Republic of the Union of Myanmar
Myanma Port Authority

THE PREPARATORY SURVEY FOR THE PROJECT FOR EXPANSION OF YANGON PORT IN THILAWA AREA

SUMMARY

June 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

The Overseas Coastal Area Development Institute of Japan
NIPPON KOEI CO., LTD

Summary

1. Outline of the Study

1.1. Objectives of the Study

The objective of the original study is to formulate;

① '**Yangon Port Basic Development Policy**' which will clarify and define the role of Yangon Main Port and Thilawa Area Port,

② '**Thilawa Area Port Urgent Development Plan**', which includes the urgent works as the first phase implementation package and based on this Basic Development Policy,

③ '**Thilawa Area Port Development Plan**' covering all the projects targeting year 2025, and,

④ '**Yangon Port Master Plan**' which will also include the future plans of Yangon Main Port and Thilawa Area Port.

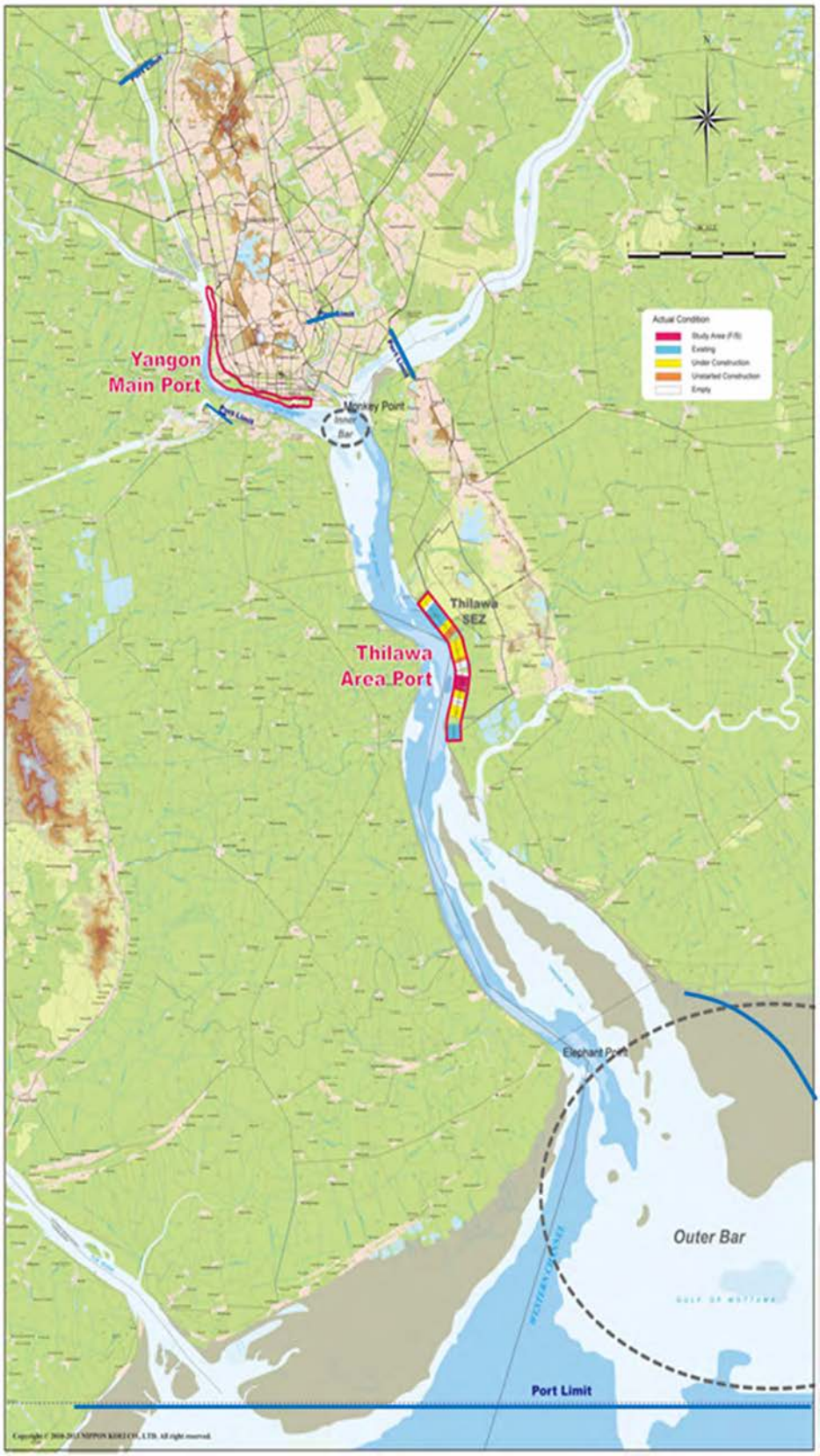
1.2. Location of the Study Area and Study Subject

The major port facilities of Yangon Port are separately located in Yangon Main Port and Thilawa Area Port. Yangon Main Port is located about 32 km from the mouth of the Yangon River and extends about 9 km on the left bank of the river. Thilawa Area Port is located about 16 km downstream and extends on the left bank of The Yangon River. The port limit of Yangon Port which is depicted in blue line covers from the river mouth to about 40 km up-stream of The Yangon River (Figure 1-1).

Major cargo of Yangon Port is handled at container terminals, the general cargo terminal and coastal/inland waterway transport jetties (Figure 1-2). Myanmar International Terminal Thilawa (MITT) which handles containers, timber and used cars etc. and some other port facilities are currently operating at Thilawa Area Port (Figure 1-2, Figure 1-4).

There are jetties and pontoons used for domestic/inland waterway transport and wharves owned by MPA and private companies for handling general cargoes and containers in Yangon Main Port.

Taking into account of the importance of facilities in Yangon Port, the study objective covers mainly major facilities of Yangon Main Port and Thilawa Area Port.

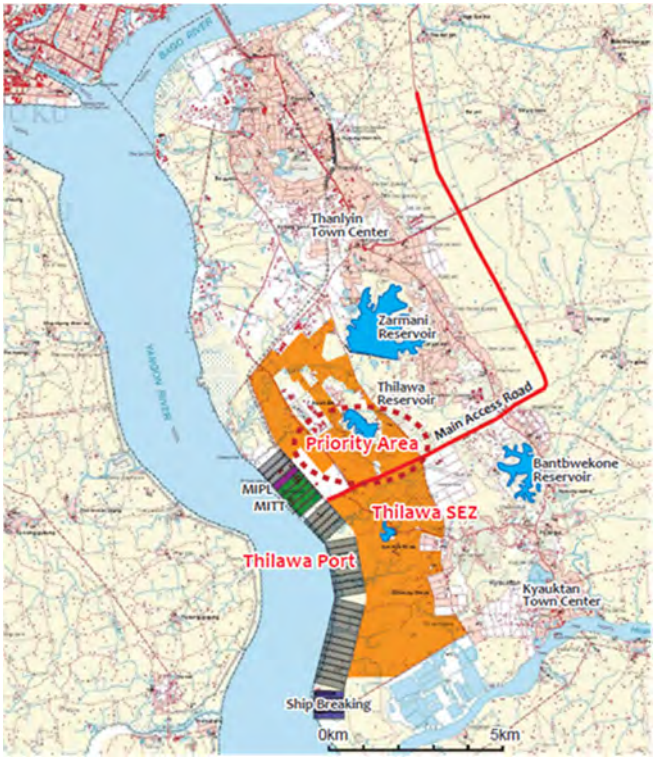


Prepared by the Study Team

Figure 1-1 Location of Yangon Main Port and Thilwa Area Port and Port Limit

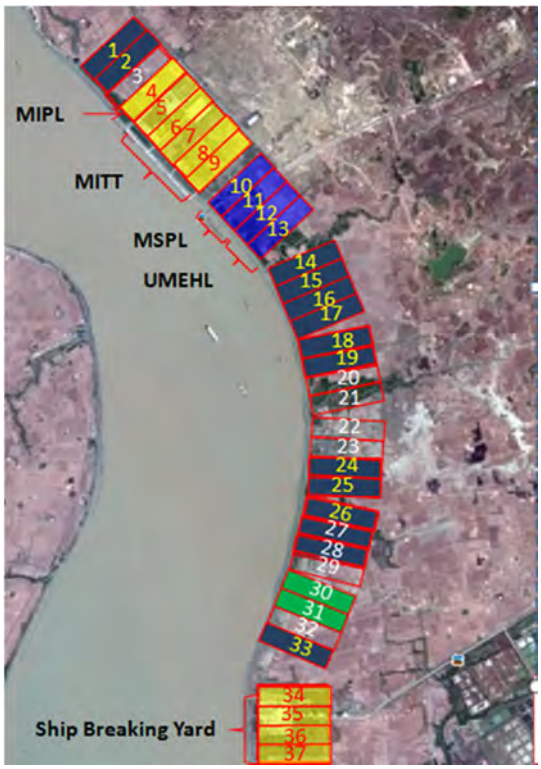
Prepared by the Study Team (Google Earth)

Figure 1-2 Major Port Facilities of Yangon Main Port



Source：MPA

Figure 1-3 Location of Thilawa Area Port



Source：MPA

Figure1-4 Plots of Thilawa Area Port

2. Present Situation Relevant to Ports in Myanmar

2.1. Socio-economic Trends

2.1.1. GDP

IMF's GDP per capita forecast for the year 2010 is US$ 702. As long-standing economic sanctions by US and EU countries are removed, foreign investment is expected to increase. President U Thein Sein has targeted economic growth of 7.7 % until the year 2015. Table 2.1-1 shows the GDP growth rate from 2007 to 2010 and projection by ADB from 2001 and 2013.

Table 2-1 GDP Growth Rate of Past Record and Projection in Myanmar

	2007	2008	2009	2010	2011	2012	2013
GDP Growth Rate (%)	5.5	3.6	5.1	5.3	5.5	6.0	6.3

Source：ADB

2.1.2. Population

Last population census was conducted in 1983 and next census is planning for 2014. Therefore, estimated population data has been used. Estimated population published by Central Statistics Organization in 2009 is 50,931,000. Central Statistics Organization estimates annual population growth rate has been 1.29%.

2.2. Port and Relevant Transport Sectors

2.2.1. Ports

Myanmar Port Authority (MPA) manages ports in Myanmar as a public corporation reorganized in 1989 under the jurisdiction of the Ministry of Transport. The capital investment plan of MPA must be authorized by the government. On the other hand, the use of private capital such as B.O.T (Build-Operate-Transfer) is becoming more common.

There are nine main ports in Myanmar. Yangon port is a river port, located upstream about 32km from the mouth of the Yangon-river. The maximum ship sized which can currently call the port has a draft of 9m and a length of 167m.

2.2.2. Inland Waterway Transport

Inland Water Transportation (IWT) was established to bear the inland water transportation of Myanmar. IWT was nationalized in 1948. Ayeyarwaddy and Chindwin are the main rivers that can be

used in all seasons; they cater to both national and regional transport. There are 218 inland waterways ports. Maximum drafts are about 4.5ft to 5.5ft. There are some 400 river stations in addition to 16 important general cargo ports.

2.3. Flow of Port Related Cargo

2.3.1. External Trade Trend of Myanmar

Trade value of export and import in Myanmar has increased.

Among export commodities, natural gas ranks first with 30% of total export value followed by beans, garments and teak.

Among import commodities, refined mineral oil ranks first followed by non-electric machinery and transport equipment and base metal and manufactures.

Among main export partner countries, Thailand ranks first followed by Hong Kong, China, India and Singapore. Main export commodity from Myanmar to Thailand is natural gas while precious stones is the main commodity exported to Hong Kong; precious stones, rubber products, fishery products and agricultural products are the main products for China and pulse, teak and hardwood are the main commodities bound for India.

Among main import partner countries, China ranks first followed by Singapore, Thailand, Korea and Indonesia. Main import commodities to Myanmar from China are non-electric machinery and transport equipment, electrical machinery and apparatus, spare parts and garment material. From Singapore main import commodities are refined mineral oil and machinery. From Thailand are gas oil drilling machine and construction materials.

Japan is the main market for the garment industry of Myanmar. In 2009 and 2010, almost 40% of garment products were exported to Japan.

2.3.2. Cargo Handling Volume in Myanmar Ports

Record of cargo handling volume throughput at ports in Myanmar is given in Table 2-2.

Table 2-2 Cargo Handling Volume throughput in Myanmar Ports

unit:ton

		2006	2007	2008	2009	2010	2011
International	Import	5,168,750	5,812,793	5,735,245	9,172,538	11,908,660	14,225,240
	Export	5,146,594	5,541,104	8,122,714	11,146,486	7,146,366	9,059,520
	total	10,315,344	11,353,897	13,857,959	20,319,024	19,055,026	23,284,760
Coastal	Unload	937,622	929,259	814,511	760,640	1,027,881	1,101,651
	Load	1,115,308	1,134,394	1,114,189	1,140,100	1,372,667	1,309,746
	Total	2,052,930	2,063,653	1,928,700	1,900,740	2,400,548	2,411,397
Total		12,368,274	13,417,550	15,786,659	22,219,764	21,455,574	25,696,157

Source：MPA

2.4. Port Hinterland Development

2.4.1. A Geographical Location of the Port

Thilawa Area Port is located at the place which is the focal node of the Greater Mekong Subregion (GMS) economic corridors, namely East-West Economic Corridor, Western Economic Corridor, and Southern Economic Corridor, and Asian Highway (see Figure 2-1). Thilawa Area Port is belong to Yangon Region which is consisted of totally 46 townships as shown in Figure 2-2. Although 33 townships are under YCDC (Yangon City Development Committee)'s jurisdiction, Thanlyin Township and Kyauktan Township, in which Thilawa Area Port is located, are outside of YCDC's jurisdiction.

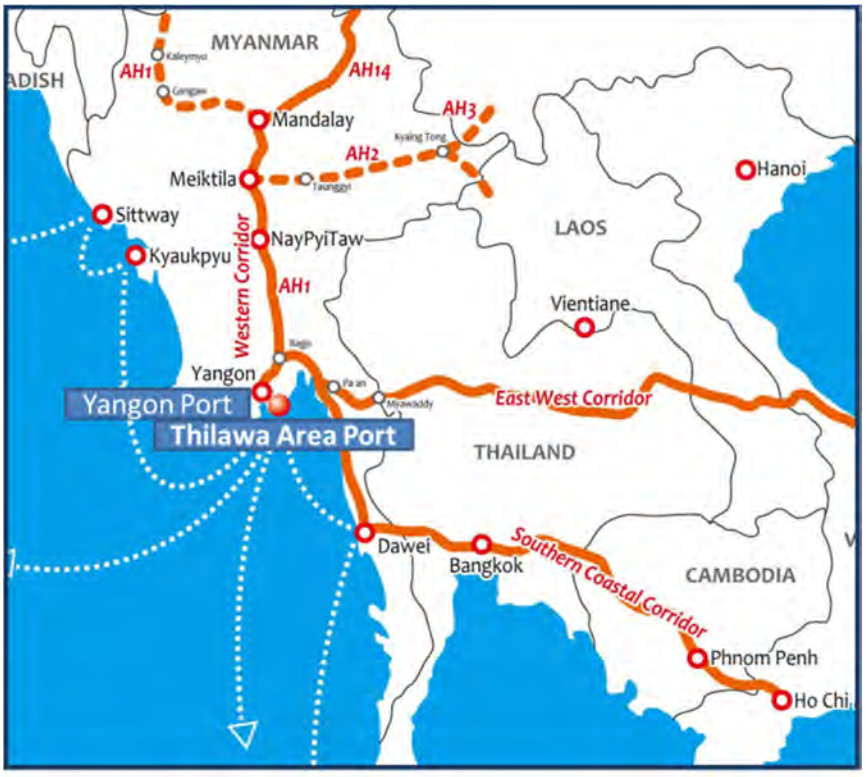


Figure 2-1 Economic Corridor and Myanmar

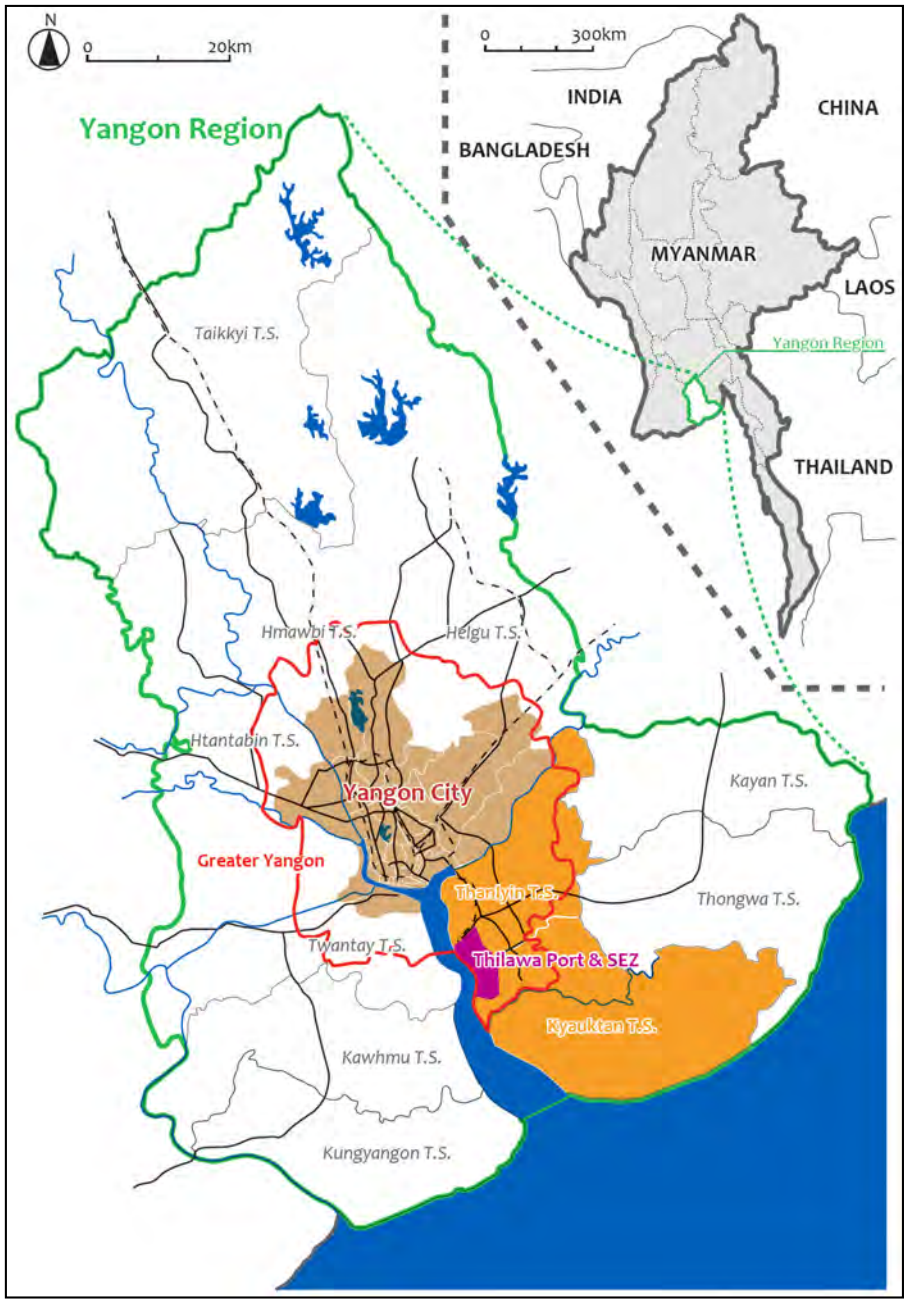


Figure 2-2 Location of Thilawa Area Port in Yangon Region

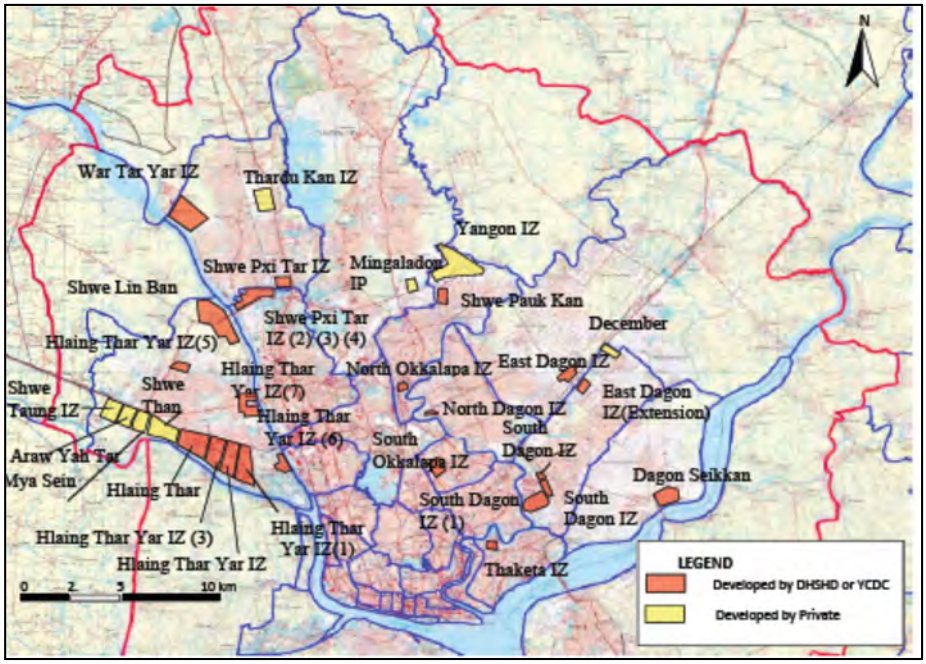
Table 2-3 Basic Information of Thanlyin and Kyawktan Townships

	Thanlyin Township	Kyauktan Township
Population	204,486	123,565
Area (ha)	36,859	58,608
Population Density (persons/ha)	5.5	2.1
Household No.	44,119	29,676

Source: JICA Study Team based on YCDC and Division statistical data in 2011

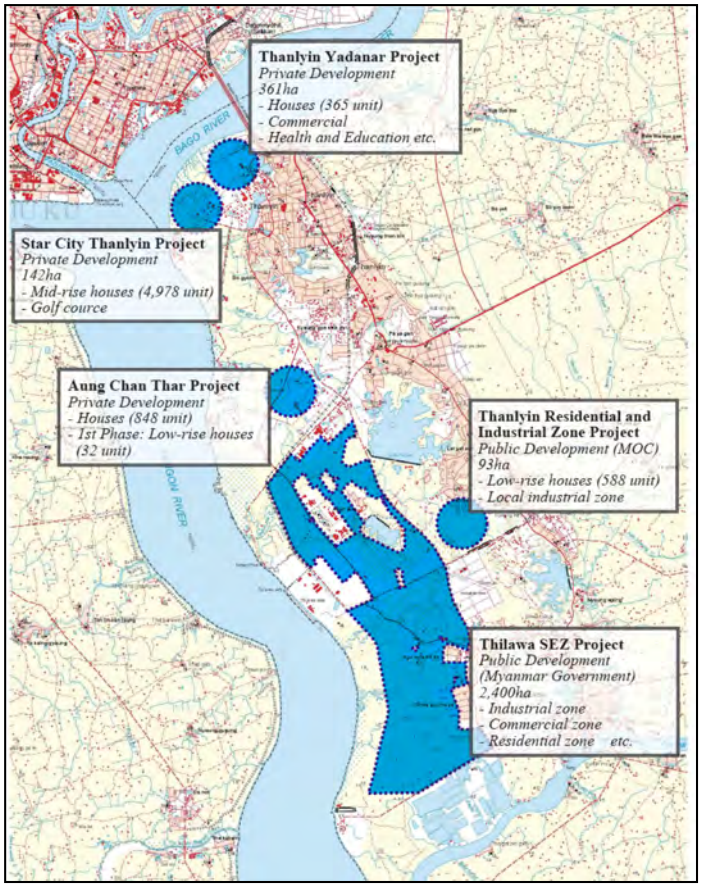
2.4.2. Relevant Development Projects

Thanlyin Township and Kyauktan Township accept a lot of urban development projects, especially housing projects, other than Thilawa SEZ project recently.(see Figure 2-3 and Figure 2-4)



Source: JICA Study, ITR2 of "The Project for the Strategic Urban Development Plan of the Greater Yangon"

Figure 2-3
Location of Industrial Zones



Source: METI Study, DFR of "The Basic Master Plan for the Thilawa"

Figure 2-4
Relevant Development Projects in Local Level

Population forecast and demand forecast for industrial land use are shown in Table 2-4 and Table 2-5.

Table 2-4 Population Forecast

Target Area	Target Year		Current	2015	2020	2025	2030
Local Level	Thilawa SEZ		0	(6,000)	(19,000)	(78,000)	156,000
Region Level	Located Townships	Thanlyin	181,959	285,850	431,650	597,416	785,881
		Kyauktan	48,473	58,745	73,160	89,549	108,183
	The Greater Yangon		5,572,242	6,174,750	7,020,309	7,981,656	9,074,649

Source: METI Study, DFR of "The Basic Master Plan for the Thilawa", and JICA Study, ITR2 of "The Project for the Strategic Urban Development Plan of the Greater Yangon"

Table 2-5 Development Forecast for Industrial Land Use

Target Area	Target Year		Current	2015	2020	2025	2030
Local Level	Thilawa SEZ		0ha	(150ha)	(450ha)	(717ha)	1,434ha
Region Level	Located Townships	Thanlyin	306ha	(no change)	(no change)	(no change)	(no change)
		Kyauktan	179ha	(no change)	(no change)	(no change)	(no change)
	The Greater Yangon		1,872ha	2,788ha	3,704ha	4,620ha	5,536ha

Source: METI Study, DFR of "The Basic Master Plan for the Thilawa", and JICA Study, ITR2 of "The Project for the Strategic Urban Development Plan of the Greater Yangon"

2.5. Port Management System

2.5.1. Organization of Myanma Port Authority

Myanma Port Authority (MPA) is a public entity under the Ministry of Transport (MOT) and responsible for the administration of all coastal ports in Myanmar. Its mission is to provide wide-range port-related services including stevedoring services (loading, discharging, and storage of cargoes) and marine services (pilotage, navigation lights and light houses, communications, mooring for vessels, tug service, water supply, fuel bunkering). MPA is also responsible for civil engineering works (planning, construction, maintenance and repair of port infrastructure, dredging and survey works in channels and basins) and mechanical and electrical engineering works, (building, maintenance and repair of service vessels and other floating crafts, buoys and electrical installations). MPA establishes a tariff table which is applied in both public and private terminals.

MPA is composed of eight departments, four divisions and four out-port offices. The total number of employees is 3,392, approximately 30 % of the authorized strength (11,557). The number of employees decreased roughly 1,000, or 24 %, from February, 2009.

2.5.2. Financial Conditions of MPA

State Economic Enterprises are required to deposit their receipts to the State Fund Account (SFA) and their expenditures are borne by the SFA. MPA has been in the red since 2006-2007(see Table 2-6).

Table 2-6 Current Cash Budget of MPA

(Million kyats)

Year	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
Receipts	1,761.0	2,074.0	2,595.2	2,958.3	3,516.1
Expenditure	1,715.0	3,911.8	4,329.5	5,369.4	5,396.8
Surplus+/Deficit-	＋46.0	-1,837.8	-1,734.3	-2,411.1	-1,880.7

Source: Statistical Yearbook 2010, Ministry of National Planning and Economic Development

2.5.3. Privatization of the Port Sector

MPA started to transfer the construction and operation of terminals to the private sector in late ‘90s in line with the government policy aimed to promote privatization of state enterprises. In Myanmar, privatization of public services is approved by the Privatization Commission established in 1995 on a project basis. Privatization effort has been targeted to the enterprises suffering from underutilization, lack of technological modernization, uneconomical use of inputs, or small size.[1] In Myanmar, there is no law specifically established to regulate PPP.

Several companies are currently developing and operating port terminals along the Yangon River. Port privatization scheme differs depending on the terminal as described below. MPA intends to continue the development of the port area through BOT. In August 2012, MPA had a tender briefing meeting for several projects including urban development of Botahtaung Jetty and upgrading of Sule Pagoda Terminal No. 1, 2, 3, 4. For the latter project, MPA envisages JV composed of MPA and private companies.

2.5.4. Tariff and Dues

MPA established the standardized tariff and dues, applicable for all ports of Myanmar, on March 1, 1998. Charges are classified into four categories: charges on vessels, charges on cargoes, miscellaneous charges, and container charges. Major charges applicable in ordinary conditions are summarized below. Charges in specific conditions need to be referred to the tariff table. US$ based tariff and Kyat based tariff are respectively applicable for foreign shipping line vessels and Myanmar shipping line vessels (Five Star Lines). MPA plans to revise the currency conversion rate in this table because this rate is based on the former official rate which had been valid until April 2012.

3. Present Situation of Yangon Port

3.1. Overall Port Layout

Yangon Port is located about 32 km from the mouth of The Yangon River and extends about 9 km on the left bank of the river (Figure 1-1). There are jetties and pontoons used for inland waterway transport and wharves owned by MPA and private companies for handling general cargoes and containers. Locations of the facilities and dimensions of the facilities of Yangon Main Port are shown in Figure 1-2 and Table 3-1 and Thilwa Area Port in Figure 1-3, Figure 1-4 and Table 3-2. The length of container terminals and draft and size of berthing ships are shown in Table 3-1.

Table 3-1 Dimension and Ship SIZE of International Cargo Terminals in Yangon Port

No.	Yangon Inner Harbor	Cargo Type	Length(m)	Draft(m)	DWT
1	Hteedan Port TML No.2	GC & CTNR	366	9.0	15,000
	Hteedan Port TML No.3	GC & CTNR	274	9.0	15,000
2	Asia World Port TML No,.1	GC & CTNR	198	9.0	15,000
	Asia World Port TML No,.2	GC & CTNR	150	9.0	15,000
	Asia World Port TML No,.3	GC & CTNR	260	9.0	15,000
3	Myanma Industrial Port No.1(MIP)	GC & CTNR	155	9.0	15,000
	Myanma Industrial Port No.2(MIP)	GC & CTNR	155	9.0	15,000
4	Sule No.1	GC	137	9.0	15,000
	Sule No.2	GC	137	9.0	15,000
	Sule No.3	GC	137	9.0	15,000
	Sule No.4	GC	137	9.0	15,000
	Sule No.5	GC	168	9.0	15,000
	Sule No.6	GC	162	9.0	15,000
	Sule No.7	GC	148	9.0	15,000
5	Bo Aung kyaw No.1	GC & CTNR	137	9.0	15,000
	Bo Aung kyaw No.2	GC & CTNR	137	9.0	15,000
	Bo Aung kyaw No.3	CTNR	183	9.0	15,000
	Sub Total 17 Berth				
	Thilawa				
6	Myanmar Integrated Port Ltd(MIPL)	GC & CTNR	200	9.0	20,000
7	MITT	GC & CTNR	200	9.0	20,000
	MITT	GC & CTNR	200	9.0	20,000
	MITT	GC & CTNR	200	9.0	20,000
	MITT	GC & CTNR	200	9.0	20,000
	MITT	GC & CTNR	200	9.0	20,000
	Sub Total 6 Berth				
	Total 23 Berth				

Source:MPA

Table 3-2 Present Situation of Thilawa Area Port Terminals

Current Situation of Thilawa Area Port

2013.8

Plot No.	Owner's Name	Situation	Main Cargo
1	Myat Myatta Mon Company Limited { PLOT 1, 2 (A) }	Under Construction	Fuel
2	Apex Gas & Oil Public Co., Ltd. { PLOT 1,2 (B) } Shwe Taung Company Ltd. { PLOT 1,2 (C) }		
3	PUMA Energy Group Pte., Ltd	Document Processing	Bitumen and Petrolem Product
4	MYANMAR INTEGERATED PORT LIMITED (MIPL)	Operation	General Cargo
5	MYANMAR INTERNATIONAL TERMINALS THILAWA LIMITED (MITT)	Operation	Container/General Cargo
6			
7			
8			
9			
10	MPA-SMD PORT LIMITED (MSPL)	Pending of Construction	General Cargo
11			
12	Union of Myanmar Economic Holding Limited (UMEHL){PLOT 14}	Construction hasn't started	General Cargo
13			
14		Under Construction	Fuel
15	Elite Petrochemical Co., { PLOT 15,16 (A/B) } Max Myanmar Co., Ltd { PLOT 15,16 C }	Under Construction	Fuel
16			
17	Green Asia Co., Ltd { PLOT 17,18 (A) } Denko Petrochemical Co., Ltd { PLOT 17,18 (B) } Thuriya Energy Depot Management Co., Ltd { PLOT 17,18 (C) }	Under Construction	Fuel
18			
19	Union Solidarity and Development Association (USDA)	Construction hasn't started	Fuel
20	Wilmar International Ltd. {PLOT 20/21}	Feasibility Study	Agricultural Products
21			
22	MPA (ODA Loan) (5 PLOT) {PLOT 22/23/24/25/26}	Under Preparation	Container/General Cargo
23			
24			
25			
26			
27	MPA (PLOT 27)	Remaining	
28	Myanmar Agribusiness Public Corporation Ltd.	Document Processing	Grain Terminal
29	Myanma Agricultural & General Development Public Co., Ltd. {PLOT29}	Document Processing	Grain Terminal
30	Diamond Star Co., Ltd. {PLOT 30}	Document Processing	Grain Terminal
31	MPA Plot ⅜ { PLOT 31 }	Remaining	
31	IGE Service Co., Ltd. { PLOT 31/32 (B)} Kaung Myanmar Aung Shipping Co., Ltd.{Plot 31/32 (C)}	Under Construction	Fuel
32			
33	Padauk Shwe Wah Petrochemical Co., Ltd. {PLOT 33}	Under Construction	Fuel
34	Myanma Economic Coporation (MEC)	Operation	Ship Breaking Yard
35			
36			
37			

Source:MPA

3.2. Cargo Handling Volume

Cargo handling volume records by regions and transport measns re shown in Table 3-3, Table 3-4 and Table 3-5.

