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 Por**t, 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

As almost all container cargo of Myanmar has been handled at Yangon port, study team assume all of forecast container cargo volume of Myanmar will be handled in Yangon port. Table 5.2-1 shows estimation results of container volume to be handled in Yangon Main Port and Thilawa Area Port where containers to/ from the SEZ shall be handled. Detailed forecast calculation is mentioned in chapter 4.2.1. 'Cargo Demand Forecast'.

Table 5.2-1 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

(Prepared by the Study Team)

5.3. Capacity of Existing Container Terminal

Capacity of container terminal is determined from such factors as the handling capacity on the pier side which depends on the handling capacity of gantry cranes and the yard handling capacity which depends on the area and the capacity of yard handling equipment.

Annual container handling capacity of pier side container handling equipment (TEUs/year) can be estimated under the following parameters.

1. Number of gantry cranes
2. Hourly container handling number of gantry cranes
   (This is estimated at 20 to 30 in case of developing countries. Handling efficiency of the 2nd gantry crane will be decreased)
3. Annual working days of gantry cranes
4. Daily working hours of gantry cranes
5. Annual berth occupancy rate
6. Ratio of 20 foot containers and 40 foot containers

7 Box Ratio

Since handled containers dwell in the yard, annual container handling capacity can be estimated taking into account the container storage capacity of the yard. The factors which affect the handling capacity of the yard are as follows;

1. Slot number of container yard
2. Container stacking height
3. Usage rate of container storage capacity
4. Ratio of the maximum container handling volume against weekly average
5. Container dwelling days in yard
6. Annual working days of yard

The handling capacity of container terminal is the smaller value among the values determined above.

Table 5.3-1 shows the maximum container handling capacities of existing facilities given in Table 3.2-1. This is calculated in the conditions that container equipment necessary for achieving the maximum capacity is prepared and handling efficiency improvement is achieved. And future container handling capacity of each terminal based on future expansion plan of jetties and yards is given in Table 5.3-1. The factors used for estimating container handling capacity are as shown below;

Annual container handling capacity of pier side container handling equipment (TEUs/year)

1. Number of gantry cranes = 2
2. Hourly container handling number of gantry cranes = 25 boxes/hour
3. Handling efficiency of the 2nd gantry crane = 0.9
4. Annual working days of gantry cranes = 365 days
5. Daily working hours of gantry cranes = 21 hours
6. Annual berth occupancy rate = 0.4
7. Ratio of 20 foot containers and 40 foot containers = 1.5
8. Box Ratio = 1.4

Annual container storage capacity of the yard (TEUs/year)

1. Slot number of container yard
2. Container stacking height = 3.5
3. Usage rate of container storage capacity = 0.75
4. Ratio of the maximum container handling volume against weekly average = 1.4
5. Container dwelling days in yard = 7 days
6. Annual working days of yard = 365 day

In addition to the existing container terminals, a part (540m in length) of Sule Pagoda Terminal

within its total length of 1,041m is to be privatized for handling general cargo and containers. Due to the narrow yard area of yard of about 100m in width, container handling capacity at Sule Pagoda Terminal is estimated at about 50,000 TEUs/year. Capacity increase of Sule Pagoda Terminal is expected to be achieved in 2015 at the earliest because BOT contract is still under preparation.

On the other hand, facility construction for capacity increase of MIP and Ahlone Terminal will only starts from 2016 when an actual capacity shortage emerges. The capacity increase of 147,000 TEUs/year of those terminals will be realized between 2018 and 2010 provided that the facility construction takes 2 years.

According to the BOT contract of MITT with MPA, MITT is entitled to handle a maximum of 320,000 TEUs/year containers preferentially in proportion to the number of gantry cranes. The container handling capacity of MITT is expected to increase gradually. The capacity is expected to increase by 80,000 TEUs/year in the year 2016 when the container handling demand will exceed the capacity of whole Yangon Port and to reach a maximum capacity of 815,000 TEUs/year in 3 years.

The current and future container handling capacities in Yangon Port can be estimated as shown in Table 5.3-1.

