption per capita for tourist use
*3: Daily water consumption per hectare for industrial area

Daily sewage quantity per capita is set at 80% of daily water consumption (120 L/capita/day in 2020, 150 L/capita/day in 2030). That for public wastewater quantity is set at 10% of domestic wastewater, and for tourist wastewater at 80% of tourist water consumption which is 300L/capita/day. Industrial wastewater is set at 80% of industrial water consumption for industrial area which is 25m^3/ha.

(2) Sewage Treatment Plant

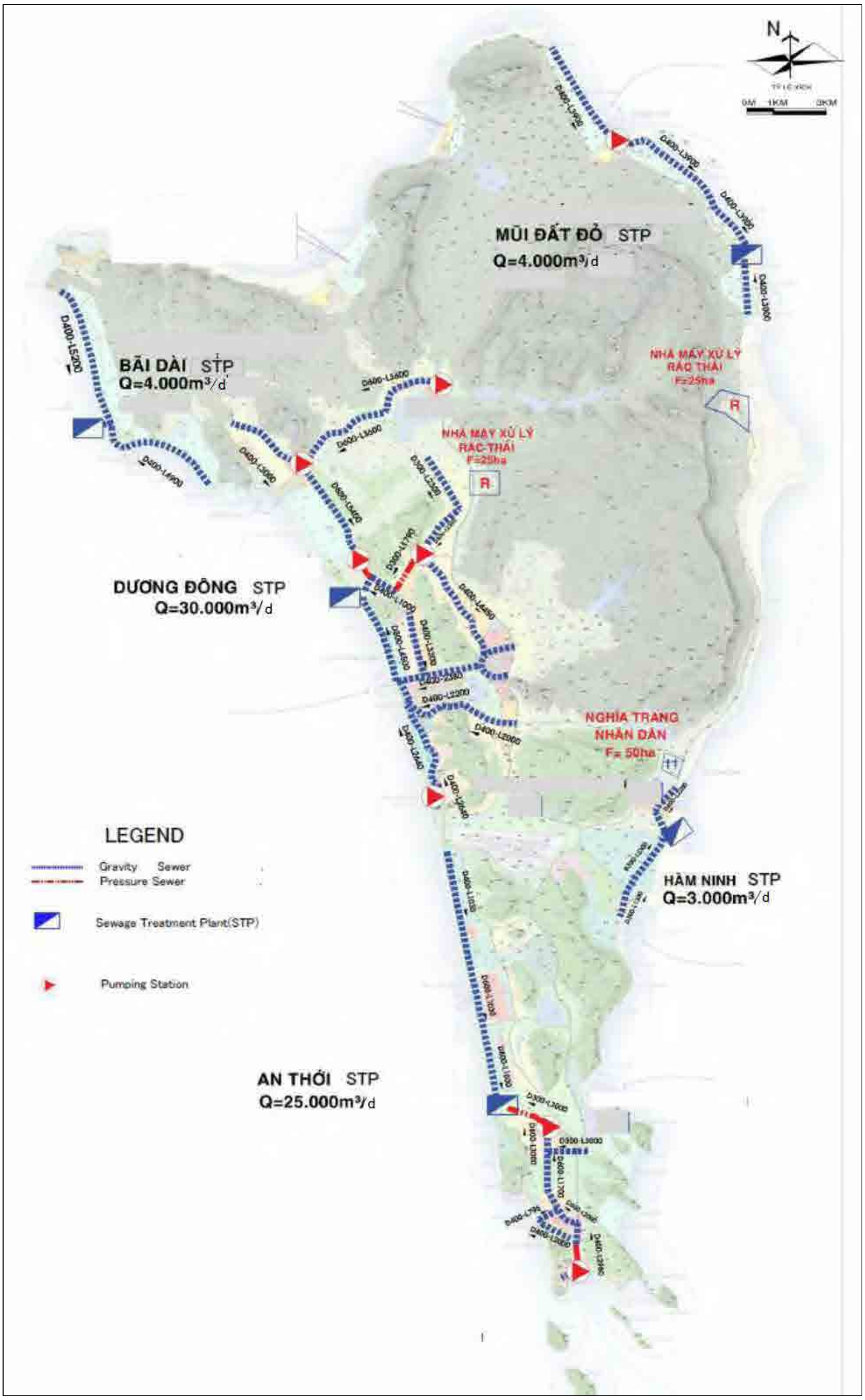
Five sewage treatment plants are planned and the sewage quantities projected for 2020 and 2030 are shown in **Table 2-2-2-2**. Industrial wastewater is estimated to be 4,800 m^3/day.

Table 2-2-2-2 Planned Sewage Quantity of Sewage Treatment Plant

Name of Sewage Treatment Plant	Planned Sewage Quantity (m^3/day)	
	Y2020	Y2030
Duong Dong	30,000	30,000
Bai Dai	2,000	4,000
Ham Ninh, Bai Vong	2,000	3,000
An Thoi, Bai Truong	20,000	25,000
Mui Dat Do	2,000	4,000
Total	56,000	66,000

Source: Master Plan
Notes: Planned sewage quantity excludes Industrial wastewater.
Each factory or industrial complex owns an individual treatment facility.

The proposed sewerage system layout is shown **Figure 2-2-2-1**.



Source：Adjusted Master Plan

Figure 2-2-2-1 Planned Sewerage Layout

2.2.3 Other Infrastructure Development Plans in Mater Plan

(1) Roads

The following road construction projects are underway:

i. Main Axis（An thoi – Duong Dong – Suoi Cai – Bai Thom）
ii. Suoi Cai – Bai Thom Road
iii. Suoi Cai – Ganh Dau Road
iv. Duong Dong – Cua Can Road
v. Duong Dong – Duong To – An Thoi Road
vi. The road running around the island
vii. Duong Dong urban roads
viii. Other urban roads

The total length of the main axis and lateral roads to be constructed is 215 km. Budget is allocated for 152 km.

(2) International Airport

A new 905 ha international airport (ICAO Standard 4E) was constructed in the Duong To area, and opened at 2nd of December 2012. The airport has enough area of air strip (length 3,000 m x width 45 m) for B767 and B747 aircrafts to make landing. The number of tourist arrivals per year is estimated at 2.65 million (including 1 million foreigners) in 2020 and 7 million in 2030.

In April 2013, there were 4 airlines from/to Ho Chi Minh, Ha Noi, Kan Tho, and Rach Gia by Vietnam Airline, and 2 airlines from/to Ho Chi Minh and Ha Noi by Air Mekong. It is expected that the international airlines will come from/to Cambodia and Singapore within the year 2013.

(3) Seaport

Major facilities planned are as follows.

i. An Thoi international port: to handle 450,000 ton of cargos and 360,000 passengers; estimated construction cost is 150 billion VND (110 billion VND in 2011)
ii. Dat Do Port: international cruise ship terminal, south-eastern way port.
iii. Breakwater and Duong Dong port: Marina for fishing boats, cruise ships.

(4) Power Supply

Power supply to domestic customers in urban area is planned to be 750 kW/capita/year by 2020 and 1,500 kW/capita/year by 2030.

The following power development plans are underway:

i. Marine cable from Ha Tien (110 kV): Approximately 90 million US$ (among which, 60 million US$ by World Bank, 30 million US$ by Southern Power Corporation, Vietnamese Power Public Corporation). Presently, by Prysmian Powerlink S.r.l, Italian company, it is being conducted that designing, procurement and installation of marine cable. Until July 2014, power supply from Vietnam mainland is scheduled to be started. Power supply capacity is expected to be 131 MVA.

ii. Duong Dong – Phu Quoc: 30 MW diesel power generation

iii. Cua Can wind power generation: 90 MW

iv. Ganh Dau Thermal Power Plant (by 2020) 200 MW or 230 MW：Prime Minister approved to promote a construction plan of a thermal plant at Ganh Dau. The investment cost 300 - 350 million US$.

(5) Garbage Disposal

Two disposal sites are planned as shown in **Figure 2-2-3-1**. A part of the Ham Ninh disposal facilities would start operating by the end of 2013, with the full operation in 2015. The investment cost is estimated to be 280 billion VND.

Source: Master Plan

Figure 2-2-3-1 Garbage Disposal Sites

2.3 Present Water Supply and Sewerage Systems and Other Projects

2.3.1 Existing Water Supply System and Other Related Water Supply Projects

(1) Existing Duong Dong water supply system

The water supply service in Phu Quoc started by KIWACO in 2006 covers only the Duong Dong township area. The raw water source is the Duong Dong impounding reservoir, located approximately 5 km northeast of Duong Dong. The raw water is treated at the Duong Dong water treatment plant (WTP). The supply capacity of the existing system is 5,000 m^3/d, and 41% of the population of Duong Dong township is connected to the system. **Table 2-3-1-1** shows general information on the Duong Dong water supply service.

Table 2-3-1-1 Existing Water Supply Service in Phu Quoc

	Unit	Values in Year 2010
Water Production	m^3/d	2,640
Water Distributed (billed)	m^3/d	2,194
Domestic Consumption (billed)	m^3/d	1,832
NRW ratio	%	10.8
Capacity of Water Treatment Plant	m^3/d	5,000
Operation Rate	%	53
No. of Connections	connections	3,699
No. of Domestic Connections	connections	3,599
Duong Dong Town Population	persons	32,738
Population Served	persons	16,645
Service Ratio	%	51
Unit consumption by domestic customer	lpcd	113
No. of Employees	persons	20
No. of Employees per 1,000 connections	persons	5.4
Water Tariff (Domestic)	VND/m3	5,500
Annual Bill	VND	4,293,317,649
Average monthly bill per customer	VND/month/customer	96,722
Connection Charge	-	Free up to 5m from the tapping point on distribution pipe. Over 5m customer bears the actual installation cost.

Figure 2-3-1-1 summarizes the Duong Dong water supply system.

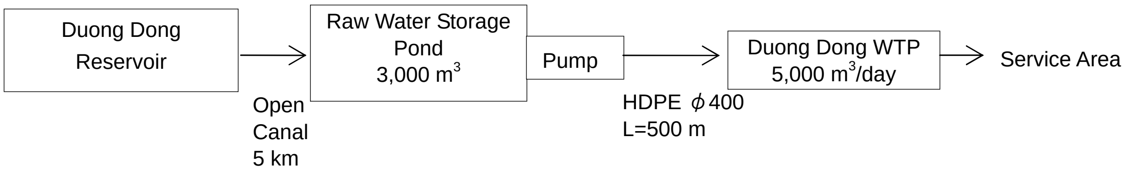


Figure 2-3-1-1 Existing Duong Dong Water Supply System

The Duong Dong impounding reservoir is owned and operated by DARD (Department of Agriculture and Rural Development, Kien Giang Province). The facilities from raw water transmission to distribution networks are operated and maintained by KIWACO.

The service area of the system is between the northern road of the airport and the southern road of the Duong Dong River, and the area between the Duong Dong WTP and the coastline as shown in **Figure 2-3-1-2**.

The existing distribution pipelines are of HDPE with nominal diameters ranging from 100 mm to 400 mm.

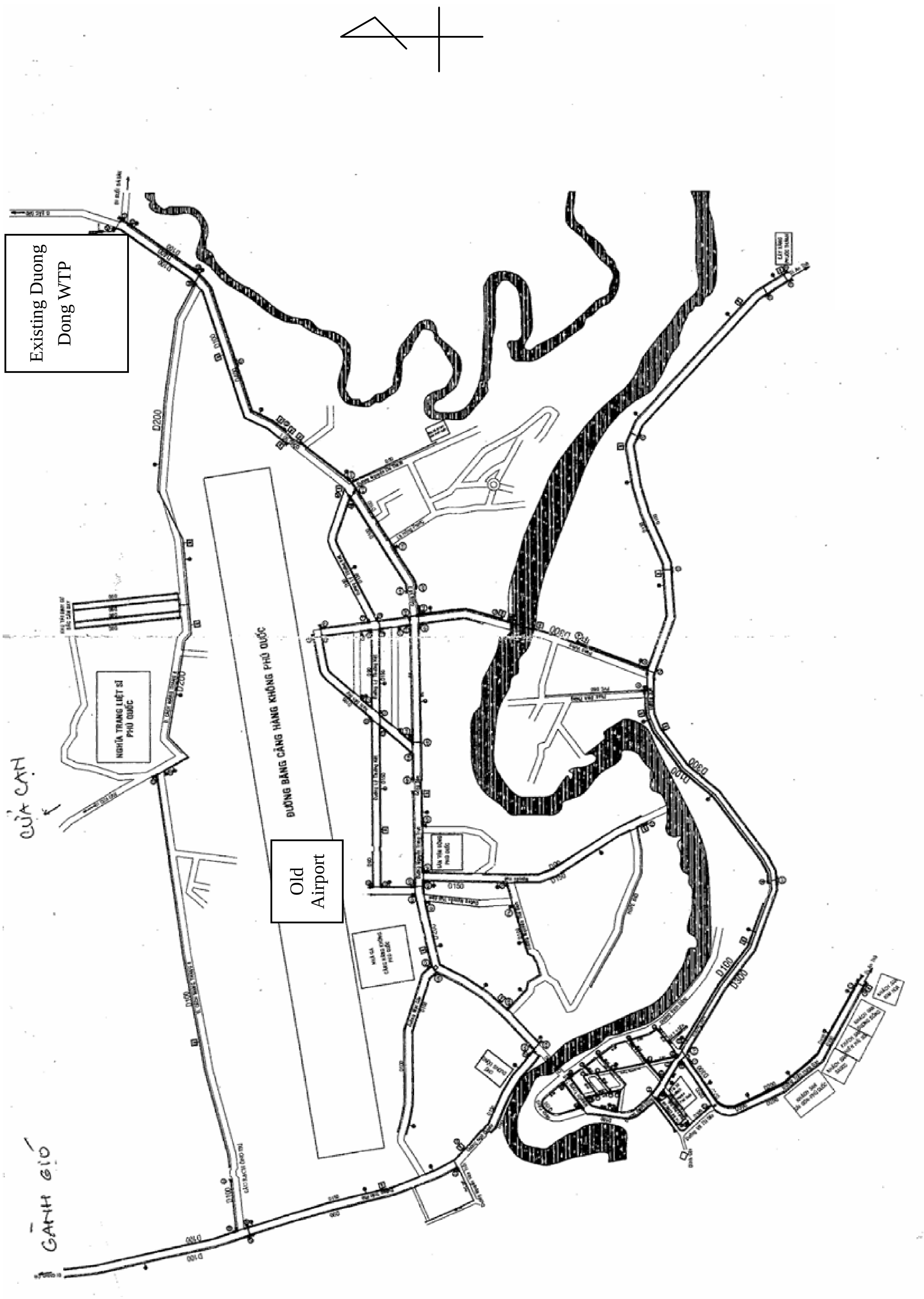


Figure 2-3-1-2 Service Area of Duong Dong Water Supply System

(2) Other related water supply projects

The "Phu Quoc District Water Supply Project" which will expand the water supply services in Phu Quoc urban center is funded by the World Bank with target completion by 2020. The 5,000 m^3/day Duong Dong WTP would be rehabilitated and expanded to 16,500 m^3/day and the distribution networks would be expanded in Duong Dong town and Duong To commune. The Stage I Duong Dong Dam Upgrading Project funded by the government and implemented in 2012 would provide the water source at the supply capacity of 16,500 m^3/day.

Table 2-3-1-2 shows the summary of Phu Quoc District Water Supply Project.

Table 2-3-1-2 Summary of Phu Quoc District Water Supply Project

Project name	Vietnam Urban Water Supply and Wastewater Project (VWSWP)
Subproject name	Phu Quoc District Water Supply Project
Project owner	Kien Giang Water Supply & Drainage One Member Limited Company (KIWACO)
Project area	Duong Dong town, Duong To commune and a part of area on the way to Cua Can
Scope of water supply expansion development	1) Modify the raw water intake at Duong Dong Lake 2) Install raw water pipeline φ560 mm, 3.2 km 3) Improve the 3,000 m^3 raw water reservoir and install raw water pumps 4) Rehabilitate and expand Duong Dong WTP (5,000 m^3/day to 16,500 m^3/day) 5) Construct sludge settling ponds on a site 80 m east of the WTP 6) Construct a 500 m^3 reservoir and a new treated water pumping station at WTP 7) Install 16.5 km of treated water transmission mains between Duong Don town and Suoi Lon booster pumping station (BPS) and install 7.5 km to new Phu Quoc airport and residential area toward Cua Can, and construct Suoi Lon BPS 8) Install 44.2 km of distribution pipeline throughout the service area 9) Construct a 500 m^3 reservoir on Provincial road 47 hill 10) Install house connections
Implementation period	2012 to June 2014
Total project cost	US$ 12,872,921

By executing the World Bank project, the water supply service area would cover not only Duong Dong town and Duong To commune but also the new international airport (400 to 900 m^3/d) and Bai Trung development area along the west coast in Duong To commune. However, it is estimated that the water supply amount of 5,000 m^3/d by 2020 would not be sufficient to meet the projected water demand.

Therefore, this project would have to cover the projected water supply deficit after the World Bank project.

2.3.2 Existing Sewer and Other Sewerage Project

(1) Existing Sewer

There is no sewage treatment plant for domestic wastewater on Phu Quoc Island. Human waste from each household is treated by a septic system with the effluent from the septic tank discharged into water bodies outside the house. Other wastewater is discharged without any treatment.

Hotels categorized as shown in **Table 2-3-2-1,** are required to have their own sewage treatment facilities to satisfy the effluent water quality standards shown in **Table 2-3-2-2**. The monitoring of effluent water quality is not regularly conducted by KGPPC.

Table 2-3-2-1 Categories of Hotels

Hotel	No. of Rooms	Category
Hotel	<60	III
	60 – 200	II
	>200	I
Bungalow Guest House	10 – 50	IV
	50 – 250	III
	>250	II

Source：TCVN 6772:2000

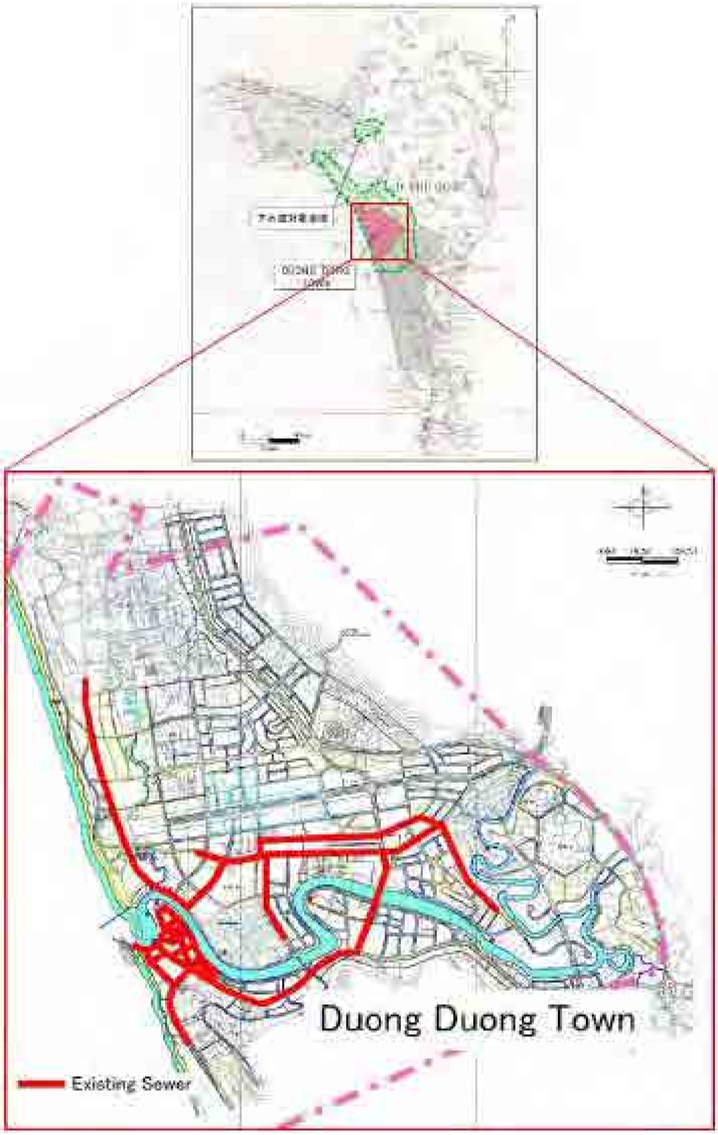
Table 2-3-2-2 Allowable Effluent Water Quality from Accommodation Facilities

No	Water Quality Parameter	Unit	Allowable Level			
			Category I	Category II	Category III	Category VI
1	Ph	-	5-9	5-9	5-9	5-9
2	BOD_5	mg/l	20	30	40	50
3	SS	mg/l	50	50	60	100
4	Depositional solids	mg/l	0.5	0.5	0.5	0.5
5	TDS	mg/l	500	500	500	500
6	H_2S	mg/l	1	1	3	4
7	NH_3^-	mg/l	30	30	40	50
8	Oil(foods)	mg/l	20	20	20	20
9	PO_4^{3-}	mg/l	6	6	10	10
10	Coliform	MPN/100ml	1,000	1,000	5,000	5,000

Source: TCVN 6772:2000

There is a limited sewer system in the Duong Dong area. Sewer pipes were installed during road construction. The collected rainwater and wastewater from households are directly discharged into rivers or the sea.

Figure 2-3-2-1 illustrates the existing sewer system in Duong Dong.



Source: JICA Survey Team

Figure 2-3-2-1 Existing Sewer System in Duong Dong

(2) Status of Other Sewerage Projects

This Master Plan is using the same service area, the number of sewage treatment plants, capacities of the sewage treatment plants and sewer routes as those proposed in the January 2010 sewerage system plan prepared by the Blue Water Bio's Korean branch of UK companies and its Vietnamese partner Thuan Thaon. These partners built a sewage treatment demonstration plant with a capacity of 300 m^3/day in Duong Dong town, and carried out the verification test. The demonstration plant employed the ABC (Advanced Biological Contactor) process. Data from the demonstration plant was sent to the governmental institute for evaluation. The result of the evaluation was not acceptable to KGPPC, according to the information from Phu Quoc Development Management Board as of April 2012.

2.3.3 Financial Condition of KIWACO and Water Supply and Sewerage Tariff

(1) Financial Condition of KIWACO

KIWACO is managed based on the self-supporting financial system. KIWACO's costs including operation and maintenance costs, loan repayment, and depreciation costs, are basically covered by water tariff revenue. Facility construction is funded mainly by loan including foreign ODA loan as sub-loan from the central government. **Tables 2-3-3-1** to **2-3-3-3** are the balance sheet, income statement, and cash flow statement of KIWACO, edited by JICA Survey Team, based on the annual Financial Reports.

Table 2-3-3-1 Balance Sheet of KIWACO

Unit: million VND

	Items	31 Dec. 2006	31 Dec. 2007	31 Dec. 2008	31 Dec. 2009	31 Dec. 2010
1	**ASSETS**					
1.1	**Current assets**	**20,994**	**32,719**	**75,028**	**64,575**	**81,568**
(1)	Cash & cash equivalents	4,671	16,254	19,074	3,994	47,919
(2)	Short-term financial investments	3,500	3,500	19,000	27,000	3,500
(3)	Receivables	7,636	8,937	32,824	26,046	13,774
(4)	Inventory	4,541	2,798	2,553	5,810	14,926
(5)	Other current assets	646	1,230	1,577	1,725	1,449
1.2	**Long-term assets**	**63,658**	**85,691**	**152,744**	**232,845**	**288,500**
(1)	Long-term receivables	646	0	0	0	0
(2)	Fixed assets	62,652	82,572	149,471	229,041	272,544
(3)	Investment properties	0	0	0	0	0
(4)	Long-term financial investments	298	1,898	2,580	3,029	7,520
(5)	Other fixed assets	62	1,221	693	775	8,436
	TOTAL ASSETS	**84,652**	**118,410**	**227,772**	**297,420**	**370,068**
2	**LIABILITIES & EQUITY**					
2.1	**Liabilities**	**25,748**	**28,163**	**56,285**	**126,513**	**203,495**
(1)	Current liabilities	12,065	18,770	14,498	15,398	65,502
(2)	Long-term liabilities	13,683	9,393	41,787	111,115	137,993
2.2	**Owner's Equity**	**58,904**	**90,247**	**171,487**	**170,907**	**166,573**
(1)	Equity	56,920	86,102	167,244	166,000	166,573
	Contributed Capital	47,627	73,609	151,465	145,886	161,763
	Treasury stocks	3,601	4,926	4,926	4,926	0
	Development and investment fund	3,525	4,724	7,375	10,869	0
	Financial reserves fund	2,167	2,843	3,478	4,319	0
	Undistributed profits	0	0	0	0	4,810
(2)	Other funds	1984	4145	4243	4,907	0
	TOTAL LIABILITIES & EQUITY	**84,652**	**118,410**	**227,772**	**297,420**	**370,068**

Source: Financial Report 2006 to 2010, KIWACO

Table 2-3-3-2 Income Statement of KIWACO

Unit: million VND

	Items	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010
1	**Revenue from sales and services**	**36,179**	**45,615**	**56,471**	**66,838**	**87,299**
1.1	Deductions	6	4	1	3	0
2	Net revenue from sales and provision of services	36,173	45,611	56,470	66,835	87,299
2.1	Cost of goods sold	29,443	37,081	47,544	54,327	71,106
3	**Gross profit from sales and services**	**6,730**	**8,530**	**8,926**	**12,508**	**16,193**
3.1	Revenue from financial activities	484	429	1,669	2,476	5,869
3.2	Financial expenses	381	459	381	1,976	7,598
	Of which: interest expense	381	1	38	1,652	7,442
3.3	Selling expenses	54	3	0	0	0
3.4	Administration expenses	1,225	1,213	1,516	1,795	3,120
4	**Net operating profit**	**5,554**	**7,284**	**8,698**	**11,213**	**11,344**
4.1	Other income	10	911	132	4	987
4.2	Other Expenses	0	6	5	0	132
4.3	Other profit	10	906	127	4	855
5	**Profit before tax**	**5,564**	**8,190**	**8,825**	**11,217**	**12,199**
5.1	The cost of existing corporate income taxes	1,558	2,293	2,471	2,804	2,578
5.2	Income tax expense deferred	0	0	0	0	0
6	**Profit after tax**	**4,006**	**5,897**	**6,354**	**8,413**	**9,621**

Source: Financial Report 2006 to 2010, KIWACO

Table 2-3-3-3 Cash Flow Statement of KIWACO

Unit: million VND

	Items	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010
1	Cash flow from business activities	2,995	14,335	5,759	11,486	21,088
2	Cash flow from investing activities	-90	-2,966	-22,091	-8,100	-17,005
3	Cash flow from financing activities	-2,286	214	19,153	-18,466	-3,642
4	Net cash flow for the period	619	11,583	2,821	-15,080	441
5	Cash and cash equivalents at beginning of period	4,052	4,671	16,254	19,074	3,994
6	Cash and cash equivalents at the end of period	4,671	16,254	19,075	3,994	4,435

Source: Financial Report 2006 to 2010, KIWACO

KIWACO has been generating profit after tax for the 2006 – 2010 period. “2.1 Cost of goods sold” in the income statement includes the costs of electricity, chemicals, staff salary, repairs, and depreciation costs for all of the facilities and equipment. Profit doubled over the 5 years to 9,621 million VND (457,968 USD at the exchange rate of 21,008 VND/USD).

Long-term liabilities in 2010 are composed of long-term loans for facility construction from the following 4 domestic and international agencies: Development Fund of Kien Giang Province, Vietnam Development Bank (VDB), AFD (Agency for France’s Official Development), and ADB.

Table 2-3-3-4 shows the major financial indicators of KIWACO for the 2006 - 2010 period.

Profit margin and working ratio are the indicators showing the profitability of the enterprise. These two indicators show high profitablity. Profit margin is higher than the average of the private companies in Japan. Working ratio, at around 85%, indicates that annual O&M cost is 85% of annual revenue. Profitability of KIWACO is excellent and has been stable for that period.

Table 2-3-3-4 Financial Indicators of KIWACO

	2006	2007	2008	2009	2010	Reference for evaluation
Profit margin	15.1%	16.0%	13.1%	16.0%	15.0%	Average 5% in private (Japan), good in high figure.
Working ratio	0.85	0.84	0.87	0.84	0.85	Ave. 1.05 (18 large water supply entities in Asia), good in low figure.
Return on Equity (ROE)	6.8%	6.5%	3.7%	4.9%	5.8%	Ave. 2% in private (Japan), good in high figure.
Return on Assets (ROA)	6.6%	6.9%	3.9%	3.8%	3.3%	Ave. 4% in private (Japan), good in high figure.
Equity ratio	69.6%	76.2%	75.3%	57.5%	45.0%	Ave. 37% in private (Japan), good in high figure.
Interest coverage ratio	15.6	18.8	24.2	6.7	2.6	Ave. 5 in private (Japan), good in high figure.

Source: prepared by JICA Survey Team , based on the Balance sheet and Income statement

Notes: Profit margin = Operating income before interest / Total operating revenues

Working ratio = Annual O&M cost / Annual revenue

Return on equity = Net profit after tax / Owner's equity

Return on assets = Profit before tax / Total Assets

Equity ratio = Owner's equity / Total Assets

Interest coverage ratio = Operating income before interest / Interest expenses

Return on equity (ROE) is the indicator thatshows the net profit after tax generated by the equity input. The ROE of KIWACO is better than the average of the private sector in Japan. Return on assets (ROA) showsthe profit before tax generated by the internal fund (owner's equity) and external fund (liabilities). The ROA of KIWACO also healthy but has decline during this period.

The equity ratio indicates the relative proportion of equity used to finance the organization's assets (total liabilities & equities). The organization is healthy financially if this figure is higher since the share of owner's equity is larger and its liability (loans etc.). KIWACO's equity ratio has been declining but the figure is still better than the average the private companies in Japan. Interest coverage ratio is a measure of the organization's ability to honor its debt payments. Until 2009, the KIWACO's interest coverage ratio had been better than that of the average private companies in Japan. The lower interest coverage ratio seen in 2010 is still within the acceptable range but more scrutiny may be required when new loans are considered.

KIWACO's financial condition is excellent with stable high profitability for the 2006 - 2010 period, but the share of liabilities is increasing. Therefore, KIWACO would need to assess carefully its capability of taking on new loans to make sure that the organization stays profitable.

(2) Water Supply and Sewerage Tariff in Kian Giang Province

<u>Water supply tariff</u>

Table 2-3-3-5 shows the water tariff charged by KIWACO. The tariff rates for households and governmental institutions are stipulated in the Decision No. 1555/QP-UBND dated 19 July 2011, issued by Kien Giang Provincial PC. Tariff rates for commercial and industrial customers are stipulated in the Decision No. 16/QD-CTN dated 20 July 2011, issued by KIWACO.

Table 2-3-3-5 Water Supply Tariff of KIWACO

Unit: VND/m^3

Category \ Areas	Rach Gia, Ha Tien, Hon Dat, Phu Quoc, Kien Luong		Other areas
Household & Governmental	5,500[*1]		4,000[*1]
Category \ Areas	**Rach Gia, Hon Dat, Phu Quoc**	**Ha Tien, Kien Luong**	**Chau Thanh, An Minh, An Bien, Tan Hiep, Giong Rieng**
Commercial	10,000[*2]	12,000[*2]	8,000[*2]
Industrial	7,500[*2]	8,000[*2]	6,000[*2]

Source: *1; Decision No.1555/QD-UBND dated 19/7/2011 issued by Kien Giang Provincial PC.
*2; Decision No.16/QD-CTN dated 20/7/2011 issued by Kiwaco.

Note: The above tariffs include Value Added Tax, connection cost in case of the length between water meter and public pipe is less than 5 meters. The above tariff does not include environment protection fee. The above tariff is effective from July 2011.

The government of Viet Nam stipulated the method for calculation of water tariff in “Circular Ref. 95/2009/TTLT-BTC-BXD-BNN” (Inter-Ministerial Circular: Guidelines on the principles, methods and jurisdiction for determination of clean water tariff rates at urban areas, industrial zones and rural area). This circular was issued on 19 May 2009, by 3 ministries - MOF, MOC, and MARD. According to the circular, the average tariff for clean water must be calculated using the following formula:

$$\text{Gttbq} = \frac{\text{GTtb}}{\text{SLtp}} + \text{P}$$

Whereas:

Gttbq: average tariff (unit: VND/m^3);

GTtb: overall cost of price (unit: VND/year),

SLtp:produced water volume minus amount of water losses, P: reasonable profit rate, based on the actual conditions of the water provider and income of the local people, minimum 3% of owned capital.

GTtb, overall cost of price, covers the following costs:

No.	Cost
1	Direct material cost
2	Direct labor cost
3	General production cost
4	**Sub-total Cost** (1+2+3)
5	Enterprise management cost
6	Sale cost
7	**Total Cost** (4 + 5 + 6) for GTtb

These costs are defined as follows:

1. Direct material cost includes cost of materials, and cost of purchasing raw water, electricity and chemicals for water treatment.
2. Direct labor cost includes payments to employees directly involved in the production, such as monthly salary, allowances, social and medical insurance.
3. General production cost includes indirect production expenses, such as depreciation and repair of fixed assets, expenses for materials, tools and equipments for the factory, salary, allowances, social and medical insurance, paid to the factory workers, outsourcing and other related costs.
4. Enterprise management cost includes expenses for the management office and staff such as depreciation and repair of fixed assets, salary and allowance, social and medical insurance, office equipment and facilities, tax, fees/charges and other service costs, and other general costs including interest payment on loans, contingencies, R&D activities, training, medical care for employees, and other related costs.
5. Sale cost includes all items of expenditures related to the sales department and its staff, such as investment cost for water meters and auxiliary devices of the customers, salary and allowances, social and medical insurance, advertisement, outsourcing and other related expenses.

Water tariff in Viet Nam is basically calculated to cover all of the necessary cost of water supply; such as, electricity, chemicals, staff salary and allowances, depreciation, materials & equipment, repairs, management costs, sales cost.

The same conditions apply to KIWACO. Water tariff is calculated to cover all the necessary costs including depreciation costs of all the facilities. Depreciated water supply facilities cover all of the facilities from raw water reservoir to distribution pipe owned by KIWACO. Tariff revision plan is proposed to the Kien Giang Provincial PC (KGPCC) for approval.

Sewerage fee

Sewerage fee in Kien Giang Province is set at 140 VND/m^3 for each water consumption volume. It is included in the water tariff bill. The sewerage fee is low at present since there is no sewerage facility in Kien Giang Province. New regulations would be established to stipulate the new sewerage tariff when the new sewerage facilities are built.

Table 2-3-3-6 Present Sewerage Fee

Item	Unit	Unit price
Sewerage fee	VND/m^3	140

Source: KIWACO

(3) Customer Number, Billed and Collected Tariff

Table 2-3-3-7 shows the customer number, billed volume of water, billed and collected revenue of KIWACO and the portion for Phu Quoc Island.

Table 2-3-3-7 Management Data of KIWACO

No.	Items	KIWACO		Phu Quoc Island	
		Dec. 2010	**Nov. 2011**	**Dec. 2010**	**Nov. 2011**
1	Customer number (Water supply)	58,747	65,043	3,786	4,373
2	Staff number		372		30
No.	**Items**	**Year 2009**	**Year 2010**	**Year 2009**	**Year 2010**
3	Water supply volume (m^3/year)	16,545,473	19,546,330	688,170	963,736
4	Billed amount of water (m^3/year)	13,075,170 (100%)	15,211,490 (100%)	606,311 (100%)	860,077 (100%)
4-1	Household & Governmental	10,315,649 (79%)	12,074,680 (79%)	513,342 (85%)	727,914 (85%)
4-2	Commercial	1,861,916 (14%)	2,256,462 (15%)	91,221 (15%)	125,353 (14%)
4-3	Industrial	402,133 (3%)	437,591 (3%)	1,748 (0.3%)	6,810 (1%)
4-4	Others	492,472 (4%)	442,757 (3%)	0	0
5	Billed amount of money (VND/year)	58,587,790,767	77,470,596,741	3,237,273,120	4,293,317,649
6	Collected amount of money (VND/year)*1	58,267,639,267	77,122,358,341	3,208,705,220	4,274,301,149

Source: KIWACO

Note: *1; Collected amount of money is calculated for each year, based on the issued date of the bill, but not the receipt date of tariff. For example, if a certain tariff is collected in January 2011 for the bill issued at December 2010, the money is counted in the collected amount in the year 2010.

Table 2-3-3-8 shows the management indicators of KIWACO and the portion for Phu Quoc Island based on the data in **Table 2-3-3-7**.

Table 2-3-3-8 Management Indicators of KIWACO

No.	Items	KIWACO		Phu Quoc	
		Monthly	**Yearly**	**Monthly**	**Yearly**
1	Ave. billed amount per customer (VND/customer) (2010)	109,893	1,318,716	94,500	1,133,998
2	Ave. billed volume per customer (m^3/customer) (2010)	21.58	259	18.93	227

No.	Items	KIWACO		Phu Quoc	
3	Ave. collected amount per customer (VND/customer) (2010)	109,399	1,312,788	94,081	1,128,975
		Year 2009	Year 2010	Year 2009	Year 2010
4	NRW ratio *1	20.97%	22.18%	11.90%	10.76%
5	Collection efficiency *2	99.45%	99.55%	99.12%	99.56%
6	Satff per 1,000 connections *3	-	5.7*6	-	6.9*6
7	Average billed amount (VND/m^3) *4	4,480.84	5,092.90	5,339.29	4,991.78
8	Average collected amount (VND/m^3) *5	4,456.36	5,070.01	5,292.18	4,969.67

Source: JICA Survey Team, based on the data provided by KIWACO

Notes: Some management indicators were calculated by following formula.

*1; NRW ratio = (Water supply volume – Billed amount of water) / Water supply volume

*2; Collection efficiency = Collected amount of money / Billed amount of money

*3; Staff per 1,000 connections = Number of staff / (Number of customers / 1,000)

*4; Average billed amount = Billed amount of money / Billed amount of water

*5; Average collected amount = Collected amount of money / Billed amount of water

*6; Values on November 2011

The NRW ratio (21 to 22%), staff / 1,000 connections (5.7), and collection efficiency (99.6%) are much better than those of the 18 Asian major water supply entities (NRW: 34%, staff / 1,000 connections: 8.3, collection efficiency: 87.7%, Water in Asian Cities, ADB). Collection efficiency of KIWACO is excellent because of the incentive/penalty system for the bill collection staff. According to the "Regulation on the salary payment to the collecting staff under the business department" dated 5 October 2000 issued by KIWACO, the target collection rate is 88% for the areas other than Rach Gia city. If a collection employee successfully achieves the collection rate of 98% in his area, he would get an additional monthly salary of 315,000 VND. If he reaches only 85% of the collection target, 90,000 VND would be deducted from his salary. For Rach Gia city, the target collection rate is more strictly set at 97%.

2.4 Legal Frameworks

2.4.1 Investment and Land Related Laws

(1) Investment Laws

Viet Nam became a member of the WTO in January 2007 triggering the establishment and amendment of Viet Nam's various domestic laws. The "INVESTMENT LAW" and the "ENTERPRISE LAW" replaces the "FOREIGN INVESTMENT LAW" as the governing law to harmonize domestic investments with foreign investments.

"INVESTMENT LAW" was promulgated on July 1st, 2006 in order to make both Vietnamese investors and foreign investors follow a unified legal framework when making the investment inside or outside of Viet Nam. More specifically, preferred or restricted fields of investment, types of investment, essential conditions for licensing, dispute resolution, and the general provisions under which the Vietnamese government would indemnify investors, are provided in this law. The special law in the specific investment field had precedence over the Investment Law, however, any investment activities must follow the provisions of the Investment Law.

The following types of investment are allowed by the Investment Law.

・100% (foreign) full ownership of capital
・Joint venture by foreign and domestic investors
・Contract patterns:
 -BCC (Business Cooperation Contract)
 -BOT (Build-Operate-Transfer) contract
 -BTO (Build-Transfer-Operate) contract
 -BT (Build-Transfer) contract
・Investment for business development
・Stock purchase or investment pattern (indirect investment) for managing investment activities
・Joint venture and M&A

ENTERPRISE LAW, which provides the legal framework for establishment and management of all types of enterprises, was also enforced on July 1st, 2006.

The following listed management options are allowed by this law. However, it is common to choose "limited liability company with single member" or "limited liability company with two or more members" or "joint stock company" as a type of business enterprise, when foreign investors establish the subsidiary company.

・Limited liability company with single member
・Limited liability company with two or more members
・Joint Stock company
・Partnership company
・Private enterprise
・Holding company and its subsidiary company, economic conglomerate, corporate group

(2) Land Related Laws

In Viet Nam, land is common property of the citizens of Viet Nam and the government is managing it as a representative of the nation. The legal system regarding to "land" is regulated by "Law on Land (No. 13/2003/QH11)", which came into force on July 1st, 2004. It is not possible for foreign investors to own land. They have to receive the "Land Use Right" as follows.

・lease or sub-lease "Land Use Right"

Foreign companies would lease or sub-lease the "Land Use Right" from the "nation" or "legally licensed person".

・receive the "Land Use Right" from local partner who already has it

The foreign investor(s) would establish a joint venture with a local partner who is already assigned the land by the government, and the joint venture would receive the Land Use Right.

2.4.2 PPP/BOT Related Laws and Regulations in Viet Nam

(1) PPP Related Law

1) PPP Pilot Regulation

In November 2010, "Decision No. 71/2010/QD-TTg Regulation on pilot investment using Public - Private Partnership model" was executed by the Vietnamese government as PPP (Public - Private Partnership) related legal framework. Viet Nam has a huge number of investment projects for infrastructures. Introduction of private fund is necessary for the projects were to be implemented promptly and efficiently.

2) Applicable Fields for PPP

PPP can be applied in the following fields.

1.	road works, bridge construction, tunnel, harbor
2.	train, railroad bridge, train tunnel
3.	urban transport
4.	airport, seaport, river port
5.	water supply facility
6.	power plant
7.	sanitation (hospital)
8.	environmental facility (wastewater treatment facility)
9.	other Prime Minister's decision on infrastructure and public service.

3) Issues for Applying PPP Pilot Regulation

Although the investment from private funds is essential, PPP Pilot Regulation imposes a number of constraints on private investors. For example, the private investor has to be chosen by open bidding. In addition, detailed rules for the actual operation are not specified in the PPP Pilot Regulation so that it is unclear for the investors how much of their risk is covered. Vietnamese government is aware of this opinion, and the PPP Pilot Regulation is now in the process of being modified.

(2) BOT Related Regulation

In Vietnam, any BOT project is to be executed in compliance with the "BOT Decree", Decree 108/2009/ND-CP (Decree on Investment in the Form of Build - Operate - Transfer, Build – Transfer - Operate or Build - Transfer contract).

1) Definition and Target of the BOT Contract

Under the BOT contract, the foreign investors would build the infrastructure, such as bridge, road, airport, seaport or power plant, operate the BOT business (providing products or services) for a period of time as approved by the Vietnamese government to recover the capital invested. Then they would transfer the business to the Vietnamese government after the termination of contract without compensation.

In addition, even in the fields other than infrastructures, if the project is authorized to be implemented as a BOT project by the Vietnamese government and is transferred to the government at no charge after the contract period, there is a chance that the project would be treated as a BOT contract.

2) Selection of Business Investors

In BOT regulations, if no proposal is put forward other than the one from the project investors, after the 30 days of tender notice, the project investors would receive the right to negotiate the contract.

3) Preferential Treatment for the BOT Project

In the BOT regulation, taxes and rents of the land to be used for the project are exempt. Other various taxes that can be exempt are also mentioned in this regulation.

2.5 Water Infrastructure Needs on the Island

(1) Development Need as PPP Infrastructure Project

By 2020 the island population of 91,000 would almost double to around 200,000 - 230,000, and the number of tourists would increase more than ten times from 200,000 to 2 - 3 million. This scenario, together with such a rapid change of socio-economic conditions, would require significant and intensive investments in infrastructure and developments in the tourist industry sector.

A new international airport opened recently, and construction of main roads and sea ports are underway. Some of the construction projects are delayed due to the shortage of government budget to cover the sharp increase the infrastructure developments across the country. Therefore, the government is shifting its policy to utilize private capital.

It is well-established that the water supply business can be financially independent, and the introduction of private funds in BOT and BOO schemes are encouraged. Thus, the water supply business is open to foreign companies.

Water supply infrastructure development should be synchronized with tourism development. Investment in the former would attract investment in the latter. It is advisable to consider private funding to ensure timely and early implementation of water infrastructure development projects.

Sewerage service is not yet prevalent in the country and the sewerage business is not expected to be self-supporting. The present sewerage tariff is quite low, at only 10% of the water tariff and is collected as environment protection charge. The construction cost for the sewerage system would have to be either fully covered by government subsidy or co-funded under a public-private partnership. As Phu Quoc would be developed into a world class tourist destination, it may not be difficult to attract private sector interest and therefore, a PPP scheme for financing sewerage development may be quite feasible.

A wide range of technologies and experience in the fields of water supply and sewerage management are available from Japanese companies to implement this project efficiently and economically. The public-private partnership would instill confidence in the customers that the services would be satisfactory and reliable. These infrastructure investments would boost the tourism and other major industries on the island and thus expand the customer base and increase the profitability of the operating agencies.

(2) Need for Water Supply System Utilizing Surface Water from Cua Can Impounding Reservoir

Projected water demand in 2020 is 68,000 m^3/d, according to the Master Plan. However, the water supply capacity on the island is at 16,500 m^3/d, even after the completion of the expansion project by the World Bank. The areas covered by the existing and on-going projects are limited to Duong Dong and Duong To. There is still a huge gap to be filled.

Duong Dong is the center of government services and economic activities on the island. Duong To has an expanding tourist resort area at Bai Trung and the new international airport opened in December 2012. The water demand increase in these areas would be covered by the on-going World Bank project.

In the vast area extending from Cua Can to Ganh Dau, many huge resort and housing developments are underway along the sea shore. The developers may drill their own wells if the piped water supply system is delayed in this area. Preliminary study shows that intensive groundwater exploitation should be avoided and extraction should be limited to less than 4,000 - 5,000 m^3/d and 1 to 3 m^3/hr from shallow wells with the depth of 5 - 10 m or artesian layers with the depth of 20 - 30 m at rural and unpopulated areas. Regulations to limit groundwater use are under preparation and the proposed water supply system would build an impounding reservoir in Cua Can for water source. However, once the tourist resorts and housing developments establish with their own well water supply and sewage treatment facilities, it would take a long time to switch them to the new water supply and sewerage treatment systems.

It is quite important to harmonize resort and housing developments with and water and wastewater infrastructure development, to avoid overlapping investments and to secure long term water revenue from large customers.

Cua Can impounding reservoir will also serve as a water source for Duong Dong and Duong To since the on-going World Bank project will face the shortage of approximately 5,000 m^3/d of water supply in 2020 due to the limited capacity of the existing Duong Dong impounding reservoir. Thus, Cua Can surface water system will also supplement Duong Dong system in the future.

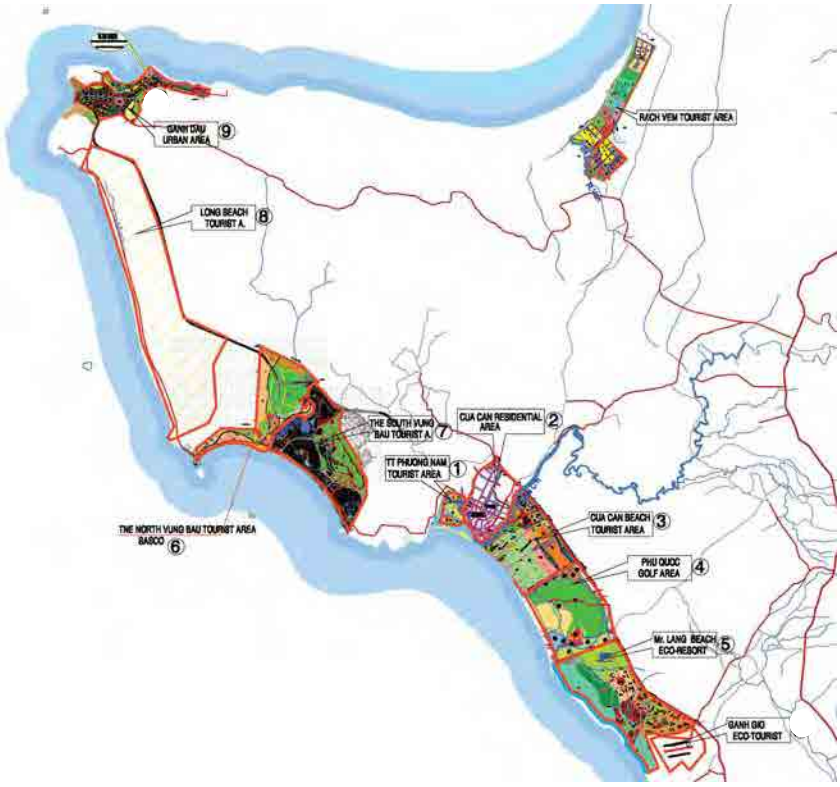


Figure 2-5-1 Tourist Resort Development Areas in Planned Service Areas

(3) Justification for Sewerage System Development

Domestic and industrial effluents would be collected and treated by the new sewerage system before being discharged into the surrounding water courses.

The recent results of water quality analysis of the Duong Don River are shown in Figure 2-5-2. The upstream sampling point A is not populated and categorized as agriculture land, and its BOD, which is an organic pollution indicator, remains low. In contrast, BOD at the downstream point B is much higher indicating that pollution has been proceeding along the river due to the inflow of domestic and industrial effluents from Duong Dong town.

In Phu Quoc Island, human wastes are treated by septic systems installed at individual houses, and the effluents from septic tanks are discharged into public water bodies. Other domestic wastewater is, however, directly discharged without any treatment. Many households do not conduct regular sludge extraction, so that the retention time in the tanks becomes too short for the proper operation of the septic tanks. As a result effluents insufficiently treated are discharged into public water bodies. Hotels are equipped with wastewater treatment facilities but monitoring of operation performance or treated water quality is not properly conducted by government agencies. These incidences contribute to water pollution in the Duong Dong River.

Sampling Date	Sampling Point A	Sampling Point B
Oct 21, 2011	BOD 12 mg/l	BOD 60 mg/l
March 9, 2012	BOD 12 mg/l	BOD 148 mg/l

Source: JICA Survey Team

Figure 2-5-2 Results of Water Pollution Survey of Duong Dong River

Domestic septic tanks and individual wastewater treatment facilities operated by developers may not be very effective to ensure that no contamination enters the water bodies. There may be various constraints to enforcing the regulations, conducting, monitoring and imposing penalties.

The introduction of an integrated sewerage system with a centralized sewage treatment plant would be more effective to control the effluent water quality since the system would be managed under strict operating conditions and monitored by a responsible organization such as the SPC.

Thus, sewerage system development will contribute not only to the improvement of people's sanitary conditions and living standards but also the protection of the natural environment of the island.

CHAPTER 3 PROJECT DESCRIPTION

CHAPTER 3　PROJECT DESCRIPTION

3.1　Water Supply System

3.1.1　Planned Service Area and Outline of Water Supply Development Plan

Figure 3-1-1-1 shows the planned water supply service area together with the service area covered by the on-going World Bank loan project.

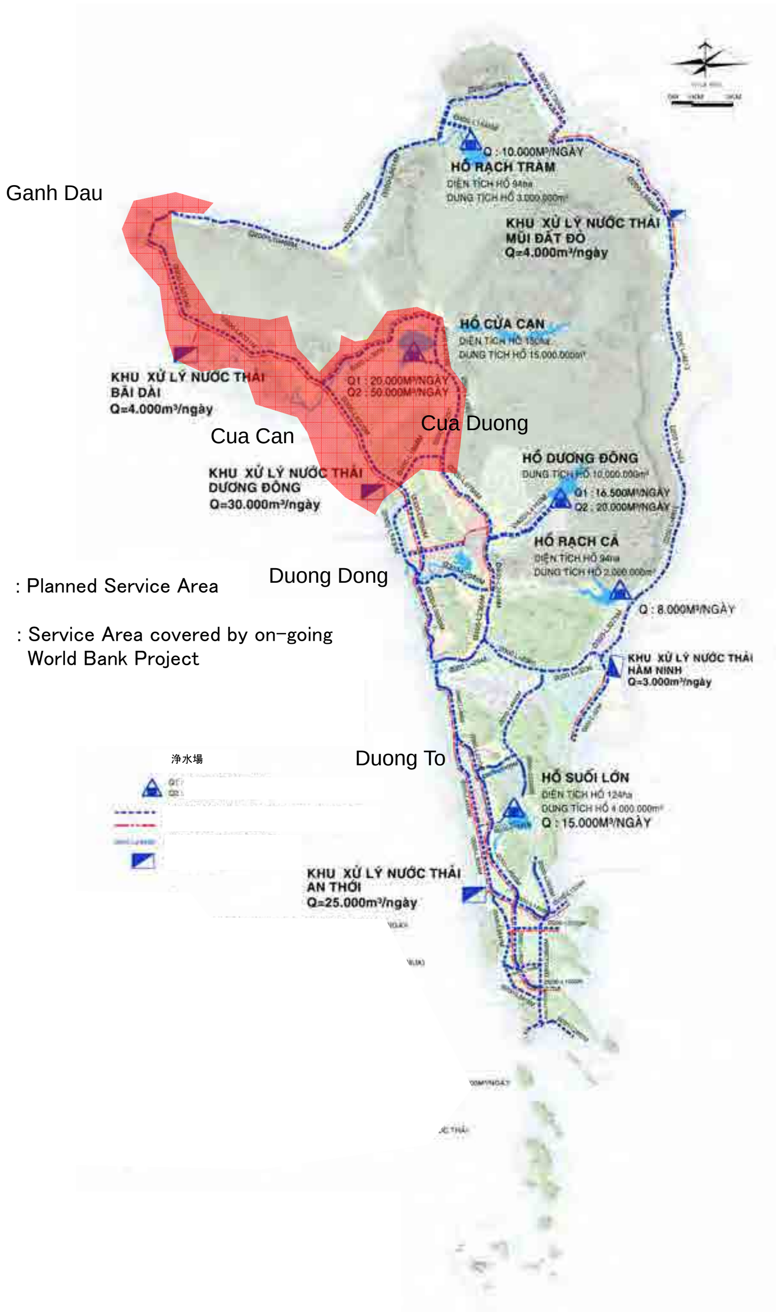


Figure 3-1-1-1　Planned Service Area

As stated in the minutes of the discussion between KGPPC and JICA on August 11, 2011, Cua Can Commune, Duong Dong Township and the surrounding communes are selected as the planned service areas.

Many resort developments have been planned along the western seashore of the Cua Can area extending as far as Ganh Dau to the north-west of the island. One of the three urban development plans stipulated in Master Plan is in the area north of the planned Cua Can impounding reservoir. This Project would cover these areas in Cua Can Commune, Cua Duong Commune and Ganh Dau Commune.

