No.

Metropolitan Cebu Water District（MCWD）
The Republic of the Philippines

PREPARATORY SURVEY ON THE PROGRAMME GRANT AID FOR ENVIRONMENT AND CLIMATE CHANGE（WATER TECHNOLOGY）IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

January 2010

Japan International Cooperation Agency（JICA）
NJS Consultants

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PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the Programme Grant Aid for Environment and Climate Change (Water Technology) in the Republic of the Philippines. JICA sent to the Philippines a survey team from 27th September 2009 to 30th October, 2009.
The team held discussion with the officials concerned of the Government of the Philippines, and conducted a field survey at the study area. After the team returned to Japan, further studies were made and as this result, the present report was finalized.

I hope that this report will contribute to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

January 2010

Kikuo NAKAGAWA
Director General, Global Environment Department
Japan International Cooperation Agency

Letter of Transmittal

We are pleased to submit to you the preparatory survey report on the Programme Grant Aid for Environment and Climate Change (Water Technology) in the Republic of the Philippines.

This survey was conducted by NJS Consultants Co., Ltd., under a contract to JICA, during the period from September 2009 to January 2010. In conducting the survey, we have examined the feasibility and rational of the project with due consideration to the present situation of the Republic of the Philippines and the most appropriate outline design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to the reference of design for desalination plant and water supply improvement in the Republic of the Philippines.

Very truly yours,

January 2010

Hirofumi SANO
Chief Consultant
Preparatory Survey Team on the Programme Grant Aid for Environment and Climate Change (Water Technology) in the Republic of the Philippines
NJS Consultants Co., Ltd.

SUMMARY

1 Features of Study Area

The target Area for this project is located in Mactan Island, Cebu Province; its water service is handled by MCWD (Metropolitan Cebu Water District). There are two municipalities named Lapu-lapu City and Cordova Town in Mactan Island.

Metropolitan Cebu is the center of economic activities in the province. It is also where the majority of the population is concentrated. This area is host to various manufacturing industries, shopping centers, educational institutions, financial institutions, and other service-oriented establishments that cater not only to the needs of the people in the region.

On tourism in Mactan Island, white sand beaches and diving sites vis-à-vis the dynamic and diverse local culture have attracted foreign tourists. Catering to foreign and domestic tourists are the hotels, inns, and pension houses scattered all over the metropolis. Service industries that support tourism are equally important to Cebu's economy.

2 Outline of Grant Aid Project

The Japanese Government introduced "Programme Grant Aid for Environment and Climate Change" (GAEC) in 2008 to assist developing countries in their endeavors to contribute to the global climate stabilization by balancing reduction of Green House Gas (GHG) emission with economic growth. In the promotion of this programme, the Japan International Cooperation Agency, hereinafter referred to as "JICA" proposed the implementation of "Co-benefit type Grant Aid" and geared its assistance policy towards aggressively promoting the application of Japanese advanced technology in the field of GHG emission reduction.

Water-related technology typified by water treatment technology utilizing Reverse Osmotic (RO) membranes is regarded as one of the most competitive technical fields. The Ministry of Foreign Affairs conducted needs/idea surveys among Cool Earth Partner countries aimed at water related technologies presented at the Davos Congress held in 2008 to extract GAEC projects in this field. As a result, projects assisting water source development and water supply by desalination plant applying RO membranes, one of the advanced Japanese technologies was proposed. Lapu Lapu City in Mactan Island under jurisdiction of MCWD was recommended as a potential and encouraging candidate.

Since the official request form has not yet been submitted from the recipient country the contents of this grant aid project according to the results of a Questionnaire Form are as follows:

Total Project Cost : 520 Million Yen（estimated by MCWD）
Component : (1) Assistance in Hardware, (2) Assistance in Software

(1) Assistance in Hardware

Desalination Plant with capacity of 10,000m^3/day = 450 Million Yen
Seawater Intake Facility＝ 60 Million Yen

Generator ＝ 10 Million Yen

(2) Assistance in Software（Simplified manuals shall be prepared）

Target Area : Lapu Lapu City, Mactan Island
Beneficiaries : Residents in Mactan Island, 65,000 persons
Implementation Agency : MCWD

This preparatory survey is composed as Phase 1 of appropriate project planning and cost estimation and as Phase 2 of reference material for biding document and outline design report preparation.

However, the project did not proceed from Phase-1 to Phase-2 and was terminated after Phase-1 as a result of the following circumstances/reasons. (The Study report prepared was based on data collected during Phase-1).

<Circumstances and Reasons>

At the launching of this project, the following items were presented to the preparatory survey team as major pending issues:

1. Burden of VAT and custom duties to be borne by MCWD
2. Land acquisition for the proposed facilities to be borne by MCWD
3. Prompt submission of official request form to the Japanese Government including agreement to the abovementioned items

As a result, MCWD held a board meeting on 26 October 2009 to discuss further responses. They concluded that they will not submit the official request form because fulfillment of conditions 1 and 2 as presented by the Japanese Government was quite difficult and not possible at this time.

3 Present Condition of Water Supply

Potable water constitutes water sent from Cebu Island through two pipe bridges and is also extracted from groundwater wells drilled within the island and water supplied from the private company named the Mactan Rock Company. The Mactan Rock water treatment plant utilizes a membrane system and currently supplies 5,000m^3/day. The entire water distribution pipeline network involving reservoirs is managed by MCWD.

Actual water supply of MCWD at the end of 2008 was 166,000 m^3/day and 88% of this amount was generated by groundwater wells. Of the remaining 12%, 3% is surface water and 9% is purchased water generated by groundwater wells and the desalination plant. Regarding groundwater, the major water source is now being compromised by saline water intrusion triggered by excessive pumping. Therefore, a water supply system depending largely on groundwater will be risky since groundwater cannot serve as a reliable permanent water source into the future.

Defining safe water sources to include community/ private systems (individual or communal connections), **Table 1** shows that about 82% of the total households in MCWD covered area had access to safe water sources in 2000. The City of Lapu-lapu and the municipality of Cordova had the lowest percentage of households with access to safe drinking water, at 62% and 58%, respectively.

Table 1 Drinking Water Source in the Study Area by Household Rate (%)

	Base Information		Community System		Private System		Safe Wells	Un-safe Wells	Spring, Lakes	Vendor, Bottled
	LGUs	HHs	Indi-vidual	Comm-unal	Indi-vidual	Comm-unal				
City	Cebu	147,600	38.3	28.3	4.5	14.0	1.1	1.8	5.7	6.3
City	Lapu-lapu	44,439	12.6	17.2	6.2	26.3	4.8	14.1	2.1	16.8
City	Mandaue	54,882	28.2	35.6	4.8	19.5	1.6	0.9	0.2	9.2
City	Talisay	28,751	21.0	27.6	11.1	28.9	3.9	1.9	2.3	3.3
Municipality	Compostela	6,296	14.7	30.3	3.9	38.6	2.0	5.7	4.3	0.6
Municipality	Consolacion	12,837	16.8	15.4	4.4	39.3	8.9	3.8	5.3	6.0
Municipality	Cordova	6,520	6.6	14.5	7.8	29.2	9.5	17.6	5.5	9.3
Municipality	Lilo-an	13,381	18.1	25.2	4.9	32.2	6.0	11.2	1.2	1.3
	Total	**314,706**	**28.46**	**27.04**	**5.46**	**20.67**	**2.68**	**4.28**	**3.68**	**7.74**

Source: Cebu: A Demographic and Socioeconomic Profile Based on the 2000 Census, op cit

4 Contents of the Project

The scope of this project is to carry out the basic designs for a desalination facility including its components such as sand filtration and reverse osmosis (RO) membrane units, an intake, electrical facility, distribution (including connection to existing water supply pipeline), a discharge facility for concentrated wastewater and also a soft component plan.

Table 2 shows the outline of major facilities in this Study.

Table 2 Outline of Main Facilities

Item	Facility	Specification	Remarks
1. Design Capacity		3,000 m^3/day	
2. Service Population		20,000 person	
3. Main Facility	(1)Intake Well	Diameter 4.0 m	
	(2)Intake Pump	200mmx2.60m^3/minx15kwx3units	
	(3)Storage Tank	4.0m(W)x5.0m(L)x4.0m(H)	
	(4)Pre-treatment	Sand Filterx3units	
	(5)RO Membrane	1,000m^3/day x 3units	Spiral Type
	(6)Desalinized Water Tank	10.5m(W)x12.0m(L)x4.0m(H)	
	(7)Wastewater Tank	4.0m(W)x5.0m(L)x4.0m(H)	
	(8)Generator	750 kvA	
	(9)Others	Administration Building, Road, Drainage	Excluding the fence and gate

5 Project Cost and Implementation Schedule

Total amount of this project cost implemented by Japanese Grant Aid is about 979 million yen as shown in **Table 3** and the project cost covered by Philippines is about 205 million yen as shown in **Table 4**.

Table 3　Responsibility of Japanese Side

Item		Amount（mill. Yen）
Facility (Construction)	Intake Desalination Plant New Reservoir and Distribution Pump Distribution and Discharge Pipe	889
Detailed Design, Construction Management, Soft-component (O&M Training etc.)		51
Procurement		9
Fee for Procurement Agency		30
Total		979

Table 4　Responsibility of Philippines side

1)Fence and Gate of Desalination Plant （2 places）	318 Thou. Php	(0.63 mill. yen)
2)Electricity Wiring（1 Place）	4,007 Thou. Php	(7.99 mill. yen)
3)Land Acquisition	40,500 Thou. Php	(80.80 mill. yen)
4)VAT（12%）	57,930 Thou. Php	(115.57 mill. yen)
5)Import Duty		Exemption or return
Total	102,755 Thou. Php	(204.99 mill. yen)

Operation and maintenance (O&M) cost (except the depreciation costs) in this project have to be considered significant: increasing electricity costs, chemicals costs, consumables and exchange of Membrane.　The estimated O&M cost per year is 100 million yen.

8 months are needed for equipment and material procurement.　Adding Soft Component period, total project implementation period is 29 months.　**Figure 1** shows the schedule:

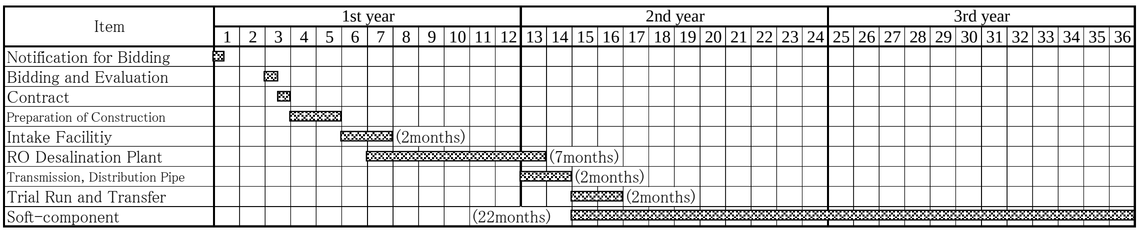

Figure 1　Project Implementation Schedule（Draft）

6　Verification of Project Adequacy

(1) Benefits to be generated by Project Implementation

Several benefits for the water supply business conducted by MCWD and for users are expected through the implementation of this project.　They are tabulated in **Table 5**.

Table 5 Benefits to be generated by Project Implementation

Current Status and Issues	Countermeasures taken by this Project	Benefits to be generated
A: Direct Benefits		
・Major water source has been groundwater but lowering of groundwater table and water quality deterioration due to saline water intrusion has occurred ・Current water supply capacity is insufficient to meet water demand ・Only 60% of the total population has access to safe water	・Desalination plant with capacity of 3,000m^3/day will be constructed	・As 3,000m^3/day of potable water will be generated by the plant, corresponding amount of groundwater will not need to be pumped out. This will mitigate the following issues: ➢ Lowering of groundwater table ➢ Water quality deterioration due to saline water intrusion ・Total water supply capacity will be increased by 3,000m^3/day ・Safe water can be served to users utilizing insanitary private wells; 【Number of additional service population is anticipated as 20,000 persons (= 3,000/0.15)】
B: Indirect Benefits		
・Water fetching from communal taps has been heavy burden to residents	―	・As water will be supplied to private taps, such a burden can be mitigated
・ Due to shortage of safe and sanitary water supply, insanitary water has been the main cause of water-borne diseases	―	・Additional safe potable water supply will decrease the morbidity rate of water-borne diseases

(2) Tasks and Recommendations

For the appropriate management of the desalination project in future, MCWD will need to carry out the following tasks:

- ➢ Land for the proposed desalination plant shall be acquired in advance
- ➢ Environmental Impact Assessment (EIA) shall be conducted to get approval from the Central Government
- ➢ Securing the budget for works to be undertaken by MCWD such as Land Acquisition, Power Supply, Fence and Gate
- ➢ Ensure that staff needed for project implementation and O&M of the completed system are available and facilitate their skill level development
- ➢ Necessary licensing procedures shall be acquired on a timely basis. Anticipated procedures are as follows:
  - ・ Drilling of sea water intake well at sea shore
  - ・ Traffic scheduling for construction machinery

- Excavation in paved roads
- Other relevant matters

(3) Verification of Project Adequacy

As an immediate benefit generated by the desalination project, mitigation of excessive groundwater pumping and improvements in potable water quality is expected. Furthermore, the following items are proposed to assess the project benefits quantitatively:

- Continuous measurement of groundwater table to confirm the rising water table brought about by mitigation in the quantity of groundwater being pumped.
- Continuous analysis of saline content in the groundwater to confirm the decline of saline water intrusion as a result of the groundwater table rising
- Continuous investigation on patient numbers showing evidence of water-borne diseases to confirm patient number decreases as a result of the provision of a safe and sanitary potable water supply.

(4) Conclusion

Since ocean surface water levels are expected to rise as a result of global warming, the saline content in groundwater is also anticipated to increase. The desalination project therefore will ultimately be an effective countermeasure against this trend. As the study area is an island with flat topographic features, sufficient surface water is not available and groundwater pumping has already reached a critical limit. Thus the desalination project is deemed as beneficial in mitigating extensive groundwater pumping.

However, aside from these aforementioned tasks that need to be tackled by MCWD, both organizational strengthening and appropriate water tariff setting will also be important towards attaining sustainable and financially sound project management in the future.

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FINAL REPORT

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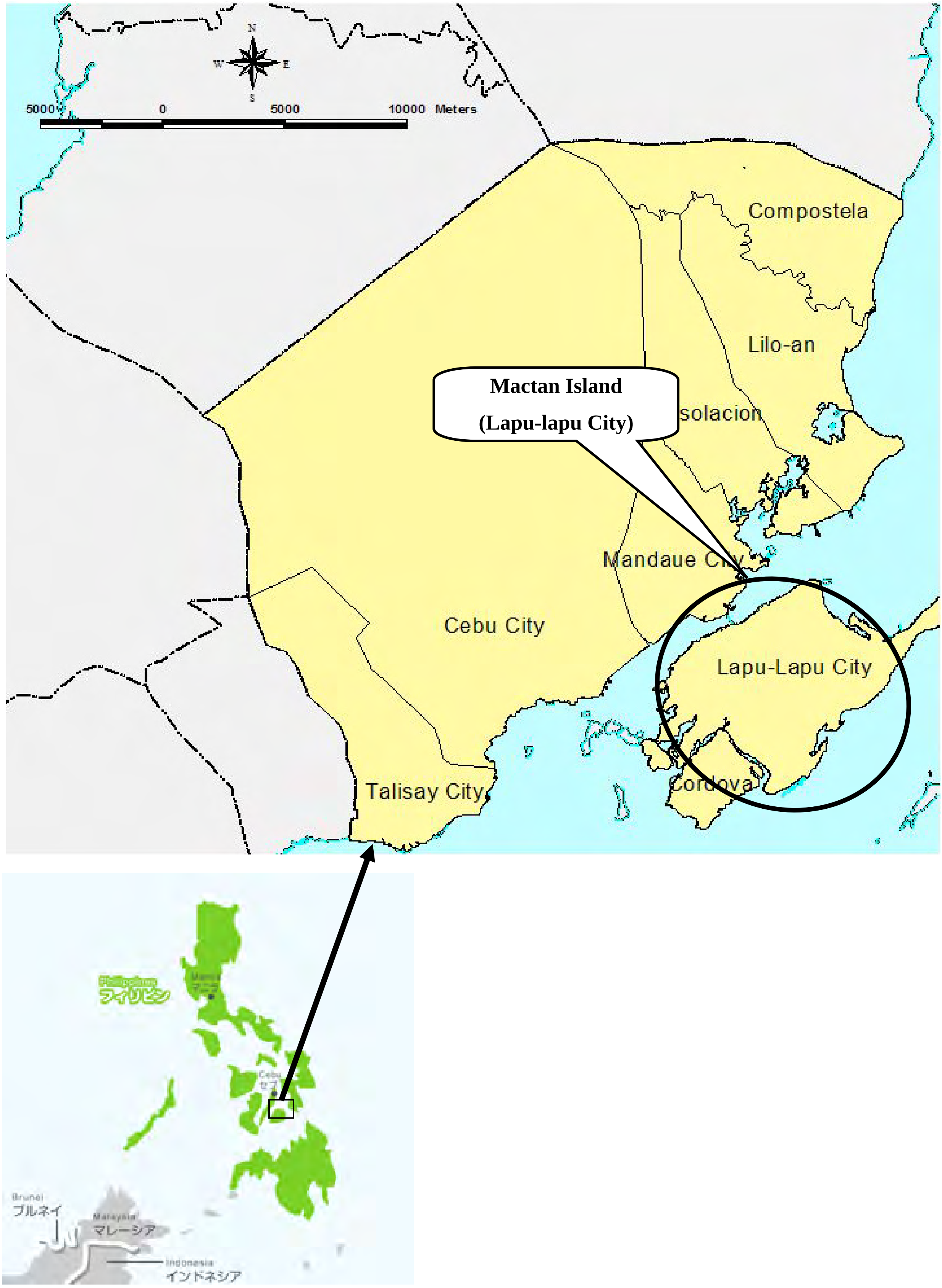

Location Map

List of Tables and Figures

Abbreviations

ADB.......... Asian Development Bank
CI .... Cast Iron
DBP .... Development Bank of the Philippines
DENR .... Department of Environment and Natural Resources
DOE.......... Department of Energy
DOF.......... Department of Finance
DTI............ Department of Trade and Industry
ECC .... Environmental Compliance Certificates
EIA............ Environmental Impact Assessment
EMB.......... Environmental Management Bureau
EMP.......... Environmental Management Plan
FI............... Fouling Index
FRP .... Fiber Reinforced Plastic
GM............ General Manager
GOJ........... Government of Japan
GOP .... Government of the Philippines
GRP .... Glass-Fiber Reinforced Plastic
HWL .... High Water Level
IEE............ Initial Environmental Examination
IPP .... Independent Power Producer
JICA.......... Japan International Cooperation Agency
JICS .... Japan International Cooperation System
LWUA ...... Local Water Utility Administration
MCWD ..... Metropolitan Cebu Water District
MECO....... Mactan Electric Company
MF .... Micro Filtration
MIS .... Management Information System
MWSS ...... Metro-Manila Waterworks and Swerage System
NEDA .... National Economic and Development Authority
NPC .... National Power Company
NPCC........ National Power Construction Company
OPS........... Office of Population Studies
PE .... Polyethylene
PEP .... Philippine Energy Plan
PLC........... Programable Logic Controller
PVC .... PolyVinyl Chloride
RC............. Reinforced Concrete
RO............. Reverse Osmosis Membrane
RPM.......... Revised Procedual Manual
SDI............ Sludge Density Index
SRR........... Service Recovery Rate Committee.
TDS .... Total Dissolved Solid
UF .... Ultra Filtration
USTDA ... United States Trade and Development Agency
VAT.......... Value Added Tax
VECO .... Visayan Electric Company
WESM .... Wholesale Electricity Sales Market
WRKC ..... Water Resources Knowledge Center

Chapter 1 Background of the Project

1-1 Present Condition and Needs for the Project

1-1-1 Present Condition and Needs

The target Area for this project is located in Mactan Island, Cebu Province; its water service is handled by MCWD (Metropolitan Cebu Water District). The water volume supplied by MCWD was about 166,000 m^3/day at the end of 2008. The coverage of direct water supply by MCWD is nominally only about 36%; serving a population of 650,000 out of the total population of 1,840,000 in 4 cities and 4 municipalities. However MCWD estimates that the total coverage is in fact 54% which means that an additional 350,000 people are indirectly supplied water from water taps.

The present target of the water supply by MCWD is neither the expansion of the service area nor full coverage in the service area, but to raise the efficiency within the framework of the current facility capacity such as the existing reservoirs and the existing pipeline network.

Mactan Island is the candidate site of the facility construction for this project “The Programme Grant Aid for Environment and Climate Change” and its goals are also same as above. In 2007, house connections numbered only 7,280 which accounted for 15% of the total estimated 48,644 households in Mactan Island. Most of water resources available in Mactan Island are dependent upon the groundwater in Cebu (main) Island except for the purchase of 5,000 m^3/day from the private desalination plant named the Mactan Rock Company. Therefore, the supply and demand situation from the main island directly affected this company’s supply condition.

In Mactan Island, it is difficult to utilize surface water, which is very limited, as a water resource, moreover the island also faces the problem of the groundwater salination. Therefore some security of the water resources is required for any intended improvement to the water service provision rate. Furthermore, global warming will result in a rise in ocean levels, which will only cause more difficulties in preserving sufficient acceptable quality groundwater.

1-1-2 National and Sector Development Plan

According to the report “Provincial Water Supply, Sewerage and Sanitation Sector Plan, 2003”, there is a plan to obtain water supply from Inabanga-Wahig River in Bohol Island. However, implementation of this plan is not been realized at present. The Provincial government of Cebu says there is a plan with a high possibility of being implemented for a water supply transmission from Calmen to Cebu city to meet the demand of 35,000m^3/day by Manila Water.

The possibility of groundwater resource development through pumping is very limited because of its regulation due to water quality control reasons. A spring which is named Cambuhawe spring in Balamban area very little amounts of water, approximately 5 L/s (=432 m^3/day), and is available only for recreation purposes. The following criteria were adopted for the selection; 1) rivers currently utilized for domestic water supply, 2) rivers which have gauging stations, 3) rivers with watersheds of 40km^2 or more.

Four rivers have met the criteria above, which are: a) Pitogo River, b) Balamban River, c)

Guinabasan River, d) Sta. Ana River. However implementation of these plans has as yet not materialized at this time.

1-1-3 Socio-economic Conditions

1-1-3-1 Population

The total population of Metropolitan Cebu including Mactan Island which is the location of the current study area was 1,853,231 according to the 2007 Census . The cities of Cebu, Mandaue and Lapu-lapu have the biggest share of population as shown in **Table 1.1.1**. Mandaue City has the highest density of 10,679.7 persons per km^2 followed by Lapu-lapu City with 4,827.2 and Cordova with 4,457.6 persons per km^2, respectively. The municipality of Cordova has a high population density due to its small land area but high population growth. On the other hand, the municipality of Compostela is the least densely populated municipality in the study area with about 757.7 persons per km^2.

Table 1.1.1 Total Population and Population Density in the Study Area

LGUs (MCWD Franchise)		Population Census in 2007	
		Population	Population Density
City	Cebu	798,809	2,803.8
	Lapu-Lapu	292,530	4,827.2
	Mandaue	318,575	10,679.7
	Talisay	179,359	3,784.7
Municipality	Compostela	39,167	757.7
	Consolacion	87,544	2,591.6
	Cordova	45,066	4,457.6
	Liloan	92,181	1,669.6
Total		1,853,231	3,231.4

Source: NSO, 2007 Census of Population. Population Density: Capita/ km^2

1-1-3-2 Poverty Situation and Income Level

Currently, there is no available data on the poverty situation and income level for specific cities and municipalities. The general situation in the study area is shown in the table below.

Table 1.1.2 Poverty Situation in the Study Area

Items		Figure
Annual per Capita Poverty Threshold in 2006	Urban Areas of Cebu	PHP14,467.00
	Rural Area of Cebu	PHP12,107.00
Annual per Capita Food Threshold in 2006	Urban Areas of Cebu	PHP9,917.00
	Rural Area of Cebu	PHP8,825.00
Poverty Incidence in the Philippines	In 2006	32.9%
	In 2003	30 %
Number of Poor Families in the Philippines	In 2006	26.9%
	In 2003	24.4%
Number of Poor Families in Cebu Province	In 2006	33 %
	In 2003	29.4%

Source: National Statistical Coordination Board

1-1-3-3 Industry and Economic Activities

Monthly salary average per household of Metropolitan Cebu is about 10,400 pesos and water tariff of monthly average is about 500 pesos (Average demand = Approx. 11.5 m^3/household) as determined by the socio-economic survey for the JICA project “The Study for Improvement of Water Supply and Sanitation in Metropolitan Cebu Water District”. In such socio-economical conditions, it is required to study carefully whether customers can bear the water tariff increase as a result of the installment of a desalination plant and whether the higher O&M cost can be met sustainably.