Table 3-3 Cargo Handling Volume in Yangon Main Port and Thilawa Area Port

unit: ton

			2006	2007	2008	2009	2010	2011
Yangon								
Main	International	Import	3,696,507	4,666,074	5,075,561	8,401,014	10,478,230	11,894,990
		Export	3,616,940	4,032,683	4,555,790	4,741,898	4,408,795	5,714,969
		Total	7,313,447	8,698,757	9,631,351	13,142,912	14,887,025	17,609,959
	Coastal	Unload	613,105	614,589	523,711	458,674	599,712	649,417
		Load	402,318	393,431	388,960	448,163	466,960	399,036
		Total	1,015,423	1,008,020	912,671	906,837	1,066,672	1,048,453
	Total		8,328,870	9,706,777	10,544,022	14,049,749	15,953,697	18,658,412
Thilawa	International	Import	1,313,081	959,461	551,203	632,391	1,229,454	1,916,926
		Export	1,313,081	1,193,248	1,220,723	1,463,782	1,255,490	1,147,005
		Total	2,626,162	2,152,709	1,771,926	2,096,173	2,484,944	3,063,931
	Coastal	Unload						
		Load				1,527		
		Total	0	0	0	1,527	0	0
	Total		2,626,162	2,152,709	1,771,926	2,097,700	2,484,944	3,063,931
Total	International	Import	5,009,588	5,625,535	5,626,764	9,033,405	11,707,684	13,811,916
		Export	4,930,021	5,225,931	5,776,513	6,205,680	5,664,285	6,861,974
		Total	9,939,609	10,851,466	11,403,277	15,239,085	17,371,969	20,673,890
	Coastal	Unload	613,105	614,589	523,711	458,674	599,712	649,417
		Load	402,318	393,431	388,960	449,690	466,960	399,036
		Total	1,015,423	1,008,020	912,671	908,364	1,066,672	1,048,453
Grand total			10,955,032	11,859,486	12,315,948	16,147,449	18,438,641	21,722,343

Source：MPA

Table 3-4 Container Cargo Handling Volume in Myanmar Port

		2004	2005	2006	2007	2008	2009	2010
Export	TEU	77,553	79,330	95,782	109,953	121,348	148,482	167,011
	ton	1,247,984	1,334,620	1,726,990	1,916,037	2,063,443	2,330,219	1,939,262
Import	TEU	80,394	83,030	93,962	113,059	125,364	149,472	168,335
	ton	1,087,986	1,151,965	1,246,601	1,541,239	1,554,282	2,089,863	2,496,199
Total	TEU	157,947	162,360	189,744	223,012	246,712	297,954	335,346
	ton	2,335,970	2,486,585	2,973,591	3,457,276	3,617,725	4,420,082	4,435,461

Source：MPA

Table 3-5 Inland Water Transport Cargo Volume in Yangon Port

unit:ton

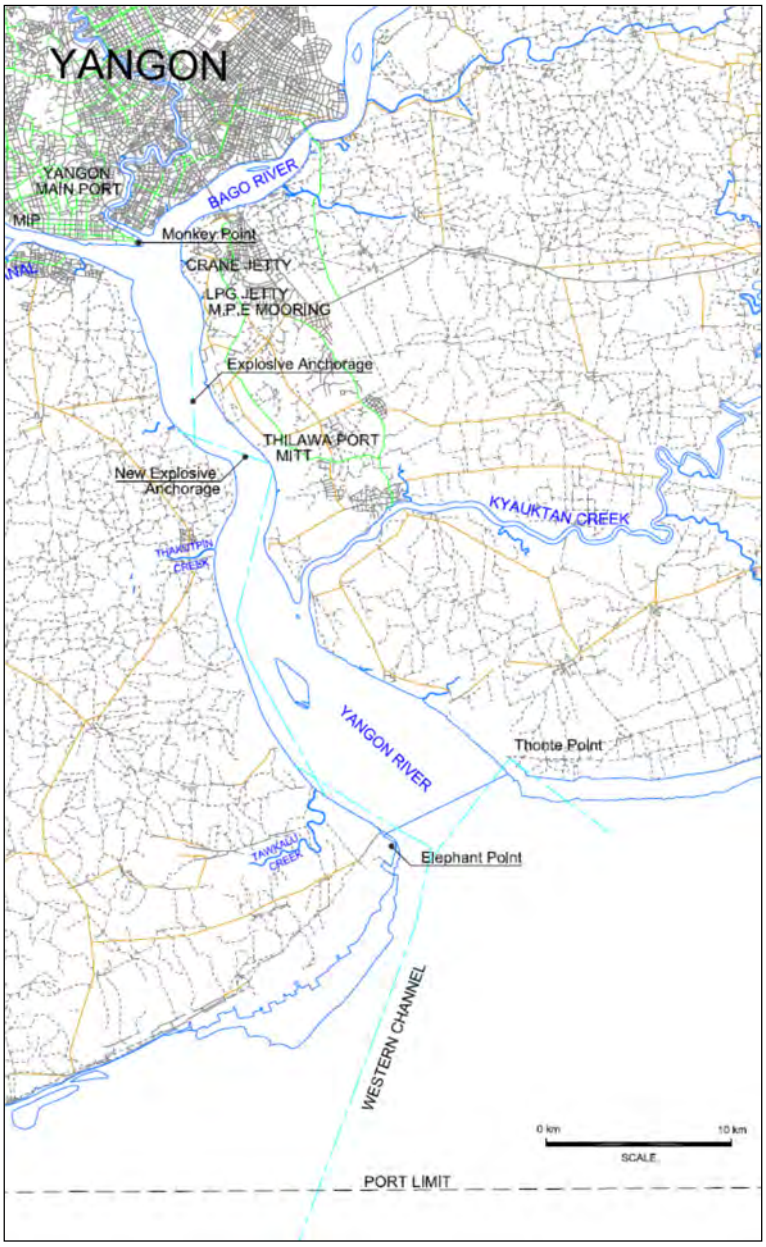
	2003	2004	2005	2006	2007	2008	2009	2010	2011
Unload	832,530	722,282	613,116	576,657	492,561	453,130	370,890	379,050	403,692
Load	652,055	442,860	443,416	378,135	365,621	178,911	226,905	214,957	171,043
Total	1,484,585	1,165,142	1,056,532	954,792	858,182	632,041	597,795	594,007	574,735

Source：MPA

3.3. Navigation Channel

Maximum draft of vessels is restricted to 9m or less due to the shallow water depth of the Yangon port. The shallow depth allows the large vessels to access to the port only during the high tide which is twice a day (see Table 3-6). As a result, all large vessels congest the passage route during the time. The passage route is restricted to one way at Monkey Point Channel, where the passage route bends sharply and furthermore the width of the passage is minimum and 100m.

It is also restricted at Western channel located near the estuary and off Elephant point. There is no other restriction except for them (see Figure 3-1).



Prepared by the Study Team

Figure 3-1 Current Navigation Channel for Large Vessels

Table 3-6 Restrictions for Calling Vessels

Item	Season	Yangon	Thilawa
Maximum Ship's Size (DWT)		15,000	20,000
Length over all (LOA)		167m or less	200m or less
Maximum Draft (m)	Rain	9.0	9.0
	Dry	8.5	9.0
Pilot Service Time		Daytime	All day
		(high tide)	(high tide)

Prepared by the Study Team

Problems on navigation safety are as follow;

① High age of the Pilot Vessels ; Pilot vessels used as the pilot station are too degraded and aged for the appropriate pilot service. Alternative measures must be considered and executed as soon as possible.

② Pilot Boats ; Pilot boats are small having LOA of 4m. Even small waves, just 1.5 m high, it is difficult to provide the appropriate pilot service.

③ Problems during the monsoon season and rough weather condition ; During the rough weather condition, it is quite difficult to provide the pilot service due to the tough motions of the pilot vessel. As a result, it reduces the efficiency of the port operation. As an alternative of the degraded and aged pilot vessels, it is required to introduce a fixed pilot station so that the pilot service is always available.

④ Communication with arriving and departing vessels ; Currently, VHF is the only communication method available for the pilot vessels and the large arriving and departing vessels. It is required to introduce comprehensive VTMS (Vessel Traffic Management System) that allows the pilot station to communicate with the all vessels in Yangon port, Thilawa area and Elephant Point.

⑤ Tugboats ; It requires two or more tugboats with 3000 or more HP to assist the maneuver of vessels calling Thilawa area port.

3.4. Port Security

3.4.1. Port Security System and Role

1) DMA (Department of Marine Administration)

① DMA is the DA (Designated Authority) in Myanmar. Hence they will approve the PFSP and may change security levels.

② DMA issues State of Compliance every year. However, there is no expiration date for PFSP

③ PFSO is approved by DMA

④ Communication exercise is conducted for security exercise. Conducting exercises once a year in regional level and twice a year in individual wharf.

2) MPA

① As a port security, numbers of gates were reduced and monitoring by CCTV was conducted.
② The utilization of the wharf, pilotage, navigation and stevedore are controlled by MPA
③ Once something happens at the cargo wharf, together with the Shipping Agency Department of MPA and the DMA shall deal with the incident. MPA has authorization to check the PFSP of the wharf at that time.

3) Customs

Myanmar became a member of the WCO in 1991 and expressing intent of the implementation of the SAFE Framework. All four ports handling container (AWPT, Bo Aung Kyaw Wharf, Myanmar Industrial Port, and MITT) have x-ray inspection system.

3.4.2. Target Wharf for Port Security

As a member country of the IMO, Myanmar ratifies the SOLAS Convention and the ISPS Code and strengthening counter-terrorism measures in the marine field. There are 12 port facilities in Yangon and 5 port facilities in region reported to the IMO as the ISPS complied facilities.

4. Basic Concept and Plan of Yangon Port Development

4.1. Basic Concept

4.1.1. Present Situation of Yangon Port

MPA manages 9 ports in the country. Among those, Yangon Port handles about 90% of waterborne transport cargo of Myanmar. General cargo handling facilities at the ports except Yangon Port are constructed in shallow water areas where deepening is considered difficult. Therefore, port cargo transport in Myanmar will likely continue to be concentrated in Yangon Port and delivered to local destinations by domestic transport means. Accordingly, Yangon Port should keep its function as a gate way for the waterborne cargo transport of Myanmar in the future.

Major port facilities at Yangon Port are spread through Yangon Main Port and Thilawa Area Port. Among those, port facilities at Yangon Main Port extend over about 9 km in a narrow area adjacent to Yangon city. Therefore, port yard areas are very narrow and consequently cargo handling productivity is very low. Further, land transport traffic generated from port cargo causes traffic congestion in the city. On the other hand, an ample area of 7.4 km in length and 750 m in width is available in Thilawa Area for port terminal construction. Some areas are in operation and others are under construction.

From the view point of city planning, generally it is desirable to use waterfront area in the vicinity of an urban area for facilities which related directly to the lives of citizens such as passenger terminals, domestic transport terminals, promenades, shopping centers and office buildings. However, relocating the existing large size port terminals which are developed at Yangon Port for such purposes would incur an economic loss to the country.

4.1.2. Coordination between Land and Inland Waterway Transport

A distribution pattern of goods in the whole of Myanmar is forming in the center of the Yangon port shown in Figure 2.3-1 and 2.3-2. Almost all imported goods are transported to eight local ports in Myanmar. In addition, they are transported to northern inland area by inland water transport, roads and railways. Annual transport volume of each of transport in Yangon city region is as follows; Inland water transport is about 600,000 tons. Road is about 3.4 million tons. Railway is about 1 million tons. Rice and beans for export are carried to Yangon port by inland water transport and transported overseas.

In this way, cargo transport in Myanmar is dependent on Yangon port and cooperation with inland water transport, roads and railways. Transport by inland water transport, roads and railways connecting port and inland is becoming increasingly important. From such a point of view, It have to consider next points for each sector cooperation with Yangon port.

4.1.3. Deep Sea Port Develpment

Due to the limited water depth of 9 m at the Yangon Port channel, only feeder container ships of 1,000 TEU from Singapore can call Yangon Port. Taking into account the economic development of Myanmar, the country should develop ports which can accommodate container ships of about 40,000 DWT which are sailing in intra-Asia shipping routes. Taking into account the trends of the changes in container ship size in the world and Asian region, Myanmar needs to develop deep sea ports of 14 m deep which are able to accommodate container ships of 4,000 TEU (50,000 DWT, 13 m draft) in the vicinity of the Yangon area in the future.

4.1.4. Basic Policy of Yangon Port Development

The basic policy of Yangon Port development can be summarized as below:

① No additional large terminal development at Yangon Main Port should be conducted but the existing and planned port facilities for international trade cargo should be utilized as extensively as possible.
② Increase handling capacity of Yangon Port
③ Secure the navigation safety at Yangon Port
④ Consider carefully about the environmental impact of port development at Yangon Port
⑤ The remaining water front areas should be used for facilities which directly benefit the lives of citizen such as passenger terminals, domestic transport terminals, promenades, shopping centers and office buildings.
⑥ Port facilities which will handle future increasing international trade cargo should be constructed in Thilawa Area Port.
⑦ Promotion of a new road network development connecting Thilawa area and the city and other areas should be contemplated in order to improve the existing poor road network.
⑧ The north part of Thilawa area should be utilized for facility development needed after the completion of the whole planned facilities at Thilawa area.
⑨ Take perspective necessary actions for the development of a deep sea port in the vicinity of Yangon

4.2. Basic Plan

4.2.1. Cargo Demand Forecast

(1) Target Year

The target years of the port development are 2015, 2020 and 2025.

(2) Forecast of Economic Scale

Study team estimate economic scale of targets year as scale of year 2020 is 1.0. Table 4-1 shows economic scale and estimated population in each target year.

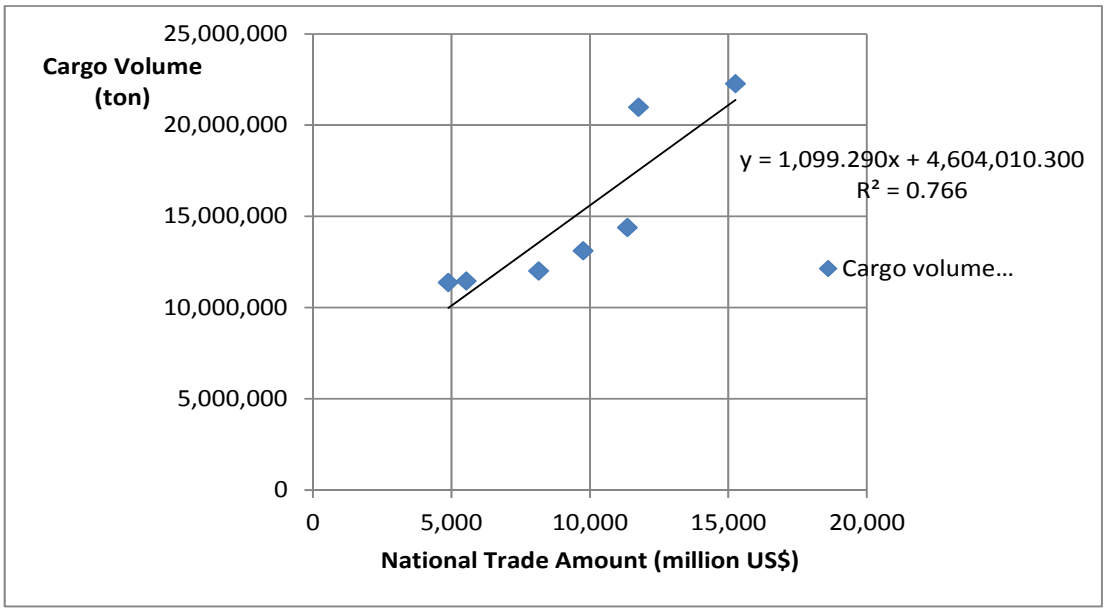
Table 4-1 Estimated Economic Scale and Population of Target Years

Target year			2015	2020	2025
Economic growth rate	High Case	7.7%	1.38	2.00	2.90
	Low Case	5.3%	1.32	1.71	2.21
Population		1.29%	63,857,000	68,083,000	72,589,000

Prepared by the Study Team

(3) Estimate of Cargo Volume

Cargo volume estimate is made on the assumption that the volume is inproportion to the economic scale of the target year (see Figure 4-1 and Table 4-2).



Prepared by the Study Team

Figure 4-1 Foreign Trade Amount and Cargo Volume Throughput in Myanmar

Table 4-2 Result of Cargo Volume Projection of Myanmar Port

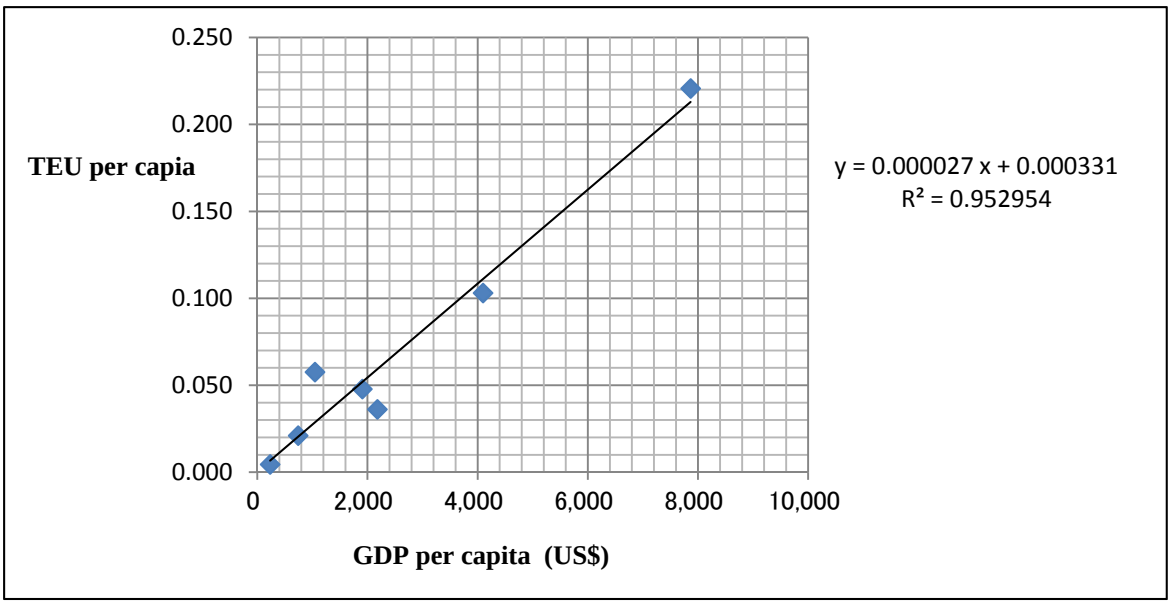
unit : ton

	2015	2020	2025
High Case	29,607,000	42,999,000	62,221,000
Low Case	28,321,000	36,689,000	47,417,000

Prepared by the Study Team

(4) Container Volume Estimate

Container cargo handling volume per capita varies widely among ASEAN countries because economic growth levels are different. Correlation between GDP per capita and container cargo volume TEU per capita in AESAN countries shall be examined to forecast future container cargo volume in Myanmar with economic growth to some degree(see Figure 4-2 and Table 4-3).



(Prepared by the Study Team)

Figure 4-2 Correlation between GDP per capita and TEU per capita in ASEAN Countries

Table 4-3 Result of Container Cargo Volume Forecast of Myanmar

unit : TEU

	2015	2020	2025
High Case	892,000	1,986,000	4,014,000
Low Case	853,000	1,700,000	3,064,000

Prepared by the Study Team

4.2.2. Basic Plan and Master Plan of Yangon Port

(1) Cargo Demand Estimate in Yangon Port

The share of cargo volume in Yangon Port in the whole cargo volume of Myanmar was 91.5% in 2010 and 2011. Provided that there will be no significant changes in the share, the cargo demand of Yangon Port in 2025 can be estimated at 56.93 million tons and 43.38 million tons in the high case estimate and the low case estimate respectively.

Table 4-4 shows the commodity-wise cargo demand estimate of Yangon Port in 2025.

Table 4-4 commodity-wise cargo demand estimate of Yangon Port in 2025

unit:ton

		2025	
		High Case	Low Case
Foreign Trade			
Import	Containerized Cargo	25,108,000	19,165,000
	Non Contaierized Cargo		
	Fuel	7,285,000	5,117,000
	Cement	1,155,000	1,072,000
	Cooking Oil	250,000	250,000
	Iron Mterial (Billet)	1,202,000	991,000
	Steel Product	601,000	496,000
	Car	396,000	251,000
	General Cargo	2,232,000	1,704,000
	total	13,121,000	9,881,000
	Total	38,229,000	29,046,000
Export	Containerized Cargo	15,956,000	12,180,000
	Non Containerized Cargo		
	Rice	1,000,000	700,000
	Total	16,956,000	12,880,000
total		**55,185,000**	**41,926,000**
Coastal Trade		**2,000,000**	**2,000,000**
Total		**57,185,000**	**43,926,000**

Prepared by the study Team

In addition, coastal/Inland waterway cargo demand estimate in Yangon Port is shown in Table 4-5.

Table 4-5 Coastal/Inland Waterway Cargo Demand Estimate in Yangon Port

Unit: Thousand tons

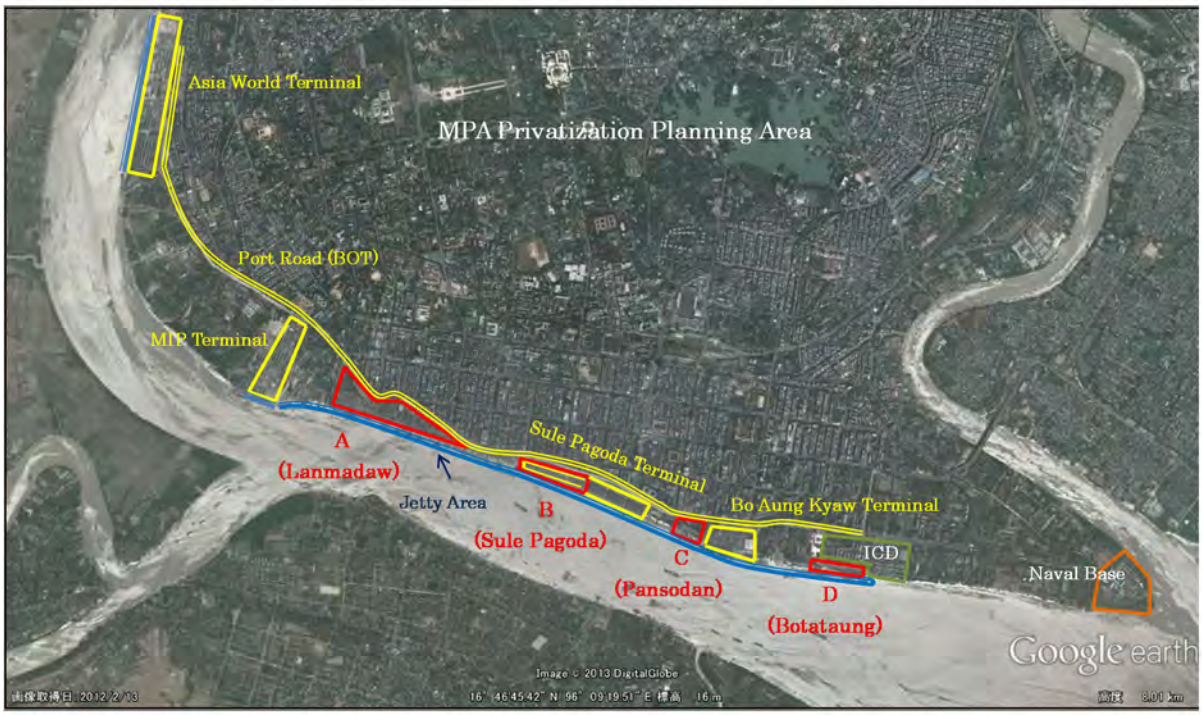
	2010	2015	2020	2025
Coastal Shipping Cargo	1,070	1,370	1,650	2,000
Inland Waterway Transport (IWT) Cargo	590	760	920	1,110

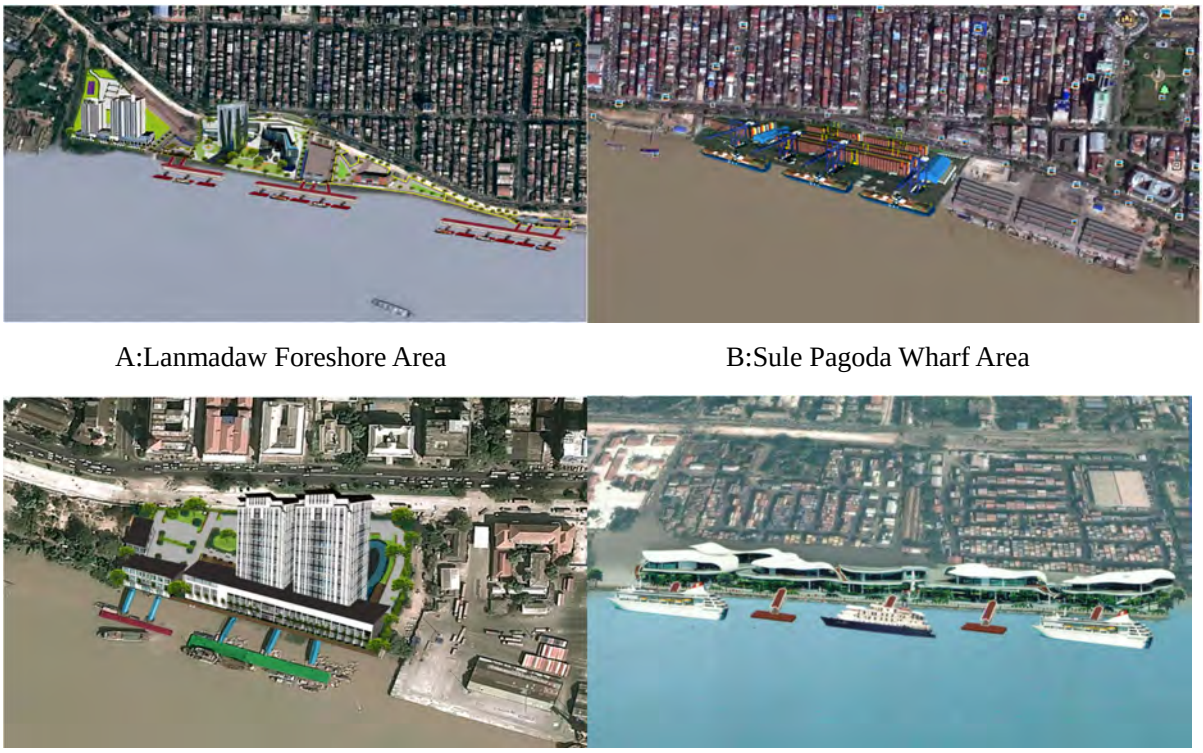
Prepared by the Study Team

(2) Future Port Development Plan of Yangon Port Prepared by MPA

MPA introducing a privatization scheme to obtain private funds as explained in **2.5.3 Privatization of Port Sector.** Under this initiative, MPA is floating 4 projects (A, B, C and D in Figure 4-3) for proposals from private companies.

The above basic concept of MPA is in conformity with the policy recommended by the Study Team given in **4.1.1 Role Sharing between Yangon Main Port and Thilawa Area Port** which states that the remaining water front areas should be used for facilities which directly benefit the lives of citizens such as passenger terminals, domestic transport terminals, promenades, shopping centers and office buildings.





A:Lanmadaw Foreshore Area　　B:Sule Pagoda Wharf Area

C:Nanthida and Pansodan Area　　D:Botataung Foreshore Area

Source：MPA

Figure 4-3　Future Development Projects at Yangon Main Port by MPA

(3)　Port Facilities for Coastal/Inland Waterway Transport

Coastal/inland waterway traffic and passenger transport which play important roles in waterborne transport at Yangon Port is undertaken at many pontoon jetties which is able to adapt to the tidal changes of about 6 m. Pontoon jetties at Lanmadaw extended over a distance of about 1.5 km are the major coastal/inland waterway transport facilities. Due to the construction of a port road in addition to the original narrow land space the cargo handling productivity has become worse.

There are a total of 36 berths of the coastal/inland waterway transport in Yangon Main Port.. Manual handling operations are conducted at pontoon type jetties which are used for handling coastal/inland waterway cargo. As mentioned above, it is difficult to develop port facilities in Yangon Main Port to meet estimated demand. Instead of increasing the number of berths, it will be possible to meet the handling capacity increase by changing pontoons to fixed type jetties which allow efficient mechanical handling operations. The mechanical cargo handling productivity will become 3.3 times of the manual cargo handling productivity**.** By the year 2015, 2020 and 2025, about 20 %, 30 % and 40 % of pontoon jetties are recommended to be changed to fixed type jetties respectively to meet the future cargo handling demand.

The water front area of The Yangon River in the main port should be used for facilities which

directly benefit the lives of citizens except the existing container terminal which has been developed with a large amount of investment. As a lot of heritage buildings exist in CBD which is the hinterland of Yangon Port, comprehensive redevelopment of CBD including the water front area of The Yangon River should be done by making good use of those heritage buildings. Lanmadaw and Botahtaung areas which are used for coastal/inland waterway transport including passenger transport are too narrow for efficient cargo handling. Thus these areas should be used for passenger terminals, promenade, shopping centers and office buildings as valuable waterfront areas.

In accordance with the expected development of land transport means, the number of water borne transport passengers is not expected to increase on a large scale. As shown in **2) Future Port Development Plan of Yangon Main Port Prepared by MPA** above, the passenger terminal development project is expected to be implemented. Accordingly, capacity of passenger transport will be increased to meet the increase of passenger transport demand (although the increase is estimated to be minimal).

(4) Yangon Port Master Plan

Additional berth needs in Yangon Port in 2025 are estimated taking into account projected cargo demand which is shown in Table 4-4 and Table 4-5 and the total number of available berths (existing and planned) in 2025. The results are shown in Table 4-6. A new terminal development with berths of 6,600m in total length will be needed after the completion of the whole Thilawa area port.

Candidate locations of the new terminal development are selected taking into account availability of required water depth and area. Four candidate locations are shown below and in Figure 4.2-11.

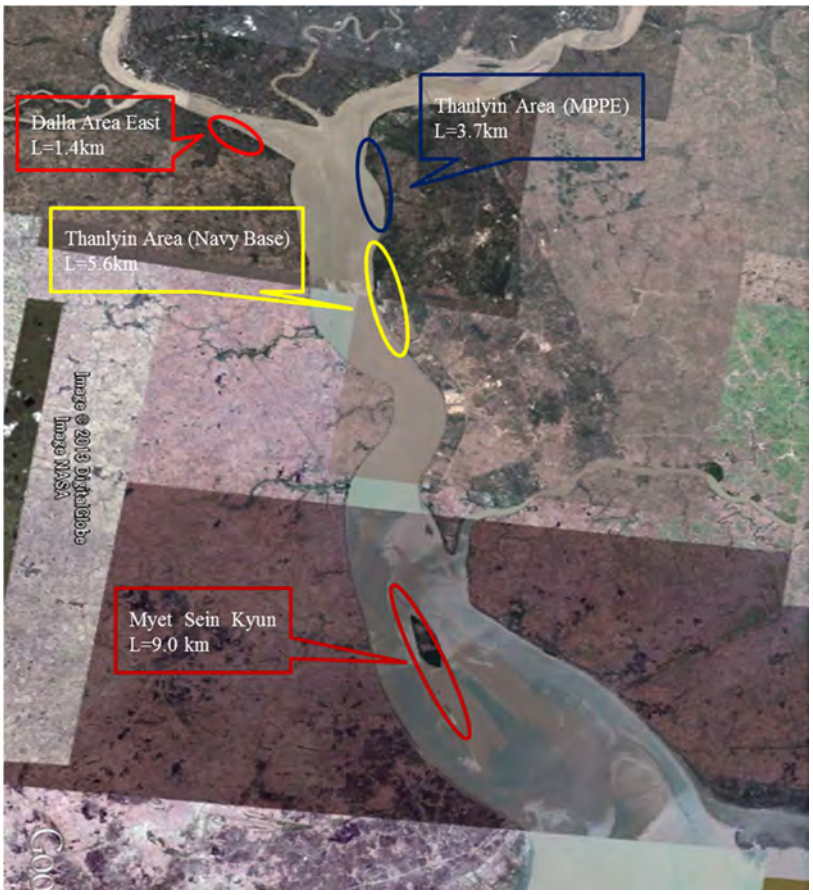
① The waterfront and backyard currently occupied by MPPE in Thanlyin area (about 1,400 m)
② The waterfront and backyard currently occupied by the Navy in the south part of Thanlyin area (about 5,600 m)
③ The area owned by MPA in Dalla area (about 1,400 m)
④ The shallow area along Myet Sein Kyun south of Thilawa area on the Yangon River

The candidate areas and their evaluation are shown in Table 4-7. The most preferable location is the area currently occupied by MPPE at Thanlyin with the shore length of 3,700m. It will also be necessary to examine the possibility of using of the naval base area in order to secure an additional 2,900m in length since the total required length is 6,600m.