In Duong Dong Commune, as explained in Chapter 1.3, a water supply project supported by the World Bank loan is in progress. Transmission and distribution facilities would be constructed to supply water to the entire Duong Dong Commune and Duong To Commune covering the large tourist resort at Bai Trung and the new international airport. The F/S study for the World Bank project indicates that these areas will face a water shortage of about 5,000 m^3/d by 2020 as shown in **Table 3-1-1-1**. It is understood that water supply from other projects would be needed. This Project would meet this need by supplying bulk water from the new water treatment plant to the Duong Dong area.

Table 3-1-1-1 Balances between Water Demands and Water Supply Capacities in Cua Can and Duong Dong

Description	Year 2020	Year 2030	Remarks
Cua Can system proposed supply capacity※1	20,000	50,000	(1)
Water Demand in Cua Can area	12,435	43,072	(2)
Bulk Supply Available to Duong Dong System	Max 7,565	Max 6,928	(3)＝(1)-(2)
Duong Dong system supply capacity※2	16,500	20,000	(4)
Water Demand in Duong Dong area※2	21,497	37,190	(5)
Water Shortage in Duong Dong area	4,997	17,190	(6)=(5)-(4)

※1 proposed in Master Plan
※2 determined by World Bank Project

The outline of the planned water supply system is described below, and the major planning conditions are summarized in **Table 3-1-1-2**.

- Phase 1
  - Target Year: 2020
  - Service Area: Cua Can, Cua Duong, Duong Dong (Bulk Supply)
  - Supply Capacity（Day Max）: 20,000 m^3/d

- Phase 2
  - Target Year: 2030
  - Service Area: Phase 1 Area plus Ganh Dau
  - Supply Capacity（Day Max）: 50,000 m^3/d

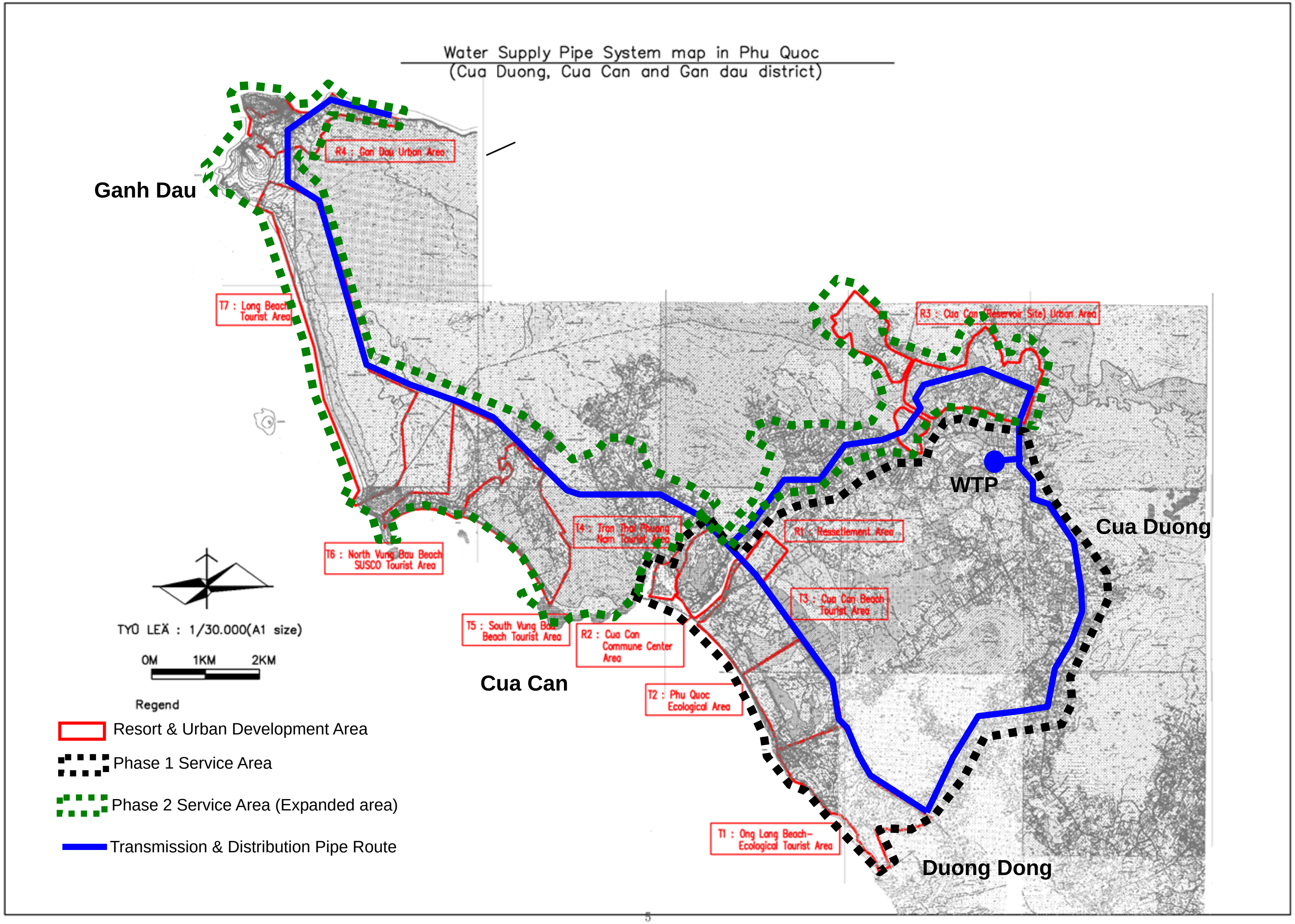


Figure 3-1-1-2 Water Supply Service Areas in Phase 1 and Phase 2

Table 3-1-1-2 Major Planning Conditions

Items	Figures applied		Description
1. Target Year			- In accordance with Vietnamese Design Standards
	Phase-1	Year 2020	- Conform to Master Plan
	Phase-2	Year 2030	
2. Per capita water consumption			- Conform to Master Plan
- Domestic water consumption	Phase-1	120 liter/capita/day	
	Phase-2	150 liter/capita/day	
- Commercial and industrial	3% of domestic water consumption		
- Public water use	5% of domestic water consumption		
3. Population projection (residential)			
	Phase-1	16,432 people	- Natural growth in Cua Can and Cua Duong
	Phase-2	30,472people	- Natural growth in Cua Can, Cua Duong and Ganh Dau - Population growth rate of 3% by the past trend - The figures do not include population in resort & housing development areas.
4. Water demands of tourist resort and housing development plans			- Water demands referred to the detailed investment plans as shown in Table 2-1-2-7.
5. Leakage ratio		10%	- Present leakage ratio in Phu Quoc
6. Peak day factor		1.2	- Refer to World Bank funded project
7. Peak hour factor		1.5	- Refer to World Bank funded project
8. Capacity of distribution reservoir		Ten (10) hours of maximum daily	

3.1.2 Water Demand Projection

Water demand of rural inhabitants and small businesses in the service area is expected to increase according to the past population growth trend. In addition there will be demand from large tourist resorts and housing developments as shown in the development plans submitted by the developers and agencies related to PQDMB. Thus, the total water demand in the service area is estimated as the sum of the above water demand projected from the past trend and that from new resort and housing development plans.

(1) Setting Target Year

As stipulated in the Vietnamese design criteria, target years for water supply developments should be around 10 to 20 years.

Therefore, the target years of 2020 and 2030 are used for planning the 2 phases of development.

Target Year	
Phase 1	Year 2020
Phase 2	Year 2030

(2) Per Capita Water Consumption

The per capita water consumption in 2020 and 2030 would be 120 lpcd and 150 lpcd, respectively according to the Master Plan.

Table 3-1-2-1 shows actual per capita consumption data for the six year period from 2006 – 2011, as calculated from the water bills of Phu Quoc KIWACO. The data indicates that using a unit consumption of 120 lpcd for the year 2020 is reasonable because it compares well with 122 lpcd recorded in 2009 and 113 lpcd recorded in 2010. For per capita consumption in 2030 the urban level of the island is expected to increase and per capita consumption will increase, accordingly. It is reasonable to adopt 150 lpcd for year 2030 as proposed in the Master Plan.

Table 3-1-2-1 Per Capita Water Consumption Calculated from Water Bills

Year	Domestic Consumption m3/year ①	No. of Domestic Customers Connections ②	Per Capita Consumption lpcd ③=①/②/1000/4.5※	Remarks
2,006	61,686	864	43	
2,007	207,769	1,366	93	
2,008	360,305	1,944	113	
2,009	513,342	2,567	122	
2,010	668,706	3,599	113	
2,011	716,781	4,107	142	up to September

※ 4.5 persons/connection

In this study, 120 lpcd and 150 lpcd, which are the same figures proposed by Master Plan, are used as the per capita domestic water consumptions for 2020 and 2030.

(3) Population

Population projection in the Master Plan is based on the expected population densities indicated in the general land use plan. In this study, however, the past population trend is used to estimate the growth of the existing population and also includes immigrants to the island.

Table 3-1-2-2 shows the past population trend of the service area from 2005 to 2008 (Cua Can Commune, Cua Duong Commune and Ganh Dau). During this period the population increased by around 3% every year. For the population projections for 2020 and 2030 shown in **Table**

3-1-2-3, the population growth rate of 3% is used.

Table 3-1-2-2 Population Trend in the Service Area

Year	Commune					
	Cua Can		Cua Duong		Ganh Dau	
	population (person)	grouth rate	population (person)	grouth rate	population (person)	grouth rate
2005	3,166		7,467		4,042	
		2.4%		2.5%		2.4%
2006	3,241		7,655		4,138	
		3.2%		3.2%		3.2%
2007	3,345		7,899		4,271	
		2.5%		2.5%		2.5%
2008	3,429		8,096		4,378	

Source；Niên giám thống kê năm 2005～2008

Table 3-1-2-3 Population Projection in the Service Area

Unit: person

Year / Commune	2005	2006	2007	2008	・・・	2020	2030
Cua Can	3,166	3,241	3,345	3,429	・・・	4,889	6,570
Cua Duong	7,467	7,655	7,899	8,096	・・・	11,543	15,513
Ganh Dau	4,042	4,138	4,271	4,378	・・・	6,242	8,389
Total	14,675	15,034	15,515	15,903	・・・	22,674	30,472

Source: Niên giám thống kê năm 2005～2008, JICA Survey Team for 2020 and 2030

(4) Small-scaled Commercial and Industrial Water Demands and Public Water Use

In the service area it is expected that commercial and tourist industry water demands will increase drastically as a result of resort developments. The water demand of the resort developments is discussed in the next section. This section focuses on water demand for small shops, local restaurants and traditional industries, and assumes that such water demand will increase in accordance with the past trend in the service area.

Table 3-1-2-4 shows actual consumption of the commercial and industrial customers in Phu Quoc. It indicates that the commercial and industrial water demand accounts for around 3% of the domestic consumption. Although there is no category for public water use in the billing data of Phu Quoc the water demand is assumed to be at 5% of domestic water demand.

- Small-scaled Commercial and Industrial Demand: 3％of Domestic Water Demand
- Public Water Use: 5% of Domestic Water Demand

Table 3-1-2-4 Commercial and Industrial Water Consumption (Duong Dong)

Year	Population	Domestic Water Demand※ m3/year (A)	Industrial m3/year (B)	Commercial m3/year (C)	(B+C)/(A) %
2006	30,074	1,317,241		8,066	0.6%
2007	31,035	1,359,333		32,910	2.4%
2008	31,811	1,393,322		59,767	4.3%
2009	31,940	1,398,972	1,748	91,221	6.6%
Total		5,468,868	1,748	191,964	3.5%

※ Domestic water demand in each year is estimated when the connection rate is 100%.
※ Domestic per capita demand 120 lpcd is used.

(5) Water Demands for Tourist Resort and Housing Development Plans

Water demands for tourist resorts and housing developments are taken from the water requirements described in the detailed investment plans prepared by the developers or the related agencies. The latest data are collected from Phu Quoc Development Management Board.

Table 3-1-2-5 summarizes the water requirements of the planned resort and housing development projects. The number identifying the development project in **Table 3-1-2-5** corresponds to the location numbers previously shown in **Figure 3-1-2-1**.

Table 3-1-2-5 Water Demands of Planned Resort and Housing Development Projects

Category	No.	Development Area	Present Status as of November 2011	Water Demand in 2030 (m3/day)	Remarks
Tourist	T1	Ong Lang Beach-Ecological Tourist Area	Detailed plan in 7/2010	1,570	Detail MP (by Investor) Compensation phase has been suspended because people do not agree with the compensation fee of the regulation.
	T2	Phu Quoc Ecological Tourist Area	Compensation 85%	1,214	Detail MP (by Investor) The investor has got the right of land use. - Phase 1: Construction work will be completed in 2015 in 25% area of total project area of 100 ha including 500 rooms hotel and 1 restaurant. - Phase 2: 100% of the project will be in operation
	T3	Cua Can Beach Tourist Area	Compensation 70%	2,950	Detail MP
	T4	Tran Thai Phuong Nam Tourist Area	Under compensation phase	960	Detail MP
	T5	South Vung Bau Beach Tourist Area	Detailed plan in 4/2010	2,200	Detail MP
	T6	North Vung Bau Beach SASCO Tourist Area	Detailed plan in 6/2010	3,960	Detail MP
	T7	Long Beach Tourist Area	Investment License 24/3/2008	7,000	Detail MP (by Investor) Some small resort is in operation partly. (Mai Phuong, Bamboo, Chez Carol)
Urban Area / Ressetlement Area	R1	Resettlement Area (Cua Can River Left Bank)	Detailed plan in 10/2010	1,819	(by Detailed Plan approval decision by PQMB) Population: 6,261(Year 2030) 4,659(Year 2020 ; 6,261 / $(1+0.03)^{10}$) This demand is included in domestic demand.
	R2	Cua Can Commune Center Area	Approved but under revision	1,278	
	R3	Cua Can (Reservoir Site) Urban Area	No detailed plan. Development after 2015	3,975	(by Ajusted M/P) Population: 26,500 Per capit consumption: 150 lcpd
	R4	Ganh Dau Urban Area	Investment License 5/4/2010	1,782	
Total Demand at Full Development				28,708	

Source: Prepared by JICA Survey Team from data obtained from Phu Quoc Development Management Board

(6) Other Factors

Other factors necessary for water demand projections are determined as follows, with reference to the figures employed by the on-going World Bank projects.

(a) Leakage Ratio: 10% (the same level of the present leakage ratio at Phu Quoc)
(b) Peak Day Factor: 1.2
(c) Peak Hour Factor: 1.5

(7) Phased Development Plan

Water demand in the service area would grow with the progress of the planned resort and housing developments. The water supply facilities should be expanded in a timely manner to meet the growing water demand in order to attract continued investments to this area.

It is paramount to keep abreast of resort and housing development plans and secure the up-to-date information regularly from the Phu Quoc Development Management Board.The progress of each development project can be appraised in terms of issuance of investment licenses, progress of compensation to and availability of other infrastructure such as electricity and roads. The present project is divided into two Phases (Phase 1 and Phase 2) considering the following points.

(a) Present Status of Other Infrastructure Developments

Two main roads stretching north and south are planned in the service area, one along the western coast and the other in the center of the island. These two main roads would be connected by two sub-main roads stretching east to west. The status of the main road construction is shown in **Figure 3-1-2-1**.

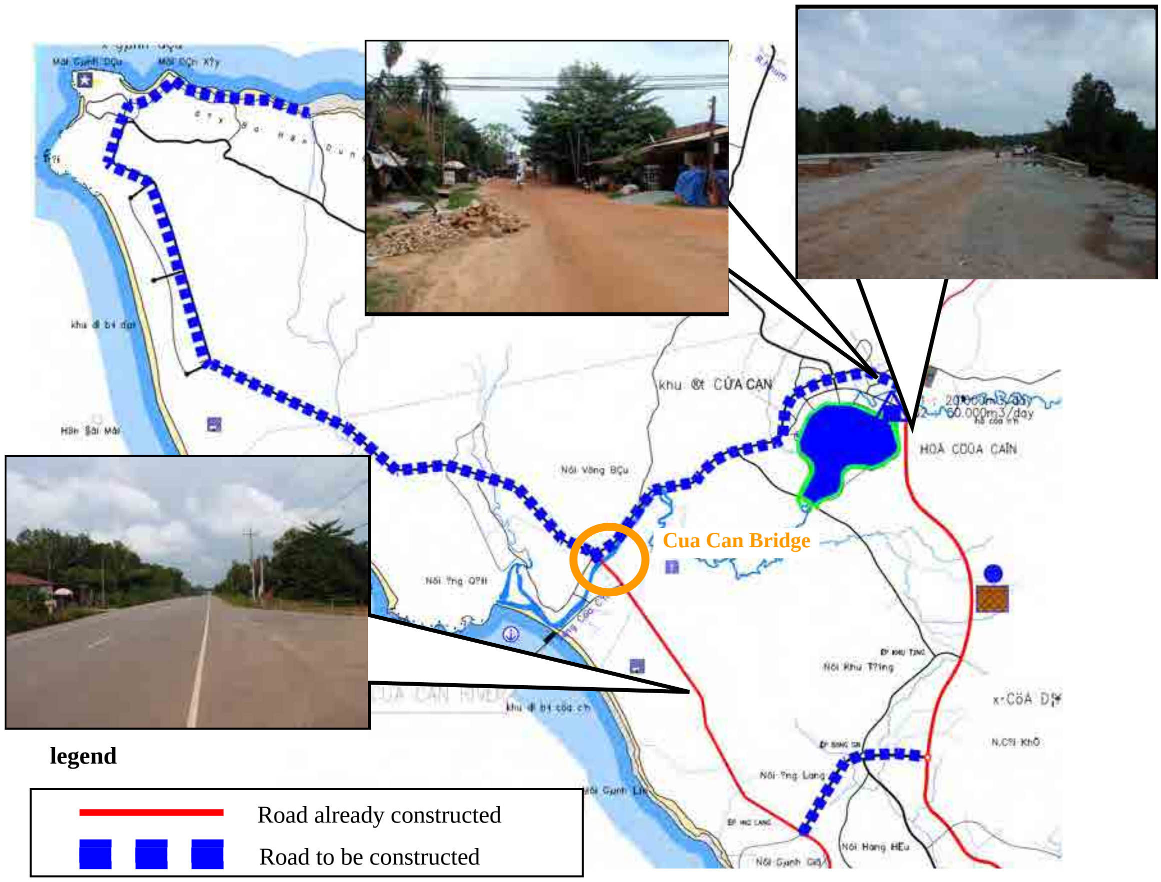


Figure 3-1-2-1 Status of Major Road Construction

Among these roads, the north – south main roads are almost completed up to the Cua Can River, but the design and construction plan of the northern sections has not been prepared as of November 2011. It is likely that the planned resort developments along these sections would be delayed.

(b) Progress of Resort and Housing Development Projects

The resort and housing developments require large amounts of water and their progress has a significant impact on the water supply system. These development projects usually proceed with the approval steps as shown in **Figure 3-1-2-2**.

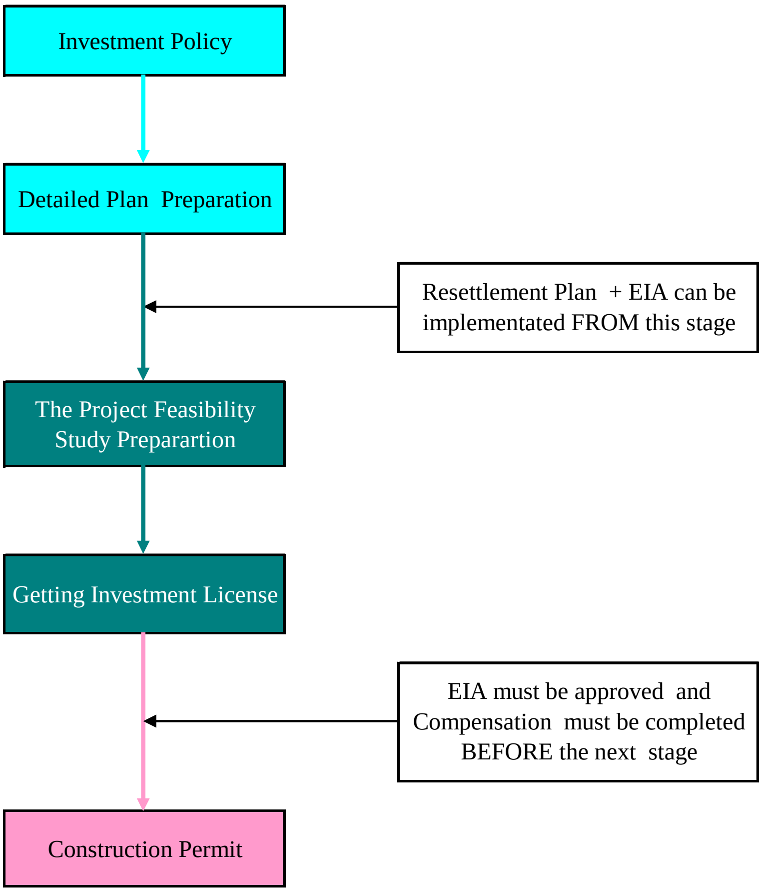


Figure 3-1-2-2 Approval Process of Development Projects

The progress of the resort and housing development projects in the service area is analyzed based on the latest information from Phu Quoc Development Management Board. Their water requirements are estimated as shown in **Table 3-1-2-6**.

Table 3-1-2-6 Criteria for Setting Water Demand for Development Projects

Progress of Development Project	Water Demand
(A) Already received investment license and finished more than 70% of compensation.	100% of water demand in 2030 is allocated to Phase 1 .
(B) Feasibility Study has started.	50% of water demand in 2030 is allocated to Phase 1 and the rest to Phase 2.
(C) Do not satisfy (A) and (B)	No water demand is allocated to Phase 1 but 100% to Phase 2.

(D) Cua Can River left bank resettlement area (R1Area)	Population in 2030 is projected to be 6,261 and population in 2020 is estimated from the 2030 population by using population growth rate of 3%.

Table 3-1-2-7 summarizes water demands for 2020 and 2030 taking into consideration the above discussion.

Resort development projects located south of the Thai Phuong Nam Tourist Area (T4), as shown in **Figure 3-1-1-2**, are included in the Phase 1 service area and the priority of water supply is given to these projects. The water supply to the development projects not included in Phase 1 will be covered in Phase 2 according to the progress of other infrastructure developments in these areas.

Table 3-1-2-7 Water Demands of Resort and Housing Development Projects in the Service Area in Year 2020 and Year 2030

Category	No.	Development Area	Present Status as of November 2011	Water Demand in 2030 (m3/day)	Water Demand in 2020 (m3/day)		Remarks
					Priority	Water Demand (m3/day)	
Tourist	T1	Ong Lang Beach-Ecological Tourist Area	Detailed plan in 7/2010	1,570	50%	785	(by Investor) Compensation phase has been suspended because people do not agree with the compensation fee of the regulation.
	T2	Phu Quoc Ecological Tourist Area	Compensation 85%	1,214	100%	1,214	(by Investor) The investor has got the right of land use. - Phase 1: Construction work will be completed in 2015 in 25% area of total project area of 100 ha including 500 rooms hotel and 1 restaurant. - Phase 2: 100% of the project will be in operation
	T3	Cua Can Beach Tourist Area	Compensation 70%	2,950	100%	2,950	
	T4	Tran Thai Phuong Nam Tourist Area	Under compensation phase	960	100%	960	
	T5	South Vung Bau Beach Tourist Area	Detailed plan in 4/2010	2,200	0%	0	
	T6	North Vung Bau Beach SASCO Tourist Area	Detailed plan in 6/2010	3,960	0%	0	
	T7	Long Beach Tourist Area	Investment License 24/3/2008	7,000	0%	0	(by Investor) Some small resort is in operation partly. (Mai Phuong, Bamboo, Chez Carol)
Urban Area / Ressetelement Area	R1	Resettlement Area (Cua Can River Left Bank)	Detailed plan in 10/2010	1,819	74%	1,346	(by Detailed Plan approval decision by PQMB) Population: 6,261(Year 2030) 4,659(Year 2020 ; 6,261 / $(1+0.03)^{10}$) This demand is included in domestic demand.
	R2	Cua Can Commune Center Area	Approved but under revision	1,278	50%	639	
	R3	Cua Can (Reservoir Site) Urban Area	No detailed plan. Development after 2015	3,975	0%	0	(by Ajusted M/P) Population: 26,500 Per capit consumption: 150 lcpd
	R4	Ganh Dau Urban Area	Investment License 5/4/2010	1,782	0%	0	
Total Demand at Full Development				28,708		7,894	

(8) Required Water Supply Capacities for Phase 1 and Phase 2

Tables 3-1-2-8 and **3-1-2-9** summarize water demands of Phase 1 and Phase 2, respectively. Water supply volume to Duong Dong area from the planned water supply system is approximately 7,500 m^3/day in 2020. Although this more than covers the anticipated water shortage of 5,000 m^3/d, it is advantageous to have the extra capacity considering the uncertainty of other water supply schemes as well as the potential of better than predicted growth in the tourism industry.

Phase 1 Water Demand	19,935 m^3/d	→	Planned Supply Capacity 20,000 m^3/d
Phase 2 Water Demand	48,072 m^3/d	→	Planned Supply Capacity 50,000 m^3/d
			（Water use in WTP is not included.）

Table 3-1-2-8 Water Demand Summary in Year 2020

				Domestic				Resort								Urban Area & Resettlement Area					total	Distribute	Total
				Cua Can	Cua Duong	Ganh Dau	Total < A >	T1	T2	T3	T4	T5	T6	T7	Total < B >	R1	R2	R3	R4	Total < C >	<D>	Other Area < E >	<A>+<D>+<E
Person	Calculation	(1)	(person)	4,889	11,543		16,432												4,659				
	resettlement	(2)	(person)	※1 2,330	※1 2,329		4,659																
	Total	(3)=(1)-(2)	(person)	2,559	9,214	0	11,773																
per capita demand		(4)	(l/pcd)	120	120	120																	
Domestic		(5)=(3)x(4)/1000	(m3/day)	307	1,106	0	1,413	785	1,214	2,950	960	0	0	0	5,909	1,346	639	0	0	1,985	7,894	5,682	14,989
Water Consumption								(1,570)	(1,214)	(2,950)	(960)	(2,200)	(3,960)	(7,000)	(19,854)	(1,819)	(1,278)	(3,975)	(1,782)	(8,854)	(28,708)		
Commercial		(6)=(5)x0.03	(m3/day)	9	33	0	42																42
Institutions		(7)=(5)x0.05	(m3/day)	15	55	0	71																71
Total		(8)=(5)+(6)+(7)	(m3/day)	332	1,194	0	1,526	785	1,214	2,950	960	0	0	0		1,346	639	0	0		7,894	5,682	15,102
Leaking		(9)=(8)*0.10	(m3/day)	33	119	0	153	79	121	295	96	0	0	0		135	64	0	0		790	568	1,511
Total		(10)=(8)+(9)	(m3/day)	365	1,314	0	1,678	864	1,335	3,245	1,056	0	0	0		1,481	703	0	0		8,684	6,250	16,612
Peak factor		(11)		1.2	1.2	1.2		1.2	1.2	1.2	1.2	1.2	1.2	1.2		1.2	1.2	1.2	1.2			1.2	
Max daily demand		(12)=(10)*(11)	(m3/day)	438	1,576	0	2,014	1,037	1,602	3,894	1,267	0	0	0		1,777	844	0	0		10,421	7,500	19,935
Peak factor		(13)		1.5	1.5	1.5		1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.5	1.5	1.0	1.5			1.0	
Max hourly demand		(12)*(13)	(m3/day)	656.7	2,364.4	0.0	3,021	1,037.0	1,602.0	3,894.0	1,267.0	0.0	0.0	0.0	7,800	2,665.5	1,266.0	0.0	0.0	3,931.5	11,731.5	7,500	22,253
		(14)=(12)*(13)/24	(m3/hr)	27	99	0	126	43	67	162	53	0	0	0		111	53	0	0		489	313	928
		(12)*(13)/86400	(m3/s)	0.0076	0.0274	0.0000	0.0350	0.0119	0.0186	0.0450	0.0147	0.0000	0.0000	0.0000		0.0308	0.0147	0.0000	0.0000		0.1358	0.0869	0.2577

Table 3-1-2-9   Water Demand Summary in Year 2030

				Domestic				Resort								Urban Area & Resettlement Area					total	Distribute	Total
				Cua Can	Cua Duong	Ganh Dau	Total < A >	T1	T2	T3	T4	T5	T6	T7	Total < B >	R1	R2	R3	R4	Total < C >	<D>	Other Area < E >	<A>+<D>+<E
Person	Calculation	(1)	(person)	6,570	15,513	8,389	30,472																
	resettlement	(2)	(person)	3,130	3,131		6,261																
	Total	(3)=(1)-(2)	(person)	3,440	12,382	8,389	24,211																
per capita demand		(4)	(l/pcd)	150	150	150																	
Domestic Water Consumption		(5)=(3)x(4)/1000	(m3/day)	516	1,857	1,258	3,632	1,570	1,214	2,950	960	2,200	3,960	7,000	19,854	1,819	1,278	3,975	1,782	8,854	28,708	5,682	38,022
Commercial		(6)=(5)x0.03	(m3/day)	15	56	38	109																109
Institutions		(7)=(5)x0.05	(m3/day)	26	93	63	182																182
Total		(8)=(5)+(6)+(7)	(m3/day)	557	2,006	1,359	3,922	1,570	1,214	2,950	960	2,200	3,960	7,000	19,854	1,819	1,278	3,975	1,782	8,854	28,708	5,682	38,312
Leaking		(9)=(8)*0.10	(m3/day)	56	201	136	392	157	121	295	96	220	396	700	1,985	182	128	398	178	886	2,871	568	3,831
Total		(10)=(8)+(9)	(m3/day)	613	2,206	1,495	4,314	1,727	1,335	3,245	1,056	2,420	4,356	7,700	21,839	2,001	1,406	4,373	1,960	9,740	31,579	6,250	42,144
Peak factor		(11)		1.2	1.2	1.2		1.2	1.2	1.2	1.2	1.2	1.2	1.2		1.2	1.2	1.2	1.2			1.2	
Max daily demand		(12)=(10)*(11)	(m3/day)	736	2,648	1,794	5,177	2,072	1,602	3,894	1,267	2,904	5,227	9,240	26,206	2,401	1,687	5,248	2,352	11,688	37,894	5,000	48,072
Peak factor		(13)		1.5	1.5	1.5		1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.5	1.5	1.0	1.5	6	6	1.0	
Max hourly demand		(12)*(13)	(m3/day)	1,103	3,972	2,691	7,766	2,072	1,602	3,894	1,267	2,904	5,227	9,240	26,206	3,602	2,531	5,248	3,528	14,908	41,114	5,000	53,880
		(14)=(12)*(13)/24	(m3/hr)	46	165	112	324	86	67	162	53	121	218	385	1,092	150	105	219	147	621	1,713	208	2,245
		(12)*(13)/86400	(m3/s)	0.0128	0.0460	0.0311	0.0899	0.0239	0.0186	0.0450	0.0147	0.0336	0.0606	0.1069	0.3033	0.0417	0.0292	0.0608	0.0408	0.1725	0.4758	0.0578	0.6235

3.1.3 Water Source

KGPPC is considering the restriction of groundwater use and moving consumers to the public water supply system which uses surface water, in order to protect the natural environment of Phu Quoc Island.

Four new impounding reservoirs are planned on Phu Quoc Island as the water source for the new water supply system. The largest of these impounding reservoirs has the capacity of 50,000 m^3/d and is in the Cua Can area as shown in **Figure 3-1-3-1**. This reservoir is planned as the source for the water supply project formulated in this study.

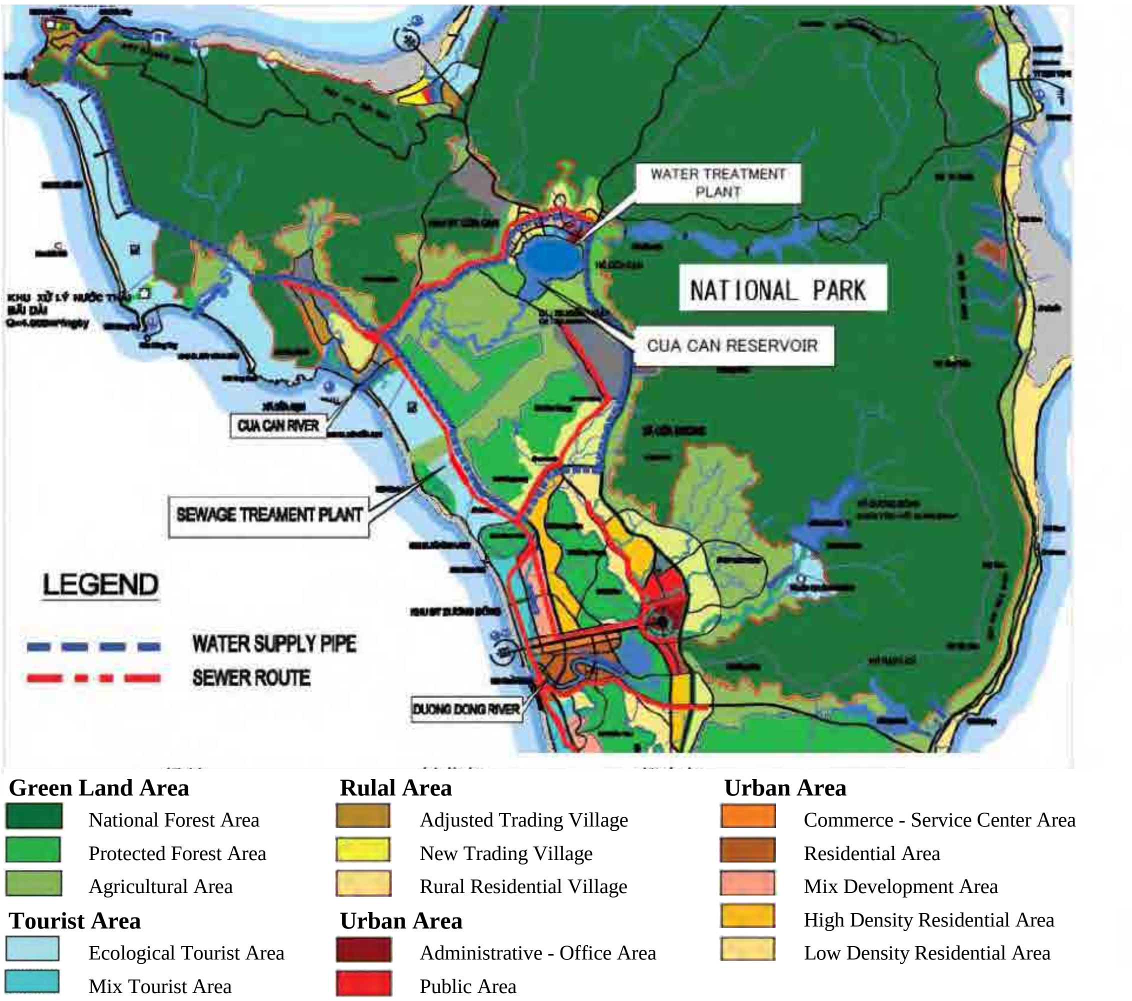


Figure 3-1-3-1 Location of Cua Can Impounding Reservoir in Master Plan

Preliminary study was carried out on the technical feasibility of the reservoir construction, and the social and environmental considerations were also reviewed. The investor under the PPP scheme should prepare the EIA according to the guidance and advice given by this study.

(1) Planned Impounding Reservoir Site

The proposed site of the Cua Can impounding reservoir is located on the north side of the island. The coordinates of the center of the reservoir are N10°18′58’″and E103°57′41″. The catchment area of the reservoir is covered by a vast natural forest extending to north-east of the island, in a national park. The reservoir site is rather flat and low with ground elevation between +4 m to +10 m.

The proposed reservoir site is advantageous to supply water to the development areas along the west coast of the island as well as to Duong Dong by interconnecting the water distribution pipes with the existing KIWACO water supply system.

(2) Hydrological and Hydraulic Conditions of the Reservoir

Since there is no flow data for the Cua Can River, which is the source of the impounding reservoir, hydrological and hydraulic characteristics of the Cua Can River are analyzed based on the precipitation and evaporation data of the upstream area for the past 49 years. **Table 2-1-3-1** indicates the results of the analysis on the annual designed flow at the proposed reservoir site.

Table 3-1-3-1 Distribution of Annual Designed Flow of Cua Can River at Reservoir Site

Fre-quency P%	River Flow (m^3/s)	Month											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
50	4.130	0.818	0.529	0.401	1.268	2.400	5.414	5.068	11.775	9.326	7.124	3.692	1.747
75	3.360	0.699	0.373	0.296	0.528	1.045	2.379	4.976	6.347	8.145	10.030	3.978	1.522
90	2.690	0.560	0.299	0.237	0.422	0.837	1.905	3.984	5.081	6.521	8.030	3.185	1.219
95	2.300	0.478	0.255	0.202	0.361	0.715	1.628	3.406	4.345	5.575	6.866	2.723	1.042

Based on the designed flow with frequency 95%, the required reservoir storage calculated for the water supply is 21,000 m^3/d for 2020 and 52,500 m^3/d for 2030.

The environmental flow of 0.237 m^3/s which is the flow in March with the frequency of 90% is used, according to the practice in other impounding reservoir development projects under the Ministry of Agriculture and Rural Development.

(3) Planned Reservoir Storage

Planned reservoir storage is determined from the water balance of the designed river flow with the frequency of 95% and the required flow for the water supply intake and environmental flow.

Water losses due to evaporation from the reservoir surface and seepage from the bottom of the reservoir are calculated based on the meteorological and geological conditions of the reservoir site and its surroundings.

Table 3-1-3-2 summarizes the planned reservoir storage for Phase 1 (4.15 million m^3) and Phase 2 (10.47 million m^3).

The elevation of the reservoir bottom is set at +7.0m and some allowance is made for sedimentation.

Water balance analysis to determine the required water quantity for Phase 1 and Phase 2 is shown in **Tables 3-1-3-3** and **3-1-3-4**. Based on this analysis the required capacity of the reservoir is determined.

Table 3-1-3-2 Planned Reservoir Capacity

No	Parameters	Unit	Phase 1	Phase 2
1	Reservoir bottom elevation	m	7.0	7.0
2	Deposit Level	m	7.07	7.36
3	Minimum Water Level	m	7.6	7.9
4	Maximum Water Level	m	9.2	12.5
5	Dead Volume	10^6 m^3	1.13	1.69
6	Effective Capacity	10^6 m^3	3.02	8.77
7	Total Capacity	10^6 m^3	4.15	10.47

Table 3-1-3-3 Water Balance Analysis for Phase 1

WATER BALANCE WITH FREQUENCY P = 95% - Alternative 3 (phase 1)

Vc = 1.13 $10^6 m^3$

Days	Month	Q_{inflow} m³/s P95%	W_{inflow} 10^6m³ P95%	$W_{require}$ 10^6 m³	Excluding water loss: Water balance ΔW+ 10^6 m³	Water balance ΔW- 10^6 m³	V 10^6 m³	F km²	V_{tb} 10^6 m³	F_{tb} km²	Water loss: Evaporation ΔZ mm	Evaporation Wz 10^6 m³	Seepage Criteria	Seepage W_{th} 10^6 m³	Total 10^6 m³	Including water loss: balance ΔW+ 10^6 m³	balance ΔW- 10^6 m³	V 10^6 m³	$W_{release}$ 10^6m³	Z (m)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
	5		1.92															1.55		7.83
30	6	1.628	4.22	1.24	2.98		2.73	1.89	1.93	1.88	45.3	0.085	take 10 percent -age of average volume	0.19	0.28	2.70		3.82	0.43	9.03
31	7	3.406	9.12	1.29	7.84		2.73	1.89	2.73	1.89	42.6	0.080		0.27	0.35	7.48		3.97	7.33	9.11
31	8	4.345	11.64	1.29	10.35		2.73	1.89	2.73	1.89	43.4	0.082		0.27	0.35	10.00		3.97	10.00	9.11
30	9	5.575	14.45	1.24	13.21		2.73	1.89	2.73	1.89	38.8	0.073		0.27	0.35	12.86		3.97	12.86	9.11
31	10	6.866	18.39	1.29	17.10		2.73	1.89	2.73	1.89	38.1	0.072		0.27	0.34	16.76		3.97	16.76	9.11
30	11	2.723	7.06	1.24	5.81		2.73	1.89	2.73	1.89	59.7	0.113		0.27	0.39	5.43		3.97	5.43	9.11
31	12	1.042	2.79	1.29	1.51		2.73	1.89	2.73	1.89	77.3	0.146		0.27	0.42	1.09		3.97	1.09	9.11
31	1	0.478	1.28	1.29		0.01	2.72	1.89	2.73	1.89	62.8	0.119		0.27	0.39		0.40	3.58	0	8.90
28	2	0.255	0.62	1.16		0.54	2.18	1.89	2.45	1.89	52.2	0.099		0.25	0.34		0.89	2.69	0	8.43
31	3	0.202	0.54	1.29		0.74	1.43	1.88	1.81	1.88	56.6	0.107		0.18	0.29		1.03	1.66	0	7.88
30	4	0.361	0.94	1.24		0.31	1.13	1.88	1.28	1.88	50.6	0.095		0.13	0.22		0.53	1.13	0	7.60
31	5	0.715	1.92	1.29	0.63		1.13	1.88	1.13	1.88	48.7	0.092		0.11	0.20	0.43		1.55	0	7.83
	Total		72.96	**15.14**	**59.42**	**1.60**					**616.1**	**1.162**		**2.77**	**3.93**	**56.74**	**2.85**		**53.46**	**9.11**

Normal water level selected for stage 1 **9.20 m**

Total reservoir volume for stage 1: **4.15 x10^6m³**

3.02

(0) - number days monthly
(2) - Month in the year is period of calculation of flows
(3) - Inflow with frequency of 95% in the river (before extraction into reservoir) every month
(4) - Inflow volume = (0)x(2)x3600x24
(5) - Redundant water volume = (3)-(4)
(6) - Deficient water volume = (4)-(3) ---> we can calculate total total deficient water volume = 5.2 milion ----> We have total water volume of reservoir (without water loss) = 6.89 milion. This volume is maximum storage of reservoir excluding water loss. This result will be used for calation of water loss due to dependent of water loss on volume of reservoir
(7) - Water volume of reservoir at the end of month
(8) - Water surface area of reservoir at the end of month
(9) - Everage water volume of reservoir in month
(10) - Everage water surface area of reservoir in month
(11) - Evaporation of water surface in mm calculated from hydrography
(12) - Water loss of reservoir due to evaporation = (10)x(11)
(13) - Criteria to estimate water loss due to seepage. It is usually 2% to 5% of water volume. However, Cua Can Reservoir set on the sandy foundation and the embankment surrounds reservoir so we suggest it is 10%.
(14) - Water loss of reservoir due to seepage = (9)x(13)
(15) - (12)+(14)
(16) - similar to (5) but including water loss = (5)-(15)
(17) - similar to (6) but including water loss = (6)-(15)
(18) - Water volume of reservoir at the end of month including water loss
(19) - Redundant water volume are releases to downstream
(20) - Water level in the reservoir at the end of month is reffered from Z~V relationship based on water volume in columb (18)

Table 3-1-3-4 Water Balance Analysis for Phase 2

WATER BALANCE WITH FREQUENCY P = 95% - Alternative 3 (phase 2)

Vc = 1.691 $10^6 m^3$

Days	Month	Q_{inflow} m³/s P95%	W_{inflow} 10^6m³ P95%	$W_{require}$ 10^6 m³	Excluding water loss: Water balance ΔW+ 10^6 m³	Water balance ΔW- 10^6 m³	V 10^6 m³	F km²	V_{tb} 10^6 m³	F_{tb} km²	Water loss: Evaporation ΔZ mm	Evaporation Wz 10^6 m³	Seepage Criteria	Seepage W_{th} 10^6 m³	Total 10^6 m³	Including water loss: balance ΔW+ 10^6 m³	balance ΔW- 10^6 m³	V 10^6 m³	$W_{release}$ 10^6m³	Z (m)
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
	5		1.92															1.69		7.90
30	6	1.628	4.22	2.19	2.03		3.72	1.89	2.71	1.89	45.3	0.086	take 10 percent -age of averag e volume	0.27	0.36	1.67		3.36	0	8.79
31	7	3.406	9.12	2.26	6.86		6.89	1.91	5.31	1.90	42.6	0.081		0.53	0.61	6.25		9.61	0	12.06
31	8	4.345	11.64	2.26	9.38		6.89	1.91	6.89	1.91	43.4	0.083		0.69	0.77	8.60		10.40	7.81	12.47
30	9	5.575	14.45	2.19	12.26		6.89	1.91	6.89	1.91	38.8	0.074		0.69	0.76	11.50		10.40	11.50	12.47
31	10	6.866	18.39	2.26	16.13		6.89	1.91	6.89	1.91	38.1	0.073		0.69	0.76	15.37		10.40	15.37	12.47
30	11	2.723	7.06	2.19	4.87		6.89	1.91	6.89	1.91	59.7	0.114		0.69	0.80	4.07		10.40	4.07	12.47
31	12	1.042	2.79	2.26		-0.53	7.42	1.92	7.16	1.91	77.3	0.148		0.72	0.86		0.34	10.07	0	12.29
31	1	0.478	1.28	2.26		0.98	6.44	1.91	6.93	1.91	62.8	0.120		0.69	0.81		1.80	8.27	0	11.36
28	2	0.255	0.62	2.04		1.43	5.01	1.90	5.73	1.91	52.2	0.100		0.57	0.67		2.10	6.18	0	10.27
31	3	0.202	0.54	2.26		1.72	3.29	1.89	4.15	1.90	56.6	0.107		0.42	0.52		2.24	3.93	0	9.09
30	4	0.361	0.94	2.19		1.25	2.04	1.89	2.66	1.89	50.6	0.096		0.27	0.36		1.62	2.32	0	8.23
31	5	0.715	1.92	2.26		0.35	1.69	1.88	1.86	1.88	48.7	0.092		0.19	0.28		0.63	1.69	0	7.90
	Total		72.96	**26.64**	**51.52**	**5.20**					**616.1**	**1.173**		**6.41**	**7.58**	**47.45**	**8.71**		**38.74**	**12.47**

Normal water level selected for stage 1 **12.50 m**

Total reservoir volume for stage 1: **10.47 x10^6m³**

8.78

(4) Storage Method

The Master Plan only shows the conceptual design of the Cua Can reservoir as shown in **Figure 3-1-3-2**. Water is stored by constructing a dam in the downstream reach of the Cua Can river.

This design would have trouble with reconciling the storage water level and the upstream ground elevation. This study proposes the reservoir design shown in **Figure 3-1-3-2**, which separates the river flow and the reservoir, causing practically no alteration to the conditions of the Cua Can River.

The reservoir shown in **Figure 3-1-3-2** would be made by constructing a dam in the downstream reach of the river. But there are low elevation areas of about 2.2 m upstream, and these areas will always be subject to flooding. In order to avoid the flooding it is necessary to lower the reservoir bottom requiring deeper excavation resulting in a significant increase in the quantity of excavated soil. By separating the river course and the reservoir, the required water level in the reservoir can be maintained without deeper excavation.

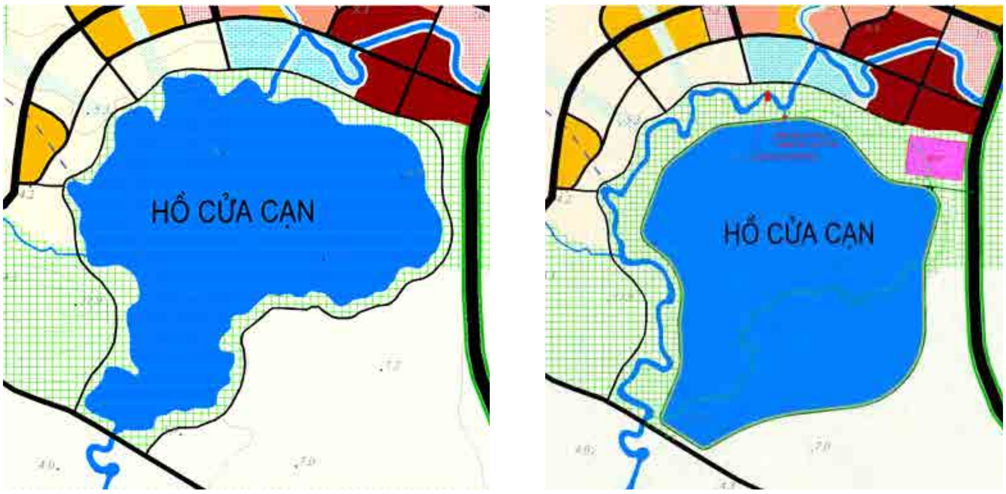


Figure 3-1-3-2   Alternative Storage Methods

(5)   Geological Conditions of Reservoir Site

Geological surveys at the construction site and test boring at ten different points were conducted during the period between December 2011 and January 2012. Detailed results are provided in the attachment.

The reservoir bottom level should be at about +1.8 m elevation to draw river water to the reservoir by gravity for Phase 1. At this level is a sandy-clay soil layer which has a high water permeability and would cause serious water loss. To avoid the seepage it is proposed to cover this area with a seepage prevention clay layer with a thickness of about 1 m or to raise the bottom of the reservoir to the layer with low permeability. Such alternatives are compared in the following sections.

(6)   Other Alternative Plans

Figure 3-1-3-3 illustrates the three alternatives.

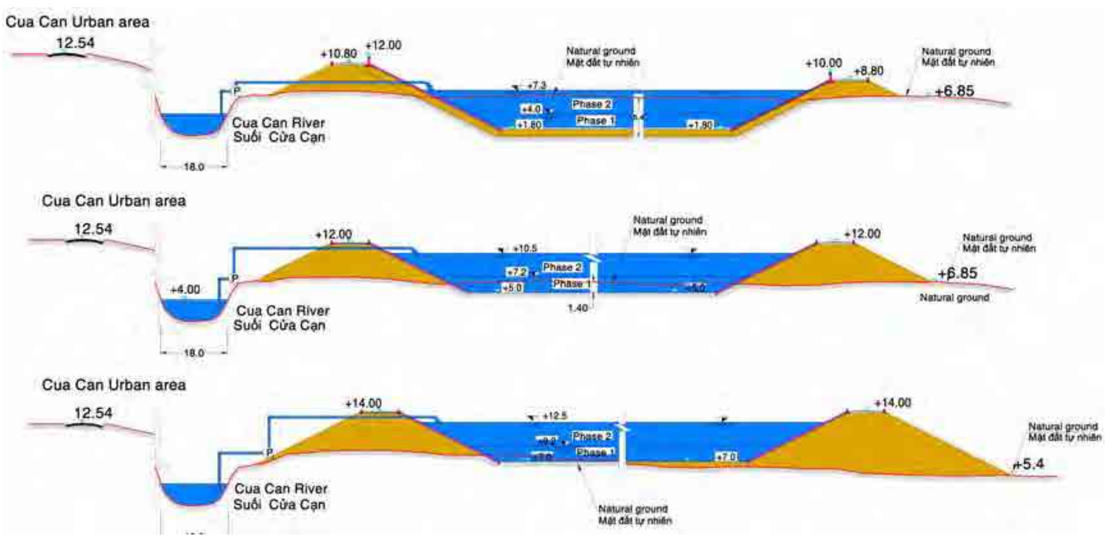


Figure 3-1-3-3 Cua Can Reservoir Alternatives

Table 3-1-3-5 compares the three alternative plans. Alternative 1 can utilize gravity flow during Phase 1 and pumping for Phase 2. Alternatives 2 and 3 require pumping for both Phase 1 and Phase 2. Alternative 3 the preferred option avoids seepage from the bottom and produces the minimum amount of excavated soil.

Table 3-1-3-5 Comparison of Alternative Reservoir Plans

No	Items	Alternative 1	Alternative 2	Alternative 3
1	Construction cost	high cost 592.864.686.000	Medium cost 398.027.630.000	Low cost 294.424.752.000
2	Operation cost	average	high	high
3	Waterproofing for reservoir bed.	Waterproofing for reservoir bed by filling clay soil of 1m thick	Remaining 1 m clay layer for waterproofing	most of the clay layer remains for waterproofing
4	Landscape design	Advantageous because embankment level is lower than urban area	Advantageous because embankment level is lower than urban area	Moderate because embankment level is almost the same as urban area
5	Proposed storage area for excessive excavated soil	Filling for urban development area	Filling for urban development area	Storage area not needed, material is used for reservoir area leveling
6	Risk of construction cost increase without coordination with urban area development for the use of excessive	Cost increases by a factor of 4 due to transportation and compensation increases.	Cost increases by a factor of 2 due to transportation and compensation increases.	No risk due to no residual soil. excavated soil is just enough for filling & leveling.

	excavated soil			
7	Construction Priod	Long	Medium	Short

3.1.4 Design Concept of Water Treatment Plant

(1) Raw water quality and water treatment processes

Water quality analysis was carried out in the dry and rainy seasons by taking water samples from the Cua Can River.

As shown in **Table 3-1-4-1**, the raw water quality is characterized as follows:

- Turbidity is low.
- pH and alkalinity are low.
- Iron concentration is high.

Table 3-1-4-1 Major Results of Raw Water Quality Analysis

Parameter	Unit	Raw Water Quality taken from upstream of planned impounding reservoir		Vietnamese Drinking Water Quality Standard
		Rainy Season in October, 2011	Dry Season in March, 2012	
Turbidity	NTU	2.8	3.0	2
pH		5.3	5.2	6.5 - 8.5
Alkalinity	mg/l	6	6	
Total iron	mg/l	1.2	1.8	0.3

The range of turbidity fluctuations in the Cua Can River is not known because the data are limited. It is quite likely that the turbidity could be much higher during the rainy season and may exceed the acceptable level for treatment options such as slow sand filtration.

Conventional rapid sand filtration would be preferred since it can treat raw water with a wide range of turbidity.

Low pH and alkalinity of the raw water is usually disadvantageous for the coagulation process, and alkali pre-treatment would be required to adjust the pH and alkalinity to the preferred ranges. PAC would be used as coagulant because it performs better than other coagulants when there is pH fluctuation. Pre and intermediate-chlorination would also be required to oxidize iron to reduce the high concentration of iron to an acceptable level.

It is not easy to predict the water quality of impounding reservoirs, whether they are man-made or natural, because varying degrees of eutrophication would take place over time. If the raw water quality deteriorates in future some pretreatment process may be necessary to remove the undesirable substances in the raw water. A bio-contact filter is proposed for this project, and the required land and hydraulic head for its installation are stated in the design.

The sequence of the proposed water treatment processes is shown in **Figure 3-1-4-1**.