Metropolitan Cebu is the center of economic activities in the province. It is also where the majority of the population is concentrated. The metropolis is host to various manufacturing industries, shopping centers, educational institutions, financial institutions, and other service-oriented establishments that cater not only to the needs of the people in the region but also those from other provinces in the Visayas and Mindanao. As reported by the Department of Trade and Industry (DTI) in 2005, the dominant service sectors in Metropolitan Cebu are tourism, trade, transportation, and information technology (IT)-enabled services.

In recent years, IT companies have significantly contributed to the growth of the economy of Metropolitan Cebu. Many of the new graduates from various disciplines usually serve as the labor force for IT companies of foreign direct investors (FDIs) such as call centers and business process outsourcing. There are at least 19 FDIs in Cebu, which are primarily American, Australian, and Japanese firms.

On tourism, white sand beaches and diving sites vis-à-vis the dynamic and diverse local culture have attracted foreign tourists who are mostly nationals from Korea, Japan, USA, Hong Kong, and Taiwan. Catering to foreign and domestic tourists are the hotels, inns, and pension houses scattered all over the metropolis. Service industries that support tourism are equally important to Cebu’s economy. Most of the country’s major shipping lines are based in Cebu. These include Cebu Ferries, Sulpicio Lines and Gothong Lines which ply the Luzon-Visayas, intra-Visayas, and Visayas-Mindanao routes.

Over the years, the number of financial institutions in Cebu has increased. Metro Cebu has branches of international and national banks with head offices in Metro Manila. Among the international banks operating in the province are Hongkong Shanghai Banking Corp. (HSBC), Maybank, Standard Chartered Bank, and Citibank.

In terms of exports, Cebu's top products include electronics, fashion accessories, furniture, garments, machinery parts, metal and steel products, processed foods, gifts, toys, and house-wares. The top markets of these products are USA, Japan, Hong kong, Belgium, Indonesia, China, Netherlands, Korea, Singapore, and Thailand. According to DTI, there were 12,165 new businesses registered in Cebu in 2005.

Because of its strategic location and good seaport, Cebu City is the center of trade and industry. It hosts several large banks, financial institutions, and business establishments such as hotels, restaurants, call centers, recreation/entertainment facilities, and shopping malls. On the other hand, Mandaue City is a favored location for factories and manufacturing firms while Lapu-lapu City hosts two Export Processing Zones and several hotels and resorts. Talisay City and the other municipalities have also contributed their share to the economic growth by serving as the residential areas. The presence of a skilled workforce entices various establishments and manufacturing firms to set-up their business in these areas.

1-1-3-4 Water Supply

Table 1.1.3 presents the data on percentage of households by source of drinking water in the eight (8) cities and municipalities within the study area using information taken from the Cebu: A Demographic & Socio-Economic Profile Based on the 2000 Census, a study undertaken by JICA, Cebu SEED (Socio-Economic Empowerment and Development) Project, and Office of Population Studies (OPS).

Table 1.1.3 Drinking Water Source in the Study Area by Household Rate (%)

Base Information			Community System		Private System		Safe Wells	Un-safe Wells	Spring, Lakes	Vendor, Bottled
	LGUs	HHs	Indi-vidual	Comm-unal	Indi-vidual	Comm-unal				
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Total		**314,706**	**28.46**	**27.04**	**5.46**	**20.67**	**2.68**	**4.28**	**3.68**	**7.74**

Source: Cebu: A Demographic and Socioeconomic Profile Based on the 2000 Census, op cit

The 1990 Census of Population identified five (5) types of water sources: (1) community/

private systems, (2) safe wells (tube wells), (3) un-safe wells (dug wells), (4) springs/lakes/ rivers/rain and (5) vendors. In the 2000 Census of Population, bottled water was added as the sixth source together with other sources. Defining safe water sources to include community/ private systems (individual or communal connections), the data showed that about 82% of the total households in the study area had access to safe water sources in 2000. The City of Lapu-lapu and the municipality of Cordova had the lowest percentage of households with access to safe drinking water, at 62% and 58%, respectively.

The other cities/municipalities of Cebu Province that are outside Metropolitan Cebu had lower percentages of households (59%) with access to safe drinking water supply. The better condition of water supply in Metropolitan Cebu can be attributed to the presence of MCWD. The records of MCWD showed that it provided water at a daily average of 141,600 m^3 in 2002 with a daily production capacity of 51,953 m^3 from its 67 production wells, 34 direct supply wells, and a surface water source (Buhisan Dam).

Water from 67 production wells was distributed from reservoirs to service areas while water from 34 wells was supplied directly to households in 2002. There were 92,484 service connections with daily demand billings of 35,205 m^3. The MCWD service area constitutes about 52% of the total population. The rest of the households were supplied by privately owned wells and private water vendors/providers. Some of the well fields of MCWD were within the watershed areas of Lilo-an in the north and Talisay in the south. According to MCWD, 2008 data in the Metro-Cebu district, 67% of households can be provided with a 24 hours service of water supply. However, in the Mactan north-east coast area water supply service is over short time periods of 8 to 12 hours.

1-2 Background of the Grant Aid

1-2-1 Present Condition of Water Supply for Metro-Cebu

Metro Cebu city area including Lapu Lapu City in Mactan Island, the target area of this Study is composed of 4 cities and 6 towns located in the central area of Cebu Island. As the second largest international entry-hub for airline and marine traffic, Metro Cebu became the second largest commercial area following Manila. Lapu-lapu City, the study target area is a representative resort area of Cebu well-known as the "Tourism City". The annual number of tourists visiting from Japan and other countries amount to almost 1 million. Besides this there are two Export Processing Zones and therefore Mactan Island is regarded as an important commercial area hosting commercial development in Metro Cebu. Mactan international airport acts as a major Asian hub airport and is currently expanding its transport capabilities. Mactan Island which is connected to main Cebu Island by two bridges has an area of about 68km^2.

Potable water constitutes water sent from Cebu Island through two pipe bridges and is also extracted from groundwater wells drilled within the island and water supplied from the private company named the Mactan Rock Organization. The Mactan Rock water treatment plant utilizes a membrane system and currently supplies 5,000m^3/day. The entire water distribution pipeline network involving reservoirs is managed by MCWD which exercises its jurisdiction over 4 cities and 4 towns.

Actual water supply of MCWD at the end of 2008 was 166,000 m^3/day and 88% of this amount was generated by groundwater wells. Of the remaining 12%, 3% is surface water and 9% is purchased water generated by groundwater wells and the desalination plant. However, Unaccounted for Water (UFW) amount is still high, so that the effective water amount supplied is counted as 122,000 m^3/day. Regarding groundwater, the major water source is now being compromised by saline water intrusion triggered by excessive pumping. Therefore, a water supply system depending largely on groundwater will be risky since groundwater cannot serve as a reliable permanent water source into the future. A rational water management plan containing potential new water source development is now on-going through “The Study for Improvement of Water Supply and Sanitation in Metro Cebu” financed by JICA.

Under such circumstances, a new water source development by construction of another desalination plant through “Programme Grant Aid for Environment and Climate Change” in Lapu Lapu City the representative city in Metro Cebu may be judged as a timely project.

1-2-2 Background

The Japanese Government introduced “Programme Grant Aid for Environment and Climate Change” (GAEC) in 2008 to assist developing countries in their endeavors to contribute to the global climate stabilization by balancing reduction of Green House Gas (GHG) emission with economic growth. In the promotion of this programme, the Japan International Cooperation Agency, hereinafter referred to as “JICA” proposed the implementation of “Co-benefit type Grant Aid” and geared its assistance policy towards aggressively promoting the application of Japanese advanced technology in the field of GHG emission reduction. Suitable technologies developed in private sectors would also be affirmatively adopted.

Water-related technology typified by water treatment technology utilizing Reverse Osmotic (RO) membranes is regarded as one of the most competitive technical fields of Japan. The Ministry of Foreign Affairs conducted needs/idea surveys among Cool Earth Partner countries aimed at water related technologies presented at the Davos Congress held in 2008 to extract GAEC projects in this field. As a result, projects assisting water source development and water supply by desalination plant applying RO membranes, one of the advanced Japanese technologies was proposed. Lapu Lapu City in Mactan Island under jurisdiction of MCWD was recommended as a potential and encouraging candidate.

1-2-3 Outline of Grant Aid Project

Since the official request form has not yet been submitted from the recipient country the contents of this grant aid project according to the results of a Questionnaire Form are as follows:

Total Project Cost : 520 Million Yen（estimated by MCWD）
Component : (1) Assistance in Hardware, (2) Assistance in Software
(1) Assistance in Hardware
Desalination Plant with capacity of 10,000m^3/day = 450 Million Yen
Seawater Intake Facility＝ 60 Million Yen
Generator ＝ 10 Million Yen
(2) Assistance in Software（Simplified manuals shall be prepared）

Target Area : Lapu Lapu City, Mactan Island
Beneficiaries : Residents in Mactan Island, 65,000 persons
Implementation Agency : MCWD

This preparatory survey is composed as Phase 1 of appropriate project planning and cost estimation and as Phase 2 of reference material for biding document and outline design report preparation.
However, the project did not proceed from Phase-1 to Phase-2 and was terminated after Phase-1 as a result of the following circumstances/reasons. (The Study report prepared was based on data collected during Phase-1).

<Circumstances and Reasons>
At the launching of this project, the following items were presented to the preparatory survey team as major pending issues:

1. Burden of VAT and custom duties to be borne by MCWD
2. Land acquisition for the proposed facilities to be borne by MCWD
3. Prompt submission of official request form to the Japanese Government including agreement to the abovementioned items

As a result, MCWD held a board meeting on 26 October 2009 to discuss further responses. They concluded that they will not submit the official request form because fulfillment of conditions 1 and 2 as presented by the Japanese Government was quite difficult and not possible at this time.

1-3 Existing Water Supply Facilities

Present condition of water supply in the target area is outlined based on the results of this Study and with reference to the on-going JICA Study titled “The Study for Improvement of Water Supply and Sanitation in Metropolitan Cebu Water District”.

1-3-1 Present Condition of Water Supply in Mactan Island

(1) Service Area

There are two municipalities named Lapu-lapu City and Cordova Town in Mactan Island and the existing service area of their areas are shown in **Table 1.3.1**.

Table 1.3.1 Water Supply Service Area in Mactan Island

(unit: km^2)

Municipality	Administrative Area	Service Area
Lapu-lapu	60.31	12.27
Cordova	7.96	1.65
Total	68.27	13.92

Source: WRKC, Water Resources Knowledge Center, as of March, 2009

(2) Water Production

Water is produced from three types of water sources, namely ground water, surface water and through bulk supply. A Breakdown of the volumes supplied as of December 2008 is summarized in **Table 1.3.2**.

Table 1.3.2 Breakdown of Water Source

Water Source		Production (December 2008)			Remarks
		Monthly Volume (m3)	Daily Average Volume (m3)	Percentage (%)	
Groundwater	Own Well	4,509,933	145,482	87.5	Wells
	Bulk Water	496,772	16,025	9.6	3 private firms
Surface Water		147,308	4,752	2.9	Tisa WTP
Total		5,154,013	166,259	100	

Source: Corporate Planning Department, MCWD

The water sources in Mactan Island are covered by five wells, bulk water from one private firm and supply from Cebu Island. The bulk water is purchased from the Mactan Rock Company based on the contract between MCWD and this private firm. A summary of the Mactan Rock facility is given below.

- Water source : Brackish water
- Purification method : Sand filtration + RO membrane
- Supply volume : 5,000m^3/day
- Supplied area : Lapu-lapu and Cordova
- Land area of plant : 2,000m^2
- Selling cost : 26 peso/m^3

According to the 2000 Census, about 82% of the total households in MCWD had access to safe water sources, whereas similar access percentages in Lapu-lapu and Cordova were 62% and 58% respectively. The reason of the lower percentages of access to safe water in Lapu-lapu and Cordova as compared with the figure for MCWD is because the water supply network in these areas was insufficient and the remaining people are dependent on water derived/supplied from springs, vendors and bottled water. **Table 1.3.3** shows the figures on percentage of households by source of drinking water.

Table 1.3.3 Drinking Water Source in the Study Area by Household rate (%)

Municipality	Household	Community System		Private System		Private Well		Spring, Lakes	Vendor, Bottled	Total
		Individual	Communal	Individual	Communal	Safe	Un-safe			
Lapu-lapu	44,439	12.6	17.2	6.2	26.2	4.8	14.1	2.1	16.8	100.0
Cordova	6,520	6.6	14.5	7.8	29.2	9.5	17.6	5.5	9.3	100.0

Source: A Demographic and Socioeconomic Profile based on the 2000 Census

Table 1.3.4 shows the water balance in 2008. Out of the total amount of water production, the authorized consumption accounts for 71.2%. Water losses, which account for 28.8% of the total, consist of the physical losses and marginal commercial losses.

Table 1.3.4 Water Balance in 2008

<table>
<tr><td rowspan="7">Total production (100%)</td><td rowspan="4">Authorized consumption (71.2%)</td><td rowspan="2">Billed authorized consumption (71.0%)</td><td>Billed metered consumption (71.0%)</td><td rowspan="2">Revenue water (71.0%)</td></tr>
<tr><td>Billed un-metered consumption (0.0%)</td></tr>
<tr><td rowspan="2">Unbilled authorized consumption (0.2%)</td><td>Unbilled metered consumption (0.1%)</td><td rowspan="5">NRW (29.0%)</td></tr>
<tr><td>Unbilled un-metered consumption (0.1%)</td></tr>
<tr><td rowspan="3">Water losses (28.8%)</td><td rowspan="2">Commercial losses (0.8%)</td><td>Un authorized consumption (0.1%)</td></tr>
<tr><td>Meter inaccuracy and data error (0.7%)</td></tr>
<tr><td colspan="2">Physical losses (28.0%)</td></tr>
</table>

Source: Corporate Planning Department, MCWD

(3) Water treatment Plant (WTP)

There is one existing WTP is the Tisa WTP which was constructed in 1911 within the MCWD jurisdictional area. Approximate service area is 2.47 ha. Source water is delivered by gravity from the Buhisan Dam, 2km away. **Figure 1.3.1** shows the flow diagram of Tisa WTP.

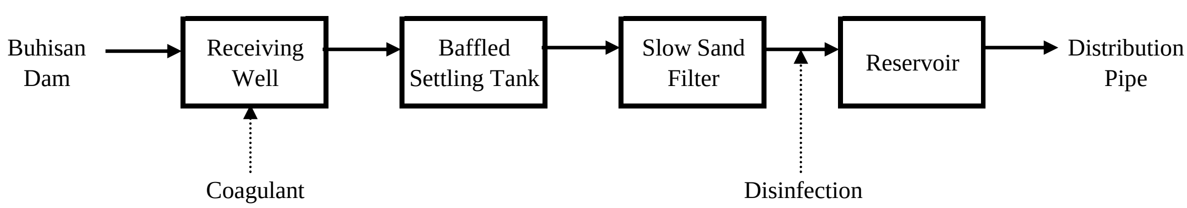


Figure 1.3.1 Flow Diagram of Tisa WTP

Three modules of rapid sand filters are only used as a stand-by in case of an emergency or for slow sand filter repairs. Once, in 1991, ADB made an improvement plan to increase plant capacity. This project was however discontinued because of the difficulty in ensuring an adequate water supply source. Tisa WTP is almost 100 years old and deterioration is taking place rapidly and projects on water source development and renovation/renewal are both being proposed.

(4) Reservoir

There are 3 reservoirs in Mactan Island within the MCWD jurisdiction area. Their characteristics are shown in **Table 1.3.5**.

Table 1.3.5 Outline of Reservoirs

Name	Construction	Volume (m^3)
Mactan MEPZ Tank	1983	3,200
Mactan Saucer Shaped Tank	1997	2,000
Cordova Water Tower	1993	200

(5) Pipeline Network

Table 1.3.6 shows the characteristics of the existing pipeline network in Mactan Island. Out of the total pipeline network, the percentage of pipes with diameters of 150mm and 200mm pipes is over 50%.

Table 1.3.6 Outline of Pipeline Network

Diameter (mm)	Length (m)	Percentage (%)	Pipe Material
50	1,510	1.5	PVC, GI, PE
75	6,780	6.9	PVC, GI
100	12,480	12.7	PVC, GI, CI
150	23,210	23.7	PVC, GI
200	27,970	28.5	PVC, GI
250	2,280	2.3	PVC, STL
300	9,570	9.8	STL
350	9,180	9.4	
400	1,810	1.8	
600	3,380	3.4	
合計	98,170	100.0	

Source: Technical Service, MCWD

1-4 Conditions of the Project Site

1-4-1 Natural Conditions

1-4-1-1 Geography

The Philippines comprises 7,107 islands divided into three groups; namely Luzon in the north, Visayas at the centre and Mindanao in the south. Extensive islands exist in Luzon and Mindanao, on the other hand, there are medium-sized islands in Visayas. Cebu Island is located at the middle of Visayas between Negros and Bohol Islands.

Cebu Island with an area of 4,870 km^2 is 210 km long and 25 km wide, measuring 35 km in its broadest section near the centre. Several islets dot the waters between Cebu Island and Bohol Island. Mactan Island is the nearest to Cebu Island.

1-4-1-2 Geomorphology & Geology

Cebu Island is mountainous to hilly with high elevation terrains reaching up to more than 600 m above sea level. Because the central mountain range with steep slopes is close to the seashore, coastal plains are quite limited. In comparison with Cebu Island, the topography of Mactan Island is almost flat. The highest elevation is only about 11 m above sea level. The topographical map of the study area is shown in **Figure 1.4.1**.

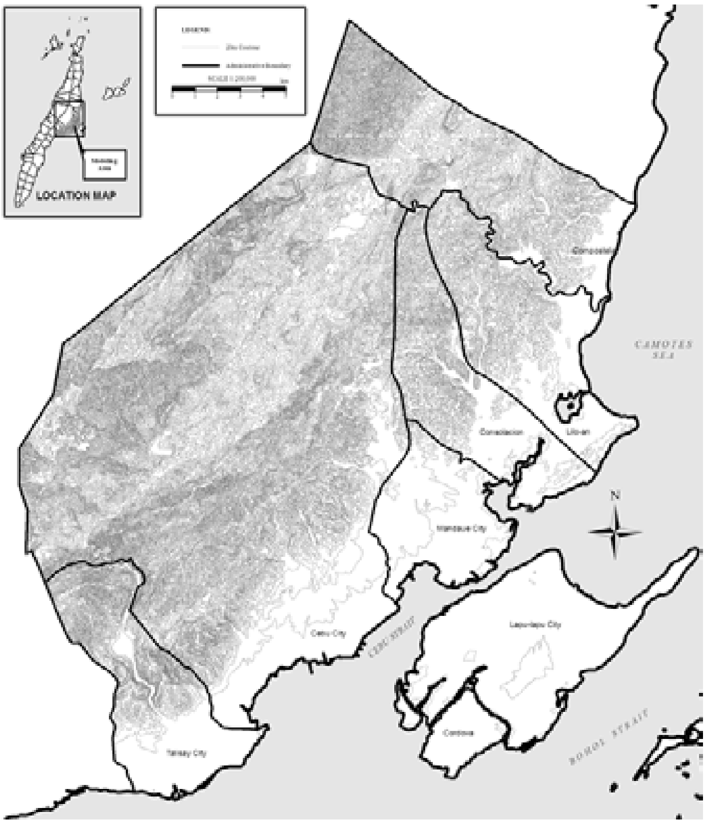


Figure 1.4.1 Topographical Map of the Study Area

1-4-1-3 Geological Feature

In general, the geology and stratification of Cebu shows younger sedimentary rocks along the coastline becoming older towards the mountainous inland, with the older sedimentary rocks being metamorphosed to varying degrees and intruded by dioritic and ultra-basic igneous bodies. The geanticlinal evolution of Cebu has formed an elongated narrow shaped island, which abruptly terminates at the sea on the eastern flanks of the island, giving limited catchment basins for fresh groundwater.

The topography of the study area is as diverse as its geology. Generally, most of the limestone areas underlain by Tertiary age rocks have karstic terrain, while where the limestone and metamorphic rocks are absent, gentle slopes cover the topography. The areas underlain by metamorphic rock always tend to be resistant to weathering and develop rugged terrain with steep slopes. The areas underlain by the younger Carcar limestone is also varied, wherein in areas where the formation is observed to be hard, steep slopes have developed with gentle slopes observed where the limestone is fragmented and porous.

1-4-1-4 Meteorology

Using temperature and rainfall as bases, the climate of the country can be divided into two major seasons: (i) the rainy season, from June to November; and (ii) the dry season, from December to May. The dry season may be subdivided further into (ii-1) the cool-dry season, from December to February; and (ii-2) the hot-dry season, from March to May.

Based on the available one PAGASA climatological-normals and fifteen Water Resource Center (WRC) (referred to as long record stations; from the year 1982 to 2004) in the study area and its surrounding, isohyetal map, the average annual precipitation over the study area is shown in **Figure 1.4.2**.

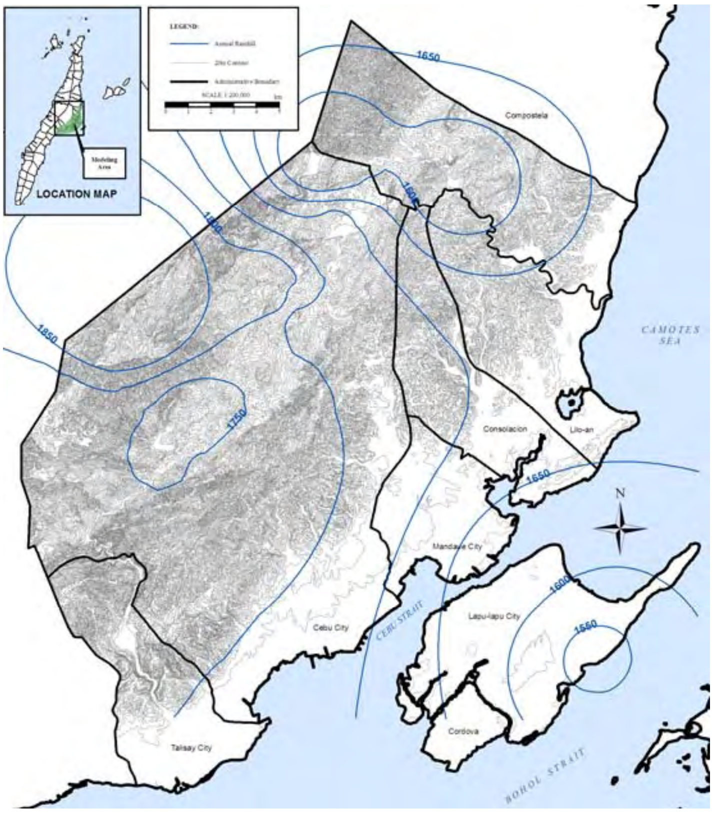
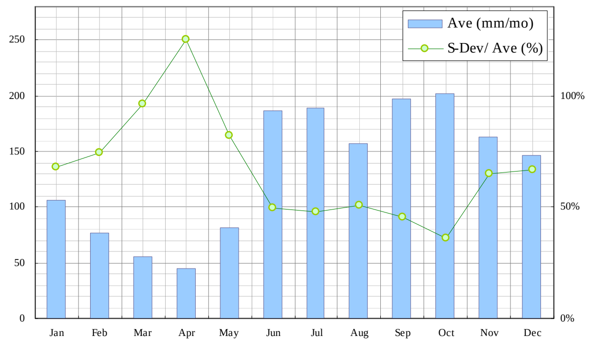
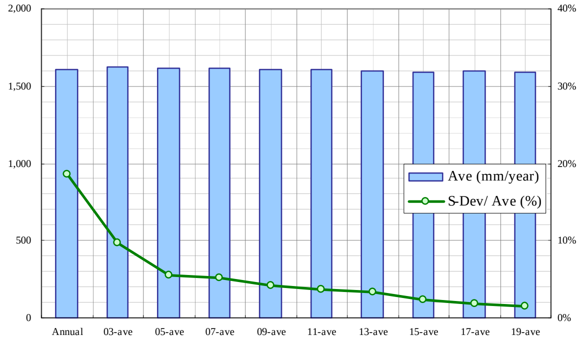


Figure1.4.2 Isohyetal Map of the Study Area (1982-2004)

Figure 1.4.3 shows monthly distribution & annual variation of rainfall in Mactan stations. Coefficient of variation (standard deviation per average) in monthly distribution has a similar pattern which means the starting period of the wet season is sometime in April. The same variation in annual rainfall indicates a comparatively high ratio in mountainous and a low ratio in lowland/ plains.