Table 4-6 Required Berth Number in Yangon Port and Thilawa Area Port in 2025

	Cargo volume (2025)		Existing berth			Current expansion plan			Objective ship		Annual handling capacity		Required berth		Additional berth	
									Size	Draft						
General cargo(cement, metal, other GC)	5,441,000	ton	Sule	1,026	m	MEC	600	m	Yangon 15,000DWT	9m	200,000	t/B	5,500	m	2,651	m
			Bo Aung Kyaw	223	m	MSPL(Plot 10,11)	400	m			(1,000)	(t/m)	28	B	13	B
			MIPL(Plot 4)	200	m	UMEHL(Plot 12,13)	400	m	Thilawa 20,000DWT	9m						
			Hteedan Oile	1	B											
			Sub-total	1,449	m	Sub-total	1,400	m								
Vehicle	396,000	unit /ton	Exclusive use	0	m	Exclusive use	0	m	54,000GT	9m	200,000 (4,300)	unit/B (unit/ship)	2	B	2	B
Grain	1,000,000	ton				Thilawa (Plot 20, 21, 28, 29, 30)	1,000		15,000DWT	9m	200,000 (1,000)	t/B (t/m)	5	B	0	B
Petroleum	7,285,000	ton	MED	2	B	Plot 1,2	2	B	15,000DWT	8m	720,000	t/B	10	B	-3	B
						Plot 3	1	B								
						Plot 14-19	6	B								
						Plot 32-33	2	B								
			Sub-total	2	B	Sub-total	11	B								
Container			Hteedan(3)	640	m				1,000TEU (15,000～20,000DWT)	9m	206,000	TEU/B	37	B	12	B
			AWPT(4)	841	m											
			MIP(2)	310	m	MIP(2)	390	m								
	(4,014,000)	TEU	Bo Aung Kyaw (1)	224	m	Sule (3) (conversion from GC berth)	548	m								
	41,063,000	ton	MITT(5) (Plot5-9)	1,000	m	MPA(5) (Plot22-26)	1,000	m								
			Sub-total	3,015	m	Sub-total	1,938	m								
				15	B		10	B								
Coastal shipping	2,000,000	ton		8	B	Re-development			1,000DWT	4.2m	100,000	t/B	20	B	12	B
Inland waterway	1,000,000	ton		36	B	Re-development				2.4m	21,600	t/B (manual)	32 (manual)	B	0	B
											79,200	t/B (mechanical)	4 (mechanical)	B	0	B
Passenger (IWT, Private)	35,490,000	pax	Pansodan jetty (ferry)	2	B	Re-development				2.4m			2	B	0	B
			Botahtaung jetty	4	B	Re-development							4	B	0	B
			Wardan jetties	Cargo-cum-passenger ship use	B	Re-development										
			Shin O Tan jetties			Re-development										
Total cargo	58,185,000	ton														

Prepared by the Study Team



Source : Google Map, Prepared by the Study Team

Figure 4-6 Candidate Locations for Future Port Development

Table 4-7 Evaluation of Candidate Locations for Future Port Development

	Dalla	Thanlyin MEEP	Thanlyin Naval Base	Myet Sein Myun
Shore Line length (km)	1.4	3.7	5.6	9.0
Water Depth (m)	9	7 - 10	8.5	5 - 10
Land Owner	MPA	MPPE	Navy	
Land Use	Shipyard, Factory	Fuel Base	Naval Base	
Present Facilities	Jetty, Shipyard, Factory	Fuel jetty, Fuel tank	Navy Jetty, Shipyard	
Residents	Few residents within 200m from shoreline	no	no	no
Transportation Network	Small ferry boat	Road	Road	Nothing
Issues	Neede of Yangon river cross bridge (air draft of about 50m) and Road connnection, Residents removal,	Insufficient water depth at some areas	Alteration of naval base use, Insufficient water depth atsome areas	Large land preparation by reclamation, Need of Yangon river cross bridge (special air draft is not neccesary) and road connection
Others	Yangon river cross bridge is in the planning stage			
Total Evaluation	Good	Excellent	Good	Fair

Prepared by the Study Team

4.2.3. Actions to be taken by MPA

The following projects are deemed necessary based on the findings of the above study but are assumed not to be carried out under the Urgent Development Plan.

(1) Channel Improvement

There is a size restriction on vessels which can enter Yangon Port due to difficulty in the channel depth maintenance as described on Table 5.4-34 Size Restriction on Vessels in Yangon Port in 5.4.5 Navigation Planning Safety. If the channel depth can be increased and maintained, ships can enter the port any time regardless of tide (tidal range of about 6m) and large size ships can enter the port. As a result, effective utilization of the port facilities can be expected. However, there are many technical problems to be resolved for the dredging and maintenance of channel in Yangon River which is rich in suspended soil. Therefore, the study was made on the present size restriction of vessels in Yangon Port.

Additional studies showing in Table 4-8 and Table 4-9 are needed on the channel improvement which is an important issue to be resolved for realizing effective use of Yangon Port.

Table 4-8 Survey Items and Specification for Sand-spit Formation System Study

Survey Item	Specification	Remark
Bathometric survey		2 times/year before and after monsoon season
Current and sedimentation	5 points	One month during monsoon and dry seasons respectively
Bottom Sediment Sampling Survey	Sampling by 200m x 200m grid location	

Prepared by the Study Team

Table 4-9 Survey Items and Specification for Channel Deepening and Widening

Survey Item	Specification	Remark
Bathymetric Survey (Channel)	cross section @200m along the channel	2 times/year before and after monsoon season
Bathymetric Survey (Broad Area)	@500m	Broad area survey including channel
Wave and Current (Off-shore, Elephant Point)	2 locations at Elephant Point and offshore with water depth of more than 20m.	Long term measurement
Wave, Current and Turbidity	More than 2 locations at Elephant Point and at other locations along the channel. Multilayer survey of current and turbidity at each location.	During the high wave conditions of monsoon season with offshore wave measurement above
Bottom Sediment Sampling Survey	Sampling by 500m x 500m grid location	Same area with Bathymetric Survey (Broad Area)

Prepared by the study Team

(2) Navigation Safety

Present problems and countermeasures of the safety navigation are summarized in Table 4-10 of **5.4.5 Navigation Safety Planning.** In order to secure the navigation safety, it is necessary to develop the navigation safety system (VTMS) urgently.

The VTMS consists of the radar site for tracking the echoes from vessels navigating in the port waters and coastal waters, and the VHF radio transmission/receiving stations for communications with navigating vessels, and the AIS allowing vessels to identify the attribute information on other vessels. This system will support the safety of navigation for vessels, monitoring of off-route vessels, provision of dangerous information, anchorage management and management of vessels entering and leaving ports.

Table 4-10 Present problems and countermeasures of the safety navigation

Subjects	Problems	Countermeasures
Aids to navigation Electrical nautical charts (Objective) • Improving the aids to navigation so that the vessels are capable to navigate at night.	Vessels calling at the port are restricted to navigating at only daytime due to the deficiency of lighthouses and aids of navigation, and the absence of electrical nautical charts. Those problems causes casualties.	Defining the improvement plan of aids to navigation and installing the lighthouses, buoys, and leading lights according to the plan. The plan excludes the electrical nautical charts because they are controlled by Myanmar Navy.
Vessel Traffic Management System (VTMS) (Objective) • Improving the port operation efficiency and defining the safety navigation measures at Outer Bar, Yangon river navigation channel, and Thilawa Area Port .	All vessels calling at Thilawa Area Port Area Port must navigate through Outer Bar and the Yangon river navigation channel where the water depth is critically shallow. The deficient of aids to navigation such as lighthouses and buoys and the strong tidal current of the channel are the critical problems of the safety navigation. The problems restrict the vessels to navigating at daytime and the restriction is a crucial factor decreasing the port operation efficiency.	In order to improve the safety navigation and the port operation efficiency corresponding to the vessels increasing rapidly, it is requisite to introduce and install the VTMS composed of a radar, AIS base, camera equipment, and VHF.
Improving Pilot Service (Objective) • Improving the safety and efficiency • Constructing a fixed pilot station at Outer Bar and replacing the pilot boats	• Pilots get on board the small pilot boats from the pilot vessels for providing the pilot services. During the monsoon season, it is too danger for the pilots to get on board the boats because the motion of the pilot vessel is violent due to the rough weather.	• Replacing the pilot vessels to the fixed pilot station. • Examining and executing the replacement of the present pilot boats to the larger, faster, and safer offshore boats. Additionally, introducing a helicopter should be considered.

Prepared by the Study Team

(3) Introduction of a port EDI

The Port EDI is a system to handle port activity relevant declaration or reporting such

as port entry document and mooring facility use request document by electric means

Table 4-11 Effect of the Introduction of Port EDI

Before Port EDI introduction	After Port EDI introduction
➢ Documents preparation is needed for each relevant administrative organ ➢ Duplicated data are required from each administrative organ ➢ Heavy work load is required for documentation	➢ Document submission to several offices can be performed simultaneously by one time input and transmission ➢ Document submission can be made any time and any place where internet connection is available ➢ Substantial work simplification can be achieved

Prepared by the Study Team

In order to achieve effective port management and operation, it is necessary to introduce an Electric Data Interchange system including the documentation relevant to port entry and exit, database and accounting.

(4) Enactment of a New Port Act

Effective use of waterfront area is very important issue for any nation. In this respect, waterfront in the port area plays an important role in socio-economic development of the country as well. A long-term approach to managing and utilizing the water and land area adjacent to the waterfront is required for the orderly development of national territory.

In Japan, the Minister of Land, Infrastructure, Transport and Tourism shall formulate a Basic Policy for the development, utilization and preservation of ports in accordance with the Port and Harbor Act. The following items are included in the Basic Policy.

① Matters concerning the direction of the development, utilization and preservation of ports
② Basic matters concerning the location, functions and capacities of ports
③ Basic matters concerning the preservation of environment to be considered in the development, utilization and preservation of ports
④ Basic matters concerning the need to ensure cooperation among ports which have a close relationship from economic, natural or social viewpoints
⑤ Basic matters concerning effective port operation including the utilization of the capacity of private sector

Subsequently, a port authority formulates a Port Plan based on the Basic Policy. The port

authority shall hear opinions of a Local Council for Port Plan in the formulation of Port Plan. The Minister of Land, Infrastructure, Transport and Tourism shall hear opinions of Transport Policy Council for the Minister of Land, Infrastructure, Transport and Tourism for the Port Plan. Port development is to be implemented based of the Port Plan.

Currently, The Rangoon Port Act, The Port Act and Outports Act which were enacted in 1905, 1908 and 1914 respectively are acts relevant to ports in Myanmar. There are no clause covering the formulation of port master plan. Although harbor area is designated, water and land area of the port are used in a disorderly fashion by each property owner because MPA does not have any right to control usage of water area in the port. Under this situation, orderly use of water and land area in the port cannot be achieved because cargo distribution function and urban function are forced to coexist.

The following measures are expected to assist in establishing the orderly development of the harbor and thereby support the socio-economic development of Myanmar.

① Formulate a Port Act which regulates planning, development and operation of port in general
② Formulate a Port Plan which is authorized by a Port Act
③ Conduct orderly development and management of a port in accordance with a Port Plan

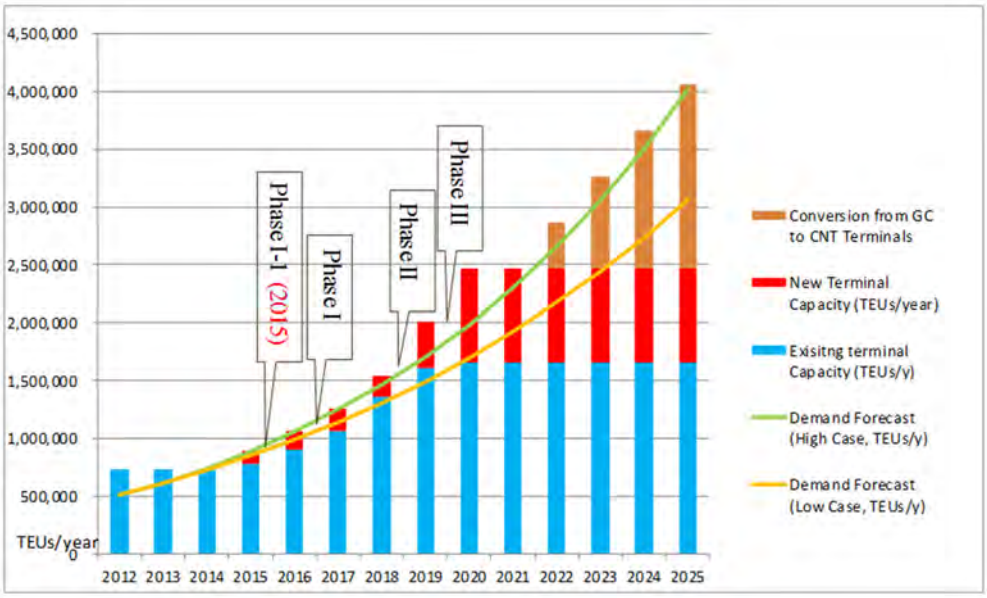
(5) Development of a Port Master Plan

Land use plan which is able to cope with future cargo transport demand shall be examined in order to formulate the regally authorized Port Plan. Following matters shall be considered in making a land use plan.

① Securing of water area and water depth
② Securing of land
③ Land ownership

In order to formulate a Port Plan, it is required to make several alternative plans of water and land use from national development view point without considering current restriction on land use resulting from ownership issues and the current land use situation. Thereafter, advantage and disadvantage of the alternative plans shall be evaluated. A Port Mater Plan shall be established through additional study on the alternative plans and consultation with a Steering Committee composed of stakeholders of the plans.

As shown in Figure 4-7, even after the completion of planned container terminals in Yangon main port and Thilawa area port in 2022, container terminals are not sufficient to handle the future demand



Prepared by the Study Team

Figure 4-7 Demand Forecast and Phased Development Program of Thilawa Area Port Terminal

As explained in **4.2.3 (3) Yangon Port Master Plan,** candidate areas for the development of port facilities of about 10 m in depth at Yangon Port are limited. The north part area of Thilawa Area Port is considered a high priority area among several alternative areas after preliminary examination. In order to achieve well-organized port development, establishment of a legally authorized and long perspective port master plan is needed.

(6) Development of Deep Sea Ports

As described in **4.1.3 Deep Sea Port,** due to the limited water depth of 9 m at the Yangon Port channel, only feeder container ships of 1,000 TEU from Singapore can call Yangon Port. Taking into account the economic development of Myanmar, the country should develop ports which can accommodate container ships of about 40,000 DWT which are sailing in intra-Asia shipping routes. Taking into account the trends of the changes in container ship size in the world and Asian region, Myanmar needs to develop deep sea ports of 14 m deep which are able to accommodate container ships of 4,000 TEU (50,000 DWT, 13 m draft) in the vicinity of the Yangon area in the future.

For the development of deep sea port plan, a detailed study including demand forecast and selection of the construction site is needed.

The necessity of deep-sea port and preliminary examination results are shown in the study report titled “Preliminary Study on National Port Development Plan in Myanmar” prepared by the Port and

Harbour Bureau, Ministry of Land Infrastructure, Transport and Tourism of Japan in February 2013. In the report, it is concluded that the development of a deep-sea port with a depth of 14m which is capable of accommodating 3,000 to 5,000 TEU container ships is needed in the vicinity of Yangon and the first priority candidate location of the deep-sea port is 35km off the left bank of Yangon River estuary.

(7) Schedule of the Action Plan

Development plans given in **5. Development Plan of Thilawa Area Port, 5.4 Development Plan of Facilities and Equipment** and program of the future studies and projects given in **4. Basic Concept and Plan of Yangon Port Development Plan, 4.2 Basic Plan** are shown in Table 4-12..

Table 4-12 Program of the Future Studies and Projects

				2014	2015	2016	2017	2018	2019	2020	2021
1	Thilawa Area Terminal	Phase I -1									
		Phase I									
		Phase II	Study								
			Imple.								
		Phase III	Study								
			Imple.								
2	Channel Improvement	Study									
		Implementation									
3	Navigation Safety (VTMS etc.)	Implementation									
4	Port EDI	Study									
		Implementation									
5	Drafting of Port Act	Study									
6	Port Master Plan	Formulation									
7	Deep Sea Port	Study									

Prepared by the study team

5. Development Plan of Thilawa Area Port

5.1. Role of Thilawa Area Port

As explained in **4.1.1 Role Sharing between Yangon Main Port and Thilawa Area Port**, there is no area in Yangon Main Port suitable for the development of port facilities needed for Yangon Port. Therefore, Thilawa Area where necessary water and land area can be secured will play a very important role in supporting port activities in Yangon Port.

5.2. Cargo Demand Forecast

Table 5-1 Estimation of Container Volume to be handled in Yangon Port and Thilawa Area Port

(TEUs/year)

Year		2015	2020	2025
Yangon Port	High Case	892,000	1,986,000	4,014,000
	Low Case	853,000	1,700,000	3,064,000
Thilawa SEZ relevant		75,000	226,000	392,000

Prepared by the Study Team

5.3. Capacity of Existing Container Terminal

Table 5-2 Possible and Potential Capacity of each Terminal (TEUs/year)

	Hteedan Terminal	Ahlone Terminal	MIP Terminal	Bo Aung Kyaw Terminal	Sule Pagoda Terminal	Yangon Main Port Sub-total	MITT Terminal	Grand Total
Max. Possible Capacity of Existing Terminals	149,000	191,000	131,000	57,000	—	528,000	203,000	731,000
Future Potential Capacity of Terminals	149,000	280,000	189,000	57,000	50,000	725,000	815,000	1,540,000

Unit;1,000 TEUs/year

Calender year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Expected capacity ('000 TEUs/y)	731	731	731	781	898	1,063	1,277	1,491	1,540	1,540	1,540	1,540	1,540	1,540
Theedan Terminal	149	149	149	149	149	149	149	149	149	149	149	149	149	149
Ahlone Terminal	191	191	191	191	191	191	221	250	280	280	280	280	280	280
MIP Terminal	131	131	131	131	131	131	150	170	189	189	189	189	189	189
Bo Aung Kyaw Terminal	57	57	57	57	57	57	57	57	57	57	57	57	57	57
MITT	203	203	203	203	320	485	650	815	815	815	815	815	815	815
Sule Pagoda Terminal	0	0	0	50	50	50	50	50	50	50	50	50	50	50

Prepared by the Study Team

5.4. Development Plan of Facilities and Equipment

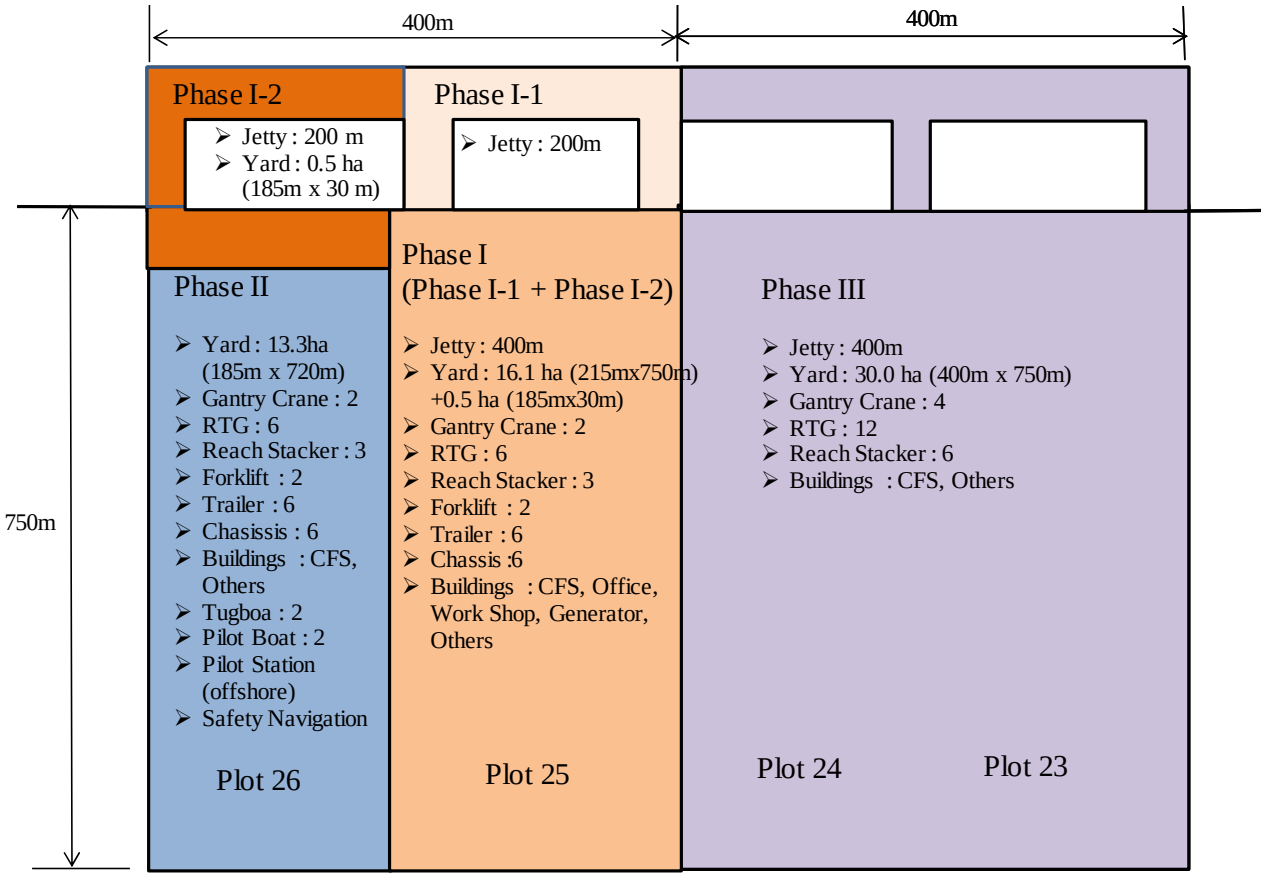
5.4.1. Port Facilities

Table 5-3 shows container terminal development plan at Thilawa area in corresponding to the demand forecast scenario. The terminal layout of Thilawa Area Port is shown in Figure 5-1. Chronological demand forecast and phased development program of Thilawa Area Port is given in Figure 5-2. As shown in the Figure 5-2, the capacity will saturate in the rapid growth of demand in 2015, even when the project is implemented. There is a possibility that the port will not be able to handle all of the amount based on the demand forecast, the lack of capacity will be obvious, and capacity shortage of the port becomes the bottleneck of the economic growth of Myanmar.

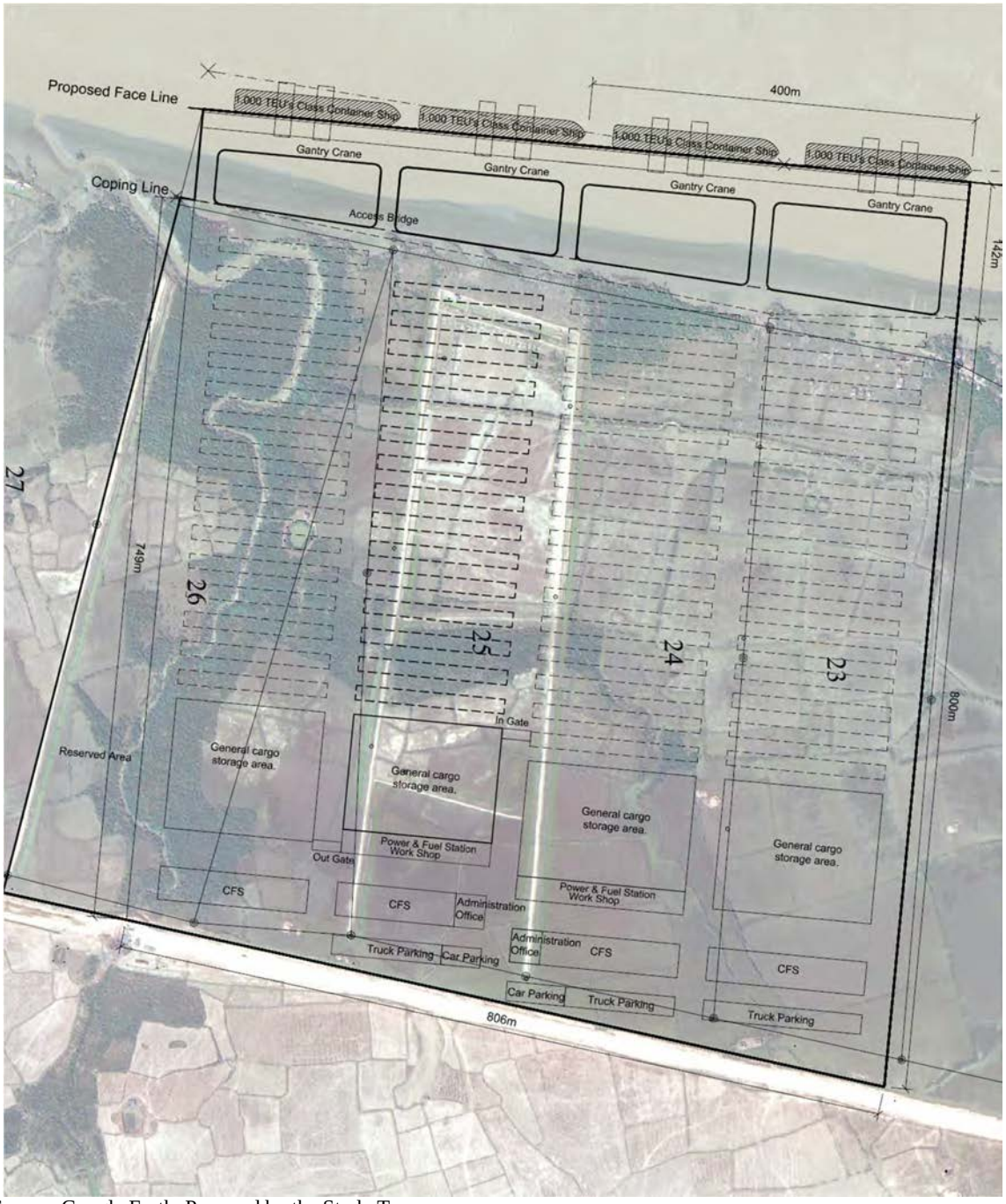
Table 5-3 Container Terminal Development Plan of Thilawa Area Port

Calender year		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Demand forecast ('000TEUs/y)	high case	509	615	744	892	1,058	1,248	1,464	1,709	1,986	2,299	2,653	3,052	3,502	4,014
	middle case	509	615	736	873	1,023	1,194	1,385	1,599	1,843	2,104	2,400	2,731	3,098	3,507
	low case	509	615	727	853	990	1,142	1,310	1,495	1,700	1,923	2,170	2,441	2,738	3,064
Expected capacity ('000TEUs/y)		731	731	731	781	898	1,063	1,277	1,491	1,540	1,540	1,540	1,540	1,540	1,540
Required additional capacity ('000TEUs/y)	high case	0	0	13	111	160	185	187	218	446	759	1,113	1,512	1,962	2,474
	middle case	0	0	0	92	125	131	108	108	303	564	860	1,191	1,558	1,967
	low case	0	0	0	72	92	79	33	4	160	383	630	901	1,198	1,524
Project implementation schedule	high case Phase I -1														
	high case Phase I														
	high case Phase II														
	high case Phase III														
	middle case Phase I -1														
	middle case Phase I														
	middle case Phase II														
	middle case Phase III														
	low case Phase I -1														
	low case Phase I														
	low case Phase II														
	low case Phase III														

Note : ▬ : Construction and Procurement Period

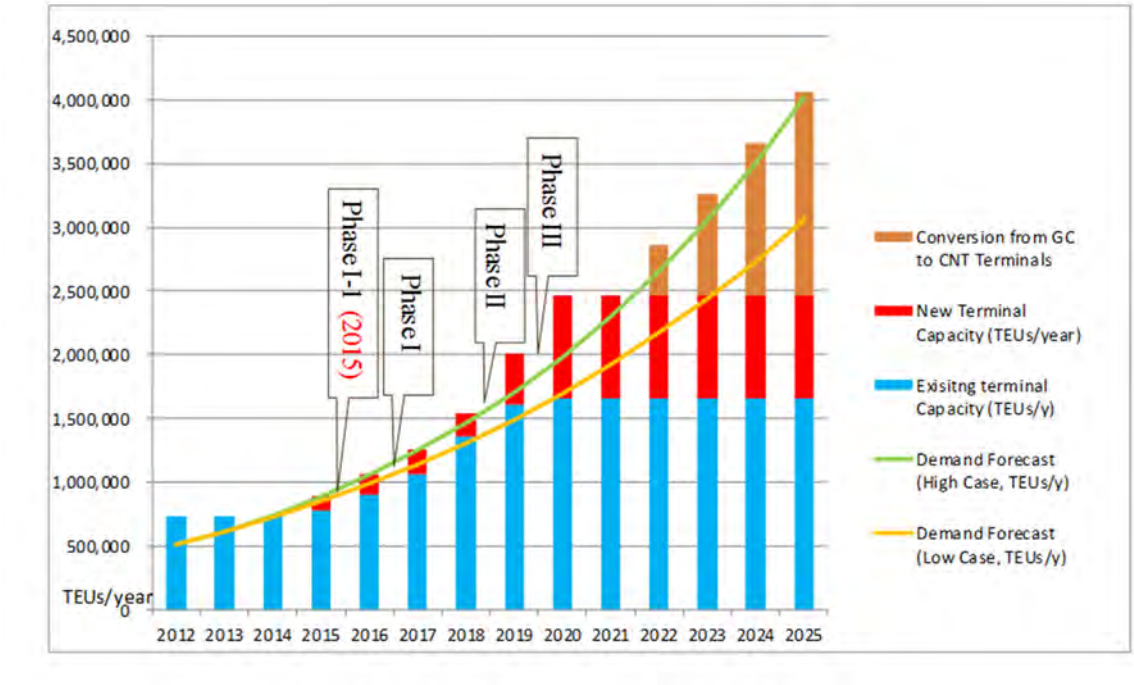


Prepared by the Study Team



Source; Google Earth, Prepared by the Study Team

Figure 5-1 Thilawa Area Port Terminal Layout



Prepared by the Study Team

Figure 5-2 Demand Forecast and Phased Development Program of Thilawa Area Port Terminal

The project completion year and container handling capacity of each Phase is shown in Table 5-4.

Table 5-4 Project Completion Year and Container Handling Capacity

Phase		Project completion year	Container handling capacity (approximate TEUs/year)
Phase I	I-1	2015	-
		2016	190,000
Phase II		2018	400,000
Phase III		2019	800,000

Prepared by the Study Team

Six Plots (4, 10, 11, 12, 13 and 27 shown in Table 3.2-1) are used or are to be used for conventional cargo, grain and oil handling berths in Thilawa Area Port beside the 5 berths at MITT. In order to cope with the need to increase container handling capacity after 2020, it is necessary to convert conventional terminals to container terminals and/or to construct additional container terminals. The conversion and/or additional is recommended to be implemented as shown in Table 5-5 provided that one container berth is able to handle about 200,000 TEUs per annum.

In case of Low Case forecast, container handling volume in 2025 is estimated at about 3 million

TEUs. As shown in Table 5-5 (2), it is necessary to convert conventional terminals to container terminals and/or to construct additional container terminals after 2021.

Table 5-5 Implementation Schedule of Terminal Conversion to Container Terminal and/or Additional Construction in Thilawa Area Port

(1) High Case estimates

Year	2021	2022	2023	2024	2025
Required Capacity (’000TEU/y)	759	1,113	1,512	1,962	2,474
Number of Required Berth	4	5	8	10	12
Number of Berth to be developed by the Project	4	4	4	4	4
Number of Expected Converted /Additional Container Berth	—	1	4	6	8
Total Number of Expected Container Berth at Thilawa Area	4	5	8	10	12

(2) Low Case estimates

Year	2021	2022	2023	2024	2025
Required Capacity (’000TEU/y)	383	630	901	1,198	1,524
Number of Required Berth	2	4	5	6	8
Number of Berth to be developed by the Project	4	4	4	4	4
Number of Expected Converted /Additional Container Berth	—	0	1	2	4
Total Number of Expected Container Berth at Thilawa Area	4	4	5	6	8

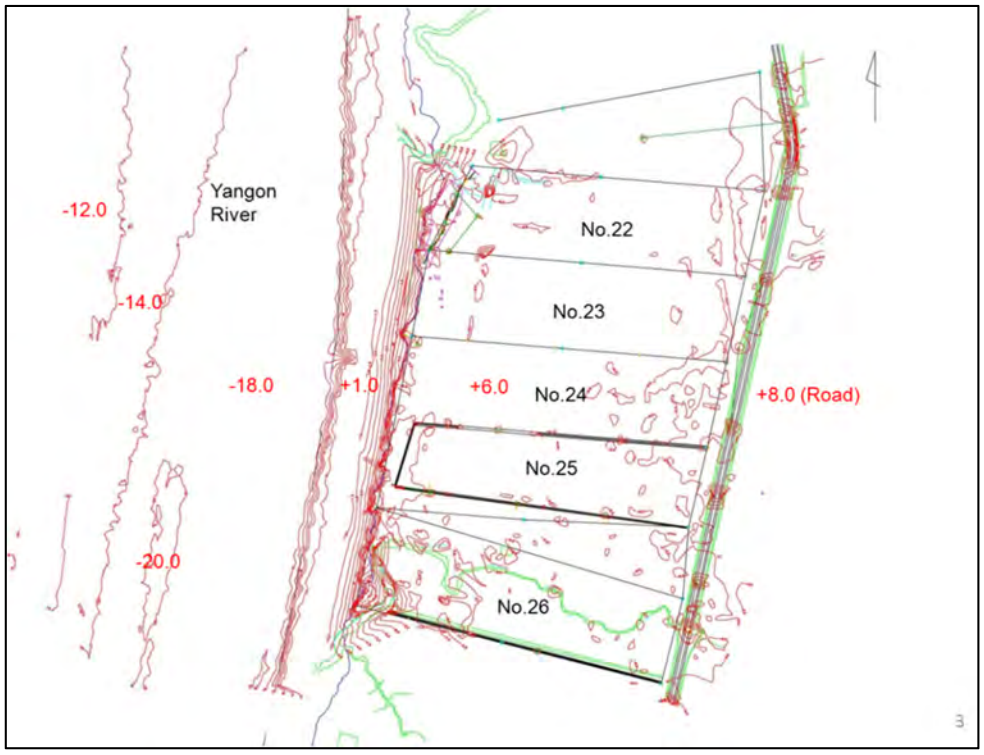
Prepared by the Study Team

In case of High Case estimate, the number of expected converted/additional container berth is insufficient to fulfill the required number of berth after 2025. Therefore it is necessary to develop a new port area at the north of Thilawa Area Port as evaluated in Table 4-7 of **4.1.4 Basic Concept of Yangon Port Development, (3) Yangon Port Master Plan.**

5.4.2. Facility Design

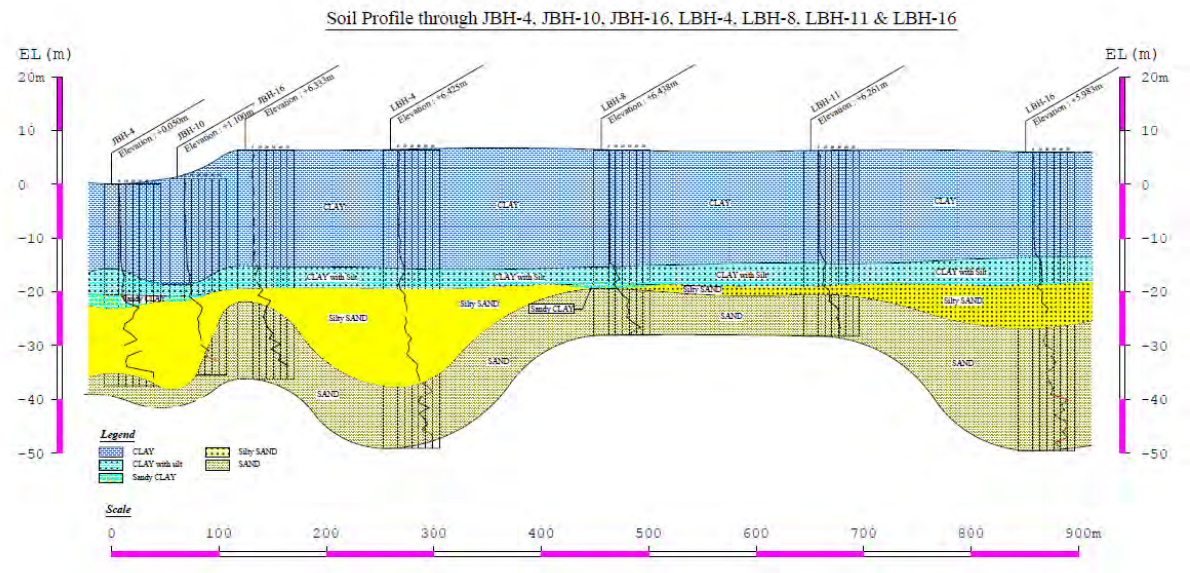
1） Natural Conditions

Topographic survey, bathymetric survey, boring and river flow and water quality surveys have been conducted. Results of topographic and bathymetric surveys, soil profile, design geological condition and other conditions are illustrated in Figure 5-3, Figure 5-4, Table 5-6 and Table 5-7 respectively.