Table 5.3-1 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

('000TEUs/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

(1) Port Planning

As shown in Table 5.3-1, the current container handling capacity of Yangon Main Port is estimated at about 528,000 TEUs/year. In order to prepare for the increasing container transport demand, several terminal expansion works are being carried out.

As shown in 5.3 Capacity of Existing Container Terminal, handling capacity of a container terminal is estimated based on the handling capacities at berth or yard, whichever is smaller. Unfortunately, a sufficient yard area cannot be secured at container terminals at Yangon Main Port because the port spreads over a very narrow land area. Therefore, the maximum container handling capacity in the future is expected to be about 725,000 TEUs/year. Currently, Myanmar International Terminal Thilawa (MITT) with a 1,000 m long berth has a handling capacity of about 203,000 TEUs/year. This terminal is expected to increase container handling capacity to as much as 815,000 TEUs/year by the expansion of yard area and additional installation of necessary handling equipment. Taking into account the above, the total container handling capacity of Yangon Port and MITT is expected to increase to about 1,540,000 TEUs/year but it will take some time to achieve the capacity increase.

According to the cargo demand forecast, it can be estimated that a shortage of container handling capacity of Yangon Port will surface after 2015 because the necessary container handling capacity will be secured with the existing facilities until the year 2014. Capacity increase plans have not, however, been announced by private container terminal operators to cope with the shortage. In addition, it will take some time for expanding and/or rearranging container handling yards and installing container handling equipment to improve the container handling capacity because they are conducting general cargo handling at the existing terminals too.

Operation of SEZ which is expected to be developed behind the container terminal is required to start by 2015. In accordance with Table 5.4-1 which is developed by applying the demand forecast method shown in Forecast of Container Handling Volume, a container terminal with the capacity of 160,000 TEUs/year including SEZ relevant demand of 75,000 TEUs/year is needed by the year 2015 as the first phase development. A new terminal development in Thilawa Area Port will be needed even though 6 additional gantry cranes will be installed in 2016 and the preferential right of container handling volume will reach 320,000 TEUs/year.

Hence, as one berth of a container terminal is able to handle 203,000 TEUs/year as shown in section 6.1 Urgent Development Plan of Thilawa Area Port, at least one berth (Phase I-1) needs to become operational in order to cope with the container handling demand in 2015. Because the demand in the year 2019 is expected to exceed the annual capacity of one berth (200,000 TEUs), it is required

to complete one additional berth as the Phase II project by the year 2018. Since, the demand in the year 2020 is expected to exceed Phase II capacity of 400,000 TEUs/year, Phase III development with two berths is needed by the year 2019.