Mactan International Airport/ Mac-01（Plains）

Figure 1.4.3 Monthly Distribution & Annual Variation of Rainfall

1-4-1-5 Land-use

Actual contrast in the past years cannot be determined from the recorded information. However, changes of land use patterns in the study area can be summarized into the following features according to MCWD.

- the intensification of suburban commercial areas at major intersections and transport routes,
- increase in the number of squatter housing areas,
- the conversion of agricultural and fishpond lands to residential and or commercial use,
- the development of middle and upper class residential subdivisions on urban peripheries,
- the development of townhouses and high-rise condominiums for middle class and upper class income in the main urban core, and
- the location/relocation of new and existing industries into industrial zones/and outside industrial zones where land is cheaper and along major transport routes.

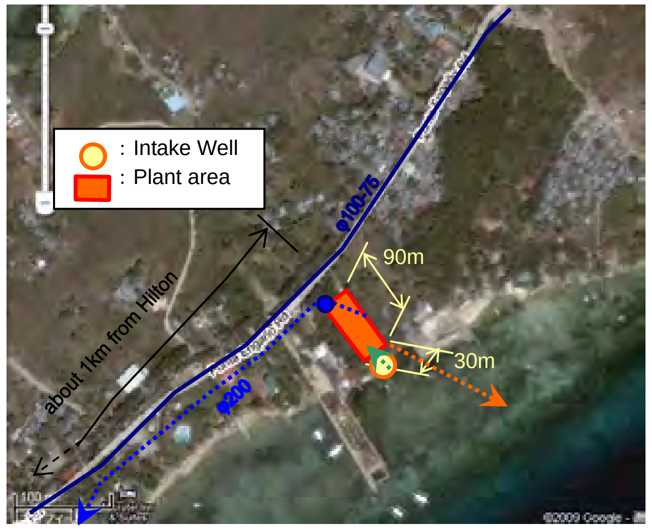
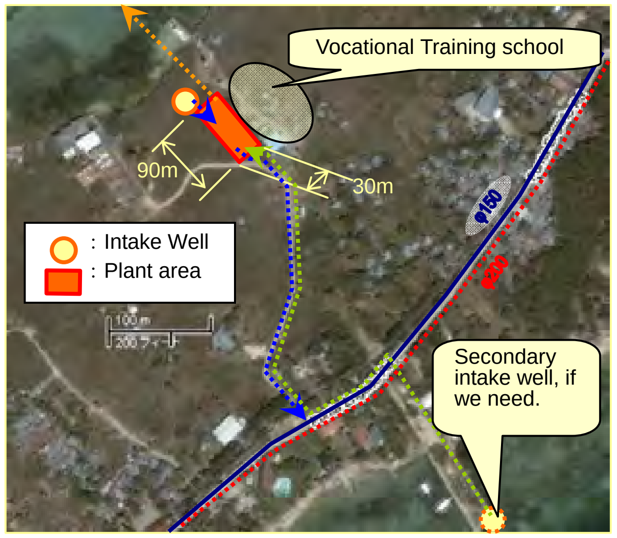
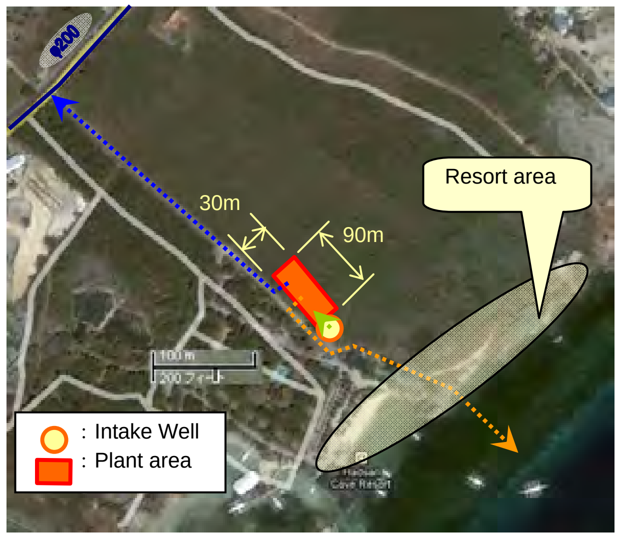
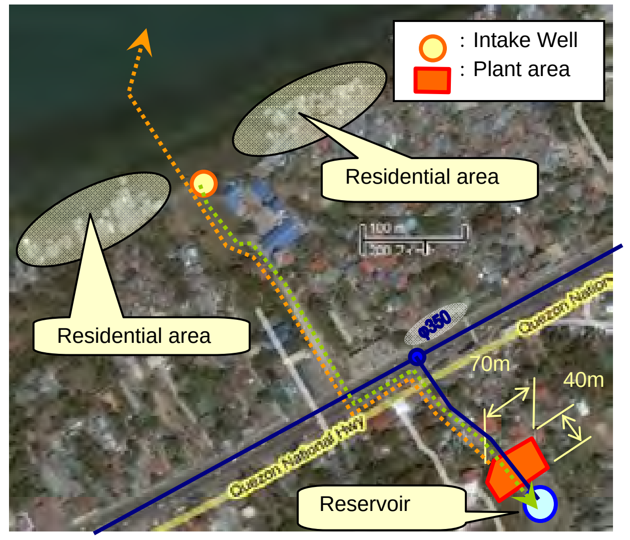
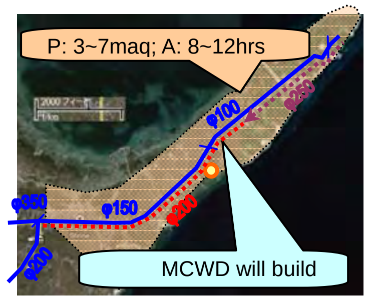
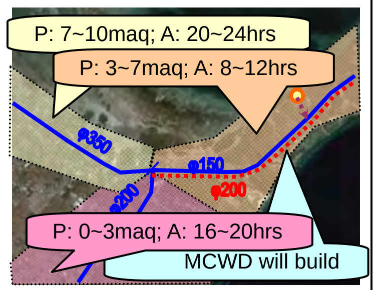
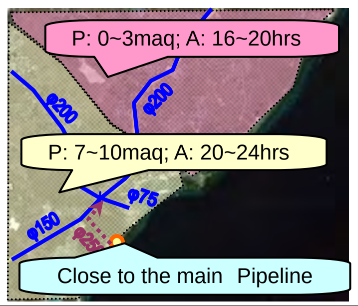
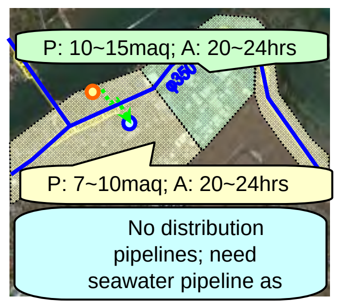
1-4-1-6 Hydrogeology (Groundwater)

The Carcar Limestone Formation is outcropped at the Mactan Island, and underlies along the coastal area. MCWD production wells are located along the coastal side of the Carcar Limestone Formation. In this regard, the major aquifer of groundwater development for MCWD wells can be recognized as this formation.

1-5 Selection of Candidate Site

Several sites were identified by field investigations for closer scrutiny to choose an appropriate site. A total of four (4) candidate site including two (2) site recommended by MCWD were compared with respect to land use, intake and discharge conditions, site access and connection to the existing water supply network. The comparison of candidate sites for the desalination plant is shown in **Table 1.5.1.**

Table 1.5.1 Comparison of Candidate sites for Desalination Plant

Number and location	Site No.1 at the south of peninsula 	Site No.2 at the base of the peninsula 	Site No.3 by the bay of Hadsan cove resort 	Site No.4 by the MCWD R.T. 
Map and site abstract Map: from Google earth				
Raw seawater quality	**Adequate.** ➢ Possibility of good quality seawater. ➢ Some smell and some floating wastes were detected. Should estimate the quality of seawater.	**Adequate.** ➢ Possibility of good seawater quality. ➢ It is possible to intake seawater from either coast; in the case of seawater quality problems.	**Good**. ➢ Maybe, best site to intake seawater based on quality.	**Risky; quality of the raw seawater is not good.** ➢ Detected anaerobic decomposition of organic matter through odor. It comes from wastewater and trash. ➢ Concentrated seawater discharge may affect the coastal environment; need to discharge effluent far from coastline.
Area for plant / intake and desal	**Wide enough, but a little risky.** ➢ Intake: very near the sea. ➢ Plant: wide enough; but will not be easy to extend. The foundation of the site is good.	**Very wide.** ➢ Intake: very near the sea. ➢ Plant: wide enough; easy to extend. The foundation of the site is good.	**Very wide.** ➢ Intake: Near the sea, and the coral areas contain clean water. ➢ Plant: wide enough; easy to extend; the foundation of the site is good.	**Wide enough, a little risky.** ➢ Intake: Near the sea. A little far from the Plant. ➢ Plant: enough. The foundation of the site is good. Difficult to extend the plant area.
Wastewater discharging point	**Adequate.** ➢ A little far from resort coast. ➢ Face to open sea	**Adequate.** ➢ Far from resort coast or residential areas	**Adequate, a little risky.** ➢ Far from residential areas, but near the resort coastline. Cleansing chemicals may cause bubbles; resorts may not want to accept such problems.	**Most risky.** ➢ Near residential area. Cleansing chemicals may cause bubbles, so discharging line needs to be extended far from the coastline.
Power supply	**May be able to obtain power.**	**May be able to obtain power.** Need expense to wire for electricity for the Plant	**May be able to obtain power.** Need expense to wire for electricity for the Plant	**May be easy to obtain power.**
Connection to the existing water supply	➢ **Easy** to connect in the constructing pipeline. ➢ Supply to the water shortage area possible, leading to **service availability.** 	➢ **Easy to connect in the constructing pipeline.** ➢ Supply to the water shortage area possible, leading to service availability, and increased pressure. 	➢ **Need** to lay a new pipeline. ➢ Supply to the water shortage area possible, leading to service availability, and increased pressure. 	➢ **Easy** to connect in the reservoir. 
Land owner and land cost	Private (Chinese Philippino), may be available at reasonable price.	Private (An American company), may be available at reasonable price.	Private (Chinese Philippino), may be expensive.	Well site: Private (Chinese Philippino), may be available at reasonable price. Plant site: Owned by MCWD.
Resettlement	Not necessary.	Not necessary.	Not necessary.	Not necessary.
Evaluation	**Best site plan.** This site plan is superior in water quality, meeting supply demand. New main pipeline under construction makes it connected.	**Best alternative site plan**. This site plan meets supply service demand, but may be difficult to buy the site in the affordable cost.	This site plan is superior for water quality and in meeting supply demand, but may be difficult to buy the site in the affordable cost.	This plan is the lowest cost required, but lacks water quality, seriously.

1-6 Environment and Social Considerations

1-6-1 Site Details

The potential site is located due north of resort hotels including the Hilton, Microtel and Shangri-La Resort areas and borders the Hilutangan Channel. The approximate area of the land is 3000m^2 and includes land on either side of the main road. The land is covered with weeds and slopes towards the shoreline. The owner is said to be a Chinese-Filipino asking for approximately PHP 14,000/m^2, but this will have to be finally negotiated and approved by MCWD. The following aspects will be studied at this preliminary stage prior to implementation of the Project.

- Confirmation of the EIA System and Approval Process for environmental and social considerations as they apply to the Philippines in general and the study area in particular.
- To confirm if any involuntary resettlement is necessary
- To confirm impacts on fishery and nursery environments and on the natural environment and private enterprises, specifically on ocean ecology as a result of discharge of highly concentrated wastewater and with due consideration of methods to reduce or alleviate impacts as much as possible.
- To study noise/vibration and accidents etc., by construction machinery and vehicles during the construction phase.

1-6-2 General Environmental Laws

General environmental laws in Philippines are as follows;

PD No. 1151 (1977)	Environmental Policy
PD No. 1152 (1977)	Environment Code - Covers Air, Water, Land Use, Natural Resource Management, Waste management, Miscellaneous
PD No. 1586 (1978)	Establishing an Environmental Impact Statement System
P. No. 2146 (1981)	Environmentally Critical Areas and Projects
PD. No. 984 (1976)	National Pollution Control Decree
RA No. 6969 (1990)	Toxic Substances and Hazardous and Nuclear Wastes Control Act
RA No. 7586 (1992)	National Integrated Protected Areas System Act
RA No. 9147 (2001)	Wildlife Resources Conservation and Protection Act
RA No. 8749 (1999)	Clean Air Act – gives Air Quality Standards
RA No. 8550 (1998)	Fisheries Code
PD No. 979 (1976)	Marine Pollution Decree
DAO No. 43-90	Water Usage and Classification
AO No. 35 (1990)	Revised Effluent Regulations
RA No. 9003 (2000)	Ecological Solid Waste Management Act
PD No. 1219 (1977)	Coral Resources Development and Conservation Decree

(PD = Presidential Decree; P= Proclamation; AO = Administrative Order; RA= Republic

Act; DAO = Department Administrative Order)

【References】

1) Revised Procedural Manual (RPM) for DENR Administrative Order No. 30 of 2003 (DAO 03-30) Implementing Rules and Regulations of PD. No. 1586 establishing PEISS – DENR-EMB Publication Environmental Impact Assessment and management Division of Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources –(DENR). August 2007 (2nd Printing January 2008)
2) Environmental Laws in the Philippines (1999 – 2nd Ed) Compiled by the Central Book Supply Inc. Editorial Staff (Reprinted 2000 with some Inserted Footnotes and Other Corrections).
3) A Legal Arsenal for the Philippine Environment (2002) by Antonio A. Oposa Jr. The Philippine Islands: Batas Kalikasan (2002).
4) Geological Map of Cebu Quadrangle (Sheet 3750 I) – Philippine Bureau of Mines and Geosciences (First Ed. 1985)

1-6-3 Confirmation of EIA System and Approval Process

Philippine legislation covers both environmental and social considerations. Social considerations cover mainly resettlement. There is much environmentally relevant legislation which covers aspects such as Air Quality, Noise, Water Quality, Biodiversity Conservation, Solid Waste, etc. The main environmental considerations mainly stem from Presidential Decree (PD) No. 1151 of 1977 which covers the Philippine Environmental Policy; Section 4 of which requires an assessment and environmental impact statement for all actions, projects or undertakings that significantly affects the quality of the environment. This detailed statement would include environmental impacts, unavoidable adverse impacts, possible alternatives, determination that short-term uses are consistent with preserving long term productivity, and the justification for any use of depletable or non-renewable resources. Thus Environmental Impact Assessments (EIAs) were systematized into the Philippine Environmental Impact Statement System (PEISS) established in 1978 (PD 1586).

The Department of Environment and Natural Resources (DENR) was established by Executive order 192 in 1987 and with the subsequent setting up of the Environmental Management Bureau (EMB) as a line Bureau of DENR, EMB-DENR was mandated as the lead agency in the implementation of the country’s environmental Laws and PEISS. Currently clearance of projects is by the DENR Administrative Order No. 30 of 2003 (DAO 03-30) which through the Revised Procedural Manual (RPM) of 2007 details the procedures for processing of project applications for Environmental Compliance Certificates (ECC).

The EIA process is used to enhance planning and guide decision making and integrates environmental concerns into the planning process of projects at the Feasibility Study Stage. Environmental impacts are considerably reduced through a reiterative process of project site selection, design and other alternatives with subsequent formulation of Environmental

Management and Monitoring Plans. A positive determination of the EIA Report by DENR leads to the issuance of an Environmental Compliance Certificate (ECC) document whose requirements the Proponent guarantees to conform to and represents the Project's ECC. This allows the Project to move to next stage of the planning process which is the acquisition of approvals by other Government Agencies (GAs) and Local Government Units (LGUs) only after which the project can start implementation. **Table 1.6.1** shows the EIA Process by the Project Cycle Stage.

Table 1.6.1 EIA Process within the Project Cycle

Project Cycle Stage	Activities (between successive stages)	Comments
1) Project Conceptualization /Improvement	➢ Site Selection ➢ Environmental Screening ➢ Initial rapid site and impact assessment to determine criticality of location. ➢ Initial scoping of key issues	EIA related activities include self screening as to whether proposal is covered by PEISS. Determination of all requirements for application process
2) Preliminary Feasibility Study Stage	➢ Detailed EIA initiated ➢ Environmental Management Plan ➢ –EMP(Identification of mitigation ➢ needs with Proponent deciding on ➢ final project option, siting and ➢ design) ➢ Inputs to Cost Benefit Analysis	Formal EIA Application initiated a positive review by DENR results in issuance of ECC with Proponent's commitments and other requirements for compliance with existing environmental regulations and best practices.
3) Feasibility Study Stage	➢ Findings and recommendations of EIA considered in various permits and licenses needed	
4) Detailed Engineering & Design	➢ Detailed design of mitigation measures	Post ECC additional baseline monitoring may be required prior to construction or project implementation to help define EMP
5) Project Construction & Development	➢ Implementation of mitigation measures	Monitoring of the Proponent's environmental performance will be continuously done with findings fed back for continual improvement of Project and updating of EMP Major improvements may require new formal applications for DENR approvals.
6) Operation & Maintenance	➢ Monitoring, Validation and evaluation/ audit of environmental compliance and overall performance	

The concentrated wastewater from the plant is discharged in the marine waters which have marine ecosystems and fishery potential in its waters. Therefore, EIA Study is required according to the Revised Procedural Manual (RPM), which is required to conduct a detail investigation and study about the impact on the environment. The number of well as an intake facility is less than six (6), thus the categories of intake facility is required an Initial Environmental Examination (IEE) to obtain the ECC under the RPM.

IEE outline given in the RPM have the following sections:

Project Fact Sheet

Table of Contents

Executive Summary

(1) Brief Project Description
(2) Brief Summary of Project's IEE Process
(3) Summary of Baseline Characterization
(4) Summary of Impact Assessment and Environment Management Plan
(5) Summary of Environmental Monitoring Plan

【DRAFT MAIN IEE】

- ✓ Basic Project Information
- ✓ Description of Project's IEE Process (Including TOR, IEE Team, Study Schedule, Study Area, Methodology)
- ✓ Project Description (Includes Project location, Rationale, Development Plan, Process/Technology and Components, Description of Project Phases, manpower requirements, Cost, Duration and Schedule
- ✓ Baseline Environmental Conditions, Impact assessment and Mitigation (Includes Land, Water Air and People)
- ✓ Environmental Management Plan [EMP] (Includes Impacts, Emergency Response Policy, Environmental Monitoring plan, Institutional Plan for implementation)
- ✓ Bibliography/References
- ✓ Annexes (Includes Sworn Accountability Statements by Proponent and IEE Preparer, Baseline Study Support System).

(1) Selection of Local Consultant：

The DENR has given a short-list of acceptable local consultants approved by them to carry out the IEE (See **Table 1.6.2**). The consultant should be identified as soon as possible as he/she could give valuable information from past experience on the process steps required and forms that have to be filled before the IEE is lodged most effectively. DENR intimated that if the IEE is correctly and completely filled out and presented the time taken for processing the application and release of the ECC could be minimized.

Table 1.6.2 Communication List of Local Consultants

Name	Office	Contact No.	Qualifications
Rolando Pecasion	ACP Consultants	414-5021 0918-3329886	Environmental Consultant
Danil Jaque	Hydronet Consultants Inc	0917-7246425 404-4597	Environmental Consultant/Hydrologist
Andres Muego	T & M Consultancy	0919-621125	Environmental Consultant/Environmental Planner
Jun Villafane	Oikos Enviro-tek, Inc.	0917-7202707 238-0967	Environmental Consultant
Emma Irene Menede		0917-5460186	Environmental Consultant

(2) Other Application Forms:

DENR has managed the application forms about the air pollutants, solid waste treatment and effluent from sewage depending on the number of persons working at the proposed facility and an application will have to be made for discharge permit.

(3) Time Frame:

From all discussions and consultation with DENR and other knowledgeable persons (e.g. Environmental Division of MCWD) the approximate time frame for all activities leading up to the issue of ECC as well as LGU/GA clearances would be between 4-6 months.

1-6-4 Social Considerations - Need for Involuntary Resettlement

While this is dependant on the final site location, so far, looking at the sites under consideration there does not seem to be any resettlement issues (voluntary or involuntary). However, the general acceptance of the project will depend on how effectively the importance and benefit of having such a Project being sited in their Barangay with the benefits it could bring in the form of enhanced water supply. Once the site is confirmed it will be necessary to have the meeting of the public scoping to get the acceptance of the Barangay Captain with City Hall officials and DENR. After the public consultation, the negotiation and contract on land acquisition will be carried out with the land owner.

1-6-5 Confirm Impacts on Fishery, Nursery and Natural Environments

The location of the final site is crucial to the determination of any impacts on the above environments. The sea condition has considerable marine ecology in the area including corals. According to the DENR Pollution Control Officer interviewed there would be a need to secure a Discharge Permit as the plant would have employees, hence sanitary and solid wastes would be produced which could have an effect on the marine waters. Also as the Project anticipates discharging effluent into the sea, sea water quality data would be important so that acceptable parameters could be maintained.

1-6-6 Noise, Vibration and Accidents during Construction Phase

The final determination of such effects and measures to ameliorate any adverse effects will be dependant upon the ultimate site selected and details of the engineering plans, which will have to be submitted to DENR. The proposed site which is located on the peninsula of Mactan Island and is on the resort belt but is not too densely populated. Noise, dust during transport of material for construction, preparation of the site etc., by construction machinery and vehicles would be expected during the construction phase. Suitable safety procedures should be exercised during construction to prevent accidents as well as minimize noise during construction and the construction work schedule should not inconvenience residents living in the area by work being done at inappropriate times.

1-7 Others

In Cebu Province, the existing desalination plants have been operated by private sector called Mactan Rock Organization and by resort hotels and treated water has been utilized as potable water, as aforementioned. According to the interview to Cebu Province Government, desalination plants have been operated in numerous isolated inhabited islands as well. Further, on-going "The Study for Improvement of Water Supply and Sanitation in Metro Cebu" suggested the introduction of desalination plant with capacity of 28,000 m^3/day to cope with future water demand growth and to improve water service ratio.

Operation of the existing plants was confirmed through field survey. As to those constructed in resort hotels, they are operated appropriately because they are still new. However, as to plant constructed by Mactan Rock Organization, it was constructed more than 10 years ago and remarkable water leakage was observed. This shows that proper O&M is critically important to maintain sustainable functioning of a desalination plant. Therefore, preparation of efficient O&M plan, recognition on significance and necessity of O&M activities and soundness of financial status are indispensable for sustainable and proper management of this project.

Philippines joined to "Cool Earth Partnership" to tackle with climate change and attended several international conferences but contents of their concrete engagement are still not obvious.

Chapter 2 Contents of the Project

2-1 Outline of the Project

NWRB has presented their basical policy in groundwater conservation in early 1990s. As part of this policy, groundwater modeling and flux simulation was conducted for stage-1 groundwater investigation target area. The target area is Metro Manila and Metro Cebu, where living environment has been aggravated by deregulated groundwater development. On May 2007, NWRB issued basic policy on groundwater development restraint and specific groundwater development restraint area was concluded. Accordingly, MCWD is carefully supervising groundwater pumping within the restricted area and is also conducting new groundwater source development outside of restricted area in parallel.

The objective of this project is to construct a desalination facility including its components such as sand filtration and reverse osmosis (RO) membrane units, an intake, distribution (including connection to existing water supply pipeline) and also a discharge facility for concentrated wastewater. Although preliminary facility design was prepared, project implementation was cancelled through discussion with MCWD. The following sections show the contents of this project as reference.

2-2 Basic Design of Target Project

Population projection and future water demand in the target area are described based on the results of this Study and with reference to the on-going JICA Study titled “The Study for Improvement of Water Supply and Sanitation in Metro Cebu in the Republic of the Philippines”.

2-2-1 Design Policies

2-2-1-1 Basic Policies

The target year of starting operation was set as 2012. System design was executed aiming easiness in O&M activities and sustainable safe water supply to residents. Upon transmission/ distribution pipeline design, “MCWD Technical Standards Manual” was referred, while in case of desalination plant design, Japanese design standard and results of interview to plant manufactures were referred.

2-2-1-2 Design Policy on Desalination Plant

The optimum seawater intake method shall be selected considering intake amount, topographic features of intake site, fluctuation in seawater level and ocean current. Desalination plant can be divided into pre-treatment facility and membrane facility. Appropriate type or structure shall be precisely chosen for both facilities based on global application results, raw seawater quality, easiness and cost in O&M activities.

2-2-1-3 Diagnosis Policy on Managerial Impact to MCWD

At present, annual management of MCWD is profitable basis and is maintaining sound status.