Prepared by the Study Team

Figure 5-3 Results of Topographic and Bathymetric Surveys



Prepared by the Study Team

Figure 5-4 Soil Profile of the Project Site (perpendicular to the berth face line)

Table 5-6 Design Geological Condition

Surface	Layer	N value	γ (kN/m3)	γ (kN/m3)	C (kN/m2)	ϕ (°)
-23.0m	Soft Clay	2	17	7	C=1.79xZ+25.81 (Z=0 at 0.0)	-
-27.0m	Loose Sand	30	19	10	-	32
	Firm Sand	40	20	10	-	34

Prepared by the Study Team

Table 5-7 Other Natural Conditions

Conditions	Items	Details	
Hydrographic	Tide level	H.H.W.L	+7.10m
		H.W.L	+6.24m
		M.W.L	+3.28m
		L.W.L	+0.33m
		C.D.L	+0.00m
	Current	Velocity	3.1m/s
		Direction	
		Height	H1/3=1.7m
		Period	T1/3=3.5s

		Direction	SW/NW
Meteorological	Wind	Maximum wind velocity	59.2m/s
		Maximum instantaneous wind velocity	72.0m/s
Earthquake		Horizontal seismic coefficient	Kh=0.15
		Vertical seismic coefficient	Kv=0.0

Prepared by the Study Team

(2) Planning Conditions

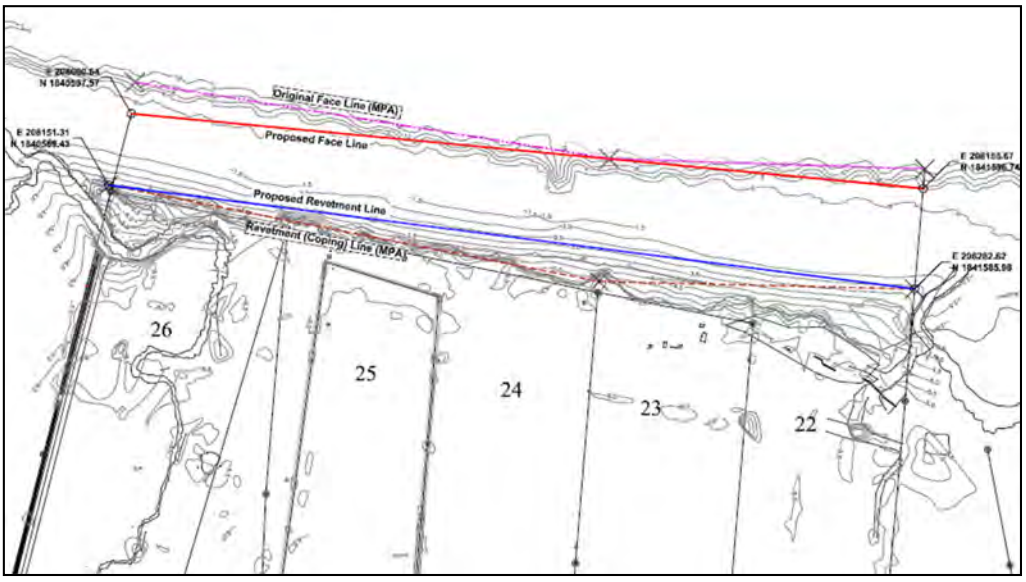
The berth face line in front of Plots 22-26 which was set by MPA has a bent between Plots 23 and 24. A continuous berth having a bent in the face line (see original berth line in Figure 5-5) is not convenient as a berthing facility. The study team has therefore conducted a study and reached a conclusion to use a strait berth face line for the Plots 22~26 as shown in red line in Figure 5-5.

It is necessary to consider the following conditions in the study of the berth face line.

① MPA has already set each berth face line for all Plots in consideration of respective water depth prior to the selling to private corporations.

② The berth face line of a plot owned by individual is modifiable, but the berth line connection point with the neighboring plot can't make so great change.

Other planning conditions are given in Table 5-8.



Prepared by the Study Team

Figure 5-5 Face Line of Berth

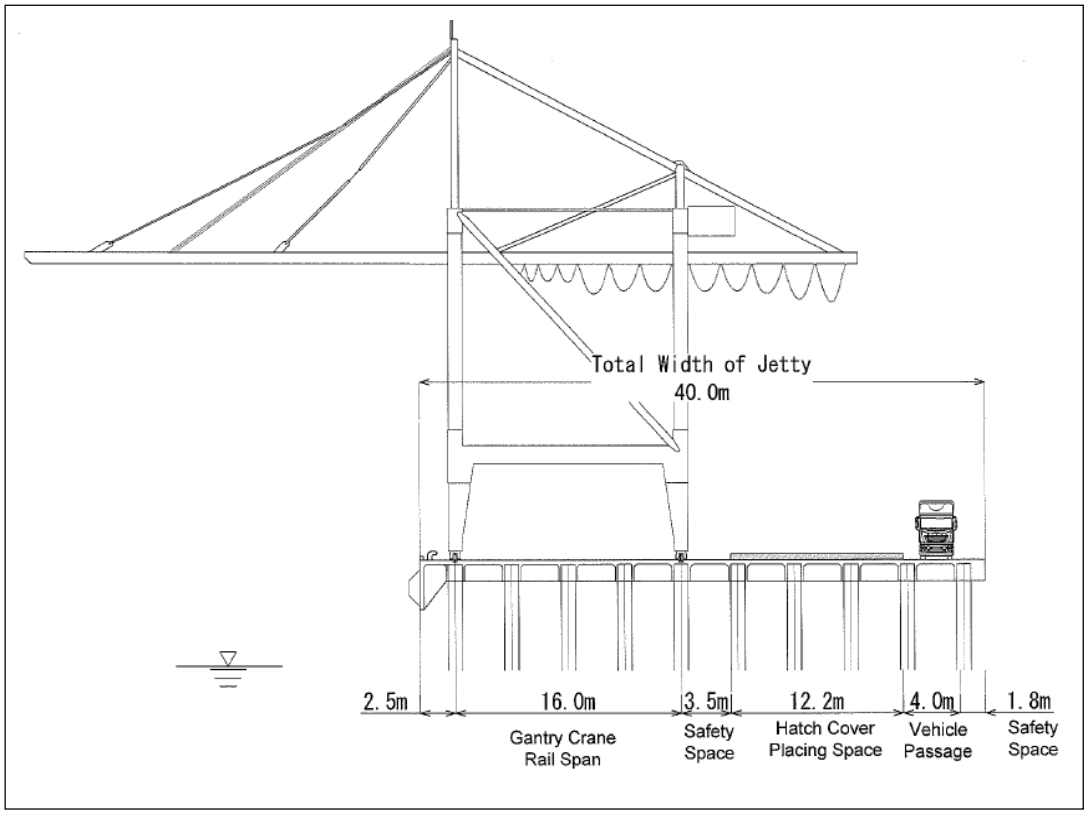
Table 5-8 Other Planning Conditions

Conditions	Items	Details	
Layout	Number of Berths		2Berth
Vessel	Design vessel	DWT	20,000DWT
		Lap	177.0m
		Lpp	165.0m
		B	27.1m
		d	9.0m
		TEU	1,000TEU
Fender	Berthing velocity		V=0.1m/s
	Berthing energy		200kN
		Cell Type・Face Plate 6m	H-1,000mm
		Layout	10mPiti
Mooring bollard	Mooring forces	Bollard	1500kN
		Layout	25mPiti
Surcharge	Surcharge load	Quay	W=20kN/m2
		Container yards	W=50kN/m2
Cargo handling equipment	Gantry container crane	Crane Total Weight	7000kN
		Operating Condition	Pv=450kN/wheel
		Stowed Condition	Pv=600kN/wheel
		Seismic Condition	Pv=450kN/wheel

Prepared by the Study Team

(3) Basic Quaywall Structure

Berth width composition is shown in Figure 5-6.

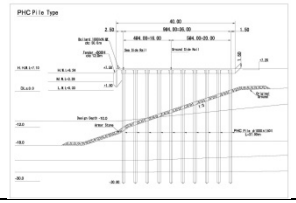
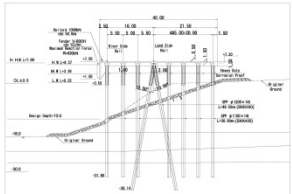
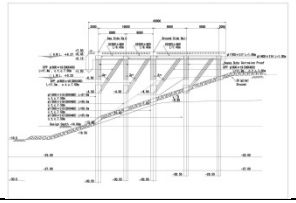
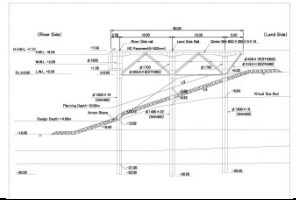


Prepared by the Study Team

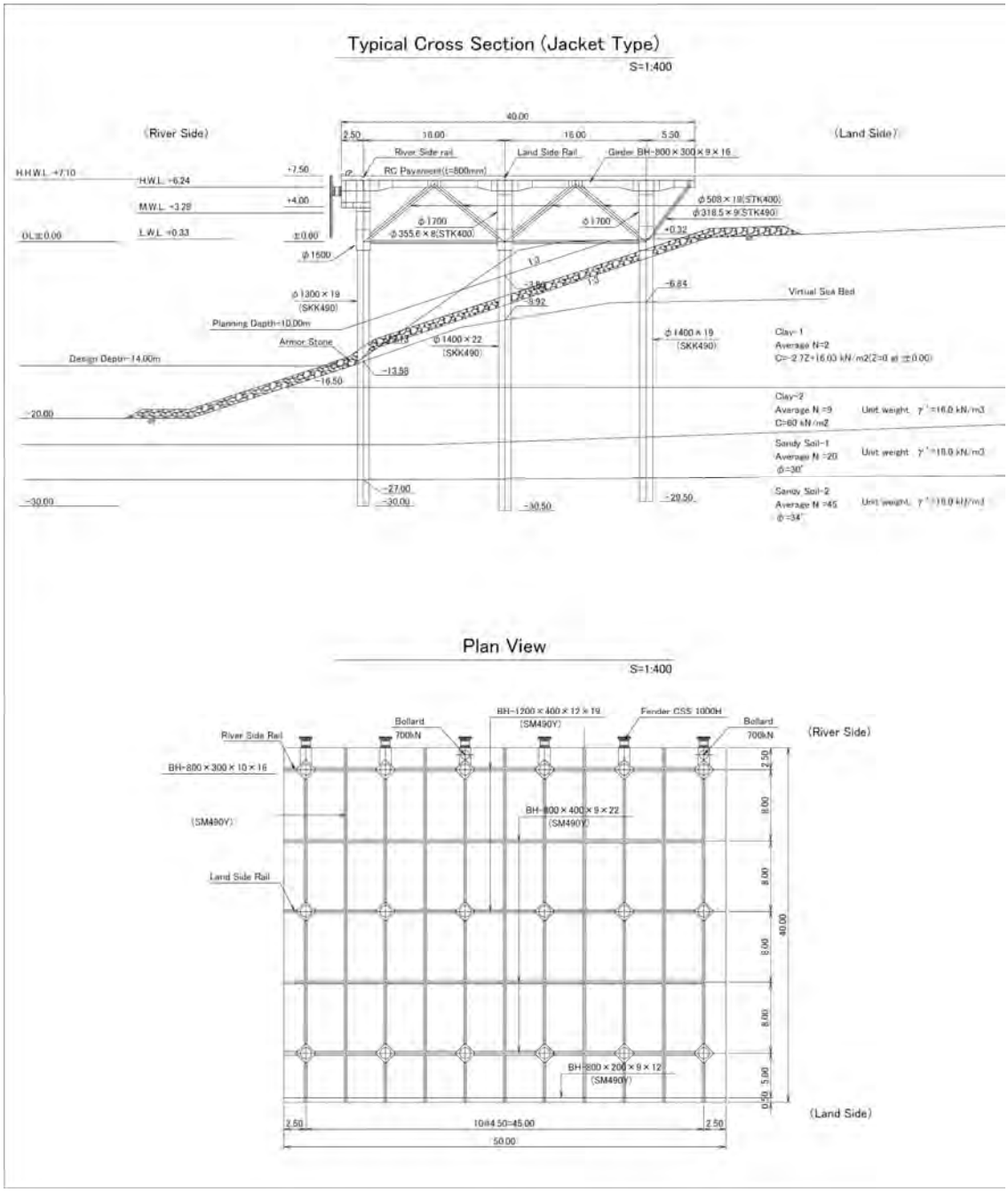
Figure 5-6 Berth Width Composition

A comparison table of pile type quaywall and a general plan of the jacket type structure selected as the most appropriate structure are shown in Table 5-9 and Figure 5-7 respectively.

Table 5-9 Comparison of Pile Type Quaywall

	Vertical pile type		Batter pile type		Strut type		Jacket type	
Typical Cross Section								
		Rate		Rate		Rate		Rate
Structural particulars	-Large number of piles is needed. -Kind of pile material is not retested - Horizontal displacement is large. (>10cm)	C	- Batter piles can reduce total number of piles. - Especially as for batter pile, the kind of pile is in particular retested. -Horizontal displacement is small. (<10cm)	A	- As a beam is connected to the low position of a pile , this type can reduce the number of pile - Horizontal displacement is small. (<10cm)	A	- Jacket structure built-up beams and braces is very stiff. This type can reduce much number of pile. - Horizontal displacement is small. (<10cm)	A
Characteristics for methods Possibility of terminal opening in 2015 (<17.0M/200m)	-Placing of piles is easy. -Many piles are required and it takes a long construction term.	C	-Batter pile receives restrictions in construction. -As the number of pile is smaller, construction term becomes shorter.	C	-High accuracy is required for Strut's manufacture and construction. -The construction term is not so long. - The underwater work of the Strut attachment is hard.	C	- Manufacturing accuracy and quality control are required for a jacket fabrication. - Large-size crane is required for installation of jacket. - The construction term is short.	A
	Construction term : 21.0 M/200 m	C	Construction term : 20.0M/200 m	C	Construction term :19.5 M/200 m	C	Construction term : 16.5 M/200 m	A
Construction cost	- Due to the large number of piles, economical efficiency is poor.	C	-Economical efficiency is higher than a vertical pile type by reducing number of piles.	A	- Although the number of piles is small, Strut's manufacture and attachment raise costs. Economical efficiency is a little low.	B	- Although the number of piles is small, jacket's manufacture and installation raise costs. Economical efficiency is a little low.	B
	Cost：1.74		Cost：1.00		Cost：1.16		Cost：1.16	
Influence on environment	-A lot of piles obstruct the flow of river. -A construction period is long, and there is a lot of influence on environment	C	-A lot of piles obstruct the flow of river. -A construction period is long, and there is a lot of influence on environment	B	-Since there are few piles, the flow of the river is not obstructed. -A construction period is long, and there isa lot of influence on environment	B	-Since there are few piles, the flow of the river is not obstructed. -A construction period is short, and there is little influence on environment	A
Comprehensive valuation And Possibility of terminal opening in 2015	-Economical efficiency is poor. - Displacement is large. -Construction term is long.(Difficult to open in 2015) - It is not suitable for this site.	C	- Displacement is small. -The construction term is comparatively long. (Difficult to open in 2015) - Economical efficiency is good. - It is suitable for this site.	B	- Strut's underwater work is hard. -The construction term is comparatively long. (Difficult to open in 2015) - Economical efficiency is a little low. - It is not suitable for this site.	C	- The construction term is short. (Possible to open in 2015) - Economical efficiency is a little low. -This structure type can be recommended as a suitable structure for this site.	A
Evaluation	**Not recommendable** (high construction cost and long construction term)	**C**	**Recommendable** (a little high economical efficiency and a little long construction term)	**B**	**Not recommendable** ((high construction cost and hard construction)	**B**	**Most recommendable** (short construction term and good stability)	**A**

prepared by the Study Team



Prepared by the Study Team

Figure 5-7 General Plan of Jacket Typical Structure

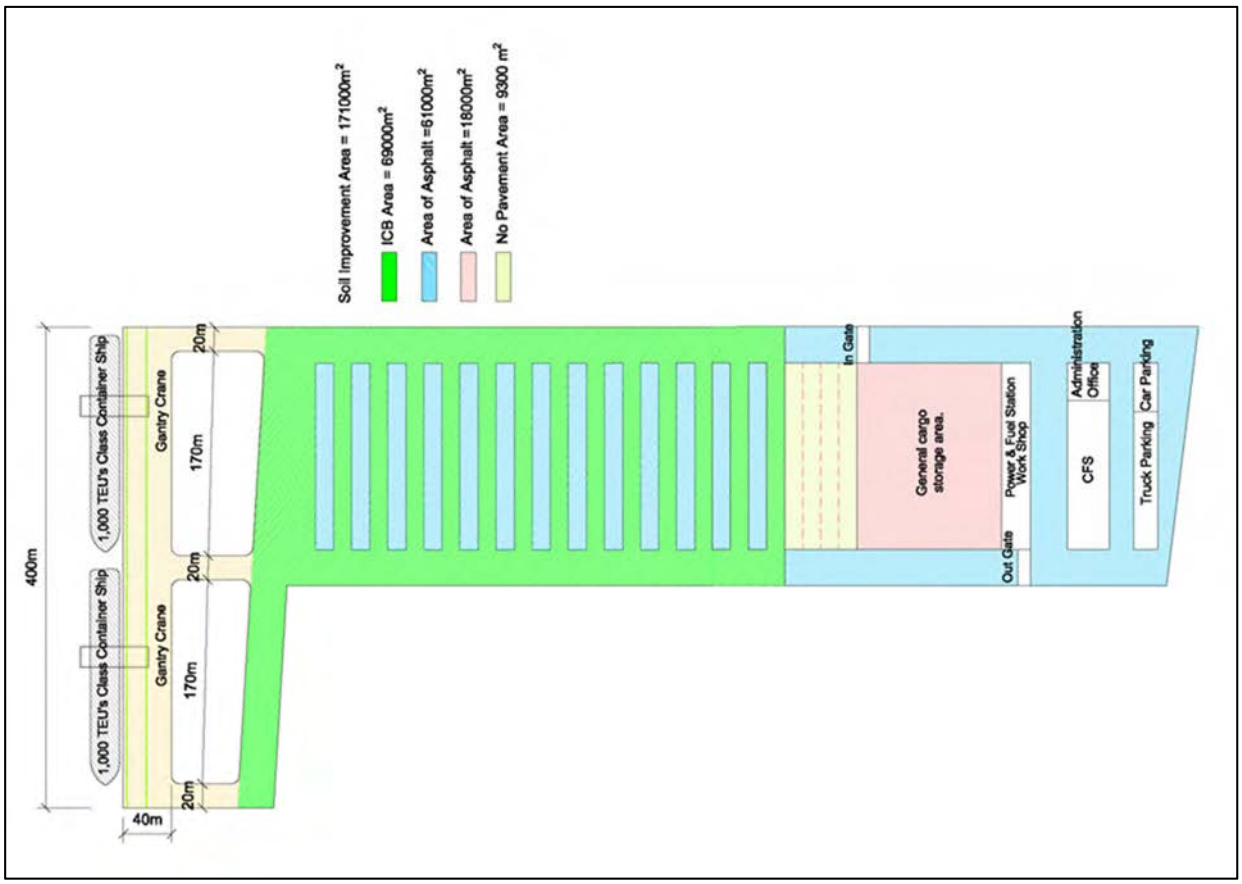
(4) Land Reclamation Design

The necessary elevation of the yard surface is CDL+8.0m. The elevation of reclaimed land is CDL+7.5m taking into account the pavement thickness of 50 cm.

As a result of comparing some soil improvement methods, a consolidation settlement acceleration method by PVD (Prefabricated Vertical Drain) with preloading is adopted as a soil improvement method in view of construction speed and economy.

(5) Pavement Design

Layout plan of the soil improvement and pavement is given in Figure 5-8.



Prepared by the Study Team

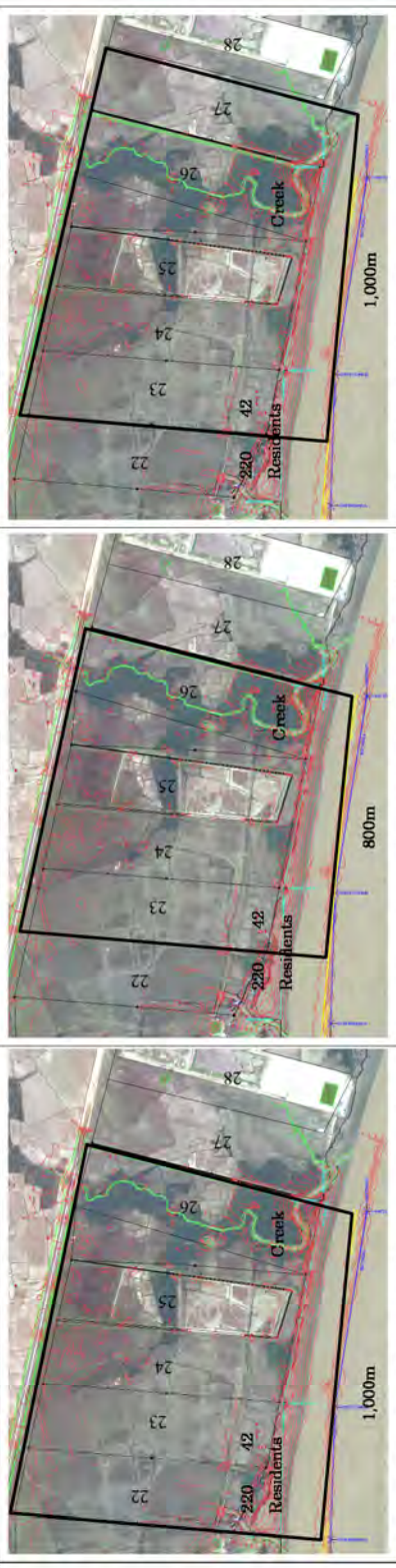
Figure 5-8 Layout Plan of the Soil Improvement and Pavement

5.5. Environmental and Social Consideration

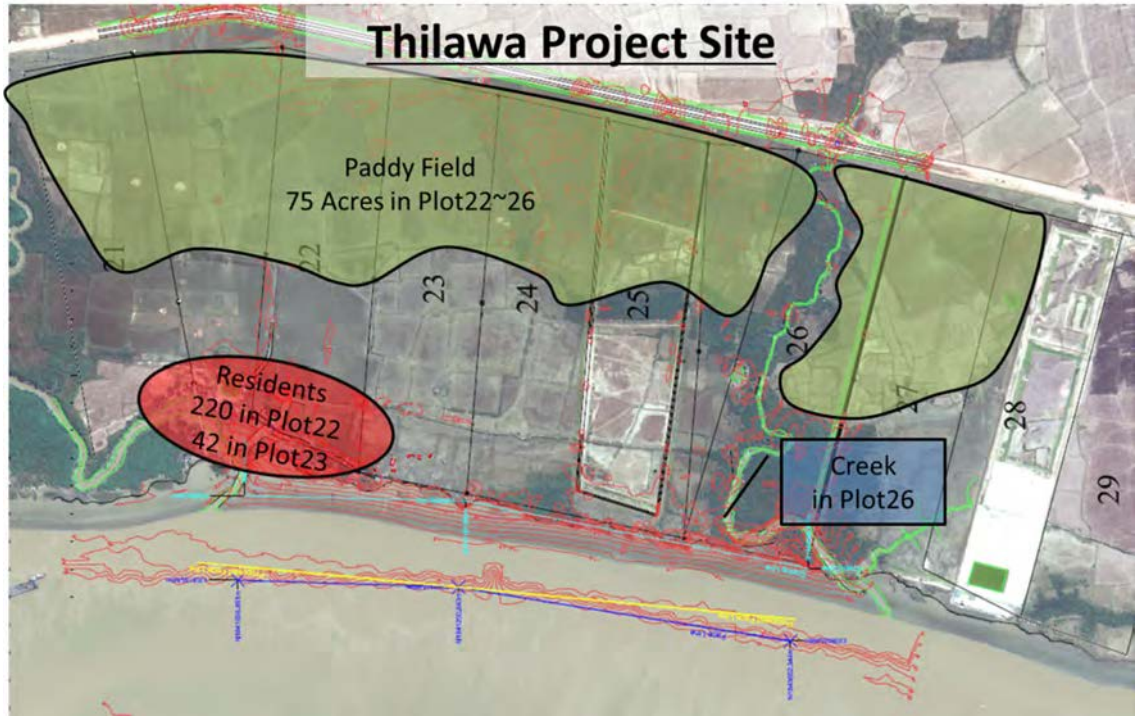
5.5.1. Determination of Project Planning Site

Thilawa Area Port is composed of 37 Plots. 5 plots from Plot 22 to Plot 26 are allocated for the Project Site. From the aspects of not only future demands, commercial issues, technical issues but also environmental and social considerations, alternatives of terminal location are compared as shown in Table 5-10. The Study Team examined 3 alternatives (Alternative 1: 1,000m from Plot 22 to Plot 26, Alternative 2: 800m from Plot 23 to Plot 26 and Alternative 3: 1,000m from Plot 23 to Plot 27) and concluded that Alternative 2 is an optimum alternative based on overall evaluation.

Table 5-10 Comparison of Alternatives of Terminal Location

	Alternative 1 (1,000m between Plots 22 and 26)		Alternative 2 (800m between Plots 23 and 26)		Alternative 3 (1,000m between Plots 23 and 27)	
Plan						
M/M Agreement	✓ Plan is in line with the M/M agreed between JICA and MPA.	A	✓ M/M agreement may not need to be changed.	B	✓ Amendment of M/M is needed.	C
Social Environmental Impacts	✓ There are 220 and 42 residents in Plots 22 and 23 respectively, and it will take a long time to clear "JICA Guidelines for Environmental and Social Considerations (April 2010)" including possible resettlement. ✓ Current use of 75.4 acre paddy field needs to be examined according to the above JICA Guidelines.	D B-	✓ Relocation of 42 residents in Plot 23 is still needed, but relocation of 220 residents in Plot 22 can be avoided. ✓ Current use of 57.9 acre paddy field needs to be examined according to the JICA Guidelines.	B B	✓ Relocation of 42 residents in Plot 23 is still needed, but relocation of 220 residents in Plot 22 can be avoided. ✓ Current use of 77.9 acre paddy field needs to be examined according to the JICA Guidelines.	B B-
Natural Environmental Impacts	✓ Natural environmental preservation around the creek in Plot 26 needs to be considered.	B	✓ Same as Alternative 1	B	✓ Same as Alternative 1	B
Technical Issues	✓ All natural condition survey has been conducted.	A	✓ All natural condition survey has been conducted.	A	✓ Additional natural condition survey is required in Plot 27. ✓ Large volume of dredging is required due to the straight extension of face line toward Plot 27. This affects planning and use of Plot 28.	B C
Flexibility of Future Demands	✓ Flexibility in responding to future demand increase is high.	A	✓ Flexibility in responding to future demand increase is inferior to Alternatives 1 and 3 because of shorter berth length.	B	✓ Same as Alternative 1	A
Commercial Issues	✓ No commercial issue.	A	✓ No commercial issue.	A	✓ Only Plot 28 remains. Selling of one plot may be hard.	B
Total Evaluation	C		A		B	

① 220 persons are living in Plot 22 and 42 are living in Plot 23 and a part of areas between Plot 22 and Plot 26 is cultivated by farmers illegally as shown in Figure 5-9. MPA claims that the project site area is owned by MPA and farmers cultivate the area illegally.



Prepared by the Study Team (Google Earth)

Figure 5-9 Present Land Use of the Project Site

② There are social environmental issues at the project site as shown above. Taking into account anticipated resettlement scale of the above, the area between Plots 23 and 26 with a total length of 800 m is determined as the area to be used for the project.

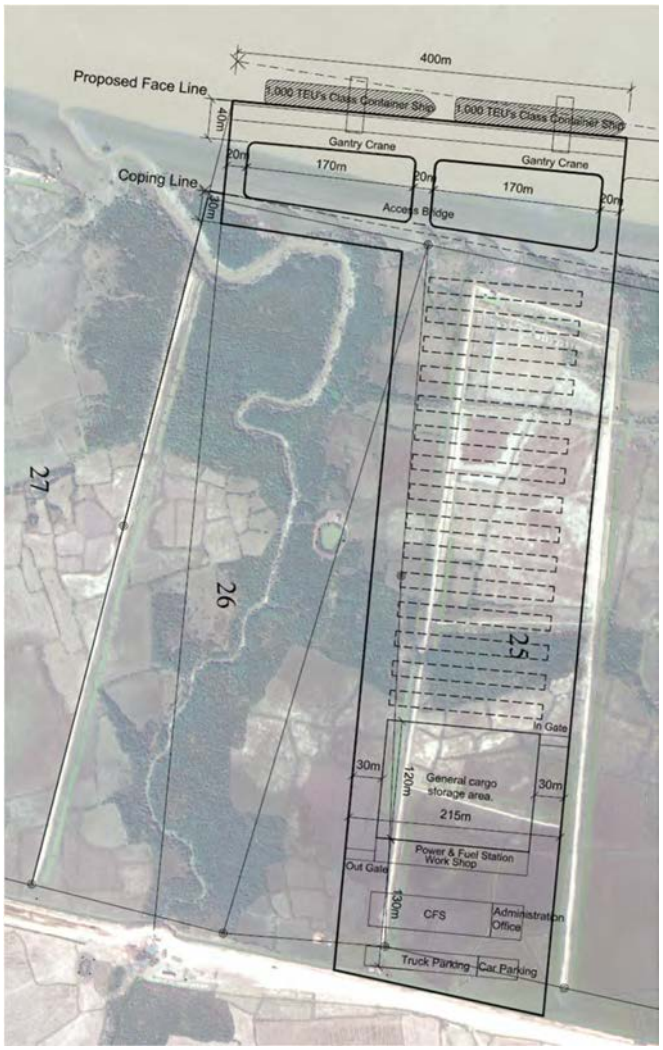
6. Urgent Development Plan of Thilawa Area

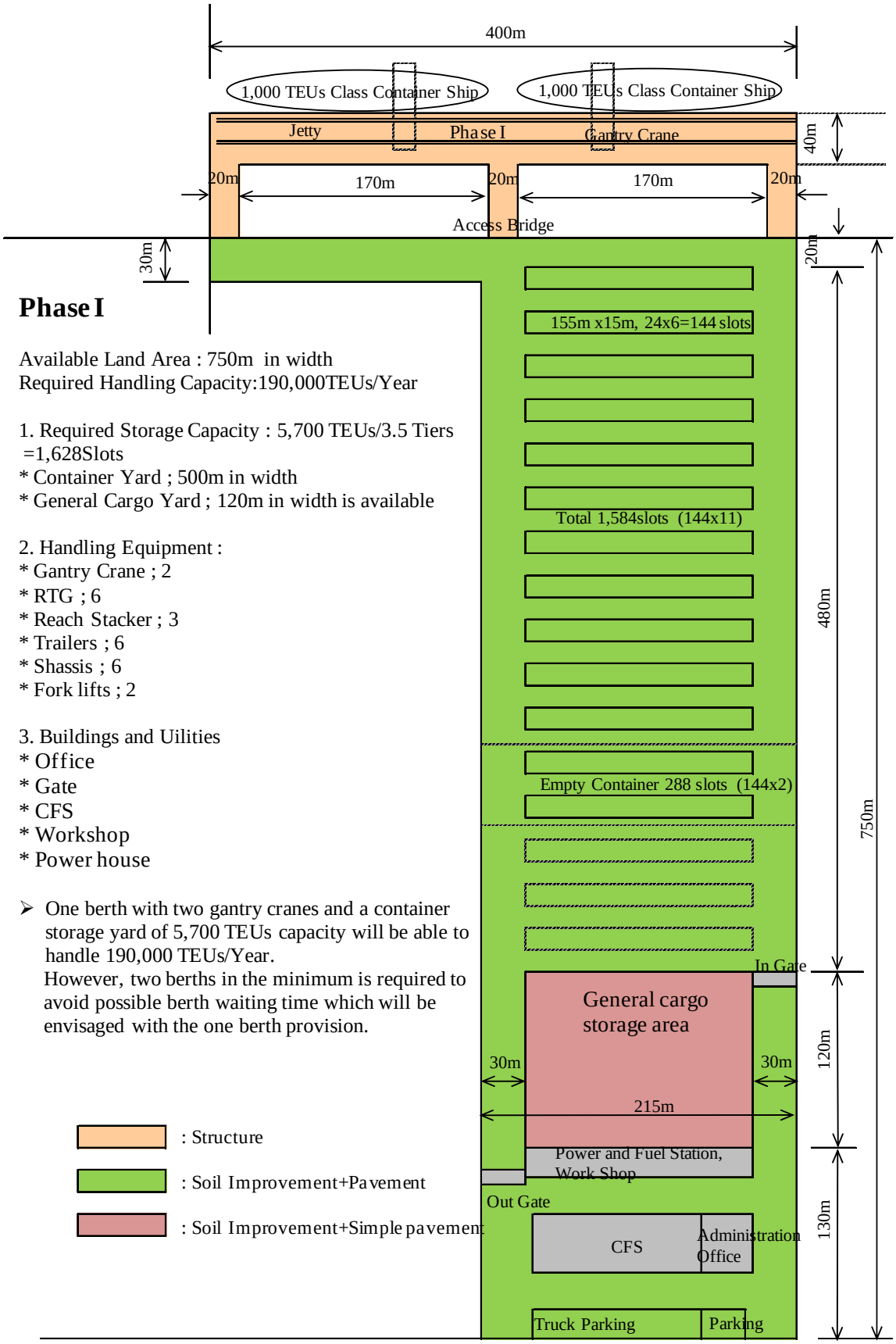
6.1. Urgent Development Plan

As shown in **5.3.1(1) Layout Plan**, there is a need to develop a container terminal with an 800m jetty at Thilawa Area Port by the year 2020 in case of the high case demand forecast. In particular, it is urgently needed to construct a terminal for handling containers generated from the SEZ which is expected to be in operation by the year 2015. One berth terminal with 200m quaywall in length and a container storage yard of 5,700 TEUs can handle SEZ related containers expected to be generated in the year 2015.