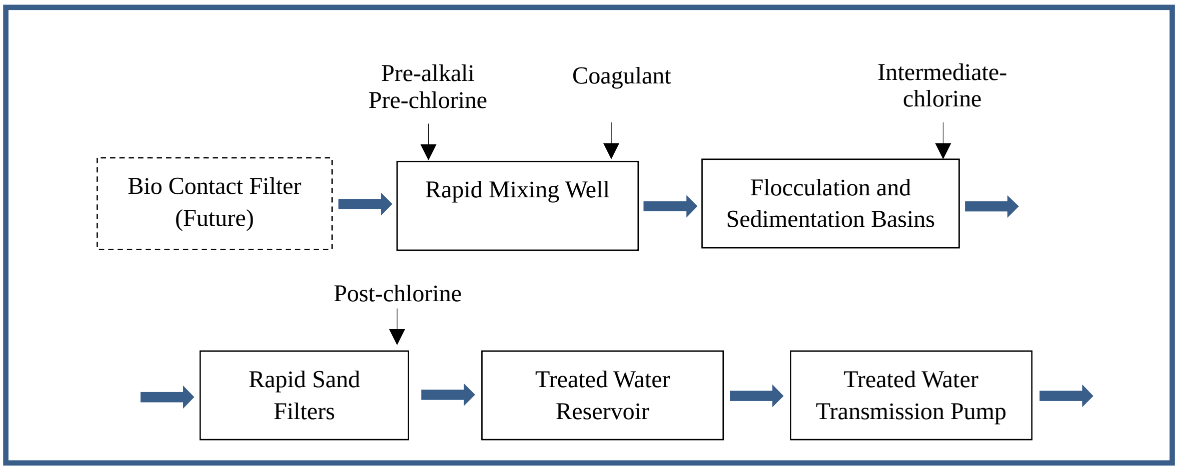


Figure 3-1-4-1 Sequence of Water Treatment Processes

(2) Water Treatment Facilities

The planned production capacities of the proposed treatment plant are 20,000 m^3/day in Phase 1 and 50,000 m^3/day in Phase 2. Five percent loss in the treatment processes is included in the production capacity.

	Production capacity (m^3/day)	Treatment capacity (m^3/day)
Phase 1	20,000	21,000
Phase 2	50,000	52,500

Some provisions for Phase 2 will be constructed in the Phase 1 project to make it easier to expand later and more efficient to operate as shown in **Table 3-1-4-2**.

Table 3-1-4-2 Designed Capacities of Water Treatment Facilities

1. Cua Can Impounding Reservoir and Intake Facility	
a) Cua Can Impounding reservoir	: Phase 2
b) Raw water intake pump station	: Phase 2
c) Raw water intake pump	: Phase 1
2. Raw Water Transmission Facility	: Phase 2
3. Water Treatment Facility	
a) Bio contact filter	: Planned in Phase 2

b) Rapid mixing well	: Phase 1
c) Flocculation basin	: Phase 1
d) Sedimentation basin	: Phase 1
e) Rapid sand filter	: Phase 1
f) Wastewater basin	: Phase 1
g) Sludge drying bed	: Phase 1
h) Chemical dosing facility	: Phase 1
i) Buildings (administration, chemical, etc.)	: Phase 2
4. Treated water transmission facility	
a) Treated water reservoir	: Phase 1
b) Treated water transmission pump station	: Phase 1
c) Treated water transmission pump	: Phase 1

3.1.5 Planned Methods of Water Distribution (Bulk Supply and Supply to Individual Connections)

Developers for resort and housing developments are required to install all the distribution facilities in their development areas. The project would provide bulk water to such development areas. The developers may also have to install receiving tanks as required. Peak hour demand should be managed within the distribution facilities installed by developers.

In designing the distribution facilities for the urban water supply system, peak day demands can be utilized. However, domestic customers who live along the distribution pipe routes will be connected directly to the distribution pipes. For such water demands peak hour demands are utilized in the design.

For bulk supply to the Duong Dong service area, new distribution pipes would be connected with the existing distribution pipes of KIWACO at the boundary of the Duong Dong service area.

3.2 Sewerage System

3.2.1 Sewerage Service Area

(1) Target Year

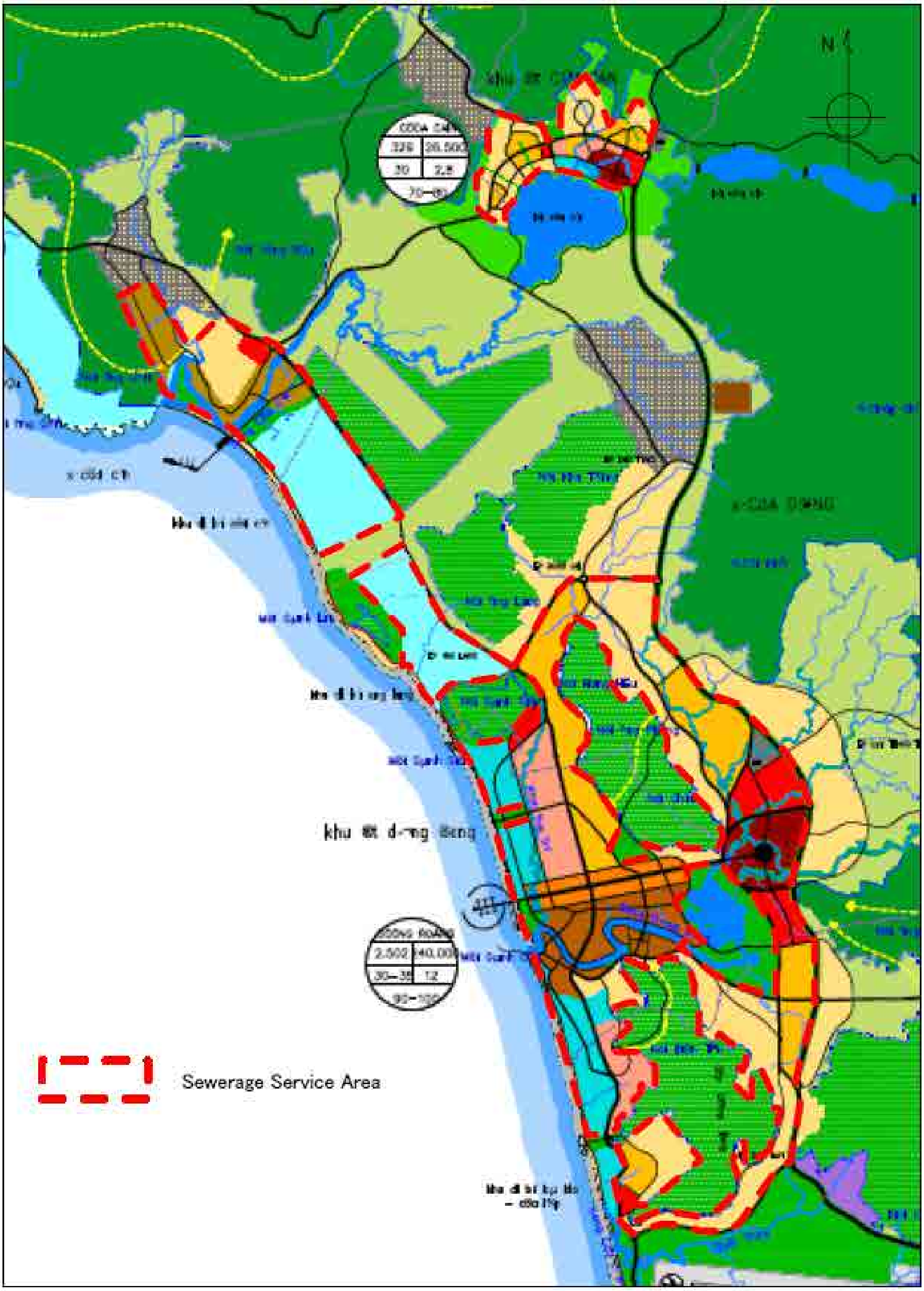
Article 13 of Vietnamese DECREE 88 on Drainage and Sewerage for Urban Areas and Industrial Zones dated 28 May, 2007 states that “Drainage/sewerage plans shall be prepared for short-term phases of 10 years; long-term phases of 20 years and longer. Consistent with this requirement, this survey adopts the target years of 2020 for Phase 1 and 2030 for Phase 2.

(2) Sewerage Service Area

The planned sewerage service area covers mainly Duong Dong urban area, Cua Can urban area and Cua Can tourist resorts.

The service area boundaries in Phase 1 and 2 are shown in **Figure 3-2-1-1**, and the area size of each phase is described below:

Service Area	Area Size (ha)
Total Service Area	2,912
・Phase 1	1,632
・Phase 2	1,280



Source：Adjusted Master Plan, JICA Survey Team

Figure 3-2-1-1 Sewerage Service Area and Land Use Plan

Land required for the sewerage system to be implemented under Phase 1 and 2 by 2030 is shown in **Table 3-2-1-1**.

Table 3-2-1-1 Sewerage System Land Use under Phase 1 and 2 by 2030

Land Use	Area (ha)		
	Total	Phase 1	Phase 2
ADMINISTRATIVE- OFFICE AREA	126.63	0.00	126.63
PUBLIC AREA	156.03	36.14	119.89
COMMERCE-SERVICE CENTER AREA	78.61	78.61	0.00
RESIDENTIAL AREA	196.03	196.03	0.00
MIXED DEVELOPMENT AREA	212.64	197.63	15.01
HIGH DENSITY RESID AREA	505.08	163.16	341.92
LOW DENSITY RESID AREA	750.27	109.40	640.87
ADJUSTED TRADING VILLAGE	136.77	136.77	0.00
RURAL RESIDENTIAL VILLAGE	788.00	101.90	686.10
MIXED TOURIST AREA	253.71	244.23	9.48
ECOLOGICAL TOURIST AREA	469.56	469.56	0.00
BUS STOP	26.67	0.00	26.67
Entire Area	3,700.00	1,733.43	1,966.57
Main Service Area	2,912.00	1,631.53	1,280.47
Sub-service Area	788.00	101.90	686.10

Source：Measured by the Survey Team from Adjusted master plan Figure

The total area required is 3,700 ha, of which, 2,912 ha is the sewerage service area and would be developed by 2030. The sewerage treatment for the remaining 788 ha occupied by rural residential villages would be developed in the future.

- Entire Land Use Area : 3,700 ha

  (Breakdown)

  - Major Land Use : 2,912 ha (Sewerage Service Area)
  - Rural Residential Villages : 788 ha

3.2.2 Sewage Collection Systems

A separate sewage collection system is selected for the following reasons.

Sewage collection systems can be either combined or separate. Combined sewers carry both storm water and sewage in the same pipes. In dry weather, the flow, which is mostly sewage, is diverted into an interceptor sewer and conveyed to the treatment plant. In wet weather, some of the flow gets diverted to the treatment plant and flows in excess of interceptor capacity are diverted to the river.

In separate systems, storm water does not mix with sewage. Sewage is conveyed to the STP through separate trunk sewers and pumping stations. In practice, there is usually ingress of storm water into sewage pipes, because of unsealed pipe joints, and unintentional or illegal connections of rainwater runoff.

A comparison of the two types of sewage collection systems is presented in **Table 3-2-2-1**. The development of separate sewerage systems is usually preferred because storm water is generally less polluted than sewage and the treatment of combined sewage and storm water is difficult during heavy rainfalls, resulting in untreated overflows.

Ground elevation of the existing urban area in the planned sewerage service area is very low, therefore the drainage system in this area is easily affected by the backwater from the sea and river. In case of combined system, Drainage pumping station would be required in a combined system to avoid the backwater, making this more costly. **Table 3-2-2-1** shows the advantages and disadvantages of the two systems.

Table 3-2-2-1 Comparison of Sewage Collection Systems

Item		Combined system		Separate system	
Maintenance & Operation	Existing Sanitary facility (Septic Tank)	- Need to de-sludge once every two years	×	- No need to de-sludge	○
	Collection System (sewer)	- In dry season, sediment settles in pipe - In wet season, sediment in pipe is flushed out and overflows into public water body	△	- It is possible to collect all sewage if households connect to the new sewer	○
	STP	- Inflow increases during wet weather potentially leading to process upsets	△	- flows are more steady and sewage strength more stable	○
Collecting/increasing Sewage Tariff		- The residents' incentive for payment of Sewage tariff is low because there is no perceived improvement in sanitary conditions.	△	- benefits of connecting are tangible therefore easier to justify a sewage tariff	○
Improvement of Living condition		- Maintenance of septic tank is still required. - Vacuum tanker for sludge removal from septic tank moves around the town with odour	×	- Living conditions can be improved if resident do not have a septic tank	△
Effect of Water Environment Improvement in public water body	Intake of water supply	- Some influences	△	- No influence	－
	Rivers and Lakes	- Combined flow including sewage is flowing into public water bodies	△	- Sewage is treated before discharging public water bodies	○
Basic Construction Cost of Sewerage System		- Construction cost of pipeline is cheaper than separate system due to short length of proposed pipe	○	- Construction Cost is much higher than combined system, as both sanitary and drainage sewers are installed.	△

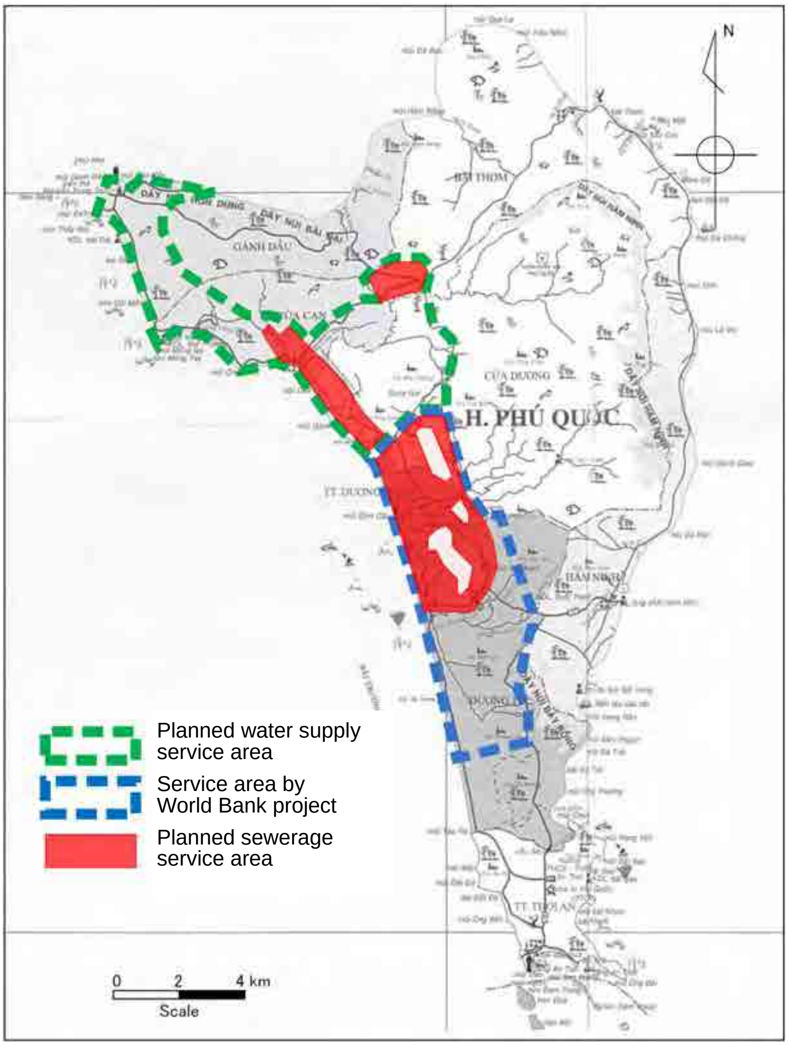
Item	Combined system		Separate system	
Necessity of upgrading sewerage system in future (investment to new facilities)	- Change to separate system is required in the future	△	- No need for future investment	○

Source: JICA Survey Team

3.2.3 Estimating Sewage Quantity and Influent Quality

(1) Sewage Quantity

Sewage quantity is determined based on the projected water demands. Water supply to the planned sewerage service area will be provided by the World Bank water supply project and the water supply system proposed by this survey as shown in **Figure 3-2-3-1**. Since the Duong Dong and Duong To areas are mainly covered by the World Bank project and Cua Can area is supplied by the system proposed by this survey, projected water demands for these projects are used to determine planned sewage quantities.



Source: JICA Survey Team

Figure 3-2-3-1 Planned Sewerage Service Area and Water Supply Service Areas

Table 3-2-3-1 shows the breakdown of water demands and sewage quantities calculated for the planned sewerage service area.

Table 3-2-3-1 Planned Sewage Quantity in Sewerage Service Area

No	Description	Unit/Year	**2020**	**2030**	Remarks
	Domestic Water Consumption				
(1)	Duong Dong	m^3/day	6,265	12,350	World Bank Project data
(2)	Cua Can	m^3/day	1,413	2,244	This survey projection
(3)	Cua Can Development Area	m^3/day	1,985	7,072	This survey projection
(4)	Total	m^3/day	9,663	21,666	(4)=(1)+(2)+(3)
	Domestic and Other Wastewater Flow				
(5)	Domestic Wastewater	m^3/day	7,730	17,333	(5)=(4)*80%
(6)	Public and Commercial Wastewater	m^3/day	773	1,733	(6)=(5)*10%
(7)	Small Industry Wastewater	m^3/day	773	1,733	(7)=(5)*10%
(8)	Infiltration	m^3/day	773	1,733	(8)=(5)*10%
(9)	Total	m^3/day	**10,049**	**22,532**	(9)=(5)+(6)+(7)+(8)
	Tourist Wastewater Flow				
(10)	Duong Dong Water consumption	m^3/day	3,394	7,216	WB project *1
(11)	Duong Dong Wastewater Flow	m^3/day	2,715	5,773	(11)=(10)*80%
(12)	Cua Can Wastewater Flow	m^3/day	4,568	5,163	This survey projection
(13)	Total	m^3/day	**7,283**	**10,936**	(13)=(11)+(12)
(14)	Total Wastewater Flow		**17,332**	**33,468**	(14)=(9)+(13)
(15)	Connection Ratio	%			
	Domestic	%	30%	90%	
	Tourist Duong Dong	%	45%		
	Tourist Cua Can	%	70%		
(16)	Daily Average Wastewater Flow	m^3/day			(16)=(14)*(15)
	Domestic		3,015	20,279	
	Tourist Duong Dong		1,222	5,196	
	Tourist Cua Can		3,198	4,647	
	Total		**7,435**	**30,122**	
(17)	Daily Average Wastewater Flow(Rounded)	m^3/day	**7,500**	**30,000**	

Source: JICA Survey Team

Note: *1; Regarding Duong Dong Water consumption in the year 2030, please refer to Annex-4.

1) Domestic, Public, Commercial and Industrial Wastewater

Domestic wastewater is assumed to be 80% of the domestic water demand and each category of public, commercial, industrial wastewater is assumed to be about 10% of domestic wastewater.

2) Wastewater for the Tourist Sector

The quantity of wastewater generated by the tourist activities in the Duong Dong area is assumed to be 80% of the tourist water demand projected in World Bank water supply project.

Tourist wastewater quantity in the Cua Can area is determined from the wastewater quantities estimated in the tourist resort development plans submitted to PQDMB. Since there is no public sewage treatment plant in the Cua Can area, each resort developer plans to have his own sewage treatment facility.

Table 3-2-3-2 shows the water demands and sewerage treatment capacities of resort development projects located in the planned sewerage service area.

Table 3-2-3-2 Water Supply Capacities and Individual Sewage Treatment Plant Capacity proposed by Resort Developers in Cua Can Resort Development Projects

（unit：m^3/d）

Resort Development Projects	Water Supply Capacity		Sewage Treatment Capacity	
	Y2020	Y2030	Y2020	Y2030
Ong Lang Beach (T1)	785	1,570	595	1,190
Phu Quoc Ecological (T2)	1,214	1,214	971	971
Cua Can Beach (T3)	2,950	2,950	2,242	2,242
Tran Thai Phuong Nam (T4)	960	960	760	760
Total	5,909	6,694	**4,568**	**5,163**

Source：Information from Phu Quoc Development Management Board

3) Connection Ratio

Connection ratios to sewerage system are estimated to be 30% for domestic customers, 45% for the Duong Dong tourist area, and 70% for the Cua Can tourist area where large resorts are proposed. The connection ratios are expected to increase to 90% by 2030.

(2) Designed Sewage Influent

Daily average and maximum sewage influent are set at the same level, at 7,500 m^3/day for Phase 1 and 30,000 m^3/day for Phase 2.

Daily maximum flow is used to determine the capacity of sewage treatment plant. Since the service area is located in the tropic area, it is determined that the seasonal variation of water supply is small.

The following values are the daily average and daily maximum flow rate ratio in other cities in Vietnam:

Name of City/Province	Daily Average	Daily Maximum
- Hochi Minh City	1.0	1.1
- Hue City	1.0	1.0
- Binh Duong Province	1.0	1.0

The daily average and daily maximum flow rate ratio in this survey set at 1:1, is the same as that for Hue city and Binh Duong province.

(3) Influent Quality

1) Estimate of Influent Quality

The influent quality at the sewage treatment plant is estimated based on the daily pollution load and daily average wastewater flow designed for the target year, as shown below.

$$\text{Design Influent Quality} = \frac{\text{Design Daily Pollution Load}}{\text{Design Daily Average Wastewater Flow}}$$

The pollution load of domestic wastewater, commercial wastewater and tourist wastewater should be determined separately. Since it is difficult to obtain data for commercial and tourist pollution load, in Vietnam, the influent quality is based solely on the pollution load of domestic wastewater (calculated from **Table 3-2-1-10**) which accounts for about 65% of the total sewage quantity.

2) Design Daily Pollution Load

There is no description of design daily pollution load in the Master Plan, therefore design influent quality are based on the pollution loads of data from other Vietnamese cities and other countries.

Examples of per capita pollution load are shown in **Table 3-2-3-3**.

Table 3-2-3-3 Examples of per Capita Pollution Load

（Unit：g/capita/day）

Country Name	City/ Period	BOD	SS	T-N	T-P
Japan	1970	36	41	7	1.1
	2000	58	45	11	1.3
Indonesia	Jakarta	28	-	-	-
Thailand	Chaopia	53	25	-	-

	Puket	42	-	-	-
Viet Nam	Hanoi	40	-	-	-
	Ho Chi Minh	55	55	-	-

Source: The Guideline for Comprehensive Basin-wide Planning of Sewerage Systems, Japan Sewage Works Association 2000
: The Guideline for Establishment of the Master Plan in Developing Countries, Japan Sewage Works Association 1997

Assuming that future conditions in Phu Quoc Island may be similar to those in Japan in 1970 the following sewage characteristics are calculated:

- BOD_5 : 36 g/capita/day
- SS : 41 g/capita/day
- T-N : 7 g/capita/day
- T-P : 1.1 g/capita/day

3) Design Daily Average Wastewater Flow

As explained in "2.2.3 Estimating Sewage Quantity and Influent Quality", the various sewage quantities in 2030 are calculated as a percentage of the average daily water consumption as shown in the following table.

(1)	Daily Average Water Consumption	150 L/capita/day	Formula
(2)	Domestic Wastewater	120 L/capita/day	(1)×80%
(3)	Public and commercial wastewater	12 L/capita/day	(2)×10%
(4)	Small industry wastewater	12 L/capita/day	(2)×10%
(5)	Infiltration	12 L/capita/day	(2)×10%
(6)	Design Daily Average Wastewater Flow	156 L/capita/day	(2)+(3)+(4)+(5)

4) Influent Quality

Each influent quality is calculated as shown in the **Table 3-2-3-4**, by applying the aforementioned formula.

Table 3-2-3-4 Influent Quality

Quality	g/capita/day	L/capita/day	mg/L	Adoption
BOD_5	36	156	231	230
SS	41	156	263	260
T-N	7	156	45	45
T-P	1.1	156	7.1	7

Source：JICA Survey Team

3.2.4 Sewage Treatment

(1) Site of Sewage Treatment Plant

The sewage treatment plant (STP) of about 48 ha is planned to be located in a part of a farming area in Ong Lang Beach Eco-Resort shown in **Table 3-2-4-1**. The building plan has not been made. It is important to select the treatment method to minimize the physical footprint for the facilities.

A site on the road on the west side is selected for the STP because this location would have minimal impact on the development of the farming area.

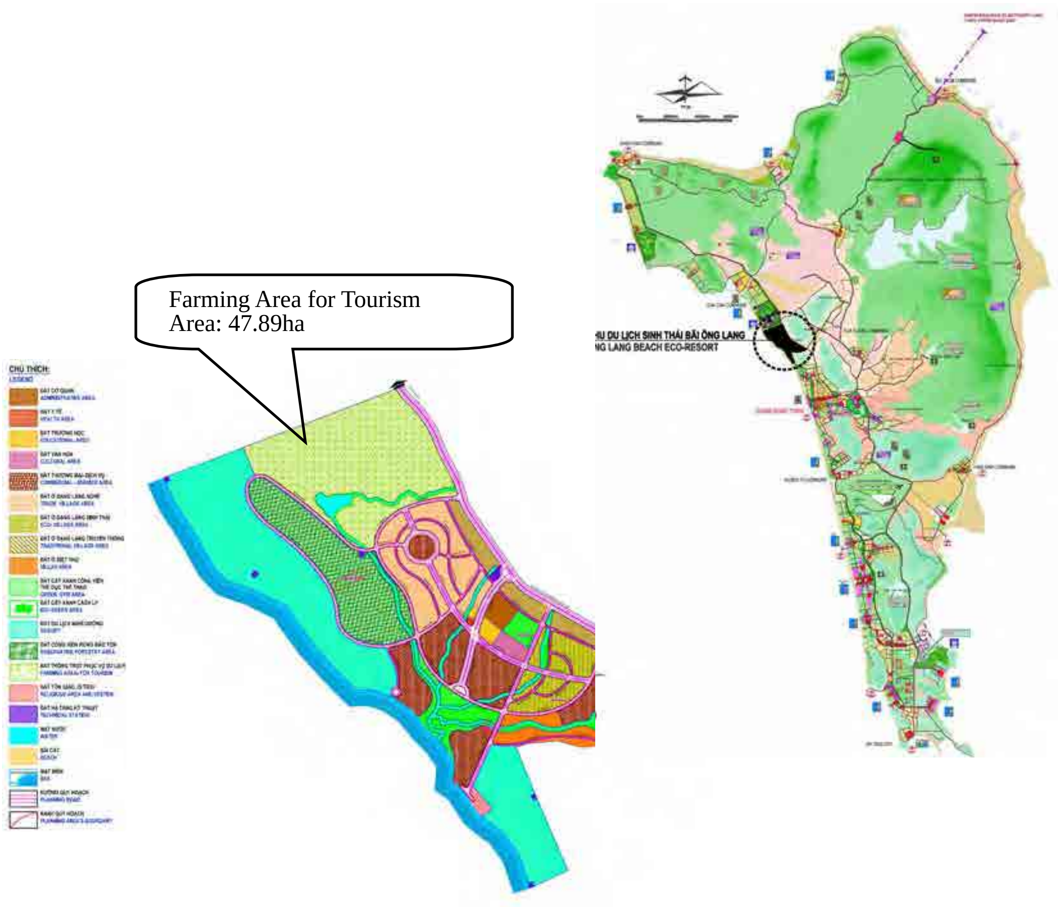


Figure 3-2-4-1 Land Use Plan of Ong Lang Beach Eco-resort Development

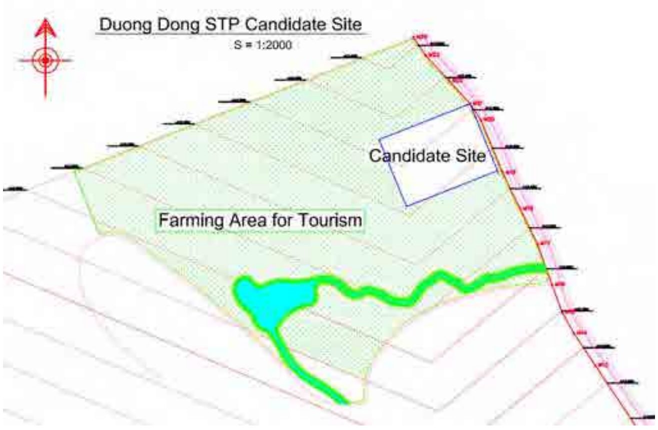


Figure 3-2-4-2 Candidate Site for Duong Dong STP

(2) Sewage Treatment Process

1) Important Considerations

The STP must comply with the following key regulatory requirements the:

- Effluent quality
- Buffer zone

Effluent quality requirements are specified in the Vietnamese National Technical Regulations on Domestic Wastewater (QCVN 14-2008/BTNMT). The regulations are indicated in **Table 3-2-4-1**.

Table 3-2-4-1 National Technical Regulations on Domestic Wastewater

No	Parameters	Unit	A	B
1	pH	-	5 – 9	5 - 9
2	BOD_5 (20 ^{0}C)	mg/l	30	50
3	Total suspended solids (TSS)	mg/l	50	100
4	Total dissolved solids	mg/l	500	1000
5	Sulphur (counted following H_2S)	mg/l	1.0	4.0
6	Ammonium (counted following N)	mg/l	5	10
7	Nitrate (NO_3^-)(counted following N)	mg/l	30	50
8	Oil and grease	mg/l	10	20
9	Total surface activated substances	mg/l	5	10
10	Phosphate (PO_4^{3-}) (counted following P)	mg/l	6	10
11	Total Coliforms	MPN/100 ml	3,000	5,000

Remarks:
- Column A regulates the value C of polluted parameters used for calculating the maximum allowable value in domestic wastewater when discharging into rivers/pools which are used for water supply purposes (having water quality similar to column A1 and A2 in National technical regulation on surface water quality).
- Column B regulates the value C of polluted parameters used for calculating the maximum allowable value in domestic wastewater when discharging into rivers/pools which are not used for supplying water purpose (having water quality similar to column B1 and B2 in National technical regulation on surface water quality or water near the sea).

The receiving water body is a small river in the area to be developed. Because the effluent is discharged into a water body that is not used for drinking water, category B is applicable for this

STP. The effluent could be of higher quality to meet the surface water quality for public water body because there is no dilution in the small river which has a low maintenance flows.

The Vietnamese surface water quality requirements are specified in the National Technical Regulations on Surface Water Quality, QCVN08-2008/BTNMT.

The regulations are presented in **Table 3-2-4-2**.

Table 3-2-4-2 National Technical Regulations on Surface Water Quality

No.	Specifications	Unit	Limitation values			
			A		B	
			A1	A2	B1	B2
1	pH		6-8.5	6-8.5	5.5-9	5.5-9
2	Dissolved oxygen (DO)	mg/l	≥ 6	≥ 5	≥ 4	≥ 2
3	Total of suspended solid (TSS)	mg/l	20	30	50	100
4	COD	mg/l	10	15	30	50
5	BOD_5 (20^o C)	mg/l	4	6	15	25
6	Ammonia ($NH^+{}_4$) (to be calculated as N)	mg/l	0.1	0.2	0.5	1
9	Nitrite ($NO^-{}_2$) (to be calculated as N)	mg/l	0.01	0.02	0.04	0.05
10	Nitrate ($NO^-{}_3$) (to be calculated as N)	mg/l	2	5	10	15
11	Phosphate (PO_4^{3-}) (to be calculated as P)	mg/l	0.1	0.2	0.3	0.5
24	Total of oils and grease	mg/l	0.01	0.02	0.1	0.3
32	Coliform	MNP/100ml	2,500	5,000	7,500	10,000

Remarks: The surface water is classified to evaluate and control water quality for different purposes' water utilization:

A1 – it is good for domestic water supply and others like A2, B1 and B2.

A2 – it is used for domestic water supply but it must be applied the suitable treatment technologies; to preserve aquatic animals and plants or other purposes like B1 and B2.

B1 – it is used for irrigation or other purposes requiring similar water quality or other purposes like B2.

B2 – it is used for sea traffic and other purposes with the requirement of low quality water.

The reuse of effluent for domestic water supply and irrigation is not considered in this plan. Therefore, the effluent should meet Category B2 shown in **Table 3-2-4-2**. Based on the above two regulations, the design effluent quality is set as shown in **Table 3-2-4-3**.

Table 3-2-4-3 Design Effluent Quality

No.	Specifications	Unit	Design Effluent
1	pH		5.5-9
2	Dissolved oxygen (DO)	mg/l	≥ 2
3	Total of suspended solid (TSS)	mg/l	50
4	COD	mg/l	50
5	BOD_5 (20^o C)	mg/l	25
6	Ammonia ($NH^+{}_4$) (to be calculated as N)	mg/l	1
9	Nitrite ($NO^-{}_2$) (to be calculated as N)	mg/l	0.05
10	Nitrate ($NO^-{}_3$) (to be calculated as N)	mg/l	15
11	Phosphate (PO_4^{3-}) (to be calculated as P)	mg/l	0.5
24	Total of oils and grease	mg/l	0.03
32	Coliform	MNP/100ml	3,000

The buffer zone for the STP is specified in QCVN 07-2010/BXD. The values are presented in **Table 3-2-4-4**.

Table 3-2-4-4 National Technical Regulations on Domestic Wastewater

No.	Items	Buffer zone (m) based on capacity (×1000m³/day)			
		< 0.2	0.2 ー 5	5 ー 50	>50
1.	Pumping Station	15	20	25	30
2.	Sewage treatment plant				
a.	Physical treatment (combine with Sludge drying bed)	100	200	300	400
b.	Biological treatment (combine with Sludge drying bed)	100	150	300	400
c.	Biological treatment without Sludge drying bed (combine with Sludge drying equipment, Sludge treated equipment)	10	15	30	40
d.	Underground sewage filter yard	100	150	300	500
e.	Sewage farming	50	200	400	1,000
f.	Biological pond	50	200		
g.	Sewage Oxidation channel	50	150		

- Source: QCVN-07:2010/BXD

The capacity of the STP is 30,000 m3/d and biological treatment without sludge drying bed is selected as the treatment method. Therefore, the buffer zone is set at 30 m.

The STP would be located in an area to be developed. A large golf course would be located on the north side of the STP. There is enough space around the STP to accommodate a 30 m buffer zone.

2) Selection of Sewage Treatment Process

The selection of an appropriate sewage treatment process takes the following factors into account:

- required removal efficiency
- required facilities and their land use area
- ease of operation and maintenance
- construction and O&M costs

The selection of the sewage treatment process is carried out in two stages. The preliminary study would look at the various processes that are commonly used. Then some selected processes are compared in detail to arrive at the process of choice.

2-1) Preliminary study

a) Screening of sewage treatment method

Treatment methods used and proposed in Viet Nam are listed in **Table 3-2-4-5**. All STPs use biological treatment.

The types of sewage treatment methods adopted in Vietnam are:

- aerated lagoon
- oxidation ditch
- conventional activated sludge (including anaerobic-anoxic-oxic process)
- Sequencing batch reactor

Table 3-2-4-5 Existing and Planned STP in Viet Nam

No.	STP Name	Location	Treatment Methods	Capacity (m^3/day)	Donor	Conditions
1	Truc Bach STP	Hanoi	Anaerobic-anoxic-oxic Activated Sludge	3,000 m^3/day	JBIC	Operation
2	Kim Lien STP	Hanoi	Anaerobic-anoxic-oxic Activated Sludge	3,700 m^3/day	JBIC	Operation
3	Van Tri STP	Hanoi	Conventional Activated Sludge	50,000 m^3/day	GOV	Operation
4	Ha Long STP	Ha Long City	Sequencing Batch Reactor	3,500 m^3/day	WB	Operation
5	Hoa Lac Hi-Tech Industrial Zone STP	Ha Tay province	Conventional Activated Sludge	6,500 m^3/day	GOV	Finished Construction
6	Vinh Yen Town STP	Vinh Phuc Province	Conventional Activated Sludge	5,000 m^3/day	JBIC	Construction Tender
7	Lien Chieu STP	Da Nang City	Conventional Activated Sludge	62,900 m^3/day	METI (Japan)	Before detailed design
8	Binh Hung STP	Ho Chi Minh City	Conventional Activated Sludge	141,000 m^3/day	JBIC	Operation
9	Thu Dau Mot STP	Binh Duong Province	Sequencing Batch Reactor	17,650 m^3/day	JBIC	Under Construction
10	Bay Mau STP	Hanoi	Conventional Activated Sludge	13,300 m^3/day	JBIC	Under Construction
11	Vinh Niem STP	Hai Phong Province	Conventional Activated Sludge	36,000 m^3/day	JBIC	Under Construction
12	North Thang Long STP	Hanoi	Conventional Activated Sludge	42,000 m^3/day	JBIC	Operation
13	Thuy An STP	Hue City	Conventional Activated Sludge	20,000 m^3/day	JBIC	Before detailed design

In addition to the above treatment methods, the upflow anaerobic sludge blanket (UASB) process is often used in other tropical countries. These five treatment processes are evaluated.

b) Required Removal Efficiency

The required removal efficiency is calculated based on the designed influent quality and the required effluent quality. The required removal efficiency is presented in **Table 3-2-4-6**.

Table 3-2-4-6 Calculation of Required Removal Efficiency

	Influent Quality	Including recycle flow	Design Influent Quality	Effluent Standard[*2]	Required Removal Efficiency
BOD	230 mg/l	282 mg/l	290 mg/l	25 mg/l	91.4%
SS	260 mg/l	308 mg/l	310 mg/l	50 mg/l	83.9%
T-N[*1]	45 mg/l	56 mg/l	60 mg/l	15 mg/l	75.0%

T-P	7.0 mg/l	8.1 mg/l	9 mg/l	0.5 mg/l	94.4%

- *1: T-N of Effluent Standard means nitrate-nitrogen (NO_3^--N)
- *2: Source: QCVN14-2008 / BTNMT and TCVN7222:2002

c) Preliminary Study

Based on the evaluation, two treatment methods are rejected for the following reasons.

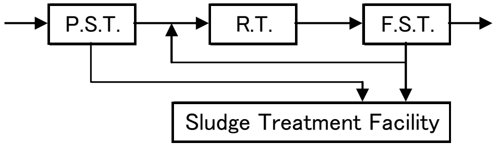
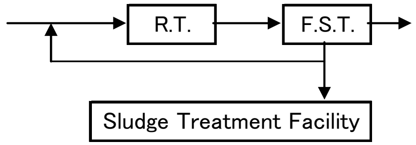
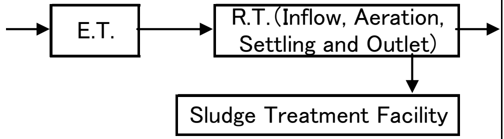
- Aerated lagoon: The removal efficiencies for BOD_5 and SS are 60 to 70% by this method. This performance does not satisfy the required removal efficiency. The STP site would need to be two or three times larger than that of other treatment methods.
- UASB: Effluent BOD after treatment (limit value: 50mg/l) does not meet the design effluent quality, and the effluent is anoxic. Therefore, trickling filter treatment or aeration treatment is necessary if UASB is adopted. Compared to other treatment methods, a larger area would be required and O&M becomes more complicated.

Conventional activated sludge (CAS) and oxidation ditch (OD), and sequencing batch reactor (SBR) processes are compared in detail.

2)-2 Comparison

The results of the comparison of CAS, OD and SBR methods are shown in **Table 3-2-4-7**.

Table 3-2-4-7 Comparison of Sewage Treatment Methods (1/3)

Treatment Process	**Conventional Activated Sludge (CAS)**		**Oxidation Ditch (OD)**		**Sequencing Batch Reactor (SBR)**	
Process Diagram						
Description	Relatively short retention time in the reactor (8 hrs), i.e. high load operation is conducted. Pollution load is reduced at the primary clarifier. Sludge is withdrawn in primary and final clarifiers, and separately treated. The extraction of the sludge also removes some of the nitrogen. More nitrogen can be removed by conducting a multi-stage process with step feed. The multi stage nitrification denitrification process with step feed is proposed for this project.		Relatively long retention time in the reactor at (24 to 36 hrs), i.e. low loading rate, able to keep treatment process stable even with changing flow and loading rate. Primary clarifier to reduce pollution load is not required. A fine screen to prevent the production of scum should be installed. Sludge is withdrawn in the final clarifier and treated. This process can remove nitrogen, but it is hard to achieve more than 75% removal.		This is a fill and draw type system involving a single complete-mix reactor in which all steps of the activated sludge process occur. Operation of this process can be affected by flow fluctuations. To minimize the effect of changing flow on the operation, an equalization tank is necessary. There is no primary clarifier. A fine screen is necessary to prevent scum production in the front of reactor. Sludge is withdrawn and treated. This process can remove nitrogen and phosphorus, but it is hard to achieve more than 75% nitrogen removal.	
BOD Removal	90 – 95%	○	90 – 95%	○	90 – 95%	○
T-N Removal	About 75%	○	About 70%	△	About 70%	△

Note: P.S.T.: Primary Sedimentation Tank, R.T. : Reactor Tank, F.S.T.: Final Sedimentation Tank, E.T. : Equalization Tank

Table 3-2-4-7 Comparison of Sewage Treatment Methods (2/3)

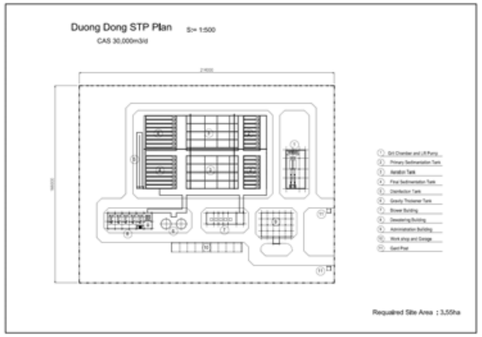
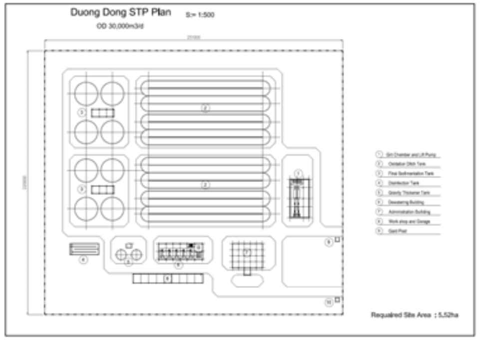
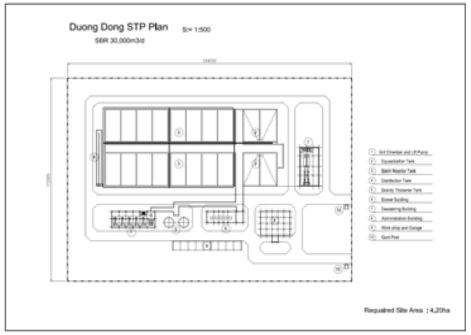
Treatment Process	Conventional Activated Sludge (CAS)	Oxidation Ditch (OD)	Sequencing Batch Reactor (SBR)
Operation at Flow Fluctuation	Relatively stable because of primary clarifier	Stable because of long hydraulic retention time (24 hrs)	Relatively stable when a equalization tank is set
	△	○	△
Required Site Area	 Required site area = 3.55 ha	 Required site area = 5.52 ha	 Required site area = 4.20 ha
	◎	△	○
Sludge Production	100% of removed amount of SS is converted to sludge as dry solid base. Water content of dewatered sludge is low. Sludge production is 100%.	75% of removed amount of SS is converted to sludge as dry solid base. Water content of dewatered sludge is high. Sludge production is 100%.	90% of removed amount of SS is converted to sludge as dry solid base. Water content of dewatered sludge is high. Sludge production is 123%.
	○	○	△

Table 3-2-4-7 Comparison of Sewage Treatment Methods (3/3)

Treatment Process	**Conventional Activated Sludge (CAS)**	**Oxidation Ditch (OD)**	**Sequencing Batch Reactor (SBR)**
Impact (Odor) on the Environment	Slight odor (methyl mercaptan) is detected in the reactor. The concentration is not high enough to require the installation of odor control equipment.	Slight odor (methyl mercaptan) is detected in the reactor. The concentration is not high enough to require the installation of odor control equipment.	Slight odor (methyl mercaptan) is detected in the reactor. The concentration is not high enough to require the installation of odor control equipment.
	○	○	○
Operability	Operation is relatively difficult due to many operational factors and requires more manpower.	Operation is relatively easy because of fewer operational factors and requires less manpower.	Operation is relatively difficult due to many operational factors and involves more equipment to control the processes, requiring high maintenance skill and more manpower.
	△	○	△
Construction Cost	100%	115 %	100 %
O&M Cost	100 %	95 %	105 %
Number of Adoption in Vietnam	9 locations (most popular process)	Only one location with small capacity	2 locations
	○	△	△
Evaluation	○	△	△

Note: Costs on construction and O&M in previous JICA Studies are presented for reference. Land acquisition costs are not included.

Based on the evaluation, the CAS process (a multi-stage nitrification denitrification process with step feed) is selected as the preferred treatment method for the following reasons.

- Area requiring odor control is the smallest in screened methods.
- Cost is same or small comparing to that of the other treatment methods.
- Effluent quality is almost same as that of others.
- Nitrogen removal is better than that of others.
- It is adopted in many places, and operating ways are established.

(3) Method of Sludge Treatment and Disposal

1) Selection of Sludge Disposal Methods

Sludge produced in the sewage treatment process is finally disposed or reused.

Based on other studies in Vietnam, a disposal is a cheaper way than a reuse in case of that there is a large land for disposing sludge. Reuse is studied under special conditions that there are high demands for reuse or is difficulties to find a land for disposing sludge.

2) Selection of Sludge Treatment Methods

Sludge produced in sewage treatment process contains water which occupies 98% of sludge weight. Water of sludge is extracted to reduce volume before disposal. The extraction of water is conducted in thickening and dewatering processes. In a case of that further water is extracted, incineration is conducted after dewatering.

Table 3-2-4-8 shows the sludge treatment and disposal methods. The drying bed is not considered in this study because of requiring a large area for facilities and buffer zone, and producing nuisance odor. Also, incineration is not considered because disposal site has enough space and high construction and O&M costs are required.

As for use of digester gas produced in digestion, gas power generation is selected in **Table 3-2-4-9**.

Case 1 in which digestion process is not conducted is a better method than Case 2 in terms of flow cost and simple operation although Case 2 has positive points on stability of sludge and energy utilization produced in the process. Also, Case 1 process can adopt digestion treatment in the process when the demands to use sludge as energy source grows in the future.

Based on these reasons, case 1 is selected as a sludge treatment and disposal method.

Table 3-2-4-8 Sludge Treatment for Volume Reduction

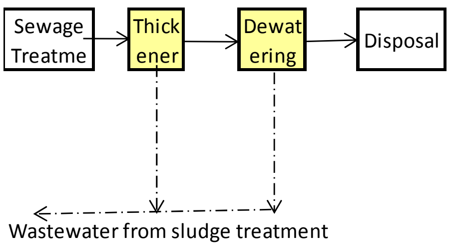
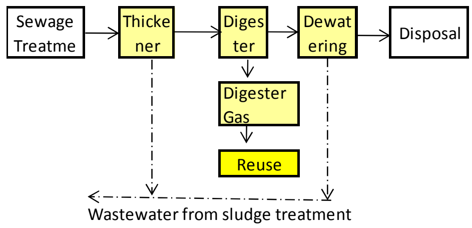
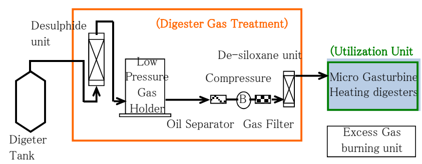
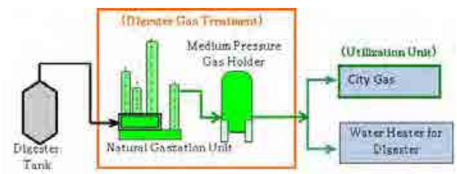
Content		Case 1 (without Digestion)	Case 2 (with Digestion)
Process Diagram		 Sludge (0.9% of solid content) produced in sewage treatment process is thickened to increase solid contents to 2% by gravity. Thickened sludge is dewatered to reduce water content (78%). Finally, dewatered sludge is removed to a disposal site.	 Sludge (0.9% of solid content) produced by the sewage treatment process is mechanically thickened (to increase solid content to 4 %) by gravity in order to reduce sludge digestion volume. Thickened sludge is anaerobically digested and in the process biogas is produced. Digested sludge is dewatered to reduce water contents (82%). Finally, dewatered sludge is moved to a disposal site.
Evaluation of advantages and disadvantages		• lower costs. • smaller space • easier operation and fewer equipment • smaller sludge volume for disposal	• higher costs • larger space • more difficult operation and more equipment to operate and maintain • large amounts of phosphorus in the sludge is extracted to the effluent in the digestion process.
Cost Comparison	Construction	100 %	332 %
	O&M	82 %	84 %
	Benefits	0 %	22 %
	Depreciation	18 %	55 %
	O&M + Depreciation-Benefits	100 %	117 % (Cost of case 1 is set at 100%.)

Table 3-2-4-9 Use of Digester Gas Produced in Digestion

Content	Digester Gas as a fuel for Electricity Generation	Digester gas as city gas
Process Diagram		
Description of System	Digester gas is used to move gas turbines after hydrogen sulphide is removed from bio gas by chemical reaction in which hydrogen sulphide is oxidized to iron sulphide.	Digester gas is supplied to city gas after CO_2 and H_2S are absorbed under different pressures.

Characteristics	General	• Methane concentration of digester gas is 60%. • Digester gas is used as fuels for boiler, or gas turbine after de-sulphide treatment. • Processes are simple.	• Methane concentration of digester gas is more than 97%. - Removal rate of hydrogen sulphide is more than 98%.
	Advantages	• Mechanical troubles are rare.	• All gas can be used depending on the quality. • It is possible to remove siloxane. • Refined gas can be used as a fuel for CNG car. • Not much space is required with the medium pressure gas holder. - Corrosion of pipe does not occur due to a low dew point and dry conditions of refined gas.
	Disadvantages	• Sulphide removal agents have to be regularly replaced. • De-siloxane agent has to be regularly replaced. • Corrosion sometime occurs on gas holders and pipes when disulphide is deteriorated by sulphide acid produced in when hydrogen sulphide reacts with water. • Because desulphide concentration in biogas is monitored before and after treatment, equipments are easily corroded when hydrogen sulphide concentration suddenly increases due to the deterioration of treatment.	• Special operations are necessary to prevent negative pressure in the tank during the extraction of gas from the digester. • Sulphide removal is not conducted when there is power outage and system malfunction. (It is necessary to have a back-up system such as compressor, pump and so on.) - Maintenance should be conducted during low energy consumption periods when electricity produced by the bio gas is used in a STP. Because electricity is not produced during maintenance, supplemental power is necessary to continue to operate the treatment process.
Adoptability to this study		This system is adopted as the digester gas utilization system because STP can use electricity produced from digester gas and waste heat can warm a digester. ○	At the present, propane which is shipped from the main land. The island does not have a gas provider. Therefore, this system is not adopted. X

(4) Effect of Garbage Disposal Units

The use of garbage disposal units is expected in resort areas of Viet Nam in the future. In this section, the effect of using a garbage disposal unit is studied.

1) Effect of using garbage disposal units on the influent quality

Assumptions:

- Pollution load in a resort area is almost same as that of sewage in residential area.
- The increase of pollution loads would be 10 to 15 % for BOD and SS, and 5% for T-N and T-P based on Japanese data.
- The per capita pollution loads by using garbage disposal units are as follows:

BOD: 36 x 1.125 = 40.50 g/capita/d

SS : 41 x 1.125 = 46.13 g/capita/d

T-N : 7 x 1.05 = 7.35 g/capita/d

T-P : 1.1 x 1.05 = 1.16 g/capita/d

- 35% of the sewage comes from the resort area and 65% from households in the residential area.

Calculated influent of sewage

Item	Pollution load from resort area, g/capita/d	Pollution load from residential area, l/capita/d	Sewage from resort area, mg/l	Sewage from residential area, mg/l	Total, mg/l
BOD	40.50	156	260	230	240
SS	46.13	156	296	260	273
T-N	7.35	156	47	45	46
T-P	1.16	156	7	7	7

Based on the above table, total influent quality would be as follows:

BOD: 230 mg/l → 240 mg/l

SS : 260 mg/l → 273 mg/l

T-N : 45 mg/l → 46 mg/l

T-P : 7 mg/l → 7 mg/l

2) Effect of changing influent quality on treatment facilities

○ Effect of increased BOD, SS and T-N on sewage treatment facility

Based on the capacity calculations, when BOD and SS increase, the calculated volume for the aeration tank increased from 5,640 m^3 to 5,910 m^3 (only 5%). By modifying calculation coefficients within allowable ranges, calculated reactor volume for aeration tank would be reduced to 5,760 m^3 which is almost the same as the design volume without a garbage disposal unit (5,745 m^3). Based on these calculations, the increase of BOD and SS does not have negative effects on the treatment process.

Also, the increase of T-N from 45 mg/l to 46 mg/l is small and does not show negative effects on the design reactor without garbage disposal units.

○ Effect of increased BOD, SS and T-N on sludge treatment facility

Increase in solids is calculated as follows:

Input solids to thickening facilities: 9.08 t/d → 9.53 t/d

Input solids to dewatering facilities: 7.72 t/d →8.09 t/d

Solids loading rate for gravity thickener would be changed as follows:

Solids loading rate: 61.2 $kg/m^2/d$ → 64.2 $kg/m^2/d$

The range of design solids loading rate would be 60 to 90 $kg/m^2/d$. The increase of solids does not require any change in the design of gravity thickeners.

On dewatering facilities, the working time of dewatering machines would change as follows:
Working time: 5.5 hours → 5.8 hours
This working time is less than the planned working time which is 7 hours, the design does not need to be changed.

3) Results of effect on treatment facilities

The use of garbage disposal units does not affect the designs of STP because the changes caused by garbage disposal units are within the design ranges.

(5) Energy Saving Measures

Energy saving measures and biomass utilization in the STP are studied so that this project can contribute to the global effort to reduce electricity consumption and greenhouse gas emission.

1) Measures in STP for greenhouse gas reduction and the outcomes

By implementing energy saving measures in each unit process, a total cost of electricity can be saved by the final stage of the project.

2) Biomass utilization

Using digester gas is considered to be a way of reducing the biomass produced in sewage treatment processes. The need for digestion equipment and bio gas utilization equipment would increase the construction costs.

Based on the cost comparisons, the construction cost (on depreciation cost base) of digestion facilities is higher than incomes generated by selling electricity produced from the biogas. Therefore, digestion facilities are not adopted in this study.

The digestion with electricity generation from biogas should be studied in the future when the electricity price is higher.

(6) Reuse of Reclaimed Water

Phu Quoc Island has rainy season and dry season. In the dry season the water supply volume is not stable. Hotels would use ground water when there is water shortage. For Phu Quoc Island where the water resource is limited the use of reclaimed water could alleviate the water shortage problem. Reclaimed water instead of treated water could be used by hotels for landscape irrigation.

The establishment of reclaimed water quality for each usage would be needed. Reclaimed water could become a reliable water source.

1) Design reclaimed water volume

There is a plan to develop the Long Beach tourist area located north of the STP. Water would be needed for irrigation of the golf courses (Refer to PQDMB). In this study reclaimed water volume is determined based on the irrigation needs in this tourist area development plan. **Table 3-2-4-10** shows the reclaimed water volume. It is assumed that irrigation is conducted in dry season.