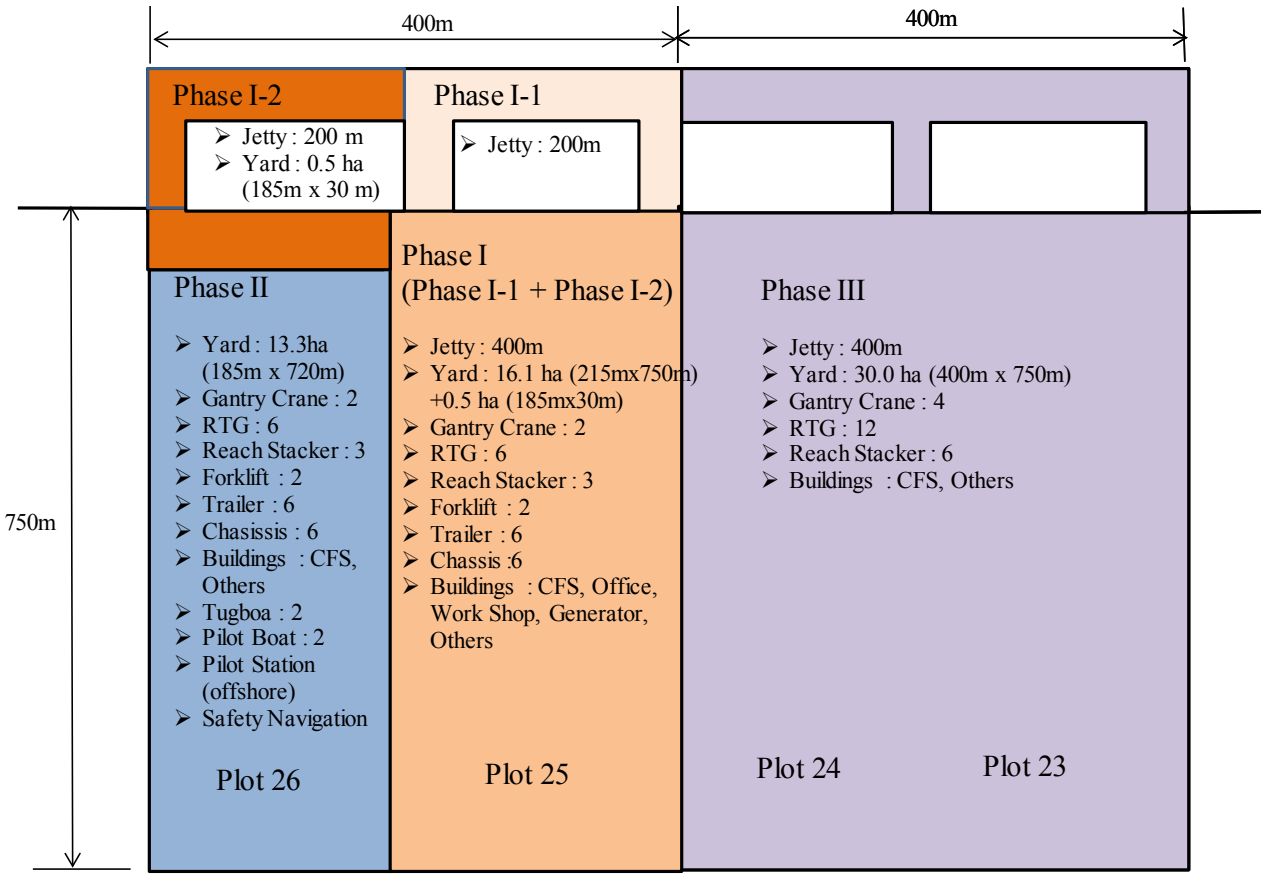
The project implementation schedule of the above is shown in Table 5.4-1 which summarizes development schedule by each case of the demand forecast. Figure 5.4-1 shows a layout of Thilawa Area Port Terminal. In this planning, Plot 22 is excluded from the planning area for the time being as shown below.

Figure 5.4-2 shows chronological demand forecast and phased development program of Thilawa Area Port terminal. As shown in the figure, 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.