However, once operation of completed desalination plant is started, huge operation cost and periodical replacement of expensive membrane is needed continuously and this might stress finance of MCWD in future. Hence, O&M cost was estimated contributing to the financial examination in future.

As MCWD does not possess their own desalination plant, they have no experiences in plant O&M. Outline of the existing plant owned by private company and resort hotels is introduced as reference materials for future organization formulation.

2-2-1-4 Policy on Selection of Concentrated Seawater Discharge Point

As desalination plant generates concentrated seawater, its disposal method and disposal site shall be properly selected. Mactan Island is well-known not only as center of marine resort, but also as treasure of marine life including fishery industries and coral shelves. Therefore, disposal method and disposal point must be carefully planned to minimize the anticipated impacts on natural environment and social activities.

2-2-2 Future Water Demand in Mactan Island

2-2-2-1 Domestic Water Demand

(1) Population Projection

1) Total Population

Table 2.2.1 and **Figure 2.2.1** show the future population trend of Lapu-lapu and Cordova until 2030 based on the National Statistics Office (NSO) census data.

Table 2.2.1 Total Population Projection

Municipality	1995	2000	2007	2010	2015	2020	2025	2030
Lapu-lapu	173,744	217,019	292,530	321,100	375,200	438,300	512,100	598,300
Cordova	26,613	34,032	45,066	47,600	52,000	56,900	62,200	68,100
Total	200,357	251,051	337,596	368,700	427,200	495,200	574,300	666,400

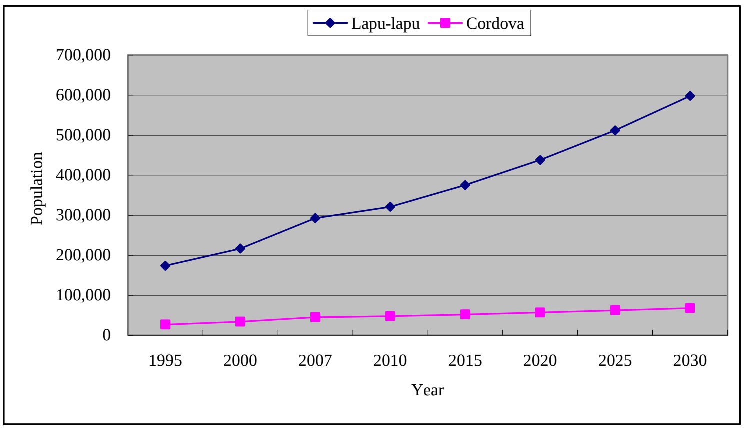


Figure 2.2.1 Population Trend and Projection

2) Service Population

The service ratio of public water supply in Lapu-lapu and Cordova in Mactan Island corresponds to 16% of the total population of these two municipalities. Households, excepting those receiving public water supply, use wells, vendors and bottled water as their source of water. According to the JICA Development Study, the service ratio is estimated to rise to 46% in 2030 if accompanied by an active development of the water supply system as shown in **Table 2.2.2**.

Table 2.2.2 Projection of Water Service Population

Municipality	2007	2010	2015	2020	2025	2030
Lapu-lapu	45,585	74,239	131,285	168,112	215,396	275,514
Cordova	8,314	12,400	19,672	23,473	27,929	33,185
Sub-Total	53,899	86,639	150,957	191,585	243,325	308,699
Total	337,596	368,700	427,200	495,200	574,300	666,400
Service Ratio (%)	16.0	23.5	35.3	38.7	42.4	46.3

(2) Per Capita Water Consumption

Table 2.2.3 shows the record of per capita consumption in recent years.

Table 2.2.3 Per Capita Water Consumption

(unit: L/capita/day)

Item	2005	2006	2007	2008	Remarks
Residential	175	175	168	170	Served population in 2007: 569,319
Communal	16	17	17	15	Served population in 2007: 60,200

Source: MCWD data

The per capita consumption of residential connections varies in a range of 170 - 175 L/capita/day. As mentioned earlier, this consumption includes that of households of non-served area using hoses and containers. According to the result of household survey in the JICA Development Study, these non-served households use 30 L/capita/day of water on average. Assuming that the 30 L/capita/day is provided by neighboring water consumers, out of the 170 - 175 L/capita/day of residential concessionaires/customers consumption, 140 - 145 L/capita/day is used for their own consumption. In summary, the per capita consumption presented in **Table 2.2.4** is adopted for the domestic water demand.

Table 2.2.4 Adopted Per Capita Consumption for Domestic Demand Projection

Category of Users	Per Capita Consumption
Residential	150 L/capita/day
Communal	25 L/capita/day

(3) Gross Water Demand Projection

According to afore mentioned “The Study for Improvement of Water Supply and Sanitation in Metro Cebu”, water consumption was estimated by water usage categories:

- Domestic Use: Estimated by per capita water supply amount and service population
- Commercial/Industrial Use: By actual water consumption record and questionnaire survey results
- Un-accounted for Water: By database in MCWD

Table 2.2.5 shows the result of gross water demand projection by water usage categories.

Table 2.2.5 Tabulates the Water Demand Projection

Category		2007	2010	2015	2020	2025	2030
Revenue Water	Domestic	8,338	12,836	21,674	27,258	34,368	43,353
	Commertial & Industrial	3,566	6,216	11,093	12,951	14,918	17,289
	Sub-total	11,904	19,052	32,767	40,209	49,286	60,742
NRW		5,102	6,351	8,192	9,431	10,819	12,421
Total		17,006	25,403	40,959	49,640	60,105	73,063

In **Table 2.2.5**, the rate of NRW is assumed to reduce with time as shown in **Table 2.2.6**.

Table 2.2.6 NRW Rate Assumption

Rate of NRW (%)	2007	2010	2015	2020	2025	2030
	30.0	25.0	20.0	19.0	18.0	17.0

(2) Water Demand and Supply Balance

In Mactan Island, MCWD owns 5 wells from which about 3,500 m^3/day is being abstracted in total. Bulk water is purchased from Mactan Rock Inc. and its contract volume is 5,000 m^3/day. **Table 2.2.7** shows the water balance in 2007.

Table 2.2.7 Water Balance in 2007

Demand (m^3/day)		Supply (m^3/day)	
Domestic	8,338	Well	3,500
Commercial & Industrial	3,566	Bulk Water	5,000
NRW	5,102	Import from Cebu	8,500
Total	17,006	Total	17,000

To improve the water shortage in Mactan Island, a seawater desalination system was recommended in the JICA Development Study. The water demand and supply balance including the future production volume by the desalination project in 2015 and 2030 is shown in **Table 2.2.8**.

Table 2.2.8 Water Balance in 2015 and 2030

Year	Demand (m^3/day)		Supply (m^3/day)	
2015	Domestic	21,674	Well	3,500
	Commercial & Industrial	11,093	Bulk Water	5,000
	Government	0	Import from Cebu	4,500
	NRW	8,192	Desalination	28,000
	Total	40,959	Total	41,000
2030	Domestic	43,353	Well	3,500
	Commercial & Industrial	17,289	Bulk Water	5,000
	Government	0	Import from Cebu	36,600
	NRW	12,421	Desalination	28,000
	Total	73,063	Total	73,100

2-2-2-2 Design Capacity of Facility in this Study

This Study is the JICA Preparatory Survey on the Program Grant Aid for Environment and Climate Change under the Japanese budget in the fiscal year 2009. Thus, the design capacity for the target facility is determined by taking into account the limited budget and implementation schedule. This project is based on the premise that Japanese products are to be purchased for the main components of desalination plant which will include, at the very least, high-pressure pumps, and Reverse Osmosis (RO) membranes. The design capacity of the facility in this Study is finally proposed based on the cost estimation and its figure is 3,000 m^3/day. This volume of water contains 40% of shortage flow in 2010 in Mactan Island (water shortage volume = water demand in 2010 (25,400 m^3/day) - existing supply volume (17,000 m^3/day) = 8,400 m^3/day).

2-2-3 Basic Plan

2-2-3-1 Basic Concept

Basic concepts of this facility plan are shown below;

- Design plant capacity was set by 3,000m^3/day. Necessary seawater intake amount is estimated as 7,500m^3/day, providing that recovery rate is 40%. Amount of concentrated seawater waste is calculated: 7,500 – 3,000 = 4,500m^3/day.
- Capacity calculation and procurement were basically based on the MCWD design manual, which is used to handle projects by MCWD. In cases where there is a big difference between Japan and MCWD on design concept or materials used, such matters were discussed to take decisions in terms of design.
- According to MCWD, it is possible to stop water supply for 1 day if an announcement is made 3 or more days before. Therefore a cleaning facility etc. which is an extra facility which is used for maintenance during operation was not considered.

2-2-3-2 Outline Drawings

In this study, the General Layout Plan and System Flow Diagram for the outline plan were prepared. As this plan was not based on any detailed survey of levels and plans, it serves merely as a point of reference.

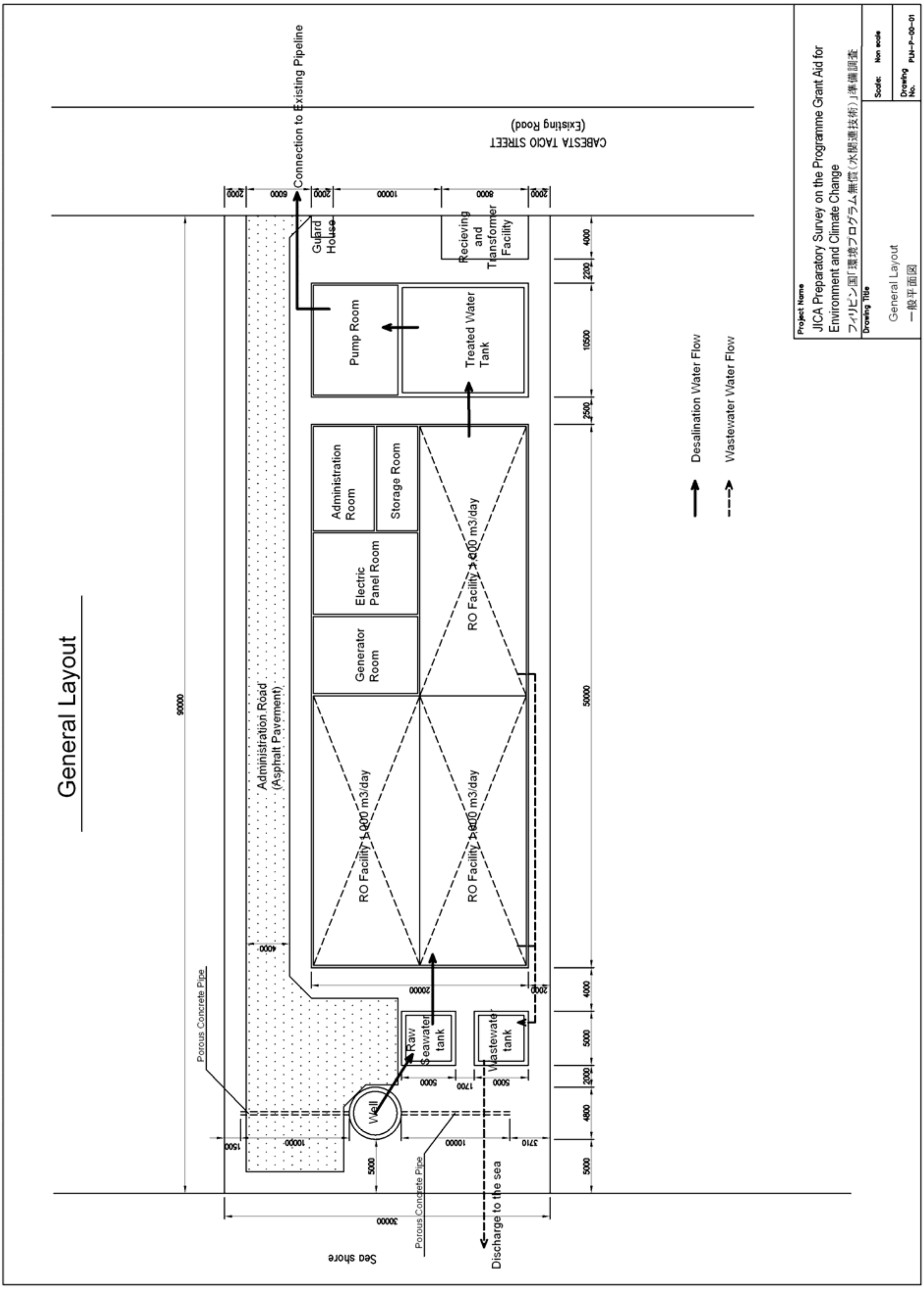


Figure 2.2.2 General Layout Image of Desalination Plant Plan

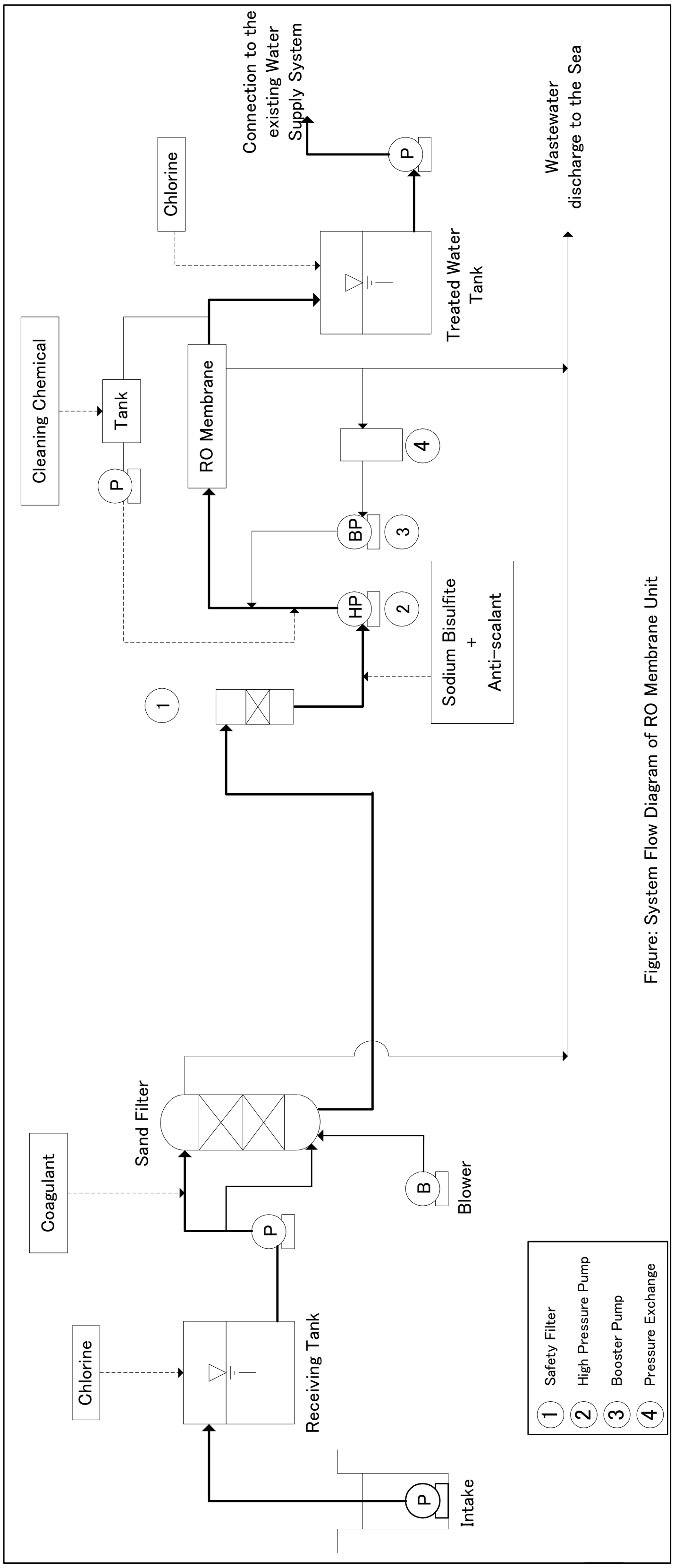


Figure 2.2.3 System Flow Diagram of Desalination Plant

2-2-3-3 Design of Seawater Intake Facility

The Intake Facility to be designed in this project is one for seawater. Among many types of seawater intake facilities (refer to **Table 2.2.9**) which have been proposed, a shallow well type intake facility was adopted considering the following conditions:

- Target ground has high permeability
- Design intake amount is not very large
- Construction cost will be the most economical

(1) Basic Structure of Seawater Intake Facility

A perforated seawater collection pipe is to be installed along the coastline to accumulate infiltrated seawater. According to the basic study and the results of field survey, target ground was determined as younger limestone or coral stone having sufficient hydraulic conductivity. Therefore, design intake amount of 7,500 m^3/day is assumed to be possible. **Figure 2.2.4** shows the schematic plan of the intake well and seawater collection pipe.

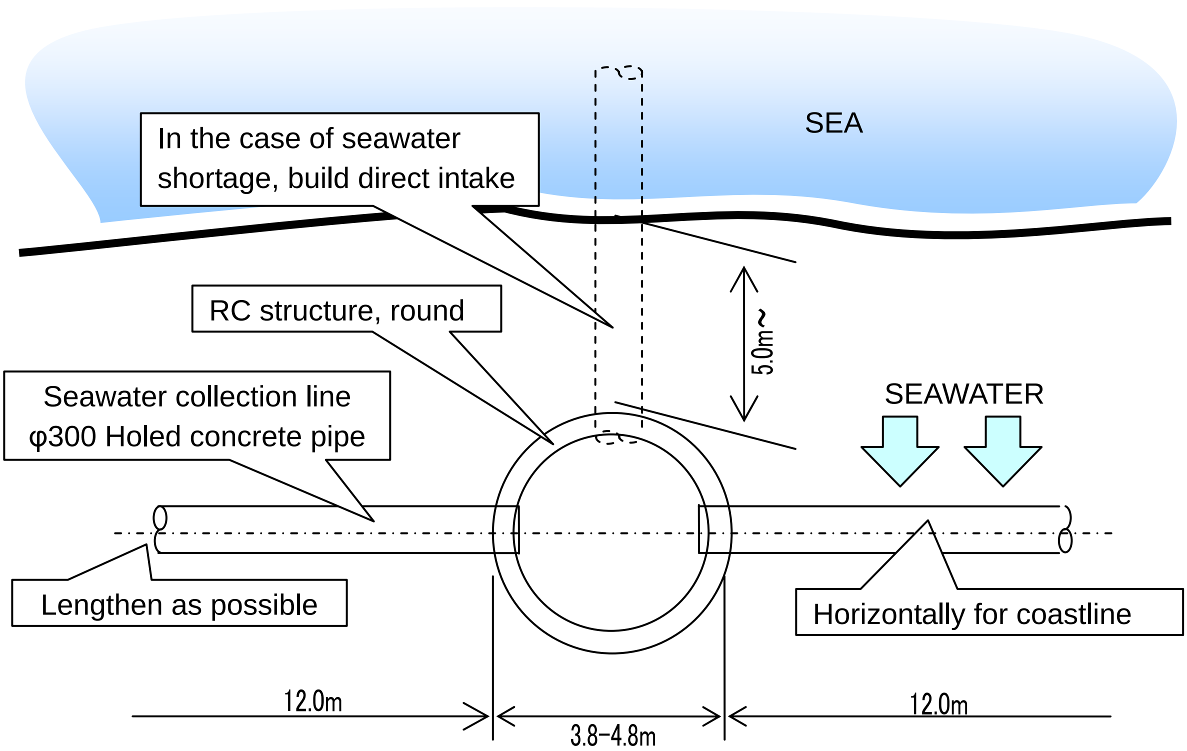
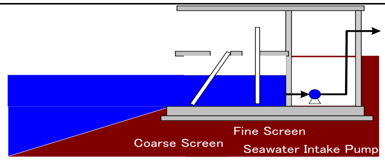
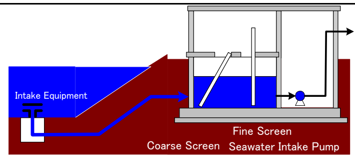
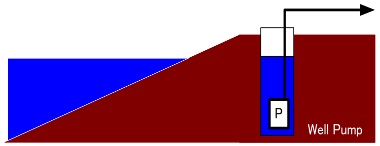
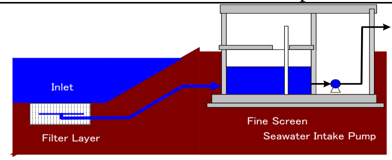


Figure 2.2.4 Schematic Plan of Seawater Intake Facility

Table 2.2.9 Seawater Intake Method Comparison Table

	Direct Methods		Indirect Methods	
	Plan A Surface Intake Method	Plan B Seabed Intake Methos	Plan C Seashore Well Intake Method	Plan D Infiltration Pipe Intake Method
Schematic Drawing				
Outline	Surface seawater is directly taken and after screening, inlet seawater is pumped to the plant. Less affected by waves and high water level in front of the facility is available. This method is applicable if surface water is clean. Large intake volume is also available.	Intake pipe is installed up to intake point at seabed. After screening, inlet seawater is pumped to the plant. Seawater introduction by gravity is reliable and stable.	The most simplified method. Depending on the soil characteristics but this method is not applicable to large amount intake.	Perforatede pipe is embedded in sand bed layed on seabed. As seawater infiltrated into pipe is already screened by sand bed, coarse screen can be omitted. Mitigation in pump loading and simplification in pre-treatment process can be expected.
Advantages	・Ease in large amount intake ・As pump well is always poured by seawater, temporally gravity seawater feeding to the plant is also available	・This method is available where largely affected by waves ・As sand is removed by screen, the loading to the subsequent pumps and plant is mitigated ・Fine screenings is also removed	・Only wells are needed ・The most cost effective	・This method is available where largely affected by waves ・As seawater is primary screened by sand bed, loading to the subsequent facilities and equipment is mitigated ・Less shells and seaweeds inside intake pipe, less cloggings ・Less fish eggs and sewaweeds intake, less impact to marine life
Disadvantages	・As direct and gravity intake from the sea, design facility bottom level shall be set lower than sea surface level ・Affected by waves ・Sufficient water level is needed in front the facility ・Large incoming screenings ・Since incoming grease is also anticipated, incoming seawater quality shall be monitored continuously	・Same to Plan A, design facility bottom level shall be set lower than sea surface level ・If the seabed profile is not flat, this method will be less cost effective	・Design intake amount is restricted by the well structure ・Large mineral elude attributes to the cleaning and clogging frequency of membranes	・Same to Plan A, design facility bottom level shall be set lower than sea surface level ・Intake sand beds need periodical back washing by water from elevated tank or back wash pumps
O&M Activities	・Not like Plan B and D, periodical intake pipe cleaning is not needed ・Daily screenings removal is indispensable as expected screening amount is the largest	・Periodical cleaning is needed for intake pipe and pump well ・Daily screenings removal is needed	・Most easy as the least equipment is installed	・Few clogging is expected as seawater is screened by sand bed

(2) Seawater Intake Well

A shallow well with a standard structure will be installed. As perforated seawater collection pipes will be connected, this well is designed to act as both a junction pit and a pump pit. Considering the practicality of space required for work required in the installation of pumps (3 units), prevention of mutual interference and needed work area for cleansing of seawater collection pipe, the optimum well diameter was determined to be 4.0 m. Seawater intake will be effected by the infiltration at the well bottom and permeation through collection pipes. Pumps shall be located apart from the outlets of collection pipes to reduce the vibration at the seawater surface.

Since pump maintenance work in seawater is difficult, pumps shall be lifted up to the ground. To ease such pump hoisting works, the top of well shall have to be opened and will therefore be covered by a removable cover. **Figure 2.2.5** shows schematic plan of seawater intake well.