Table 3-2-4-10 Reclaimed Water Volume

Operator	**Reclaimed Water Volume**			
	Purpose	**Unit consumption, l/day/m^2**	**Area, m^2**	**Reclaimed Water Volume, m^3/day**
Khu du lịch Bãi Dài (Long Beach Tourist Area)	Landscape irrigation for golf courses	1.5	1,100,000	1,650
			Total	1,650

2) Reclaimed water quality and types of filtration

There are no standards for reclaimed water quality in Viet Nam. In this study, Japanese standards are used for the reclaimed water qualityas shown in **Table 3-2-4-11**.

The reclaimed water would be used for landscape irrigation with unrestricted access. There are two popular treatments to produce reclaimed water for irrigation water. One is sand filtration and other is microfiltration (MF). Those two treatments are compared in **Table 3-2-4-12** in terms of water quality characteristics of two treatments.

Table 3-2-4-11 Reclaimed Water Quality for Purposes

Item	**Purpose**			
	Toilet flushing	**Landscape irrigation with unrestricted access**	**Landscape irrigation with restricted access**	**Recreational uses**
Description	Water is used for toilet flushing.	Water is used for greenbelts, lawns, roads, and ground.	Water is used for landscape under the conditions that people would not be in contact with the reclaimed water.	Water is used for any purpose except for drinking. (including bathing, and fountain)
Coliform group	Not detected	Not detected	Below 10,000CFU/100ml	Not detected
Turbidity, NTU	Below 2 (Operational Target)	Below 2 (Operational Target)	Below 2 (Operational Target)	Below 2
pH	5.8 to 8.6	5.8 to 8.6	5.8 to 8.6	5.8 to 8.6
Appearance	Not offensive	Not offensive	Not offensive	Not offensive
Chromaticity	Not applicable	Not applicable	Below 40	Below10
Odor	Not offensive	Not offensive	Not offensive	Not offensive

Residual Chlorine	(Operational Target) More than 0.1 mg/l as released chorine or more than 0.4 mg/l as combined chlorine	(Operational Target) More than 0.1 mg/l as released chorine or more than 0.4 mg/l as combined chlorine	Not applicable	(Operational Target) More than 0.1 mg/l as released chorine or more than 0.4 mg/l as combined chlorine

Table 3-2-4-12 Reclaimed Water Quality Characteristics

Items	**Treated Water Quality**			
	Sand filtration (with chlorine treatment)	**Evaluation**	**MF (with chlorine treatment)**	**Evaluation**
Coliform group	Not detected due to chlorine treatment	○	Not detected	○
Turbidity, NTU	Below 2 (Operational Target)	○	Below 1	○
pH	5.8 to 8.6	○	5.8 to 8.6	○
Appearance	Not applicable	○	Not applicable	○
Chromaticity	Quality same as that of secondary treatment	○	Below 15	○
Odor	Quality same as that of secondary treatment	○	Quality same as that of secondary treatment	○
Residual Chlorine	More than 0.1 mg/l as released chorine by chlorine treatment	○	More than 0.1 mg/l as released chorine by chlorine treatment	○

Note: Applicability of reclaimed water to irrigation is evaluated.

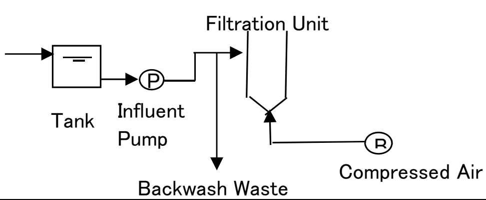
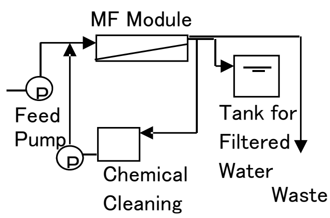
3) Comparisons of filtration types

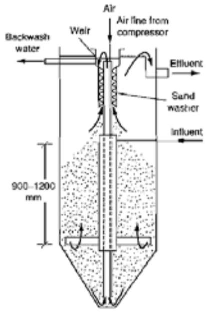
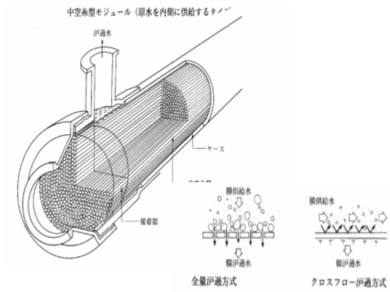
The reclaimed water from two filtrations, a sand filtration and MF methods satisfies the quality standard required for landscape irrigation with unrestricted access.

Table 3-2-4-13 shows the cost comparisons of sand filtration (deep-bed upflow continuous backwash filter) and MF.

Based on the comparisons, sand filtration (deep-bed upflow continuous backwash filter) is selected because the total cost of sand filtration is much lower than that of MF.

Table 3-2-4-13 Cost Comparisons of Filtrations

Content	**Deep-bed upflow continuous backwash filter**	**Microfiltration (MF)**
Process Diagram		

Description		Hollow Fiber Module 
	• Main unit is made of steel and the bed depth is about 1 m. 24 hour operation is possibleck. • Wastewater flows upward through a series of riser tubes and is distributed evenly into the sand bed. During upflowing SS is trapped by sand. • Washing is continuously conducted by sand washing equipment consisting of airlift tube and labyrinth structure.	• Materials of MF are polyethylene, polypropylene and others. Filtration is conducted by pressure differences, 450 kPa (5 kg/cm^2). There are two types of filtration methods, direct filtration and cross flow filtration (feedwater flows tangential to membrane. This flow prevents the fouling of the membrane by solids.).
Filtration Rate	Typical Filter Rate Advanced Treatment Manual* 300m^3/m^2/day JS Design Manual* 200m^3/m^2/day	Typical Filter Rate Membrane Treatment Manual* 2.5m^3/m^2/day
Treated Water Quality	Feedwater BOD 20 mg/l, SS below 20 to 30 mg/l Treated water quality BOD and SS below 10 mg/l	Feedwater BOD 20 mg/l, SS below 20 to 30 mg/l Treated water quality BOD and SS below 20 mg/l
Filter Media	Dual-medium made of anthracite (size of granular medium 1.5mm and bed depth more than 600 mm) and sand (size of granular medium 0.65mm, specific gravity 2.57 to 2.67 and bed depth more than 400 mm)	Materials of MF are polyethylene, polypropylene, polysulfone, acrylonitrile, cellulose acetate, polyamides, polyethersulfone, polyvinylfluoride and others
Pressure Loss	5.0 mAq	Maximum Pressure differences: 20.0 mAq (10 to 20mAq)
Washing Methods	Sand is washed continuously by filtered water.	Backwash process is decided by the membrane type. 1) First-wash Bubble+ water wash 2) Second-wash Backwash by air and filtered water (injected by pump or compressor)
Back wash Water volume for washing	Back wash volume: 5 to 10% of feedwater Operation: 24 h/d	Back wash volume: 2 % of feedwater
Construction	100%	729%
O&M	32 %	114%
Depreciation	68 %	494%
O&M + Depreciation	100 %	608% (Cost of a deep-bed upflow continuous backwash filter is a base cost.)

*Japanese Design Manual

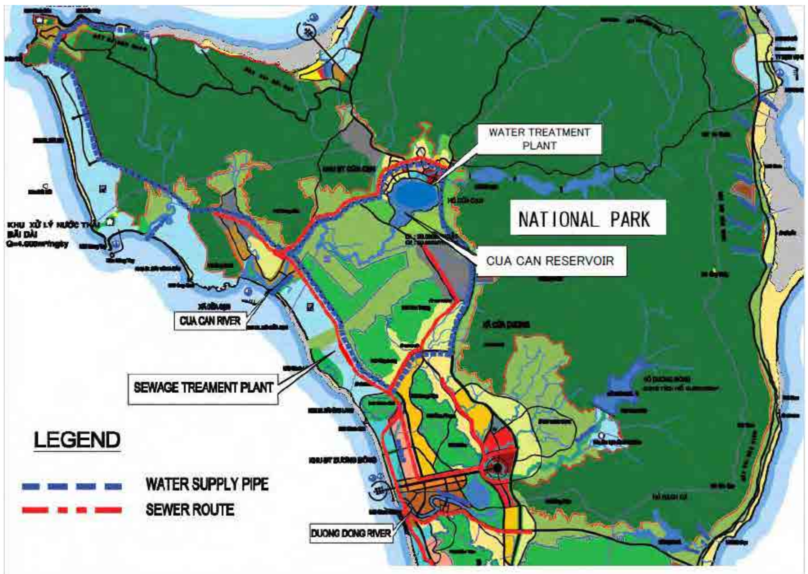
4) Cost Analysis on Reclaimed Water

User charge for reclaimed water is about 30 yen/m^3 (8,100VND/m^3) based on the sum of "depreciation cost of treatment & transmission facilities" and " O&M cost" divided by "used volume". Compared with 37 yen/m^3 (10,000 VND/m^3 for commercial use) of piped water charge, reclaimed water is economically viable.

3.3 Environmental and Social Considerations

3.3.1 Outline of Project Components That Have Environmental and Social Impacts

The main components of the project are; i) reservoir, ii) water supply system and iii) sewer system. The map shown below indicates the project are with the components.



Source: Master plan 2009

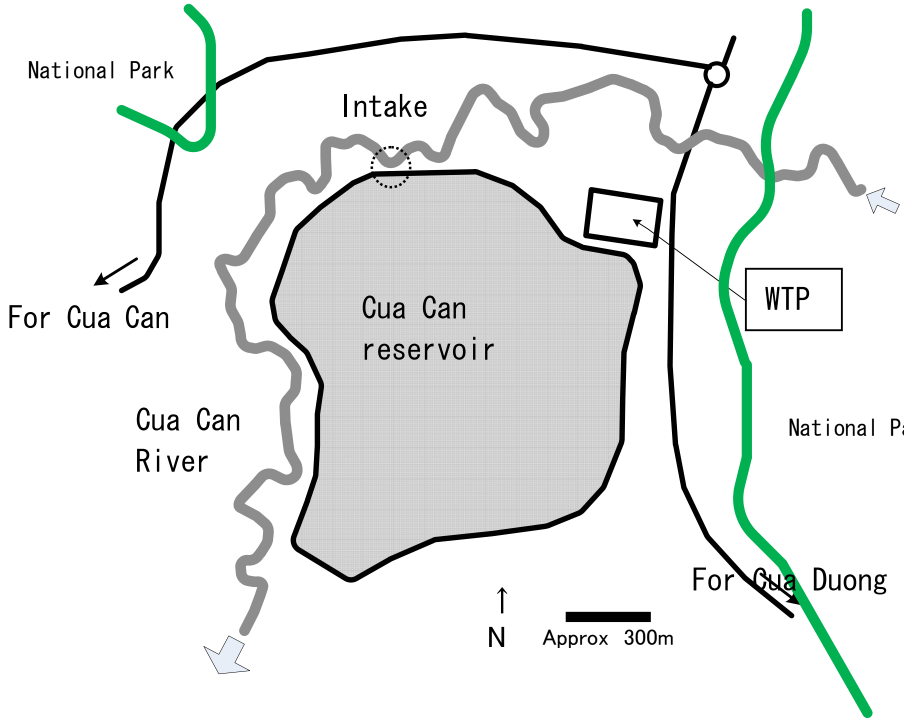
Figure 3-3-1-1 The Project Area

Figure 3-3-1-2 shows an outline of the Cua Can reservoir design. The Cua Can River will be left as it is and the Cua Can reservoir will be constructed on the side. This design avoids impacts to the Cua Can River by the construction of the Cua Can reservoir. Water will be withdrawn from the river only when extra water is available to preserve the current river environment in the future.

The Cua Can reservoir and the site of the planned WTP are outside the national park and the closest distance between the project sites and the park will be approximately 300m.

Soil excavated to create the reservoir will be used to construct the reservoir embankments therefore there is no significant problem with disposal of excess soil.

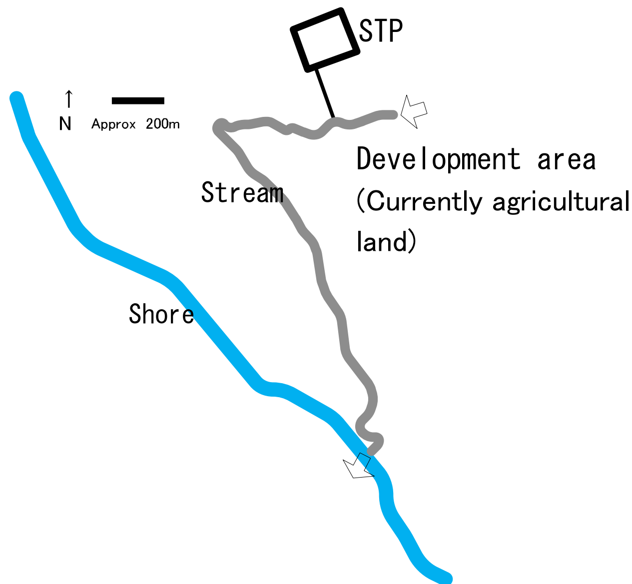
The WTP is scheduled to be constructed adjacent to the reservoir, and the site will be 3.5 ha (**Figure 3-3-1-2**).



Source: JICA Survey Team

Figure 3-3-1-2 Cua Can Reservoir & WTP

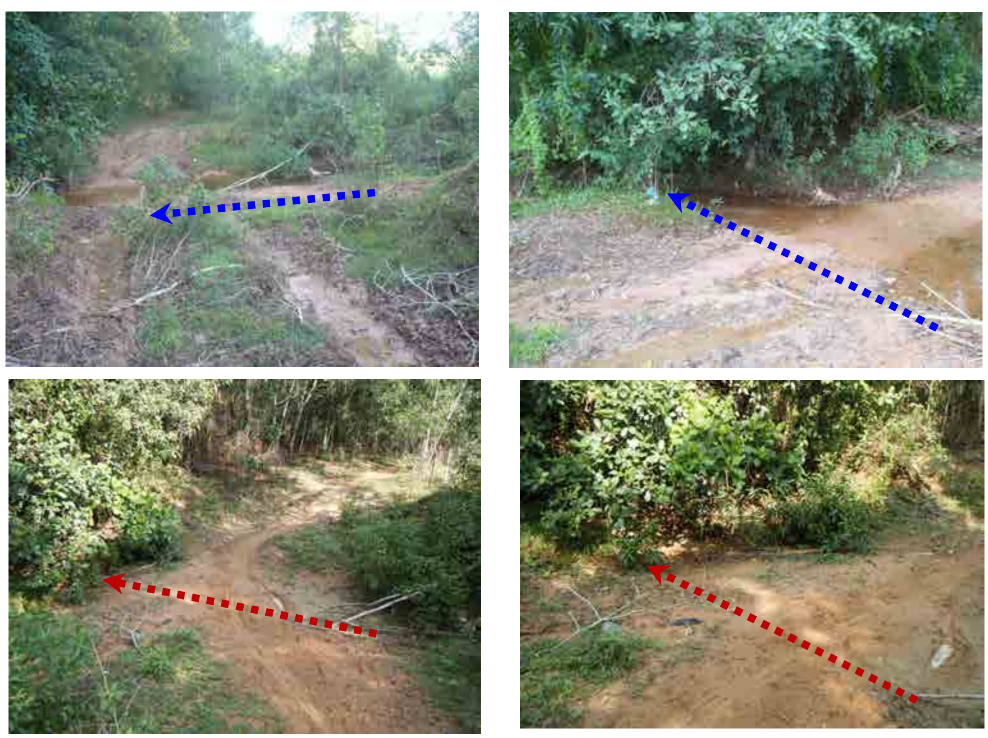
The STP site is approximately 2km upstream of a tributary that discharges to the sea. The site will be approximately 4ha. The stream to which the STP will discharge effluent is about 20cm deep and 2m wide in the wet season and is dry at other times of the year. The environment is not suitable for aquatic organisms or for fishery (**Figure 3-3-1-2** and **Picture 3-3-1).**



Source: JICA Survey Team

Figure 3-3-1-3 STP Planned Site

《Picture 3-3-1-1》The stream to which the STP will discharge effluent (upper: wet season, lower: dry season(no water observed))

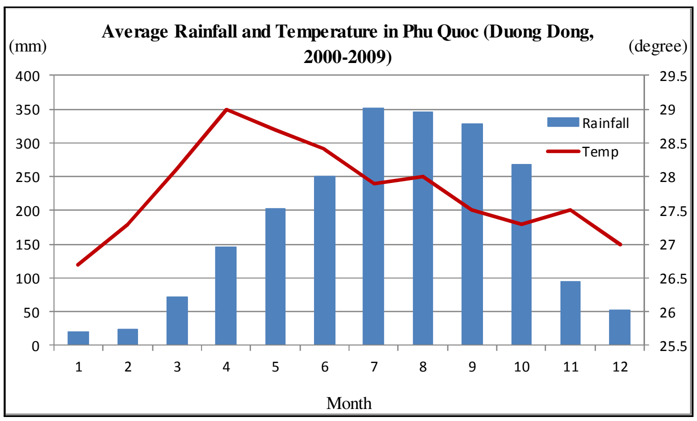


(by JICA Survey Team)

3.3.2 Current Environmental Conditions

(1) Meteorology

Phu Quoc Island has a tropical climate with monsoon which is divided into two distinct seasons: the rainy season lasting from May to November, and the dry season lasting from December to April of the next year with an average temperature of 27 deg C; average rainfall of 2,879 mm. The average rainfall and temperature in Duong Dong, Phu Quoc is shown in **Figure 3-3-2-1.**



Source: JICA Survey Team

Figure 3-3-2-1 Average Rainfall and Temperature

(2) Geography

Phu Quoc Island (Phú Quốc) is located in the Thailand gulf with the area of 560 km² (largest island in Vietnam). It is located 40 km away from Vietnam mainland. In the south of the island are small islands of An Thoi. In the North-east of the island, there is a border with islands of Cambodia. Cua Can River and Duong Dong River start from forests in the north-east part of the island and reach to the west shore. Alongside the shore, Long Beach and Sao Beach stretch out. Long Beach is located on the west side and is 20 km long.

(3) Water regime

a. Water quality

Water quality measured in October (wet season) 2011 and March (dry season) 2012 is shown in **Table 3-3-2-1**. The data indicates that there is no significant difference between the seasons and that the water quality resembles rain water with low pH and low concentration in hardness, dissolved solids and Cl^- . Harmful materials such as heavy metals are not present.

Table 3-3-2-1 Cua Can River Water Quality (supplying the Cua Can Reservoir)

Wet season (Oct. 2011)					
General item			Heavy metals, etc.		
Item	Result	Unit	Item	Result	Unit
Temperature	27.5	Deg C	Sb	Not detected	mg/L (<0.001)
Odor	None	-	As	Not detected	mg/L (<0.0005)
Color	10	TCU	Cd	Not detected	mg/L (<0.0005)
Turbidity	2.8	NTU	Cr	Not detected	mg/L (<0.005)
pH	5.3	-	Hg	Not detected	mg/L (<0.0001)
Hardness	6	mg/L	Se	Not detected	mg/L (<0.001)
Dissolved solid	36	mg/L	Ni	Not detected	mg/L (<0.005)
Alkalinity	6	mg/L	Fe	1.2	mg/L
Cl^-	8	mg/L	Mn	Not detected	mg/L (<0.005)
e-coli	450	Unit/100mL	Cyanide	Not detected	mg/L (<0.05)
Dry season (Mar. 2012)					
General item			Heavy metals, etc.		
Item	Result	Unit	Item	Result	Unit
Temperature	28.5	Deg C	Sb	Not detected	mg/L (<0.001)
Odor	None	-	As	Not detected	mg/L (<0.0005)
Color	12	TCU	Cd	Not detected	mg/L (<0.0005)
Turbidity	3.0	NTU	Cr	Not detected	mg/L (<0.005)
pH	5.2	-	Hg	Not detected	mg/L (<0.0001)
Hardness	8	mg/L	Se	Not detected	mg/L (<0.001)
Dissolved solid	12	mg/L	Ni	Not detected	mg/L (<0.005)
Alkalinity	6	mg/L	Fe	1.8	mg/L
Cl^-	8	mg/L	Mn	Not detected	mg/L (<0.005)
e-coli	4	Unit/100mL	Cyanide	Not detected	mg/L (<0.05)

Source：JICA Survey Team

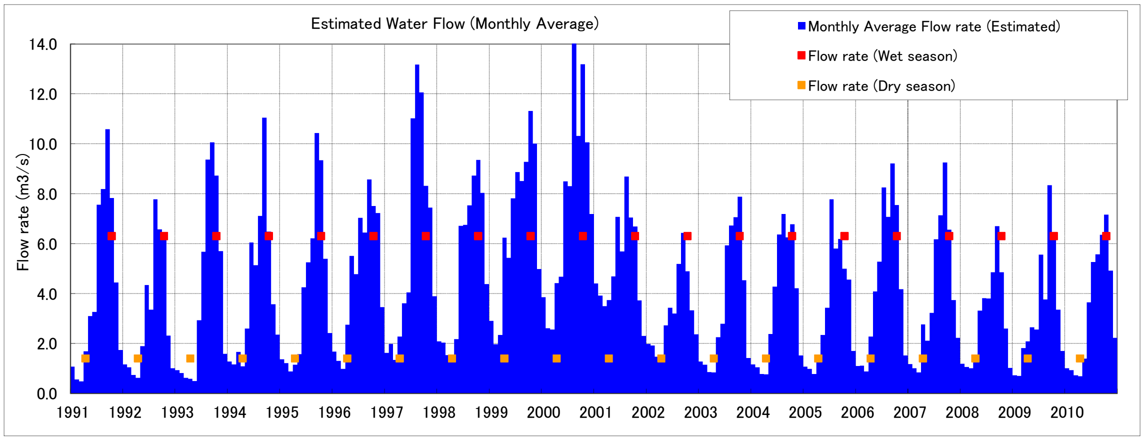
b. Flow Rate

The flow rate of Cua Can River is estimated from rainfall in the catchment area from a 20 year record as shown in the figure below. Wet seasons flows are 5-10 m^3/s on average more than dry season flows.

The reservoir will not take water from the river for 5 months during the dry season which means that it has to take enough water for the annual demand within the other 7 months. In that case it will be necessary to withdraw 0.4 m^3/s (on average) from the river to supply a WTP with a capacity of 20,000 m^3/day and 1 m^3/s (on average) for a WTP with a capacity of 50,000 m^3/day.

The flow rate of the Cua Can River at the station adjacent to the proposed reservoir site was 6.3 m^3/s during the wet season and 1.4 m^3/s during the dry season by simple measurement studies carried out by the JICA Survey Team.

As explained in the intake plan, no water will be taken from the river during the dry season and only a small rate of water will be taken during the wet season when there is more than sufficient water in the river. In other words, the intake will have a relatively insignificant impact with no observable difference before and after the project.



Source：JICA Survey Team

Figure 3-3-2-2 Cua Can River Flow-rate (measured and estimated)

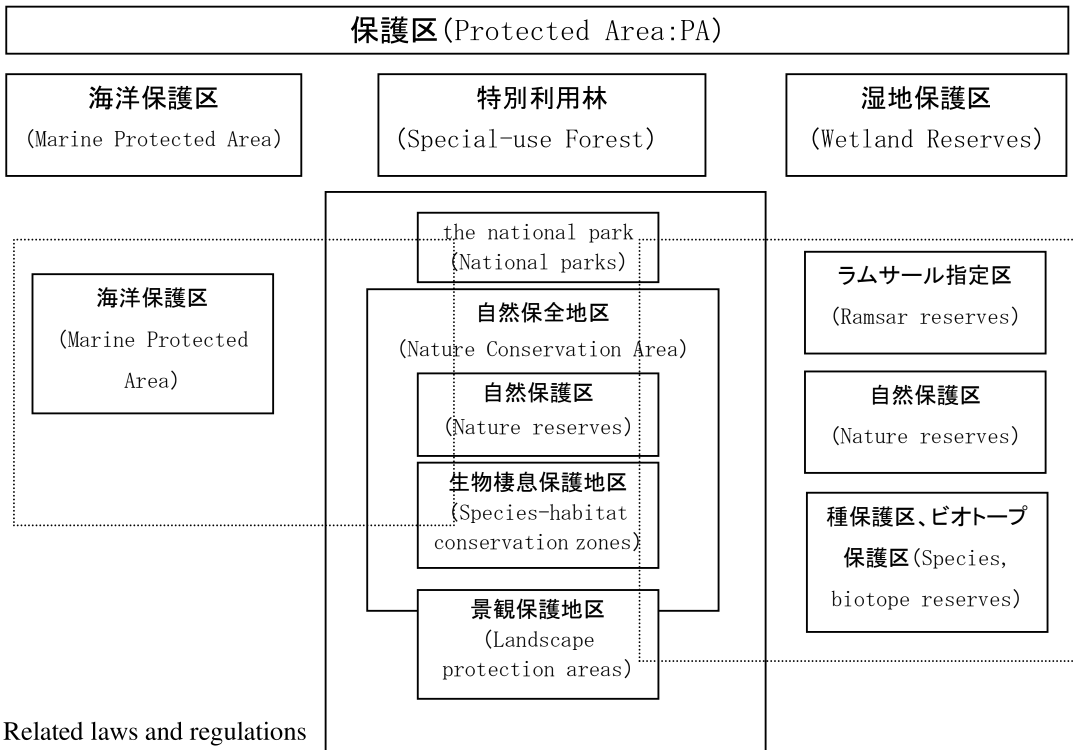
(4) Protected area

The national park occupies 56% of Phu Quoc Island. The national park is shown in deep green in **Figure 3-3-1-1** and covers the northern part of Phu Quoc Island. The project sites are all located outside of the national park and the closest distance will be approximately 300m.

The national park is categorized as a Special-use forest where the following conditions should be maintained; (i) conservation of biodiversity of forests and habitats of endangered species / rare species, (ii) fauna and flora valuable in terms of science, education, tourism and economy, (iii) values in terms of scenery, culture, history and environment.

Diagram of Protected area is shown in **Figure 3-3-2-3** and related laws and regulations are shown in **Table 3-3-2-2.**

The protected forest area shown in **Figure 3-3-3-4** is described in **3.3.3 (4) Land use** and is not included in the Protected area described below. .



Related laws and regulations

National MPA System Plan	No.29/2004/QH11 Decree No. 23/2006/ND-CP	No.109/2003/ND-CP No.109/2003/ND-CP No.18/2004/TT-BTNMT

(Source: JICA)

Figure 3-3-2-3 Diagram of Protected Area

Table 3-3-2-2 Main laws and Regulations of Special-use Forest Management

Laws and regulations	Date
Decree 58/LCT/HDNN	1991/08/19
Decision No. 327/CT	1992/09/15
Decree No. 14/CT	1992/12/05
Directive No. 130/TTg	1993/3/27
Decree No. 77/CP	1996/11/29
Directive 286/TTg	1997/5/2
Decision 661/1998/QD-TTg	1998/7/29
Decision 245/QD-TTg	1998/12/21
Decision 34/1999/QD-BNN-TCCB	1999/2/12
Circular 56/1999/TT-BNN-KL	1999/3/30
Decree 163/ND-CP	1999/11/16
Decision No. 08/QD-TTg	2001/01/11
Decree No. 139/2004/ND-CP	2004/01/25
No. 29/2004/Q11	2004/12/14
Decision No. 61/2005/QD-BNN	2005/10/12
Decision No. 62/2005/QD-BNN	2005/10/12
Decree No. 23/2006/ND-CP	2006/03/03

Source: Review of the Protected Area System of Vietnam (ASEAN Regional Centre for Biodiversity Conservation)

A buffer zone (shown in red in the following map) was designated around the National Park (Core Zone) in accordance with the idea of creating a Biosphere Reserve. A fire-prevention campaign was held for people living in the buffer zone . However, the division that was in charge of the management of the zone category was closed in 2005 and the status of the category has been uncertain for the time being.

Development projects in the Buffer Zone area are admitted by Decree No.23/2006/ND-CP and the approval shall be obtained through application to the National Park Management Board and the local PC.

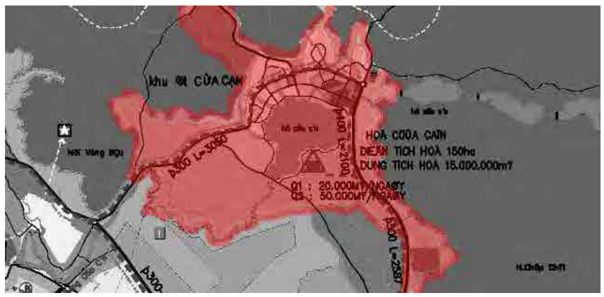


Figure 3-3-2-4 Buffer Zone related to the Project Sites

(5) Fauna

A fauna and flora study targeting the Phu Quoc national park was carried out by the University of Agriculture and Forestry (UAF) in 2005. In the study the total number of wildlife species confirmed was 206 in 75 families, 24 orders, 4 classes. 35 species are designated as rare or restricted for hunting. 15 species are in the IUCN red book (2004). 24 species are in the Vietnam red book (2000). 22 species are identified in Decree 32/2006/ND-CP. (**Table 3-3-2-3**). The study describes following as commonly seen wildlife.

・Mammals: classes of wild pig, deer, bat, monkey, otter, marten, squirrel.
・Birds: classes of duck, swallow, goosey, hornbill, heronry, pelican, robin, owl, pigeon, wagtail, woodpecker.
・Reptile / Amphibian: classes of snake, crocodile, turtle, lizard, frog.

Table 3-3-2-3 Rare or Restricted Species in the Phu Quoc National Park

Classification	No.	Scientific name	IUCN (2004)	SDVN (2000)	ND32 (2006)
Mammal	1	*Nycticebus coucang* *Nycticebus bengalensis*	DD	V	IB
	2	*Nycticebus pygmaeus*	VU	V	IB
	3	*Trachypithecus germaini*	DD		IB
	4	*Aonyx cinerea*	LR/nt	V	IB
	5	*Callosciurus finlaysoni harmandi*		R	
Bird	1	*Buceros bicornis*	T	NT	IIB
	2	*Ichthyophaga ichthyaetus*		NT	
	3	*Halcyon capensis*	T		
	4	*Polihierax insignis*		NT	IIB
	5	*Ketupa flavipes*			IIB
	6	*Copsychus malabaricus*			IIB
	7	*Gracula religiosa*			IIB

Classification	No.	Scientific name	IUCN (2004)	SDVN (2000)	ND32 (2006)
	8	*Tyto alba*			IIB
Reptile / Amphibian	1.	*Gekko gecko*		T	
	2.	*Physignathus cocincinus*		V	
	3.	*Varanus bengalensis*		V	IIB
	4.	*Varanus salvator*		V	IIB
	5.	*Python molurus*	LR/nt	V	IIB
	6.	*Python reticulatus*		V	IIB
	7.	*Elaphe prasina*		T	
	8.	*Elaphe radiata*			IIB
	9.	*Ptyas korros*		T	
	10.	*Ptyas mucosus*		V	IIB
	11.	*Bungarus candidus*			IIB
	12.	*Bungarus fasciatus*		T	IIB
	13.	*Naja atra*		T	IIB
	14.	*Ophiophagus hannah*		E	IB
	15	*Dermochelys coriacea*	CR	E	
	16.	*Chelonia mydas*	EN	E	
	17.	*Eretmochelys imbricata*	CR	E	
	18.	*Lepidochelys olivacea*	EN	V	
	19.	*Hieremys annandalii*	EN	V	IIB
	20.	*Malayemys subtrijuga*	VU		
	21.	*Amyda cartilaginea*	VU		
	22.	*Crocodylus siamensis*	CR	E	IIB

【Legend】
・IUCN (IUCN red book)
- Critically Endangered (CR) - Endangered (EN) - Vulnerable (VU) - Lower Risk / Near Threatened (LR/nt)
- Data Deficiency (DD)
・SDVN (Vietnam red book)
- Endangered: E - Vulnerable: V - Rare: R - Threatened: T
・ND32 (Decree 32/2006/ND-CP)
- IB (Wildlife species that are strictly prohibited to any hunting and use) - IIB (Wildlife species that can be limitedly hunted and used under strict control)

Source: Ecotourism Development Strategy of The Phu Quoc National Park（University of Agriculture and Forestry,2006）

The study did not include fish but the Department of Kien Giang Natural Resources and Environment (DONRE) which is planning an environmental study of the Cua Can River says it is assumed that there are only a few kinds of fish species in the river. Cua Can Commune's People's Committee reports that only a few kinds of fish inhabit the river and no fishing is carried out on the river. Phu Quoc National Park Management Board says rare wildlife is only found in the national park.

(6) Flora

The UAF study identified categories of flora such as; i) Mangrove, ii) Melaleuca Forest, iii) Brushland with Oncosperma tigillaria, iv) Dry forest, v) Open Dipterocarp forest, vi) Imperata grassland, vii) Secondary forests and viii) Primary Dipterocarp Forest. The project sites are located in secondary forests.

Table 3-3-2-4 shows the major flora systems in the national park summarized by the study.

Rare flora is not mentioned by the study and Phu Quoc Forestry Agent who attended a site visit by the JICA Survey Team in October 2011 says that no rare flora species exist in the proposed sites.

Vegetation in the proposed Cua Can Reservoir site is shown in **Table 3-3-2-5**. Two major types are miscellaneous trees (e.g. Melaleuca) and Acacia type trees making up secondary forests which are mainly exploited for lumber. Some kinds of Melaleuca trees are used for medical purposes but not in this region.

The areas downstream of the STP are also covered by secondary forests of artificial palm tree in lines, pine type trees and scrub. There are no natural or mangrove forests to be protected.

Table 3-3-2-4 Geo-botanical Elements in the Flora of Phu Quoc Island

Flora system	Typical elements		Number of Taxa
Malayano-Indonesian	-	Dipterocarpaceae	6 genera / 16 species
Hymalayano-Yunnan	Gymnospermae:	Podocarpaceae	2 genera / 4 species
		Gnetaceae	1 genera / 1 species
	Angiospermae:	Ulmaceae	1 genera / 1 species
		Oleaceae	3 genera / 3 species
		Aceraceae	10 genera / 12 species
		Rosaceae	1 genera / 1 species
		Fagaceae	2 genera / 4 species
		Lauraceae	6 genera / 8 species
Indo-Mianma	-	Combretaceae	5 genera / 7 species
		Lythraceae	1 genera / 3 species
		Bombaceae	2 genera / 2 species

Source: Ecotourism Development Strategy of The Phu Quoc National Park（University of Agriculture and Forestry,2006

Table 3-3-2-5 Vegetation in the Proposed Cua Can Reservoir Site

Vegetation	Area (Approximation)	Usage	Protection designation
Miscellaneous trees	90ha	Wood	None
Acacia	80ha	Wood	None
Orchard	9ha	Food	None
Pepper field	4.5ha	Food	None

Source: Cua Doung PC (2012)

3.3.3 Current Social Conditions

(1) Population

The population of Phu Quoc Island lives in 2 towns and 8 villages. The whole population of the island is approximately ninety thousand. **Table 3-3-3-1** shows changes in the population from 2005 to 2009.

Table 3-3-3-1 The Changes in Population 2005 - 2009

Town/Commune		Y2005	Y2006	Y2007	Y2008	Y2009
Town	Duong Dong	28,370	30,074	31,053	31,811	31,940
	An Thoi	17,854	18,927	19,531	20,292	19,880
Commune	Cua Can	3,058	3,241	3,345	3,429	3,394
	Cua Duong	7,213	7,655	7,899	8,096	7,789
	Ham Ninh	6,706	7,108	7,336	7,519	7,573
	Duong To	6,069	6,434	6,640	6,806	7,204
	Bai Thom	4,632	4,909	5,066	5,193	4,404
	Ganh Dau	3,904	4,138	4,271	4,378	4,294
	Hon Thom	2,697	2,859	2,950	3,024	2,438
	Tho Chau	1,480	1,563	1,612	1,652	1,755
Total		81,983	86,908	89,703	92,200	90,671

Source: Phu Quoc Census Book 2009

(2) Social economic condition

Major economic activities in Phu Quoc Island are fishery, black pepper and fish sauce (Nuoc Mam). **Table 3-3-3-2** shows the population by occupation in the island.

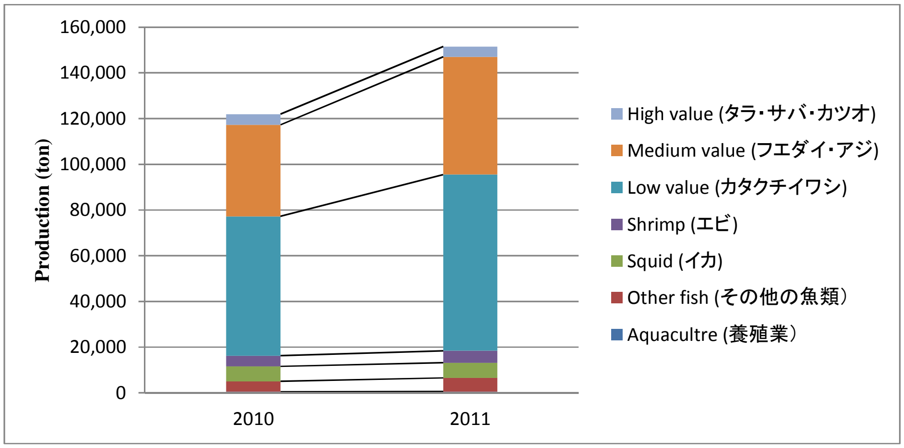
Table 3-3-3-3 shows important infrastructure such as educational and medical institutions. They do not exist within 2km of the project site.

The breakdown of production for the two major industries (fishery and agriculture) in Phu Quoc are shown in **Figure 3-3-3-1** and **2**.

Table 3-3-3-2 Population by Occupation

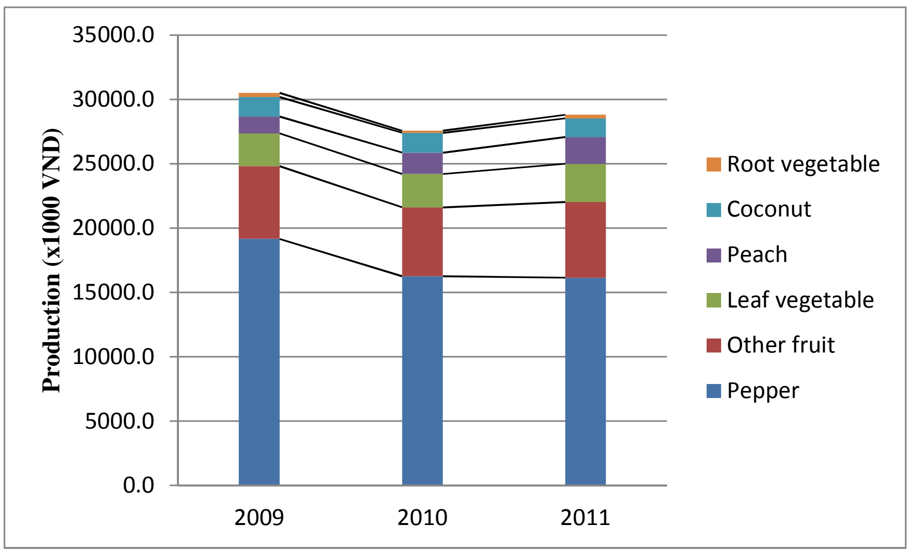
No.	Occupation	Population (2009)	Rate (%)
1	Aquatic product	13,546	14.94%
2	Agricultural production	7,446	8.21%
3	Commerce, Vehicle's Motor and Engine Repair	3,552	3.92%
4	Food Process Industry	3,146	3.47%
5	State Management , The National Defense Security, etc.	2,616	2.89%
6	Restaurants, Hotel	2,486	2.74%
7	Transportation, Warehouse, etc.	2,430	2.68%
8	Education and Training	970	1.07%
9	Construction	857	0.95%
10	Other	2,410	2.66%
-	Total	39,459	43.52%
Not working		51,212	56.48%

Source: Phu Quoc Census Book 2009



Source: Phu Quoc Statistic Bureau

Figure 3-3-3-1 Breakdown of Fishery Industry in Phu Quoc



Source: Phu Quoc Statistic Bureau

Figure 3-3-3-2 Breakdown of Agriculture Industry in Phu Quoc

Table 3-3-3-3 Important Infrastructure

No	Important infrastructure	Number
	Educational	
1	Primary School	11
2	Primary+ Secondary School	7
3	Secondary School	6
	Medical	
1	Hospital	1
2	Regional General Surgery Room	1
3	Town, Commune Medical Care Station	43

Source: Phu Quoc Census Book 2009 and JPST

(3) Tourism

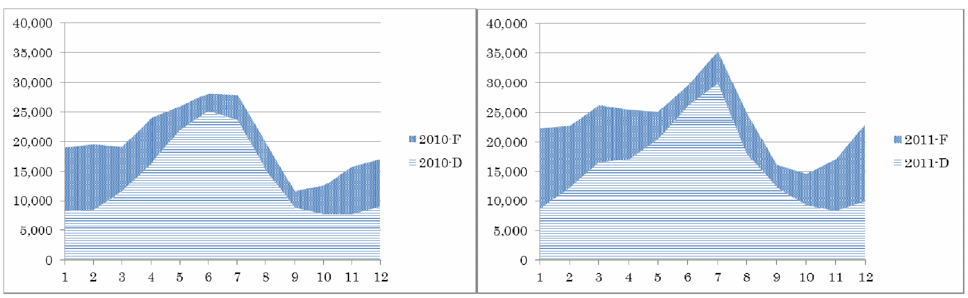
The number of tourists visiting Phu Quoc Island has increased in recent years as shown in **Table 3-3-3-4**. The change in the monthly tourist population is also shown in **Figure 3-3-3-3**. The number of domestic tourists is double the number of foreign tourists. Foreign tourists increase in the dry season (Dec.-Apr.) while the whole tourist population increases from May to July which is a major holiday season in Vietnam.

According to forecasts in the 2009 M/P, two million tourists in 2020 and 5 million in 2030 can be expected but the basis for the estimates are not described and it is assumed that the numbers are non-binding targets.

Table 3-3-3-4 Yearly Tourist Population in Phu Quoc

Year	2005	2006	2007	2008	2009	2010	2011
Tourist	130,400	148,200	160,200	184,100	220,350	239,794	282,270

Source: Phu Quoc Census Book 2009 and JICA Survey Team



Legend : F(foreign)/D(domestic), Source: Phu Quoc Statistic Bureau

Figure 3-3-3-3 Monthly Tourist Population in Phu Quoc

(4) Land use

Approximately 70% of Phu Quoc Island is forest and 20% is agricultural land. The project sites are located in agricultural lands. The site of the proposed reservoir will be on land with miscellaneous trees where logging and pepper and livestock farming take place. Depending on the final design it could include protected forest areas. The proposed WTP site will be on land with miscellaneous trees where there is no activity and grassland where livestock farming takes place. The proposed STP site will be on land with miscellaneous trees where there is no activity.

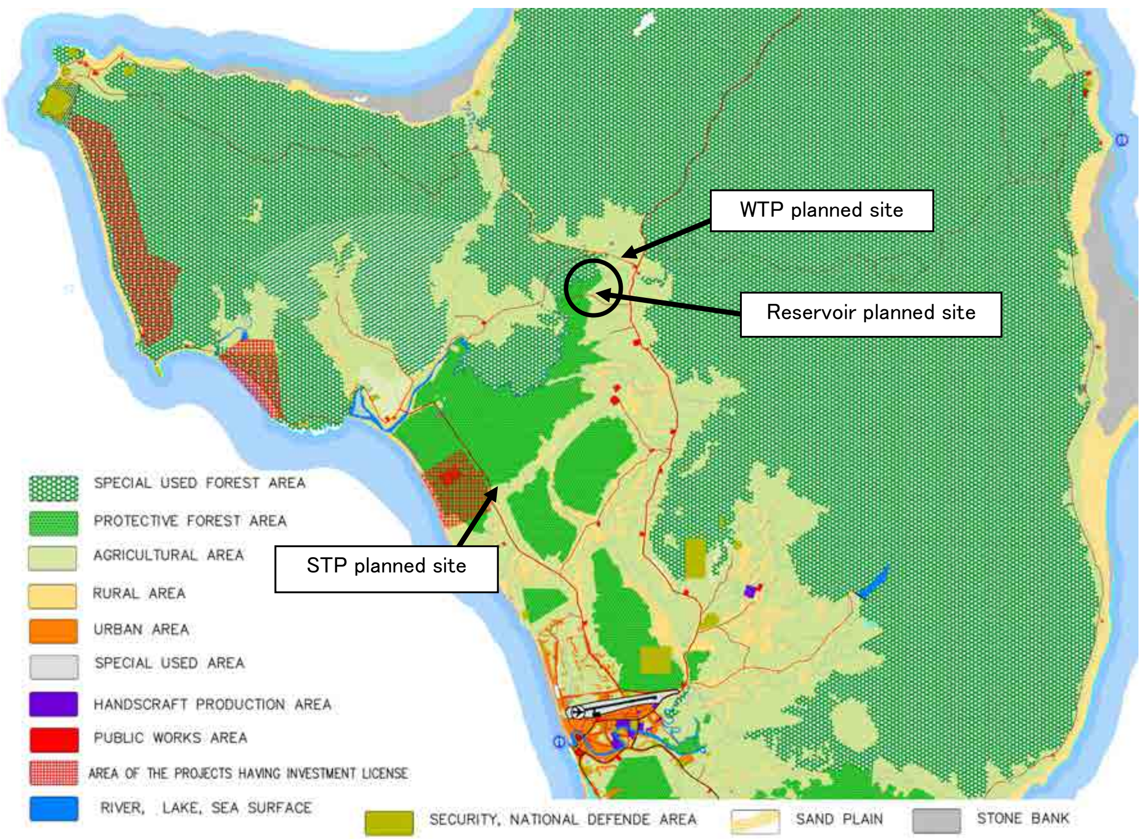
Protected forest areas are different from the Special-use forest mentioned in **(4)**. Protected forest areas can be designated for other land uses by following a certain procedure with the provincial People's Committee. There are no anticipated problems with the proposed sites

Land use conditions as of 2007 are shown in **Table 3-3-3-5** and **Figure 3-3-3-4**.

Table 3-3-3-5 Land Use Condition in Phu Quoc Island (2007)

No.	land use	Area(ha)	Rate
1	Urban area	872	1.5%
2	Touristic area	243	0.4%
3	Sporting facility, etc.	179	0.3%
4	Park / Green space	309	0.5%
5	Airport / Port site	969	1.6%
6	Agriculture	11,351	19.3%
7	Military related site	1,880	3.2%
8	Forest	41,757	70.9%
9	Other	1,355	2.3%
Total		58,915	100.0%

Source: Phu Quoc Census Book 2009



Source: Master Plan (2009)

Figure 3-3-3-4 Land Use Map of Phu Quoc Island

(5) Water use

No irrigation or fishery activity were observed in the Cua Can River downstream of the proposed reservoir, during site visits conducted by JICA Survey Team in October 2011. DONRE, in charge of water rights, says that river water is not used in the area. Cua Can Commune People's Committee, located in the area, says that there are no fishery activities.

Also in the stream near the proposed STP site there is no specific water use.

3.3.4 Environmental Social Consideration Regulation and Organization

(1) Outline of relevant laws and regulations
The requirements for EIA in Vietnam are prescribed by the Law on Environmental Protection (LEP; No.52/2005/QH11), Decree No. 80/2006/ND-CP, No. 21/2008/ND-CP and No. 29/2011/ND-CP.

The LEP was made public by decree No. 29/2005/L/CTN and came into effect in 2006. It prescribes Strategic Environment Assessment, EIA and Environment conservation pledge.

Decree No. 80/2006/ND-CP, No. 21/2008/ND-CP and No. 29/2011/ND-CP prescribe the LEP administrative set-up, EIA target project list, EIA procedure, and contents of an EIA report. By these decrees, it is prescribed that projects involving reservoirs of 100,000 m^3 or more and sewer system of 500 m^3/d or more need to prepare EIA reports. Therefore an EIA will be required for the proposed reservoir and the STP but not for the WTP.

An EIA report should be prepared within 24 months before the commencement of the project. The procedure to be followed is shown in section (2).

The approval authorities for the project are the Ministry of Natural Resources and Environment (MONRE) or DONRE.

Stakeholder consultation should be held at the stage of EIA report preparation, which is prescribed by Decree No. 29/2011/ND-CP.

For information disclosure, the decree describes that the authority send the EIA report to the proponent and the environmental departments and the Provincial PC distributes the copies to local PCs.

Table 3-3-4-1 shows laws and standards related to environmental and social consideration.

Table 3-3-4-1 Laws and Standards related to Environmental and Social Consideration

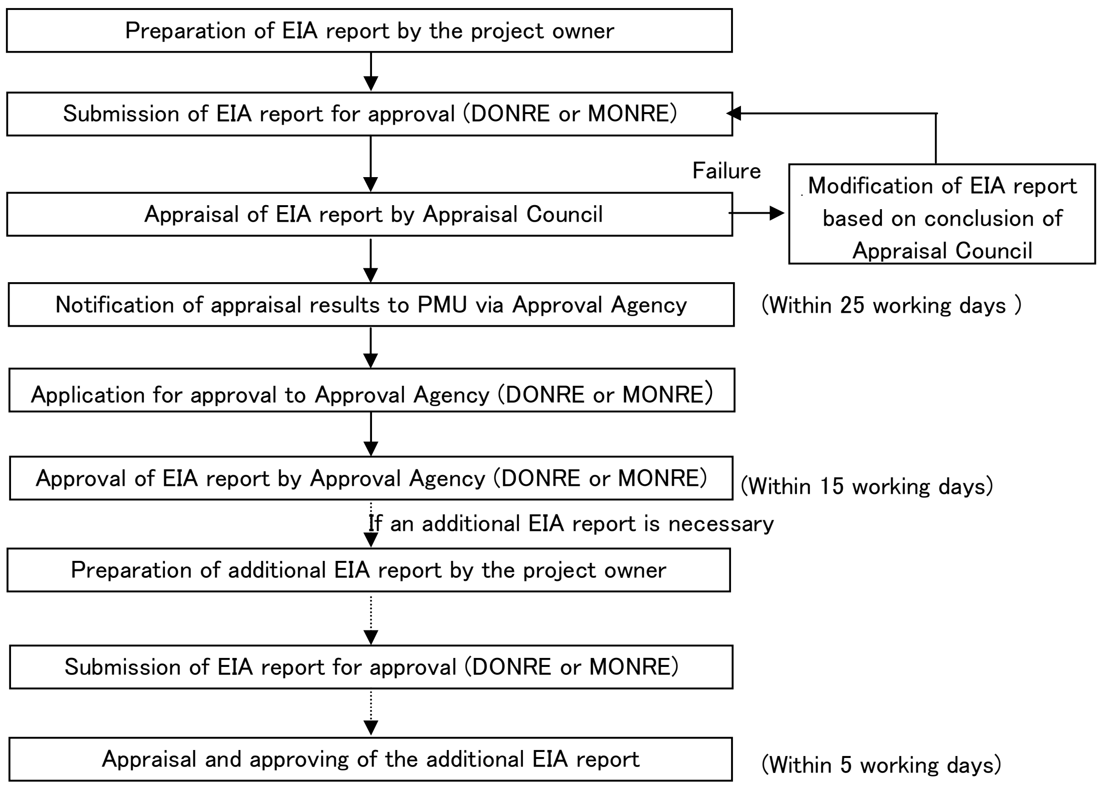
No.	Laws and standards
Laws and regulations	
1	LEP(No.52/2005/QH11)
2	Decree No. 80/2006/ND-CP
3	Decree No. 21/2008/ND-CP
4	Circular No 26/2011/TT-BTNMT
Environmental standards	
1	QCVN 05-2009
2	QCVN 06-2009

No.	Laws and standards
3	QCVN 19-2009
4	QCVN 20-2009
5	QCVN 24-2009
6	QCVN 08-2008
7	QCVN 09-2008
8	QCVN 10-2008
9	QCVN 26-2010
10	QCVN 14-2008
11	TCVN 7222-2002

Source: JICA Survey Team

(2) The EIA procedure

The procedure for appraisal and approval of the EIA report is shown in **Figure 3-3-4-1**.



Source: JICA Survey Team (by consultation with DONRE)

Figure 3-3-4-1 Procedure for Appraisal and Approval of the EIA Report

Contents of the environmental impact assessment report are as follows.

1) Enumeration and detailed description of the project's construction components, construction area, time and workload; operational technology for each component and the entire project.

2) Overall assessment of the environmental status at the project site and neighboring areas; the sensitivity and load capacity of the environment.

3) Detailed assessment of possible environmental impacts when the project is executed and

environmental components and socio-economic elements affected by the project; prediction of environmental incidents possibly caused by the project.
4) Specific measures to minimize bad environmental impacts, prevent and respond to environmental incidents.
5) Commitments to take environmental protection measures during project construction and operation.
6) Lists of project items, the program on management and supervision of environmental issues during project execution.
7) Cost estimates for building environmental protection works within the total cost estimate of the project.
8) Opinions of the commune/ward or township People's Committees (hereinafter collectively referred to as commune-level People's Committees) and representatives of population communities in the place where the project is located; opinions against the project location or against environmental protection solutions must be presented in the environmental impact assessment report.
9) Citation of sources of figures and data, assessment methods.

3.3.5 Alternatives Comparison (including the "without project" option)

(1) Result of alternatives comparison (water source for WTP)

Alternatives water sources for the WTP were considered. Alternatives are; i) "without the project", ii) ground water abstraction, iii) seawater desalination, iv) reservoir construction. A qualitative comparison of options is shown in **Table 3-3-5-1**. In terms of feasibility, reservoir construction was adopted.

Table 3-3-5-1 Alternatives Comparison (Water Source for WTP)

	Without project	Ground water	Seawater desalination	Reservoir construction
Benefit to Phu Quoc Island's water supply	×	○	○	○
Supply amount	—	— (relatively small)	○	◎
Exploitation restriction	—	×	—	—
Construction cost	—	— (relatively small)	×	△
OM cost	—	△	×	△
Increase of employment opportunity	—	○	○	◎
Impact to ground water	—	×	—	—
Flood prevention	—	—	—	○
Fire control	—	—	—	○
Scenery	—	—	—	○
Ecosystem	—	—	—	△
Land use	—	—	—	×

	Without project	Ground water	Seawater desalination	Reservoir construction
Air pollution	－	－	×	－
Water pollution	－	－	×	－
Waste	－	－	×	△
Noise and vibration	－	△	△	△
Geographical features	－	－	－	△
Global warming	－	△	×	△
Involuntary resettlement	－	－	－	△
Result of comparison	Rejected	Rejected	Rejected	Adopted
Conclusive aspect	Shortage of water supply	Shortage of water supply / ground water depletion	High cost	Feasible

【Legend】 － : No impact, × : Large adverse impact, △ : Adverse impact, ○ : Positive effect, ◎ : Significant positive effect

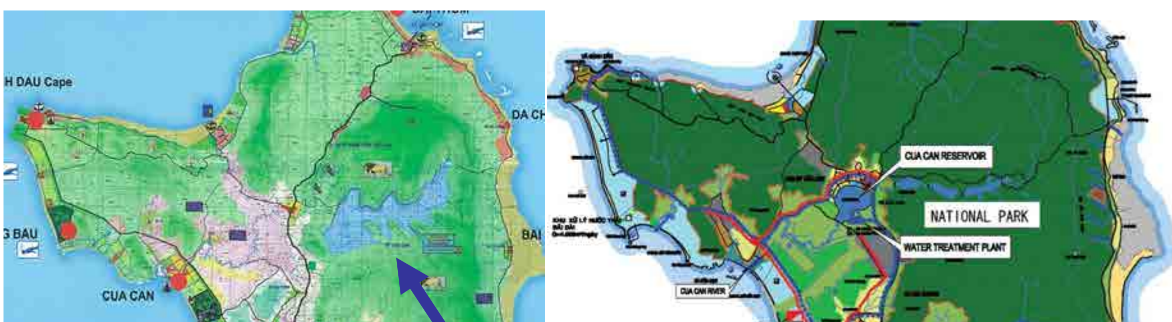
Evaluation includes considerations for the future.