In case of one berth terminal, frequency of the berth waiting is expected to increase. It is necessary to prepare a two-berth terminal to ensure that ships do not have to wait for berthing frequently. From the navigational constraints, the maximum size of ships entering Thilawa Area Port is limited to 200 m LOA and 9 m draft. This ship is equivalent to 1,000 TEUs class in case of container ship.

Layout of the urgent development plan is given in Figure 6-1.





Prepared by the Study Team

Figure 6-1 Layout Plan of Thilawa Area Port Terminal (Urgent)

6.2. Environmental and Social Considerations

Environmental and social impacts which are expected to affect by the project implementation are evaluated as shown in Table 6-1. As the results, the mitigation measures and the monitoring plan as shown in Table 6-2 and Table 6-3 are proposed.

Table 6-2 Mitigation Measures

No.	Impacts	Mitigation Measures
During Const.		
1	Air Pollution	To carry out necessary countermeasures for dust prevention such as cleaning tires and water spray, etc. if a large amount of removed soil after soil improvement should be delivered by trucks from the site.
2	Water Pollution	①To monitor turbidity in the Yangon River during dredging, disposal of dredged material and collecting landfilling material. To select mitigation method which generates less turbidity during dumping of dredged material in the River, such as usage of bottom-dump barge. To take into account a silt curtain or work volume restriction, in case a mass turbid water.. ②To monitor water quality of surplus water from land filling material, ③To prevent washing water used for construction equipment especially agitator cars from discharge directly to the river ④To maintain construction equipment in good condition, and to prepare contingency plans for oil leakage such as preparation of oil fence, neutralization reagent and adsorbing material ⑤To install sanitary facilities such as temporary toilets or septic tanks at the construction sites and to operate those appropriately.
3	Wastes	①To prohibit dumping all solid wastes including stripped vegetation except for dredged soil in the river or any other place unless the approved dumping site To minimize solid waste through reuse and recycling, To collect and dispose those appropriately under responsibility of contractor. ②To prevent turbidity and diffusion of contaminated soil for example by using bottom-dump barge during disposal of dredged material in the river.
5	Noise/ Vibrations	①To appropriately maintain construction vehicles ②To consider inhabitants and road users (strictly abide by the speed limit and avoid unnecessary revving/idling, etc.)
8	Sediment	①To minimize dispersion of sediment (see “Water Pollution”) ②To monitor sediment quality at the dumping site in the River before and after dumping.
10	Ecosystem	①To install green-belt in the yard ②To conduct water pollution counter measure to reduce ecosystem deterioration
11	Hydrology	①To install bypass drainage to secure the same sectional area as the existing discharge ②To install culvert or other structure to avoid stoppage of the stream at the west side channel along the road
13	Involuntary Resettlement/Site Acquisition	To conduct income restoration measures and its monitoring (See ANNEX Resettlement Action Plan(Draft))
16	Local Economy such as Employment and Livelihood	①To minimize turbid water (see “Water Pollution”) ②To take necessary action to secure fishery activities at the delivery of soil on river traffic ③To conduct income restoration measures and its monitoring (See ANNEX Resettlement Action Plan(Draft))
17	Land Use and Utilization of Local Resources	①To install discharge channel , etc. avoiding influence of surplus water from land filling to the surrounding paddy field ②To minimize turbid water (see “Water Pollution”)
27	Infectious diseases such as HIV/AIDS	To educate construction workers on prevention against infectious diseases (HIV/AID etc.) at safety induction course

No.	Impacts	Mitigation Measures
28	Work Environment (incl. Work Safety)	To establish and comply with safety standards for project site (e.g., safety training, periodical safety patrol, or safety meeting, etc.)
29	Accidents	To plan and comply with on-land and marine traffic regulation/rules for project (e.g., providing fence, sign board, or off-limits area of outsiders, and arrangement of guardsman or security boat, etc.)
Operation Phase		
2	Water Pollution	①To discharge sewer and domestic wastewater from the office after appropriate treatment ②To provide oil separator at places where oily wastewater is generated such as container cleaning or maintenance areas ③To recover sludge in septic tank and waste oil in oil separator periodically and ensure that it is appropriately treated ④To monitor water quality at drainage or surrounding of the port
3	Wastes	①To prohibit disposal to the river and any place without permit and direction ②To promote recycle and handle waste properly
5	Noise/Vibrations	①To properly conduct maintenance of cargo truck to mitigate noise/vibrations ②To consider inhabitants and road users (strictly abide by the speed limit and avoid unnecessary revving/idling, etc.)
8	Sediment	To conduct water pollution counter measure to reduce deterioration of sediment
10	Ecosystem	To conduct water pollution counter measure to reduce ecosystem deterioration
17	Land Use and Utilization of Local Resources	To conduct water pollution counter measure to reduce impact on agricultural resources
18	Water Use	To ensure that the water supply will have no harmful impact on the surrounding environment, through discussions with MOC and MOI, etc. will be held
27	Infectious diseases such as HIV/AIDS	To provide education of port workers on prevention against infectious diseases (HIV/AID etc.) at safety induction course
28	Work Environment (incl. Work Safety)	To establish and comply with safety standards for operation site
29	Accidents	To plan and comply with on-land and marine traffic regulation/rules for project

Prepared by the Study Team

6.3. Port Management and Operation System

The Study Team suggests the following PPP scheme for Urgent Development Plan of Thilawa Area:

a) Duration of JV should be 40 years corresponding to the repayment period of Japanese ODA loan (40-year repayment with 10-year grace period).

b) The concession fee should be composed of the fixed fee and variable fee. The fixed fee should be set based on the financial analysis so that MPA can repay the interest and principal of Japanese ODA loan out of the fixed fee and it should be a given condition in the operator selection process. It would be better to set the fixed fee lower in the construction period and the early stage of operation in which a new terminal generally has a limited number of customers. Profit sharing between the JV partners based on equity ratio is recommended to encourage management efforts (Figure 6-2). JV (SPC) is expected to pay the fixed fee as is the case with Sule Pagoda Terminal.

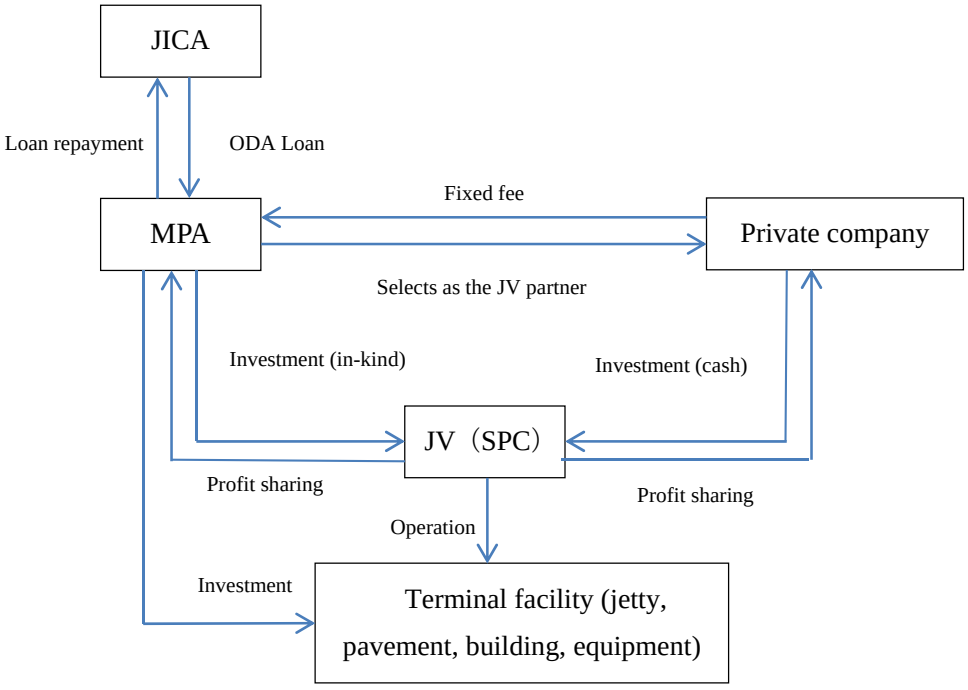


Figure 6-2 PPP scheme for Urgent Development Plan of Thilawa Area (JV scheme)

c) The following criteria is recommended to select the operator (JV partner)

- ✧ Financial soundness
- ✧ Experience of terminal operation
- ✧ Credibility of the terminal operation plan

Demand forecast

Estimated financial statement

Marketing plan

Access transportation plan

Staffing plan

Terminal operation system

✧ Estimated profit share

MPA could concede the terminal operation to a private company by leasing out its facility and equipment. In this case too, the concession period should be 40 years corresponding to the repayment period of Japanese ODA loan (40-year repayment with 10-year grace period). The fixed fee should be set based on the financial analysis so that MPA can repay the interest and principal of Japanese ODA loan out of the fixed fee and it should be a given condition in the operator selection process. It would be better to set the fixed fee lower in the construction period and the early stage of operation in which a new terminal generally has a limited number of customers. Since it is rather difficult for MPA to check the administration costs in the lease scheme, MPA would favor revenue sharing rather than profit sharing. On the other hand, revenue sharing scheme involves a greater risk for the private company (concessionaire) in the event of an economic downturn.

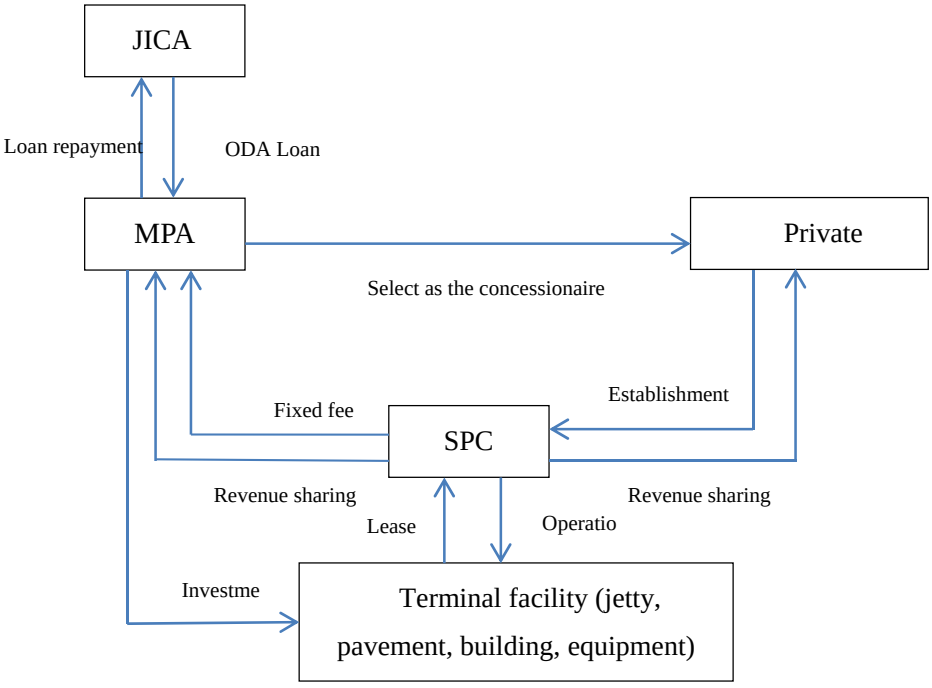


Figure 6-3 PPP scheme for Urgent Development Plan of Thilawa Area (lease scheme)

6.4. Project Cost Estimate and Implementation Schedule

6.4.1. Project Cost Estimate

Project cost estimate subject to the Japanese ODA Loan is shown in Table 6-4.

Table 6-4 Project Cost Summary

Item		Content	Total (1,000 US$)	FC (1,000 US$)	LC (1,000US$)	Remark
1	Construction and Procurement		**192,614**	**150,874**	**41,740**	Sum of item 1
	(1)	Civil and Building	139,042	104,099	34,943	Land preparation, Jetty, Trestle, Pavement, Drainage, Buildings, Facility
	(2)	Cargo Handling Equip.	32,763	32,763	0	STS crane, RTG, Trailer, Chassis, Reachstacker, Forklift
	(3)	Working Boat	0	0	0	Tugboat, Pilot boat
	(4)	Aid to Navigation	0	0	0	Pilot station, VTMS
		sum	171,805	136,862	34,943	
	(3)	Inflation contingency	9,906	5,471	4,434	FC: 2.1% /year LC: 6.1% /year
	(4)	Physical contingency	10,903	8,540	2,363	6%
2	Consultant Cost		**12,329**	**7,203**	**5,125**	Sum of item 2
	(1)	Design	0	0	0	
	(2)	Supervision	11,009	6,632	4,376	
	(1)	Base cost	11,009	6,632	4,376	
	(2)	Inflation contingency	733	228	505	FC: 2.1% /year LC: 6.1% /year
	(3)	Physical contingency	587	343	244	5%
3	Project Administration Cost		2,031	0	2,031	1%
4	Preparation Cost					
	(1)	Compensation	0	0	0	
	(2)	EIA Cost	0	0	0	
5	Tax		2,343	0	2,343	5% commercial tax. Assume import duties are exempted.
6	Interest					
	(1)	Interest	42	42	0	0.01% /year
	(2)	Commitment charge	0	0	0	0% /year
7	Total	Project Cost	**209,359**	**158,120**	**51,240**	
	Total	JICA Portion	**204,985**	**158,120**	**46,865**	Item 1, 2, and 6

Prepared by the Study Team

Project estimate of all 3 Phases is shown in Table 6-5

Table 6-5 Cost Estimate Summary of 3 Phases

Phase I

Item	Amount (million US$)
A. Civil	**171**
i. Wharf (400m) urgent	110
ii. Reclamation & Soil Improvement	30
iii. Pavement & Drainage	8
iv. Buildings	6
v. Utilities	17
B. Cargo Handling Eqiupment	**38**
i. STS Ganrty Crane (2 units)	20
ii. RTG(6), Reachstacker(3), Chassis+Truck(6), Forklift(2)	18
C. Working Boat	
D. Aid to Navigation	
sum	**209**

Phase II

Item	Amount (million US$)
A. Civil	**54**
i. Wharf	0
ii. Reclamation & Soil Improvement	25
iii. Pavement & Drainage	7
iv. Buildings	6
v. Utilities	17
B. Cargo Handling Eqiupment	**38**
i. STS Ganrty Crane (2 units)	20
ii. RTG(6), Reachstacker(3), Chassis+Truck(6), Forklift(2)	18
C. Working Boat	**28**
i. Tugboat (2 unit)	18
ii. Pilot Boat (3 units)	10
D. Aid to Navigation	**64**
i. Safety Navigation Facilities	50
ii. Pilot station (offshore)	14
sum	**185**

Phase III

Item	Amount (million US$)
A. Civil	**212**
i. Wharf (400m) normal	95
ii. Reclamation & Soil Improvement	56
iii. Pavement & Drainage	16
iv. Buildings	12
v. Utilities	33
B. Cargo Handling Eqiupment	**76**
i. STS Ganrty Crane (4 units)	40
ii. RTG(12), Reachstacker(6), Chassis+Truck(12), Forklift(4)	36
C. Working Boat	
D. Aid to Navigation	
sum	**288**

Prepared by the Study Team

6.4.2. Construction Schedule

(1) Construction Plan

① **Site Preparation:** Currently, the project site is swamp, and is partly covered with shrubs. First, the shrubs are cut and removed manually. Then, about one meter thick sand (sand mat) are placed on the surface all over the site, which is used for the working platform for the PVD driving machines as well as the access from the landside and construction yard. The sand mat is filled hydraulically. A trailing suction hopper dredger (TSHD) dredges the sea sand from the borrow pit expected to be near the Outer Bar, travels to the site, and discharges the sand mixed with water directly to the site through the discharge pipe line. While placing the sand mat, revetment at the waterfront is constructed, and the construction of the revetment is completed before placing the preload sand.

② **Soil Improvement:** PVD (plastic vertical drain) method is applied for the soil improvement of the terminal area. About four PDV driving machines are mobilized to drive the plastic drain material into the about 30m of the soft subsoil layer (as seen in the picture). After completion of the vertical PDV driving, horizontal drain material (similar to the vertical drain material) is placed, and the preload sand will be filled hydraulically 2 to 6m thickness in order to expedite the consolidation of the soft subsoil layer. When the consolidation ratio reaches the required level, surcharge fill are removed and transported to the Phase II site adjacent to the Phase I area by earth equipment such as backhoe and dump truck. The sand transported sand will be used for the sand mat for the Phase II.

③ **Jetty Foundation**: A piling barge is mobilized to drive the steel pipe piles at the jetty. Since the river flow is very fast, it is very difficult to splice the piles on the water. Thus, piles are

spliced to the required length (about 40m) before the pile is brought to the piling barge for driving. Piling barge and the hammer shall be capable to drive the pile with 1200 mm diameter and 40m length. As for the pile driving at the trestle, when the piling barge cannot access near the shore, temporary bridge is constructed along the trestle and a crawler crane is mounted on the bridge for driving piles.

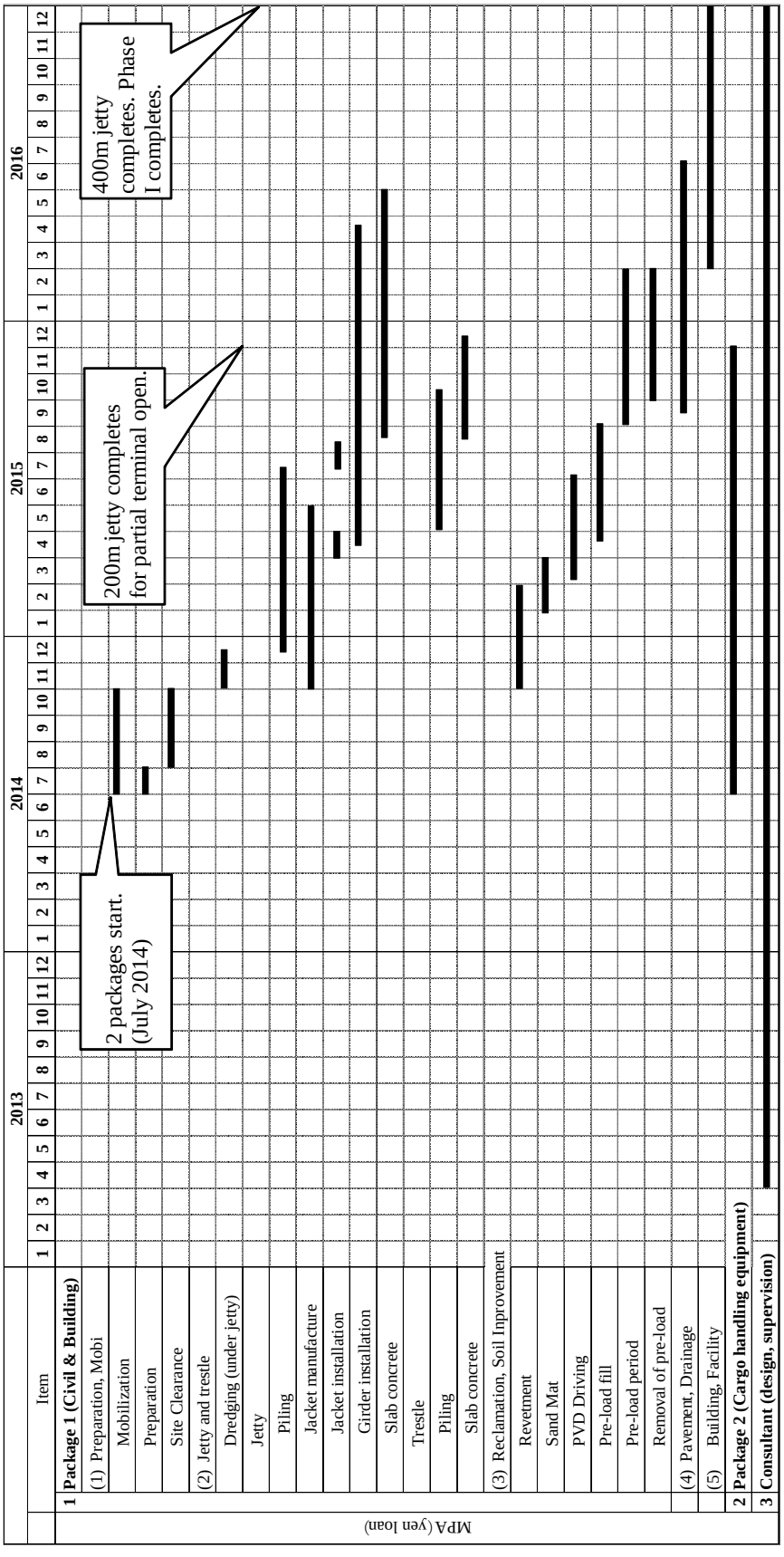
④ **Jetty Upper Structure:** Pre-fabricated jacket will be installed on the driven piles by a large crane barge (picture). The jacket is manufactured in a factory, and transported to the site by a barge. A concrete batching plant is established at the site to mix and provide the concrete for the project. Since the milestone of the 17th month (November 2015) requires that 200m of the jetty and two trestles be completed, jetty materials such as fender and bollard need to be procured to stay on schedule.

⑤ **Pavement and Building & Facility:** As soon as the preload fill is removed, the terminal operator can commence the work. To make the part of the terminal operational in December 2015, necessary access road and the terminal yard are constructed first.

(2) Project Implementation Schedule

Table 6-6 shows the implementation schedule of the Urgent Development Plan of Thilawa Area (Phase I).

Table 6-6 Project Implementation Schedule



Prepared by the Study Team

6.4.3. Economic and Financial Analysis

(1) Thilawa Area Port Development Project

1) Economic Analysis

Estimate of Economic Internal Rate of Return (EIRR) is as below;

- Economic benefit; added value of export containers
- Cost ;
  - Construction, maintenance and repair of facilities,
  - Purchase, maintenance, repair and renewal of handling equipment and,
  - Operation cost of the terminal.
- Evaluation period; 30 years

EIRR ; 14.8 % (Bench mark value of World Bank is 12%)

Table 6-7 EIRR of Thilawa Area Port Development Project

Unit: '000 USD/Yr

Year		Cost				Revenue		Total	Cost+10% Revenue-10% Total
		Const-ruction	Mainte-nance	Terminal Operation	Tug	Container (TEU)	Value		
2013		1,229	0	0	0	0	0	-1,229	-1,352
2014		64,755	57	0	0	0	0	-64,812	-71,294
2015	1	78,594	329	108	25	24,000	6,300	-72,757	-81,292
2016	2	123,205	851	433	96	92,000	24,150	-100,435	-115,309
2017	3	207,401	1,077	650	83	79,000	20,738	-188,472	-211,467
2018	4	245,493	1,249	650	34	33,000	8,663	-238,763	-264,372
2019	5	114,706	1,464	1,300	4	4,000	1,050	-116,423	-128,276
2020	6	0	2,392	2,599	167	160,000	42,000	36,842	32,126
2021	7	0	3,507	2,599	400	383,000	100,538	94,031	83,327
2022	8	0	4,742	2,599	658	630,000	165,375	157,376	140,038
2023	9	0	5,592	2,599	836	800,000	210,000	200,973	179,071
2024	10	0	5,592	2,599	836	800,000	210,000	200,973	179,071
2025	11	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2026	12	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2027	13	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2028	14	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2029	15	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2030	16	0	10,956	2,599	836	800,000	210,000	195,609	173,170
2031	17	0	15,395	2,599	836	800,000	210,000	191,171	168,288
2032	18	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2033	19	0	14,441	2,599	836	800,000	210,000	192,124	169,337
2034	20	0	41,115	2,599	836	800,000	210,000	165,451	139,996
2035	21	0	32,082	2,599	836	800,000	210,000	174,483	149,932
2036	22	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2037	23	0	15,421	2,599	836	800,000	210,000	191,144	168,259
2038	24	0	35,454	2,599	836	800,000	210,000	171,112	146,223
2039	25	0	25,440	2,599	836	800,000	210,000	181,125	157,237
2040	26	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2041	27	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2042	28	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2043	29	0	5,408	2,599	836	800,000	210,000	201,157	179,273
2044	30	0	5,408	2,599	836	800,000	210,000	201,157	179,273
Total		835,383	282,053	68,118	19,850	19,005,000	4,988,813	3,783,409	3,185,823

EIRR	14.8%	12.3%

2) Financial Analysis

Estimate of Financial Internal Rate of Return (FIRR) is as below;

- Revenue; Revenue based on MPA tariff
- Cost;
  - Construction, maintenance and repair of facilities,
  - Purchase, maintenance, repair and renewal of handling equipment and working vessels,
  - Operation cost of the terminal and
  - Construction and maintenance of navigation safety facilities
- Evaluation period; 30 years

FIRR ; 9.7 % (Market interest is about 10%)

Table 6-8 FIRR of Thilawa Area Port Development Project

Unit: '000 USD/Yr

Year		Cost			Revenue				Total	Cost+10% Revenue-10% Total
		Const-ruction	Main-tenance	Terminal Opera-tion	Container (TEU)	Container Handling	Port Entry charges	Revenue Total		
2013		1,246	0	0	0	0	0	0	-1,246	-1,370
2014		67,148	0	0	0	0	0	0	-67,148	-73,862
2015	1	83,997	280	139	24,000	3,924	233	4,157	-80,259	-89,116
2016	2	128,383	815	555	92,000	15,042	893	15,935	-113,819	-128,387
2017	3	207,401	1,049	833	79,000	12,917	767	13,683	-195,599	-217,896
2018	4	245,493	1,221	833	33,000	5,396	320	5,716	-241,831	-267,157
2019	5	114,706	1,436	1,666	4,000	654	39	693	-117,115	-128,965
2020	6	0	2,364	3,332	160,000	26,160	1,553	27,713	22,017	18,676
2021	7	0	3,479	3,332	383,000	62,621	3,717	66,338	59,527	52,212
2022	8	0	4,714	3,332	630,000	103,005	6,115	109,120	101,073	89,357
2023	9	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2024	10	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2025	11	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2026	12	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2027	13	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2028	14	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2029	15	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2030	16	0	11,112	3,332	800,000	130,800	7,764	138,564	124,120	108,819
2031	17	0	15,551	3,332	800,000	130,800	7,764	138,564	119,682	103,937
2032	18	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2033	19	0	14,597	3,332	800,000	130,800	7,764	138,564	120,636	104,986
2034	20	0	41,271	3,332	800,000	130,800	7,764	138,564	93,962	75,645
2035	21	0	32,238	3,332	800,000	130,800	7,764	138,564	102,994	85,581
2036	22	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2037	23	0	15,577	3,332	800,000	130,800	7,764	138,564	119,655	103,908
2038	24	0	35,610	3,332	800,000	130,800	7,764	138,564	99,623	81,872
2039	25	0	25,597	3,332	800,000	130,800	7,764	138,564	109,636	92,887
2040	26	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2041	27	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2042	28	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2043	29	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
2044	30	0	5,564	3,332	800,000	130,800	7,764	138,564	129,668	114,922
Total		848,373	284,812	87,321	19,005,000	3,107,318	184,454	3,291,772	2,071,266	1,620,038

FIRR	9.7%	7.6%

(2) Thilawa Area Port Urgent Development Project

1) Economic Analysis

Estimate of Economic Internal Rate of Return (EIRR) is as below;

- Economic benefit; added value of export containers
- Cost ;
  - Construction, maintenance and repair of facilities,
  - Purchase, maintenance, repair and renewal of handling equipment and,
  - Operation cost of the terminal.
- Evaluation period; 30 years

EIRR ; 14.6 % (Bench mark value of World Bank is 12%)

Table 6-9 EIRR of Thilawa Area Urgent Port Development Project

Year		Cost				Revenue		Total	Cost+10% Revenue-10% Total
		Const-ruction	Mainte-nance	Terminal Operation	Tug	Container (TEU)	Value		
2013		1,229	0	0	0	0	0	-1,229	-1,352
2014		64,755	57	0	0	0	0	-64,812	-71,294
2015	1	78,594	329	108	25	24,000	6,300	-72,757	-81,292
2016	2	46,591	826	433	96	92,000	24,150	-23,797	-31,007
2017	3	0	836	650	83	79,000	20,738	19,169	16,938
2018	4	0	606	650	34	33,000	8,663	7,372	6,377
2019	5	0	461	650	4	4,000	1,050	-65	-282
2020	6	0	1,241	650	167	160,000	42,000	39,942	35,536
2021	7	0	1,241	650	167	160,000	42,000	39,942	35,536
2022	8	0	1,241	650	167	160,000	42,000	39,942	35,536
2023	9	0	1,241	650	167	160,000	42,000	39,942	35,536
2024	10	0	1,241	650	167	160,000	42,000	39,942	35,536
2025	11	0	1,241	650	167	160,000	42,000	39,942	35,536
2026	12	0	1,241	650	167	160,000	42,000	39,942	35,536
2027	13	0	1,241	650	167	160,000	42,000	39,942	35,536
2028	14	0	1,241	650	167	160,000	42,000	39,942	35,536
2029	15	0	1,241	650	167	160,000	42,000	39,942	35,536
2030	16	0	6,789	650	167	160,000	42,000	34,394	29,433
2031	17	0	11,228	650	167	160,000	42,000	29,955	24,551
2032	18	0	1,241	650	167	160,000	42,000	39,942	35,536
2033	19	0	1,241	650	167	160,000	42,000	39,942	35,536
2034	20	0	9,856	650	167	160,000	42,000	31,328	26,060
2035	21	0	9,856	650	167	160,000	42,000	31,328	26,060
2036	22	0	1,241	650	167	160,000	42,000	39,942	35,536
2037	23	0	1,241	650	167	160,000	42,000	39,942	35,536
2038	24	0	1,241	650	167	160,000	42,000	39,942	35,536
2039	25	0	1,241	650	167	160,000	42,000	39,942	35,536
2040	26	0	1,241	650	167	160,000	42,000	39,942	35,536
2041	27	0	1,241	650	167	160,000	42,000	39,942	35,536
2042	28	0	1,241	650	167	160,000	42,000	39,942	35,536
2043	29	0	1,241	650	167	160,000	42,000	39,942	35,536
2044	30	0	1,241	650	167	160,000	42,000	39,942	35,536
Total		191,170	66,909	18,735	4,420	4,232,000	1,110,900	829,666	695,314

EIRR	14.6%	12.0%

Prepared by the Study Team

2) Financial Analysis

Estimate of Financial Internal Rate of Return (FIRR) is as below;

- Revenue; Revenue based on MPA tariff
- Cost;
  - Construction, maintenance and repair of facilities,
  - Purchase, maintenance, repair and renewal of handling equipment and working vessels,
  - Operation cost of the terminal and
  - Construction and maintenance of navigation safety facilities
- Evaluation period; 30 years

FIRR ; 8.6 % (Market interest is about 10%)

Table 6-10 FIRR of Thilawa Area Port Urgent Development Project

Unit: '000 USD/Yr

Year		Cost			Revenue				Total	Cost+10% Revenue-10%
		Const-ruction	Main-tenance	Terminal Opera-tion	Container (TEU)	Container Handling	Port Entry charges	Revenue Total		
unit				832.9493		0.16	8.735			
2012		0	0	0	0	0	0	0	0	0
2013		1,246	0	0	0	0	0	0	-1,246	-1,370
2014		67,148	0	0	0	0	0	0	-67,148	-73,862
2015	1	83,997	280	139	24,000	3,840	233	4,073	-80,343	-89,191
2016	2	51,769	790	555	92,000	14,720	893	15,613	-37,502	-44,375
2017	3	0	808	833	79,000	12,640	767	13,407	11,765	10,261
2018	4	0	578	833	33,000	5,280	320	5,600	4,189	3,488
2019	5	0	433	833	4,000	640	39	679	-588	-782
2020	6	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2021	7	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2022	8	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2023	9	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2024	10	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2025	11	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2026	12	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2027	13	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2028	14	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2029	15	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2030	16	0	6,761	833	160,000	25,600	1,553	27,153	19,559	16,084
2031	17	0	11,200	833	160,000	25,600	1,553	27,153	15,120	11,202
2032	18	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2033	19	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2034	20	0	9,828	833	160,000	25,600	1,553	27,153	16,492	12,711
2035	21	0	9,828	833	160,000	25,600	1,553	27,153	16,492	12,711
2036	22	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2037	23	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2038	24	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2039	25	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2040	26	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2041	27	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2042	28	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2043	29	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
2044	30	0	1,213	833	160,000	25,600	1,553	27,153	25,107	22,187
Total		204,159	65,989	24,017	4,232,000	677,120	41,074	718,194	424,029	322,793

FIRR	8.6%	6.4%

Prepared by the Study Team

7. Detailed Study

7.1. Environmental and Social Consideration

7.1.1. Sediment and Soil

As there are no sediment quality standards in Myanmar, the results were compared with the Soil Contamination Countermeasures Act in Japan and the Agricultural Land Soil Pollution Prevention Law in Japan. Concentration above the screening level would mean that toxic effects on organisms could be expected. The result is shown in Table 7-1 and the result of the grain size distribution is shown in Table7-2.