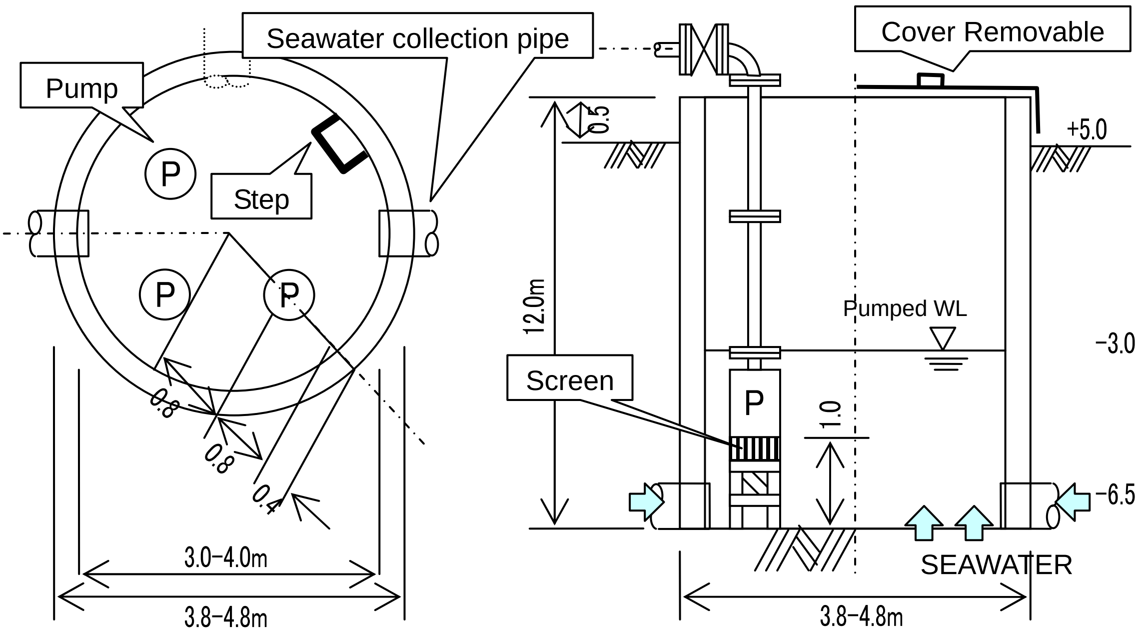


Figure 2.2.5 Schematic Plan of Seawater Intake Well

In general, a hoisting tower is planned for such pump hoisting works but as this plant is located near the sea shore, there is high possibility in material corrosion. Therefore, the hoisting work shall be conducted as required by a truck fitted with a hydraulic crane.

(3) Embedded Seawater Collection Pipe

To augment the seawater well intake capacity, seawater collection pipes will be installed on both sides along with coastline. Straight pipes will be used and the pipe length will be approximately 12 m on both sides. Considering the corrosive nature of seawater, pipe material with high durability against corrosion needs to be properly selected. Consequently, perforated concrete pipes with diameter of 300 mm were selected.

If pipe clogging occurs, divers will work at the well bottom to scrape out any clogging materials using scraper devices. If the infiltration amount is much lower than the design amount owing to low permeation, another collection pipe shall be installed starting from the well towards the sea. The methods used pipe installation will have to be carefully planned.

(4) Seawater Intake Pump

The seawater intake pump should also have highly anti-corrosive properties against seawater. The proposed pump specification is as follows:

Single-phase dual suction submersible pump

φ200［mm］×2.60［m^3/min］×15［m］×15［KW］×3（1 unit stand-by）

1) Design Pump Capacity

Total design intake amount from the well is 7,500 m^3/day, of which 3,000 m^3/day will be supplied as potable water and the remaining 4,500 m^3/day will be disposed of in the sea as concentrated seawater. Accounting for some pump capacity allowances, the design pump capacity is 3,750 m^3/day × 2 units with 1 unit for stand-by use. A further 1 unit will be stored in a ground store room as a back-up. The design pump head was set at 15 m taking into account some allowances. Therefore, pump output was calculated as follows:

$$P = 0.163 \times 2.60\,[m^3/min] \times 15\,[m] \times (1+0.15) / 0.65 = 11.3\,[kW] \fallingdotseq 15\,[kW]\ (\text{Nominal})$$

According to pump type selection charts, suction pipe diameter was set at 200 mm taking into account some allowances.

2) Pump Auxiliaries

Foot valves, sluice valves and air valves are needed for smooth pump starting and operation. They shall be anti-corrosive.

3) Pump Installation Method

To raise the pump screen 1 m above the well bottom level, a simplified platform will be installed on the well bottom. Platform material shall be anti-corrosive.

(5) Raw Seawater Storage Tank

Raw seawater storage tank will stabilize the influent/inflowing amount to the desalination plant and also will regulate seawater intake pump operation by stored seawater level inside of the tank. Back flow to intake well is prevented by a suitable pipe arrangement. Overflow seawater is discharged into the intake well.

1) Capacity of Storage Tank

According to the requirements to secure stable operation of the desalination plant, the tank shall have a capacity equivalent to 15 minutes of intake volume amount:

V＝（7,500／24／60×15）＝78［m^3］≒ 80［m^3］

2) Structure of Storage Tank

Tank shall be made of RC which is available using local technology. Tank dimensions are Width=4［m］× Length =5［m］× Height =4［m］. Although 2 tanks are preferable for tank cleaning and emergencies, they need complicated pipe arrangements and higher construction costs. Further, according to MCWD, desalination plant operation can be ceased by advance announcement. Thus, a single storage tank was proposed. The schematic diagram of the storage tank is shown below:

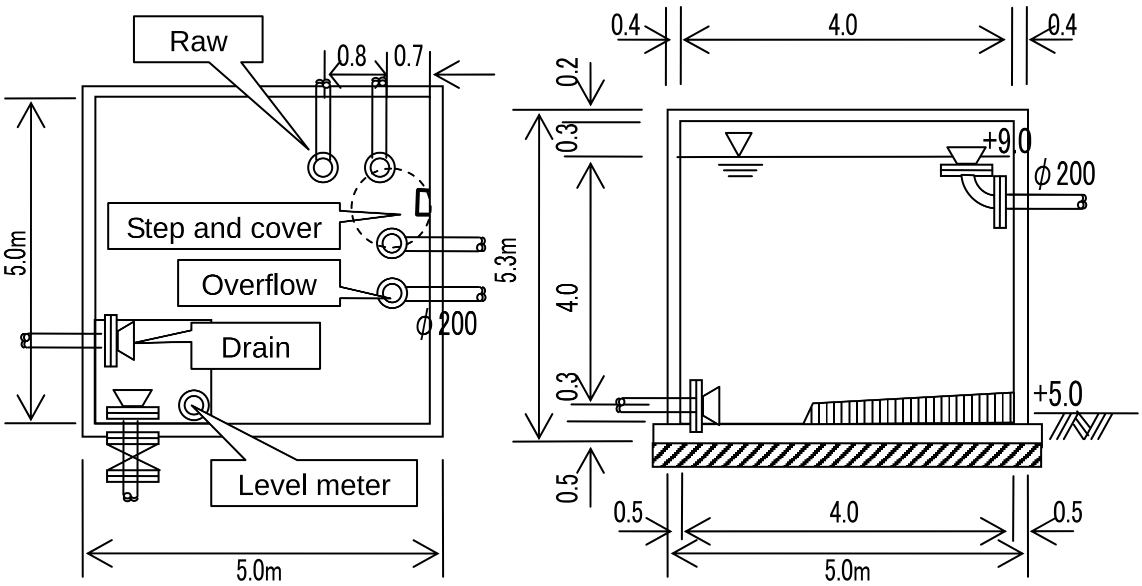


Figure 2.2.6 Schematic Diagram of Raw Seawater Storage Tank

(6) Raw Seawater Transmission Pipes and Auxiliary Pipes

Diameter of transmission pipes is 200 mm and PVC is proposed as the pipe material but exposed portions shall be coated to prevent degradation by sunlight. For pipes connecting facilities, flex pipe which have been adopted by MCWD is recommended. The overflow pipe with a diameter of 200 mm is directly connected to the intake well and the drain pipe is laid towards the coastline.

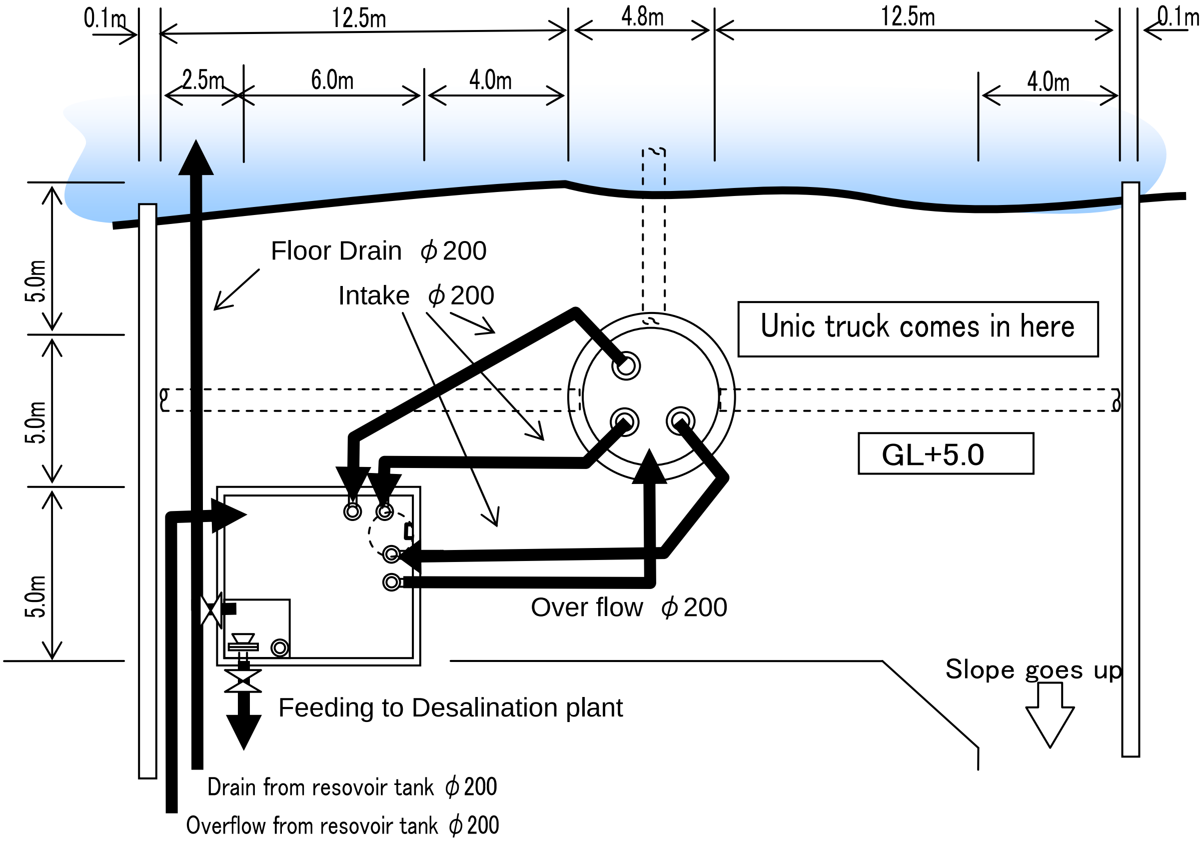


Figure 2.2.7 Layout Plan of Seawater Transmission Pipes

2-2-3-4 Planning of Desalination Facility

(1) Outline of Seawater Desalination Facilities

The seawater desalination facilities consist of the following elements.

1) Seawater intake facility (Refer to above report)

2) Pre-treatment：To make FI[1], SDI[2] values both less than 4 or 3 ideally

- Multi media filter

3) RO membrane treatment unit

- High pressure pump
- RO modules
- Energy recovery devices

4) Incidental facilities

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[1] Fouling Index

[2] Sludge Density Index

[5] Source：JBIC (Japan Bank for International Cooperation), 4.2.11 Seawater Design Value, Final Report of Feasibility Study of Seawater Desalination Facility for Water Supply in Metro Cebu, September 2005

- Pre-treatment and post treatment chemical injection facilities
- Product distribution facilities
- Concentrate discharge facility
- CIP (Cleaning In Place) facility
- Control/Monitor instruments
- Building
- Piping and wiring

(2) Design Conditions

- Product water: 3,000m^3/day
- Raw seawater/Product water quality
  Raw water TDS: 35,000 ~ 38000 mg/L, Ave. 35,900 mg/L[5]
  Product water TDS: less than 500 mg/L
- Recovery rate: 40 %, 25 ℃
- RO inlet FI value: Less than 4
- RO inlet turbidity: less than 0.5 NTU
- Max. operation temperature: 45℃
- Free chlorine: less than 0.1 mg/L
- pH range: 2 to 11

(3) Design Example of Desalination Facilities

The design capacity of the seawater desalination plant by RO membrane is 3,000 m^3/day. In the design, three units of RO units with the capacity of 1,000 m^3/day are required. The following is a conceptual design of seawater desalination facility by RO membranes with the capacity of 1,000 m^3/day/unit (41.7 m^3/hour/unit), excluding seawater intake, product water distribution and concentrate (brine) discharge facilities.

1) Feed pump (Filter pump)

- For providing flow and pressure from the feed water tank to the downstream equipment
- Type: Centrifugal pump (common use for backwashing)
- Nos. of unit: 3 units
- Specifications: 34 m^3/h (816 m^3/day) x 40 mH/unit
- Materials
  Casing, impeller, shaft: Duplex Stainless Steel
  Sealing: Mechanical seal for seawater application
- Motor per unit: 7.5 kW x 440 V x 3 phase x 60 Hz/unit
- Diameter for Suction/Discharge pipe: DN 125/DN80/unit

2) SBS (Sodium Bisulfite) dosing system for disinfection

- To prevent bacteria growth and biological fouling on the surface of RO membranes, inject SBS for one hour per a day[6]
- Injection point: before filter inlet
- Chemical: SBS[7]
- Dosing rate: 200 mg/L
- SBS tank
  - Nos. of unit: 1
  - Capacity: 500 L
  - Type: Cylindrical
  - Material: PE[8]
- SBS dosing pump
  - Unit: 1
  - Specifications: 3.5L/min x 700 kPa x 0.1kW x 230V x 3 phase x 60Hz
  - Type: Plunger

3) Filter

In using RO membrane system, FI or SDI value which relates to turbidity is the most important. It is expected to be less than 4, ideally less than 3. There are two types of pre-treatment process for turbidity removal. One is using MF or UF membrane system and conventional filtration widely being used in water purification processes. The membrane system can easily achieve FI value less than 3; on the other hand however, it is costly, suitable mainly for large scale plants, and needs backwash and chemical cleaning. In using conventional filtration as pre-treatment of RO system, inorganic coagulants such as $FeCl_3$ or $Fe_2(SO_4)_3$ is added to ensure turbidity removal in general. By this operation, SS load in backwash water increases due to produced $Fe(OH)_3$ flocculants and colloids which is not measured in raw seawater.

In addition, coagulation and direct filtration is used widely without the sedimentation process. In this process performance depends on the injection point. The most suitable injection point and the time to reach the filter media, depends on the temperature, composition and structure of filter media, etc. If an inadequate injection point is used, Fe may leak, in particular when using $FeCl_3$, which will have a negative performance effect on the safety filter or RO membranes after filtration.

In this project, sand filtration is adopted owing to the followings:

- Design plant capacity is not so huge
- Raw seawater quality is fair

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[6] A amount of SBS is injected for only one hour per day for disinfection in order to prevent bacteria growth and biological fouling in the pipe and on the surface of RO membranes. For this purpose, another way is to inject 0.5 to 2.5 mg/L as Cl_2 by NaOCl (Cl_2 12%). In case of using spiral type of polyamide composite RO membrane, residual free chlorine should be removed before RO inlet by SBS because polyamide membrane is weakened by free chlorine.

[7] $NaHSO_3$ solution(35 % solution)

[8] Polyethylene

- O&M cost is much lower than membrane method
- Application experiences in the existing plants

The intake point in this Project is near the possessing desalination plant of Imperial Palace Hotel RO system. In addition, seawater intake method through a seashore well intake method as similar to that adopted by the Imperial Hotel. The RO system in the Imperial Palace Hotel does not use any coagulant, therefore, use of coagulant is not considered in this Project.

➢ Type	Vertical Multi Filtration
➢ Composition	Anthracite + sand
➢ Nos. of unit	3 units
➢ Dimensions	1,830 x 2,400 mmHg/unit (2.7 m^2/unit)
➢ Operation velocity (LV）	13 m/H
➢ Max. pressure drop	100 kPa
➢ Max. operation pressure	700 kPa
➢ Material	FRP
➢ Valve, pipe size	5 inch (125 mm)/unit
➢ Backwash frequency	When ΔP（pressure loss）reaches 100 kPa or once every one or two weeks
➢ Backwash velocity	30 m/hour
➢ Backwash produced	Approximately 20m^3/cycle/unit
➢ Backwash initiation	Manual
➢ Backwash valve, piping	5 inch (125 mm)/unit

4) Anti-scalant dosing system

To prevent scaling on the surface of RO membrane by calcium or magnesium in seawater, anti-scaling chemical is added before RO module inlet. As anti-scaling, 40-80 mg/L of H_2SO_4 is also used to low pH; however, injection of anti-scalant consisting of phosphate or carbonic acid complex is commonly used at present.

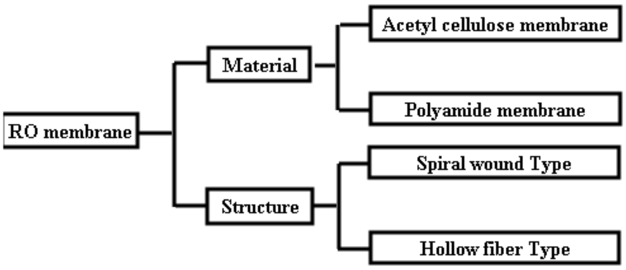
➢ Injection point	Before safety filter inlet
➢ Chemical	Anti-scalant
➢ Dosing rate	3 mg/L
➢ Anti-scalant tank	
Nos. of unit	1
Capacity	500 liter
Type	Cylindrical
Material	PE
➢ Anti-scalant dosing pump	
No. of unit	3
Specification	3 ml/min x 1.57 MPa x 0.02 kW x 230 V x 3 phases x 60 Hz

Type — Diaphragm type with empty operation prevention function

5) Safety filter

- Nos. of unit — 3
- Material — P.P
- Casing — FRP
- Normal flow rate — 34 m^3/hour/unit
- Openings — 1 μm[9]
- Pressure loss — 100 kPa
- Replacement — When ΔP reaches 100 kPa or once every three to 6 weeks
- Inlet/Outlet size — 3" Flange/unit

6) RO membrane unit



RO membrane being used is roughly categorized as an acetyl cellulose membrane and polyamide membrane from a materials aspect and spiral wound and hollow fiber type from a structural aspect.

Acetyl cellulose and polyamide membranes are used for hollow fiber type membrane and polyamide composite membrane is used for spiral wound type membrane. There are two types of spiral wound polyamide composite membranes; cross-linked and filament aromatic polyamide membranes.

The factors that give negative effects on RO performance are scale generation on the surface of RO membrane and biological fouling due to growth of bacteria.

Accordingly, a disinfectant, like chlorine, to prevent bacterial growth and H_2SO_4 to lower pH or anti-scalant to prevent scaling are added before the RO module inlet. The acetyl cellulose membrane is relatively tolerant to chlorine; therefore, chlorine dosing is effective for prevention of bacteria growth.

The features of spiral wound type polyamide composite membrane are widely being used due to the following features;

- Possible to remove tri-halomethanes which can not be removed by acetyl cellulose membrane.
- In general, spiral type wound RO membrane is superior to hollow fiber type membrane in clogging. Mesh spacer with acceptable openings of approximately 30 μm is used in

[9] In general media with less than 25 μm openings is used. In this Project, safety filter with 1μm openings is planned to reduce turbidity load on RO membrane due to without use of inorganic coagulant in filtration process.

spiral wounded type RO element in order to increase inlet flow velocity and to improve turbulence effect at inlet.

- Spiral wound type membranes are produced by many companies and have common dimensions, although their appearances are different. It means those membranes can be accommodated in the same pressure vessels.

However, de-chlorination by SBS is necessary before treated water is introduced into the RO module having polyamide membranes.

In this project, spiral wound type membrane was employed because of the following merits:

- Trihalomethanes can be removed
- Resistent to crogging
- Plural manufactures are available

6-1) RO membrane

Materials	Polyamide thin composite
Structure	Spiral
Nominal Capacity	1,000 m^3/day
Production water TDS[10]	TDS less than 500 mg/L, within WHO standard for drinking water
Salt rejection	Not less than 99 %
Feed flow rate (approx.)	104.2 m^3/hour = 2,500 m^3/day
Recover	40 ％
Design Criteria	Permeate flow and salt rejection based on feed water quality, 38,000mg/L seawater TDS, pH=8.0 and at a temperature of 25 degree Celsius
Product flow rate (approx.)	11.7 m^3/day/element
Nos. of elements	84 (=1,000 m^3/day/ 11.7 m^3/day/element)
Max. Feed flow per element	17 m^3/day/element
Dimension of element	8” dia x 40” length
Maximum pressure	6.8 MPa
Maximum pressure drop	70 kPa

6-2) Vessel

Vessel dimension	φ284 x 7,700 : (8 inch)
Maximum operating pressure	7.0 MPa
Unit vessel weight	152 kg
Inlet pressure	6.17 to 6.28 MPa
Outlet pressure	0.05 to 0.15 MPa
Brine pressure	5.78 to 5.9 MPa

[10] TDS: Total Dissolved Solids

6-3) High pressure pump

Nos. of unit	1
Type	Multistage High-Pressure Centrifugal Pump
Specification	43.2 m^3/hr x 6.17 Mpa x 110 kW x 440 V x 3 Phases x 60 Hz
Inlet/Outlet size	3" victaulic coupling connection
Pipeline and valves Material	PVC, SUS316L, Dupley Stainless Steel

6-4) Booster pump

Application	Raise water pressure of returned water discharged from energy recovery device to penetrate RO membrane
Nos. of unit	1
Type	Multistage Centrifugal Pump
Specification	63 m^3/hr x 25 mH x 7.5 kW x 440V x 3 phases x 60 Hz
Material	904 L (a high-alloy austenitic stainless steel with low carbon content) for parts that get wet
Inlet/Outlet	6 " Victaulic coupling connection

6-5) Energy recovery device

Application	Recover water pressure raised to penetrate RO membrane
Nos. of unit	2
Type	Positive displacement, ERI, USA or equivalent
Nominal Flow Rate for each Unit	31.8 m^3/hour/unit (= 763 m^3/day/unit)
Material	AL-6XN[11]、alloy, ceramic and GRP[12]

[11] AL-6XN: a superaustenitic stainless steel with extreme resistance to corrosion and stress cracking

[12] Glass-Fiber Reinforced Plastic

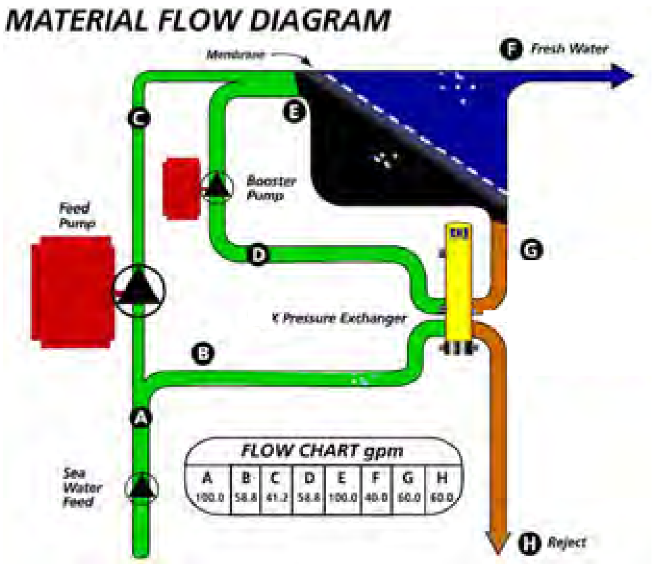


Figure 2.2.8 Conceptual figure of high pressure pump and energy recovery device

6-6) Variable Frequency Drives (VFD)

To control the RO pressure pump and booster pump speeds and balance the required flow and output pressure to ensure that the product water is produced from RO system

7) RO membrane Chemical Cleaning System （CIP = Clean in Place system）

7-1) Cleaning Chemical

Citric acid	20,000 mg/L, need to adjust pH up to 4 by NaOH
Phosphate compound	20,000 mg/L, need to adjust pH up to 10 by H_2SO_4

7-2) Chemical Tank

Nos. of unit	1 c/w dome top
Type	Cylindrical
Capacity	4 m^3
Material	Polyethylene

7-3) Pump

Nos. of unit	1	
Type	Centrifugal	
Specification	DNφ100 x 66-108 m^3/hr x 37 to 30 mH x 15 kW x 440 V x 3 phase x 60 Hz	
Material	Pump head	Stainless Steel 316
	Impeller	Stainless Steel 316
	Shaft	Stainless Steel 316

7-4) Bag Filter

Nos. of unit	1
Housing material	Stainless steel

Opening 5 µm

7-5) Conditions

Frequency of Chemical cleaning every three months

Discharging wastewater Dilution or after neutralization

Operation Semi-automatic

8) Post treatment facilities

To inject soda ash for pH adjustment and chlorine for disinfection to serve product water as drinking water.