(2) Result of alternatives comparison (Reservoir)

a. Scale of the project

A large-scale reservoir plan was first identified in the 2004 MP. Subsequently, in the 2009 MP, the large reservoir was divided into 5 smaller reservoirs including the Cua Can Reservoir. Three ponds were located inside the National Park and one pond outside.

In the current survey, it is proposed to have only one pond located outside the National Park to avoid environmental impacts. The survey has confirmed that it is possible to impound an adequate amount of water in a single pond.



2004 MP → 2009 MP（2010 Adjusted MP）

Large-scale Reservoir → Scattered into 5 smaller ponds in the Island

Figure 3-3-5-1 Change in Plans for Building Reservoirs

b. Location

The reservoir would occupy an area of about 15,000,000 m^3. The choice of available sites available is constrained by the need to avoid the national park limits. Thus, the proposed location was selected.

c. Methodology

The proposed site is located alongside the Cua Can River as shown in (i) below. The reservoir is separate from the stream to minimize the need for regulating flows and environmental impacts. The reservoir proposed in the 2009 MP was to be built by excavating the South-Eastern land of the river (ii).

(i) Present (ii) 2009 MP (iii) JICA Survey Team

Figure 3-3-5-2 Methodology of Building Reservoirs

(3) Result of alternatives comparison (sewer system)

Three alternatives are compared: "without the project", a centralized system and individual small systems. The results are shown in **Table 3-3-5-2**. Although it is more expensive, one of the main advantages of a centralized system is stable effluent water quality control. The cost for the individual small systems would normally be lower, however, when high effluent water quality is required, it ends up costing more. Even with the highest technical specifications, such small treatment systems generally cannot provide the required effluent water quality if the regulation on discharge water becomes more stringent. Furthermore, monitoring and managing water quality from individual small systems would be very difficult. As a result, central system is selected to protect the environment.

Sewage can be collected using combined or separate sewer systems. For the project, a separate sewer system is selected for the following reasons: i) to reduce costs since no major flooding problems are reported in the target area pipes can be smaller ii) to reduce environmental impacts because combined sewers usually overflow when it rains.

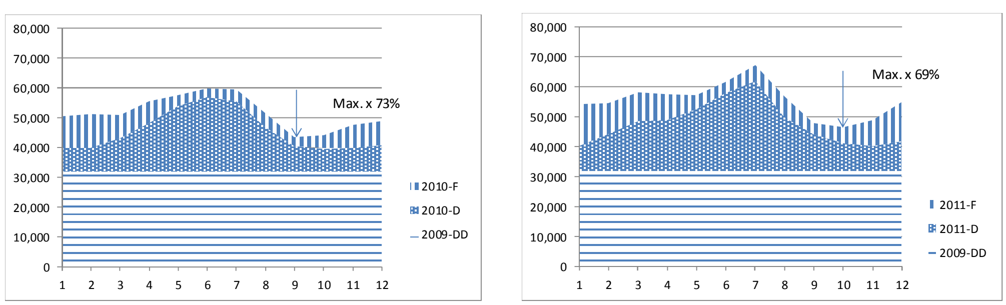
Table 3-3-5-2 Alternatives Comparison (Sewer System)

	Without project	Centralized system (broad area)	Individual systems
Water pollution	×	○	△

Odor	×	○	△
Public sanitation	×	◎	○
Construction cost	—	×	×
OM cost (tariff)	—	△	△
OM	—	○	△
Increase of employment opportunity	—	○	○
Waste	×	△ (reviewing composting)	△
Result of comparison	Rejected	Adopted	Rejected
Conclusive aspect	Pollution	Public sanitation	Difficulty of OM

【Legend】 — : No impact, × : Large adverse impact, △ : Adverse impact, ○ : Positive effect, ◎ : Significant positive effect

(Evaluation includes consideration for the future)



Legend : F(foreign)/D(domestic), Source: Phu Quoc Statistic Bureau

Figure 3-3-5-3 Yearly Change in Sewer Served Population (Estimated)

3.3.6 EIA Scoping

(1) Water Supply Reservoir

EIA scoping of the reservoir and associated facilities is shown in **Table 3-3-6-1**. The components are the reservoir, intake facility and raw water transmission facilities.

Table 3-3-6-1 EIA Scoping – Water Supply Reservoir

Item	Evaluation	Reason
1 Air pollution	B	Due to dust according to earthwork
2 Water pollution	B	Due to possibility of high-turbidity of Cua Can river
3 Soil pollution	D	No adverse impacts are expected
4 Waste	B	Due to producing soil waste
5 Noise and vibrations	B	Due to Noise and vibration according to earthwork and transfer
6 Ground subsidence	B	Impact is unknown so boring investigation is ongoing
7 Offensive odors	B	Due to Eutrophication and Rottenness of fish
8 Geographical features	A	Large-scale topographical change will take place. Impact to ground water may occur.
9 Bottom sediment	B	In case of eutrophication, sediment will be produced
10 Biota and ecosystems	B	Due to forced transfer to the animals
11 Water usage	B	Due to impact on ground water
12 Accidents	B	Due to accidents during construction and accidents along the reservoir
13 Global warming	B	Due to pump usage for intake and transmission
14 Involuntary resettlement	B	Due to and acquisition of 180ha or more and resettlement of residents
15 Local economies	A	Impact to worker depending on the site may occur
16 Land use	A	
17 Social institutions	D	No adverse impacts are expected
18 Existing social infrastructures and services	C	Impact is unknown so consideration should be done
19 Poor, indigenous, or ethnic people	C	
20 Misdistribution of benefits and damages	C	
21 Local conflicts of interest	D	No adverse impacts are expected
22 Gender	D	
23 Children's rights	D	
24 Cultural heritage	D	
25 Infectious diseases such as HIV/AIDS	C	Impact is unknown so consideration should be done

【Evaluation】 A : Large adverse impact is expected, B : Some adverse impact is expected, C : An adverse impact is indistinct, D : No adverse impact is expected

(2) Water supply system

Scoping of the water supply system is shown in **Table 3-3-6-2**. The components are the WTP, treated water transmission pipes, pumping stations, distribution reservoir and distribution pipes.

Table 3-3-6-2 EIA Scoping –Water System Facilities

Item	Evaluation	Reason
1 Air pollution 2 Water pollution 3 Soil pollution	D	No adverse impacts are expected
4 Waste	B	Due to soil waste and sludge waste
5 Noise and vibrations	B	Due to noise and vibration according to construction and transfer
6 Ground subsidence 7 Offensive odors	D	No adverse impacts are expected
8 Geographical features	B	No adverse impacts are expected for WTP. But distribution reservoir's design is unknown and to be considered
9 Bottom sediment	D	No adverse impacts are expected
10 Biota and ecosystems	C	Impact is unknown so consideration should be done
11 Water usage	D	No adverse impacts are expected
12 Accidents	B	Due to accidents during construction and operation
13 Global warming	B	Due to pump usage for distribution
14 Involuntary resettlement	B	To be discussed as the reservoir issue
15 Local economies	C	Impact is unknown so consideration should be done
16 Land use	B	Due to resettlement
17 Social institutions	D	No adverse impacts are expected
18 Existing social infrastructures and services 19 Poor, indigenous, or ethnic people 20 Misdistribution of benefits and damages	C	Impact is unknown so consideration should be done
21 Local conflicts of interest 22 Gender 23 Children's rights 24 Cultural heritage	D	No adverse impacts are expected
25 Infectious diseases such as HIV/AIDS	C	Impact is unknown so consideration should be done

【Evaluation】 A：Large adverse impact is expected, B：Some adverse impact is expected,
C：An adverse impact is indistinct, D：No adverse impact is expected

(3) Sewer system facilities

Scoping of the sewer system facilities is shown in **Table 3-3-6-3**. The components are separate sewers, pumping stations, STP and outlet channel.

Table 3-3-6-3 EIA Scoping – Sewer System Facilities

Item	Evaluation	Reason
1 Air pollution	D	No adverse impacts are expected
2 Water pollution	D	No adverse impacts are expected
3 Soil pollution	D	No adverse impacts are expected
4 Waste	B	Due to soil waste and sludge waste
5 Noise and vibrations	B	Due to Noise and vibration according to construction and transfer
6 Ground subsidence	D	No adverse impacts are expected
7 Offensive odors	D	No adverse impacts are expected
8 Geographical features	B	Due to Small-scale topological change
9 Bottom sediment	D	No adverse impacts are expected
10 Biota and ecosystems	C	Impact is unknown so consideration should be done
11 Water usage	D	No adverse impacts are expected
12 Accidents	B	Due to Accidents during construction and operation
13 Global warming	B	Due to CO_2 from reaction tank, pump, blower, dehydrator usage for distribution
14 Involuntary resettlement	B	Resettlement will not occur but land acquisition is necessary
15 Local economies	C	Impact is unknown so consideration should be done
16 Land use	B	Due to Resettlement
17 Social institutions	D	No adverse impacts are expected
18 Existing social infrastructures and services	C	Impact is unknown so consideration should be done
19 Poor, indigenous, or ethnic people	C	Impact is unknown so consideration should be done
20 Misdistribution of benefits and damages	C	Impact is unknown so consideration should be done
21 Local conflicts of interest	D	No adverse impacts are expected
22 Gender	D	No adverse impacts are expected
23 Children's rights	D	No adverse impacts are expected
24 Cultural heritage	D	No adverse impacts are expected
25 Infectious diseases such as HIV/AIDS	C	Impact is unknown so consideration should be done

【Evaluation】 A : Large adverse impact is expected, B : Some adverse impact is expected,
C : An adverse impact is indistinct, D : No adverse impact is expected

3.3.7 Environmental Impact Prediction / Assessment

Based on the scoping shown in **Table 3-3-6-1**, **2** and **3**, evaluation of predicted impacts and the mitigation measures are presented (**Table 3-3-7-1**, **2** and **3**). Many of them are described in the Environmental Management Plan (EMP) or Abbreviated Resettlement Plan (ARP).

Table 3-3-7-1 Evaluation of Predicted Impacts and Mitigation Measures (Reservoir)

Items	Scoping	Evaluation result	Reason / Mitigation measure
1 Air pollution	B	B	Due to dust according to earthwork
	EMP		e.g. watering
2 Water pollution	B	B	Due to possibility of high-turbidity of Cua Can river
	EMP		Water quality monitoring
4 Waste	B	B	Due to logging, excavated soil, waste material of used temporary facilities, common waste and human waste
	Consultation		1. Wood can be sold. 2. Excess soil can also be sold but the amount is extraordinary so coordination by KGPPC or GOV is necessary. The amount can be adjusted by the design. Currently, several options are presented. 3. Other wastes can be accepted by the existing waste dumping site.
5 Noise and vibrations	B	B	Due to Noise and vibration according to earthwork and transfer
	EMP		Noise and vibration measure before construction, prediction and consideration of mitigation / Adoption of low-vibration and low-noise machineries / Slowing down construction vehicles
6 Ground subsidence	B	D	Designing to prevent ground subsidence or corruption according to results of boring investigation
7 Offensive odors	B	D	Prevention of water quality deterioration by introduction of sewer system to catchment area
8 Geographical features	A	B	Monitoring is necessary because the reservoir is going to be built by large-scale excavation.
	EMP		Monitoring of abnormal changes caused by excavation
9 Bottom sediment	B	B	In case of outflow of sludge, sediment will be produced
	EMP		Monitoring of water quality
10 Biota and ecosystems	B	B	The site is mainly agricultural land and no protected trees are expected. No rare species are also expected but site studies should be conducted. Species such as native lizards possibly exist in the site and mitigation should be considered.
	Field study		・Flora study (Inventory study of existing vegetation with location) ・Fauna study (Refer to following / consider in and around the site) ○Mammal (Field sign study / Trap method) ○Bird (Line-census study) ○Reptile/Amphibian (Random check / collection) ○Insect (Random check & collection / Trap method)
	EMP		Trap & Release / Publicity and education to workers / Phase-to-phase construction
11 Water usage	B	B	Due to possible impact on ground water
	EMP		Monitoring of abnormal changes caused by excavation

Items	Scoping	Evaluation result	Reason / Mitigation measure
12 Accidents	B	B	Due to accidents during construction
	EMP		Safety management
13 Global warming	B	D	Consideration on energy saving for pumping facilities is carried out during the design.
14 Involuntary resettlement	B	B	Due to resettlement of approximately 50 people
	ARP		Resettlement and compensation
15 Local economies	A	B	Due to loss of large-scale agricultural lands
	ARP		Appropriate compensation
16 Land use	A	B	Due to removal of vegetation
	EMP		e.g. watering / collection and treatment of high-turbidity water, coagulation and sedimentation
18 Existing social infrastructures and services	C	D	No possible adverse impacts are expected.
19 Poor, indigenous, or ethnic people	C	D	No poor people inhabit the site. One lady from ethnic people, “Khome” inhabits but she immigrated from other region and possesses no traditional / ethnic valuable assets in the site.
20 Misdistribution of benefits and damages	C	B	Misdistribution is likely to occur according to resettlement and careful consideration must be done.
	ARP		Appropriate compensation
25 Infectious diseases such as HIV/AIDS	C	B	External workers are expected for a long period.
	EMP		Utilization of sanitary program / Consultation with local health authority

【Evaluation】 A : Large adverse impact is expected, B : Some adverse impact is expected,
C : An adverse impact is indistinct, D : No adverse impact is expected

Table 3-3-7-2 Evaluation of Predicted Impacts and Mitigation Measures (Water supply)

Items	Scoping	Evaluation result	Reason / Mitigation measure
4 Waste	B	D’	Excavated soil and sludge from the WTP can be sold. If not, can be dumped in designated dumping sites.
	EMP		Monitoring of adequate dumping
5 Noise and vibrations	B	B	Due to Noise and vibration according to earthwork and transfer
	EMP		Noise and vibration measure before construction, prediction and consideration of mitigation / Adoption of low-vibration and low-noise machineries / Slowing down construction vehicles
8 Geographical features	B	D	This issue is considered in the Reservoir component.

10 Biota and ecosystems	C	D	This issue is considered in the Reservoir component.
12 Accidents	B	B	Due to accident risks during construction and operation
	EMP		Safety management
13 Global warming	B	D	Consideration on saving energy for power-consuming facilities is included in the design.
14 Involuntary Resettlement	B	D	This issue is considered in the Reservoir component.
15 Local economies	C	D	No possible adverse impacts are expected.
16 Land use	B	D	This issue is considered in the Reservoir component.
18 Existing social infrastructures and services	C	D	No possible adverse impacts are expected. (result of consultation with PCs)
19 Poor, indigenous, or ethnic people	C	D	No possible adverse impacts are expected. (result of consultation with PCs)
20 Misdistribution of benefits and damages	C	D	No possible adverse impacts are expected. (result of consultation with PCs)
25 Infectious diseases such as HIV/AIDS	C	B	External workers are expected for a long period.
	EMP		Utilization of sanitary program / Consultation with local health authority

【Evaluation】 A : Large adverse impact is expected, B : Some adverse impact is expected,
C : An adverse impact is indistinct, D : No adverse impact is expected,
D' : No adverse impact is expected but need to be monitored

Table 3-3-7-3 Evaluation of Predicted Impacts and Mitigation Measures (Sewer system)

Items	Scoping	Evaluation result	Reason / Mitigation measure
4 Waste	B	D'	Excavated soil can be sold. If not, can be dumped in designated dumping sites. Sludge from STP will be concentrated and dumped in designated dumping sites.
	EMP		Monitoring of adequate dumping
5 Noise and vibrations	B	B	Due to Noise and vibration according to earthwork and transfer
	EMP		Noise and vibration measure before construction, prediction and consideration of mitigation / Adoption of low-vibration and low-noise machineries / Slowing down construction vehicles
8 Geographical features	B	D	Significant change of topological feature is not necessary because the selected site is in a flat area.
10 Biota and ecosystems	C	B	The site is mainly agricultural land and no protected trees are expected. No rare species are also expected but site studies should be conducted.
	Field study		・Flora study (Invention study of existing vegetation with location) ・Fauna study (Refer to following / consider in and around the site) ○Mammal (Field sign study / Trap method) ○Bird (Line-census study)

			○Reptile/Amphibian (Random check / collection) ○Insect (Random check & collection / Trap method)
12 Accidents	B	B	Due to accident risks during construction and operation
	EMP		Safety management
13 Global warming	B	D	Consideration on saving energy for power-consuming facilities is included in the design.
14 Involuntary Resettlement	B	B	Due to resettlement of a few residents
	ARP		Resettlement and compensation
15 Local economies	C	D	No possible adverse impacts are expected. (result of consultation with PCs)
16 Land use	B	B	Due to bare land under construction
	EMP		Prevention and minimization of dust by watering, etc.
18 Existing social infrastructures and services	C	D	No possible adverse impacts are expected. (result of consultation with PCs)
19 Poor, indigenous, or ethnic people	C	D	No possible adverse impacts are expected. (result of consultation with PCs)
20 Misdistribution of benefits and damages	C	D	No possible adverse impacts are expected. (result of consultation with PCs)
25 Infectious diseases such as HIV/AIDS	C	B	External workers are expected for a long period.
	EMP		Utilization of sanitary program / Consultation with local health authority

【Evaluation】 A：Large adverse impact is expected, B：Some adverse impact is expected,
C：An adverse impact is indistinct, D：No adverse impact is expected,
D'：No adverse impact is expected but need to be monitored

3.3.8 Costs of Implementing Mitigation Measures

a. Mitigation

Impacts and related mitigation measures are identified in **3.3.7 Environmental Impact Prediction / Assessment** and in **3.3.9 Environmental Monitoring Plan**. Mitigation measures should be updated according to the results of the subsequent EIA or the detailed design.

b. Cost

Mitigation consists of measures to be taken by the construction contractor as well as monitoring activities undertaken by the PMU. The cost for monitoring is going to be estimated at the EIA stage . Mitigation costs are included in the overall construction and O/M cost estimate and are not identified separately.

3.3.9 Draft Environmental Management Plan and Monitoring Plan

A draft environmental management plan based on the results of the survey is shown below for each major component of the proposed project.

Table 3-3-9-1 Draft Environmental Management Plan (Reservoir)

No.	Activities	Negative impacts	Mitigation measures	Cost Component	Implementation Unit	Supervision Unit
I	**Preparation phase**					
1	Land acquisition	Loss of vegetation, buildings and land	Replace or compensate lost assets according to current regulations of GOV and PQDPC	Resettlement and compensation cost	Center of Land Fund Development	PQDPC
2	Environmental background	Air-pollution / Dust	Identify baseline data and parameters to monitor the impact of the project.	Monitoring cost	Contractor / PMU / Environmental Consultant	Environmental Consultant
3		Noise / Vibration				
4		Surface water quality				
5		Ground water quality				
II	**Construction phase**					
1	Construction and transfer of materials and waste	Exhausted air pollutants	Maintain equipment and vehicles in good working order / Monitoring potential impacts	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	DONRE / PQDPC / PMU / Consultant
2		Noise / Vibration	Drive construction vehicles slowly when transferring soil. Maximize use of low-vibration & low-noise machineries. Prevent or minimize operation of heavy equipment at night / Monitor potential impacts			
3		Dust	Use watering agents to prevent or reduce dust. Drive construction vehicles slowly with load covers / Monitor potential impacts			
4		Polluted water	Monitor potential impacts			

No.	Activities	Negative impacts	Mitigation measures	Cost Component	Implementation Unit	Supervision Unit
5		Surface water quality				
6		Ground water quality				
7		Soil contamination				
8		Land use	Watering / collection and treatment of high-turbidity water, coagulation and sedimentation			
9		Any abnormal change to existing land use	Monitoring nearby wells and monitoring potential impacts by visual observation			
10		Worker & public injury	Follow workplace health and safety regulations of MoLISA / DoLISA. Utilize sanitary programs. Consultation with local health authority Use sufficient signage and fencing at construction sites	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	PQDPC (Division of health) / PMU / Consultant
11	Construction worker presence, and camp operation	Solid waste and domestic waste pollution	Institute a regular solids waste collection and disposal program including placement of disposal bins throughout camp and at all construction sites. Ensure adequate number of latrines at camp cleaned regularly. Temporary latrines maintained at construction sites.	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	DONRE / PQDPC / PMU / Consultant
12		Worker and public health problems	Ensure proper hygiene in worker camps. Workers should be tested for communicable diseases. Locate worker camp away from residential	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	PQDPC (Division of health) / PMU / Consultant

No.	Activities	Negative impacts	Mitigation measures	Cost Component	Implementation Unit	Supervision Unit
			areas			
13		Worker & public safety	Follow workplace health and safety regulations of MoLISA / DoLISA. Sufficient signage and fencing at construction sites			
14		Illegality prevention	Publicize prevention of illegality such as illegal logging, poaching, etc.	Construction cost	Contractor / PMU	PQDPC / PMU
15	General construction activities	Production of solid wastes, and waste construction fluids (e.g., oils) causing soil and surface water pollution	Implement solid waste collection and disposal program. Contain waste liquids for regular disposal with solid wastes in designated landfill.	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	DONRE / PQDPC / PMU / Consultant
16	Wildlife protection	changes in habitat and danger to wildlife	Educate construction workers about wildlife protection. Trap or catch wildlife and release off- site. Construct in a phased manner to provide an escape area for wildlife	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	DONRE / PQDPC (Division of natural resources and environment) / PQNPMB / PMU / Consultant
III	**Operation phase**					
1	Operation of the reservoir	Any abnormal change to existing land use	Monitoring nearby wells and monitoring potential impacts by visual observation	Monitoring cost	PMU	DONRE / PQDPC

Table 3-3-9-2 Draft Environmental Management Plan (Water Supply & Sewage)

No.	Activities	Negative impacts	Mitigation measures	Cost component	Implementation Unit	Supervision Unit
I	**Preparation phase**					
1	Land acquisition	Loss of vegetation, buildings and land	Replace or compensate lost assets according to current regulations of GOV and PQDPC	Resettlement and compensation cost	Center of Land Fund Development	PQDPC
2	Environmental background	Air-pollution / Dust	Identify baseline data and parameters to monitor the impact of the project..	Monitoring cost	Contractor / PMU / Environmental Consultant	Environmental Consultant
3		Noise / Vibration				
II	**Construction phase**					
1	Construction and transfer of materials and waste	Exhausted air pollutants	Maintain equipment and vehicles in good working order / Monitor potential impacts	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	DONRE / PQDPC / PMU / Consultant
2		Noise / Vibration	Drive construction vehicles slowly when transferring the soil. Maximize use of low-vibration & low-noise machineries. Prevent or minimize operation of heavy equipment at night / Monitor potential impacts			
3		Dust	Use watering agents to prevent or reduce dust. Drive construction vehicles slowly with load covers / Monitor potential impacts			
4		Land use	Watering / collection and treatment of high-turbidity water, coagulation			

No.	Activities	Negative impacts	Mitigation measures	Cost component	Implementation Unit	Supervision Unit
			and sedimentation			
5		Worker & public injury	Follow workplace health and safety regulations of MoLISA / DoLISA. Utilize sanitary programs. Consult local health authority Use sufficient signage and fencing at construction sites	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	PQDPC (Division of health) / PMU / Consultant
6	Construction worker presence, and camp operation	Solid waste and domestic waste pollution	Institute regular solids waste collection and disposal program including placement of disposal bins throughout camp and at all construction sites. Ensure adequate number of latrines at camp cleaned regularly. Temporary latrines maintained at construction sites.	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	DONRE / PQDPC / PMU / Consultant
7		Worker and public health problems	Ensure proper hygiene in worker camps. Workers should be tested for communicable disease. Locate worker camp away from residential areas	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	PQDPC (Division of health) / PMU / Consultant
8		Worker & public safety	Follow workplace health and safety regulations of MoLISA / DoLISA. Sufficient signage and fencing at construction sites			
9	General construction activities	Production of solid wastes, and waste construction fluids (e.g., oils) causing	Implement solid waste collection and disposal program. Contain waste liquids for regular disposal with solid wastes in a	Construction cost / Monitoring cost	Contractor / PMU / Environmental Consultant	DONRE / PQDPC / PMU / Consultant

No.	Activities	Negative impacts	Mitigation measures	Cost component	Implementation Unit	Supervision Unit
		soil and surface water pollution	designated landfill.			

For the execution of the project, a monitoring plan is needed to compare predicted and actual impacts. A draft monitoring plan is presented below. The contents should be updated during the subsequent EIA or the detailed design stage.

Table 3-3-9-3 Draft Environmental Monitoring Plan (Reservoir)

Summary of Impact / Mitigation	**Monitoring Indicators**	**Location**	**Frequency**	**Environmental Standard**	**Responsibility** Supervision / Implementation	**Reporting**
Pre-Construction Phase						
Resettlement & physical asset loss / Resettlement Plan	See Abbreviated Resettlement Plan (ARP)	See ARP	See ARP	See ARP	See ARP	See ARP
M-1: Air-pollution / Dust	SO2 / CO / NOx / O3 / TSP (Dust) / PM10 / Pb	Areas in and around the site (5+5st.)	twice with an interval greater than 2 months	TCVN 5937: 2005	PMU / Environmental Consultant	Monitoring reports prepared quarterly for PQDPC(Division of natural resources and environment)
M-2: Noise / Vibration	Decibel (dBa) levels	Areas around the site (5st.)	As above	TCVN 6962: 2001	As above	As above
M-3: Surface water quality	TSS	Upstream and downstream stations of CC River along the	As above	QCVN 08:2008 /BTNMT	As above	As above

		site				
M-4: Ground water quality	pH / TSS / TS / Cl- / E-coli	Surrounding areas (10st.)	As above	QCVN 08 / 09:2008/BTNMT	As above	As above
Construction Phase						
M-5: Air-pollution / Dust	SO2 / CO / NOx / O3 / TSP (Dust) / PM10 / Pb	Areas in and around the site (5+5st.)	Quarterly	TCVN 5937: 2005	PMU / Environmental Consultant	As above
M-6: Noise / Vibration	Decibel (dBa) levels	As above	As above	TCVN 5949: 1998	As above	As above
M-7: Solid waste pollution / Regular waste collection & disposal, placement of disposal bins throughout construction sites.	Amount of solid waste uncontained & littering the construction areas and worker camp	All construction areas (10st.)	As above	N/A	As above	As above
M-8: Polluted water / Light-polluted water such as hand-washed water should be stored for watering and should be monitored. Heavy-polluted water used for washing or cooking and containing organic materials should be disposed with solid waste	pH, DO, TSS, COD, BOD5, NH4+, Cl-, NO2, NO3, PO4 3-, Fe, total oil & grease, fecal coliform	Inside the reservoir (10st.)	As above	QCVN 08:2008/BTNMT	As above	As above
M-9: Surface water quality	TSS	Upstream and downstream stations of CC River along the site	2 times / month	QCVN 08:2008 /BTNMT	As above	As above

M-10: Ground water quality	pH / TSS / TS / Cl- / E-coli	Surrounding areas (10st.)	quarterly	QCVN 08 / 09:2008/BTN MT	As above	As above
M-11: Any abnormal change to existing land use	Visual observation	Surrounding areas (10st.)	As above	N/A	As above	As above
M-12: Soil contamination / Implement solid waste collection and disposal program. Contain waste liquids for regular disposal with solid wastes in designated landfill.	As, Cd, Cu, Pb, Zn	Excavated and reused soil (5samples)	As above	QCVN 03:2008/BTN MT	As above	As above
M-13: Worker & public safety / Follow workplace health and safety regulations of MoLISA / DoLISA. Sufficient signage and fencing at construction sites	Number of worker and public injuries	All construction areas (10st.)	As above	Decree 06/1995, Decree 10/2002/ ND-CP	As above	Monitoring reports prepared quarterly for MoLISA / DoLISA
M-14: Worker and public health problems / Ensure proper hygiene in worker camps. Workers should be tested for communicable disease. Locate worker camp away from residential areas	Incidence of sexually transmitted & other communicable diseases	Worker camp and nearby community (10st.)	As above	N/A	As above	Monitoring reports prepared quarterly for PQDPC(Division of health)
M-15: Wildlife protection	Outline (kinds & numbers) of Trap or Catch % Release result	All construction site locations (10st.)	As above	N/A	As above	Monitoring reports prepared quarterly for PQDPC(Division

						of natural resources and environment)
Operation Phase						
M-16: Ground water quality	pH / TSS / TS / Cl- / E-coli	Surrounding areas (10st.)	quarterly	QCVN 08 / 09:2008/BTNMT	As above	As above
M-17: Any abnormal change to existing land use	Visual observation	Surrounding areas (10st.)	As above	N/A	As above	As above

Table 3-3-9-4 Draft Environmental Monitoring Plan (Water Supply & Sewage)

Summary of Impact / Mitigation	**Monitoring Indicators**	**Location**	**Frequency**	**Environmental Standard**	**Responsibility** Supervision / Implementation	**Reporting**
Pre-Construction Phase						
Resettlement & physical asset loss / Resettlement Plan	See Abbreviated Resettlement Plan (ARP)	See ARP	See ARP	See ARP	See ARP	See ARP
M-1: Air-pollution / Dust	SO2 / CO / NOx / O3 / TSP (Dust) / PM10 / Pb	Areas in and around the site (4st.)	twice with an interval greater than 2 months	TCVN 5937: 2005	PMU / Environmental Consultant	Monitoring reports prepared quarterly for PQDPC(Division of natural resources and environment)
M-2: Noise / Vibration	Decibel (dBa) levels	Areas around the site & along pipelines (8st.)	As above	TCVN 6962: 2001	As above	As above
Construction Phase						
M-3: Air-pollution / Dust	SO2 / CO / NOx / O3 / TSP (Dust) / PM10 /	Areas in and around the	Quarterly	TCVN 5937: 2005	PMU / Environmental	As above

	Pb	site(4st.)			Consultant	
M-4: Noise / Vibration	Decibel (dBa) levels	Areas around the site & along pipelines (8st.)	As above	TCVN 5949: 1998	As above	As above
M-5: Solid waste pollution / Regular waste collection & disposal, placement of disposal bins throughout construction sites.	Amount of solid waste uncontained & littering construction areas and worker camp	All construction areas (5st.)	As above	N/A	As above	As above
M-6: Soil contamination / Implement solid waste collection and disposal program. Contain waste liquids for regular disposal with solid wastes in designated landfill.	As, Cd, Cu, Pb, Zn	Excavated and reused soil (5smpl)	As above	QCVN 03:2008/BTN MT	As above	As above
M-7: Worker & public safety / Follow workplace health and safety regulations of MoLISA / DoLISA. Sufficient signage and fencing at construction sites	Number of worker and public injuries	All construction site locations (10smpl)	As above	Decree 06/1995, Decree 10/2002/ ND-CP	As above	Monitoring reports prepared quarterly for MoLISA / DoLISA
M-8: Worker and public health problems / Ensure proper hygiene in worker camps. Workers should be tested for communicable disease. Locate worker camp away from residential areas	Incidence of sexually transmitted & other communicable diseases	Worker camp and nearby community (10smpl)	As above	N/A	As above	Monitoring reports prepared quarterly for PQDPC(Division of health)

3.3.10 TOR for Environmental and Social Considerations Study

(1) Purpose of the Study

The purpose is to predict and assess the contents and scale of possible impacts to the natural and social environment by the water supply and sewerage system project which is outline-designed in "the Preparatory Survey on Water Supply and Sewerage System Project in Phu Quoc Island, Vietnam".

(2) Items to be targeted in the study

In principle, items with an evaluation of A, B and C in **3.3.6 Scoping** should be studied and evaluated.

(3) Target areas

Target areas are proposed construction sites and the areas around the project facilities. Access roads, where they are necessary, should also be included.

(4) Target periods

Target periods for the study are the stages of planning, execution and operation of the project.

(5) Scope of work

1) Acquisition of information

The scope of work for the study including details on contents, type of study and methodology are shown in **Table 3-3-10-1** and **2**.

Table 3-3-10-1 Scope of Work for the Impact Assessment (Reservoir)

Evaluation	No.	Item	Studies / Countermeasures	Methodology	Status
A	8	Geographical features	Geological study	Drilling study	Done
			Ground water countermeasures	Excavation of land can affect ground water but the drilling study result indicates low possibility of it.	Done
	15 16	Local economies / Land use	RAP preparation	Countermeasures for workers depending on the proposed site for the reservoir should be considered in a draft abbreviated RAP	ARP
			Secondary forest use study	Acquisition of information from the authorities concerned (Phu Quoc Forestry Agency, Cua Duong PC)	Done
B	1	Air pollution	Pollution countermeasures	Recommendations on the prevention of dust caused by large-scale excavation	Done
	2	Water pollution	Pollution countermeasures	Water quality analysis of the river water before construction	Done
				Recommendations for the prevention of soil erosion and suspended solids in runoff from the construction sites	Done
	4	Waste	Waste countermeasures	Estimate of soil produced and used	Done
				Confirmation on waste dumping sites and reception facilities	Done
				Coordination with other development projects	Done
				Recommendations for removal of temporary facilities by the contractor at the end of the construction	Done

Eval-uation	No.	Item	Studies / Coun-termeasures	Methodology	Status
				Consultation on treatment methods for construction wastes, general wastes and human wastes with the authorities concerned (DONRE, etc.)	Done
	5	Noise and vibrations	Noise survey	Recommendations for noise measurement before construction, prediction and countermeasures	EIA
			Noise and vibration countermeasures	Recommendations for countermeasure such as reduce noise and vibration of transport of construction materials.	Done
	7	Offensive odors	Odor control measures	Recommendations for the control of offensive odors	Done
	9	Bottom sediment	Turbidity overflow prevention	Recommendations for the prevention of soil erosion and suspended solids in runoff from the construction sites	Done
	10	Biota and ecosystems	Flora survey	Document review / Acquisition of information from the authorities concerned	Done
				Site survey (frequency and contents will be suggested according to consultation with associated authorities)	EIA
			Fauna survey	Document review / Acquisition of information from the authorities concerned	Done
				Recommendations from specialists	EIA
				Site survey (frequency and contents will be suggested according to consultation with associated authorities) in and around the planned sites. e.g. Surveys for mammal, bird, reptile, amphibian and insects	EIA
	12	Accidents	Safety measure	Recommendations on safety measures during construction	Done
				Confirmation on the structural safety of the intake facility and the reservoir during the design	Done
	13	Global warming	Energy-saving strategy	Consideration on energy-saving pumps for the intake facility	Done
	14	Involuntary resettlement	ARP preparation	Preparation of a draft Abbreviated Resettlement Plan (ARP)	Done
			Land-acquisition procedure	Considerations for smooth land acquisition process	ARP
C	18	Existing social infrastructures and services	Socioeconomic survey	Consultation with PCs	Done
	19	Poor, indigenous or ethnic people	Socioeconomic survey	Interviews with PCs to confirm the existence of poor people	Done
				Initial baseline survey of RAP preparation	ARP
	20	Misdistribution of benefits and damages	Socioeconomic survey	Consultation with labor-related authorities	Done
	25	Infectious diseases such as HIV/AIDS	Sanitation	Consultation with associated authorities (Department of Health) and related organization (Women's Union)	Done

Table 3-3-10-2 Scope of Work for the Impact Assessment (Water Supply and Sewer System)

Eval-uation	No.	Item	Study / Coun-termeasure	Method	Status
B	4	Waste	Waste countermeasure	Estimate of soil produced and used	Done
				Consideration on the disposal method for trees logged at the proposed construction site	Done
				Estimate of sludge quantity from WTP and STP	Done
				Considerations for the application of sludge from the WTP on agricultural fields	Done
				Reviewing composting sludge from STP	Done

Eval-uation	No.	Item	Study / Coun-termeasure	Method	Status
				Confirmation of reception facilities for wastes (materials from settling and screening, dehydrated sludge)	Done
	5	Noise and vibrations	Noise survey	Recommendations on noise measurement before construction, prediction and countermeasure	EIA
			Noise and vibration countermeasure	Study on proximity of the proposed construction sites and nearby residences	EIA
				Recommendations on low-noise and vibration type machinery for pipeline construction	Done
				Recommendations on countermeasures such as reduce noise and vibration of transport of construction materials.	Done
	8	Geographical features	Geological study	Drilling survey	Done
			Consideration on topological conversion	Minimizing ground leveling for sites of WTP and STP	Done
	12	Accidents	Safety measure	Recommendations on safety measures during construction	Done
				Recommendations on safety measures during operation of WTP and STP	Done
	13	Global warming	Energy-saving strategy	Reviewing energy-saving measures for pumps, blower and dehydrator in associated facilities	Done
	14	Involuntary resettlement	ARP preparation	Preparation of a draft Abbreviated Resettlement Plan (ARP)	Done
				Consideration on smooth procedure for land acquisition for WTP and STP	ARP
	16	Land use	Countermeasure for dust and high-turbidity water	Sites for WTP and STP will occupy limited areas with only 4-6 ha, however, dust prevention by watering, high-turbidity reduction by coagulation treatment are recommended because the land will be stripped bare.	Done
C	15	Local economies	Socioeconomic survey	Meetings on the local economies with PCs	Done
				Initial baseline survey of ARP preparation	ARP
	18	Existing social infrastructures and services	Socioeconomic survey	Consultation with PCs	Done
	19	Poor, indigenous or ethnic people	Socioeconomic survey	Meetings on the local economies with PCs	Done
				Initial baseline survey of ARP preparation	ARP
	20	Misdistribution of benefits and damages	Socioeconomic survey	Consultation with labor-related authorities	Done
	25	Infectious diseases such as HIV/AIDS	Sanitation	Consultation with associated authorities (Department of Health) and related organization (Women's Union)	Done

2) Prediction and evaluation of the impacts by the project

Prediction and evaluation of the impacts which may be caused by the project should be conducted for all items evaluated as A, B or C in **3.3.6 Scoping**.

Each item should be re-evaluated as the survey proceeds and the scoping should be updated accordingly. Subsequently, items with A and B after the update shall be evaluated in terms of the scale. For the evaluation, aspects such as population, areas and periods should be expressed quantitatively as far as possible.

3) Consideration on the Environment Management Plan (EMP) and the monitoring plan
When environment impacts are unavoidable, the EMP to mitigate the extent of impacts and the monitoring plan should be prepared in consultation with the authorities concerned. The EMP and the monitoring plan should consider implementation requirements such as frequency, institutional aspects, necessary reinforcement of the organization and budgets.

4) Stakeholder consultation
The results of the Environmental and Social Consideration Study mentioned above shall be presented at stakeholder consultation meetings and the stakeholders' opinions shall be recorded.

3.3.11 Stakeholder consultation

The survey is categorized as type-A according to JICA's environmental and social consideration guidelines. Thus, a stakeholder consultation for the draft scoping was conducted. In addition, a second consultation was also held at the stage of the draft final report. The outline of the meetings is shown in **Table 3-3-11-1**.

Table 3-3-11-1 The Outline of Stakeholder Consultations

	The first	The second (scheduled)
Purpose	Consultation on the scoping draft	Consultation on the survey result / EIA contents and methods
Date	16/12/2011	21/6/2013
Venue	Phu Quoc District PC, Kien Giang province	Phu Quoc Island, Kien Giang province
Theme	- Project outline - Scoping draft	- Project outline - Survey results
Stakeholder	**Table3-3-11-2**	**Table3-3-11-3**

(1) The First Stakeholder Consultation
At the first stakeholder consultation, an outline of the project and the scoping draft was presented by KGPPC. Subsequently, consultation with the attendees was held. Discussions focused on the potential impacts of the reservoir on the national park and downstream areas of the river as well as the location of STP. Accordingly, it was explained that; i) the reservoir would be located outside the national park, ii) the reservoir would have no negative impact on downstream areas, and iii) the location of the STP was decided according to the Master Plan and after detailed consideration and consultation.

In addition, anonymous opinions from attendees were collected in order to hear people who may have difficulty to give opinions at the meeting. The opinions are similar to ones given in the meeting and these are summarized by the JICA Survey Team in the minutes of meeting (attached as Annex-5).

Table 3-3-11-2 The 1st Stakeholder Consultation Attendees

Affiliation	No.
District PC	3
Inhabitants	3
Central Government South-western Steering Board	1
Construction Department	1
KIWACO	3
KGPPC	4
DONRE	5
DARD	1
Phu Quoc National Park	1
Phu Quoc Military Service	1
Associated organization	2
NGO (PQ women's Association)	1
Mass media (television / radio station)	2
Construction consultant	3
Kobelco Eco-Solutions Vietnam	3
JICA Survey Team	10
Total	44

(2) The Second Stakeholder Consultation

At the first stakeholder consultation, an outline of the project and the scoping draft was presented by KGPPC. Subsequently, consultation with the attendees was held. Discussions focused on the potential impacts of the reservoir on the Cua Can River, concerns about sedimentation in the reservoir and the location of STP. Accordingly, it was explained that; i) the intake amount is limited and water is only withdrawn in the wet season, ii) the problem of sedimentation is not likely to occur in this type of reservoir, iii) the location of the STP was decided according to the Master Plan and after detailed consideration and consultation. Otherwise, there were many supportive opinions and no significant adverse attitudes.

In addition, anonymous opinions from attendees were collected in order to hear people who may have difficulty to give opinions at the meeting. The opinions are; i) concerns about the amount of water taken from the river, ii) resettlement and iii) STP service area planning. They are summarized by the JICA Survey Team in the minutes of meeting (attached as Annex-5).

Table 3-3-11-3 The 2nd Stakeholder Consultation Attendees

Affiliation	No.
District PC	3
Inhabitants	3
KIWACO	3
Phu Quoc National Park	1
NGO (PQ women's Association)	1
Mass media (television / radio station)	2
PQ Urban Management Department	1
PQ Resource & Environment Department	1

Affiliation	No.
PQ Management Board	1
PQ Economics Department	1
PQ Protection Forest Management Unit	1
PQ Land Fund Development Center	1
PQ Finance & Planning Department	1
Kobe city	1
Kobelco Eco-Solutions Vietnam	5
JICA Survey Team	5
Total	31

CHAPTER 4 PRELIMINARY DESIGN OF WATER INFRASTRUCTURE FACILITIES

CHAPTER 4 PRELIMINARY DESIGN OF WATER INFRASTRUCTURE FACILITIES

4.1 Water Supply System

4.1.1 Cua Can Impounding Reservoir

(1) Reservoir Embankment Design

The planned impounding reservoir is designed to be surrounded by the embankment with a top elevation of +14.0 m. The excavated material from the site is used for the embankment.

The top of the embankment is 5 m in width and sealed with asphalt pavement over a 20cm gravel layer. The slope of the embankment is reinforced with an 18 cm concrete slab over a 10 cm gravel layer.

Figure 4-1-1-1 illustrates the layout of the impounding reservoir.

Figure 4-1-1-1 Layout of Cua Can Impounding Reservoir

(2) Regulating Weir and Intake Facilities

A river intake is designed to pump water into the impounding reservoir for both phase 1 and phase 2. **Figure 4-1-1-2** shows the arrangement of the intake facilities and the weir for regulating river flow. The arrangement of pumping facilities for each phase is shown in **Table**

4-1-1-1.

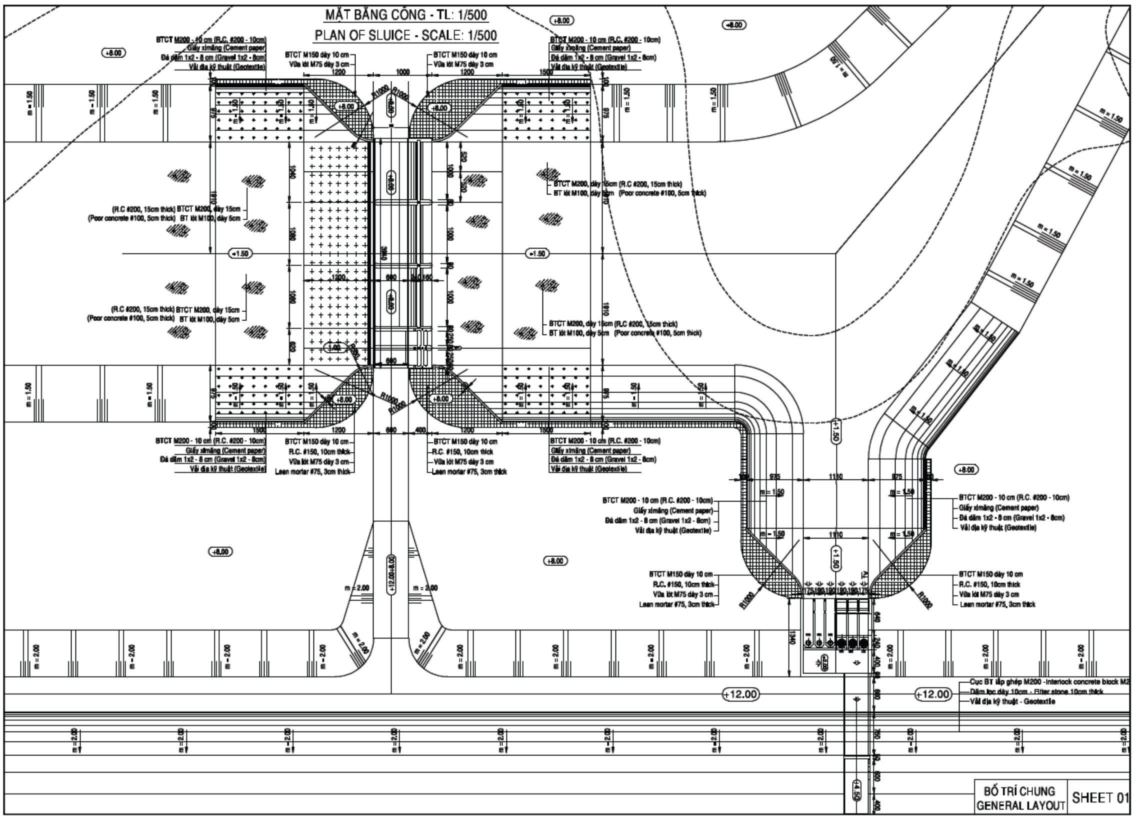


Figure 4-1-1-2 Plan of River Flow Regulating Weir and River Water Intake Facilities

Table 4-1-1-1 Pumping Facilities to Lift River Water into Cua Can Reservoir

No	Items	value		
1	Pump type	PL 7065/735	LL 3300 LT	NL 3300 LT
2	Number of pump	3	2	1
3	Total head	8	8	8
4	Static water head	7	7	7
5	Design flow (l/s)	1375	340	165
6	Efficiency (%)	79.5	77.8	78.6
7	Blade code	640	801	821
8	Rated power (Kw)	140	37	27
9	Shaft power (Kw)	136.9	37	21
10	Power input (Kw)	147.1	35	18
11	Rated speed (round/minute)	980	725	725
12	Rated voltage (3 phases)	380	380	380

Phase 1 Arrangement:1 pump of PL 7065/735 + 2 pump of LL 3300 LT + 1 pump of NL 3300 LT and 1 pump of PL 7065/735 for reservation

Phase 2 Arrangement: 3 pump of PL 7065/735 + 2 pump of LL 3300 LT + 1 pump of NL 3300 LT and 1 pump of PL 7065/735 for reservation

4.1.2 Raw Water Intake and Raw Water Transmission Facilities

(1) Raw Water Intake Facilities

Raw water intake to the water treatment plant will need pumping facilities for both Phase 1 and Phase 2.

The raw water intake is located between the river intake facilities into the reservoir and the water treatment plant as previously shown in **Figure 4-1-1-1**. The facilities are located in close proximity to each other to make operation and maintenance more convenient. **Table 4-1-2-1** outlines the raw water pumping facilities.

Table 4-1-2-1 Outline of Raw Water Pumping Facilities

Intake Structure	Intake gate width：9.0 m Coarse and fine screens equipped at low and high elevations
Raw Water Intake Pumps	Phase 1：submersible motor pumps 10,500 m^3/day x 16.5 m x 37 kW x 3 units（1 Stand-by） Phase 2: submersible motor pumps 21,000 m^3/day x 16.5 m x 75 kW x 2 units

(2) Raw Water Transmission Pipe

Raw water transmission pipe with DN 700 mm of HDPE and approximately 250 m in length will be installed from the raw water pumping station to the water treatment plant.

4.1.3 Facilities in Water Treatment Plant

(1) Planned site and ground elevation of new WTP

The planned site for the new WTP is located adjacent to the new Cua Can reservoir as previously shown in **Figure 4-1-1-1**.

The planned ground elevation at the WTP will be +11.80 m. This elevation is higher than the flood level at 200-year probability.

(2) WTP layout

The WTP layout is shown in **Figure 4-1-3-1**.

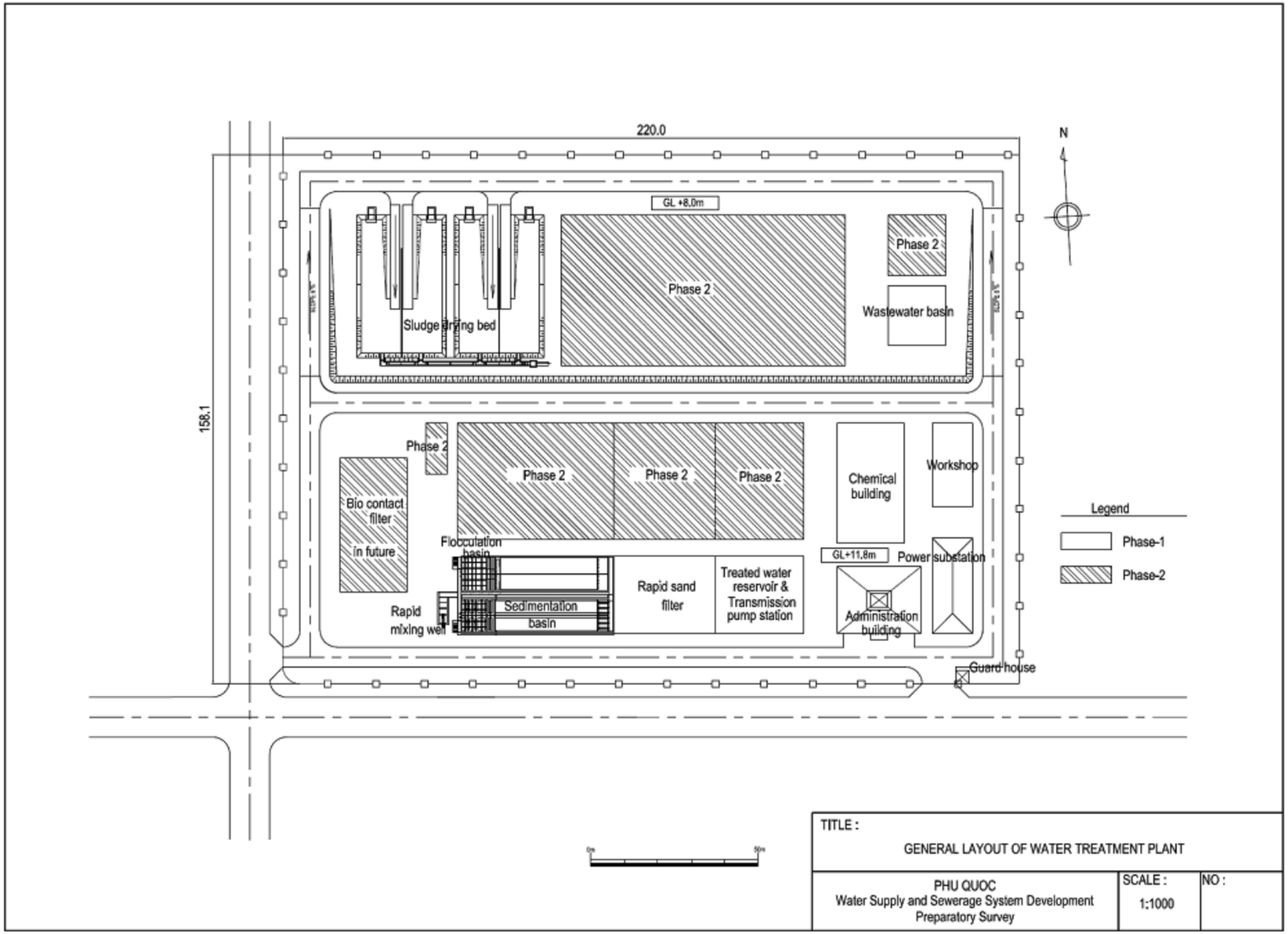


Figure 4-1-3-1 WTP Layout

(3) Hydraulic profile of WTP

The hydraulic profile is shown in **Figure 4-1-3-2**.

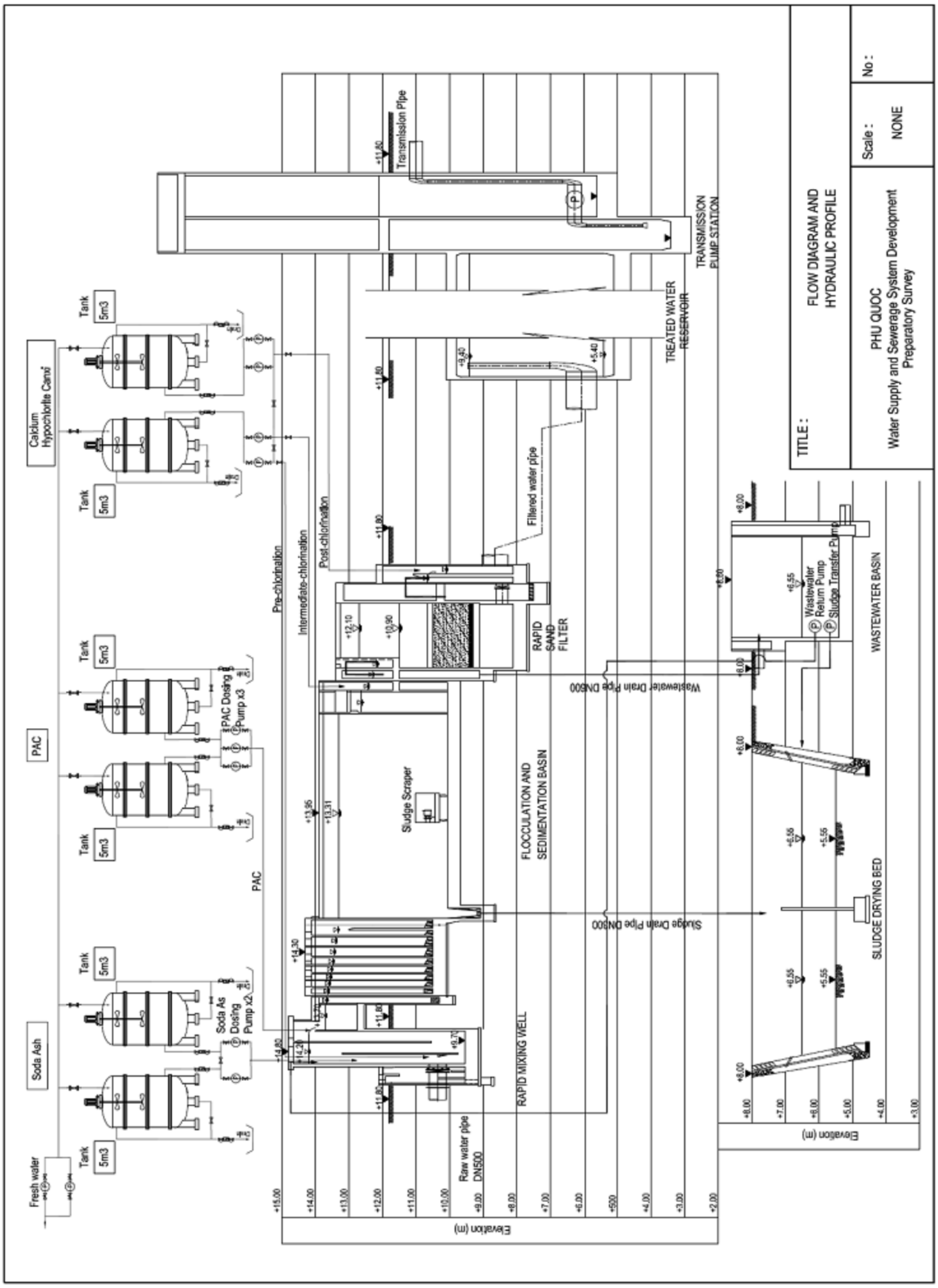


Figure 4-1-3-2 Hydraulic Profile of WTP

(4) Facilities of WTP

Table 4-1-3-1 provides an outline description of the WTP facility.