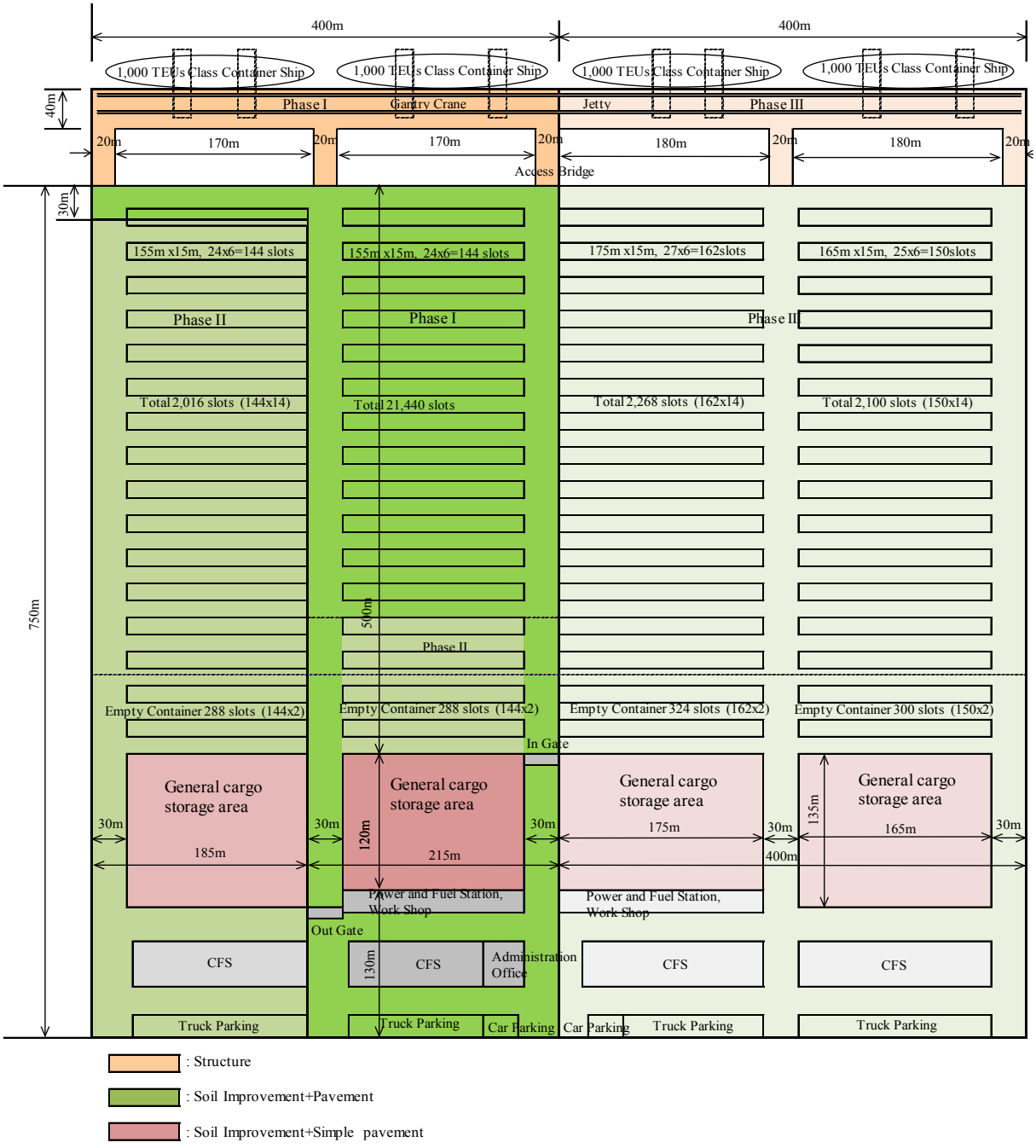
Table 5.4-1 Container Terminal Development Plan of Thilawa Area Port

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)



(Prepared by the Study Team)