Table 2.2.10 Outline of Post Treatment Facilities

Item		**Soda ash dosing for pH adjustment**	**NaOCl for disinfection**
Location		After RO skid	Before distribution
Flow (m^3/day)		1,000 m^3/day	
Dosing Rate (mg/L)		3	1.5
Tank	Unit	1	1
	Type	Cylindrical	Cylindrical
	Capacity (L)	300	300
	Material	Polyethylene	Polyethylene
Feeder	Unit	1	1
	Chemical (kg/day)	3	1.5

9) Control and Instrumentation Components

The control panels are made of metal or plastic conforming to IP55. The panel will be pre-wired with the necessary timers, relays, starters, contractors, etc. High performance PLC with a graphic touch screen shall be mounted on the control panel to control and monitor the RO system operation.

- Low Inlet Pressure Switch
- High Feed Pressure Switch
- Conductivity Meter for product water quality
- Permeate flow meter
- Feed or concentrate flow meter
- PX high pressure outlet flow meter
- Flow regulating valve to regulate the recovery ratio
- Module feed pressure gauge
- Concentrated pressure gauge
- Product pressure gauge
- Cartridge inlet pressure gauge
- Power on light
- Hour meter
- Main isolated switch

- Auto light
- Manual light
- Low inlet pressure light to shut down
- High feed pressure light to shutdown
- Trip light
- High TDS light for product

2-2-3-5 Desalinized Water Storage and Distribution Facilities

(1) Desalinized Water Storage Tank

Desalinized water is temporally stored in this tank. Main purpose of this tank is to equalize the operational load in the whole plant and to stabilize the water supply to the distribution pumps. A pump control sensor is installed to manage pump operation. Chlorine disinfection is also executed here.

1) Basic Design Policy

From the viewpoint of distribution facility operation, the capacity of the desalinized water storage tank should be preferably as large as land restriction permits. In the case of Japan, the capacity is such so that it will ensure 12 hours of daily consumption and fire extinction demand. However, according to the results of the local Mactan field survey on current water supply status, current average water supply only covers a period of 8 to 12 hours a day and this apparently shows up as serious water shortages in the study area. As the capacity of the proposed desalination plant will not satisfy the total water demand, distributed desalinized water might be consumed immediately and no water might be stored. Therefore, the need for storage tank capacity shall be carefully examined taking possible water consumption patterns into account.

Further, since distribution water pressure is also insufficient, the proposed distribution facilities shall be designed to facilitate stable distribution water pressure. As effluent from the plant has certain remaining water pressure say due to its 5 m height, it can be a valuable water pressure source.

Based on the abovementioned circumstances, the desalinated water storage tank shall be of a ground type and to be operated at the possible highest water level to utilize said remaining water pressure efficiently.

2) Storage Capacity and Structure of Tank

Although precise water demand, future demand projection and hourly demand fluctuation data in study area is needed for design storage capacity determinations, such data are not available at present. So, tank capacity shall be studied based on the design manual of MCWD as to relationship between retention time in storage tank (T) and served population (P) shown in following formula:

T［day］= 0.224－0.0416・log（P/1000）
Where, T : Storage Days
P : Service Population

Assuming that P is total population in whole Mactan Island, P is 54,000 persons. While dividing design plant capacity of 3,000m^3/day by per capita water consumption of 150 L/capita/day, possible service population is calculated as 20,000 persons. Applying these populations, tank retention time was calculated as follows:

T［day］＝0.224－0.0416・log（54,000／1000）＝0.152［day］＝3.65［hr］
T［day］＝0.224－0.0416・log（20,000／1000）＝0.170［day］＝4.08［hr］

Thus, design storage capacity shall cover 4 hours of daily water demand. 4 hours storage capacity corresponds to 4 to 5 hours demand fluctuation absorption capacity based on typical water demand pattern in Japan. Accordingly the design plant capacity of 3,000 m^3/day, tank capacity was calculated as follows:

V =（3,000/24×4）= 500［m^3］

For efficient utilization of remaining water pressure in plant effluent, HWL in storage tank shall be set high as possible but expected remaining water pressure is 5-15 m, which is not so high. Since reflux to the plant is unacceptable, insulation is needed. Accordingly, HWL in storage tank was set by 4 m above the plant including pipe loss. Considering locally available technical level, RC tank with dimension of 10.5 m Width×12 m Length×4 m Height was proposed. **Figure 2.2.9** shows structure of desalinized storage tank.

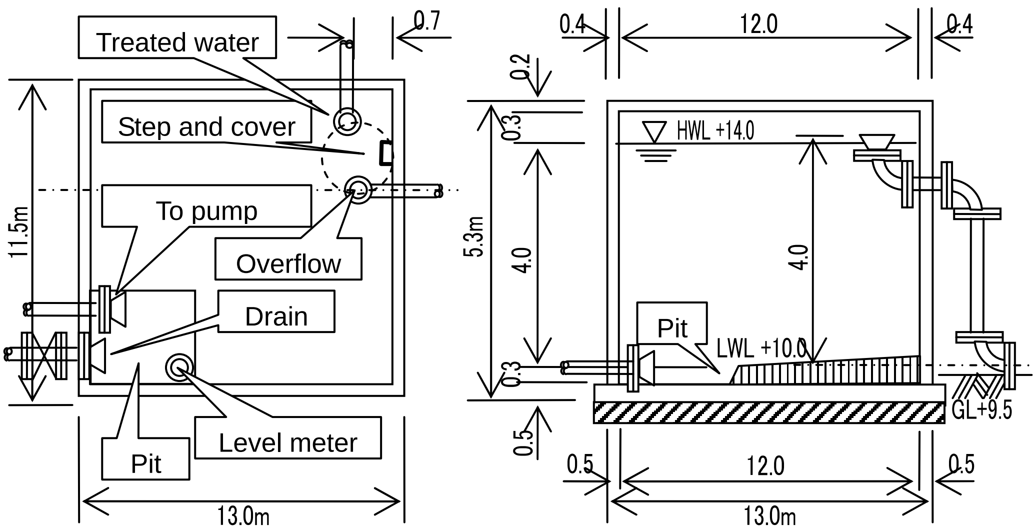


Figure 2.2.9 Structure of Desalinized Water Storage Tank

(2) Auxiliaries

200 mm PVC overflow pipe is to be connected to the seawater intake chamber. Using a water head of 5 m and pipe length of 100 m, pipe capacity is calculated as 7,500 m^3/day and it is sufficient. 200 mm PVC is also adopted to drain pipe from viewpoint of material communization utilization and to be drained directly to the Sea. Capacity of drain pipe shall be studied based on the needed performance:

1) No clogging will occur
2) Allowable drainage time to empty the tank

By water head of 1 m and pipe length of 100 m, pipe capacity is calculated as 3,200 m^3/day and it can empty the full tank with 667 m^3 of storage water within 5 hours.

2-2-3-6 Water Distribution Reservoir

(1) Basic Design Policy

Desalinized water will improve water supply conditions in the service area and will stabilize management of MCWD by increasing its water charge income through supplying water to profitable hotels. MCWD would like to utilize the sole existing reservoir located north of Mactan Island in future as additional water source providing water pressure stabilization and to supplement water shortages.

However, current water supply status in areas surrounding the proposed desalination plant is still unstable. Status was stabilized to some extent but a 24 hour supply is as yet uncertain and MCWD has not been accepting new house connections in an effort to stabilize water supply. As there are considerable differences between the future water supply structure prepared by MCWD and the current situation, the proposed water supply system shall be carefully designed giving due consideration to such circumstances.

Based on such a design background, the proposed water supply system shall be designed to simultaneously satisfy the following items :

- ➢ Water supply can cope with the peak demand generated during 6 to 8 AM
- ➢ Water supply to water distribution reservoir during nighttime during periods of less demand

Concrete provisions are as follows:

- ➢ Three water demand patterns are prepared:
    - 6 to 8 AM, 3 hours
    - 9 to 21, 13 hours
    - 22 to 5 AM, 8 hours

  Considering demand fluctuation and the existing water distribution reservoir capacity, the whole system shall be designed to minimize system load fluctuations. Assuming the total population in Mactan Island is 350,000, the peak factor C_{max} was calculated as 2.8, which is quite large.

- As to hotel demand, peak factor of 1.5 was adopted. Design remaining pressure at connection points was set by 7 m.
- Service area can be divided into two, namely:
  - Areas located along with water distribution trunk main (hereinafter referred to as "Trunk Area")
  - Areas mainly occupied by Hotels (hereinafter referred to as "Hotel Areas")

  Hydraulic analysis will be carried out based on Hourly Maximum Demand for both trunk area and hotel area.
- As to hydraulic analysis during nighttime, hourly factor will be applied to Daily Average Demand to calculate demand during nighttime. An hourly factor of 0.33 will be applied to trunk area and 0.81 will be applied to the hotel area respectively. Remaining water will be stored in the existing reservoir through existing trunk main with diameter of 350 mm.

To obtain a stable water supply to the existing reservoir, considerably high level system operation based on hydraulic analysis of the whole network system including the existing trunk main (Dia. 350 mm) and groundwater wells to be constructed, is needed. Such examination shall be carried out during the project implementation stage.

(2) Hydraulic Analysis based on 3 Patterns of Water Demand

Based on the aforementioned 3 patterns of water demand, necessary water supply amount was calculated as follows:

Table 2.2.11 Results of Trial Hydraulic Analysis on 3 Water Usage Patterns

[m3/day]

Type	O'clock	Planning usage			Now usage			Go to RT	**Total**
		Plan(av)	Rate	Plan(mx)	Now(av)	Rate	Now(mx)		
Maxtime	**6:00**	**1,973**	1.50	**2,960**	**826.8**	2.80	**2,315**	**0**	**5,275**
Maxtime	**7:00**	**1,973**	1.50	**2,960**	**826.8**	2.80	**2,315**	**0**	**5,275**
Maxtime	**8:00**	**1,973**	1.50	**2,960**	**826.8**	2.80	**2,315**	**0**	**5,275**
Daytime	**9:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**10:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**11:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**12:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**13:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**14:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**15:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**16:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**17:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**18:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**19:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**20:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Daytime	**21:00**	**1,973**	1.00	**1,973**	**826.8**	1.00	**827**	**0**	**2,800**
Night	**22:00**	**1,973**	0.81	**1,603**	**826.8**	0.33	**269**	**600**	**2,472**
Night	**23:00**	**1,973**	0.81	**1,603**	**826.8**	0.33	**269**	**600**	**2,472**
Night	**0:00**	**1,973**	0.81	**1,603**	**826.8**	0.33	**269**	**600**	**2,472**
Night	**1:00**	**1,973**	0.81	**1,603**	**826.8**	0.33	**269**	**600**	**2,472**
Night	**2:00**	**1,973**	0.81	**1,603**	**826.8**	0.33	**269**	**600**	**2,472**
Night	**3:00**	**1,973**	0.81	**1,603**	**826.8**	0.33	**269**	**600**	**2,472**
Night	**4:00**	**1,973**	0.81	**1,603**	**826.8**	0.33	**269**	**600**	**2,472**
Night	**5:00**	**1,973**	0.81	**1,603**	**826.8**	0.33	**269**	**600**	**2,472**
Average use		**1,973**		**1,973**	**827**		**827**	**200**	**3,000**
			↑			↑			

Maxtime	3hrs; 6:00-8:00	1.50	:max time rate	2.80	:max time rate
Daytime	13hrs; 9:00-21:00	1.00	:average	1.00	:average
Night	8hrs; 22:00-5:00	0.81	:minimum time ra	0.33	:minimum time rate

As shown in the **Table 2.2.11**, water distribution amount during peak hours was calculated as 5,275 m^3/day, while that during nighttime including the amount supplied to the existing reservoir was computed as 2,472 m^3/day, corresponding almost half of peak hours' demand. **Figure 2.2.10** to **Figure 2.2.12** show the results of pipe hydraulic analysis. During peak hours, since remaining water pressure at Node 51 was lowered to the minimum water supply pressure, water cannot be supplied to the existing reservoir through the existing trunk main (Dai. 350 mm). While during daytime and nighttime, as water demand decreases, remaining water pressure rises and thus water can be supplied to the existing reservoir. However, to realize the abovementioned water supply for users and reservoirs, a high level system operation according to the water demand patterns is indispensable.

Currently MCWD is planning to install additional water distribution mains with diameter of 200 mm along with the existing trunk main. As a result of the pipe hydraulic analysis, the pipe diameter shall be enlarged to 250 mm in the section of Node 11 to Node 31.

Pipeline load estimation (Maxtime)

[m3/day]

Nd	Place	Plan(av)	Plan(mx)	Now(av)	Now(mx)	Total
01	Desalination plant	-4,000				
11				16.7	47	**47**
21	AMISA	515	773	19.1	53	**826**
22				286.1	801	**801**
23	MICROTEL	150	225			**225**
31				110.2	309	**309**
41	HILTON TOWER	308	462			**462**
42	SHANGRILA	1,000	1,500			**1,500**
51	Junction point			394.8	1,105	**1,105**
52						**0**
53						**0**
61	Resovoir tank					**0**
	Total	**1,973**	**2,960**	**826.8**	**2,315**	**5,275**
	maximum time rate		1.50		2.80	

GL/WL	PWL
10.0	24.0
12.0	21.5
13.0	12.7
9.0	2.4
9.0	15.4
9.0	13.4
11.0	5.6
13.0	2.4
7.0	7.8
10.0	4.8
12.0	2.8
46.5	-31.7

C = 110

Element		φ	Length	Quantity	Gradient	H.Loss	Total
From	To	mm	m	m3/day	‰	m	m
01	11	250	10	5,275	8.65	0.09	0.46
11	21	254	1,002	5,228	7.87	7.89	8.35
21	22	100	620	801	22.94	14.22	22.57
21	23	258	350	3,601	3.66	1.28	9.63
23	31	258	600	3,376	3.25	1.95	11.58
31	41	232	1,280	3,067	4.56	5.84	17.42
41	42	232	350	2,605	3.37	1.18	18.60
42	51	232	800	1,105	0.69	0.55	19.15
51	52	350	4,940	0	0.00	0.00	19.15
52	53	350	720	0	0.00	0.00	19.15
53	61	400	240	0	0.00	0.00	19.15

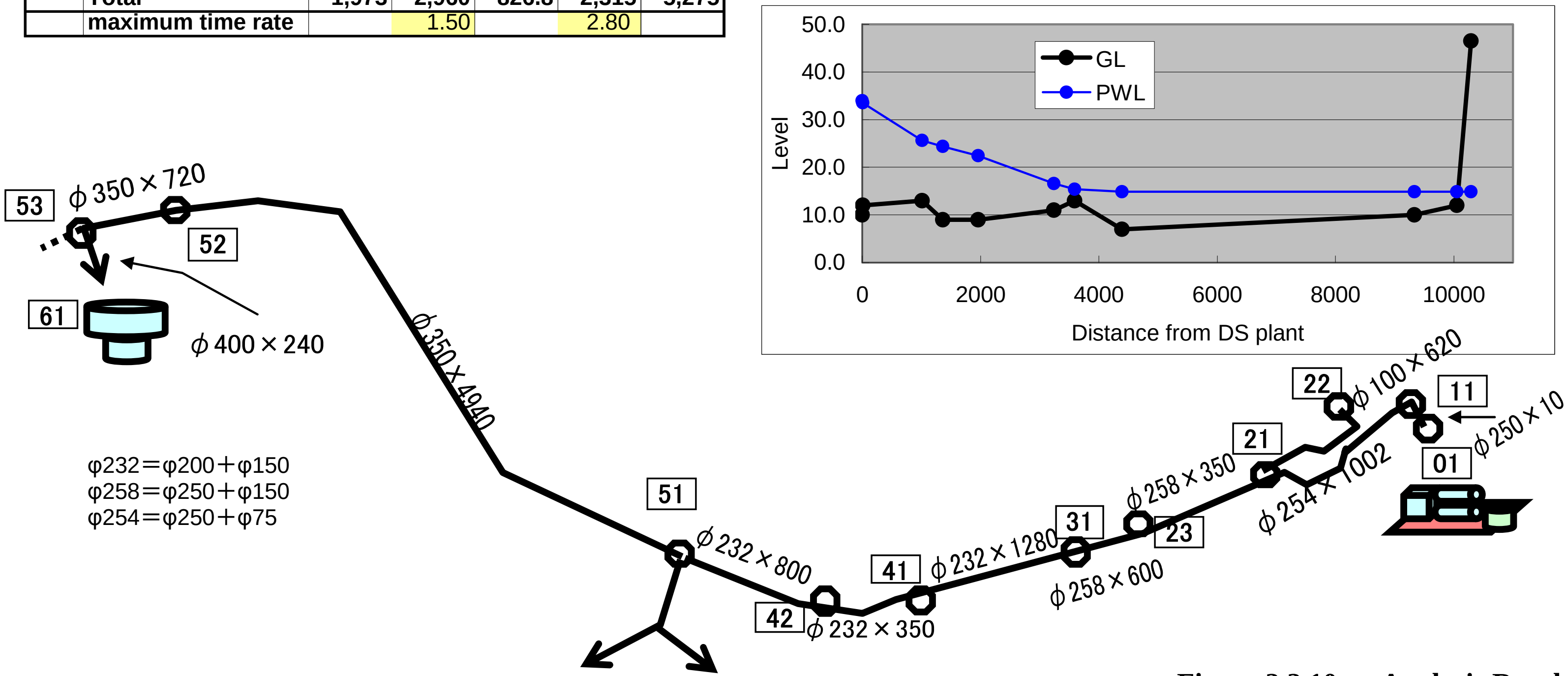


Figure 2.2.10 Analysis Results (Peak Hours)

Pipeline load estimation (Daytime)

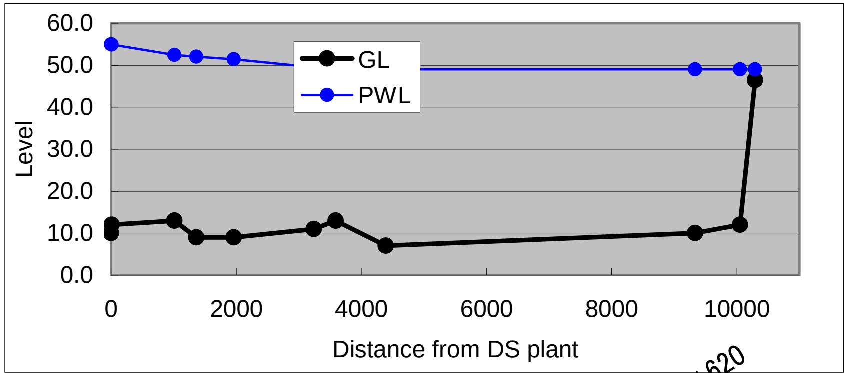
[m3/day]

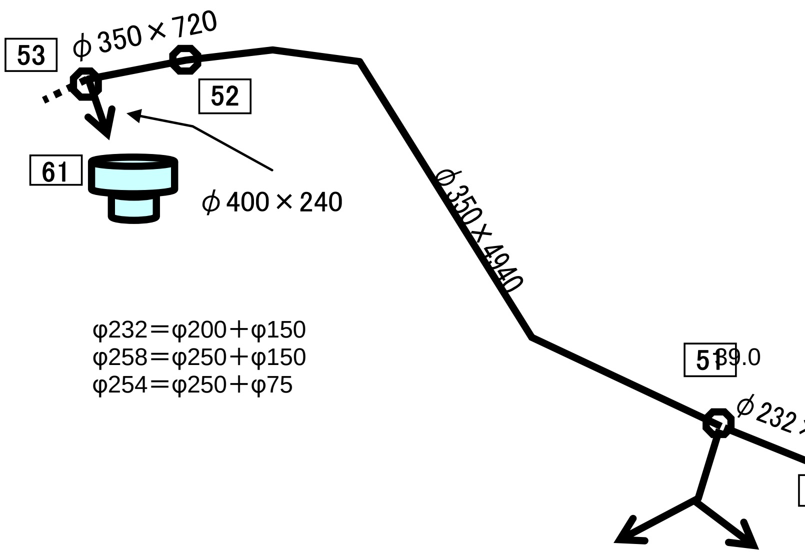
Nd	Place	Plan(av)	Plan(mx)	Now(av)	Now(mx)	Total
01	Desalination plant	-4,000				
11				16.7	17	**17**
21	AMISA	515	515	19.1	19	**534**
22				286.1	286	**286**
23	MICROTEL	150	150			**150**
31				110.2	110	**110**
41	HILTON TOWER	308	308			**308**
42	SHANGRILA	1,000	1,000			**1,000**
51	Junction point			394.8	395	**395**
52						**0**
53						**0**
61	Resovoir tank					**0**
	Total	**1,973**	**1,973**	**826.8**	**827.0**	**2,800**
	maximum time rate		1.00		1.00	

GL/WL	PWL
10.0	45.0
12.0	42.9
13.0	39.5
9.0	41.4
9.0	43.1
9.0	42.4
11.0	38.5
13.0	36.1
7.0	42.0
10.0	39.0
12.0	37.0
46.5	2.5

C = 110

Element		φ	Length	Quantity	Gradient	H.Loss	Total
From	To	mm	m	m3/day	‰	m	m
01	11	250	10	2,800	2.68	0.03	0.08
11	21	254	1,002	2,783	2.45	2.46	2.53
21	22	100	620	286	3.41	2.12	4.65
21	23	258	350	1,963	1.19	0.42	2.95
23	31	258	600	1,813	1.03	0.62	3.57
31	41	232	1,280	1,703	1.54	1.97	5.53
41	42	232	350	1,395	1.06	0.37	5.91
42	51	232	800	395	0.10	0.08	5.99
51	52	350	4,940	0	0.00	0.00	5.99
52	53	350	720	0	0.00	0.00	5.99
53	61	400	240	0	0.00	0.00	5.99





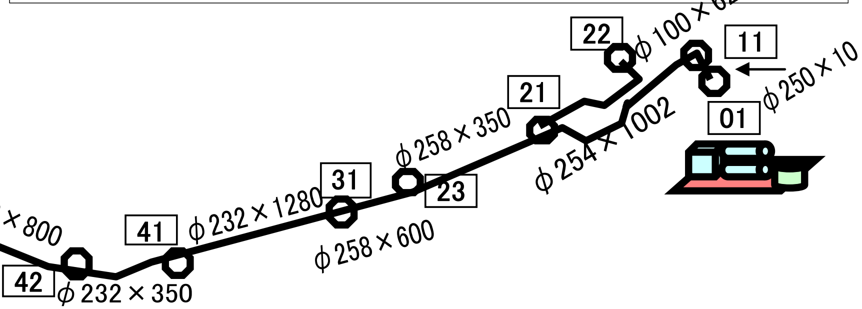


Figure 2.2.11 Analysis Results (Average Consumption during Daytime)

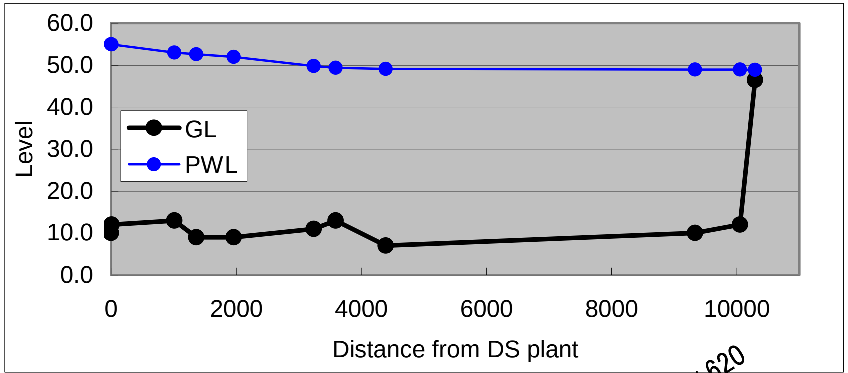
Pipeline load estimation (Night)

[m3/day]

Nd	Place	Plan(av)	Plan(mx)	Now(av)	Now(mx)	Total
01	Desalination plant	-4,000				
11				16.7	5	**5**
21	AMISA	515	418	19.1	6	**424**
22				286.1	93	**93**
23	MICROTEL	150	122			**122**
31				110.2	36	**36**
41	HILTON TOWER	308	250			**250**
42	SHANGRILA	1,000	813			**813**
51	Junction point			394.8	128	**128**
52						**0**
53						**0**
61	Resovoir tank					**600**
	Total	**1,973**	**1,603**	**826.8**	**268.0**	**2,471**
	maximum time rate		0.81		0.33	