Table 4-1-3-1 Outline Description of the Treatment Facility

Component/Facility Name	Phase 1 - Provision	Remarks
Raw water flow meter & control valve	- Electromagnetic flow meter - Motor driven toothed vane type butterfly valve	-
Bio contact filter	-	The land for the bio contact filters will be reserved within the WTP site for the future. - Up flow type, RC, 8 filters - Filtration rate: 347 m/day - Dimensions per filter: W 4.0 m x L 4.5 m D 5.0 m
Rapid mixing well	- Hydraulic type (waterfall) mixing - Reinforced concrete construction (RC), 1 well, - Dimensions: W 2.5 m x L 4.9 m D 4.5 m	Pre-alkali, pre-chlorine and coagulant will be dosed in the well. Phase 2: newly constructed
Flocculation basin	- Hydraulic type (up-and-down baffle wall) - RC, 4 basins - Retention time: 20.5 min. - Dimensions per basin: 1st & 2nd compartments W 0.8 m x L 4.5 m 3rd & 4th compartments W 1.0 m x L 4.5 m 5th & 6th compartments W 1.4 m x L 4.5 m	Phase 2: newly constructed
Sedimentation basin	- Horizontal flow type - RC, 4 basins - Overflow rate: 25 mm/min. - Mean velocity: 0.25 m/min. - Desludging: Submerged sludge collector - Dimensions per basin: W 4.8 m x L 30.4 m D 3.0 m	Phase 2: newly constructed
Rapid sand filter	- Gravity type - RC, 4 filters and 1 equipment unit - Filtration rate: 149 m/day - Dimensions per filter: W 4.0 m x L 8.8 m D 5.0 m	Phase 2: newly constructed
Treated water reservoir	- RC, 2 reservoirs - Retention time: 1.5 hours of treatment capacity of 21,000 m^3/day - Dimensions per reservoir: W 11.0 m x L 14.7 m D 4.0 m	Phase 2: newly constructed
Treated water transmission pump	- Horizontal shaft double suction volute pump 7.0 m^3/min x 53 m x 90 kW x 3 nos.	Phase 2: newly installed
Sludge drying bed	- Total effective area: 1,400 m2, 4 beds - Depth of bed: 1.0 m	Phase 2: newly constructed
Wastewater basin	- RC, 2 basins - Dimensions per basin: W 8.0 m x L 18.0 m D 2.0 m	Wastewater will be returned to the rapid mixing well by the returning pumps. Sludge will be transferred to the sludge drying bed by submersible sand pumps. Phase 2: newly constructed

Administration building	- One story - Total area: 500 m^2 - Dimension: W 25.0 m x L 20.0 m	-
Chemical building	- One story - Total area: 720 m^2 - Dimension: W 36.0 m x L 20.0 m - Soda ash solution tank with agitator: 5 m^3 x 2 nos. - PAC solution tank with agitator: 5 m^3 x 2 nos. - Calcium hypochlorite solution tank with agitator: 5 m^3 x 2 nos. - Soda ash dosing pump: 2 nos. - PAC dosing pump: 2 nos. - Calcium hypochlorite dosing pump: 2 nos.	Phase 2: 3 solution tanks and 2 dosing pumps each for soda ash, PAC and Calcium hypochlorite will be provided.

4.1.4 Water Transmission and Distribution Facilities

(1) Transmission and Distribution

In general, there are two distribution methods; one is the direct pumping method from the WTP, and the other is the gravity supply method from a distribution reservoir. The gravity distribution method requires distribution reservoirs which should be strategically located to supply water to customers by gravity. The water transmission from WTP to the distribution reservoirs is usually made by pumping.

In Vietnam the direct pumping method is widely used probably due to its topographical condition. The use of distribution reservoirs provides advantages by making it easier to cope with the fluctuation of customers' water use patterns and distribution can be continued for a certain period of time during power outage. However, both the direct pumping and the gravity system with reservoirs are compared comprehensively including the total cost comparison of the initial investment cost and O&M cost.

For the gravity supply alternative, the site for a distribution reservoir is subject to the following restrictions considering the local conditions of Phu Quoc Island and the national design criteria.

- The distribution reservoir should be outside of National Park.
- The distribution reservoir should be strategically located to supply both the planned new service area and the existing service area of the Duong Dong water supply system.
- Water pressures in transmission and distribution pipes are in principle controlled within the Vietnamese design criteria of 10 to 60 m. The planned reservoir site should be no higher than 60 m since the lowest elevation along the western coast in the service area is nearly +0 m.

(2) Selection of Pipe Material

HDPE, PVC and DCIP are available in Vietnam and have been already used in many water supply projects in Vietnam. Recently HDPE is generally preferred in many waterworks. This is because a wide range of diameters up to 630 mm is available domestically; it is easy to install; and its material cost is generally cheaper than that of DCIP.

Considering the recent practice HDPE and DCIP are preferred. Further comparison according to **Table 4-1-4-1** was made to select HDPE for this Project.

Table 4-1-4-1 Comparison of HDPE and DCIP

Item \ Material		HDPE (High Density Polyethylene Pipe)	DCIP (Ductile Cast Iron Pipe)
Advantage		・Flexible and less requirement for bends ・Light weight and easy to install ・Electric fusion bonding for joints provides high water-tightness. ・High seismic adequacy and flexible to uneven settlement	・High in intensity and high durability ・Rigid and strong against shock load ・Widely used and long time experiences in water supply ・Large diameters are available in market
Disadvantage		・Unsuitable for above ground installation due to weakness to ultra-violet ray ・week for organic solvents and heat ・Pipe thickness is larger than that of VP because pipe resin is less rigid.	・Relatively heavy weight ・Once coating and lining are damaged, subject to corrosion.
Pipe Material Cost (Yen ¥1 = 270 VND)	φ125	107,580 (¥398)	
	φ140	135,300 (¥501)	690,000 (¥ 2,556) (φ150 mm)
	φ160	178,090 (¥660)	
	φ180	222,200 (¥823)	
	φ200	275,330 (¥1,020)	922,000 (¥ 3,415) (φ200 mm)
	φ225	346,060 (¥1,282)	
	φ250	425,370 (¥1,575)	1,154,000 (¥ 4,274) (φ250 mm)
	φ280	531,100 (¥1,967)	
	φ315	675,290 (¥2,501)	1,663,000 (¥ 6,159) (φ300 mm)
	φ355	855,250 (¥3,168)	1,927,000 (¥ 7,137) (φ350 mm)
	φ400	1,084,820 (¥4,018)	2,850,000 (¥ 10,556) (φ400 mm)
	φ450	1,371,590 (¥5,080)	3,072,000 (¥ 11,378) (φ450 mm)
	φ500	1,692,000 (¥6,267)	4,007,000 (¥ 14,841) (φ500 mm)
	φ560	2,348,390 (¥8,698)	
	φ630	2,976,490 (¥11,024)	5,257,000 (¥ 19,470) (φ600 mm)

(3) Hydraulic Calculation for Transmission and Distribution Mains Design

Hydraulic calculation was carried out to determine appropriate pipe diameters of transmission and distribution mains using the following base demands.

- Transmission Main: Peak Day Demand
- Distribution Main: Peak Hour Demand

However, bulk supply to the resort and housing development areas is in principle based on Peak Day Demand, and these developers will install their receiving tanks and distribution networks inside the development areas as discussed in the previous sections.

For the resettlement area the peak hour demand was used since these areas will be supplied directly from the distribution pipes of the city water supply system.

The Hazen-William Formula was used for the hydraulic calculation, in which a C value of 130 was used.

(4) Transmission and Distribution Main Routes

As previously explained, the construction of main roads in Cua Can, Cua Duong, Ganh Dau, which will be the pipeline routes for transmission and distribution mains, are presently underway mainly on the south of Cua Can River, as shown in **Figure 4-1-4-1**. On the north of Cua Can River the construction schedule is still unknown but the planned route is used for designing the mains.

In the hydraulic calculation, the existing ground elevations were utilized since the planned road elevations are not available.

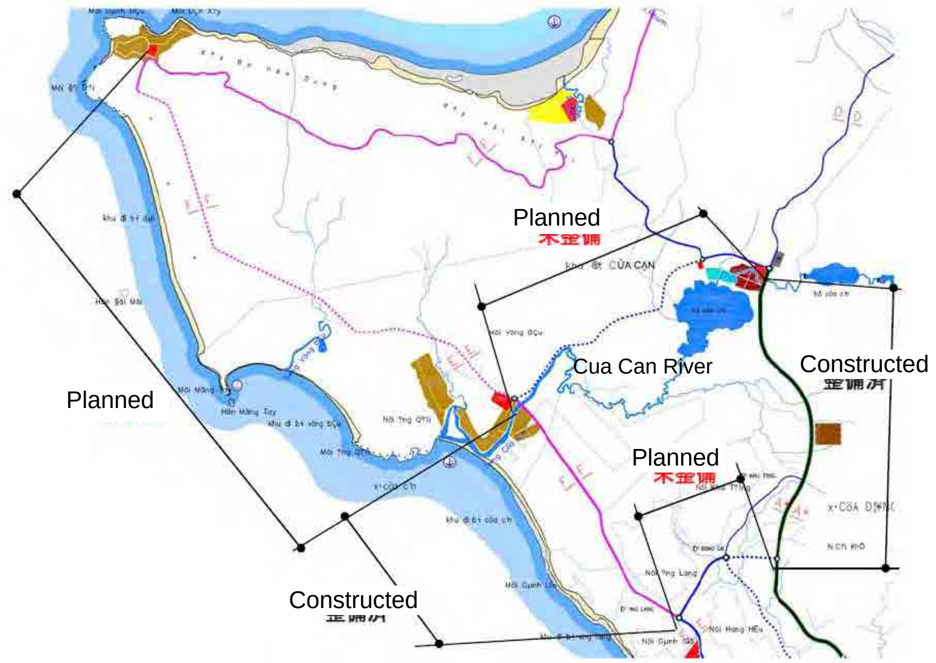


Figure 4-1-4-1 Transmission and Distribution Main Routes and their Construction Status

(5) Transmission and Distribution Pipe Alignment

Transmission and distribution pipes would be installed in road shoulders along the new roads identified in the Mater Plan as shown in **Figure 4-1-4-2** and **Figure 4-1-4-3**. The depth of pipe installation is 1.0 m.

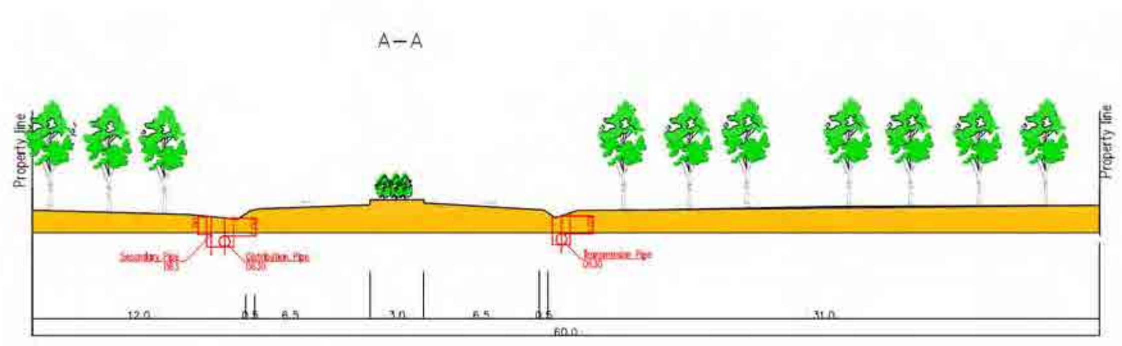
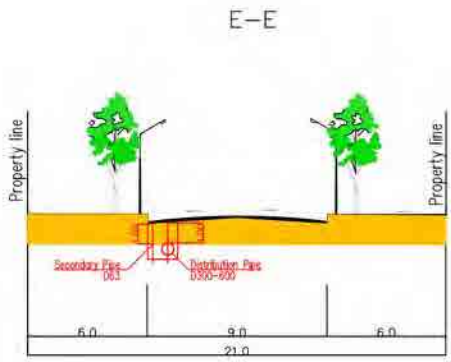


Figure 4-1-4-2 Typical Pipe Installation for Phase 1 Route (Section A-A)



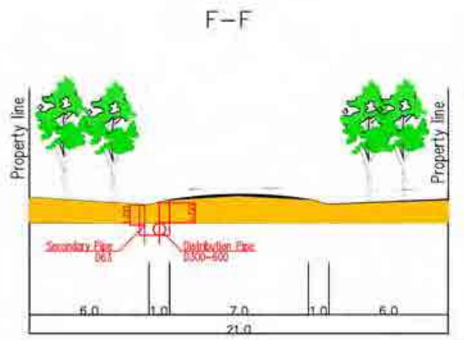


Figure 4-1-4-3 Typical Pipe Installation for Phase 1 and Phase 2 Routes (Sections E-E & F-F)

(6) Transmission and Distribution Alternatives

The following alternatives as illustrated in **Figure 4-1-4-4** were examined from various points such as availability or accessibility of candidate reservoir sites, hydraulic analysis results and construction costs.

CASE 1 With a distribution reservoir near WTP
CASE 2 With a distribution reservoir on the route (hill top)
CASE 3 With a distribution reservoir near the sea coast (hill top)
CASE 4 With an elevated tank at WTP site
CASE 5 Combination of CASE3 and CASE4
CASE 6 Direct Pumping

The results of the investigation concluded that CASE 1, CASE 3, CASE 4 and CASE 5 were not preferred due to the following reasons:

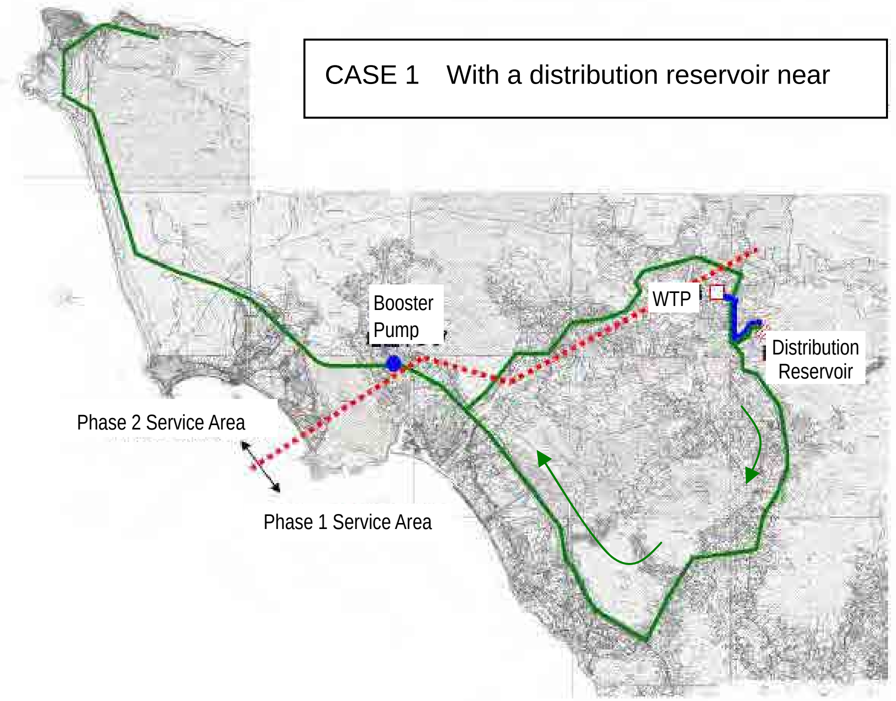
1) CASE 1 requires construction of a distribution reservoir near WTP site, but there is no appropriate site (H = 40m – 60m) found except the land within the forest belongs to

National Park. This alternative is denied as it conflicts with the prerequisite condition that the reservoir site should be outside National Park.

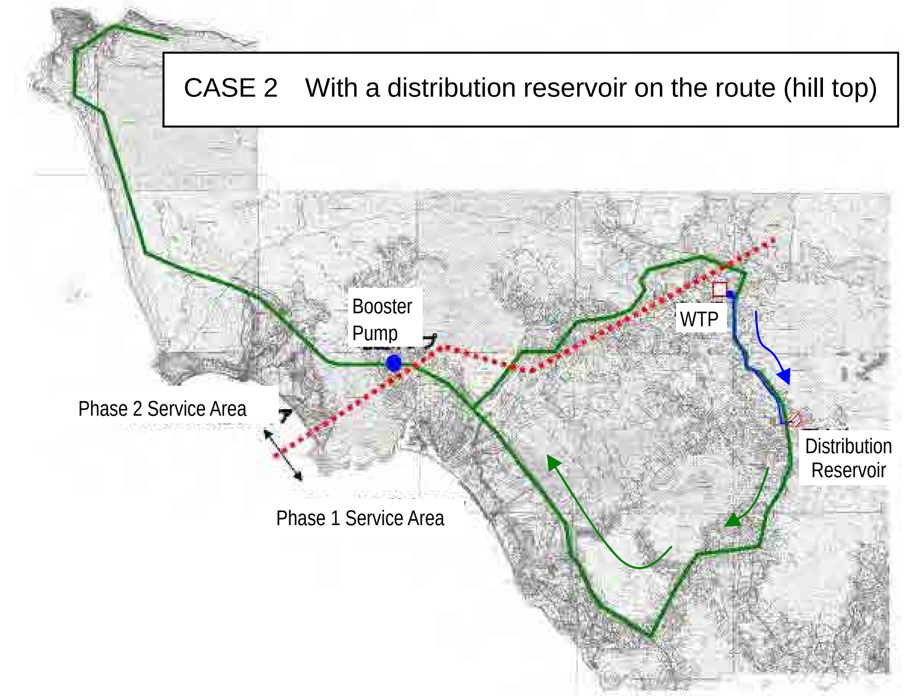
2) CASE 2 and CASE 3 are similar, but the distance from WTP to CASE 3 is much longer than that to CASE 2. As a result CASE 3 has such disadvantages that transmission main is longer and it requires higher pumping head which requires more careful operation of transmission facilities; it requires to install additionally long distribution pipeline to customers living along the transmission main. Thus, CASE 3 is judged to be inferior to CASE 2.

3) CASE 4 and CASE 5 require construction of an elevated tank at WTP site, and treated water is lifted to the elevated tank by pumping and then distributed by gravity from the elevated tank to customers. To achieve this it requires construction of a very high elevated tank over +45 m (which is around 35m high from the ground level) at WTP site since majority of the future water demands exist along the western sea coast. Thus, both the cases were omitted for further comparison.

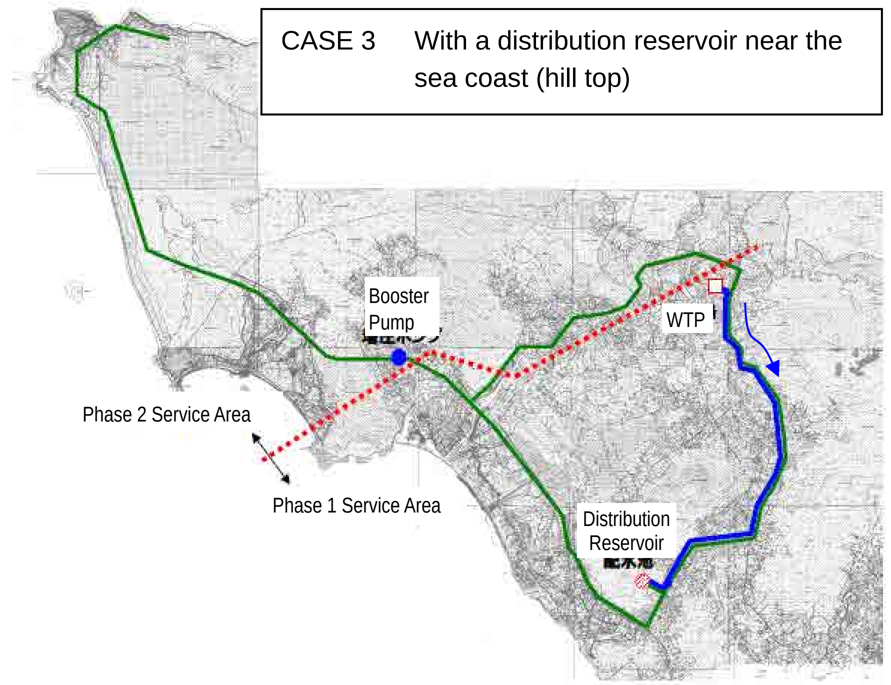
As a result, CASE 2 and CASE 6 were selected for further comparison.



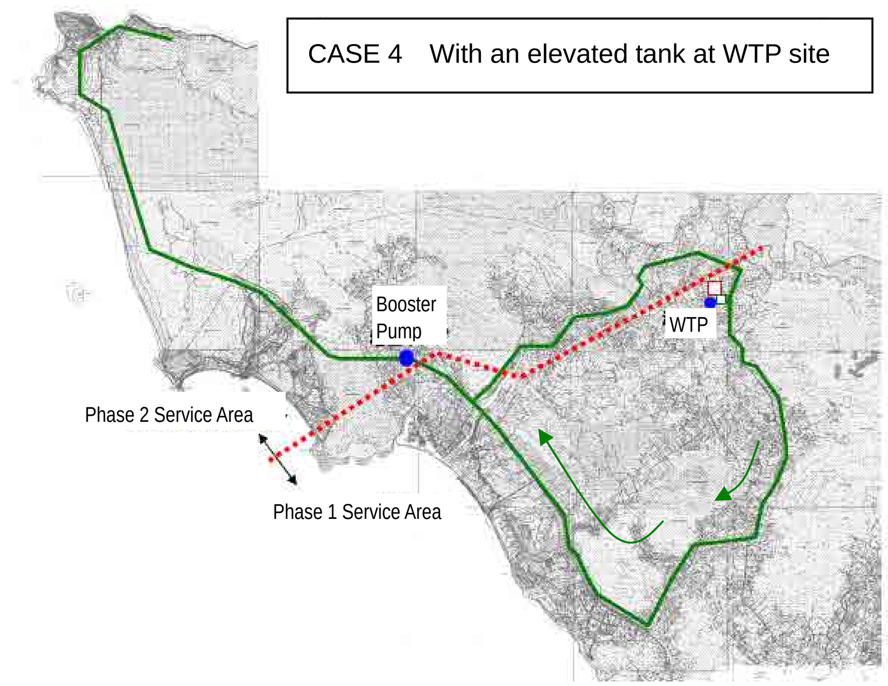
Treated water is pumped from the WTP to the distribution reservoir on the hill adjacent to the WTP, and then distributed by gravity to the Phase 1 service area through the south route. In Phase 2 booster pumps are installed on the route to Ganh Dau and water is directly distributed by pumping to the Phase 2 service area.



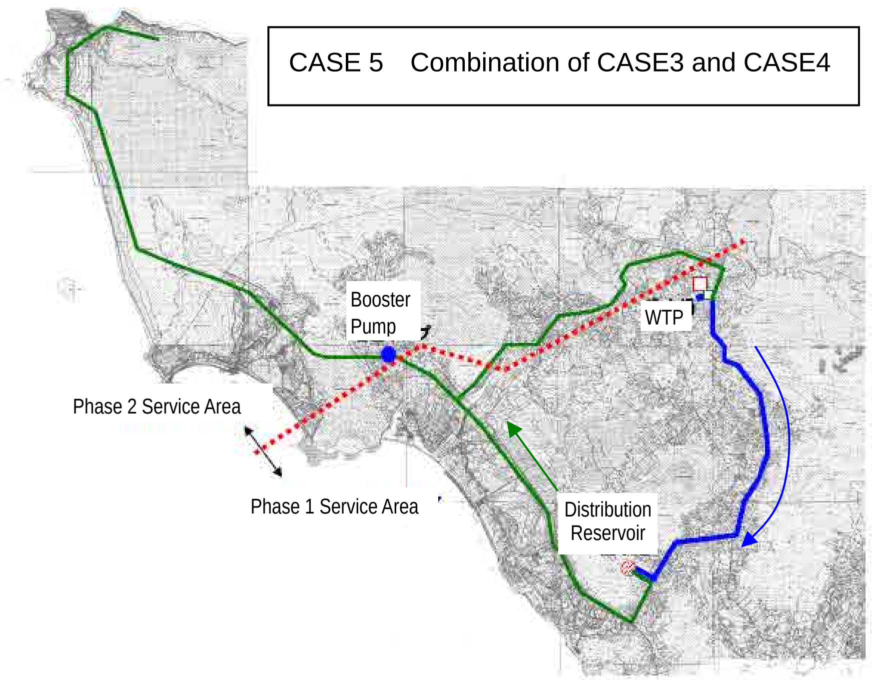
Treated water is pumped from the WTP to the distribution reservoir on the hill located several km from the WTP, and then distributed by gravity to the Phase 1 service area through the south route. In Phase 2 booster pumps are installed on the route to Ganh Dau and water is directly distributed by pumping to the Phase 2 service area.



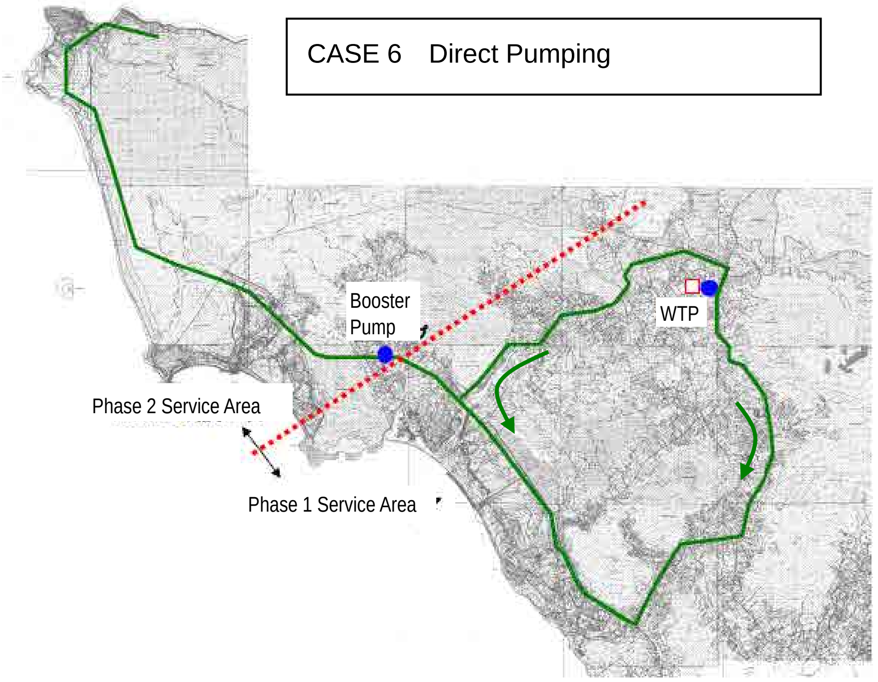
Treated water is pumped from the WTP to the distribution reservoir on the hill located 10 km from the WTP, and then distributed by gravity to the Phase 1 service area. In Phase 2 booster pumps are installed on the route to Ganh Dau and water is directly distributed by pumping to the Phase 2 service area.



An elevated tank is installed at the WTP site with sufficient height to distribute treated water to the Phase 1 service area by gravity through the south route. In Phase 2 booster pumps are installed on the route to Ganh Dau and water is directly distributed by pumping to the Phase 2 service area.



An elevated tank is installed at the WTP site with sufficient height to transmit treated water to a distribution reservoir located near sea coast. Phase 1 service area is supplied by gravity from the reservoir. In Phase 2 pumps are installed on the route to Ganh Dau and water is directly distributed by pumping to Phase 2 service area.



Treated water is distributed by pumping directly to the Phase 1 service area through the north route. In Phase 2 booster pumps are installed on the route to Ganh Dau and water is directly distributed by pumping to the Phase 2 service area.

Figure 4-1-4-4 Transmission and Distribution Alternatives

(7) The Results of Comparison of Alternatives

Table 4-1-4-2 summarizes the results of the comparative analysis of the two alternatives. CASE 2 is selected as the preferred alternative for design of the transmission and distribution facilities.

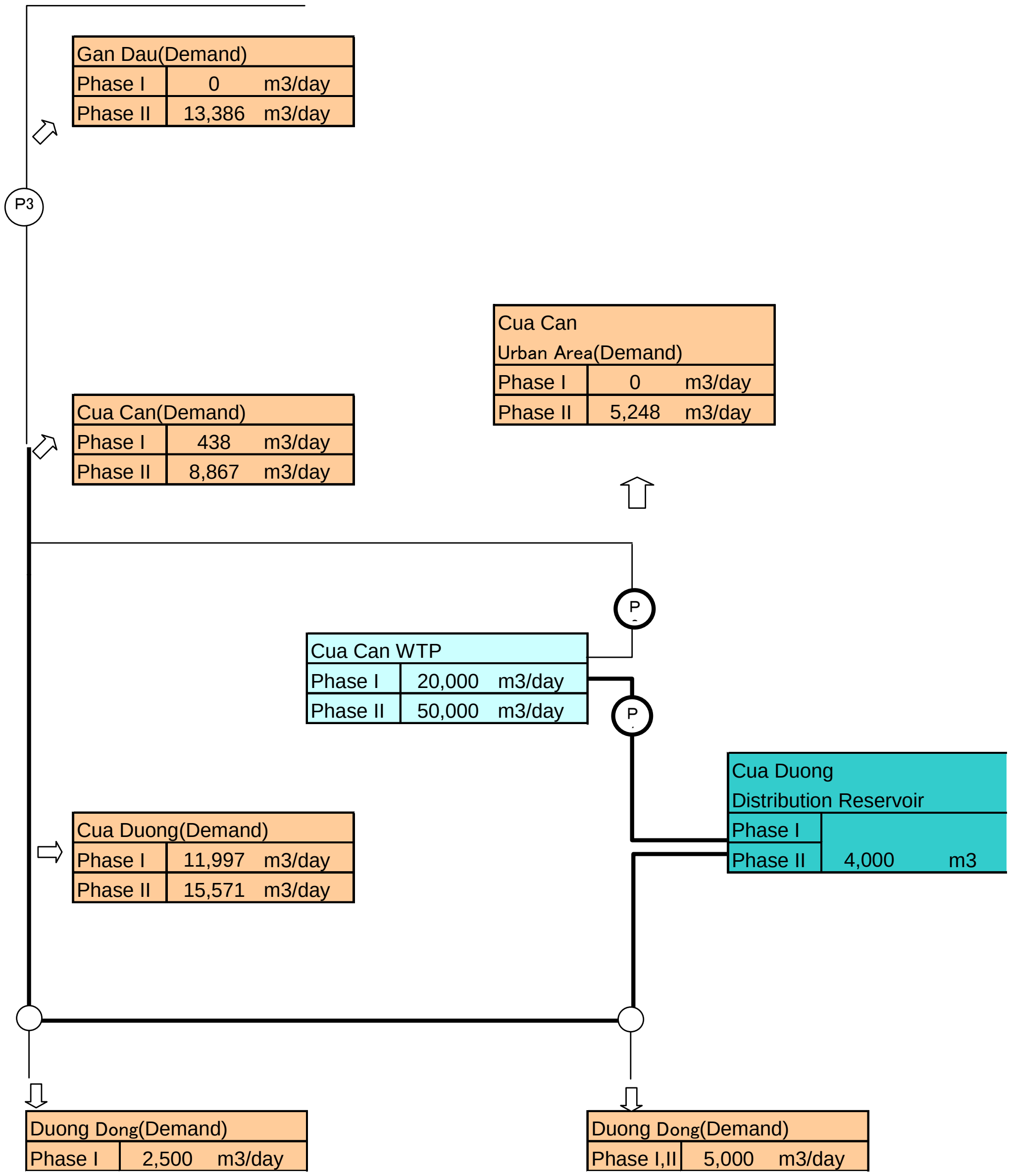
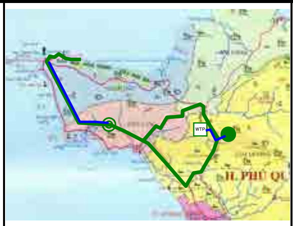


Figure 4-1-4-5 Transmission and Distribution System Schematic Flow

Table 4-1-4-2 Comparison of Transmission and Distribution Routes

			CASE2 Distribution Reservoir near the sea				CASE6 Direct distribution from WTP			
MAP WTP Water Treatment Plant ● Reservour ◎ Pump ○ Inline Pump(Booster Pump) — Pipes										
Transmission Pipe			Diameter (mm)	Length (m)	Unit Price (x1,000VND)	Costs (x1,000,000VND)	Diameter (mm)	Length (m)	Unit Price (x1,000VND)	Costs (x1,000,000VND)
			560	4,240	9,538	40,441	400	12,620	4,428	55,881
			400	12,620	4,428	55,881				
						96,322				55,881
Transmission Pump *stand-by pump included	Numbers of pump		1				-			
	Specific of Pump	Max daily demands	0.116	0.231			0.116	0.231		
		Total Discharge head	55	55			55	55		
		Number of the pump	3	2			5	1		
Distribution Reservoir	Numbers of reservoir		1				1			
	Level of Reservoir site		45 m				70 m			
	Capacity*2	No.1	4,000 m3				m3			
		No.2					m3			
Distribution Pump	Numbers of pump		1							
	Specific of Pump	Max hourly demands	0.280	0.050						
		Total Discharge head	55	55						
		Number of the pump	1	1						
Distribution pipe*3	Diameter and Length		Diameter (mm)	Length (m)	Unit Price (x1,000VND)	Costs (x1,000,000VND)	Diameter (mm)	Length (m)	Unit Price (x1,000VND)	Costs (x1,000,000VND)
			140	3,940	1,011	3,983	200	1,850	1,360	2,516
			200	1,850	1,360	2,516	315	3,130	2,983	9,337
			315	3,130	2,983	9,337	400	6,490	4,428	28,738
			400	6,490	4,428	28,738	500	10,540	7,171	75,582
			500	7,320	7,171	52,492	630	23,110	9,798	226,432
			630	22,590	9,798	221,337				
			(secondary)				(secondary)			
			63	32,700	632	20,666	63	32,500	632	20,540
			Total	78,020		339,069	Total	77,620		363,145
Inline Pump	Numbers of pump		2				2			
	Specific of Pump	Max hourly demands	0.228	0.050			0.228	0.050		
		Total Discharge head	53	60			53	60		
		Number of the pump	1	1			1	1		
Estimated Costs (interest rate ; 4%) (x1,000,000VND)			Construction	Pipe	Tranmission	96,322	Construction	Pipe	Tranmission	55,881
					Distribution	339,069			Distribution	363,145
					Total	435,391			Total	419,026
				Pump	Tranmission	38,500		Pump	Tranmission	
					Distribution	12,960			Distribution	72,360
					Inline				Inline	
					Total	51,460			Total	72,360
				tank	Elevated tank			tank	Elevated tank	
					Reservoir tank	12,119			Reservoir tank	
					Total	12,119			Total	0
				Total		498,970		Total		491,386
			OM	Electricity		30,752	OM	Electricity		31,665
				Total		30,752		Total		31,665
			Total			529,722	Total			523,051
	(Value of cost per year) (x1,000,000VND)			Costs	Working Llife (year)	Value of cost per year		Costs	Working Llife (year)	Value of cost per year
			Pipe	435,391	50	20,268	Pipe	419,026	50	19,506
			Pump	51,460	15	4,628	Pump	72,360	15	6,508
			Tank	12,119	50	564	Tank	0	50	0
			OM	30,752		30,752	OM	31,665		31,665
			Total	529,722		56,213	Total	523,051		57,679
Advantage			The distribution reservoir can be placed at the facing road.				The distribution Reservoir is not need in the Pipeline system.			
Drawback			The transmission pipe is longer than case-1.				Private power generation is needed in case the blackout is occurred.			
Evaluation			○				△			

*1 Using pipe both as Transmission Pipe and Distribution Pipe
*2 The Capacity of the distribution reservoir can reserve the water for 8 hours.
*3 The head when distributed all demands is from 10-60 m.（refer to Vietnam Standard）

(8) Required Transmission and Distribution Facilities

Quantities, diameters and other major specifications of the required transmission and distribution are summarized below for Phase 1 and Phase 2:

＜Phase-1>

(a) Required Pipes

Table 4-1-4-3 Length of Pipes

Category	Diameter	length （m）	Remarks
Transmission	560	4,240	To Cua Duong/Cua Can Distribution Reservoir
	Total	4,240	
Distribution	140	3,940	
	400	5,050	
	500	2,000	
	630	7,240	
	Total	18,230	
Secondary Pipe	63	18,230	
House Connection		2,617houses	11,773 person (Year2020) 4.5person/house

(b) Distribution Reservoir

Table 4-1-4-4 Size of Distribution Reservoir

Category	Name	Feature	Remarks
Reservoir	Cua Duong Reservoir	V=4,000m3	Build by RC

(c) Transmission Pumps

Table 4-1-4-5 Specifications of Transmission Pumps

Category	Name	Feature	Remarks
Transmission Pump	Cua Duong WTP	H=55(m),Q=0.116(m3/s)	To Cua Can Distribution Reservoir
（Cua Can WTP)	Cua Duong WTP	H=55(m),Q=0.116(m3/s)	
	Cua Duong WTP	H=55(m),Q=0.116(m3/s)	

<Phase-2>

(a) Required Pipes

Table 4-1-4-6 Length of Pipes

Category	Diameter	length (m)	Remarks
Distribution	500	8,610	
	630	14,350	
	Total	22,960	
Connection to Duong Dong	355	5,380	
	Total	5,380	
Secondary Pipe	63	22,960	
House Connection		2,764houses	24,211person(Year2030) - 11,773person(Year2020) 4.5person/house

(b) Distribution Pumps

Table 4-1-4-7 Specifications of Distribution Pumps

Category	Name	Feature	Remarks
Distribution Pump	To Cua Can & Ganh Dau 1	H=55(m),Q=0.232(m3/s)	VSC
	To Cua Can & Ganh Dau 2	H=55(m),Q=0.232(m3/s)	VSC

(d) Booster Pumps

Table 4-1-4-8 Specifications of Booster Pumps

Category	Name	Feature	Remarks
Booster Pump	Ganh Dau Booster 1	H=60 (m), Q=0.093(m3/s)	VSC
	Ganh Dau Booster 2	H=60 (m), Q=0.093(m3/s)	VSC
	Ganh Dau Booster 3	H=60 (m), Q=0.093(m3/s)	VSC
	Total		

(9) Design of the Distribution Reservoir

The capacity of the planned distribution reservoir was determined, assuming that resort and housing development projects will install their own receiving tanks, but other individual water customers in the service areas will be directly supplied through planned distribution pipes without any receiving tanks.

The storage capacity should exceed eight (8) hours based on the peak day water demand to achieve a stable water supply.

A breakdown of peak day water demands is shown in **Table 4-1-4-9**.

Table 4-1-4-9 Breakdown of Peak Day Demands for Individual Customers

Item		Peak Day Water Demand (m3/d)	
		Year 2030	Year 2020
Domestic Demand along Main Routes		3,383	2,014
Urban Area & Resettlement Area Demands	(1)	2,401	1,777
	(2)	1,687	844
	(4)	2,352	0
	Total	6,440	2,621
Other Areas		5,000	5,000
Total Peak Day Demand		14,824	9,635

The required reservoir capacities for Phase 1 and Phase 2 are calculated as follows:

Cua Duong Distribution Reservoir $9,635 \times 8 \div 24 = 3,211 \fallingdotseq 4,000$ m^3

Ten (10) hour water demand of the peak day demand for Phase 1 was proposed for the capacity of the distribution reservoir, which is equivalent to 6.5 hour capacity for Phase 2.

The planned distribution reservoir is a reinforced concrete flat slab structure.

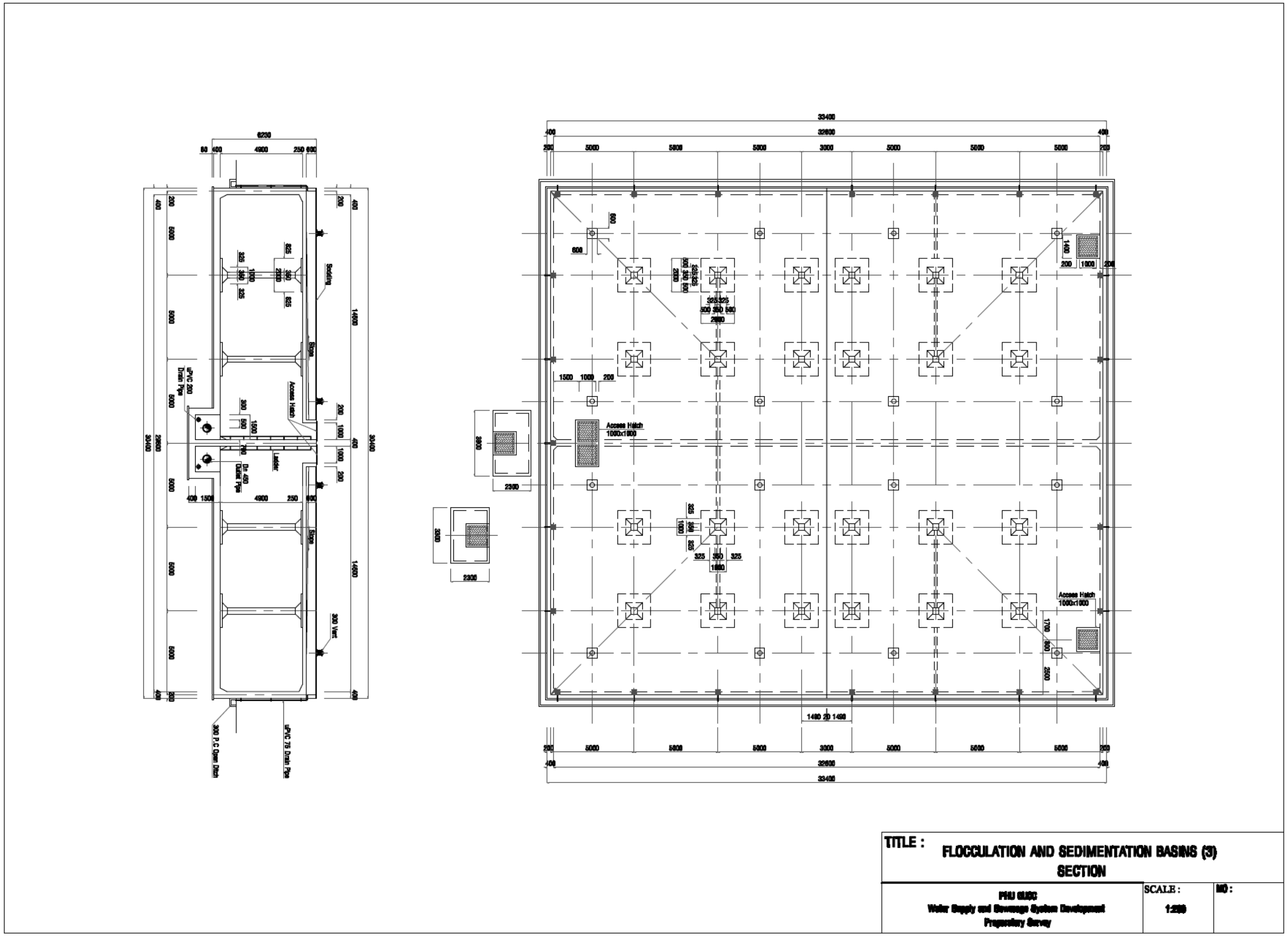


Figure 4-1-4-6 Distribution Reservoir Layout

4.2 Sewerage System

4.2.1 Sewer Network

(1) Design Sewage Flow

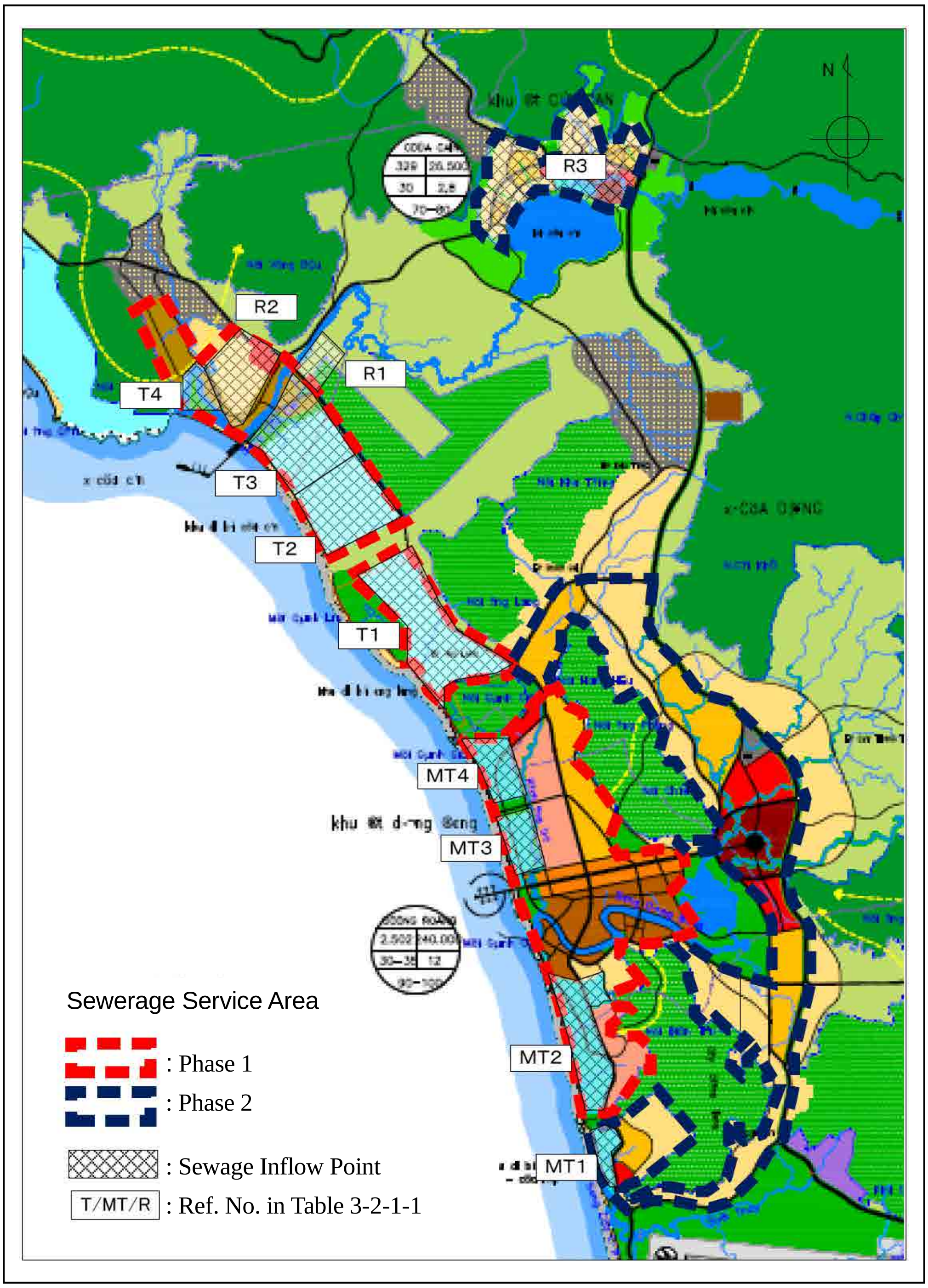
Sewage flow for sewer network design is estimated as follows; 1) entire sewage flow (refer to **Table 3-2-3-1)** minus Point Sewage Inflow (refer to **Table 4-2-1-1)**, 2) then, residual sewage flows are allocated to the other areas that are not included in Point Sewage Flow. The land use plan in 2030 is considered for the distribution of sewage flow.

Point inflow location is shown **Figure 4-2-1-1**. Per hectare sewage flows by considering land use in 2030 are shown in **Table 4-2-1-2**.

Table 4-2-1-1 Point Sewage Inflow

Area	Name of Area	Abbreviation	Water Consumption	Capacity of STP	Producted Wastewater Flow	Area Size	Connected Ratio	Total of Point Inflow	
			m^3/day	m^3/day	m^3/day	ha	%	m^3/day	L/sec
Duong Dong Mixed Tourist Area	Mixed Tourist Area 1	MT1	845	-	676	28.61	90	609	7
	Mixed Tourist Area 2	MT2	3,363	-	2,690	113.82	90	2,421	28
	Mixed Tourist Area 3	MT3	1,411	-	1,129	47.77	90	1,016	12
	Mixed Tourist Area 4	MT4	1,596	-	1,277	54.03	90	1,149	13
	Sub-total		7,216	-	5,773	244.23	90	5,195	
Cua Can Eco-Tourist Area	Ong Lang Beach	T1	1,570	1,190	-	-	90	1,071	12
	Phu Quoc Ecological	T2	1,214	971	-	-	90	874	10
	Cua Can Beach	T3	2,950	2,242	-	-	90	2,018	23
	Tran Thai Phuong Nam	T4	960	760	-	-	90	684	8
	Sub-total		6,694	5,163	-	-	90	4,647	
Duong Dong Mixed Tourist Area	Cua Can Resettlement	R1	1,819	-	1,892	-	90	1,703	20
	Cua Can Commune Center	R2	1,278	-	1,329	-	90	1,196	14
	Cua Can Reservoir Site	R3	3,975	-	4,134	-	90	3,721	43
	Sub-total		7,072	-	7,355	-	90	6,620	
Total of Point Inflow								16,462	
Others								13,538	
Total of Sewerage Service Area								30,000	

Source：JICA Survey Team



Source：JICA Survey Team

Figure 4-2-1-1 Point Inflow Location

Table 4-2-1-2 Per Hectare Sewage Flow

Land Use	abbreviation	Area Size	Population Density	Population	Unit Water Consumption	Water Consumption	Wastewater Ratio	Domestic Wastewater	Public and commecial Wastewater	Small Industry Wastewater	Infiltration	Total	Connected Ratio	Per ha Wastewater
		(1)	(2)	(3)=(1)×(2)	(4)	(5)=(3)×(4)	(6)	(7)=(5)×(6)	(8)=(7) ×10%	(9)=(7) ×10%	(10)=(7) ×10%	(11)=(7)+(8)+(9)+(10	(12)=(11) ×90%	(13)=(12)/(1)/86,400
		(ha)	(People/ha)	(People)	L/capita/day	L/capita/day	(%)	m^3/capita/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	L/sec/ha
ADMINISTATIVE- OFFICE AREA	A	104.62	65	6,800	150	1,020	80	816	82	82	82	1,062	956	0.1058
PUBLIC AREA	P	134.5	55	7,398	150	1,110	80	888	89	89	89	1,155	1,040	0.0895
COMMERCE - SERVICE CENTER AREA	C	78.61	55	4,324	150	649	80	519	52	52	52	675	608	0.0895
RESIDENTIAL AREA	R	196.03	40	7,841	150	1,176	80	941	94	94	94	1,223	1,101	0.0650
MIXED DEVELOPMENT AREA	M	197.63	105	20,751	150	3,113	80	2,490	249	249	249	3,237	2,912	0.1706
HIGH DENSITY RESID AREA	H	459.79	70	32,185	150	4,828	80	3,862	386	386	386	5,020	4,517	0.1137
LOW DENSITY RESID AREA	L	618.87	24.3	15,039	150	2,256	80	1,805	181	181	181	2,348	2,113	0.0395
ADJUSTED TRADING VILLAGE	AT	65.29	30	1,959	150	294	80	235	24	24	24	307	276	0.0489
RURAL RESIDENTIAL VILLAGE	RR	686.1	0	0	150	0	80	0	0	0	0	0	0	-
MIXED TOURIST AREA	MT	0	0	0	150	0	80	0	0	0	0	0	0	-
ECOLOGICAL TOURIST AREA	E	0	0	0	150	0	80	0	0	0	0	0	0	-
BUS TERMINAL	SB	19.07	6	114	150	17	80	14	1	1	1	17	15	0.0091
TOTAL		2,560.51		96,411									13,538	

Source：JICA Survey Team

(2) Allowance for Sewer Capacity

In order to collect sewage flow without delay, sewer design considers some allowance capacity in the design sewage flow. There is no description on the allowance for sewer design in 7957 TCVN design criteria in 2008. The following safety allowances for sewer are adopted in the design.

Diameter	Allowance of Sewer Capacity
・Diameter of 600 mm or less	Approximately 100% of Design Flow
・Diameter of more than 601～1500 mm	Approximately 50～100 % of Design Flow
・Diameter of more than 1501 mm	Approximately 25～50 % of Design Flow

(3) Hydraulic Calculation

The manning formula is used for hydraulic calculation of gravity sewers, and Hazen William formula is adopted for pressure mains as follows:

1) Manning Formula

$$Q = A \times V,\quad V = 1/n \times R^{2/3} \times I^{1/2}$$

where, Q: Flow Rate (m^3/sec), V: Flow Velocity (m/sec), n: Roughness Coefficient, R: Hydraulic Radius (m), I : Hydraulic Gradient, A : Cross Section Area (m^2)

Roughness coefficients for different types of pipe materials are provided as follow:

Table 4-2-1-3 Roughness Coefficient of Pipe Materials

Type of Sewer	n (Roughness Coefficient)
RC Pipe (Reinforced Concrete Pipe)	0.013
PVC Pipe	0.011
HDPE Pipe	0.011

Source: Design Standard - TCVN 7957:2008, JICA Study Team

2) Hazen William Formula

$$Q = A \times V,\qquad V = 0.84935 \times C \times R^{0.63} \times I^{0.54}$$

Where, Q: Flow (m^3/sec), V: Flow Velocity (m/sec), C: Flow Velocity Coefficient,
R: Hydraulic Radius (m), I: Hydraulic Gradient, A: Cross Sectional Area (m^2)

3) Peaking Factor

Sewage flow is not constant and fluctuates throughout the day following a diurnal pattern. Therefore, sewerage facilities must be designed to handle peak flows to prevent operational difficulties such as overflow from sewers, or poor treatment performance. Peak factors selected for the design of sewerage facilities are based on the Vietnamese "Design Standard TCVN 7957:2008" and are described below.