Pollutant substances above the criteria of the Soil Contamination Countermeasures Act in Japan and the Agricultural Land Soil Pollution Prevention law in Japan were not found in the proposed land filling materials or the project site.

Table 7-1 Results of Sediment and Soil Survey

Item		Criteria[1)]	Criteria[2)]	Project site (land)				Off Thilawa			Yangon Riv. Mouth		
				L1	L2	L3	L4	R1	R2	R3	R4	R5	R6
Specific gravity	-	-	-	2.68	2.69	2.71	2.69	2.65	2.68	2.66	2.67	2.63	2.65
Water content	%	-	-	32.74	38.69	26.46	28.1	27.57	30.68	29.99	30.71	33.27	34.74
TOC	mg/g	-	-	7.23	8.11	6.84	8.25	1.18	0.78	0.39	0.39	1.19	0.79
Arsenic	mg/kg	150	15	ND[4)]	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/kg	150	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	250[3)]	-	98.7	80.6	105.3	107.3	83	36	38	70.5	75.3	80
Copper	mg/kg	-	125	21.95	22.45	23.8	22.15	7.05	6.4	5.5	6.9	8.325	9.55
Lead	mg/kg	150	-	14.1	15.15	15.6	11.95	ND	ND	ND	ND	ND	ND
Nickel	mg/kg	-	-	61.4	69.85	65.35	74.50	38.9	37.55	20.3	35.15	36.55	43.85
Zinc	mg/kg	-	-	94.95	90.00	97.5	88.05	52.3	32.25	34.35	29.85	47.63	44.25
Cyanide	mg/kg	50	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

1) Soil Contamination Countermeasures Act
2) Agricultural Land Soil Pollution Prevention Law
3) Criteria for a chromium hexavalent
4) ND:Not Detectable

Prepared by the Study Team

Table 7-2 Results of Sediment and Soil Survey (Grain Size Distribution)

Size	Project site (land)				Off Thilawa			Yangon Riv. Mouth		
(%)	L1	L2	L3	L4	R1	R2	R3	R4	R5	R6
Gravel	0	0	0	0	0	1	1	0	0	0
Sand	2	1	0	1	84	95	97	98	94	95
Silt	49	46	63	51	16	4	2	2	6	5
Clay	49	53	37	48						

Prepared by the Study Team

7.1.2. Water Quality

Result of the water quality survey is summarized in Table 7-3. BOD shows relatively high values, surface; 32 ~ 92 mg/L, bottom; 35~88 mg/L, which indicates organic pollution. SS also shows high values ,surface; 328~888 mg/L, bottom; 442~986 mg/L. SS at bottom layer tends to be higher than those at surface as soil at bottom might be re-suspended due to the fast current of the river.

Table 7-3 Results of Water Quality Survey

Item		Layer	Off Thilawa			Yangon Riv. Mouth		
			R1	R2	R3	R4	R5	R6
BOD	mg/L	Surface	52	36	32	72	78	92
		Bottom	58	40	35	68	82	88
SS	mg/L	Surface	480	328	380	514	640	888
		Bottom	610	460	442	568	882	986

Prepared by the Study Team

7.1.3. Fishery Activity Survey

An interview survey was conducted to obtain information on fishing activity in the Yangon River, especially around the project site. Fishermen and fish sellers were interviewed in Aouk Taw area and Chaung Wa area in September 2013.

Fishing is usually conducted twice a day from high tide through low tide. The major fishing method is a gill net. Fishermen normally use floating type in spring tide and fixed type in neap tide. The size of the net is 50m in length and 3m in height. The floating type is set from surface and middle layer and the fixed type is set from middle layer to bottom layer. The fish species are hilsa, soldier croaker and cat fishes.

7.1.4. Farmland Use Survey

MPA conducted farmland use survey of farmers who use the project site as farmlands on Plot 25 to 26 in October 2013. JICA Study Team has requested their survey results from MPA but MPA has not released them because the negotiation with the farmers is still continuing (as of February 2014). The number of farmers using the farmland on Plot 25 to 26 is allegedly seven based on the survey result by MPA.

7.1.5. Relocation Plan of Formers and its Implementation

(1) Implementation Situation on Phase 1 Area

As mentioned above, seven farmers are using the project site as their farmlands on Plot 25 to 26

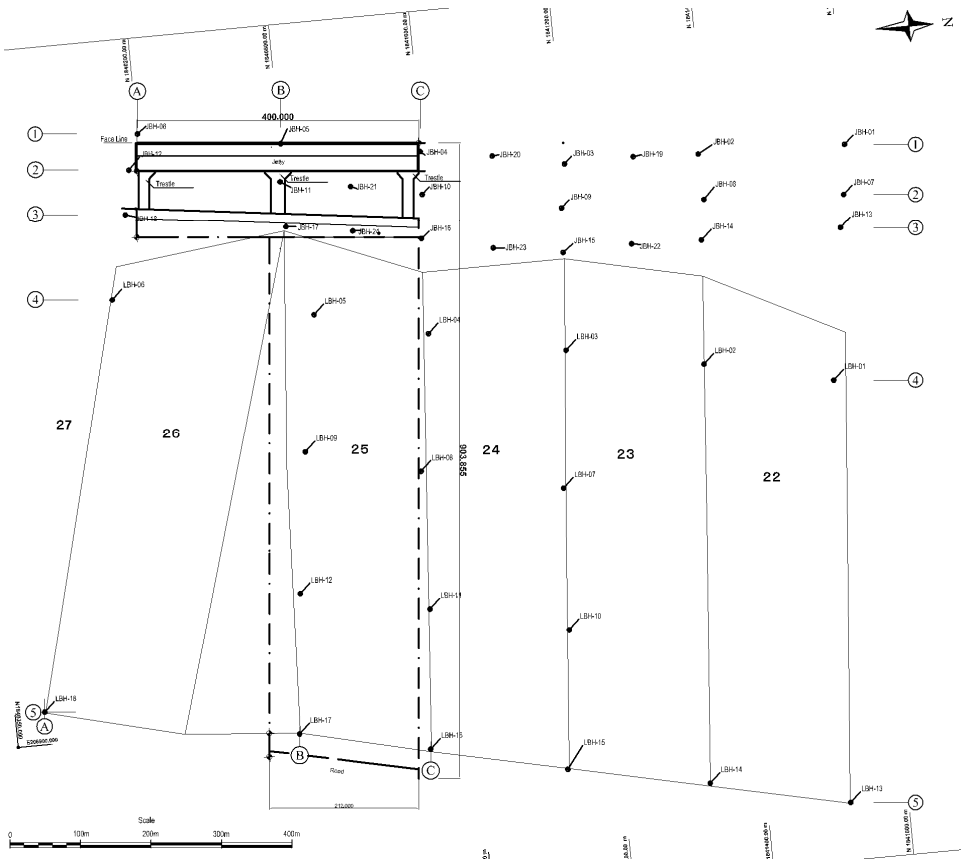
in the Phase 1 project site. Even though MPA already paid compensation of the land to them in 1996, farmers are requesting additional compensation due to insufficiency of the compensation and income restoration. MPA is currently negotiating with the farmers on the issue. Results on the resettlement and the draft additional assistance measures are shown in Annex Resettlement Action Plan Study Report in DFR1.

(2) Implementation Situation on Plot 3

A project site on Plot 3 used by three farmers as their farmlands may serve as a useful reference since the historical background is the same as in this project. MPA paid cash assistance of 1.1million kyat/acre in December 2013 after several negotiations with the farmers.

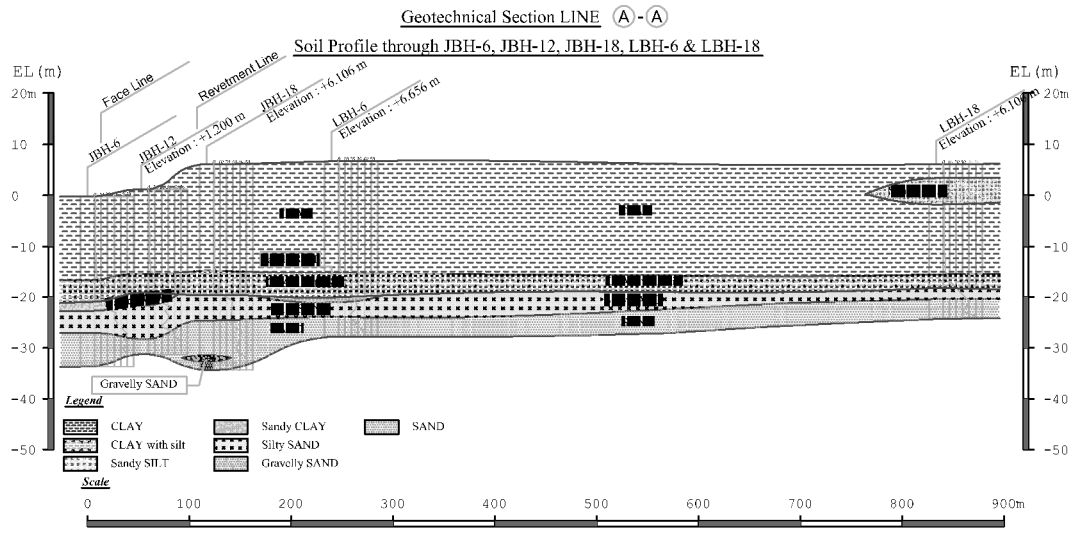
7.2. Planning and Design Conditions of Container Terminal

The planning and design conditions shown in **5.4.2 Facility Design, (1) Natural Conditions, and (2) Planning Conditions** in this summary are used except soil conditions shown in Figures 7-1 to 7-4.



Prepared by the study team

Figure 7-1 Location of Soil Survey



Prepared by the study team

Figure 7-2 Soil Profile of A-A Section (river side – land side)

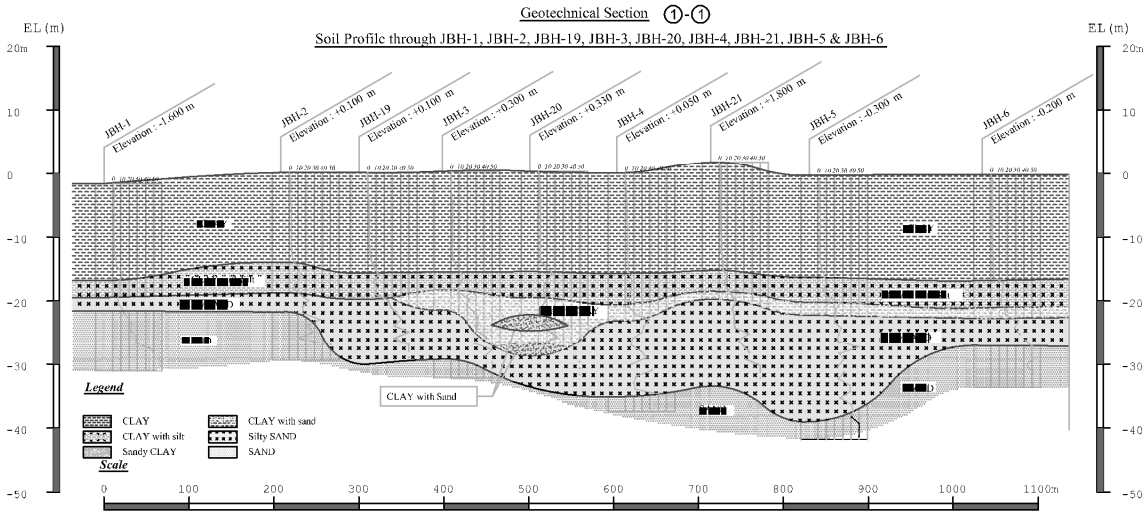


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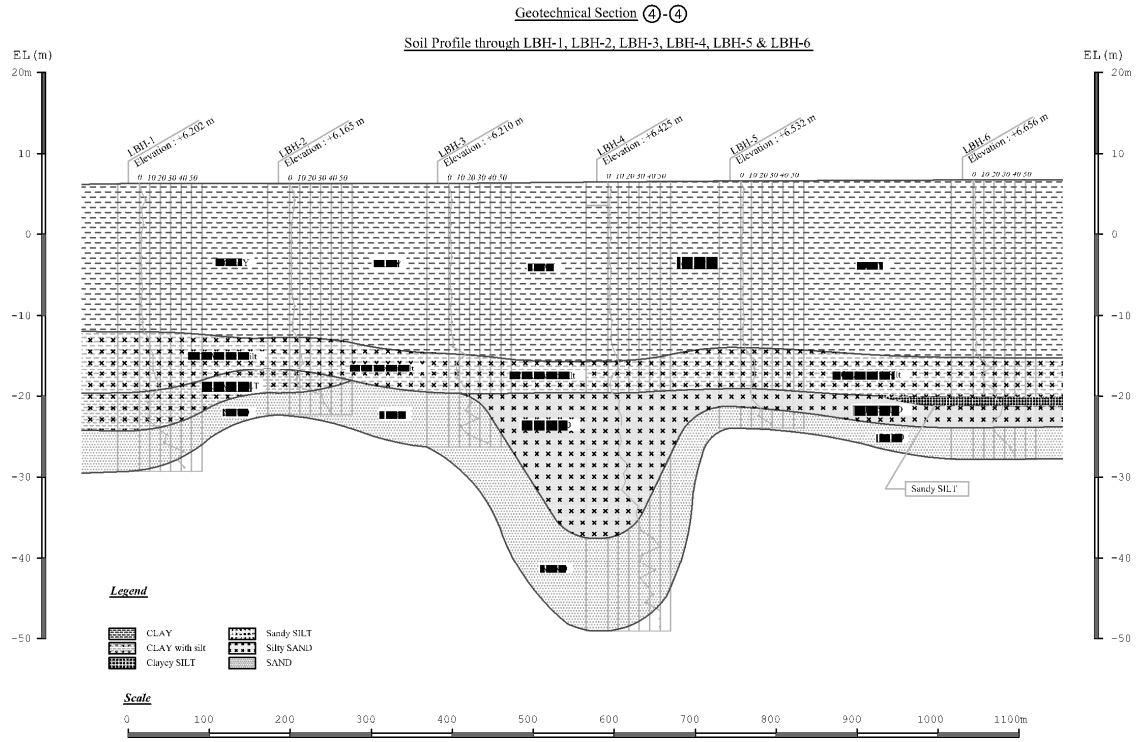
Figure 7-3 Soil Profile of 1-1 Section (river side)



Prepared by the study team

Figure 7-4 Soil Profile of 4-4 Section (land side)

Design soil conditions are determined on river side and land side as shown in Table 7-4 in accordance with the results of soil survey. The river side and soil conditions are used for design of jetty, trestle and revetment, and soil improvement and land facilities respectively.

Table 7-4 Design Soil Condition

河川側

No	Soil Name	Mean N-Value	Cohesion C kN/m^2	Friction angle φ(°)	Unit Weight γ(KN/m^3)	Unit Weight γ'(kN/m^3)	Modulus of Elasticity E (kN/m^2)
1	CLAY	2	C=-1.79・Z+25.81 (Z=0 at ±DL±0.00)	-	17	7	1300
2	CLAY with silt	10	C=-1.79・Z+25.81 (Z=0 at DL±0.00)	-	19	9	6600
3	Silty CLAY	12	50	-	18	8	8000
4	Sandy SILT	25	50	-	18	8	16600
5	Sandy CLAY	16	50	-	19	9	10600
6	Sandy CLAY and CLAY with sand interbedded	17	50	-	19	9	11300
7	Silty SAND	30	-	32	19	10	21000
8	SAND	40	-	34	20	10	28000

陸上側

No	Soil Name	Mean N-Value	Cohesion C kN/m^2	Friction angle φ(°)	Unit Weight γ(KN/m^3)	Unit Weight γ'(kN/m^3)	Modulus of Elasticity E (kN/m^2)
1	CLAY	2	C=-1.46・Z+30.89 (Z=0 at DL±0.00)	-	17	7	1300
2	Sandy SILT	9	50	-	18	8	6000
3	CLAY with silt	11	C=-1.79・Z+25.81 (Z=0 at DL±0.00)	-	19	9	7300
4	Sandy CLAY	9	50	-	19	9	6000
5	Clayey SILT	10	50	-	18	8	6600
6	Silty CLAY	11	50	-	19	9	7300
7	Silty SAND	22	-	30	19	10	15400
8	SAND	31	-	32	20	10	21700

Prepared by the study team

7.3. Terminal Planning

7.3.1. Terminal Operation

(1) Commodity-wise Annual Handling Volume

For the terminal facility design, commodity-wise annual handling volume is set as shown in Table 7-5.

Table7-5 Commodity-wise Annual Handling Volume

Type of Container		Targeted Proportions		Present Proportions	
		Proportion(%)	Container Volume (TEU/Year)	Proportion (%)	Container Volume (TEU/Year)
Import	Full Container	45%	90,000	45%	90,000
	Empty Container	5%	10,000	5%	10,000
Export	Full Container	45%	90,000	35%	70,000
	Empty Container	5%	10,000	15%	30,000
Amount		100%	200,000	100%	200,000

Prepared by the study team

(2) Berthing Side of the Calling Vessels

From the viewpoint of water side, calling vessels will berth both at starboard-side as well as port-side. From the viewpoint of land transportation, vehicles are obliged to run on the right side of the road while trailers from the hinterland mainly come from the north of the terminal; therefore, the safest and most efficient traffic flow (less intersecting in the terminal traffic road) is for trailers to 1) come into the terminal from the north side, 2) go through the traffic road in the terminal anti-clockwise, 3) enter into the stacking yard from the north side of stacking blocks, and 4) exit from the south side of the terminal. In other words, trailers for vessel operation go round between quayside and stacking yard in a clock-wise direction. Therefore, the berthing side of the calling vessel is mainly starboard side for the above reasons.

In the case that a calling vessel is moored on portside, trailers in seaside operation can easily turn round by using trailer traffic road constructed between the stacking yard and revetment alongside the river.

(3) Cargo Handling System in the Terminal

① Cargo handling system at quay-side

QGC (Quay Gantry Crane) system is applied for quay-side handling system based on the findings of the foregoing feasibility study.

② Cargo handling system in the yard

RTG (Rubber Tired Gantry Crane) system is applied for container handling in the yard (full container stacking yard) based on the findings of the foregoing feasibility study. Due to Myanmar's customs clearance regulations, container terminals are obliged to organize import and export container cargo inspection facilities in the terminal premise. Because of the limited yard space, especially in Phase-1 stage of the project, maximum stacking height of RTG is planned at five tiers (one-over-five) (See **4.2.2(1) Container Yard**) to obtain required yard capacity.

Thilawa terminal has a high possibility of being operated as a multi-purpose terminal for handling general cargoes (imported vehicles, steel products, construction materials, machinery and equipment, etc.) rather than a container-dedicated terminal in early stage of its operation or for a long period depending on the situation. Therefore, the new terminal should be planned flexibly so that it can serve as a multipurpose terminal at the final stage. Considering this requirement, the pavement structure of half the RTG yard is designed to accommodate general cargoes while it will also be possible to store empty containers using reach stackers or forklifts

(4) Cargo Handling Capacity

The result of cargo handling capacity is shown in Table 7-6.

Table 7-6 Cargo Handling Capacity Estimation Table

No.	Item	Code	Unit				
handling Lot							
1.	Parcel Size	(a)	TEU/Call	1,200			
		(b)	Box/Call	900			
2.	TEU Factor	(c)		1.3333333			
Number of Cranes, Handling Productivity, Berthing Time							
3.	Number of Cranes	(d)	Set	2			
4.	Handling Productivity	(e)	Box/Hr/Set	25			
5.	Crane Utilization Ratio	(f)		0.9			
6.	Crane Operation Hours per Day	(g)	Hr/day	21			
7.	Operation Hours rate in a Day	(h)	(g) / 24 Hr	0.875			
8.	Crane Operation Hours per Call	(i)	Hr/ Call	22.9			
9.	Average Tide Waiting Time for Sail	(j)	Hr/ Call	12.0			
	(Including Preparation Time for Sail)						
10.	Berthing Time of Calling Vessel	(k)	Hr/ Call	34.9			
Available Berthing Time							
11.	Colander Days per Year	(l)	Day/Year	365			
12.	Berth Occupancy Ratio (BOR)	(m)	%	0.5	0.6	0.7	0.8
13.	Total Available Berthing Hour per Year	(n)=	(l)*(m)*24	4,380	5,256	6,132	7,008
Number of Vessels to be called per Year (Call/Year)		(o)=	(n) / (k)	126	151	176	201
Berth Capacity for Container Handling							
15.	Berth Capacity (TEU/Year/Berth)	(p)=	(a)*(o)	150,787	**180,944**	211,102	241,259

Prepared by the study team

To avoid extreme berth congestion and long berth waiting time of calling vessels, it usually assumed at about sixty percent (60%). Therefore handling capacity of a berth equipped with QGC is estimated at 180,000 TEUs per year. On the other hand, most existing terminals in Yangon Port do not have quay gantry cranes, and half of the calling vessels to the port use ship's gear for loading and unloading operations. Therefore, 20,000 TEUs of annual capacity (to make up the required capacity) can be secured by the ship gear operation at berths without QGC operation, which means the total required berth capacity in Phase-1 project (200,000 TEUs) can be attained with two (2) berths with two (2) QGCs.

7.3.2. Size and Layout of Terminal Facilities

Detail of facilities is given in Table 7-7.

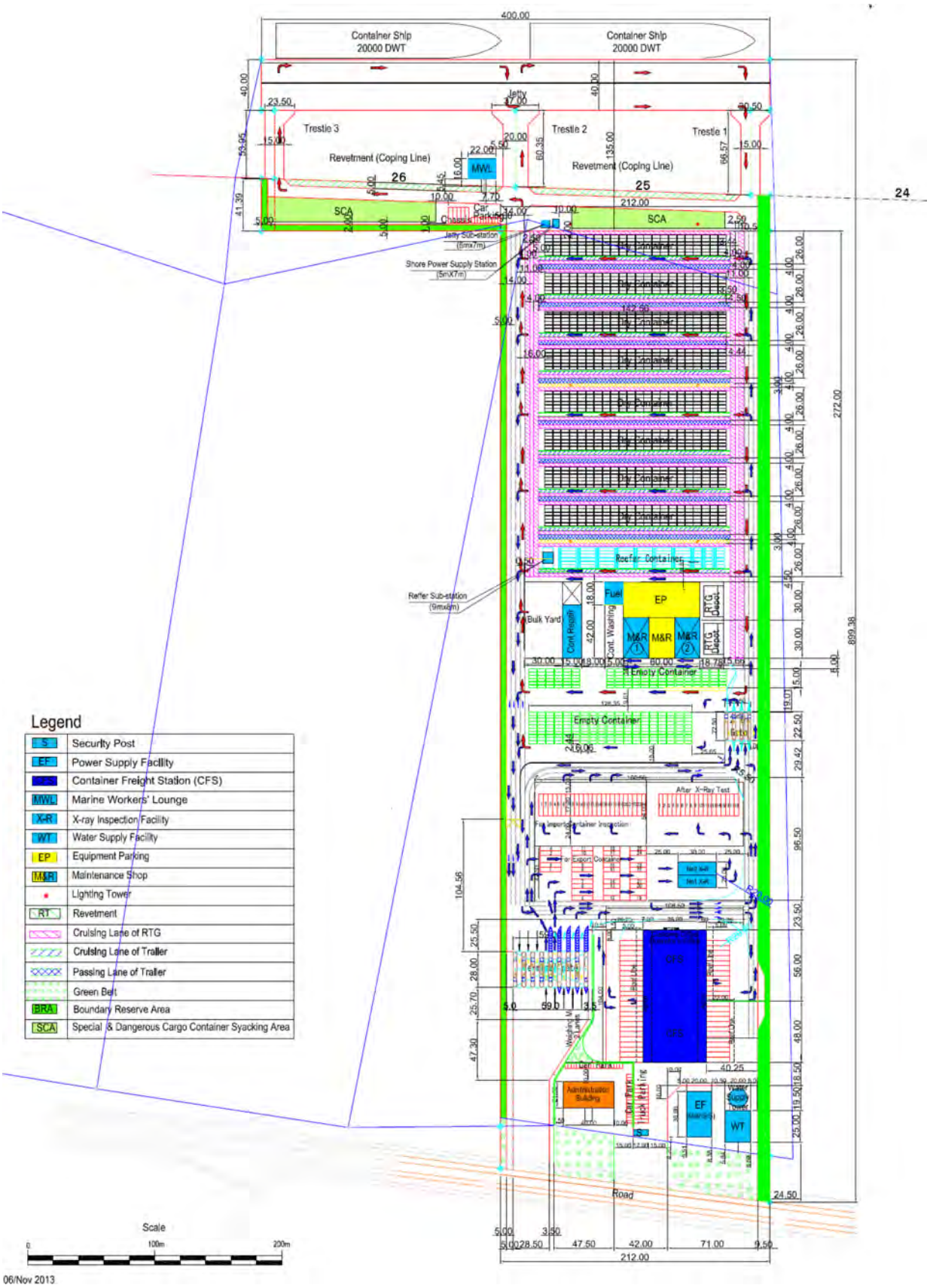
Table 7-7 Outline of Container Terminal Facilities

Objective Facility		Detail	Structure and Particular
Civil Works	Jetty		* Jacket Structure : 400m (l) x 40m (w)
	Trestle		* Piled Structure : 20m (w) x about 60m (l) x 1, 15m (w) x about 60m (l) x 2
	Revetment		* Steel Sheet Pile Structure : about 400m (l)
	Dredging		* Revetment ; 160,000 m3
	Site Clearance		* Area : 234,000m2, Removal Soil : 50,000m3 (net),
	Soil Improvement		* Reclamation ; 104,000m3, * Sand Mat ; 237,000m3, * PVD ; 4,000,000m, * Surcharge Soil ; 1,043,000m3, * Removal Soil ; 676,000m3
	Yard	Container Yard	* Dry ; 5,280 TEUs (5 tears) * Empty ; 1,520 TEUs (5 tears) * Reefer ; 306 TEUs (3 tears)
		Pavement	* Container Yard : RTG Traffic Lane x 9 lanes, Traveling Lane x 2 lanes * Container Stacking Area : Stacking Plate + Macadam Pavement ; 9,600 m2, Stacking Plate +Concrete Pavement ; 7,700 m2, Traffic Lane ; 9 lanes, * Empty Container Yard : Concrete Pavement ; 1,800 m2 * Customs Inspection Area : ICB Pavement ; 16,000 m2, * CFS Area : ICB Pavement ; 13,000 m2
		Parking	* Administration Area : 33 (passenger) * Marine Workers' Lounge : 10 (passenger) + 5 (truck) * CFS : 48 (truck) * Inspection Area : 67 (truck) * Entrance:10 (truck)
		Drainage	* Catchment Area : 15.5ha * Main Drainage (U-Ditch) : 650m * Sub-Drainage (U-Ditch) : 2,200m * Underground Pipe (PC-Pipe) : 200m
		Container Washing	* 15m x 42m
		Bulk Yard	* 30m x 60m
	Road		* ICB Pavement : 37,800m2 * Concrete Pavement : 7,900m2
Building	Administration Building		* Steel Frame : 40m x 21m (total floor space 3,400m2), 5 stories
	Terminal Gate	Main Gate	* Steel Frame : 8 lanes
		2nd Gate	* Steel Frame : 3 lanes
	CFS		* Steel Frame : 104m x 50m
	Maintenance Shop		* Steel Frame : (18m x 32m) x 2
	Container Repair Shop		* Steel Frame : 15m x 42m
	Marine Workers'		* Steel Frame : 16m x 22m, 2 stories
	X-ray Inspection		* Depend on supplier's proposal
	Weighbridge		* 3 units
	Power Supply Facility		* Steel Frame : 36m x 20m
	Water Supply Facility		* Steel Frame : 25m x 20m
	Water Supply Tower		* Steel Frame : 35m high, 40m3

Facility	Water Supply Facility		* Water Storage Tank : 480m3, * Potable Water Supply Pump: 300 l/min, * Ship Water Pump: 670 l/min.
	Fuel Station		* Fuel Tank : 4 kl x 2 units * Fuel Oil Dispenser : 2 units
	Sewage Treatment Plant		* Capacity : 26.9m3/day, 3.4m3/day, 14.2m3/day
	Power Supply Facility		* 4,000 KVA
	Generator		* 2,500 KVA (including generator for reefer)
	Reefer Plug		* 900 KVA (180 units)
	Communications		* Tel (Track ; 50 lines, extension 400 lines) * LAN (0/100/1,000 Base)
	X-ray Machine		* Steel penetration up to 300mm, 2 units
	Security Facilities	Security Post	* Brick Structure ; 3 m x 17 m
		Fence	* About 2, 700m (l)
		CCTV & PA	* Camera : 19 units * Speaker:4units
	Lighting		* 49 units (high mast : 8, others : 41)
	Water Hydrant/ Ship Fire Hydrant		* Hose connection : 65 mm, 8 units
	Fire Hydrant		* 13 Nos. (Yard)
	Container Washing		* 20 m3
Equipment	Gantry Crane		* Seismic Isolation : 40.6 ton, 16m span, 35m outreach ; 2 units
	RTG		* Hybrid Type : 40.6 ton, 6 rows x one over 5 lift height, ; 6 units
	Forklift		* 3.5 ton Type ; 2 units
	Reach Stacker		* 42 ton Type ; 3 units
	Trailer Head		* 6 units
	Chassis		* ISO containers 2x20 ft., 40/45ft ; 6 units

Prepared by the Study Team

Layout of the terminal facilities is given in Figure 7-5.



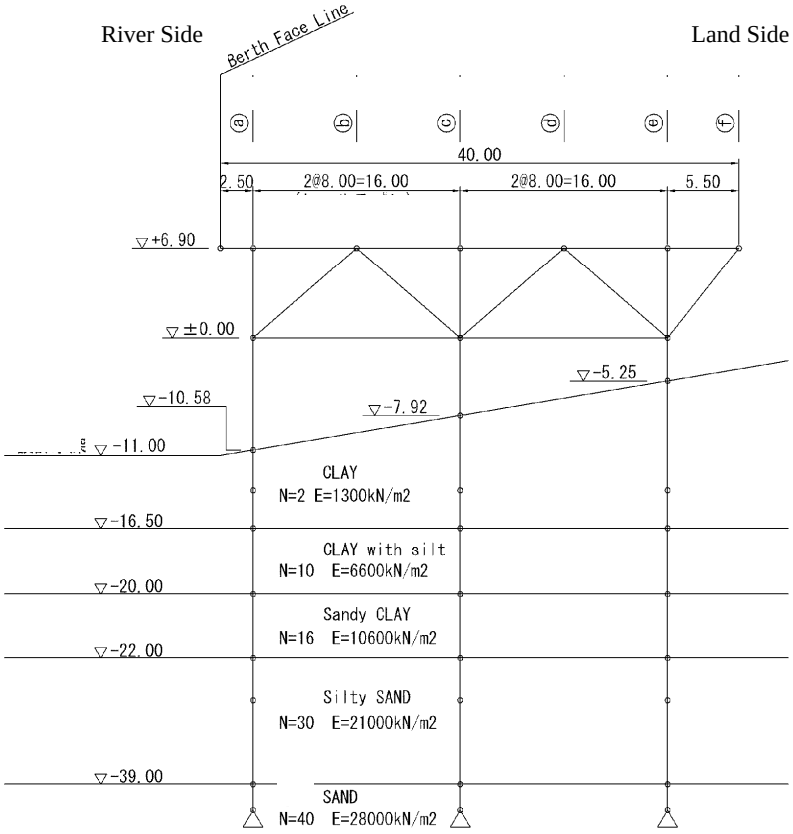
Prepared by the Study Team

Figure 7-5 Layout of the Terminal Facilities

7.4. Terminal Design

7.4.1. Jetty

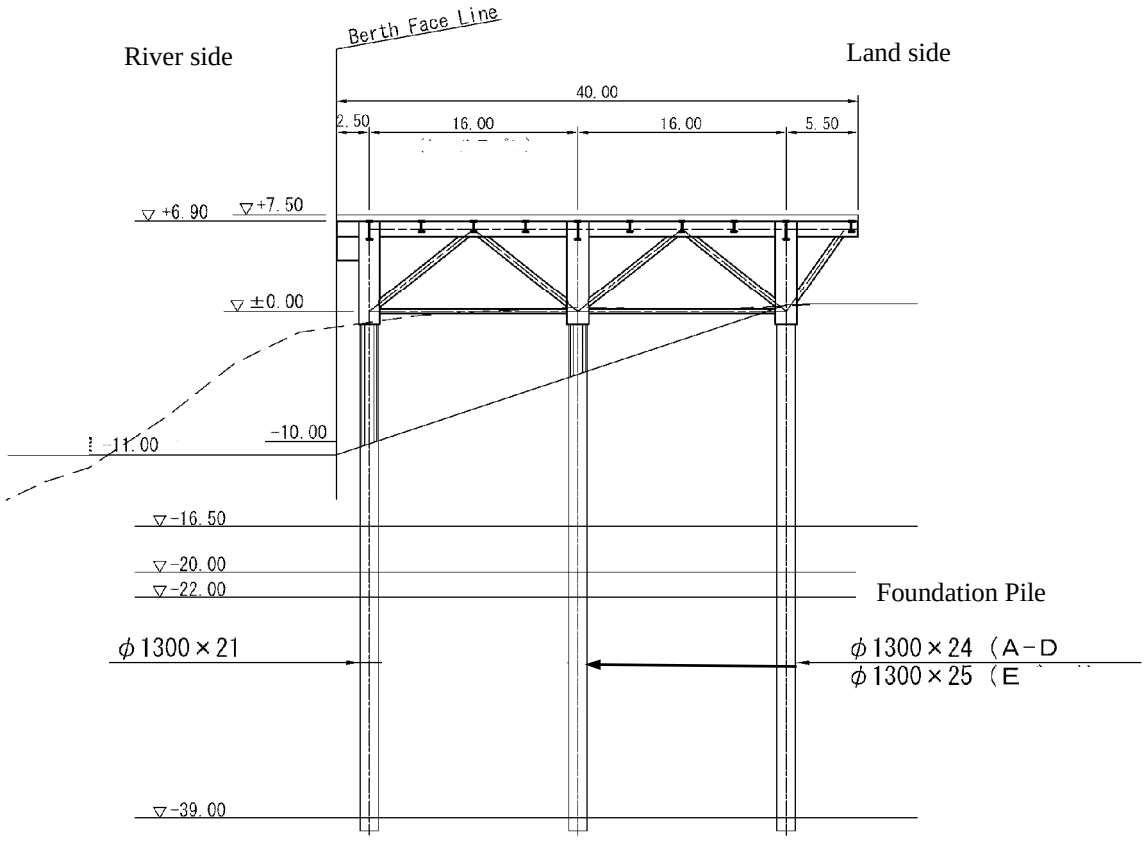
The structural analysis model analyzes a jacket structure and a pile with the united space frame model. A framework analytic-model cross section is shown in Figure 7-6.