C = 110

GL/WL	PWL	Element From	Element To	φ mm	Length m	Quantity m3/day	Gradient ‰	H.Loss m	Total m
10.0	45.0								
12.0	42.9	01	11	250	10	2,471	2.13	0.02	0.05
13.0	40.0	11	21	254	1,002	2,466	1.96	1.97	2.02
9.0	43.7	21	22	100	620	93	0.43	0.26	2.28
9.0	43.6	21	23	258	350	1,949	1.18	0.41	2.43
9.0	42.9	23	31	258	600	1,827	1.04	0.63	3.06
11.0	38.8	31	41	232	1,280	1,791	1.69	2.16	5.21
13.0	36.3	41	42	232	350	1,541	1.28	0.45	5.66
7.0	42.1	42	51	232	800	728	0.32	0.26	5.92
10.0	38.9	51	52	350	4,940	600	0.03	0.15	6.07
12.0	36.9	52	53	350	720	600	0.03	0.02	6.09
46.5	2.4	53	61	400	240	600	0.02	0.00	6.09



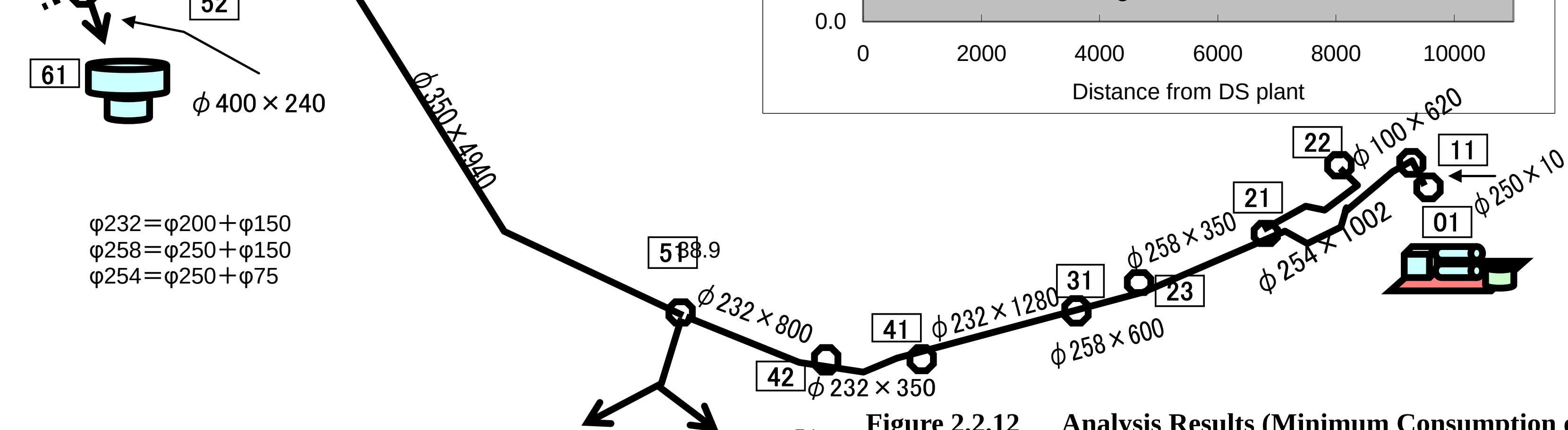


Figure 2.2.12 Analysis Results (Minimum Consumption during Nighttime)

(3) Distribution Pumps

Distribution pumps shall be operated efficiently through inverter control. Distribution flow shall be precisely controlled based on the demand patterns mentioned before. To attain necessary flow control, pumps with a wide performance range need to be selected. If hotels are accepted, a water supply plan shall be developed including supply time restrictions. Pump specification is as follows:

P＝ 1.83～0.85［m^3/min］×27～48［m］×15［KW］×3 units (1 unit stand-by)

【Peak Hours】

Q＝（5,275／2／24／60）＝ 1.83 ［m^3/min］

P＝ 0.163×1.83［m^3/min］×(24+3)［m］×（1＋0.15）／0.65＝14.2［kW］⇒15［kW］

【Daytime】

Q＝（2,800／2／24／60）＝ 0.97 ［m^3/min］

P＝ 0.163×0.97［m^3/min］×(45+3)［m］×（1＋0.15）／0.65＝13.4［kW］⇒15［kW］

【Nighttime】

Q＝（2,471／2／24／60）＝ 0.85 ［m^3/min］

P＝ 0.163×0.85［m^3/min］×(45+3)［m］×（1＋0.15）／0.65＝11.8［kW］⇒15［kW］

During peak hours, water stored in the existing reservoir will be supplied. As duration of peak hours was set as 3 hours, allowable adjustment of water amount was calculated as follows:

（5,275-3,000）×3/24＝284 m^3

As the study area has flat topographic feature and design water supply pressure is not so large, special water hammer counter-measures are unnecesswary. Generally applied flywheel will be installed to pumps.

(4) Allocation of Facilities

Considering hydraulic efficiency, desalinized water storage tank and pumps are allocated beside the road. Allocation of connection pipes and pumps are shown in **Figure 2.2.13.**

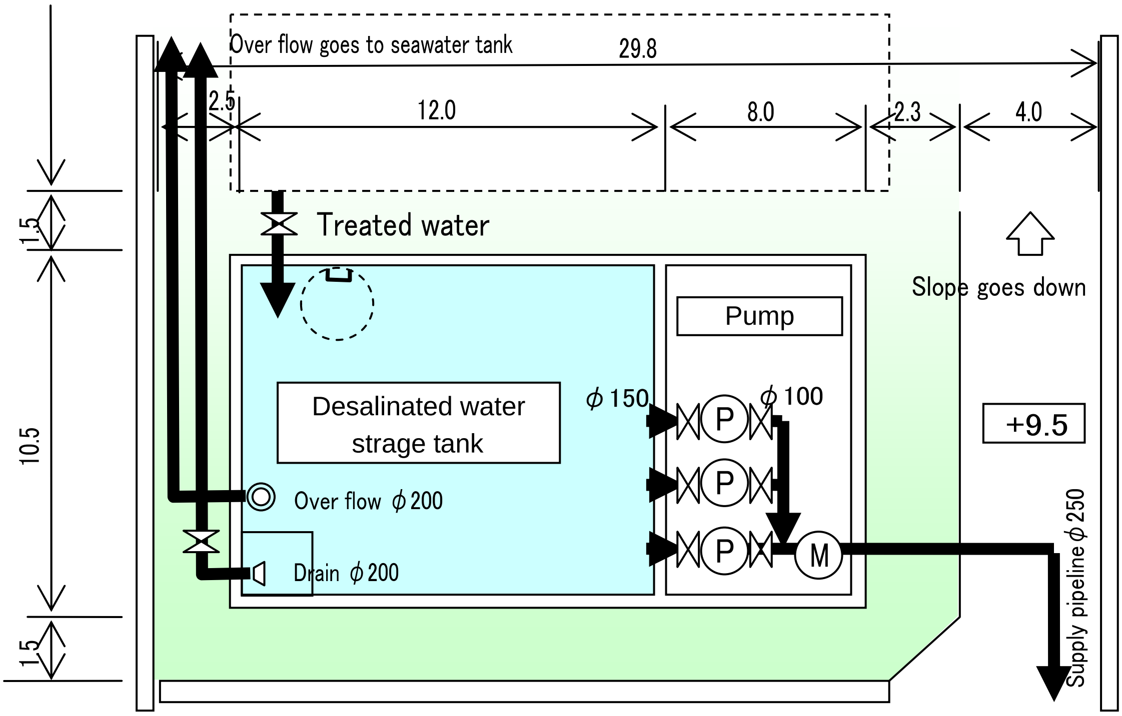


Figure 2.2.13 Layout of Distribution Pumps equipped in Distribution Reservoir

(5) Connection to additional Water Distribution Main

MCWD is planning to install an additional water distribution main along with the existing one. A main pipe with a diameter of 200 mm is to be installed up to the proposed construction site, generated desalinized water can easily be connected using conventional methods.

2-2-3-7 Wastewater Storage Facility

(1) Wastewater Storage Tank

Wastewater storage tank temporally stows concentrated seawater and chemicals discharged from RO facility before discharging to the sea. Inlet pipe shall be raised upward inside of the tank for hydraulic insulation. Backflow of wastewater to RO facility is unacceptable.

1) Capacity of Storage Tank

From viewpoint of stable plant operation, tank capacity shall correspond to 25 minutes' portion of total wastewater amount:

$$Q = 7{,}500 \times 60\,\%\ \text{(Wastewater Rate)} = 4{,}500\ m^3/day$$

$$V = (4{,}500/24/60 \times 25) = 78\ [m^3] \Rightarrow 80\ [m^3]$$

2) Structure of Wastewater Storage Tank

Considering locally available technical level, RC tank with dimension of 4 m Width×5 m Length×4 m Height was proposed. During tank cleaning, wastewater will be discharged through a by-pass route. **Figure 2.2.14** shows structure of storage tank.

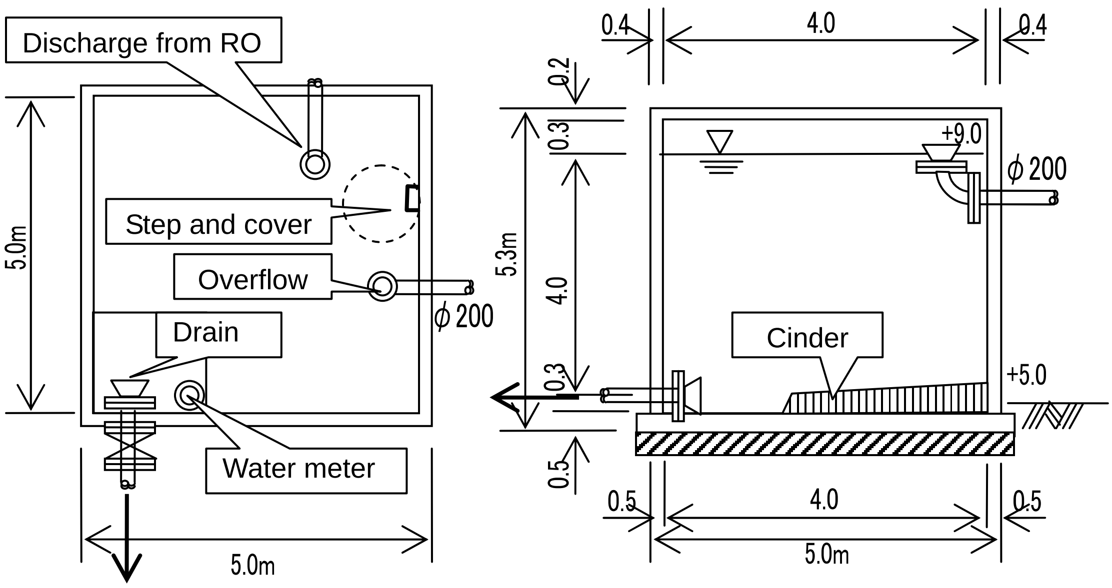


Figure 2.2.14 Structural Drawing of Wastewater Storage Tank

(2) Drain Pipe

Because of its chemical durability, PVC was adopted for the drain pipe. Considering smooth diffusion by marine currents and environmental impact to the discharge area, the pipe length was set by 700 m. According to the available marine charts, sea depth at 500 m distance from seashore is approximately 50 m. External pressure examination and selection of construction method for the proposed drain pipe shall be investigated during the project implementation stage.

(3) Wastewater Diffusion Unit

Wastewater diffusion unit type and its construction method shall be examined later in detail including marine current survey.

2-2-3-8 Electricity Facility Planning

(1) Design Concept

① Boundary point of electrical works with MECO

As a result of prior agreements with MECO, with regard to power receiving equipment up to 1,000 kVA, MECO will install the transformer and the boundary point is the secondary side of the transformer. Therefore, on this project, incoming line and power receiving equipment construction fee becomes an expenditure of MCWD. And, the burden of funds from MCWD towards the construction costs of MECO is as follows which is obtained from discussions.

② Diesel Engine Generator

It is decided with this project the suspension of water supply will occur at once due to blackouts because the water supply has adopted a pressure water supply by using a supply pump instead of gravity water supply from the high-level water reservoir. A diesel engine generator is required by MCWD in consideration of the present electric power circumstance. Therefore, the generator should be of suitable capacity so that all the equipment can be operated through its use. When the Desalination Plant of 3,000 m^3/ day is planned, a 750kVA generator becomes necessary including Intake Pump and Distribution Pump.

It also becomes necessary that a silencer is installed to satisfy the 45dB (A) noise regulation value is established by NPCC at night in the site boundary because a private house is in the neighborhood in the case as the candidate area 1. Noise standards are given in **Table 2.2.12**. On the plan, it is necessary to satisfy 65dB at the generator exhaust pipe because the distance decline of 10m can be taken into consideration when the generator is installed around the center part of the candidate area 1 with about the width of 30m.

Table 2.2.12 Standards of Noise (Unit: dB(A))

AREA CLASSIFICATION (based on dominant land-use)	Daytime (0901 to 1800H)	Morning(0501 to 0900H) and Evening (1801 to 2200H)	Nighttime (2201 to 0500H)
Class AA (Areas 100 m from schools, hospitals, playground etc.)	50	45	40
Class A (residential purposes)	55	50	45
Class B (commercial areas)	65	60	55
Class C (light industrial areas)	70	65	60
Class D (heavy industrial areas)	75	70	65

Source: 1978 NPCC Rules and Regulations Implementing PD 984

(2) Single Line Diagram

The planned desalination plant is composed of the unit of 1,000 m^3/ day, and electric equipment about the unit is decided to be contained in the unit unity, and a collective power supply feed is done in the unit.（Refer to **Figure 2.2.15**）

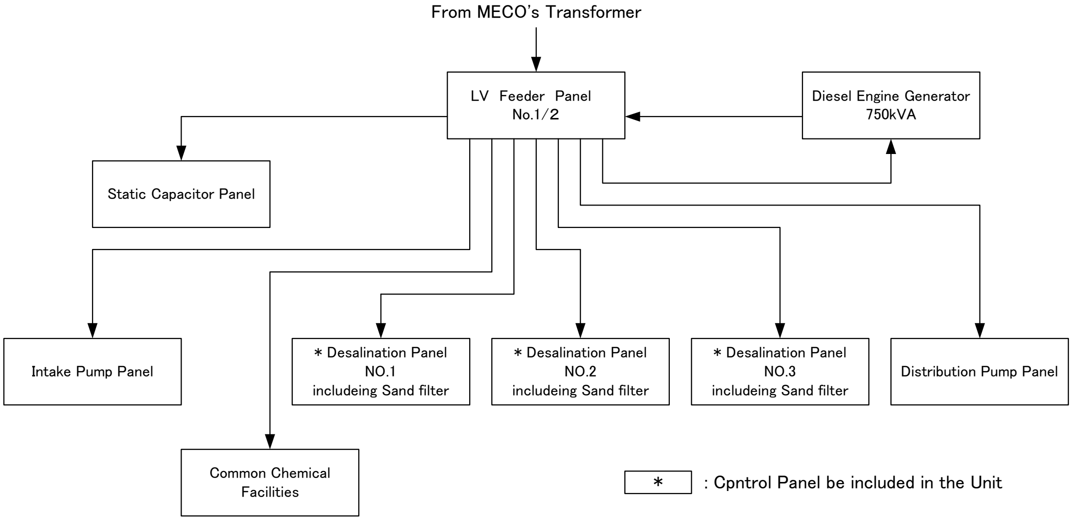


Figure 2.2.15 Power Line Connection in the Plant

According to the above result, the single line diagram of the desalination plant of 3,000m^3/day is shown in **Figure 2.2.16**.

(3) Operation Method

The system flow sheet of the desalination plant is shown in **Figure 2.2.17**. The operation of each load is done as the following.

- Intake Pump is ON-OFF operated by the level of Receiving Tank.
- Sand Filter Feed Pump is ON-OFF operated by the level of Filtered Water Tank control from the Unit Operating panel with the low level operation cut of the Receiving Tank.
- Back Wash Blower and/or Back Wash Blower is ON-OFF operated by timer and/or head loss of the Sand Filter control from the Unit Operating panel.
- Safety Filter Feed Pump、High-Pressure Pump、Booster Pump is automatically operated control from the Unit Control panel.
- Chemical Dosing Pump except the NaOCl and NaOH(Na2CO3) is operated automatically control from the Unit Control panel.
- NaOCl and NaOH (Na_2CO_3) dosing pump is ON-OFF operated with fixed dosing ratio.
- Distribution Pump is operated by the flow controller with the low level operation cut of the Treated Water Tank.

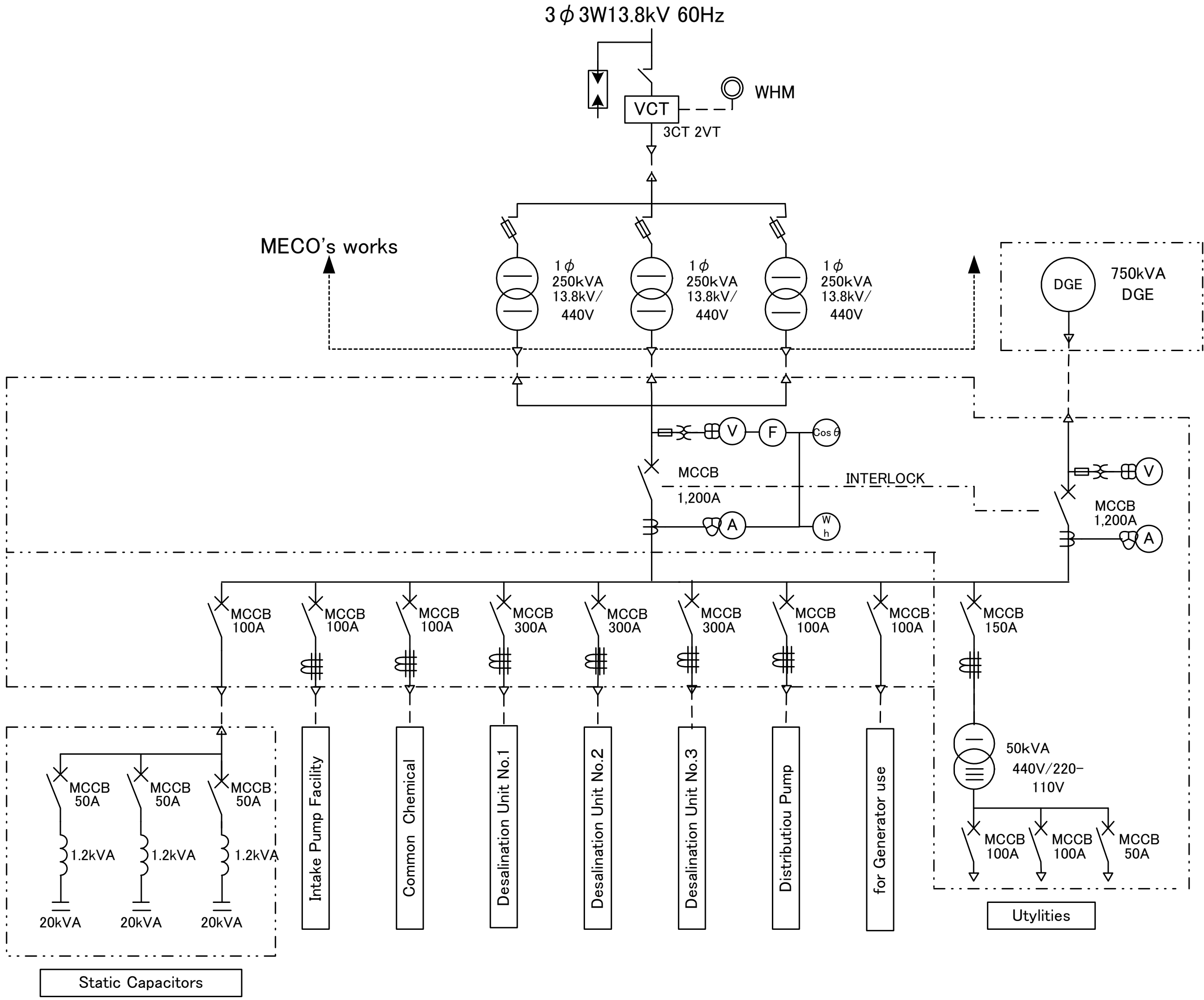


Figure 2.2.16 Single Line Diagram of Desalination Plant

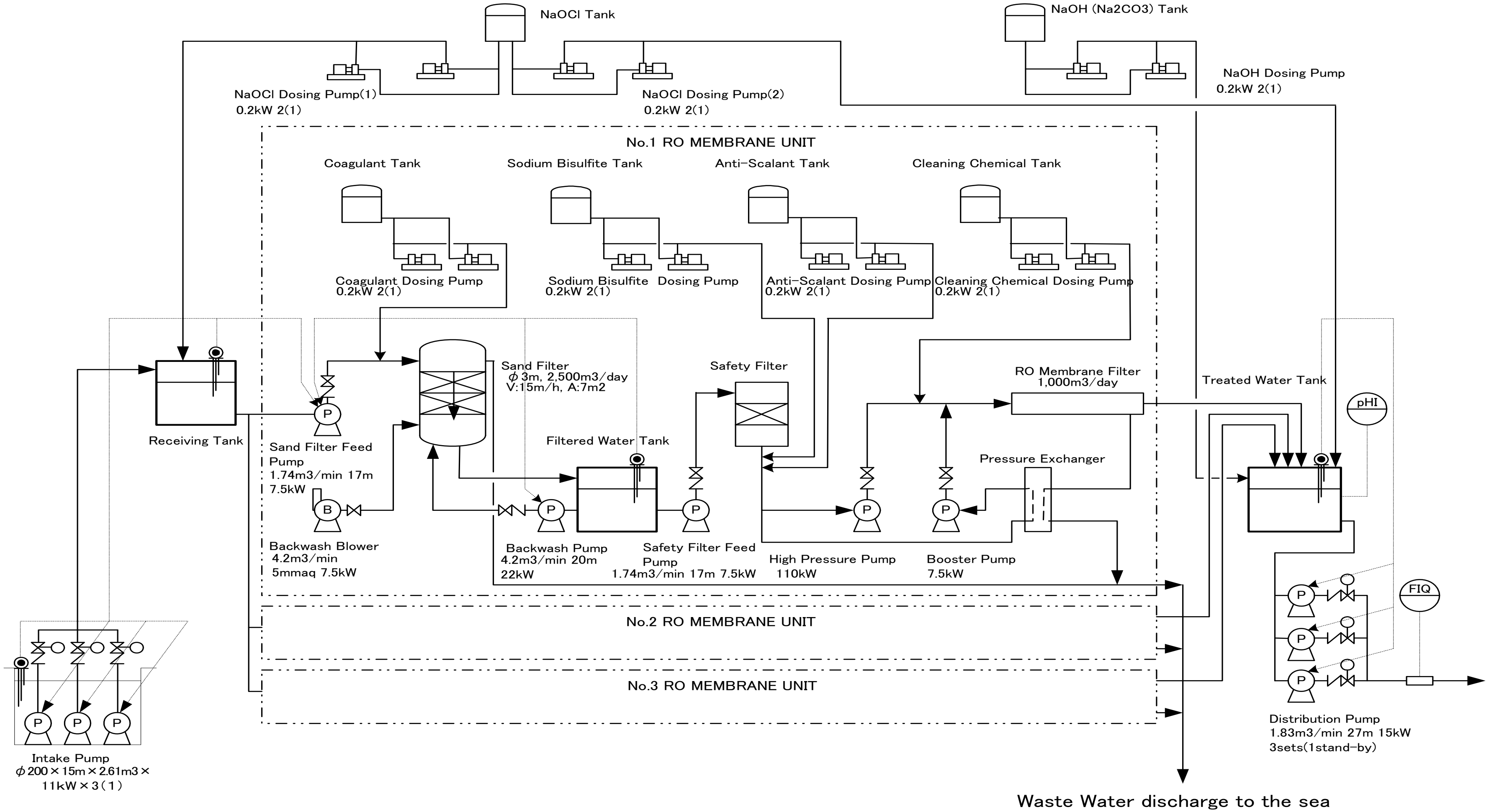


Figure 2.2.17 System Flow Diagram

2-2-3-9 Administration Space, Road and Fence Plan

(1) Administration Space

Administration space is located in the RO desalination facility. Guard house is arranged by the side of the main entrance gate.

(2) In- Plant Road and Drainage

In- plant road is planed for the availability of access to the intake well by truck crane. Drainage is installed along the In-plant road to the sea side by incline. Actual construction method and materials will be studied under detailed design phase.

(3) Gate and Fence

Gate and Fence will be the responsibility of MCWD. The candidate site for this project is partitioned on both side by concrete walls, therefore new fence and gates on the sides facing the access road and sea side will be required to be constructed. Actual specification will be decided during further negotiations with MCWD.

2-2-4 Project Implementation Plan/Equipment and Materials Procurement Plan

2-2-4-1 Project Implementation System

Figure 2.2.18 shows the implementation system for this project. Procurement agency, JICS will correspond to the necessary procedures in material/equipment procurement in this project.