Table 4-2-1-4 Peaking Factor

Description	Average Sewage Flow (L/sec)								
	5	10	20	50	100	300	500	1000	>=1000
Peaking Factor	2.5	2.1	1.9	1.7	1.6	1.55	1.5	1.47	1.44

Source：Vietnamese Standard TCVN 7957:2008

(4) Velocity and Slope

Generally, the flow velocity is set to increase more as the sewage goes further to the downstream, on the other hand, the slope of the sewer is set to be more gradual as it goes close to the downstream.

1) Minimum Velocity

The minimum velocities are set based on Vietnamese Standard – TCVN 7957:2008 as follows;

Pipe Diameter (mm)	Minimum Velocity (m/sec)
150 – 200	0.70
300 – 400	0.80
400 – 500	0.90
600 – 800	1.00
900 – 1200	1.15
1300 – 1500	1.20
Over 1500	1.30

The design of sewers follows the above standard in this study.

2) Maximum Velocity

The maximum velocities are set based on Vietnamese Standard – TCVN 7957:2008 as follow;

	Non-metallic Pipe	Metallic Pipe
Sanitary Sewer	4.0 m/sec	8.0 m/sec

The design of sewer follows the above standard in this study.

3) Minimum Slope

Generally, the minimum slopes (I_{min}) of sewer are calculated by "1/D" formula in Viet Nam.

Where,

D: Diameter (mm)

The above formula is generally used for setting the minimum slope for concrete pipes. The roughness coefficient of plastic pipe is, however, much smaller than that of concrete pipe, and plastic pipe can be used for further smaller slope than that of concrete pipes by the ratio of roughness coefficients that is "Plastic Pipe $_{n=0.011}$: RC Pipe $_{n=0.013}$". Minimum slopes adopted in this study are shown in **Table 4-2-1-5.**

.

Table 4-2-1-5 Minimum Slope

Diameter：D(mm)	RC Pipe	Plastic Pipe *1
	1/D	(1/D)*(0.011/0.013)
150	6.7	5.6
200	5.0	4.2
250	4.0	3.4
300	3.3	2.8
350	2.9	2.4
400	2.5	2.1
450	2.2	1.9
500	2.0	1.7
600	1.7	1.4
700	1.4	1.2
800	1.3	1.1
900	1.1	0.9
1,000	1.0	0.8

Source：*1 JICA Survey Team

(5) Pipe Materials

The following materials are selected considering corrosion resistance and local availability. Unplasticized Polyvinyl Chloride (PVC) pipe is generally used for small sanitary sewer, while High Density Polyethylene (HDPE) pipe is selected under soft soil condition. Ductile Cast Iron Pipe (DCIP) and HDPE pipe are generally selected for pressure pipe.

Pipe materials are selected in consideration of the condition of site and the purpose of use as shown in **Table 4-2-1-6**.

Table 4-2-1-6 Pipe Material

Sanitary Sewer		
Purpose	Diameter	Pipe Material
Gravity Sewer	Less than 600 mm	PVC Pipe, HDPE Pipe
Gravity Sewer	More than 700 mm	HDPE Pipe
Pressure Main	More than 100 mm	HDPE Pipe or Ductile Cast Iron Pipe
Pipe Jacking	Any Diameter	Reinforced Concrete Pipe for Pipe Jacking

Source：JICA Survey Team

(6) Minimum Diameter

Minimum diameter of sewer and house connection are set at 200 mm and 150 mm, respectively in this study.

(7) Sewer Location

Generally, tertiary sewers with house connections are laid under the sidewalk. In case of road without sidewalk, tertiary sewer is laid under the road. Main trunk sewers and branch sewers are usually laid under the roads.

(8) Minimum Depth of Cover

Minimum cover depth for tertiary sewers should be the depth of the house connection. Minimum cover depth for the main trunk sewers and branch sewers are set at 1.0 m.

Minimum cover depth for main trunk sewers and branch sewers are set by considering drainage sewers (usually 600-800 mm pipe or covered channel) that are laid on both sides of road. The following table is adopted in this longitudinal section design.

Items	Minimum Depth of cover (m)
- Pressure Pipe	1.0
- Gravity Sewer (Main Trunk and Branch Sewer)	2.0

(9) Layout Plan for the Sewerage System

The layout plan of the proposed sewerage system is designed based on the above design criteria and shown in **Figure 4-2-1-2**.

Sewer plan drawings, hydraulic calculation sheets, and longitudinal sections are attached in **Annex**.

Source：JICA Survey Team

Figure 4-2-1-2 Layout Plan of the Sewerage System

(10) Summary of Sewer pipes and Manhole Type Pumps

A summary of sewer pipes and manhole type pumps designed based on the above design criteria are shown in **Table 4-2-1-7** and **Table 4-2-1-8**, respectively. The sewer pipe lengths for different diameters, materials and depths of pipe laying are tabulated in **Annex**.

Most of the proposed sewerage service area is composed of new urban development areas and tourist resort development areas. In such development areas each investor will develop the sewer network, and secondary and tertiary sewer pipe lengths required to cover approximately 200 ha of the existing town area are allocated to Phase 1 as shown in **Table 3-2-1-7**. For the Phase 2 service area the sewer pipe lengths which cover approximately 5% of the area are counted as most of the area is to be covered by developer's investment.

Table 4-2-1-7 Lengths of Sanitary Sewer

Phase	Main (m)	Secondary (m)	Tertiary (m)	Total (m)
1	18,246	9,801	31,365	59,412
2	24,037	3,200	10,240	37,477
Total	42,283	13,001	41,605	96,889

Source: JICA Survey Team

Table 4-2-1-8 Summary of Manhole Type Pump

Pump No.	Design Maximum Flow (m^3/min)	Number of Pumps	Pump Head (m)	Remark
P.1	2.1	2	34	1 Stand-by
P.2	5.5	3	10	1 Stand-by
P.3	5.9	4	12	1 Stand-by
P.4	6.5	4	27	1 Stand-by
P.5	5.3	2	31	1 Stand-by
P.6	1.0	2	38	1 Stand-by
P.7	4.5	3	18	1 Stand-by
P.8	3.4	3	48	1 Stand-by
P.9	3.6	4	4	1 Stand-by
P.10	3.9	4	20	1 Stand-by
MP.1 to MP.9	0.20	2	5	1 Stand-by each

Source：JICA Survey Team

Specifications of MP.1-9 are the average values.

4.2.2 Sewage Treatment Facility

A multi-stage nitrification denitrification process with step feed, which is a type of conventional activated sludge process, is selected for the Duong Dong Sewage Treatment Plant described in the previous chapter. Phosphorus removal is conducted by chemical addition.

(1) Design Conditions

1) Design Sewage flow

Item	Unit	Phase 2	Phase 1
Daily Average Flow	m^3/day	30,000	7,500
Daily Maximum Flow	m^3/day	30,000	7,500
Hourly Maximum Flow	m^3/day	46,200	12,400

2) Design Sewage Quality

Item	Unit	Influent	Influent including recycle flow
BOD	mg/l	230	290
SS	mg/l	260	310
T-N	mg/l	46	60
T-P	mg/l	7	9

3) Design Effluent Quality

The design effluent quality is decided based on Vietnamese effluent standards (QCVN 14-2008/BTNMT) and surface water quality standards (QCVN 08-2008/BTNMT). The design effluent quality is as follows.

Item	Unit	Design Effluent
BOD	mg/l	25
SS	mg/l	50
T-N	mg/l	15
T-P	mg/l	6

4) Design Removal Rate

Item	Removal Rate (%)		
	Primary Sedimentation	Reactor + Final Sedimentation	Total
BOD	50	90	95.0
SS	50	90	95.0
T-N	15	72	76.2

○ Treated Water Quality

Item	Water Quality (mg/l)			
	Influent	After Primary Sedimentation	After Final Sedimentation	Design Effluent Quality
BOD	290	145	14.5	25
SS	310	155	15.5	50
T-N	60	51	14.3	15

○ Design Parameters for Main Treatment Facilities

Facility	Parameter	Unit	Value
Grit Chamber	Surface load	$m^3/m^2/d$	1,800
	Flow velocity	m/s	0.3
Primary Sedimentation	Surface Load	$m^3/m^2/d$	50

Tank	Weir load	$m^3/m/d$	250
Reactor	Retention time	hour	Over 8
	Sludge Recycle ratio	%	50
Final Sedimentation Tank	Surface load	$m^3/m^2/d$	25
	Weir load	$m^3/m/d$	100
Chlorination Tank	Contact time	minute	15
Gravity Thickener	Solid load	kg of dry solids/m^2/d	60
Dewatering Machine	Solid load	kg of dry solids/hr/m	90

○ Conditions of Receiving Water Body

The receiving water body is a small river in the resort development area. The river is planned to be improved in the land development although the cross section of the improved river has not been designed. Locations of the river and a discharge pipe are presented in Figure 4-2-2-1. The level of improved river bed could be the same as the present level, +10.00 m because there is enough water depth from the level of the present river bed and a planned ground level, +13.00 m. The water level of the river is subject to the effluent volume from the sewage treatment plant due to the small maintenance flow of the river.

The river reaches the sea in about 2.0 km. The average slope of the river is estimated at about 5‰.

The water depth of the river is estimated at 0.519 m based on the Manning equation by assuming a x-section with 4.0 m upper width, 2.0 m lower width, 2.0 m depth, 0.08 coefficient of roughness, and 46,200 m3/d hourly maximum flow.

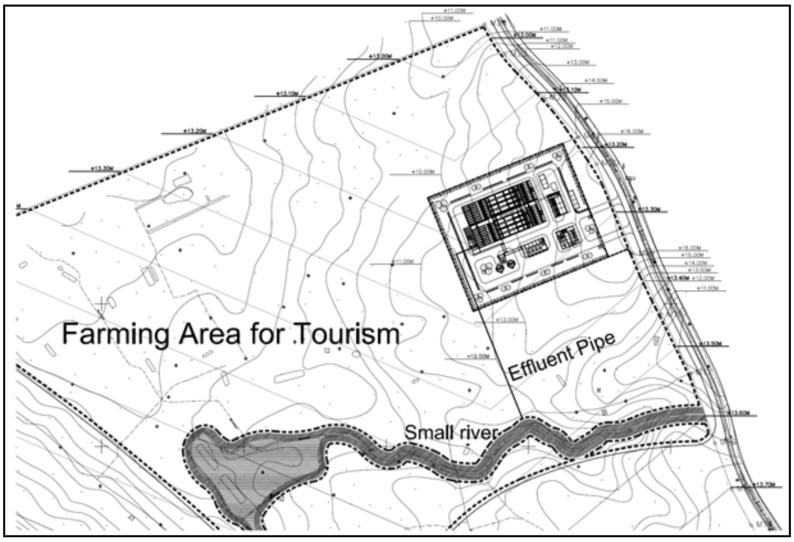


Figure 4-2-2-1 Location of Sewage Treatment Plant and Receiving Water Body

The high water level of the sea is +1.75 m based on 20 years of water level monitoring (**Table 4-2-2-1** Water Level Monitoring Data).

Table 4-2-2-1 Water Level Monitoring Data

ĐÀI KHÍ TƯỢNG THUỶ VĂN KHU VỰC NAM BỘ
TRUNG TÂM KHÍ TƯỢNG THUỶ VĂN KIÊN GIANG

BẢNG MỰC NƯỚC CAO NHẤT, THẤP NHẤT VÀ TRUNG BÌNH TRẠM PHÚ QUỐC
TỪ NĂM 1991 ĐẾN NĂM 2010

TRẠM PHÚ QUỐC ***BIỂN TÂY*** ***Tỉnh : Kiên Giang*** ***Hệ cao độ: Số "O" trạm***

MỰC NƯỚC	MỰC NƯỚC CAO NHẤT NĂM		MỰC NƯỚC THẤP NHẤT NĂM	
(Water Level)	(Maximum Water Level per Year)		(Minimum Water Level per Year)	
BÌNH QUÂN NĂM (cm)	Trị số (cm)	Ngày xuất hiện	Trị số (cm)	Ngày xuất hiện
Average per Year	Value	Date		
90	175	2009/10/5	7	22/06/2005; 18/06/2007

Kiên Giang, ngày 06 tháng 10 năm 2011

Người lập bảng **GIÁM ĐỐC**

The water level at the effluent discharge point would be unaffected by tides because the discharge point is 2.0 km away from the coast and the level of the river bed is +10.0 m.

The water level at the discharge point is estimated based on the following calculation.

$$\underline{+10.00 + 0.519 = +10.519 \rightarrow +10.52 \text{ m}}$$

(2) Specifications and Units of Facilities

The specifications and number of process units for the proposed conventional activated sludge process are presented in **Table 4-2-2-2**. The general layout plan is presented in **Figure 4-2-2-2**, the hydraulic profile is presented in **Figure 4-2-2-3**, and the process flow diagram is presented in **Figure 4-2-2-4**.

Table 4-2-2-2 Specifications and Units of Main Facilities in Duong Dong STP

Facility	Specifications	Units	
		Phase 2	Phase 1
Influent Pipe	H.P. Dim. 1,000mm Sewer invert elevation +8.803 m	1	1
Grit Chamber	Gravity sedimentation tank 3.0m W x 10.0m L x 3.0m L	2 tanks	2 tanks (civil Structure) 1 tanks (civil structure and equipment installed)
Fine Screen	Continuous auto grit collector Width 1.0m Size of opening between bars 15mm	2	1
Lift Pump	Submersible pump Dia. 150mm x 2.7 m^3/min Dia. 200mm x 5.4 m^3/min Dia. 250mm x 8.0 m^3/min	 1 1 4 (1 standby)	 1 1 1 (1 standby)

Primary Sedimentation	Rectangular type 3.0m W x 13.0m L x 3.0m H	16	4
Reactor	Two stage nitrification denitrification process Aeration Tank 5.5m W x 9.0m L x 5.5m H 5.5m W x 13.0m L x 5.5m H Anoxic Tank 3.0m W x 9.0m L x 5.5m H 3.0m W x 13.0m L x 5.5m H	 8 8 8 8	 2 2 2 2
Final Sedimentation	Rectangular type 3.0m W x 25.0m L x 3.5m H	16	4
Chlorination Tank	Rectangular type 1.5m W x 28.0m L x 2.0m H	1 tank with 4 channels	
	Rectangular type 1.5m W x 14.0m L x 2.0m H		1 tank with 4 channels
Gravity Thickener	Circular gravity thickener Dia. 10.0m x 3.0m H	2	1
Dewatering Machine	Belt press hydrator Width 3.0m x 270 kg as ds/hr/unit	5	2
Effluent pipe	H.P. Dim. 1,000mm, Length 270m Sewer invert elevation +10.40 to +10.00 m	1	1

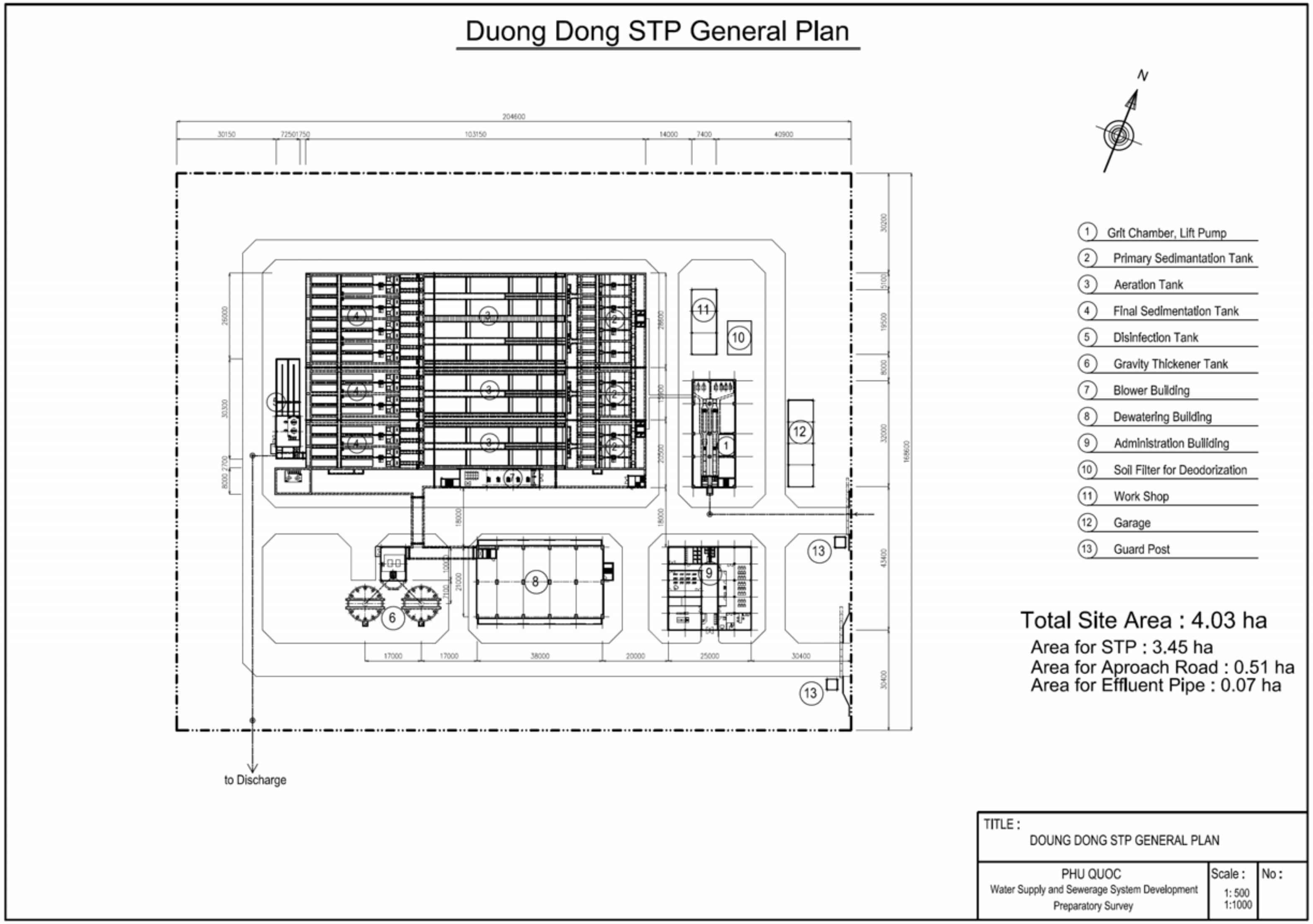


Figure 4-2-2-2 General Layout Plan

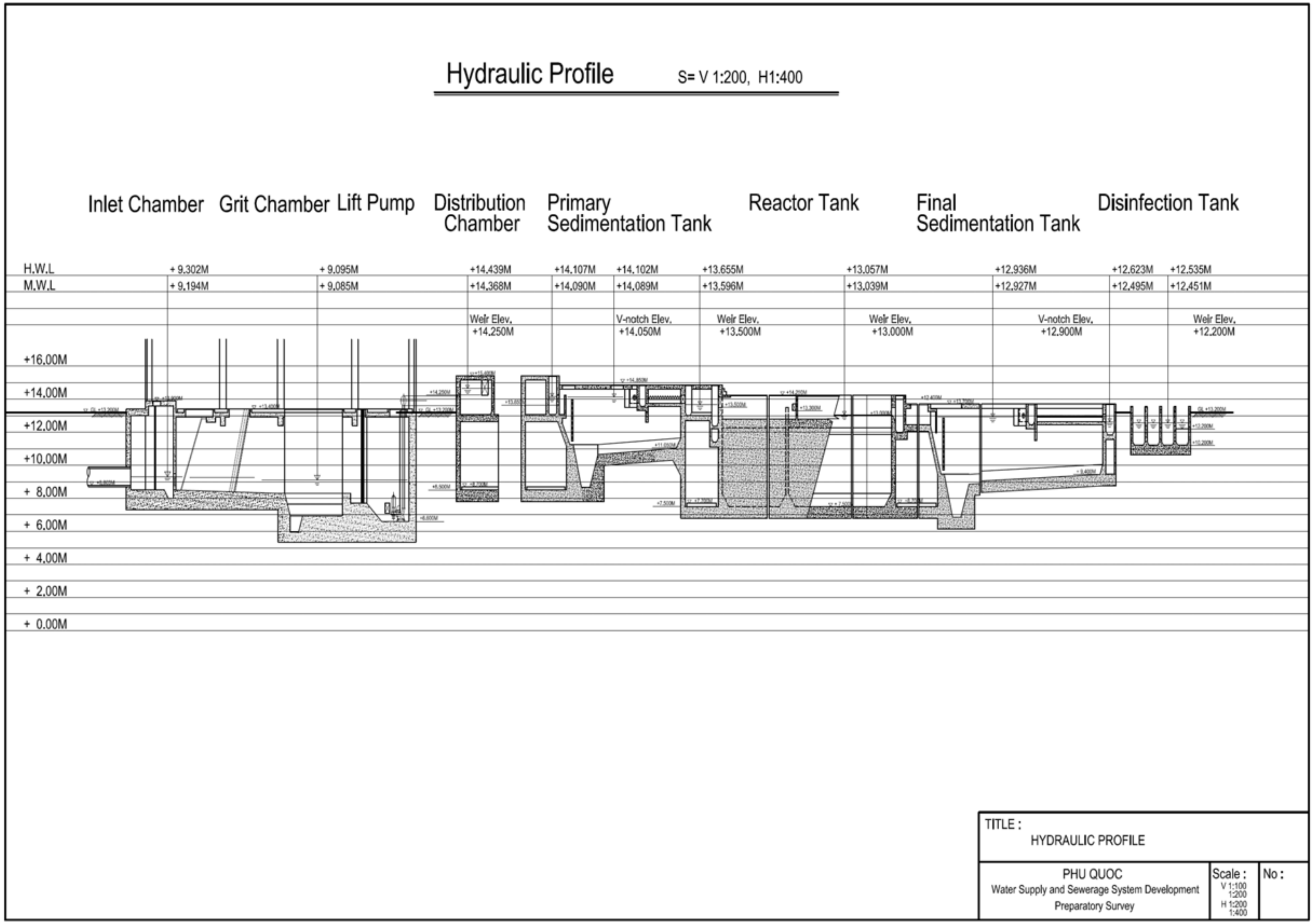


Figure 4-2-2-3 Hydraulic Profile

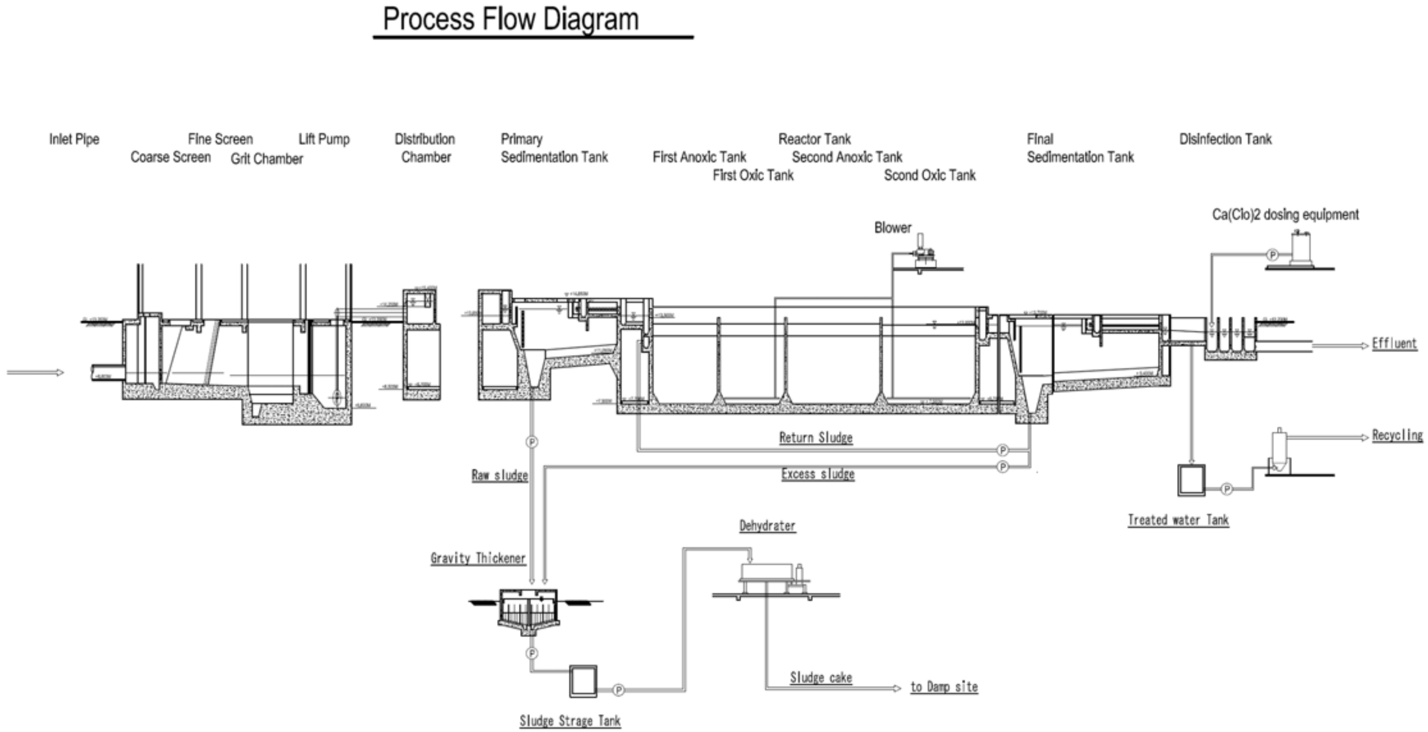


Figure 4-2-2-4 Process Flow Diagram

(3) Design Ground Level

Design ground level for the STP site is decided based on the hydraulic profile determined by the water level at the discharge point and ground levels around STP site. The planned site is gradually sloping and does not have flood risk.

The present ground levels of the STP site vary from +16.00 to 10.00 m with slope.

The facility levels are based on the hydraulic profile presented in **Figure 4-2-2-3**.

The design ground level is +13.20 m based on ground levels around the STP site.

The volume of surplus soil is 2,600 m^3 for a design ground level of +13.00 m at the 1st reclamation stage. After the 1st phase is constructed, the ground would be raised to +13.20 m and the volume of surplus soil is 32,000 m^3.

(4) Foundation Type

Based on the results of soil investigation foundations at the STP site should be spread type with partial soil improvement. The selection of the foundation type is explained in Annex.

CHAPTER 5 PROJECT COST AND DISBURSEMENT SCHEDULE

CHAPTER 5 PROJECT COST AND DISBURSEMENT SCHEDULE

5.1 Cost Estimation

Estimated construction costs are based on the Decree 12/2009/ND-CP (12/2/2009). Quantities are based on the preliminary designs. Unit prices are based on price quotations from contractors, actual costs taken from similar projects in Viet Nam, or prices published by Kien Giang Province. Contingency costs are calculated under the following conditions:

1) Physical contingency

Physical contingency is set at 10% based on the Decision No. 48/2008/GD-TTg.

2) Price contingency

The price escalation rate for local currency (Vietnamese Dong), is set at 8.94%. It is calculated by utilizing construction price escalation over the last 3 years (2009-2011) as designated by "Circular No. 04/2010/TT-BXD (26/5/2010)" by Ministry of Construction.

The price escalation rate for foreign currency (Japanese Yen) is set at 1.6% as was applied in the newest Japanese Yen loan project.

5.2 Disbursement Schedule

The disbursement schedules for the impounding reservoir, water supply system, and sewerage system, were examined respectively.

CHAPTER 6 PPP PROJECT SCHEME AND DEMARCATION BETWEEN PUBLIC AND PRIVATE

CHAPTER 6 PPP PROJECT SCHEME AND ROLES AND RESPONSIBILITIES OF PUBLIC AND PRIVATE SECTOR PARTNERS

6.1 Project Scheme and Demarcation between Public and Private

The three business areas of this project are: raw water supply business (Cua Can impounding reservoir), water supply business, sewerage business. At the meeting with KGPPC on 17 April, 2012 held at Rach Gia, it was agreed that the impounding reservoir would be constructed using governmental budget. Therefore, this section would only consider the public and private partnership arrangements for the water supply business and the sewerage business.

6.1.1 Water Supply Business

The following 2 options will be discussed with KGPPC.

Water Supply Option 1 (BOO)

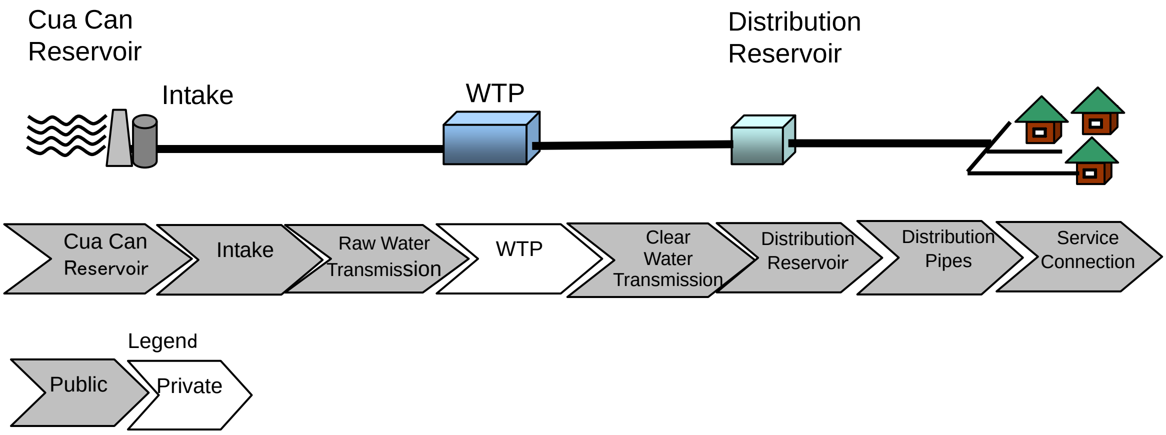


Figure 6-1-1 Water Supply Option 1 (Demarcation of Construction)

The Special Purpose Company (SPC) would construct the WTP, and operate and maintain the facilities from intake to WTP. The public sector authority would construct, operate, and maintain the other water supply facilities. This option is generally recognized as the build-own-operate (BOO) scheme.

The public sector authority would supply raw water to the SPC under a raw water bulk supply agreement. The SPC would supply the treated water to KIWACO from the WTP or from the distribution reservoir under a bulk water supply agreement. KIWACO would construct, operate and manage the distribution facilities and service connections with its own financing and collect water tariff from customers.

Water Supply Option 2 (Concession)

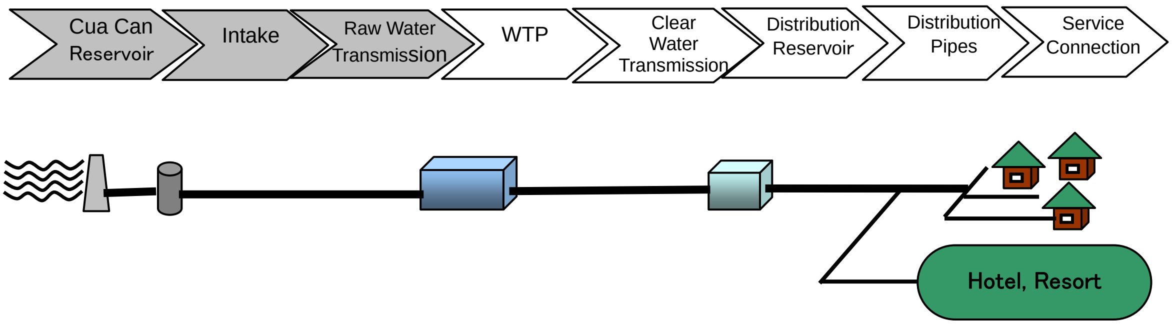


Figure 6-1-2 Water Supply Option 2 (Demarcation of Construction)

The SPC would receive a business license to construct the facilities from the WTP to service connections using its own funds and to operate and maintain the facilities from intake to service connections. The SPC would sell water directly to the customers in the new water supply areas and collect the tariffs. KIWACO would continue to manage the existing service areas by receiving bulk water supply from the SPC.

In Option 2, the SPC would manage not only the WTP but also distribution and service connections. The SPC would be required to establish the organization structure of a water supply company, including the functions of pipe maintenance, meter reading, billing and collection, customer management and water quality control. KIWACO is already managing the water supply service in Duong Dong district and surrounding areas. It is reasonable to manage the distribution facilities and service connections by KIWACO, in order to keep the service level uniform in the island and to avoid the inefficiency by double management for operation and customer management. To avoid duplication, it is advisable that the responsibility of the SPC would end at the outlet of the WTP, or at the distribution reservoir, to supply bulk water to KIWACO.

6.1.2 Sewerage Business

The sewerage treatment plant (STP) and sewage collection facilities could be constructed and managed by the private sector entity, or only the STP would be constructed and managed by the private sector entity utilizing the BOO scheme. It is usually difficult for the private sector to construct and manage sewer pipes because the construction period is long, the construction cost is very high and it takes a long time to recover the investment cost. This is particularly challenging when most of the sewerage network construction would take place in the already built up areas.

Therefore, the 2 options being considered would exclude sewer network construction in the existing town. Both options are categorized as BOO scheme.

Sewerage Option 1

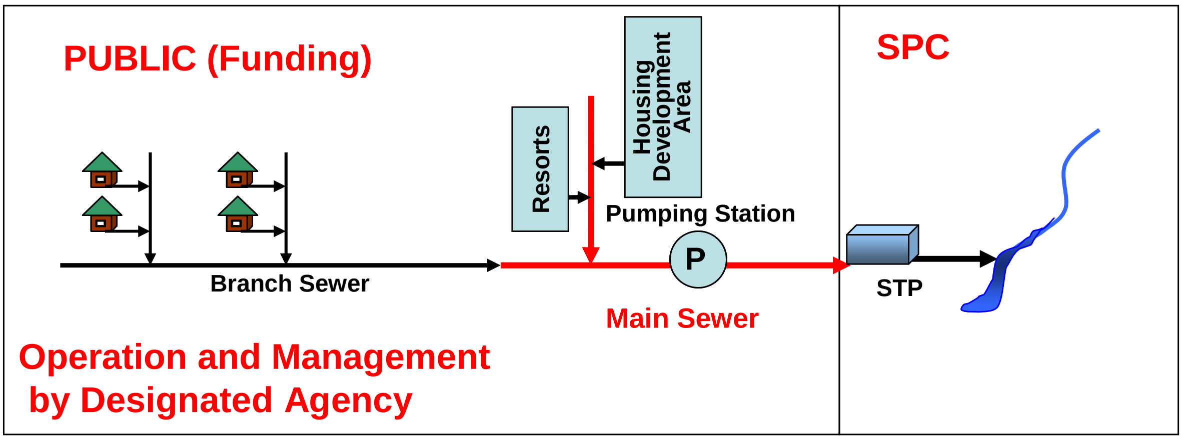


Figure 6-1-3 Sewerage Option 1 (Demarcation of Construction)

The SPC would be responsible for construction, operation and maintenance of the STP, while the public sector authority would be responsible for construction, operation and maintenance of all sewer and house connections.

Sewerage Option 2

The SPC would be responsible for construction, operation and maintenance of the STP and main trunk sewer. The public sector authority would be responsible for construction, operation and maintenance of branch and tertiary sewers, and house connections.

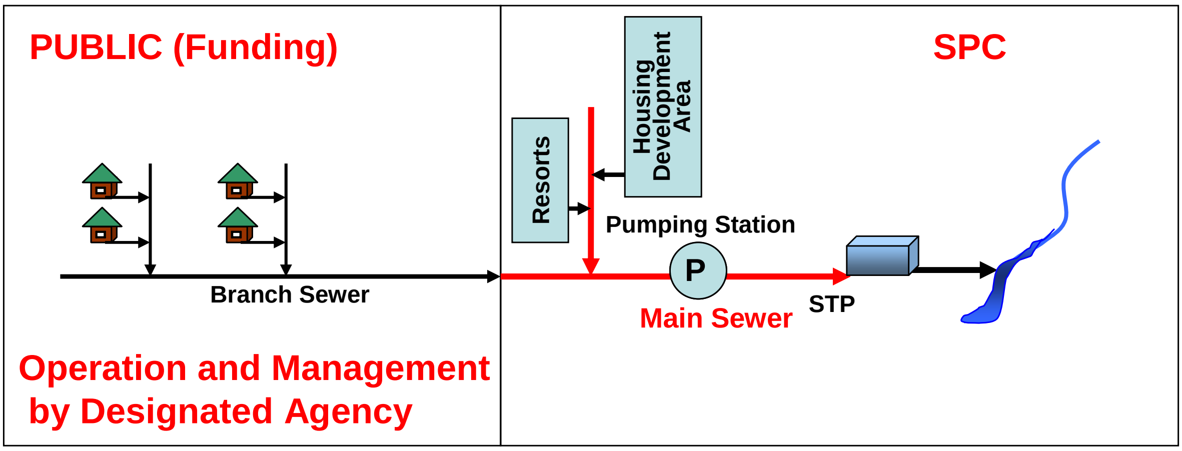


Figure 6-1-4 Sewerage Option 2 (Demarcation of Construction)

6.2 Financial Plan

6.2.1 Project Cost Funding

The project cost would be covered by capital investment from investors and loan from financial institution(s) in the proportion of 30% and 70% respectively.

The actual total loan amount is calculated as the SPC project cost plus interest during construction.

6.2.2 Breakdown of Capital Investment and Loan

Figure 6-2-2-1 shows the structure of related stakeholders to the Project concerning service provision and payment, investment and loan, and so on.

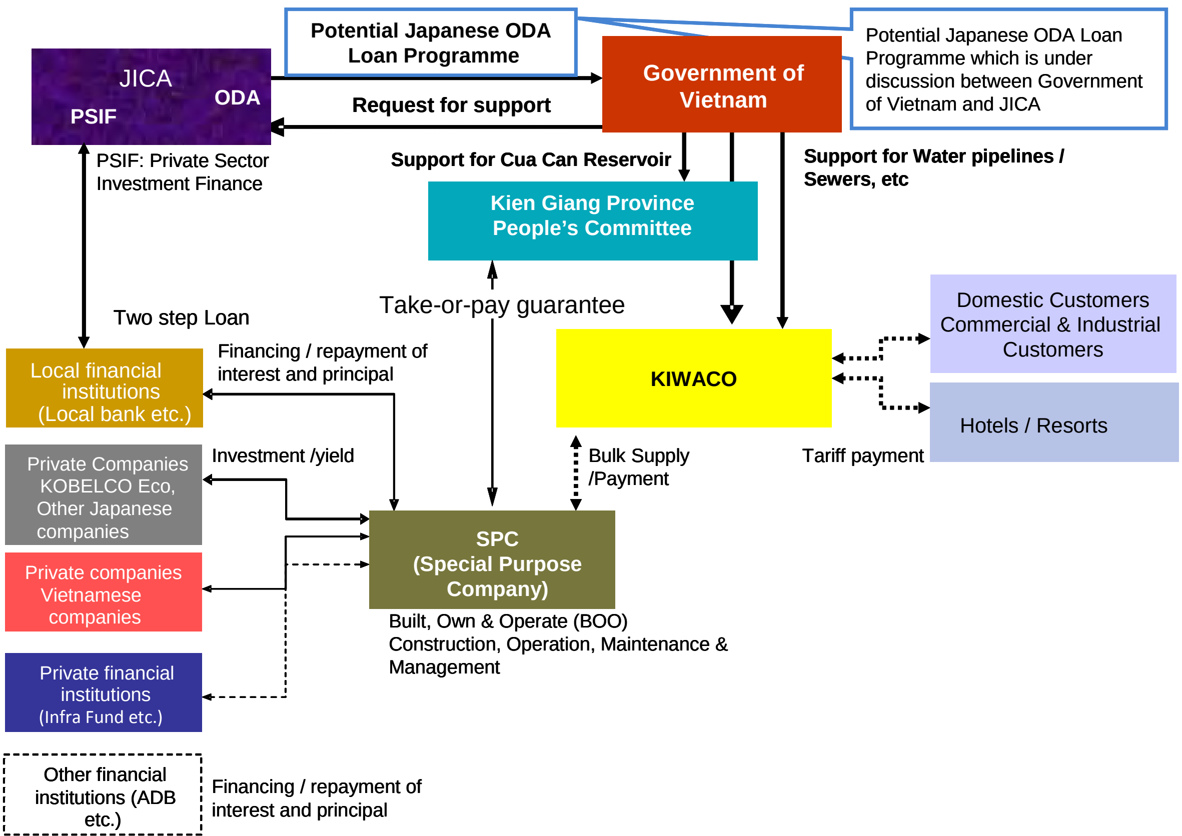


Figure 6-2-2-1 Structure of Relationship among Stakeholders

(1) Potential Capital Investors

Companies which may invest in the SPC include those listed in **Tables 6-2-2-1** and **6-2-2-2**.

Table 6-2-2-1 Potential Composition of Capital Investment to SPC (Water Supply)

Investors	Invested Amount (VND)	
KOBELCO Eco-Solutions Co., Ltd. (KESV)	Not yet determined	%
Japanese Company	Not yet determined	%
Vietnamese Company	Not yet determined	%
Total	Not yet determined	%

Table 6-2-2-2 Potential Composition of Capital Investment to SPC (Sewerage)

Investors	Invested Amount (VND)	
KOBELCO Eco-Solutions Co., Ltd. (KESV)	Not yet determined	%
Japanese Company	Not yet determined	%
Vietnamese Company	Not yet determined	%
Total	Not yet determined	%

(2) Loan from Financial Institution(s) to SPC

It would be necessary for SPC to take out a long-term loan for project implementation. The loan amount for Phase 1 is modest. For Phase 2, the loan amount would depend on the progress of the development of Phu Quoc Island and is not determined in this survey.

The two-step loan proposed for the project would be made up of 70% private fund, sourced from JICA Private Sector Investment Finance and would be routed through a private bank in Viet Nam.

Table 6-2-2-3 Terms and Conditions of Two Step Loan (JICA Private Sector Investment through Private Bank in Viet Nam)

Items			Two Step Loan (JICA Private Sector Investment Fund through Private Bank in Viet Nam)
1)	Project		Private project
2)	Application procedure		Private bank, quick & easy
3)	Terms and Loan Conditions	Interest	VND market rate minus preferential interest rate
		Repayment	Max. 25 years (including 5 years grace period)
		Currency	VND

6.2.3 Revenue From Developments Implemented Under This Project

(1) Tariff Revenue

The SPC could collect tariff revenue for water supply from KIWACO for bulk water supply (Option 1), or from KIWACO for bulk water supply as well as from customers to whom the SPC supplies water directly (Option 2).

It is impossible for the SPC to achieve financial feasibility under the current water tariff. The tariff would need to be increased. This will be further discussed in a later section.

An environmental protection fee of about 10% of the water bill is currently charged to customers for the sewerage service. The amount is not enough to cover the full cost of the sewerage service, therefore, it is necessary for the government of Viet Nam (GOV) to subsidize the SPC.

(2) Other Sources of Funding for Sewerage Services

Developers' Contribution

Developers would take on some of the burden of the construction costs of the wastewater treatment plant and sewer system in proportion to their design sewage flow in order to recover part of the initial investment costs. In this project, resort and residential developments are included in the target service area. Sewage flow from these areas could be as high as 72% for Phase 1, 55% for Phase 2. By contributing to the development of sewerage and receiving the sewerage service, the developers save on the cost for building, operating and maintaining their own sewage treatment facilities. In addition, they would not have to invest in upgrades when discharge water quality standards become more stringent in future.

The estimated total construction cost of individual sewerage facilities in each development is VND 329,577,522,000 to treat a planned sewage flow of 27,450 m^3/d. The unit construction cost of the sewerage treatment facility is VND 12,000,000 per 1 m^3/d of sewage flow. Developers' contribution can be calculated by multiplying the unit construction cost by the expected sewage flow from each resort.

Island Entry Fee

The tourism industry on Phu Quoc Island is expected to grow significantly. Protecting the water environment against impacts from increases in tourist visits and the associated tourist facility developments would be important and absolutely essential. Following Hawaii's example of using the revenue from a hotel tax (9.25% of accommodation cost) for tourism promotion, an island entry fee for visits to Phu Quoc Island could be introduced and the revenue used for sewerage developments. The Master Plan projected 2 million tourist visits per year to the island by 2020. If 10 USD is collected per visit, the annual tax revenue would be around 20 million USD (approximately 1.6 billion JPY).

The island entry fee would be in addition to hotel tax the revenue of which would be used for other services such as garbage disposal and street cleaning.

6.2.4 Project cost

Major cost items of the project and assumptions for preparation of cash flow are described as follows;

(1) Repayment of Principal and Interest of the Loan

Principal and interest repayment are included in the disbursement schedule. SPC is responsible for 70% of the project cost and this portion would be financed from bilateral funds, such as JICA Private Sector Investment Fund, or multilateral institutional financing. The interest incurred during the construction period would be included in the amount identified as the loan.

(2) Fee for Land Rental or Lease

Rent for the land to be used for the WTP and STP would be paid by the SPC.

(3) Raw Water Cost

The SPC would charge the same unit raw water cost, 750 VND/m^3, which KIWACO is currently paying the local government.

(4) Operation and Maintenance Costs

Operation and maintenance (O&M) cost estimates for the water supply and sewerage systems are considered. These cost estimates do not include cost escalation since this is not considered in the financial analysis on revenue and expenditure.

(5) Corporate Income Tax

The corporate income tax rates applicable to this project are shown in **Table 6-2-4-3**, based on the Decree No. 124/2008/ND-CP.

Table 6-2-4-3 Corporate Income Tax Rates

Years from foundation	%	Period
1st to 4th year	0.0%	4 years
5th to 13th year	5.0%	9 years
14th to 15th year	10.0%	2 years
16th to 30th year	25.0%	15 years
Total		30 years

6.3 Financial Analysis

6.3.1 Water Supply System

(1) Analysis Methodology

The discounted cash flow method is used to evaluate the financial feasibility of this project. This involves projecting the revenues, costs and free cash flows of each year through the project life cycle, calculating the terminal value at the end of that period, and discounting the projected free cash flows and terminal value using the discount rate to arrive at the net present value of the total expected cash flows of the business or asset. Revenue is the water tariff, costs are composed of construction, O&M, and replacement costs.

The financial feasibility of the entire project is determined by comparing the Financial Internal Rate of Return (FIRR) which represents the rate of return earned on the project and the Weighted Average Cost of Capital (WACC) for the project. If the rate of return exceeds the cost of capital to finance the project, it meets the test of financial viability. Both comparators are measured in real terms to remove the effect of price changes on the comparison.

The financial viability of the SPC portion of the project is judged by the Equity IRR of the project. The equity IRR calculated shows that the SPC portion of the project would not be financially viable unless the current water and bulk water tariffs are raised.

(2) Options and assumptions

Financial analysis of the water supply project is carried out for Phase 1 for two options as follows:

Water Supply Option 1: BOO

The public sector partner would construct the impounding reservoir, intake, and raw water transmission. The SPC would construct the WTP. The public sector partner would manage the impounding reservoir, and the SPC would manage the facilities from intake to the WTP. KIWACO would construct, operate and maintain the facilities from clear water transmission, distribution reservoir, distribution main, to service connections.

Water Supply Option 2: Concession

The public sector partner would construct the impounding reservoir, intake, and raw water transmission. The SPC would construct the facilities from the WTP to service connections. The public sector partner would manage the impounding reservoir, and the SPC would manage the facilities from intake to service connections. The SPC would also bill and collect water charges from the customers.

The financial analysis is based on the following assumptions:

1	Project period	2017 – 2047 (30 years)
2	Evaluation period	2014 – 2047
3	SPC evaluation period	2014－2032 (15 years from start of service)
4	Price level	Year 2012
5	Exchange rate	270.27 VND per 1.00 JPY and 76.6 JPY per US$1.00
6	Weighted Average Cost of Capital（WACC）	4.0 %*1

Note: *1; Nominal interest rate is 11.2%. Capital investment cost is 15%. Weighted average of corporate income tax is 14.67%. Inflation rate is 8%. Considering these conditions, real interest rate was calculated. Calculated real interest rate became less than 4%. Then, Minimum Rate Test (MRT) was applied. In MRT, in case the real interest rate is less than 4%, the value is replaced with 4% in financial analysis to ensure conservative analysis. (refer to "Guidelines for Financial Management and Financial Analysis of Projects", African Development Bank, 2006)

In Option 1, the SPC would conclude an agreement with KIWACO on bulk water supply and the unit price of bulk water. The SPC would receive bulk water supply revenue from KIWACO. In Option 2, the SPC would collect the water tariff directly from the customers.

(3) Results of Analysis

Financial analysis for Phase 1 of water supply project concluded that necessary tariff increase for SPC to be financially feasible is lower in Option 1 than that in Option 2. That is, Option 1 is considered to be better in financial feasibility than Option 2.

(4) Loan Repayment Capability

The loan repayment capability of the SPC is evaluated by calculating the Debt Service Coverage Ratio (DSCR) for the 2 options. If the DSCR is less than 1, repayment capability is generally evaluated as insufficient in Japan. If the DSCR is more than 1.5, repayment capability is generally considered as adequate.

Average DSCR

Options	Average DSCR
Water Supply Option 1: BOO	**1.66**
Water Supply Option 2: Concession	**1.64**

The DSCR would be over 1.5 for both options. Therefore, it is considered that the SPC has the capability to repay its loan. It is noted that the repayment capability would be inadequate (DSCR between 1.0 and 1.5) in 2020 and 2021, and effort should be made to put aside enough profit to meet this need when the time comes.

(5) Water Tariff

The World Bank water supply project has been started for the target area of the southern part of the Phu Quoc Island. In comparison with the tariff increase schedule of the World Bank project, the tariff schedule of this project is set to source the required amount of revenue for KIWACO to avoid shortage of its fund for the operation after paying the bulk water tariff to SPC.

(6) Comparison of Financial Feasibility of Each Option

The financial feasibilities of the entire Project (FIRR) including the public and private sector portions, are almost the same for Option 1 and 2. On the other hand, the financial feasibility of the SPC portion of the project (Equity IRR) is much better for Option 1 than for Option 2.

In Option 1 (BOO), the project cost for the facilities from intake to WTP would be funded by the private sector partner, and the facilities from transmission pipe to distribution pipes would be funded by the public sector partner. It is recommended that the public sector partner considers using ODA Japanese Yen loan to fund its portion of the water supply facility construction.

(7) Financial Risk Analysis of Option 1

As a result of financial comparison between Option 1 and Option 2, it was found that Option 1 has higher feasibility than Option 2. Then, regarding Option 1, it is computed that how the values of Equity IRR and of DSCR are changed by the occurrences of imaginable risks with higher potential.

As imaginable risks, 3 cases are set, such as; (a) higher O&M costs, (b) higher construction cost, and (c) higher loan interest rate for SPC. In any cases, future tariff raise is set as same as that of base case, with keeping the financial feasibility of the Project for KIWACO (FIRR≧4.0%).

Values of Equity IRR and of DSCR are changing with the same trend for each risk. That is, if a value of Equity IRR becomes lowest, that of DSCR also becomes lowest. The most influential risk to these financial indicators is a construction cost increase. Second influential risk is a higher loan interest rate. Then, minor influential risk is an O&M cost increase with a small difference between higher interest rate. At project implementation, it is necessary to be careful about the construction cost changes higher than planned.

6.3.2 Sewerage System

(1) Analysis Methodology

The discounted cash flow method is used to evaluate the financial viability of this project. This involves projecting the revenues, costs and cash flows of each year through the life cycle period, calculating the terminal value at the end of that period, and discounting the projected cash flows and terminal value using the discount rate to arrive at the net present value of the total expected cash flows of the business or asset.

The financial viability of the entire project is determined by comparing the Financial Internal Rate of Return (FIRR) which represents the rate of return earned on the project and the Weighted Average Cost of Capital (WACC) for the project. If the rate of return exceeds the cost of capital to finance the project, it meets the test of financial viability. Both comparators are measured in real terms to remove the effect of price changes on the comparison.
The financial viability of the SPC portion of the project is judged by the Equity IRR of the project.

Sewerage surcharge at 10% of present water tariff would not cover the full cost of the sewerage project. Other sources of revenue include developers' contribution and government subsidy. An island entry fee to be paid by tourists could be the source of funds for the government subsidy. The developers' contribution could be calculated based on the cost to the developers if they were to build their own sewerage treatment facilities, and the estimated sewage flow from their own developments. The amounts of sewerage tariff, government subsidy and developers' contribution for the financial viability of the SPC portion of the project are calculated.

(2) Options and assumptions

The financial analysis of the sewerage project is conducted for the 2 options for Phase 1

Sewerage Option 1: BOO of STP

The public sector partner would construct the household connections, tertiary and branch sewers, main trunk sewer and pumping stations. The organization designated by the public sector partner would operate and maintain these facilities. The SPC would construct, operate and maintain the facilities from the STP to the discharge sewer.

Sewerage Option 2: BOO of Main Trunk Sewer, Pumping Station & STP

The public sector partner would construct the facilities from household connections to tertiary and branch sewers, excluding resort and development areas. These facilities would be operated and maintained by the organization designated by the public sector partner. The SPC would construct, operate and maintain the facilities from the main trunk sewer, to the pumping stations, STP and discharge sewer, in addition to house connection, tertiary sewer, and branch sewer in resort and development areas.

Major assumptions for the financial analysis are as follows;

1	Project period	2017 – 2047 (30 years)
2	Evaluation period	2014 – 2047
3	SPC evaluation period	2014－2032 (15 years from start of service)
4	Price level	Year 2012
5	Exchange rate	270.27 VND per 1.00 JPY and 76.6 JPY per US$1.00
6	Weighted Average Cost of Capital（WACC）	4.0 %*1

Note: *1; Nominal interest rate is 11.2%. Capital investment cost is 15%. Weighted average of corporate income tax is 14.67%. Inflation rate is 8%. Considering these conditions, real interest rate was calculated. Calculated real interest rate became less than 4%. Then, Minimum Rate Test (MRT) was Applied. In MRT, in case the real interest rate is less than 4%, the value is replaced with 4% in financial analysis to ensure conservative analysis. (refer to "Guidelines for Financial Management and Financial Analysis of Projects", African Development Bank, 2006)

(3) Results of Analysis

Financial analysis for Phase 1 of sewerage project concluded that the amount of governmental subsidy or burden on tourist to recover the subsidy necessary for SPC to be financially feasible is smaller in Option 1 than that in Option 2. That is, Option 1 is better in financial feasibility than Option 2.