Prepared by the Study Team

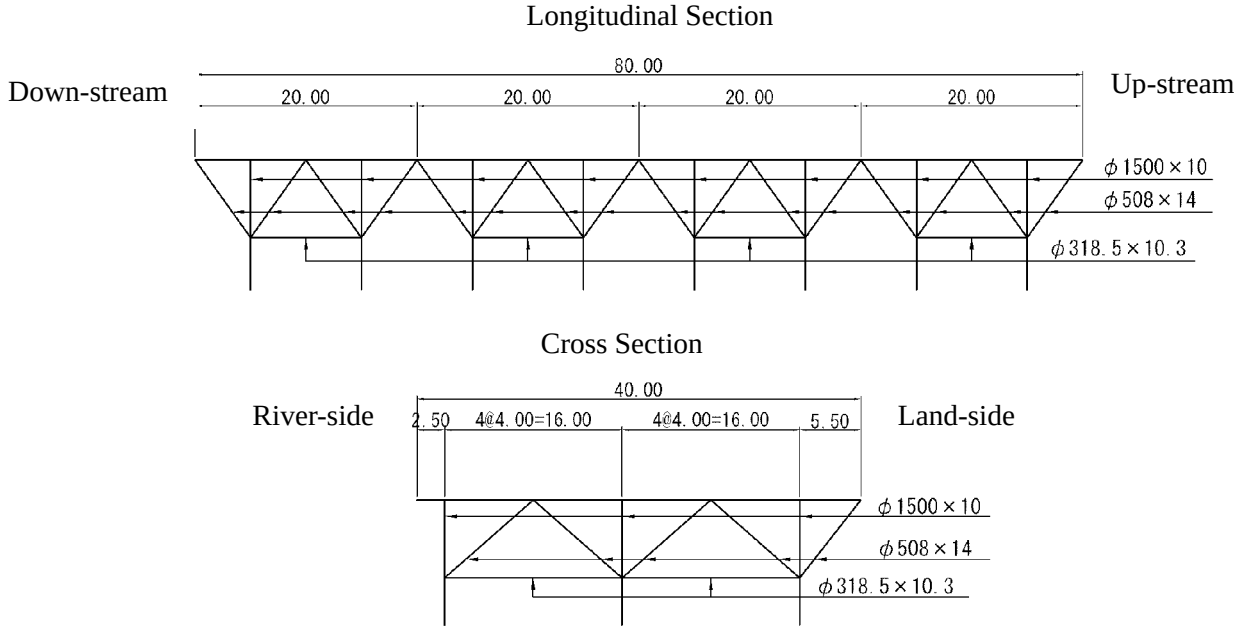
Figure 7-6 Framework Analytic-model Cross Section

The dimension of the foundation pile is shown in Figure 7-7 and of the leg and brace is shown in Figure 7-8.



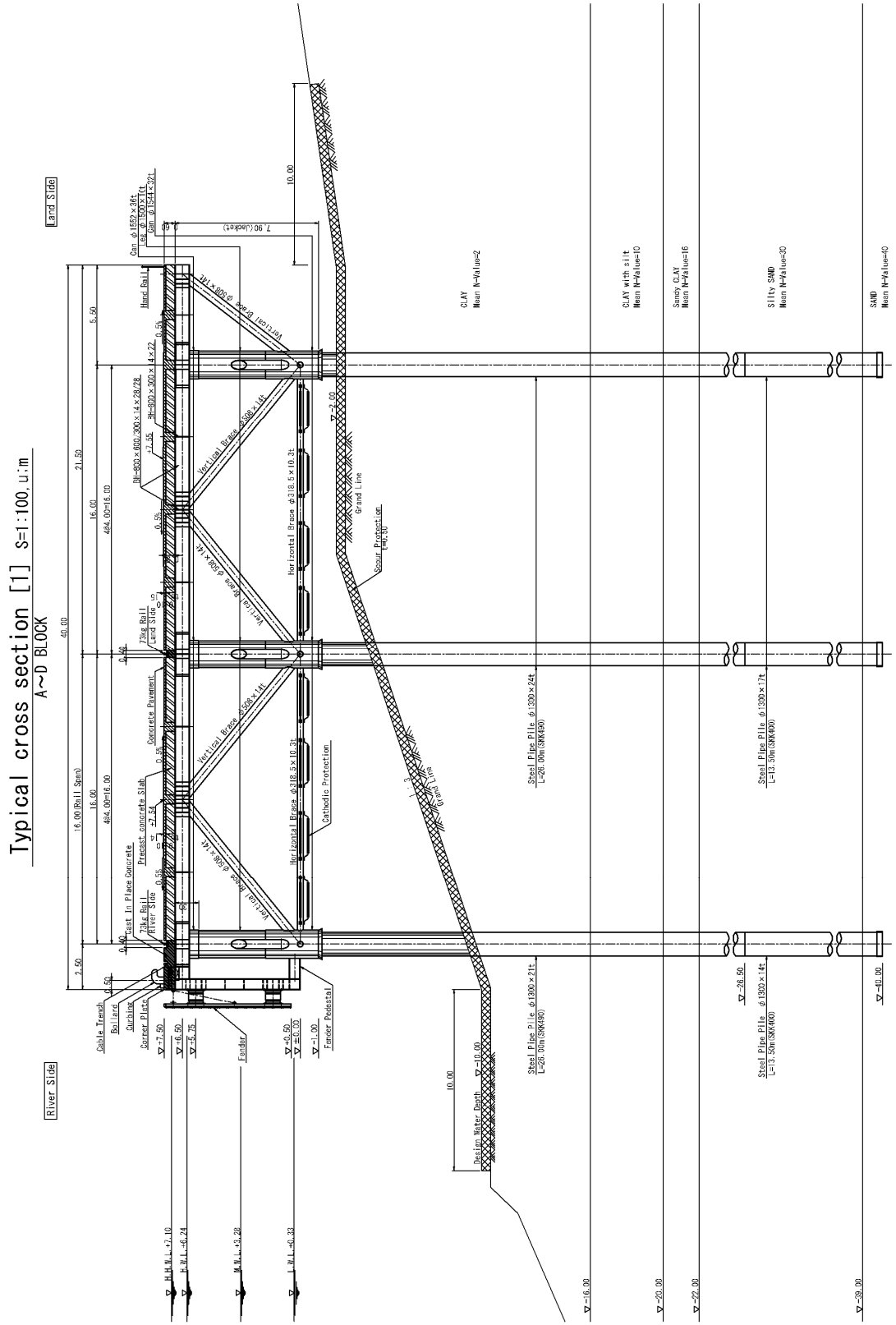
Source: Study Team

Figure 7-7 Dimension of Foundation Pile



Prepared by the Study Team

Figure 7-8 Dimension of Leg and Brace



Prepared b the Study Team

Figure 7-9 Typical Cross Section of Jetty

7.4.2. Buildings

(1) Administration Building

Administration Building shall have the function of administrative and operational center of the terminal, and various offices shall be located inside the building. The building shall have 5 story high with total floor area of approximately 3,400m2, and have steel superstructure system. As for the structure of the building, it has been studied taking into consideration the scheduled construction period which is as short as a year and a few months, and prefabricated steel structure system has been adopted in order to shorten the construction period. Besides the superstructure system, prefabricated curtain wall cladding system has also been chosen to shorten the construction period.

(2) Container Freight Station (CFS)

Container Freight Station (CFS) consists of 2 separate spaces, one is Bonded Cargo Warehouse managed by Customs and the other is Domestic Cargo Store managed by Operator, and 2 spaces are separated by boundary partition wall in between. Both Customs office and Operator's office are provided separately on both ground floor and mezzanine floor. Truck driver shall come to Customs office and/or Operator's office on the ground floor for documentation procedure. The building has total floor area of approximately 6,600m2, and steel superstructure system is adopted in order to provide a large span open space for cargo storage.

(3) Terminal Gate

Terminal Gate is planned for checking all incoming and outgoing container traffic. Total of 8 lanes with 5 lanes for incoming traffic and 3 lanes for outgoing traffic are allocated at the Gate. Besides these 8 lanes, 2 truck lanes are allocated for bulk cargo traffic at both far sides of the Gate. Clerk rooms for documentation, checker rooms for checking containers, and a catwalk for checking the roof of containers are provided under covered canopy. 3 weighbridges are provided for incoming (export) container traffic. The Gate has reinforced concrete columns and space frame roof structure composed of steel pipes and nodes.

(4) Maintenance Shop

Maintenance shop consists of 2 buildings, Maintenance Shop (1) and Maintenance Shop (2). These 2 buildings locate parallel with circulation space in between.

Maintenance Shop (1) is provided for the repairing of small equipment, such as electrical circuits of the parts, tractors, forklifts, etc. in indoor workshop. The building is planned to have total floor area of 720m2. In order to provide large span open space for working area, steel superstructure system is adopted.

Maintenance Shop (2) is provided for the repairing of large size machines, such as reach stacker,

empty container lift, chasses, etc. The building has almost the same structure as Maintenance Shop (1), however it has covered roof only and no wall is provided.

(5) Container Repair Shop

Container Repair Shop is provided to accommodate 12 numbers of 20 feet container at a time. Front side of the building has 2 spans of wide opening of 19 meters each, so that not only 20 feet containers but also 40 feet containers can be carried in and out through this opening. The building has steel superstructure to provide such wide openings. Equipment Storages on both sides and small toilet for the workers are provided.

(6) Fuel Station

Fuel Station is provided to supply fuel for equipment and trucks working in the port terminal area. It consists of canopy, worker's office building, underground oil tanks, fuel dispensers, pumps for fuel supply, etc. (Underground oil tanks, fuel dispensers, pumps for fuel supply, etc. are Mechanical Works) The canopy has covered area of 144m2 and made of reinforced concrete columns and steel roof structure.

(7) Marine Workers' Lounge

Marine Workers' Lounge is planned as welfare and administration facility for the workers in port area and it is provided in the river shore adjacent to the trestle and the revetment of the port. The building will be constructed on the steel pipe piles which are similar to the foundation of trestle and jetty of the port because it is planned to construct above the surface of the Yangon River water. And the building will be accessed through the bridge from the revetment. The building shall be constructed with reinforced concrete structure considering the corrosion proofing against brine damage and durability of the building.

(8) Security Post

Security Post is planned as a facility to control the in and out of the vehicles and people to the administration building area and the Container Freight Station (CFS) area. It consists of a security guard office building which will be constructed between the two entrance points, and two movable gates and the storages for both gates. The building will be constructed with box frame type reinforced concrete construction for the security and the efficiency of planning for this small building.

(9) Power supply Facility

Power Supply Facility consists of Panel Room, Generator Room, Transformer Yard and Fuel Tank Yard. Transformer Yard and Fuel Tank Yard are located outside of the building. The necessary spaces of Panel Room and Generator Room are determined taking into consideration future extension

for Phase 2 works, and the spaces of panels and generators for future use are reserved. The building is of a single story and steel superstructure.

(10) Water supply Facility

Water Supply Facility consists of Water Tank (Reservoir) Area and Pump Area inside the building. In Water Tank Area, a stainless steel water tank of 640m3 (16m long x 16m wide x 3m high – effective water level 2.5m) shall be provided. Bottom of water tank is raised by 50cm from floor level and 4 sides of the tank are surrounded by walking space for inspection and maintenance of the tank surfaces (4 sides, top and bottom). In Pump Area, various pressure pumps including fire-fighting pump shall be installed. The building is of a single story and steel superstructure.

(11) Water Supply Tower

Water Supply Tower is provided to supply service water to all the buildings and facilities including container wash in the port area except to supply water to ships through the elevated water tank by gravity. To maximize the safety for water supply, the elevated water tank will have a capacity of 40 m^3 which is equivalent to 50% of the daily water consumption for the building use and others except to supply water to ships. The height of the elevated water tank will be 35 meter above ground at lowest water level in the tank to maintain the minimum residual pressure. The Water Supply Tower will be constructed with steel plate construction to realize the simple and symbolic appearance of spherical shape.

(12) Outline and Structure Type of Buildings

The classification of the building works, structural and foundation types are shown in Table 7-8.

Table 7-8 Outline and Structure Type of Buildings

No.	Building	Structure,	Structural Type	Foundation Type
1	Administration Building	SC, 5 stories	Rigid frame of steel tube columns & H-shaped girders, 3x5 spans	PHC pile foundation
2	Container Freight Station (CFS) Building	SC, 1+M stories	Rigid frame of steel tube columns & H-shaped girders, 2x12 spans with cantilever beams	PHC pile foundation
3	Terminal Gate	RC+SC, 1 story	RC columns & steel roof structure of cylindrical 3-D truss, 1x8 spans	Spread direct foundation
4	2nd Gate	RC+SC, 1 story	RC columns & steel roof structure of cylindrical 3-D truss, 1x3 spans	Spread direct foundation
5	Maintenance Shop (1) Maintenance Shop (2)	SC, 1+M stories	Rigid frame of steel tube columns & H-shaped girders, 1x4 spans	PHC pile foundation
6	Container Repair Shop	SC, 1 story	Rigid frame of steel H-shaped columns & H-shaped girders, 1x2 spans	PHC pile foundation
7	Fuel Station	RC+SC, 1 story	RC columns & Steel roof structure	Spread (continuous) direct foundation
8	Marine Worker Lounge	RC+S, 2 stories	RC superstructure & Steel roof structure, 2x4 spans	Steel Pipe pile foundation
9	Security Post	RC, 2 stories	RC post and beams & Brick walls	Spread (mat) direct foundation
10	Power Supply Facility	SC, 1 story	Rigid frame of steel H-shaped columns & H-shaped girders, 2x6 spans	PHC pile foundation
11	Water Supply Facility	SC, 1 story	Rigid frame of steel H-shaped columns & H-shaped girders, 1x5 spans	PHC pile foundation
12	Water Supply Tower	SC, Tower	Steel Tube Tower	PHC pile foundation
13	Refer Substation, AMP Substation	RC, foundation	-	Spread (mat) direct foundation

Note: The final foundation type for the buildings will be decided by the additional soil investigation at the building site.

Prepared by the study team

7.4.3. Soil Improvement

Soft clay layer deposits in the project area with a thickness of around 22m. It is predicted that significant settlement occurs over a long period of time after fill construction on the soft ground. To protect the settlement problem, some measures for soft ground improvement were studied in the basic design stage. As a result of comparing some methods, Prefabricated Vertical Drain (PVD) with preloading was selected as a most suitable method from a view of economy, social environment and workability. Therefore, PVD with preload method is adopted for the project area.

(1) Classification of the Project Area

The project site is classified into three area from a viewpoint of land use as shown in Figure 7-10. Also in the ground improvement design, the analysis is carried out by the given loading condition to each area. For the study of consolidation settlement and stability, the loading condition after opening of port is set to be as followings.

① Area-1-1 : This area is to stock container outside (hereinafter referred to as "Full Container Storage Yard"). The load of the Container is set to be 50kN/m2.
② Area-1-2 : This area is to stock container outside (hereinafter referred to as "Full Container Storage Yard"). The load of the Container is set to be 50kN/m2.
③ Area-2 : Building Area except Area-1-1 and Area-1-2. The load of Building is set to be 20kN/m2（exclude pile foundation load）

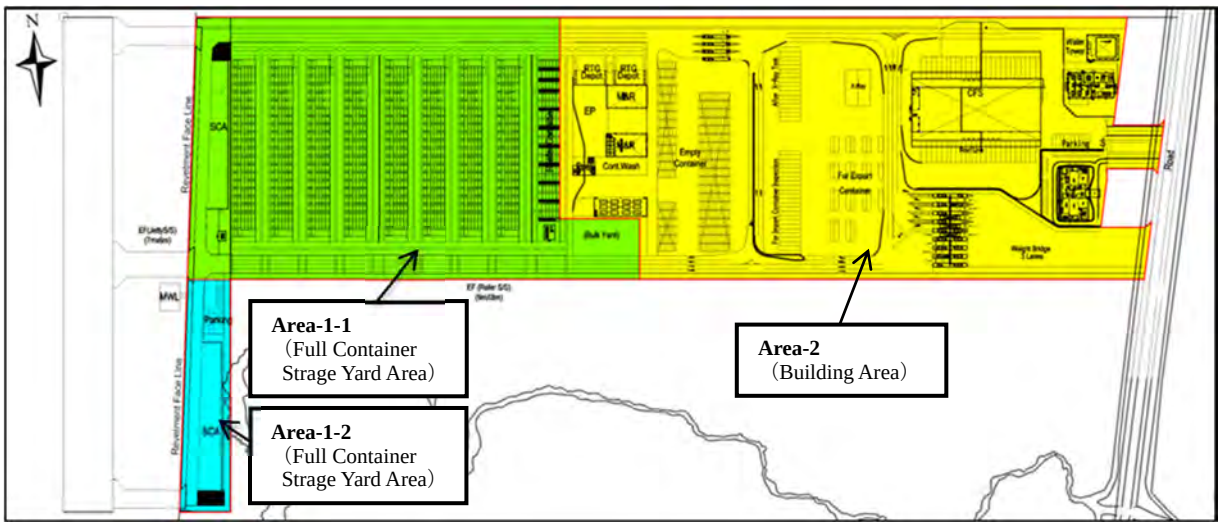
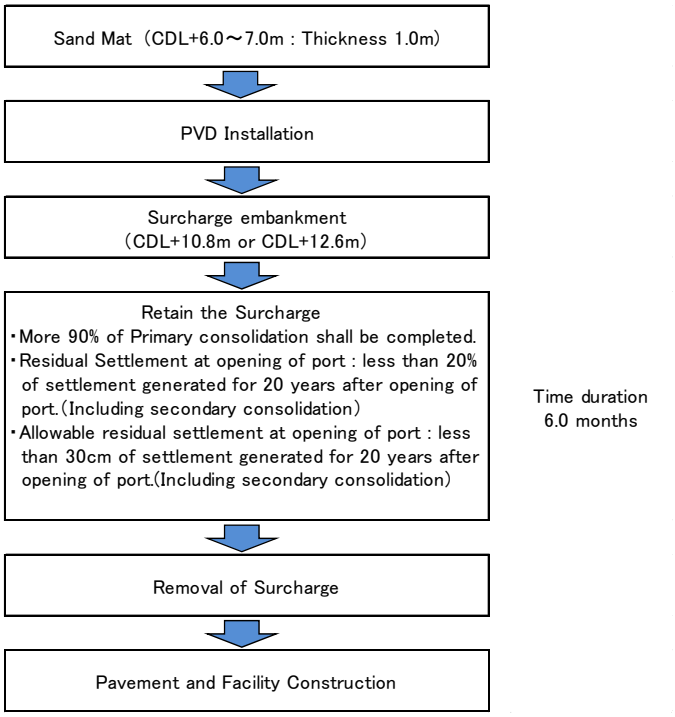


Figure 7-10 Area Classification

(2) Outline of Soil Improvement

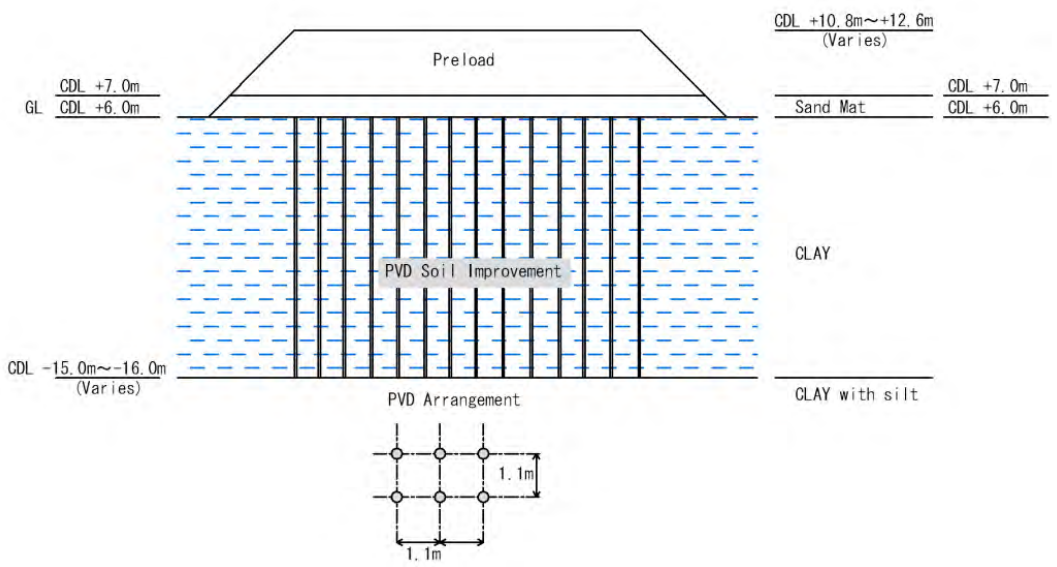
The method of soil improvement is to accelerate the consolidation for the original ground (clay layer). The main work is spreading of Sand mat after land fill up to CDL+6.0m, PVD installation and Preloading. The work flow and representative cross section is shown in Figure 7-11 and Figure 7-12 respectively. The dimension of PVD installation is set to be square type (1.1m*1.1m). The installation depth is from surface of Sand mat (CDL+7.0m) to bottom of clay layer. After PVD installation, Preload is filled up to CDL+10.8 to CDL+12.6m and kept at least 6 months for consolidation settlement. After completion of consolidation period, the preload shall be removed up to the level of subgrade. The timing of removal of preload is decided by following procedure.

- More than 90% of primary consolidation degree
- Residual settlement at opening of port shall be less than 20% of settlement generated for 20 years after opening of port. (Including secondary consolidation)
- Allowable residual settlement at opening of port: less than 30cm of settlement generated for 20 years after opening of port. (Including secondary consolidation)



Prepared by the study team

Figure 7-11 Work Flow of Soil Improvement



Prepared by the study team

Figure 7-12 Typical Cross Section of Soil Improvement

1) Area of Soil Improvement

Area of soil improvement is shown in Figure 13. It is predicted that some settlement will occur at the area of Plot 25 due to a filling load for the area of Plot 24 and Plot 26 adjacent to Plot 25 in future expansion of the project and such settlement will cause a problem of settlement and crack of existing pavement. The affective area to Plot 25 is considered to be around 22m (from surface of ground CDL+6.0m to bottom of clay layer CDL-16m) from land boundary of the Plot as shown in Figure 7-14. In case of filling work in this area, it might cause a problem of settlement and crack at pavement portion. To protect such problem in future, this area is also set to be improved (advanced improvement) .

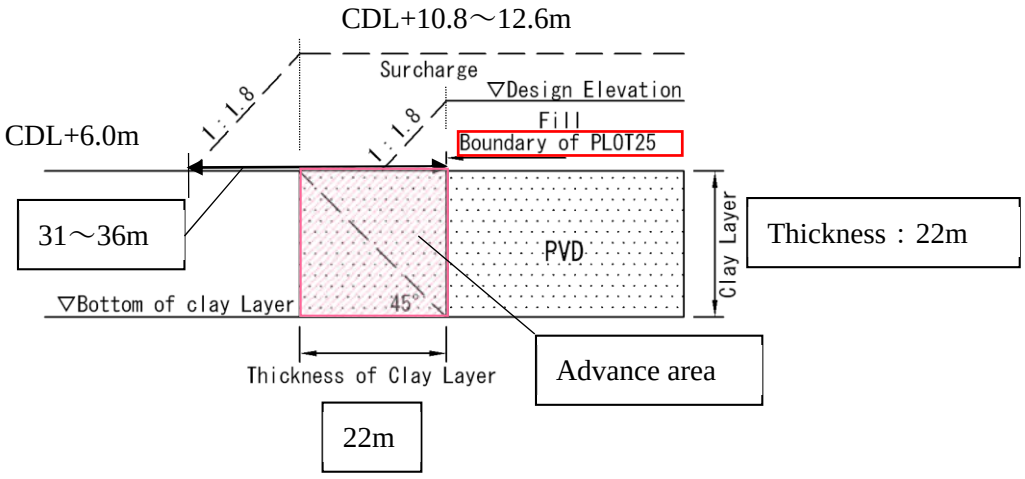


Figure 7-13 Concept of Soil Improvement Considering Advanced Improvement Area

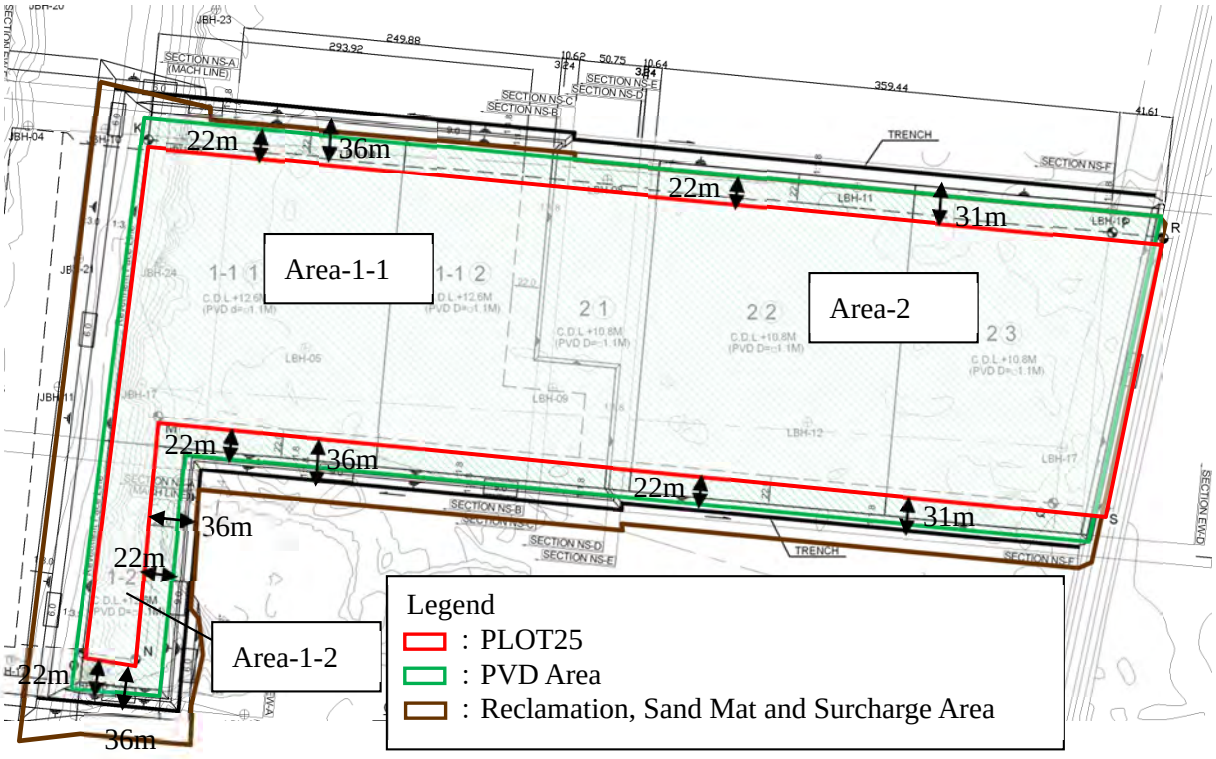


Figure 7-14 Area of Soil Improvement

7.4.4. Pavement

(1) Type of Pavement

Type of pavement for container terminal is the concrete and the interlocking concrete block pavement (ICB Pavement). The asphalt concrete pavement is not selected because there is no asphalt plant of private companies in the vicinity of the project site. Consequently, maintenance of the asphalt concrete pavement is difficult compared to other type of the pavements

(2) Pavement Classification

1) Interlocking Concrete Block Pavement (ICB Pavement)

ICB pavement is applied for heavy vehicle (trailers, etc.) traffic and pedestrian sidewalk as shown in Figure 7-15.

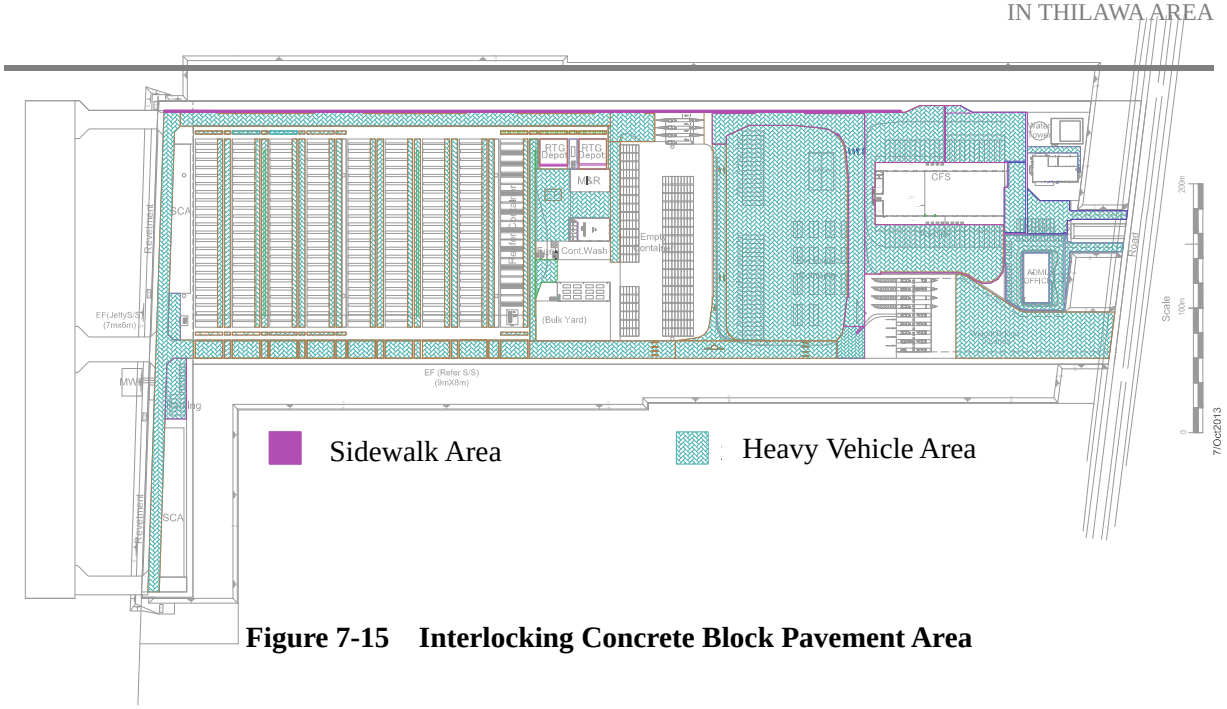


Figure 7-15 Interlocking Concrete Block Pavement Area

2) Concrete Pavement

Concrete pavement is applied for heavy vehicle traffic of reach stackers and trailers as shown in Figure 7-16.