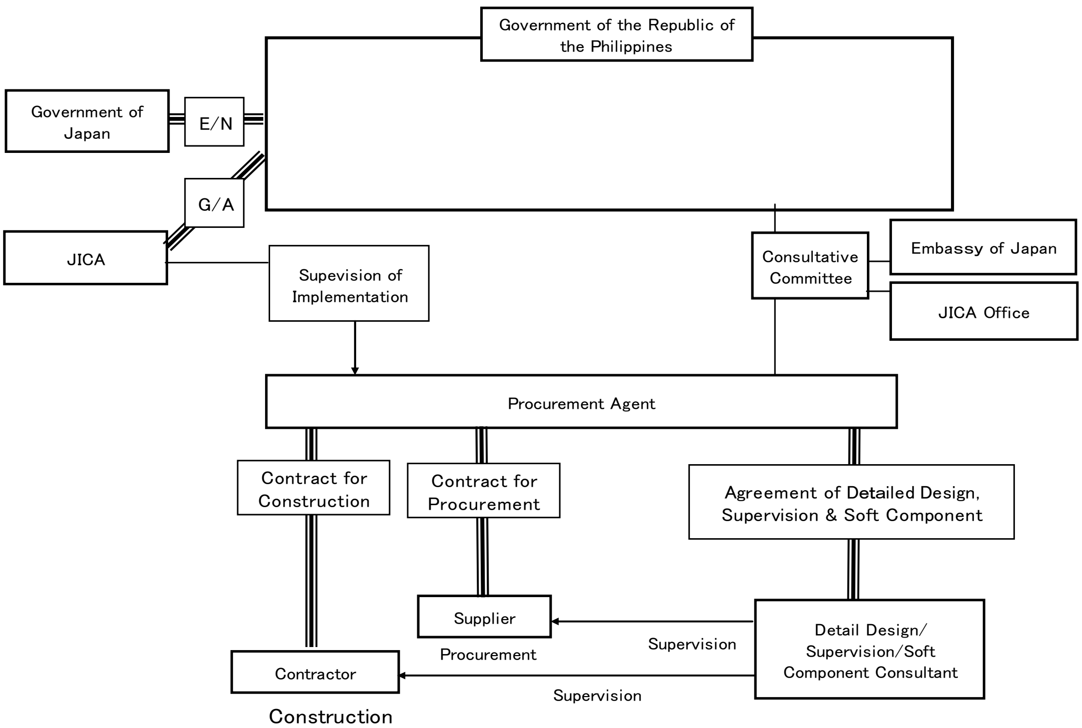


Figure 2.2.18 Project Implementation System

2-2-4-2 Remarks in Project Implementation/Procurement

(1) Tax Refund

- 12% of VAT will be imposed on commercial activities in the Philippines
- General grant aid projects are also subject to taxation, because construction contract has to be concluded between the Philippine Government and the contractor
- Based on the contents of E/N, no VAT will be imposed to Japanese Nationals
- In the Philippines, VAT will be refunded, but cannot be exempted
- Contracts to be concluded in the Philippines by Procurement Agent or Japanese contractor are subject to taxation
- Upon tax refund procedures, they must own branch office with corporate status in the Phillipines. To establish the branch office, the following registration/acquisition are needed:
  - SEC registration
  - BIR registration
  - TIN Code acquisition
- 2 months are needed to these registrations and at minimum 200 thousand US$ is needed as an initial remittance
- 2% of the initial remittance is necessary as SEC registration commission
- Branch office closure requires past 3 years' tax examination and it will take 2 years
- In case of domestic procurements in Japan, as no commercial activities will occur and therefore, they are not subject to taxation.
- Aside of VAT, imported tax is also refundable
- In case of Government Own Controlled Company, subsidy will be paid by Central Government upon tax payment
- Tax payment of 200 million yen is anticipated upon implementation of this grant aid project
- MCWD regarded the acquisition of said subsidy as almost impossible and now planning to pay the whole tax amount by themselves
- Until now, project implementation agencies can open their accounts in Japanese Banks but from now on, bank accounts shall be opened under the name of Philippine Central Bank instructed by the Ministry of Finance of the Philippines

(2) Remarks upon Construction Works

Alternative sites for site office and material storage yard shall be examined because currently available land area is insufficient. Width of the existing access road is also insufficient for hauling of huge construction materials or equipment. As local contractors have abundant experiences in road and hotel construction works, subletting of work items is deemed to be duly possible.

Though no soil investigations were conducted, as limestone is exposed on the ground, no earth retaining works are seemed to be necessary. Site ground is regarded as excellent with regard to foundations but upon land grading, excavations in some area might be troublesome. Rainy season is anticipated during June to November.

(3) Remarks upon Desalination Plant Operation

- As the proposed plant site is close to the sea and seawater/desalinated water has a corrosive nature, materials for piping, tanks, valves, meters and control/monitoring equipment shall be anti-corrosive
- In-house temperature shall be below 35℃
- Reliable and punctually supplied equipment shall be selected to prevent frequent malfunctioning and replacement
- Especially RO membranes and high pressure pumps, the heart of RO unit, shall be Japanese made as it has high reliability
- Pipe connection shall be flange-to-flange at maximum to ease assembling and dismantling.
- Equipment shall be properly allocated for easy maintenance works
- Chemicals shall be appropriately preserved, stored and handled to prevent accidents
- Hand wash stations, shower and eye-wash faucets shall be installed as provision against accidents
- Hoist rail shall be installed above manholes for replacement works
- Water analysis cocks shall be installed at necessary inspection points
- Neutralization facility shall be built in the concentrated seawater discharge facility if needed

2-2-4-3 Demarcation in Construction Works/Equipment Procurement and Installation

Table 2.2.13 shows the demarcation in work items during project implementation:

Table 2.2.13 Major undertakings to be taken by Each Government

Work Items	Japanese Government	Government of the Philippines
Construction cost of Desalination Plant including Intake Facility, RO Plant, Administration Building, Storage Tanks, Transmission and Distribution Pipelines	○	
Detailed Design, Construction Supervision and Soft Component	○	
Equipment and Materials Procurement	○	
Power Supply Work		○
Gates and Fences		○
Land Acquisition		○
VAT		○
Acquisition of necessary Official Licenses		○

2-2-4-4 Equipment and Materials Procurement Plan

(1) Eligible Countries for Procurement

Eligible countries for procurement in grant aid projects are basically Japan and the recipient country. The maximum amount of necessary construction materials and equipment shall be procured in the recipient country. However, materials and equipment with the following features shall be procured from Japan or a third country with due consideration to cost effectiveness and O&M efficiency:

- Not available in the Philippines
- Local specifications are not applicable
- Supply and procurement is not stable in terms of distribution amount and cost

Abovementioned "third countries" means nearby South East Asian Countries. Specifically RO membrane and high pressure pumps, the essential part of the RO unit, must be Japanese made with high reliability

2-2-4-5 Soft- Component Plan

Although daily operation of desalination system by RO membrane basically is not much different from the one of conventional water purification plant and water intake/supply system, however, the RO system is the first case for MCWD. Considering the current impending water sources in Cebu, seawater desalination will have a big potential. For these reasons, the Project proposes the construction supervision including installation of equipment and the operation guidance of the whole system from seawater intake, purification system by RO membrane to brine discharge.

In particular, the guidance of operation of the system is proposed as the followings;

(1) Contents of commissioning and operation guidance

- Process theory of seawater desalination system by RO membrane including seawater intake and pre-treatment and composition of equipment and facilities
- Operation and maintenance guidance of whole system
    1) Preparation and revision of operation manual
    2) Preparation of operation log-sheet
    3) Storage, preservation and handling of chemicals
    4) Tools
- Site practice of FI value and water quality analysis
- Site practice of replacement of RO elements
- Preventive maintenance

(2) Input

RO system manufacturer 2.0 months 2 persons

Consultant 2.5 months 2 persons
Including report preparation and submission

【Long-term Plant Management Instruction Plan】

RO Membrane Unit Supplier 19 Months 1 Person（Instruction and Trouble Shooting）

After the completion of initial plant operation instruction, some technical troubles that cannot be handled by MCWD might occur within several months or years. Therefore, a long-term plant management instruction plan as mentioned before shall be added upon contract conclusion as a suitable countermeasure. The complete contents of instructions and the personnel dispatching schedule shall be carefully examined in advance.

2-2-4-6 Project Implementation Schedule

14 months are needed for bidding and construction work. Adding Soft Component period, total project implementation period is 36 months. **Figure 2.2.19** shows the schedule:

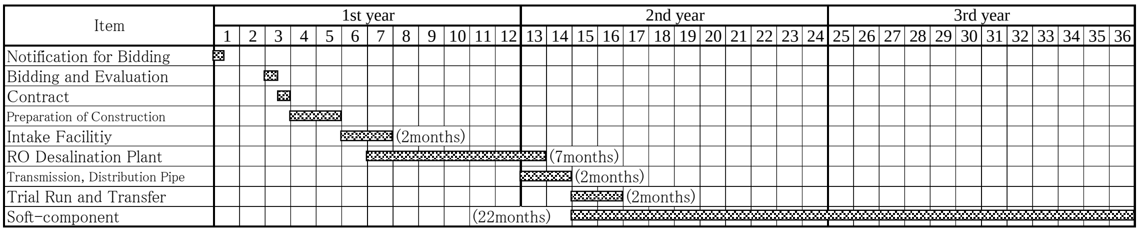


Figure 2.2.19 Project Implementation Schedule（Draft）

2-3 Major Undertakings to be taken by Each Government

The relative responsibilities are shown in **Table 2.2.13** and the detailed comments are as follows:

- Land Acquisition
  Intake Facility, New Desalination Plant, New Storage Tank：1 unit each
  Distribution Pipeline (From new desalination plant to connection with existing pipeline)
- Gates and Fences
  New Desalination Plant：2 sets（Road and Coastal sides）
- Power Supply
  New Desalination Plant：1 unit
- Exemption and refund transaction on import tax and VAT, etc
- Acquisition of Official Licenses
  EIA, etc
- Others
  Land acquisition for site office and materials storage yard

2-4 Operation and Maintenance Plan of the Project

2-4-1 Operation and Maintenance Plan

Actual O&M system and the responsible working group of the desalination plant will be discussed with MCWD in the next phase. Operator in charge for the desalination plant will be the person who has around 10 yeas experience of actual desalination plant operation. Permanent staff will be two (2) persons, guard will be one (1) person and MCWD staff for desalination plant patrol will be required two (2) to three (3) persons.
Considering the present condition of MCWD, O&M for desalination will not be outsourced.

As experiences in desalination experts and plant O&M activities, the existing desalination plant of Mactan Rock Company can be raised. Currently, MCWD is purchasing 5,000 m^3/day of desalinated water from Mactan Rock Company and supplement it to potable water supply.
During field survey on newly built luxury hotels located in the eastern coast of the island, it was revealed that large-scaled hotels such as Shangri-la, Hilton, Imperial Palace Resort, White Sands, Maribago, Bluewater Resort and Plantation Bay own private desalination system.
These hotels engaged contractor contract between Mactan Rock Company, including repair works and equipment procurement. Operation of desalination plant was simplified by computer control. In fact, the existing plant is operated by one operator trained by simple On the Job Training.
New Imperial Palace Resort Hotel engaged 2 years' O&M warranty contract between Mactan Rock Company before hand over of the plant. Though current plant O&M is managed by Mactan Rock Company, they allocated one permanent staff exclusive for plant O&M.
However, during field survey of Mactan Rock desalination plant located in Cordova, Mactan Island, it was observed that:

- Site seemed to be insanitary, and
- Considerable number of water leakage were observed in the existing plant

Owing to these, contracted out of O&M for the plant to Mactan Rock Company will not be proposed.
O&M training is absolutely needed for MCWD staff to enable them the proper O&M activities for the plants introduced this advanced technology. In reverse, during field survey of WTP under jurisdiction of MCWD, water treatment and distribution facilities were kept sanitary by the professional works rendered by MCWD staff. Studying the new water treatment technology and execution of plant operation at the new desalination plant to be implemented through this project will be valuable experiences to MCWD staff and will also be certain investment for stable plant operation through the future.

Employment of engineers experienced trainings in desalination plants in abroad is also effective. Employment of those trained in private plants constructed in hotels nearby is also applicable.

Most of them learned plant O&M in private plants by On the Job Training. Upon training on MCWD staff exclusive for desalination plant to be constructed by this project, Japanese training program shall be utilized. Not only European technology, desalination plant by Japanese technology is recommendable as well. As Japan is much nearer compared to European countries, procurement of spare parts and equipment is also much easier.

2-4-2 Number of Staff Required on an Annual Basis

For the trial run, two instructors of the constructor (desalination unit maker) for initial instructions and two consultants for operations instructions will stay for the initial stage. After that two (2) staff will stay longer. This facility has a limitation to expand the land area to accommodate additional desalination plants. Therefore there is no possibility of expansion to accommodate increases of water supply demand. This means that there will be no increase of the staff for this plant in the future.

2-4-3 Groundwater Monitoring Plan

When potable water supply amount is augmented by desalination plant operation through this project and by future surface water development or construction of additional desalination plant, mitigation in groundwater pumping amount and upgrading in potable water quality is expected. The following indices were proposed in order to measure the beneficial effect to be generated through project implementation in quantitative manner:

- Continuous measurement of groundwater table : Confirm groundwater rising caused by decrementation in groundwater pumping
- Sustainable analysis on salinity contained in groundwater : Verify mitigation in saline water intrusion generated by groundwater table rising
- Constant monitoring on water-borne disease morbidity : Affirm abatement in morbidity brought by safe and sanitary potable water supply

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

Total amount of this project cost implemented by Japanese Grant Aid is about 979 million yen and its breakdown is shown in the appendix and estimation conditions are shown in below under (3) below. However this price does not mean the limitation of Grant ceiling price for the exchange of note (E/N).

(1) Responsibility of Japanese Side

Total Project Cost Approx. 979 million yen

Table 2.5.1 Responsibility of Japanese Side

Item		Amount（mill. Yen）
Facility (Construction)	Intake Desalination Plant New Reservoir and Distribution Pump Distribution and Discharge Pipe	889
Detailed Design, Construction Management, Soft-component (O&M Training etc.)		51
Procurement		9
Fee for Procurement Agency		30
Total		979

(2) Responsibility of Philippines Side

Total Project Cost Approx. 205 million yen

Table 2.5.2 Responsibility of Philippines side

1)Fence and Gate of Desalination Plant （2 places）	318 Thou. Php (0.63 mill. yen)
2)Electricity Wiring（1 Place）	4,007 Thou. Php (7.99 mill. yen)
3)Land Acquisition	40,500 Thou. Php (80.80 mill. yen) According to negothiation
4)VAT（12%）	57,930 Thou. Php (115.57 mill. yen) Posibility of reduction
5)Import Duty	Exemption or return
Total	102,755 Thou. Php (204.99 mill. yen)

(3) Cost Estimation Conditions

Date October 2009

Exchange Rate Average Exchange rate of April 2009 to Sept 2009 (for 6 months)

Yen／Peso 1.0 Php ＝ 1.995 Yen

Price Escalation No price escalation (the construction can be finished by next year)

Unit Cost From local construction company and assessments by MCWD and local consultant.

2-5-2 Operation and Maintenance Cost Estimation

(1) Operation and Maintenance Cost

Operation and maintenance (O&M) cost (except the depreciation costs) in this project have to be considered significant: increasing electricity costs, chemicals costs, consumables and exchange of Membrane. Compared with the existing system, additional costs will be sustained. Estimation condition of the O&M cost are as follows;

- Labor cost : Unit labor cost of 2009. Reference : Minimum Labor Rates for Central Visayas plus Leaves, Bonus, SSS, Philhealth, etc. (Source: National Wages and

Productivity Commision, DOLE as of 2009)

- Electricity cost：Oct. 2009 unit cost
- Others： as shown below
- Repair costs and Engineering support：5%/year of Mechanical construction cost

Table 2.5.3 O&M Cost for this Project

Item	Calculations	O&M Cost	
		Yen/m^3	（Yen/year）
Labor	・Total 2 staff 80,000 Yen/man×month×2men÷3,000m^3/day×30day＝1.78 Yen/m^3	1.78	1,920,000
Chemicals	・SBS（35% Liquid, Dose 200ppm） 342Yen/kg×63kg/day÷3,000m^3/day＝7.18 Yen/ m^3 ・Anti-scalant（Dose 3ppm） 1,170Yen/kg×22.5kg/day÷3,000m^3/day＝8.78Yen/ m^3 ・NaClO（12%Liquid, Dose 5ppm） 117Yen/kg×15kg/day÷3,000m^3/day＝0.59Yen/ m^3 ・Na_2CO_3（20%Liquid, Dose5ppm） 173Yen/kg×9kg/day÷3,000m^3/day＝0.52Yen/ m^3	17.07	17,923,500
Electricity	・Intake, Desalination Plant, Distribution facilities 3.5kW/m^3×14Yen/kWh＝49 Yen/m^3 Basic tariff：14Yen/kWh Electricity：49Yen/m^3×3,000m^3/day×350＝51,450,000Yen/year	49.00	51,450,000
Exchange	・RO unit（Life cycle 5 years＝yearly 20％ exchange） 6,000,000Yen/year÷(3,000m^3/day×350day/year)＝5.71Yen/m^3 ・Filter media Anthracite: 0.45Yen/m^3 Sand: 0.37Yen/m^3	6.53	6,861,000
Repair and Consumables	・5% of Mechanical and electrical construction and procurement cost (517,380,000+8,850,000)×0.05= 26,311,500 Yen/year 26,311,500Yen/year÷(3,000m^3/day×350day/year)＝25.1Yen/m^3	25.06	26,311,500
Total		**99.44**	**104,466,000**
Total in Pesos		**49.84**	**52,364,000**

(2) Water Tariff setting

The current tariff levels at MCWD already reflect increased tariff costs that nearly equate to the anticipated costs of the new desalinated water that would be introduced into the system. Only minor adjustments should be necessary to introduce the new cost levels of desalinated water into the Mactan Island Water Supply System.

The largest users that will be requiring the water from the new seawater desalination plant proposed are the luxury hotels along the eastern shores of Mactan Island. These hotels would fall mainly into the upper consumption bracket of over 30 cu. M. per month which is currently at a level of 48.40 pesos. If desalination plant is to be constructed through Grant Aid from Japan, much of the capital outlay will not have to be depreciated and should then place the overall water costs within close range of the current tariff.

(3) Life Cycle of the Facilities

Life cycles of the facilities are set as follows;

- Buildings : 50 years
- Pipeline : 30 years
- Mechanical and Electrical Facilities : 15 years
- RO unit : 5 years

2-6 Remarks on Project Implementation

2-6-1 Diameter of additional distribution pipeline to be installed by MCWD

Currently, MCWD has just concluded the tender for construction work of additional distribution pipe located near to the proposed desalination plant site. Pipe diameter is 200 mm and pipe material is PVC. Actual construction work is scheduled to commence at the beginning of 2010. According to the results of discussions with MCWD, as water demand in corresponding areas is anticipated to increase because of the proposed desalination plant, pipe diameter shall be enlarged to cope with this. Therefore, pipe diameter enlargement shall be immediately recommended to MCWD at early stage of project implementation.

2-6-2 Concentrated Seawater Discharge Pipe

Desalination plant generates concentrated seawater as waste fluid. Since this waste amount is not so huge and proposed construction site is facing to the sea, direct discharge is supposed. However, as surveys on ocean current and potential impact to marine life were not conducted in this project, discussion with relevant agencies and detailed investigations on this matter is needed upon launching the project. Further, since discharge pipe shall be submerged into sea bottom, detailed examination on pipe installation method must be conducted with local contractor.

2-6-3 Land Acquisition

At present, the proposed construction site of desalination plant is private land. As it located near to ac resort area, land price is expected to be expensive. If land acquisition is to be undertaken by MCWD, its cost will be apparently be huge burden in its budgetary arrangement. Feasibility of this project is dependent on smooth land acquisition at suitable cost.

2-6-4 Design Capacity of the Plant

Based on the expected budget scale, design plant capacity was set by 3,000 m^3/day. This corresponds to only one-third of 10,000 m^3/day, original requested by MCWD. This discrepancy in design plant capacity might be serious issue in project implementation.

2-6-5 Budgetary Arrangement on VAT and Others

The total cost, especially for land acquisition and VAT to be borne by MCWD is estimated as 200 million yen. Feasibility of this project is also reliant on whether a budgetary arrangement of such a huge amount is possible for MCWD.

Chapter 3 Verification of Project Adequacy

3-1 Benefits to be Generated by Project Implementation

Several benefits for the water supply business conducted by MCWD and for users are expected through the implementation of this project. They are tabulated in **Table 3.1.1**.

Table 3.1.1 Benefits to be generated by Project Implementation

Current Status and Issues	Countermeasures taken by this Project	Benefits to be generated
A: Direct Benefits		
・Major water source has been groundwater but lowering of groundwater table and water quality deterioration due to saline water intrusion has occurred ・Current water supply capacity is insufficient to meet water demand ・Only 60% of the total population has access to safe water	・Desalination plant with capacity of 3,000m^3/day will be constructed	・As 3,000m^3/day of potable water will be generated by the plant, corresponding amount of groundwater will not need to be pumped out. This will mitigate the following issues: ➢ Lowering of groundwater table ➢ Water quality deterioration due to saline water intrusion ・Total water supply capacity will be increased by 3,000m^3/day ・Safe water can be served to users utilizing insanitary private wells; 【Number of additional service population is anticipated as 20,000 persons (= 3,000/0.15)】
B: Indirect Benefits		
・Water fetching from communal taps has been heavy burden to residents	―	・As water will be supplied to private taps, such a burden can be mitigated
・ Due to shortage of safe and sanitary water supply, insanitary water has been the main cause of water-borne diseases	―	・Additional safe potable water supply will decrease the morbidity rate of water-borne diseases

3-2 Tasks and Recommendations

3-2-1 Tasks to be tackled by MCWD and Recommendations

For the appropriate management of the desalination project in future, MCWD will need to carry out the following tasks:

- ➢ Land for the proposed desalination plant shall be acquired in advance
- ➢ Environmental Impact Assessment (EIA) shall be conducted to get approval from the Central Government
- ➢ Securing the budget for works to be undertaken by MCWD such as Land Acquisition, Power Supply, Fence and Gate

- Ensure that staff needed for project implementation and O&M of the completed system are available and facilitate their skill level development
- Necessary licensing procedures shall be acquired on a timely basis. Anticipated procedures are as follows:
  - Drilling of sea water intake well at sea shore
  - Traffic scheduling for construction machinery
  - Excavation in paved roads
  - Other relevant matters

3-2-2 Alignment with Technical Support Program and Relevant Projects

Since MCWD has no experience in O&M of desalination plants, the technical support from experienced countries, for instance Japan is indispensable. Fortunately, Mactan Island has existing desalination plants operated by Mactan Rock Organization and resort hotels, human resource development of designated O&M staff by On-the-Job Training at these plants will be an effective measure.

Alignment with relevant projects is also essential. As “The Study for Improvement of Water Supply and Sanitation in Metro Cebu” is now on-going through finance provided by JICA, project implementation of the proposed plans especially on the hardware and software sides will be effective in improving the existing insufficient water supply capacity.

3-3 Verification of Project Adequacy

This project is determined to be adequate as the Japanese Grand Aid project because of the followings:

- The beneficiaries of this project are the citizen of Lapu-lapu City in Mactan Island, about 20,000 people. Desalinated water will supplement the gap between water demand and available water amount and the completed system will realize the safe and stable water supply.
- Implementation of desalination plant instead of groundwater development will prevent the lowering of groundwater level and the groundwater aggravation due to saline water intrusion.
- Though rise in ocean level is anticipated by global warming, as further groundwater pumping will be ceased by introduction of desalinated water, further groundwater contamination by saline water intrusion will be avoided as well.
- Since desalination plant to be constructed under Japanese tied grant, sustainable O&M can be expected owing to its high quality and technology.
- The sole negative environmental impact anticipated through the project implementation is discharge of concentrated seawater.
- This project will effectively solve the problems that MCWD has been suffering from chronic water resource shortage.

3-4 Conclusion

Since ocean surface water levels are expected to rise as a result of global warming, the saline content in groundwater is also anticipated to increase. The desalination project therefore will ultimately be an effective countermeasure against this trend. As the study area is an island with flat topographic features, sufficient surface water is not available and groundwater pumping has already reached a critical limit. Thus the desalination project is deemed as beneficial in mitigating extensive groundwater pumping.

However, aside from these aforementioned tasks that need to be tackled by MCWD, both organizational strengthening and appropriate water tariff setting will also be important towards attaining sustainable and financially sound project management in the future.