(4) Loan Repayment Capability

The loan repayment capability of the SPC is evaluated by calculating the Debt Service Coverage Ratio (DSCR) for the 2 options. If the DSCR is less than 1, repayment capability is generally evaluated as insufficient in Japan. If DSCR is more than 1.5, repayment capability is generally considered as adequate.

Average DSCR

Options	Average DSCR
Sewerage Option 1: BOO for STP	**1.60**
Sewerage Option 2: BOO for trunk sewer, pumping station, STP	**1.56**

The DSCR would be over 1.5 for both options. Therefore, it is considered that the SPC has the capability to repay its loan. It is noted that the repayment capability would be inadequate (DSCR between 1.0 and 1.5) in 2020 and 2025, and efforts should be made to put aside enough profit to meet this need when the time comes.

(5) Financial Risk Analysis of Option 1

As a result of financial comparison between Option 1 and Option 2, it was found that Option 1, which requires smaller subsidy than that of Option 2, has higher feasibility than Option 2. Then, regarding Option 1, it is computed that how the values of Equity IRR and of DSCR are changed by the occurrences of imaginable risks with higher potential.

As imaginable risks, 3 cases are set, such as; (a) higher O&M costs, (b) higher construction cost, and (c) higher loan interest rate for SPC. In any cases, future subsidy is set as same as that of base case, with keeping the financial feasibility of the Project for KIWACO (FIRR≧4.0%).

Values of Equity IRR and of DSCR are changing with the same trend for each risk. That is, if a value of Equity IRR becomes lowest, that of DSCR also becomes lowest. The most influential risk to these financial indicators is a construction cost increase. Second influential risk is a higher loan interest rate. Then, minor influential risk is an O&M cost increase. At project implementation, it is necessary to be careful especially about the construction cost changes higher than planned.

6.4 Economic Analysis

6.4.1 Water Supply Project

(1) Methodology of Economic Analysis

The economic viability of a capital investment project is analyzed on the basis of the discounted cash flow method. In this method, net cash flows (project benefits minus project costs) from the project for each year are converted into present values by a certain discount rate. These present values of net cash flows are summed up for the entire evaluation period. The discount rate that makes the total present value zero, in other words, that makes present value of economic benefit equal to the present value of economic cost, is called the Economic Internal Rate of Return (EIRR). In terms of economic analysis, the discount rate is theoretically the opportunity cost of capital for the country. In this project, 12% which is generally used in Viet Nam, is set as the opportunity cost of capital. When the calculated EIRR is more than the opportunity cost of capital (12%), it suggests that the economic profitability of the project is higher than the national standard opportunity cost of capital. Therefore, the project is said to be economically viable.

(2) Assumptions for Economic Analysis

Regarding the economic analysis, the major conditions and assumptions for this study are as follows.

(a)	Project life	2017 – 2047 (30 years from start of the services)
(b)	Evaluation period	2014 – 2047
(c)	Price level	Year 2012
(d)	Exchange rate	270.27 VND per 1.00 JPY and 76.6 JPY per US$1.00
(e)	Opportunity cost of capital	12 % per annum

(3) Economic Analysis

1) Conversion from Financial Value to Economic Value

At first, project costs and benefits are identified and quantified in monetary terms all through the evaluation period. The total cost is enumerated in terms of market price, or in other words, ‘financial value’. For the purpose of economic evaluation, this financial value must be converted into economic value, since the purpose of the economic evaluation is to see the relationship between benefit and cost from the view point of national economy. The following are considered, in order to convert the financial cost into economic cost.

- Exclusion of transfer payment: tax, interest, subsidy are considered as the transfer payment from/to the government, and not as the true consumption of the resources for the project.
- Adjustment of the exchange rate distortion: Avoid the price distortion of the foreign exchange rate of the country, which originates from the import tax, export duty, export subsidy, etc.

In this analysis, international price level is applied to all cost items. As a result, the total cost in economic value is expressed in foreign currency (Japanese Yen). Prices of local goods/materials must be adjusted to avoid the exchange rate distortion by using the Standard Conversion Factor (SCF). For Viet Nam, the SCF is usually set at 0.9, which is generally used by most of the external donors to convert benefits and cost incurred in Viet Nam into economic prices.

2) Economic Benefits of the Water Supply Project

Table 6-4-1-1 shows the economic benefits of the water supply project. The benefits of the project are divided into two categories, quantifiable / tangible benefits and unquantifiable / intangible benefits. Economic evaluation includes all the quantifiable benefits as economic benefits of the project. In this study, items 2-1, 2-2, 3-1, and 3-2 of the **Table 6-4-1-1** are selected as quantifiable benefits.

Table 6-4-1-1 Economic Benefits of the Water Supply Project

No.	Effect	No.	Concrete Effects	Tangible/ Intangible
1	Improvement of amenity	1-1	Improvement of quality of life of domestic customers	Intangible
2	Cost reduction effects	2-1	Saving of alternative water procurement cost other than public water supply	**Tangible**
		2-2	Saving of incurred costs by public water supply stoppage	**Tangible**
3	Improvement of public hygiene	3-1	Saving of medical expenditure by decrease of water borne diseases	**Tangible**
		3-2	Increase of working days by decrease of waterborne diseases	**Tangible**
4	Economy stimulation effects	4-1	Stimulation of regional economy by project investment	Intangible
5	Environment preservation effects	5-1	Preservation of underground water source by constraining increase of wells	Intangible

Tangible economic benefits are explained below in more detail.

a) Cost reduction effect

Saving the costs for procuring alternative water sources

It is assumed that without the project, water demand over the present water supply capacity until 2030 (target year of Phase 2) would be satisfied by alternative sources such as ground water. However, with the implementation of the project, water supply facilities would be established to satisfy the water demand in the target water supply areas by 2030. In other words, alternative water procurement costs including construction and O&M costs for well and pumps etc., which would be required without the project, are saved. These savings are estimated for the year 2017, 2020 and 2030 as follows:

Year	Water supply volume (m^3/day)		Unit cost of alternative water (VND/m^3)		Total Benefit by saving alternative water cost (mil. JPY/year)		
	Domestic	Non-domestic	Domestic	Non-dom.	Domestic	Non-dom.	Total
2017	3,985	3,566	23,241	14,707	125.08	70.83	195.91
2020	7,970	7,132			250.15	141.65	391.80
2030	16,111	22,201			505.68	440.95	946.63

Saving the costs incurred to mitigate public water supply stoppage

Without the project, and continuing with the present situation of insufficient water supply and frequent supply disruptions, about 90% of public water supply users would still have to store water in their houses by installing water tanks. With the implementation of the project, there would be a cost saving for procurement, O&M and replacement of water storage tanks. These cost savings are estimated for 2017, 2020 and 2030 as follows:

Year	No. of water tank to be saved	Annual cost of water tank (VND/year)	Total Benefit of saving water tanks	
			(mil. VND/year)	(mil. JPY/year)
2017	2,657	131,296	348.81	1.29
2020	6,642		872.02	3.23
2030	10,741		1,410.21	5.22

b) Improvement of public hygiene

Saving of medical expenditures by decrease in the incidence of water borne diseases

Without the project, people unable to obtain water from the water supply system would have to use ground water which could be of questionable quality and may lead to outbreaks of waterborne diseases (e.g., diarrhea, typhoid, dysentery). With the implementation of the project, the water quality of supplied water is guaranteed to be safe so that the incidences of waterborne diseases would be reduced. As a result, medical costs including doctor's bills, drug costs, hospital fees, hospital visit costs, would be saved. These savings are estimated for 2020 as follows:

(1) No. of patients	(2) Average cost of treatment	(3) Ave. cost of transportation	(4) Rate of reduction with project	(5) SCF*
8,856	72,650	60,000	50%	0.9

*: SCF is Standard Conversion Factor.

Total Benefit = (1) x ((2) + (3)) x (4) x (5) =	528.64	mil. VND/year
	1.95	mil. JPY/year

Increase in working days as a result of decrease in waterborne diseases

The consumption of good quality water from the water supply system would reduce the number of patients coming down with water borne diseases and thus increase the number of productive working days. The economic benefit for the increase in the number of working days is estimated for 2020 as follows:

(1) Assumed absence days	(2) No. of patients	(3) Rate of reduction with project	(4) Ave. yearly income (VND)	(5) SWR *
5.0	8,856.0	50%	28,128,000	70%

*1; SWR is Shadow Wage Rate.

Total Benefit = (1) / 365 x (2) x (3) x (4) x (5) = 1,194.32 mil. VND/year
4.42 mil. JPY/year

Total economic benefits of the Water Supply Project are summarized as follows;

Year		Water supply by the project			Benefit (million JPY)					
		Domestic (m^3/day)	Non domestic (m^3/day)	Total (m^3/day)	Alternative water supply			Saving water tank cost	Reduction of water borne disease	Grand Total
					Domestic	Non domestic	Total			
0	2017	3,985	3,566	7,551	125.08	70.83	195.91	1.29	2.55	199.75
1	2018	5,314	4,754	10,068	166.79	94.42	261.21	1.94	3.82	266.97
2	2019	6,642	5,943	12,585	208.47	118.04	326.51	2.58	5.10	334.19
3	2020	7,970	7,132	15,102	250.15	141.65	391.80	3.23	6.37	401.40
4	2021	8,784	8,639	17,423	275.70	171.59	447.29	3.43	6.77	457.48
5	2022	9,598	10,146	19,744	301.25	201.52	502.77	3.62	7.16	513.56
6	2023	10,412	11,653	22,065	326.80	231.45	558.25	3.82	7.55	569.63
7	2024	11,227	13,160	24,387	352.38	261.38	613.76	4.02	7.95	625.73
8	2025	12,041	14,667	26,708	377.93	291.31	669.24	4.22	8.34	681.80
9	2026	12,855	16,173	29,028	403.48	321.22	724.70	4.42	8.74	737.86
10	2027	13,669	17,680	31,349	429.03	351.16	780.19	4.62	9.13	793.94
11	2028	14,483	19,187	33,670	454.58	381.09	835.67	4.82	9.52	850.01
12	2029	15,297	20,694	35,991	480.13	411.02	891.15	5.02	9.92	906.08
13	2030	16,111	22,201	38,312	505.68	440.95	946.63	5.22	10.31	962.16

Note: Amount of benefit is same as that in the year 2030 after that.

3) Economic Costs of the Water Supply Project

Construction cost covers all the costs related to procurement, construction and consulting services for both Phase 1 and Phase 2. Methodology of conversion from financial cost to economic cost is mentioned in "1) Conversion from Financial Value to Economic Value."

Residual values of replaced equipments are not deducted from the cost in the last evaluated year, since the values are negligible. Price escalation and interest during construction are also excluded from economic costs, as inflation is not reflected on the economic benefit.

(4) Results of Economic Analysis

Results of economic analysis of this water supply project (Phase 1 and Phase 2) are shown as follows.

	Economic Internal Rate of Return (EIRR)	NPV	B/C
Water Supply Project	**14.11%**	**340 million JPY**	**1.13**

Note: NPV and B/C are computed using the 12% opportunity cost of capital as discount rate.

Computed EIRR is greater than the opportunity cost of capital (12%), therefore, this water supply project is economically viable.

6.4.2 Sewerage Project

(1) Methodology of Economic Analysis

The economic viability of a capital investment project is analyzed on the basis of discounted cash flow method. In this method, net cash flows (project benefits minus project costs) from the project of each year are converted into present values by a certain discount rate. These present values of net cash flows are summed up for the entire evaluation period. A discount rate, which makes the total present values zero, in other words, which makes present value of economic benefit equals present value of economic cost, is called Economic Internal Rate of Return (EIRR). In terms of economic analysis, the discount rate is theoretically the opportunity cost of capital of the country. In this project, 12% which is generally used in Viet Nam, is set as the opportunity cost of capital. When the calculated EIRR is more than the opportunity cost of capital (12%), it suggests that the economic profitability of the project is higher than national standard opportunity cost of capital. Therefore, the project is said to be economically viable.

(2) Assumptions for Economic Analysis

Regarding the economic analysis, the major conditions and assumptions for this study are as follows:

(a)	Project life	2017 - 2046 (30 years from start of the services)
(b)	Evaluation period	2013 - 2046
(c)	Price level	Year 2012
(d)	Exchange rate	270.27 VND per 1.00 JPY and 76.6 JPY per US$1.00
(e)	Opportunity cost of capital	12 % per annum

(3) Economic Analysis

1) Conversion from Financial Value to Economic Value

At first, project costs and benefits are identified and quantified in monetary terms all through the evaluation period. The total cost is enumerated in terms of market price, or in other words, ‘financial value’. For the purpose of economic evaluation, this financial value must be converted into economic value, since the purpose of the economic evaluation is to see the relationship between benefit and cost from the view point of national economy. The following are considered, in order to convert the financial cost into economic cost.

- Exclusion of transfer payment: tax, interest, subsidy are considered as the transfer payment from/to the government, and not as the true consumption of the resources for the project.
- Adjustment of the exchange rate distortion: Avoid the price distortion of the foreign exchange rate of the country, which originates from the import tax, export duty, export subsidy, etc.

In this analysis, international price level is applied to all cost items. As a result, the total cost in economic value is expressed in foreign currency (Japanese Yen). Prices of local goods/materials must be adjusted to avoid the exchange rate distortion by using the Standard Conversion Factor (SCF). For Viet Nam, the SCF is usually set at 0.9, which is generally used by most of the external donors to convert benefits and cost incurred in Viet Nam into economic prices.

2) Economic Benefits of Sewerage Project

Table 6-4-2-1 shows the economic benefits of the sewerage project. The benefits of the project are divided into two categories, quantifiable / tangible benefits and unquantifiable / intangible benefits. Economic evaluation includes all the quantifiable benefits as economic benefits of the project. In this study, items 1-1, and 3-1 of the **Table 6-4-2-1** are selected as quantifiable benefits.

Table 6-4-2-1 Economic Benefits of the Sewerage Project

No.	Effect	No.	Concrete Effects	Tangible/ Intangible
1	Environment preservation effects	1-1	Preservation of water environment expressed by tourism revenues	**Tangible**
		1-2	Preservation of underground water source	Intangible
2	Improvement of productivity	2-1	Improvement of productivity of fishery	Intangible
3	Improvement of amenity by connecting public sewer	3-1	Improvement of amenity of land and building expressed by their value	**Tangible**
		3-2	Preventing sewage overflow	Intangible

Tangible economic benefits are explained below in more detail.

a) Environment preservation effects

Preservation of water environment expressed by tourism revenues

Phu Quoc Island has the potential to be one of the most famous tourist resorts, being blessed with abundant natural environment, white sandy beaches, and off shore coral reefs. The government of Viet Nam formulated the master plan (M/P) to promote eco-tourism on the island. In the M/P, the number of domestic and foreign tourists visiting the island every year is forecasted to be 2 to 3 million by 2020 and 5 to 7 million by 2030. **Figure 1-1-1** in Chapter 1 shows the trend of tourist numbers to Phu Quoc Island for the past 5 years. The figure indicated continuous increase in tourist visits for the period.

There is a concern that the valuable tourism resource of beautiful sea and beaches will be contaminated by the inflow of untreated sewage, because there is no public sewerage system on Phu Quoc Island. The implementation of this project would curtail the contamination of the ocean and the preserved natural environment would be beneficial to the tourism industry and boost tourism revenue.

Economic benefits related to tourism revenue are estimated for 2017, 2020, and 2030 as follows:

Year	Estimated future tourist number	Estimated future tourism revenue (million VND)	Ratio of Design Sewage Flow (DSF) of the Project among total DSF in PQ	Benefit of project * (million VND)
2017	1,514,641	2,341,933	45.5%	106,558
2020	2,000,000	3,092,394		140,704
2030	3,000,000	4,638,590		211,056

Note: *; It is assumed that tourism revenue would be 10% lower without the project case than that with the project case.

b) Enhancement of property value

By connecting domestic sewage to the public sewer system, the value of land and house / building would increase because of the improved living conditions including reduction of bad odor, better appearance, improved cleanliness, and no sludge excavation.

Generally, it is considered that the establishment of sewerage system would raise the value of the land and house / building.

There are documents and articles that state that land values generally increase with the implementation of a sewerage system. **Table 6-4-2-2** shows the information sources and the estimated percent increases.

Table 6-4-2-2 Land Value Increase With Implementation of Sewerage System

Reference document	Source	Year	% of land value increase
Draft Manual for Cost Benefit Analysis for Land Rearrangement Project	Ministry of Land, Infrastructure, Transport and Tourism	2009	9 – 30%
Sewer systems raising Westmoreland property values	Frank Delano	2009	11%
From Asset Value to Utilization Value -	Mitsubishi Research	2008	5 – 10%

Future Sewerage System -	Institute, Inc., MRI Today		
Sewerage Improvement Project in Eastern Downstream Basin of Kitakami River	Miyagi Prefecture, Japan	2004	27%
Effect of an Urban Growth Management System on Land Values	Michael E. Gleeson	2001	13%

In this analysis, in order to make the assumption simple and modest, the land value increase is assumed to be 5%. Economic benefits related to land value increase are estimated as follows:

Items	Unit	Phase I	Phase II
Area of land*	ha	1,125.83	1,007.28
Value of land in the area	million VND	21,944,329	28,856,034
Benefit from improvement of amenity	million VND	**1,097,216**	**1,442,802**

Note: *; Excluding the areas of Administration, Public, Eco-tourism, and others

Year	Total land value increase (mil. VND)	Annual benefit of land value increase (mil. VND/year)
2017 – 2020 (4 years)	1,097,216	274,304
2021 – 2030 (10 years)	1,442,802	144,280

Total economic benefits of the Sewerage Project are summarized as follows:

Year	Increase of land value (mil. VND)	Increase of revenue from tourism (mil. VND)	Total (mil. VND)	Total (mil. JPY)
2017	274,304	106,558	380,862	1,409.19
2018	274,304	117,940	392,244	1,451.30
2019	274,304	129,322	403,626	1,493.42
2020	274,304	140,704	415,008	1,535.53
2021	144,280	147,739	292,019	1,080.47
2022	144,280	154,774	299,054	1,106.50
2023	144,280	161,809	306,090	1,132.53
2024	144,280	168,845	313,125	1,158.56
2025	144,280	175,880	320,160	1,184.59
2026	144,280	182,915	327,195	1,210.62
2027	144,280	189,950	334,230	1,236.65
2028	144,280	196,985	341,266	1,262.68
2029	144,280	204,021	348,301	1,288.71
2030	144,280	211,056	355,336	1,314.74
2031	0	211,056	211,056	780.91

3) Economic Costs of Sewerage Project

Construction cost covers all of the costs related to procurement, construction and consulting services for Phase 1 and Phase 2. Methodology of conversion from financial cost to economic cost is mentioned in “1) Conversion from Financial Value to Economic Value.”

Residual values of replaced equipments are not deducted from the cost in the last evaluated year, since the values are negligible. Price escalation and interest during construction are also excluded from economic costs, as inflation is not reflected on the economic benefit.

(4) Results of Economic Analysis

Results of economic analysis of this sewerage project (Phase 1 and Phase 2) are shown as follows.

	Economic Internal Rate of Return (EIRR)	NPV	B/C
Sewerage Project	**16.27%**	**933 million JPY**	**1.18**

Note: NPV and B/C are computed using the 12% opportunity cost of capital as discount rate.

The EIRR is greater than the opportunity cost of capital (12%), therefore, this sewerage project is economically viable.

6.5 Organization for Operation and Maintenance

Organization for Operation and Maintenance (O&M) for the impounding reservoir, water supply and sewerage systems is explained in this section.

6.5.1 O&M for Impounding Reservoir

Cua Can impounding reservoir, would be operated and maintained by the Department of Agriculture and Rural Development (DARD) of Kien Giang Province, which is now operating the existing Duong Dong reservoir.

O&M of the impounding reservoir is necessary for the purpose of sustainable abstraction of raw water for water supply and to secure the safety of the reservoir.

Table 6-5-1-1 shows the O&M work items for the Cua Can River regulating weir and impounding reservoir.

Table 6-5-1-1 O&M Work Items of Cua Can River Regulating Weir and Impounding Reservoir

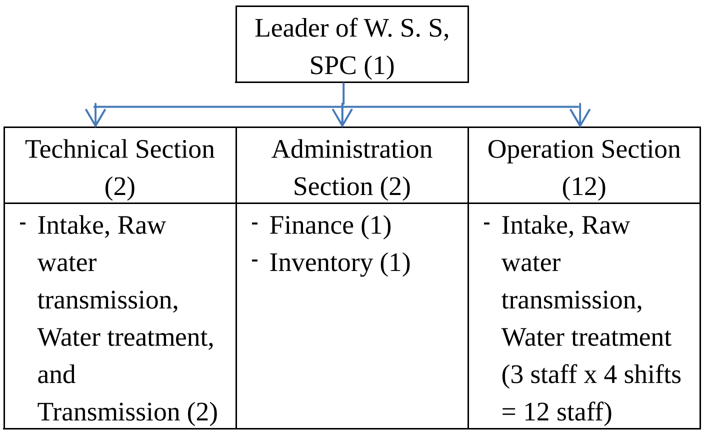
Items	Goals	Actions Required
Safety control of weir	Keep track of changes and conditions (leakage or crack) of weir, ground, and hills around the connecting point.	Evaluate the results of measurement / monitoring data. Conduct detailed investigation, repair, as needed.
Maintenance of equipment of river water intake	Ensure good working conditions of water intake pump and unhintered access to electricity and transformation equipment.	Regular check, extra check, inspection and maintenance at accident, detailed inspection and repair.
Safety control of Cua Can River regulating weir and impounding reservoir	Preserve the environment of the catchment basin.	Periodically remove sediment sand, driftwood, implement measures to preserve the natural environment in the upstream reaches of the river.
Operation of impounding reservoir	Secure the required amount of raw water for water supply and control of outflow water volume.	Measure water inflow volume, reserved water volume, and reserved water level, decide on raw water volume and outflow volume.
Preservation of water quality and water volume	Preserve the environment of catchment basin and impounding reservoir.	Periodically collect water samples and test water quality,

Response to disasters and accidents	Ensure adequate capability to respond to heavy rain, flood, earthquake, contamination by toxic substances, and any other accidents	Educate and train staff and prepare manual for disaster and accident response.
Data management	Ensure proper collection, sorting and storage of basic data and measurement and inspection record.	Keep a record of the general information of the impounding reservoir, geographical information, hydrological & meteorological data, drawing of completion of construction, water volume, rainfall, weir measurement, inspection record, sediment sand, water quality data, etc.

6.5.2 O&M Organization for Water Supply System

The Cua Can water supply system is composed of intake, raw water transmission, water treatment, and transmission and distribution facilities.

In Option 1, the SPC would operate and maintain the facilities from raw water intake at the reservoir to distribution reservoir. KIWACO would operate and maintain the facilities after the distribution reservoir. **Figure 6-5-2-1** shows the O&M organization for Option 1.



Note: W.S.S; Water Supply System. Numbers in the brackets indicates number of staff.

Figure 6-5-2-1 SPC O&M Organization for Water Supply Option 1

In Option 2, the SPC would operate and maintain all the facilities from intake to service connections. The O&M organization of the SPC for Option 2 is shown in **Figure 6-5-2-2**.

Leader of W.S.S, SPC (1)

Technical Section (6)	Administration Section (2)	Construction & repair Section (4)	Commercial Section (5)	Operation Section (12)
- Intake, Raw water transmission, Water treatment (2) - Transmission & distribution (2) - Service connection (2)	- Finance (1) - Personnel affair (1)	- Leakage repair of transmission & distribution pipes (2) - Installation & repair of service connection (2)	- Billing & collection (3) - Customer service (1) - Inventory (1)	- Intake, raw water transmission, WTP (3 staff x 4 shifts = 12 staff)

Note: W.S.S; Water Supply System, Numbers in the brackets indicates number of staff.

Figure 6-5-2-2 SPC O&M Organization for Water Supply Option 2

6.5.3 O&M Organization for Sewerage System

(1) Job Description and Work Items

The job descriptions and work items for O&M of the sewerage system are shown in **Table 6-5-3-1**.

Table 6-5-3-1 Job Description and Work Items for O&M

Tasks	Job Description	Work Items
Operation and maintenance, equipment inspection	Facility operation, Support staff, Mechanical and Electrical Engineer, Professional staff	- check & maintain mechanical and electrical equipment, quick repair of simple breakdowns, inspect, operate equipment, record and report operational information, and consult with senior staff. - Daily check of facilities, regular check, quick repair of simple breakdowns, maintain records on operation, maintenance and inspection, record of accident and complaints.
Facility management - Plant management - Sewer management	Technical staff / Professional staff	Daily inspection of facility, regular check, simple repair Facility management, improvement, repair, Preparation and control of ledger
Water quality monitoring & control	Chemical & biological Professional staff	Sampling, water quality testing / analysis of raw water (second treatment) and treated water, recording the results of water quality control and water quality analysis, inform

Tasks	Job Description	Work Items
		operation staff of water quality analysis results.
Administration	Clerical job	General office duties, personnel affair / salary / office regulation / training, contracting, procurement and management of material & equipment, documentation, advertisement and PR, etc.

Personnel plan for O&M, based on **Table 6-5-3-1**, is described in **Table 6-5-3-2**.

Table 6-5-3-2 Personnel Plan for O&M

No.	Section	Staff of the Section	Staff Number
1.	Management		2
		Head of Sewerage System, SPC	(1)
		Management & Finance	(1)
2	Administration Section		5
	(Administration & Accounting)	Engineer	(1)
		Clerical staff	(2)
		Guardian	(1)
		Office helper	(1)
3	Technical Section		12
	(STP, Pumping Station, Sewer)	Engineer	(1)
		Technical staff / Operator	(8)
		Facility control staff	(2)
		Water quality analysis specialist	(1)
		Total	19

This O&M organization is based on examples from the Duong Dong WTP in Phu Quoc, and Binh Hung STP in Ho Chi Minh. It should be noted that the above O&M organization does not include the staff for meter reading, billing & collection.

6.6 Project Implementation Schedule

6.6.1 Implementation Schedule

After completion of this survey, it is necessary to complete the processes for fund procurement (e.g. loan) and securing the licenses required for project implementation. Construction is expected to start in 2014 and operation of the facilities by 2017. The implementation schedule is shown in **Table 6-6-1-1**.

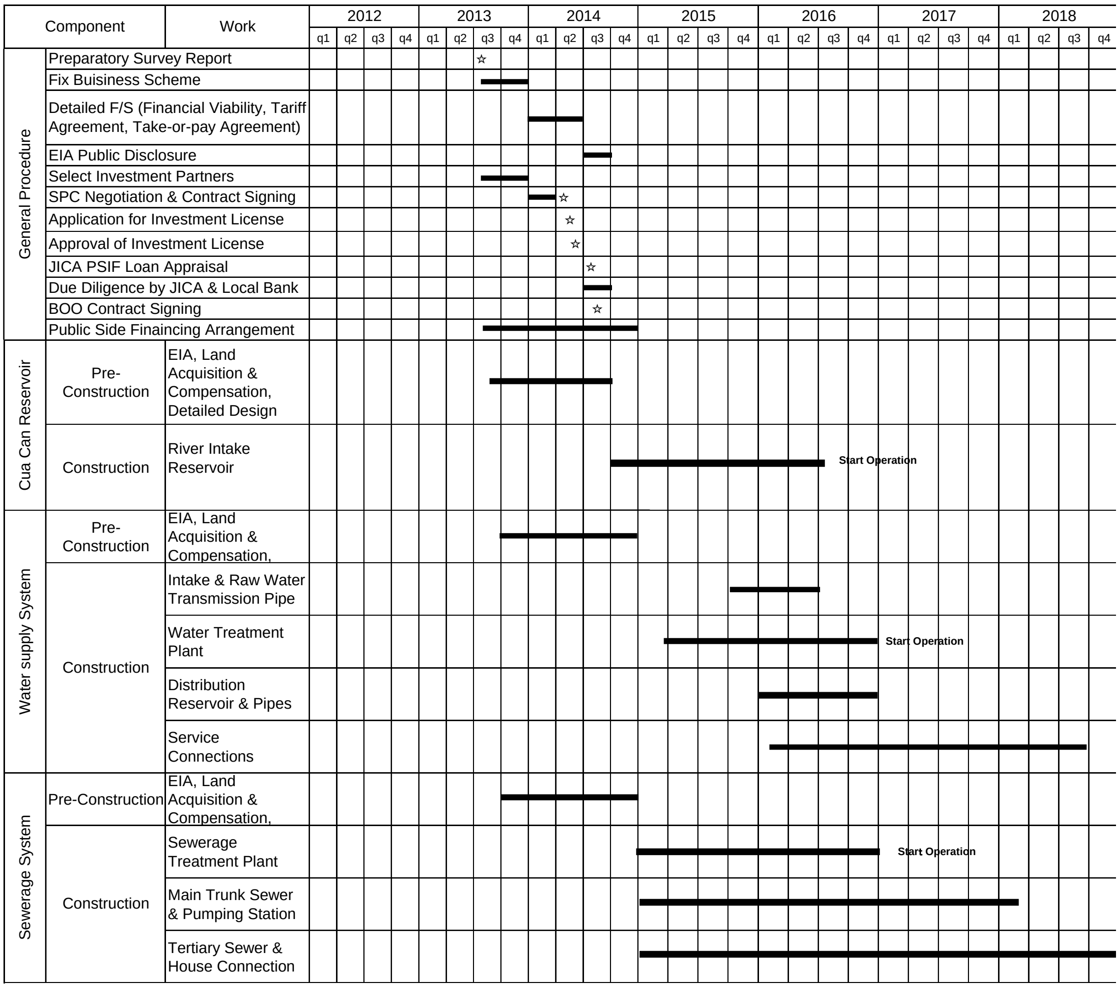


Figure 6-6-1-1 Implementation Schedule for the Whole Project

6.6.2 Impounding Reservoir and Water Supply Facility

Under this PPP scheme, different agencies are responsible for the implementation of the impounding reservoir, water treatment plant and distribution facilities. It is quite important for these agencies to know the expected timing for the completion of their respective components.

KGPPC might choose to undertake the construction of the impounding reservoir and guarantee the commencement date and quantity of the raw water supply and include the default penalty in the raw water bulk supply agreement with the Special Purpose Company. The construction of the water treatment plant and distribution facilities can start while the impounding reservoir construction is on-going to shorten the entire construction period.

Furthermore, to reduce the risk of delay, it is essential to set the conditions in the contract.

The Phase 1 construction schedule would require at least 3.5 years after finalizing this survey report, including impounding reservoir, water treatment plant and distribution facilities, even if land acquisition and compensation processes are conducted smoothly without delay.

- Financing Arrangement: 0.5 - 1 year
- Detailed Design: 0.5 - 1 year
- Construction : 2 years

Water supply facilities are composed of intake facilities, raw water transmission facilities, water treatment plant, clear water transmission facilities, distribution facilities and service connections. Intake facilities and raw water transmission facilities should be constructed at the same time as the impounding reservoir construction. Other facilities can be constructed without any coordination with the impounding reservoir construction.

Figure 6-6-2-1 shows the entire construction schedule of water supply system including the impounding reservoir.

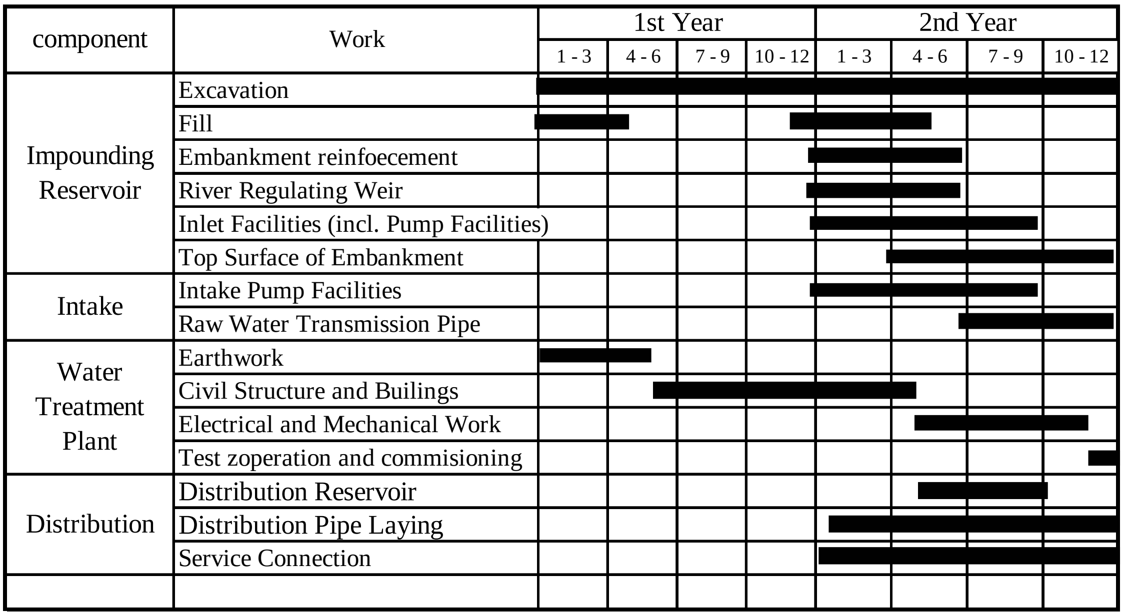


Figure 6-6-2-1 Construction schedule of Water Supply System (Phase 1) and Impounding Reservoir

Phase 2 implementation largely depends on the progress of the resort and housing developments. Water demand projections for 2030 assume that all the planned developments are completed by the year 2030.

Water demands should be reviewed and necessary adjustment made during implementation of Phase 1, depending on the actual progress of the resort and housing developments.

6.6.3 Sewerage Facilities

The main components of the sewerage system are the STP, main trunk and pumping stations, branch and tertiary sewers and house connections. Each component can be implemented independently, requiring little coordination.

The existing urban area and coastal development area are chosen as the sewerage service area for Phase 1.

Main trunk sewer construction would start from the STP. This survey recommends that the main trunk sewers to the northern and southern tourist developing areas be constructed first. Connecting the development areas would secure a certain amount of sewage inflow at the start of the STP operation.

The main trunk sewer from the STP to the southern area would then be extended to connect to the town in Duong Dong district. Outreach to the residents is essential.

It will take around 2 years for the completion of the STP construction and start of operation. The construction of the entire trunk sewer would take around 3.5 years. Several years would be required to complete the construction of branch, tertiary sewers to house connections, depending on the actual conditions of the households.

- Financing Arrangement: 0.5 - 1 year
- Detailed Design: 1 year
- Construction : 2 years until start of operation

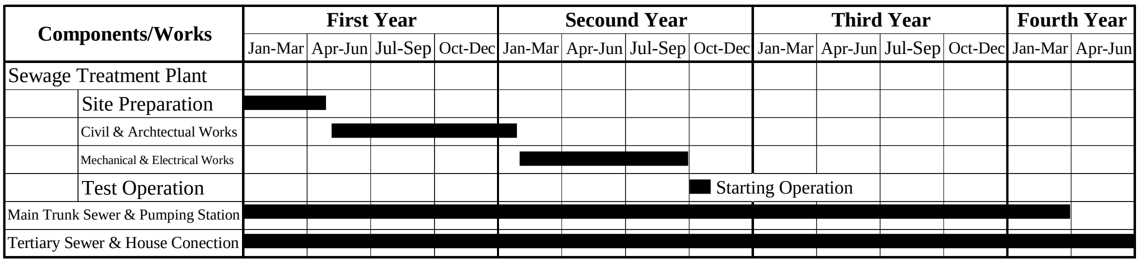


Figure 6-6-3-1 Construction Schedule of Sewerage System (Phase 1)

The implementation schedule of Phase 2 depends on the progress of the resort and housing developments. Sewage flow projections for the year 2030 assume that all the planned developments are completed by the year 2030.

Thus, depending on the actual progress of the planned development, sewage flows should be reviewed and adjusted during the implementation of Phase 1.

CHAPTER 7 PREPARATION OF BUSINESS PLAN

CHAPTER 7 PREPARATION OF BUSINESS PLAN

7.1 Proposed Project Scheme

7.1.1 Water Supply Business

Option 1 (BOO) is the proposed scheme for the water supply business of this project as explained in “6.1.1 Water Supply Business”.

Main reasons are as follows; As was described in “6.1.1 Water Supply Business”, in case of Option 2 (Concession Agreement), SPC must establish the organization to enable the whole tasks of water supply company, including the pipe maintenance, meter reading, billing and collection, as far as customer management and water quality control. In Phu Quoc Island, KIWACO has already being managing the water supply service in Duong Dong district and its surrounding areas. It is reasonable to manage the distribution facilities and service connections by KIWACO, in order to keep the service level uniform in the island and to avoid the inefficiency by double management for operation and customer management. For this project, it is advisable in the aspects of operation control and of the cost that the responsibility of SPC is until the facilities at the outlet of WTP to supply bulk water to KIWACO. Furthermore, as was financially compared Option 1 and Option 2 in “6.3 Financial Analysis”, capital expenditure by SPC to its responsible facilities in Option 2 shall be larger than that of the Option 1. In order to raise the enough profit to cover risks and for the private companies to be interested in investing it, tariff raise in Option 2 shall be higher than that of the Option 1 (BOO). In addition to this, in Option 2, water tariff billing and collection shall be conducted by KIWACO and by SPC respectively in each responsible area, therefore, total costs for tariff billing and collection shall be higher than that of the Option 1. Higher tariff raise will be required also by this reason in Option 2.

As a result, Option 1 is considered to have higher possibility to be implemented than Option 2, therefore, selected as preferred water supply scheme.

Water Supply Option 1 (BOO)

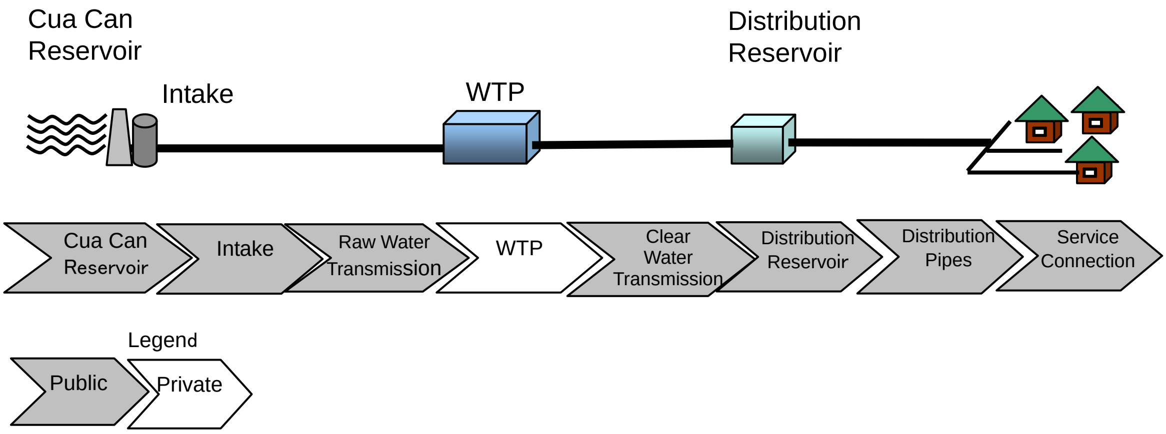


Figure 7-1-1-1 Water Supply Option 1 (Demarcation of Construction)

The SPC (Special Purpose Company), as the private entity partner, would construct the WTP, and operate and maintain the facilities from the intake to the WTP. The public sector authorities would construct, operate, and maintain the rest of the facilities in the water supply system. Specifically, Kien Giang Province would construct, operate and maintain the Cua Can impounding reservoir, and KIWACO would construct, operate and maintain the facilities from clear water transmission to the service pipes and service connections.

The SPC would buy raw water from Kien Giang Province under a Raw Water Bulk Supply Agreement, treat the water and supply the treated water to KIWACO under a Bulk Water Supply Agreement.

The SPC would pay a raw water tariff to Kien Giang Province or the organization managing the Cua Can impounding reservoir. KIWACO would pay a tariff to the SPC for treated water and in turn would collect a water tariff from customers.

7.1.2 Sewerage Business

Option 1 (BOO of STP) is the proposed scheme for the sewerage business of this project as explained in “6.1.2 Sewerage Business”.

Main reason is as follow; As shown in the comparison of Option 1 and Option 2 in “6.3 Financial Analysis”, in Option 2 (BOO of main trunk sewer, pumping station and STP), responsible facilities of SPC is larger and the capital expenditure will be bigger than that of the Option 1 (BOO of STP). Therefore, in order to raise the profit to cover risks and for private companies to be interested in investing it, the amount of subsidy from Provincial Government in Option 2 will be much larger than that in Option 1. As a result, Option 1 is considered to have more possibilities to be implemented than Option 2, therefore, it is selected as preferred sewerage scheme.

Sewerage Option 1 (BOO of STP)

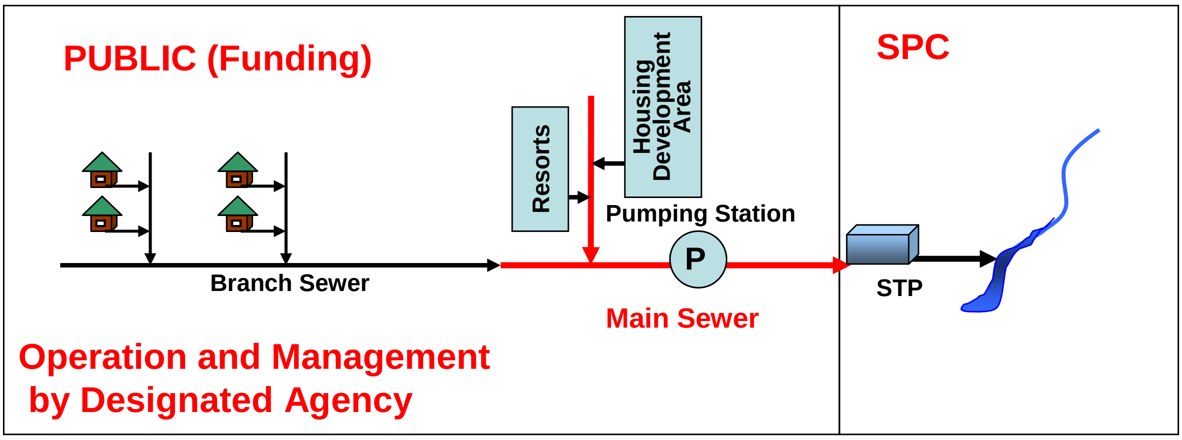


Figure 7-1-2-1 Sewerage Option 1 (Demarcation of Construction)

The SPC would be responsible for the construction, operation and maintenance of the STP. The public sector authorities would be responsible for the construction, operation and maintenance of all sewer and house connections.

KIWACO would charge an Environmental Protection Fee which is a percentage of the water tariff to cover some of the costs associated with the sewerage service. The amount charged would be far from enough to cover the full cost of the sewerage business. A portion of the construction cost would be recovered by the developers as 'developer's contribution'. Furthermore, the provincial government would provide a subsidy to KIWACO and the SPC every year after the service is started. The funding source of the subsidy is an 'Island Entry Fee' to be charged to tourists.

7.2 Project Executing Agency

(1) Executing agency (public sector authorities) : Kien Giang Province, and KIWACO

Kien Giang Province and KIWACO would establish a special unit to facilitate and manage the implementation of this project. This unit would play a role in deciding the type of PPP scheme, planning, designing and facilitating the implementation of obligations on the Vietnamese side and the development of laws and regulations as required. This unit is important for coherent and efficient execution of the project and should be established as early as possible.

(2) Private sector contract partner : SPC (Special Purpose Company)

The SPC would be the private sector contract partner of this project and would sign the Bulk Water Supply Agreement with KIWACO. KIWACO together Kien Giang Province are the public sector authorities that make up the Public Executing Agency.

The project would be implemented as a BOO scheme and the SPC would take out an investment license based on the Investment Law and the Enterprise Law. The details would be decided based on discussions with Kien Giang Province.

In the scheme of this project, the SPC would be responsible for the construction, replacement, and operation and maintenance of the facilities and may contract out some of these tasks.

7.3 Undertakings and Necessary Legislation by the Vietnamese Side

7.3.1 Public Sector Authorities' Construction and Related Responsibilities

(1) Water Supply Business

Kien Giang Province would build the Cua Can impounding reservoir using either government budget or the Water Sector Fund (explained in **7.3.2**). The province or its designated organization would replace equipment, operate and maintain this facility. KIWACO would be responsible for the procurement, construction and O&M of the facilities for transmitting clear water from the WTP, including distribution and service pipes.

(2) Sewerage Business

The SPC would build, operate and maintain (including equipment replacement) the STP and effluent pipe. Kien Giang Province would build, operate and maintain (including equipment replacement) facilities from household connections to the STP (including sewer pipes, pumping stations, and so on).

7.3.2 Legal System Requirements

(1) Securing Construction Budget

It is recommended that the public sector authorities establish a Water Sector Fund to be used over several years for the construction of the facilities. This Fund could be secured by the government as a JICA loan and can be used for projects such as (a) sewerage treatment projects in industrial towns, (b) medium and small water related projects, (c) public sector side of water supply and sewerage PPP projects.

(2) Island Entry Fee and Developer's Contribution

The Government of Viet Nam is expected to subsidize the SPC every year for part of the cost of the sewerage treatment facilities. The source of funding for this subsidy could be collected from tourists as an 'Island Entry Fee'. Or a fee could be added to the existing sewerage tariff the hotels are paying, without charging the tourists directly. Developers could also be required to contribute to the initial investment costs. A new legal framework would have to be established for the implementation of any one of these schemes.

7.4 Project Financing Plan

7.4.1 Sharing of Project Cost between Public and Private Partners and Equity and Debt

The project cost would be sourced from capital investment (Equity) from investors and loan (Debt) from financial institution(s). The proportion of capital investment and loan would be 30% and 70% respectively. The public and private sector costs for the chosen option for the water supply and sewerage systems for Phase 1 are examined**.**

Further efforts are to be exercised to minimize the construction and other costs in order to strengthen project viability in both water supply and sewerage system by both private investors and Vietnamese counterparts.

7.4.2 Potential Capital Investors and Terms of Conditions of Loan for SPC

(1) Potential Investors
Japanese companies such as KOBELCO Eco-Solutions Co., Ltd. (including Kobelco Eco-Solutions Vietnam Co., Ltd.) and Vietnamese companies could be potential investors in the SPC.

(2) Terms of Conditions of Loan
It is necessary for the SPC to borrow a long-term loan. The loan amount is limited to Phase 1. The loan amount for Phase 2 depends on the progress of developments on Phu Quoc Island. Therefore, the precise loan amount for Phase 2 is not determined in this survey. The loan is expected to be made up of 70% of private funds, sourced from JICA Private Sector Investment Finance as a two step loan through a private bank in Viet Nam.

Table 7-4-2-1 Terms of Conditions of Two Step Loan (JICA Private Sector Investment through Private Bank in Viet Nam)

Items			Two Step Loan (JICA Private Sector Investment Fund through Private Bank in Viet Nam)
1)	Project		Private project
2)	Application procedure		Private bank, quick & easy
3)	Terms of Loan Condition	Interest	VND market rate minus preferential interest rate
		Repayment	Max. 25 years (including 5 years grace period)
		Currency	VND

7.5 Risk Allocation of the Project

Risks, their allocations between the public and private sector partners, and the means to alleviate some of the risks are described in **Table 7-5-1**. The “take-or-pay clause” is the most important provision to minimize the financial risk to the private sector partner.

The water demand in the future may fall below the projected amount required to make the water supply business profitable. To minimize the financial risk to the private sector supplier, the public sector partner would guarantee to pay a certain amount of the Bulk Water Supply even if this more than it can sell to its customers.

The Government of Viet Nam is strongly committed to tourism development of Phu Quoc Island by improving transportation and municipal infrastructure. Visiting procedures for tourists would also be simplified, targeting to attract 2 million tourists per year by 2020 and 5 million by 2030. More hotels and resorts will be developed. The improvement of infrastructure, including water supply and sewerage systems is very important in facilitating the smooth operation of these businesses and would attract more developments to the island.

In this survey, the projected water demand and sewage flow (as calculated from the water demand) include the estimated infrastructure needs of the tourism industry. The estimated needs must be kept on an appropriate level to avoid any perceived less than robust outlook which may discourage continued investment. If the tourism business falls short of expectations, the government must be able to help mitigate this kind of demand risk by having the “take-or-pay clause”, for the private companies to be interested in participating in the project.

Table 7-5-1 Major Risks, Solutions, and Their Allocations for Water Supply and Sewerage Projects

◎: Major responsible organization

○: Other responsible organization

Category	Risks	Solutions	Risk allocation	
			Public	SPC
(1) Political & Economic Risk	・Foreign exchange risk Restricting the amount of foreign exchange, and preventing the SPC from procuring funds and sending money.	Make contract stipulating repayment method (foreign / local currency) corresponding to SPC's funding source requirements. Risk mitigation by transferring cash flow to a foreign bank account as soon as possible.		◎
	・Risk of cancelling the project license / changes to the license Permits for land use may be cancelled.	Government agencies should avoid any action that may jeopardize the project and make sure that the required procedures are in place and are working well. Implement the relevant application procedure.	◎	
	・Expropriation (nationalization) risk Project assets may be expropriated by the government . Thus, SPC is not able to continue the project.	Government agencies should avoid any action that may jeopardize the project.	◎	
	・Risk of the public sector authorities not fulfilling their responsibilities Governmental organization of Viet Nam, the counterpart of SPC, may violate the terms of the contract.	Ensure that the contract terms and conditions are carefully established to minimize all possible risks and that measures to deal with the risks are well thought out in advance.	◎	
	・Risk of political instability SPC may not be able to continue with the project, because of political disturbance, such as riots, terrorist attacks, strikes.	Take out insurance against such risks.	◎	○
(2) Design & Construction Risk	・Design & construction risk Unable to keep the design quality, risk of delay of construction progress.	Select qualified contractor		◎
	Delay of survey or geological survey	Select qualified contractor or project manager		◎
	Problems with land acquisition	Follow appropriate steps for land use application	◎	○
	Shortage of experienced contractors	Select experienced construction company for constructing WTP, STP, pumping station, underground pipe, etc.		◎
	Shortage of skilled workers	Provide appropriate supervision and guidance to contractor.		◎
	Delay in securing land for construction	Monitor closely the progress of securing land		◎

Category	Risks	Solutions	Risk allocation	
			Public	SPC
(3) Environ -mental Risk	・Environmental risk negative impacts on the natural and social environment during construction or operation	Conduct surveys to understand potential impacts. Take out insurance for responding to emergency situation.	○	◎
(4) Project Risk	・Risks of fund procurement SPC may not be able to procure the required funds under favorable conditions.	Conclude clear and precise contract with investors and financial banks.		◎
	・Utility Risk Infrastructures required for the project, such as electricity, may not be in place in time for the construction or operation of the project.	Request government organizations to push for timely completion of the utility infrastructure construction.	◎	
	・Construction completion risk Project equipment, facilities may not be procured or constructed within the expected period, within the planned budget, or with anticipated quality.	Request the adherence to contract terms. Secure adequate budget including covering for price and physical contingency.		◎
	・Operational risk Operational and repair costs may exceed the expected estimate.	Secure sufficient budget to cover contingency if the cost estimate is too low.		◎
	・Raw water quality risk (water supply) Raw water quality of the Cua Can impounding reservoir may worsen due to eutrophication.	Raw water supply contract must stipulate the assurance of a certain level of required raw water quality.	◎	○
	・Demand risk (water supply) Water sold may be lower than the projected water demand.	Prohibition for using ground water s and legalizing the mandatory connection to the public water supply system. The contract must include "take-or-pay clause".	◎	○

Category	Risks	Solutions	Risk allocation	
			Public	SPC
(4) Project Risk	・Insufficient sewage inflow volume (sewerage) Because of the delay of project, developers may forego connecting to the public sewer system and construct their own sewage treatment facilities.	Concession contract must stipulate the assurance of minimum revenue amount to avoid / alleviate the risk. The contract must include "Take-or-pay clause".	◎	○
	Because of the delay of development, connections of anticipated customers to public sewer may delay.	Alleviate the risk by sooner implementation and completion of the project.	◎	○
	Actual sewage inflow volume may be lower than design sewage flow volume, because of the fewer connections to the sewer.	Understand the progress of development by developers. Legalizing mandatory connection to the sewerage system and implementing an awareness and public relations campaign	◎	○
(5) Market Risk	・Foreign Exchange Risk Foreign exchange rate for the revenue currency and cost currency may be very different.	Exchange marry (using a same currency at a maximum for its buying and selling) To alleviate risk by future purchase of foreign currency method, etc.		◎
	・Interest rate risk Interest rate may be very different from what was expected when the project plan was formalized.	Using more the internal fund, such as capital and retained earnings, to minimize the loan from foreign market with higher interest risk (e.g., budget procurement from private bank of Viet Nam), in order to alleviate the risks of short-term loan.		◎
	・Inflation risk O&M costs may rise because of increase in price of electricity, commodity, and/or salary.	Conclude a contract that stipulate the water supply and sewerage tariff adjustments which reflect the price hike of electricity, commodity or salary.	◎	○
(6) Natural Disaster Risk	・Natural disaster risk Project may have to be terminated because of natural disaster, such as fire, flood or earthquake.	Contract must include the article of Force Majeure in related part. Both contract parties must discuss and agree how to respond to each natural disaster risk. By taking out an insurance, alleviate the risks.	◎	○

CHAPTER 8
RECOMMENDATIONS

CHAPTER 8 RECOMMENDATIONS

1. The proposed water supply system development is composed of three sub-projects, namely, Cua Can reservoir construction (including intake and raw water transmission), water treatment plant construction and distribution network construction. Although it is common in Viet Nam that impounding reservoirs are planned and developed by DARD, it would be necessary to establish a special unit to manage and coordinate the implementation of the three sub-projects. This is because Cua Can reservoir is exclusively used for water supply and the three sub-projects are closely related components of the water supply system.

   In the proposed business scheme, the three sub-projects would be operated and managed separately by KGPPC, a private investor, and KIWACO. A steering committee would be required for the comprehensive coordination at each stage of the implementation, such as financing, design, tender/contract, construction and operation.

2. Sewerage system developments in Viet Nam are usually financed using the central government grants and O&M expenditure covered by the environment protection fee collected as 10% of the water supply charge. Since Phu Quoc will be developed into a world class eco-tourism center, an extra fee on hotel accommodation could be collected to help finance the sewerage development so that the project would be less reliant on government subsidies. In Hawaii, a 12.5% transient accommodation tax (TAT) is collected to support schools, police, infrastructure and parks. Further discussions would be required to introduce a similar financing mechanism for this project.

3. The public sector partner should be responsible for securing funding for the construction of the Cua Can reservoir and distribution system in the proposed water supply system development and the sewer network in the proposed sewerage system development. KGPPC's own source of financing may not be sufficient. It would be necessary to seek support from the central government and/or funding from donor agencies through the central government. In competing with other candidate projects for donor funding, KGPPC would have to show strong leadership, such as establishing a sector program for the joint development and management of water supply and sewerage projects. KGPPC may also wish to make special efforts to discuss with relevant agencies to seek their support and assistance in this process.