Figure 5.4-1 Thilawa Area Port Terminal Layout

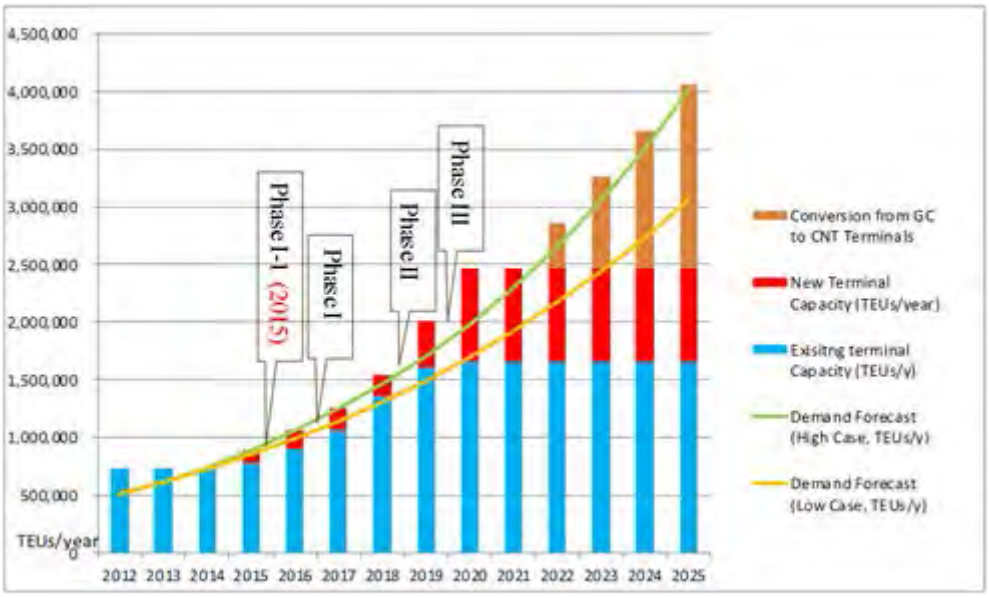


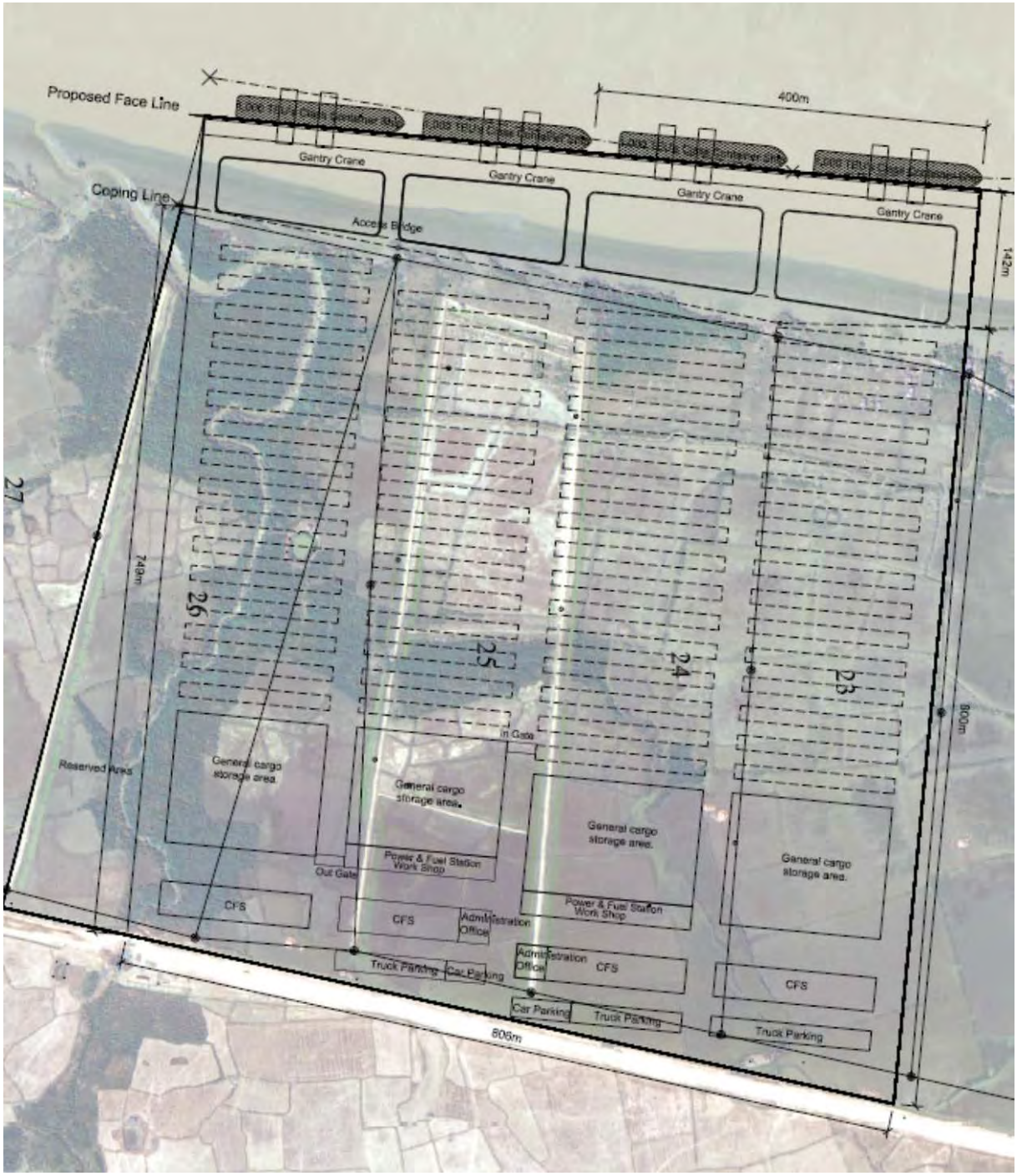
Figure 5.4-2 Demand Forecast and Phased Development Program of Thilawa Area Port Terminal

The project completion year and container handling capacity of each Phase is shown in Table 5.4-2.