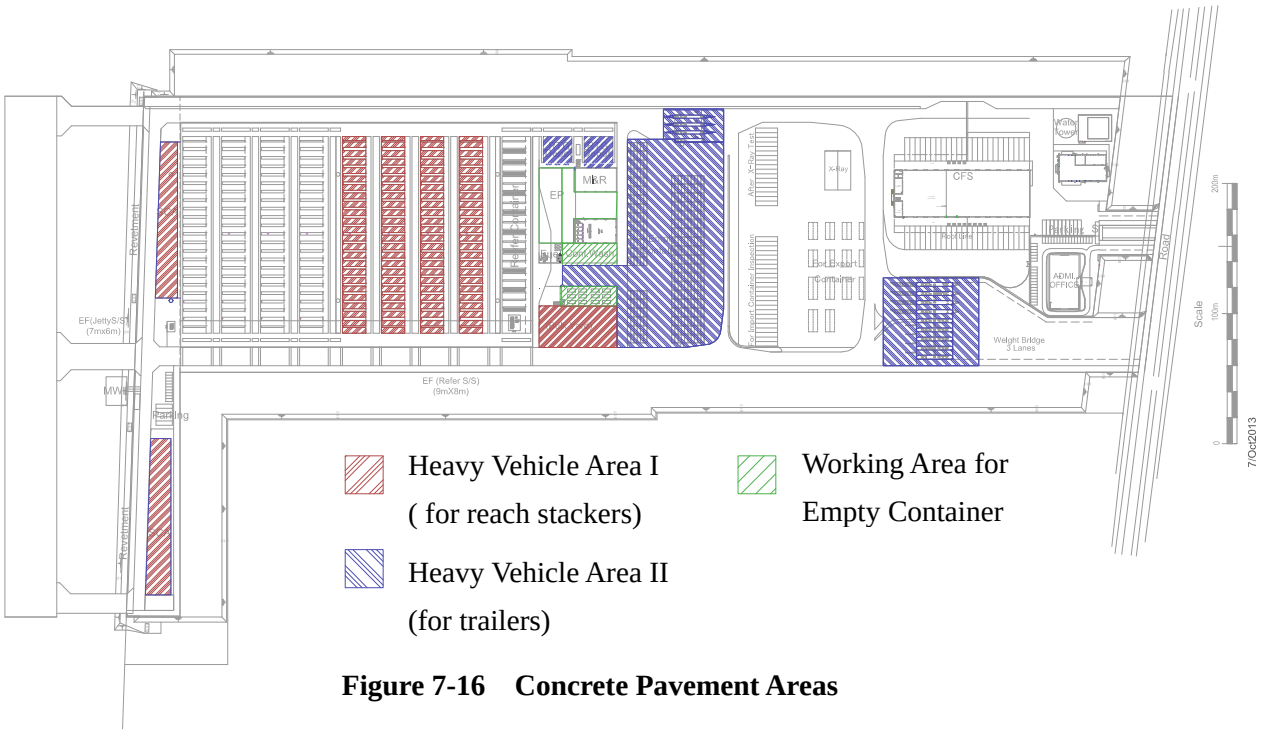


Figure 7-16 Concrete Pavement Areas

3) Macadam Pavement

Macadam pavement is applied for light vehicle traffic or no traffic area.
Macadam pavement area is shown in Figure 7-17.

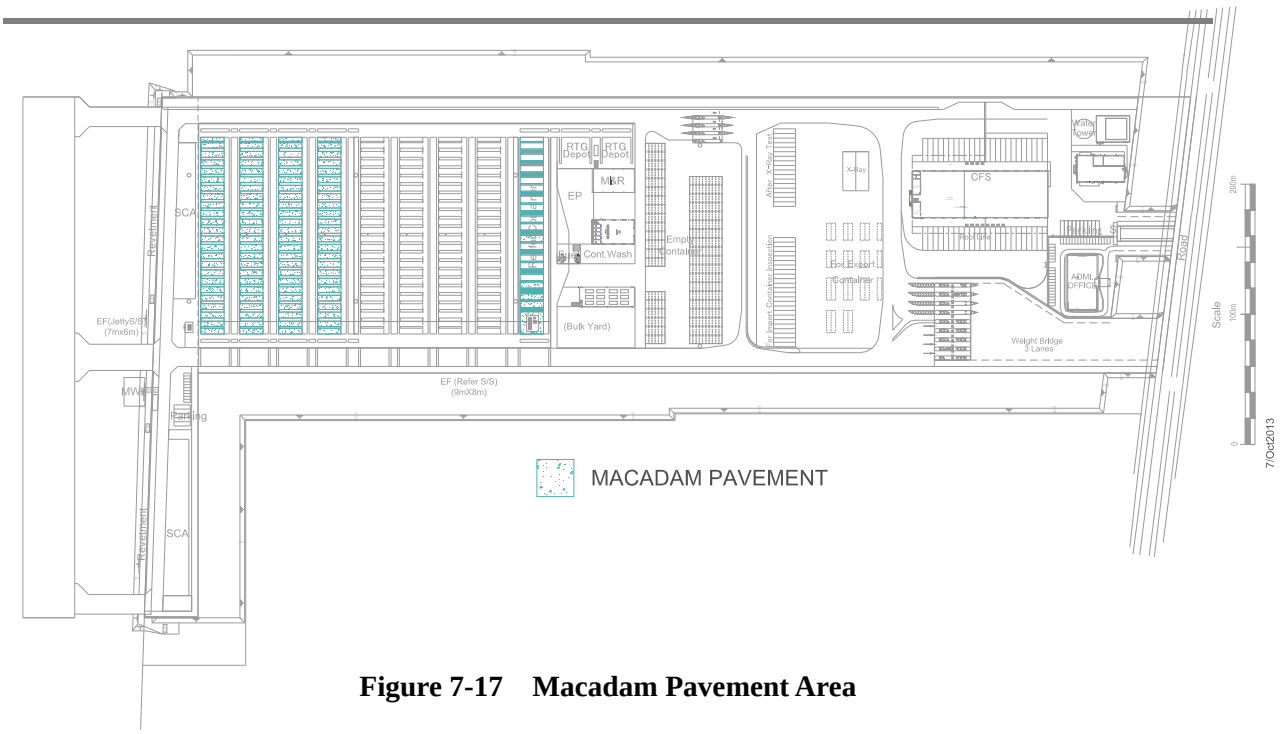


Figure 7-17 Macadam Pavement Area

7.4.5. Cargo Handling Equipment

(1) Planning of Gantry Crane

1) Specifications

Two STS Gantry Cranes applicable for Panamax ships shall be provided on the jetty. The main technical specifications of the Gantry Crane are indicated below.

a) **Load**

Lifting load under spreader	40.6 t
Lifting load under lifting beam	48.0 t
Hatch cover load	35.5 t

b) **Main dimension**

Out reach		35.0 m
Back reach		11.0 m
Span		16.0 m
Height under portal beam	more than	14.0 m
Clearance between legs	more than	16.8 m
Lift of spreader	above seaside rail	30.0 m
	under seaside rail	15.0 m
	Total lift	45.0 m
Max. width of crane(buffer to buffer)		27.0 m or less

Gantry wheel pitch		0.9 m or more
Number of gantry wheel		8 wheels/corner
Gantry rail		JIS 73Kg/m rail

c) **Main speeds**

Main hoisting speed	with full load	65.0 m /min
	with no load	130.0 m /min
Trolley traversing speed		180.0 m /min
Gantry traveling speed		45.0 m /min
Boom hoisting/lowering speed		8.0 min/cycle

d) **Sub function**

Spreader tilting angle	Trim	±5 degrees
	List	±5 degrees
	Skew	±5 degrees

e) **Power supply system**

Trolley power supply	Festoon system
Crane power supply	Cable reel system
Crane main power	AC6.0KV，50Hz、3 phases

2) **Other specifications**

a) The STS Gantry Crane shall be provided with Seismic Isolation System to increase the strength of crane and quay construction against intense earthquake.

b) The STS Gantry Crane shall be semi-rope trolley type which has no trolley traversing ropes. The maintenance and replacement work for trolley traversing ropes shall be completely eliminated.

c) All motion and switching operation of the STS Gantry Crane excepting boom motion shall be operated from the operators cab.

d) All speed reduction gears of the STS Gantry Crane shall be contained in the enclosed gear boxes to reduce the maintenance work and to prevent spreading of greases on the ground.

e) The STS Gantry Crane shall be provided with the electric sway control system which helps for an unskilled driver to operate handling of container with less difficulty.

(2) RTG

1) **Specifications**

The RTG crane is sized to be able to straddle over one chassis lane and 6 laws of 5 high

(9'6" container) stacks. The RTG is driven by a Hybrid Type Diesel Engine Generator Set. The RTG is provided with 90°wheel turning function which allow the crane run to the cross direction. This function enables RTG to move any stacking lane without difficulty. The main technical specifications for the RTG shall be indicated below.

a) **Load**

Lifting load under spreader	40.6t

b) **Main dimension**

Span	23.47 m
Trolley traverse length	19.1 m or more
Lift of spreader (above ground)	18.0 m or more
Gantry wheel pitch	2.5 m
Gantry wheel base	6.4 m
Max. crane width (buffer to buffer)	abt.11.6 m

c) **Main speed**

Hoisting speed	with 40.6 t load	23.0 m/min
	with no load	52.0 m/min
Trolley traversing speed		70.0 m/min
Gantry traveling speed		90/135 m/min

d) **Other functions**

Slewing of gantry wheel	±90.0° around vertical axis
Spreader skew	±5.0° around vertical axis
Trolley power supply	Festoon cable system
Crane power	Hybrid Diesel Engine Generator set on a crane

2) **Other specifications**

a) The RTG is provided with the Power Unit of Hybrid type Diesel Generator Set which enable reduction of the capacity of diesel engine and of its fuel consumption.

b) The RTG is provided with Automatic Straight Traveling Control System which contributes to release a crane driver from fatigue due to the difficulty of traveling control.

c) The RTG is equipped with Bay Center Detecting System which will help the crane driver stop precisely and rapidly both of the crane legs at the bay center of the target location.

(3) Reach Stacker

The main technical specifications for the Reach Stacker are indicated below.

1) **Type**

Diesel Engine Driven Type

2) **Stacking capacity (height):**

	9' 6" ISO container	8' 6" ISO container
The 1st low	5 high stack	5 high stack
The 2nd low	4 high stack	5 high stack
The 3rd low	3 high stack	4 high stack

3) **Stacking capacity (load):**

The 1st low	1st high to 4th high	43 ton
	5th high of 9' 6"stack	35 ton
	5th high of 8' 6"stack	40 ton
The 2nd low	1st high to 5th high	26 ton
The 3rd low	1st high to 3rd high	12 ton

4) **Main dimension**

Load center	the 1st low	approx.2.2m
	the 2nd low	approx.3.85m
	the 3rd low	approx.6.3m
Total length (with spreader and retracted boom)		approx.12.0m
Total width (with retracted spreader)		approx. 6.2m
Total height (boom lowered to horizontal)		approx.5.0m
Max. lifting height of spreader (from ground)		approx.15.1m

Spreader slewing	-95 º /+185 º
Spreader side shift	approx.－800mm/＋800mm
Turning radius	approx.8.3m
Width of carrier passage	15.0m or less

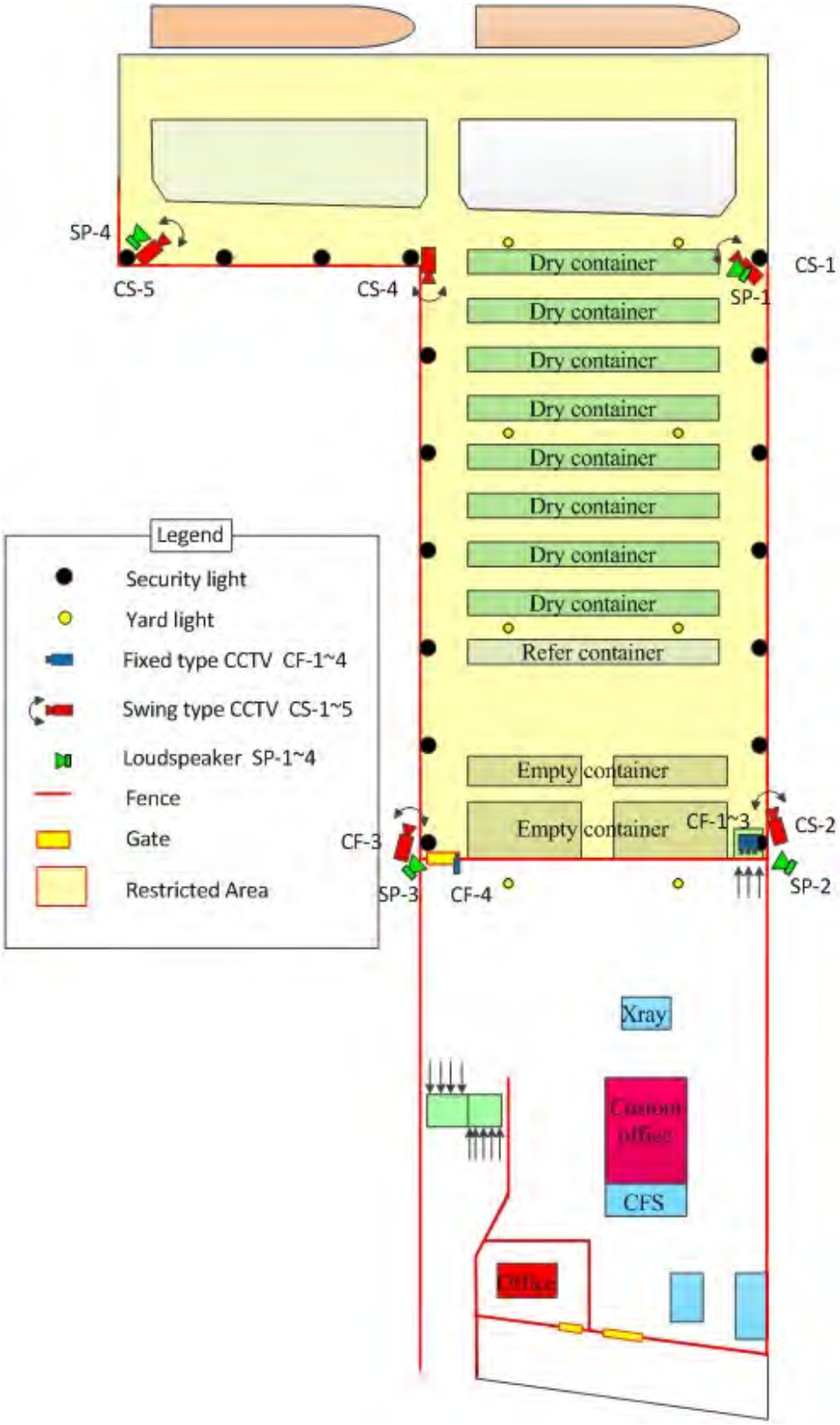
5) Speed

Traveling speed (without load)	forward	25 km/hr. or more
	backward	25 km/hr. or more
Hosting/Lowering speed (mean speed at the 1st low with load)		240 mm/sec or more

7.4.6. Lighting and Security related System

It is necessary to establish a restricted area in designing equipment of the system. When setting up the restricted area, it is necessary to consider the usage and operation method of conditions and to conduct proper access control, monitoring and control cargo without disturbing the efficient use of the port facility.

Many people attend the door-opening inspection at the customs in this port. Therefore, two cases, not include the inspection area in the restricted area (hereinafter called Case 1) and include the inspection area in the restricted area is adopted.



Source : Study Team

Figure 7.47-18 The Security Equipment Deployment Plan

7.5. Detailed Cost Estimation

Detail and preliminary cost estimates is given in Table 7-9.

Table 7-9 Detail and Preliminary Cost Estimates

Unit ; 1,000 US$

Item		Preliminary Estimate	Detailed Estimate	Balance
1	Construction and Procurement	192,614	222,325	29,711
	(1) Civil Works and Buildings	139,042	165,829	26,787
	(2) Cargo Handling Equipment	32,763	32,478	-285
	Base Cost	171,805	198,307	26,502
	(3) Inflation contingency	9,906	11,434	1,528
	(4) Physical contingency	10,903	12,584	1,682
2	Consultant Cost	12,329	12,329	0
	(1) Design	0	0	0
	(2) Supervision	11,009	11,009	0
	Base cost	11,009	11,009	0
	(3) Inflation contingency	733	733	0
	(4) Physical contingency	587	587	0
3	Project Administration Cost	2,031	2,031	0
4	Preparation Cost	0	0	0
	(1) Compensation	0	0	0
	(2) EIA Cost	0	0	0
5	Tax	2,343	2,343	0
6	Interest	42	42	0
	(1) Interest	42	42	0
	(2) Commitment charge	0	0	0
7	Total Project Cost	209,359	239,028	29,669
	Total JICA Loan Portion	204,985	234,654	29,669

Prepared by the Study Team

7.6. Procurement Package

To procure the works and plant concluded in the additional detailed study, two procurement packages are proposed:

- Package 1 : Civil Work and Buildings
- Package 2: Procurement of Cargo Handling Equipment (Design, Manufacture, Supply and Installation)

Major scope of the two packages are summarized in Table 7-10 and Table 7-11.

Table 7-10 Major Scope (Package 1)

	Item	Q'ty	Specification
A. Civil work			
1	Soil Improvement PVD method	240,000 m	・L=30m
2	Ditto Filling sand for loading	730,000 cu.m	・H=6m
3	Jetty 40×400m	16,000 sq.m	・Steel pipe pile, Jacket type deck
4	Trestle w=20m and 15m, L= about 62m	3Nr	・Steel pipe pile, Concrete structure
5	Revetment	400 m	・Sheet Pile & PHC pile
6	Access Road	800 m	・Asphalt Pavement
7	Pavement for Container	150,000 sq.m	・Interlocking, Concrete pavement
8	Dredging works	15,500 cu.m	・In the vicinity of jetty
B. Building work			
1	Administration Building	3,436 sq.m	・4 stories RC building, Curtain wall ・PHC piles ・2 elevators
2	Container freight station /Warehouse	5,000 sq.m	・1 story steel structure building ・PHC piles
3	Maintenance Shop 1	720 sq.m	・1 story steel structure building ・PHC piles ・15 t crane
4	Maintenance Shop 2	576 sq.m	・1 story steel structure building ・PHC piles
5	Terminal Gate	5 for In	・1 story steel structure building

		3 for Out	
6	Marine House	836 sq.m	・2 stories RC building ・Steel Piles
7	Fuel Station	400 sq.m	・1 story steel structure & roof
8	X-ray Building	200 sq.m	・1 story
9	Sub-station A Main Sub-Station	600 sq.m	・1 story steel structure building ・Generator
10	Sub-station B Sub-station for Jetty	35 sq.m	・1 story steel structure building
11	Sub-station C Sub-station for Refer	4 sq.m	・1 story steel structure building without exterior wall
12	Sub-station D Sub-station for Marine power	4 sq.m	・1 story steel structure building without exterior wall
13	Water Reservoir pump House	800 sq.m	・1 story steel structure building ・2,000 cubic m tank
14	Elevated Water Tank	40 m height	・200 cu.m tank
15	Guard House A	20 sq.m	・1 story RC structure building
16	Guard House B	20 sq.m	・1 story RC structure building
17	Wastewater Treatment Plant A	100 sq.m	・RC structure concealed underground
18	Wastewater Treatment Plant B	100 sq.m	・RC structure concealed underground
19	Outside Lighting A	8 poles	・30 m height pole with 6 lighting fixture
20	Outside Lighting B	2 poles	・12 m height pole with 2 lighting fixture
21	Outside Lighting C	41 poles	・12 m height pole with 1 lighting fixture

Prepared by the Study Team

Table 7-11 Major Scope (Package 2)

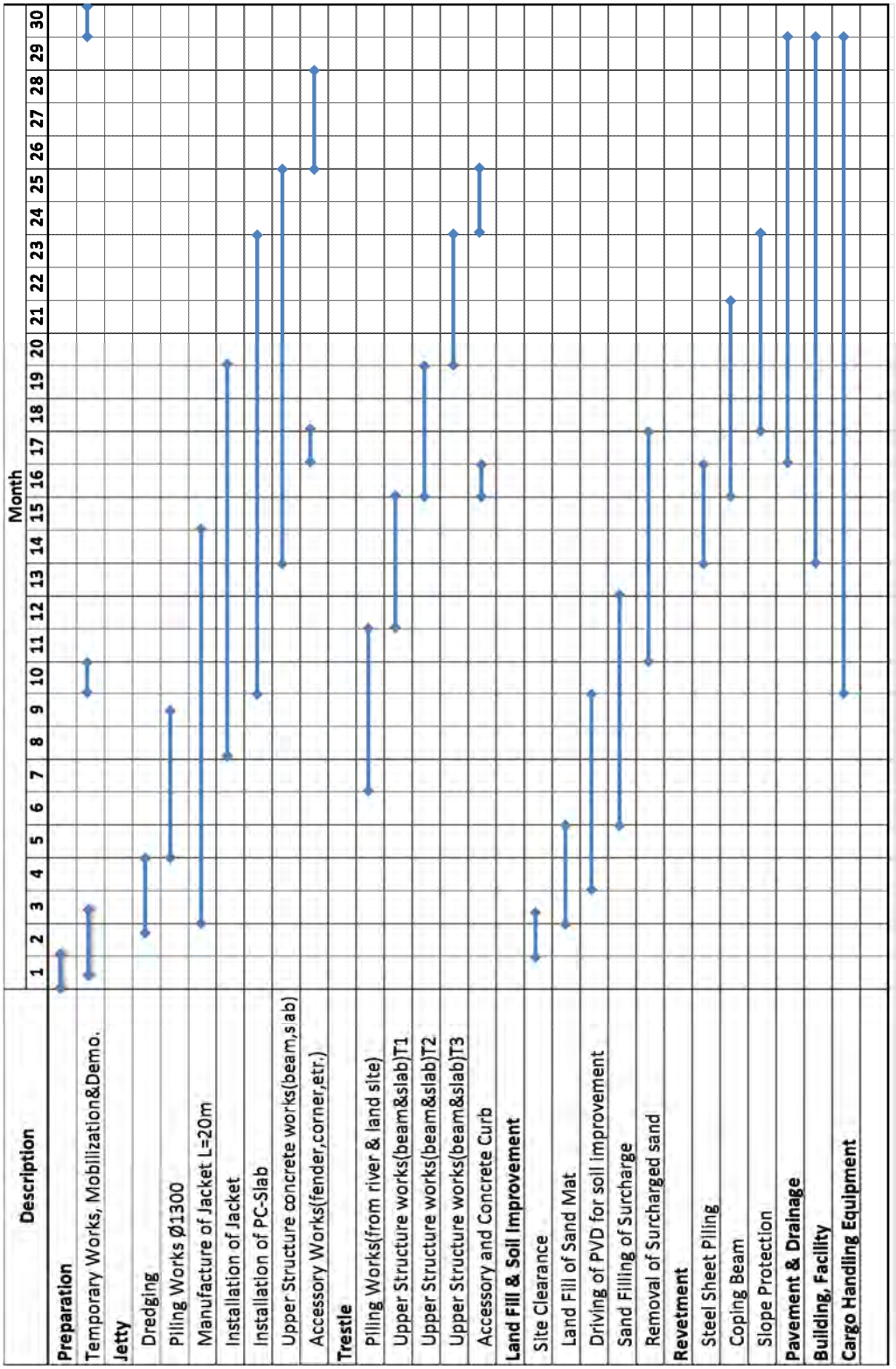
	Item	Q'ty	Specification
1	STS Gantry Crane	2 units	Hinged boom, rigid box portal construction with mono-box girder, rope trolley and self-traveling gantry crane Cargo and load handled : ISO 20/40/45Ft Container Spreader 20/40Ft telescopic type Seismic isolation system
2	Rubber Tied Gantry Crane	6 units	Crab trolley type, diesel-electric powered and self-traveling rubber tired gantry crane. Cargo handled: ISO 20/40/45Ft container Spreader 20/40Ft telescopic type
3	Reach stacker	3 units	Retractable and luffing boom type, diesel driven, self-travelling rough terrain container handling and stacking vehicle.
4	3.5t Forklift	2 units	To be used for loading/retrieving LCL load to/from ISO container at CFS , and occasionally general cargo handling at in- door/ out-door. To be Diesel engine driven, counter balance type fork lift. Lifting capacity 3.5t
5	Terminal tractor	6 units	Diesel driven tractor head for towing container chassis with load up to 40.6t
6	Terminal chassis	6 units	The Terminal Chassis to be used for transporting a laden and empty container by towed by Terminal Tractor. The terminal chassis shall have space and load capacity to carry 1x20ft container (24 metric tons),or 2 x 20ft container (20 metric tons each), or 1 x 40/45Ft container.

Prepared by the Study Team

7.7. Project Implementation Schedule

Detailed project implementation schedule is given in Table 7-12.

Table 7-12 Detailed Project Implementation Schedule



Prepared by the Study Team

7.8 Project Evaluation

In the economic analysis, the Project is evaluated by calculating an Economic Internal Rate of Return (EIRR) based on the economic price difference of the cost and benefit of 'with the project case' and 'without the project case'. In this Project, the economic benefit is set to 'Added value to the economy of Myanmar by the export containers'. For the Project cost, it is set to 'Construction, Maintenance, Repair cost of the Port facilities; Purchasing, Maintenance, Repair and Renewal cost of Cargo Handling Equipment, Yard Vehicles and Tug Boats; Management and Operation cost of the Terminal'. EIRR for the Project period of 30 years was calculated as 12.9%, which is higher than the World Bank's bench mark for project approval of 12%, hence this Project should be implemented from the view point of the national economy. (**Table 7.8-1**)

For the financial analysis, the scope of the analysis was limited to 1 berth and 1 yard of Plot 25 for the output of this 2nd stage study. This is because this Project will be opened and operated in the unusual combination of 2 berths of Plots 25 and 26, and 1 yard of Plot 25, as an interim form of the phased development, but as a terminal operating business, it is more normal to be set up including the yard of Plot 26. Also, the period of evaluation was set to 40 years, making it same with the repayment period of Japanese ODA loan.

This Project is assumed to be implemented by a public entity both developing and operating all of the terminal, or in a Public-Private Partnership (PPP) scheme where a public entity developing the main portion of the terminal and the operation and additional development done by a private operator, so firstly, this Project was evaluated by calculating the Financial Internal Rate of Return (FIRR) of the whole project which is the case a public entity develops all and operates. In this case, the revenue of the Project is set as a value which promotional cost is deducted from the tariff rate set by MPA common to all the terminals in Yangon Port. The cost of the Project is set adding repayment of Japanese ODA loan (principal and interest), the maintenance cost of facilities, the maintenance and renewal costs of machineries and equipment, and the management and operation cost of the terminal. FIRR for the 40 years of the Project implementation was 5.4%, which means the Project is financially feasible. FIRR after the sensitivity analysis of cost 10% increase and revenue 10% decrease was 3.5%, which also means the Project is feasible. (**Table 7.8-2**)

Also, financial feasibility of private entity in the case the operation is contracted to a private entity through a concession contract. Based on the scheme proposed in the 1st stage study, it was set that a private entity forms a Joint Venture company with MPA and participates to the terminal operation under the concession contract of 40 years. The concession fee was set as a fixed fee which is basically the repayment of the Japanese ODA loan, and a variable fee which is a profit share based on the percentage of the capital subscription. Other cost considered was the maintenance and renewal cost of facilities and equipment, and the terminal management and operation cost. The revenue was set based on the tariff rate of the Yangon port but promotional cost was deducted. The calculated financial

feasibility was that in the case MPA subscribes more than half of the capital as 51%, the FIRR for the private entity was 20.5%, and in the case the private entity subscribes 80% of the capital, the FIRR was 26.7%. (**Table 7.8-3**)

Moreover, the private entity can make their own additional investment such as to Inland Container Depot, and increase their tariff income by handling more containers, even more than 200,000 TEUs per a berth. Also, by providing a high value added service, they might be able to collect more cargo with less promotional cost, and then their financial viability improves more. However, in interpreting this result, it should be noted that the investment to the berth of Plot 26 is excluded on the premise of the plan that the Phase II, which is the yard at Plot 26, will be developed and enter into operation soon after the operation start of this Project. So, the Project implementing side including the Government of Myanmar should be putting continuous effort to the completion and opening of the Phase II as planned, in order to keep this Project feasible for the private entities to participate.

Table 7.8-1 EIRR of the Thilawa Area Urgent Development Plan (30 years)

Unit: '000 USD/Yr

Year		Cost				Benefit		Total	Cost+10% Revenue-10% Total
		Const-ruction	Mainte-nance	Terminal Operation	Tug	Container (TEU)	Value		
unit price				2325.773	0.001044		0.2625		
2014		1,618	0	0	0	0	0	-1,618	-1,779
2015		78,893	101	0	0	0	0	-78,994	-86,893
2016		97,130	329	0	0	0	0	-97,459	-107,205
2017	1	61,387	554	1,163	0	0	0	-63,104	-69,414
2018	2	0	813	2,326	34	33,000	8,663	5,489	4,306
2019	3	0	668	2,326	4	4,000	1,050	-1,948	-2,353
2020	4	0	1,448	2,326	167	160,000	42,000	38,059	33,465
2021	5	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2022	6	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2023	7	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2024	8	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2025	9	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2026	10	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2027	11	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2028	12	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2029	13	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2030	14	0	6,883	2,326	209	200,000	52,500	43,082	36,891
2031	15	0	11,071	2,326	209	200,000	52,500	38,894	32,284
2032	16	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2033	17	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2034	18	0	10,558	2,326	209	200,000	52,500	39,407	32,848
2035	19	0	10,558	2,326	209	200,000	52,500	39,407	32,848
2036	20	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2037	21	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2038	22	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2039	23	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2040	24	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2041	25	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2042	26	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2043	27	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2044	28	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2045	29	0	1,648	2,326	209	200,000	52,500	48,317	42,649
2046	30	0	1,648	2,326	209	200,000	52,500	48,317	42,649
Total		239,028	77,591	66,285	5,428	5,197,000	1,364,213	1,024,198	806,597

EIRR	12.9%	10.5%

Prepared by the Study Team

Table 7.8-2 FIRR of the Thilawa Area Urgent Development Plan (40 years)

Unit: '000 USD/Yr

Year		Cost			Revenue				Project Total	Cost+10% Revenue-10%
		Const-ruction	Main-tenance	Terminal Opera-tion	Container (TEU)	Container Handling	Port Entry charges	Revenue Total		
2014		1,622	0	0	0	0	0	0	-1,622	-1,784
2015		55,582	101	0	0	0	0	0	-55,683	-61,251
2016		84,119	282	0	0	0	0	0	-84,401	-92,841
2017	1	57,449	481	1,491	0	0	0	0	-59,421	-65,364
2018	2	0	730	2,981	33,000	3,168	320	3,488	-223	-943
2019	3	0	585	2,981	4,000	384	39	423	-3,143	-3,542
2020	4	0	1,365	2,981	160,000	15,360	1,553	16,913	12,567	10,441
2021	5	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2022	6	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2023	7	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2024	8	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2025	9	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2026	10	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2027	11	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2028	12	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2029	13	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2030	14	0	6,800	2,981	200,000	19,200	1,941	21,141	11,360	8,268
2031	15	0	10,988	2,981	200,000	19,200	1,941	21,141	7,172	3,661
2032	16	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2033	17	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2034	18	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2035	19	0	10,475	2,981	200,000	19,200	1,941	21,141	7,685	4,225
2036	20	0	10,475	2,981	200,000	19,200	1,941	21,141	7,685	4,225
2037	21	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2038	22	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2039	23	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2040	24	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2041	25	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2042	26	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2043	27	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2044	28	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2045	29	0	6,800	2,981	200,000	19,200	1,941	21,141	11,360	8,268
2046	30	0	10,988	2,981	200,000	19,200	1,941	21,141	7,172	3,661
2047	31	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2048	32	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2049	33	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2050	34	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2051	35	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2052	36	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2053	37	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2054	38	0	1,565	2,981	200,000	19,200	1,941	21,141	16,595	14,026
2055	39	0	10,475	2,981	200,000	19,200	1,941	21,141	7,685	4,225
2056	40	0	10,475	2,981	200,000	19,200	1,941	21,141	7,685	4,225
Total(40)		**198,773**	**124,827**	**117,767**	**7,397,000**	**710,112**	**71,792**	**781,904**	**340,537**	**218,210**

40years	FIRR	5.4%	3.5%

Prepared by the Study Team

Table 7.8-3 FIRR of the Thilawa Area Urgent Development Plan (Private Entity)

('000 USD)

Year		Cost		CF(Fix)	Revenue		Operator Profit	Operator Profit after tax	CF(Variable):MPA Share			Private Total		
		Main-tenance	Terminal Opera-tion		Container (TEU)	Container Handling			51%	40%	20%	(49% Share)	(60% Share)	(80% Share)
2014		0	0		0	0	0	0	0	0	0	0	0	0
2015		101	0		0	0	-101	-101	0	0	0	-101	-101	-101
2016		282	0		0	0	-282	-282	0	0	0	-282	-282	-282
2017	1	481	1,491	4,982	0	0	-6,954	-6,954	0	0	0	-6,954	-6,954	-6,954
2018	2	730	2,981	4,982	33,000	3,168	-5,525	-5,525	0	0	0	-5,525	-5,525	-5,525
2019	3	585	2,981	4,982	4,000	384	-8,164	-8,164	0	0	0	-8,164	-8,164	-8,164
2020	4	1,365	2,981	4,982	160,000	15,360	6,032	4,524	2,307	1,810	905	3,725	4,222	5,127
2021	5	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2022	6	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2023	7	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2024	8	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2025	9	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2026	10	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2027	11	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2028	12	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2029	13	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2030	14	6,800	2,981	4,982	200,000	19,200	4,437	3,328	1,697	1,331	666	2,740	3,106	3,771
2031	15	10,988	2,981	4,982	200,000	19,200	249	187	95	75	37	154	174	212
2032	16	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2033	17	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2034	18	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2035	19	10,475	2,981	4,982	200,000	19,200	762	571	291	229	114	470	533	648
2036	20	10,475	2,981	4,982	200,000	19,200	762	571	291	229	114	470	533	648
2037	21	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2038	22	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2039	23	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2040	24	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2041	25	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2042	26	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2043	27	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2044	28	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2045	29	6,800	2,981	4,982	200,000	19,200	4,437	3,328	1,697	1,331	666	2,740	3,106	3,771
2046	30	10,988	2,981	4,982	200,000	19,200	249	187	95	75	37	154	174	212
2047	31	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2048	32	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2049	33	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2050	34	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2051	35	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2052	36	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2053	37	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2054	38	1,565	2,981	4,982	200,000	19,200	9,672	7,254	3,699	2,902	1,451	5,972	6,770	8,221
2055	39	10,475	2,981	4,982	200,000	19,200	762	571	291	229	114	470	533	648
2056	40	10,475	2,981	4,982	200,000	19,200	762	571	291	229	114	470	533	648
Total(40)		**124,827**	**117,767**	**199,280**	**7,397,000**	**710,112**	**268,238**	**195,922**	**110,643**	**86,779**	**43,390**	**157,594**	**181,459**	**224,848**
										FIRR	**40years**	**20.5%**	**22.8%**	**26.7%**

Prepared by the Study Team.