Table 5.4-2 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

As shown in **1.3 Study Area**, plots between 22 and 26 are designated as areas for using Thilawa Area Port Development. However, as shown in **5.4 Environmental and Social Considerations** those areas are owned by MPA, 220 and 42 persons are living on Plots 22 and 23 respectively and a part of the areas of about 29 ha is used by farmers for cultivation. Since there will be difficult problems to resettle the dwellers from the present areas in a short time, it is recommended to use plots between 23 and 26 for the development of Thilawa Area Port. Figure 5.4-3 shows the project layout drawn on Google Map.



Source: Google Map , Study Team

Figure 5.4-3 Thilawa Area Port Terminal Layout (Google Map)

In case of High Case container demand forecast, handling volume in 2025 is estimated at about 4 million TEUs in case of the high estimate as shown in Table 5.4-1. And the maximum possible container handling capacity in Yangon Port is estimated at about 1.54 million TEUs per annum as shown in Table 5.4-1. On the other hand, about 800,000 TEUs of containers per annum are expected to be handled at an 800 m new Thilawa Area Port Terminal which provides 4 berths of about 200,000

TEUs handling capacity each. Therefore, there is a need to construct port facilities for handling containers after 2022 (see Table 5.4-1). 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 5-4-3 (1) 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 5.4-3 (2), it is necessary to convert conventional terminals to container terminals and/or to construct additional container terminals after 2021.

Table 5.4-3 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 4.2.12 of **4.1.4 Basic Concept of**

Yangon Port Development, (3) Yangon Port Master Plan.

(2) Facility Design

This preliminary design of port facilities includes a berth, yard, revetment, and trestle.

1) Standards and Codes

a) Design standards for port facilities

Since no technical standards or the like on port facilities are yet available in Myanmar, the design of port facilities is based on "Technical Standards and Commentaries for Port and Harbor Facilities in Japan" 2007/ Port and Harbor Association of Japan (English version 2009).

Where applicable or deemed adequate international standards, such as BS, PIANC Guidelines, or Euro Code, are also referred to.

b) Industrial Standard

Japanese Industrial Standards (JIS) is applied.

2) Berth Design

The jetty is designed for a container berth as well as for a multiple-purpose berth.

a) Design Conditions of berth

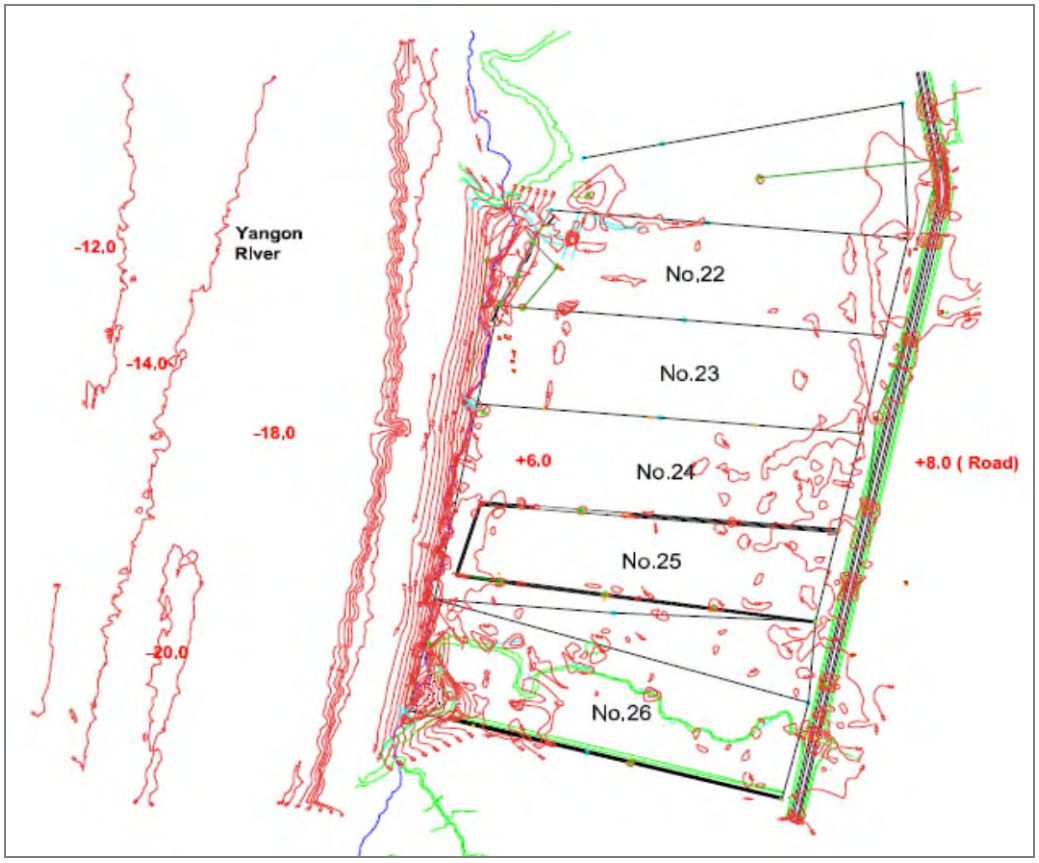
i) Site conditions

① Geological condition

The topographic and bathymetry survey result of the site is shown in Figure.5.4.-4

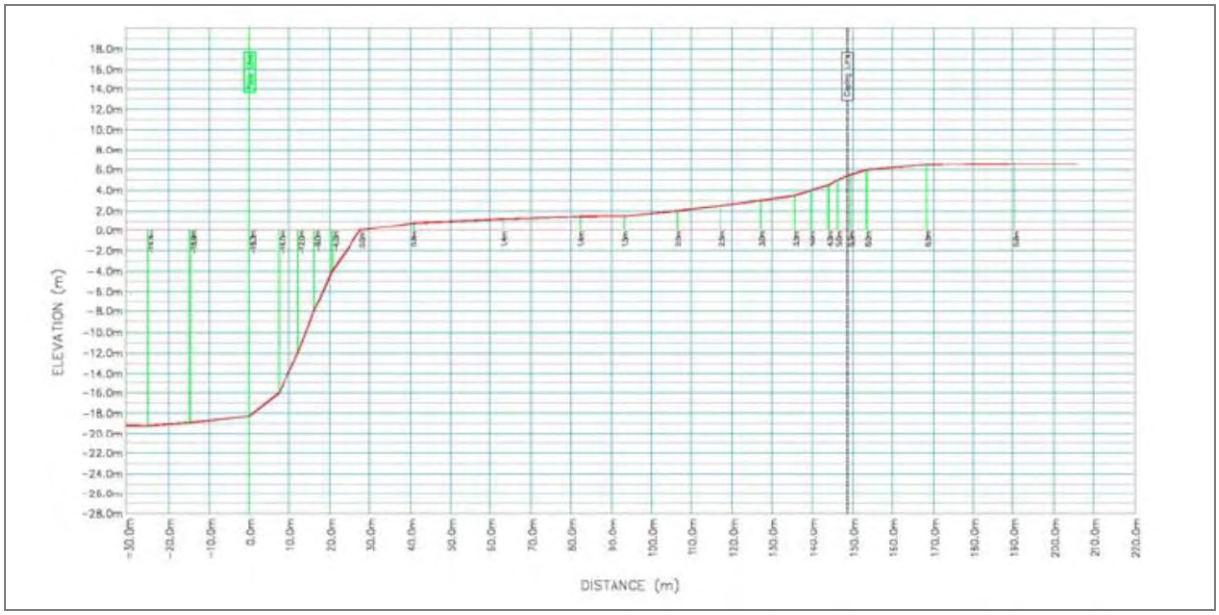
According to the typical cross section of the river at the site, the followings points are confirmed:

- Around 120m distance from riverbank, the ground level reaches CDL0.0m with 1:20 slope, and from this point (CDL0.0m) it goes down to CDL-18.0m with about 1:2 slope.
- The maximum depth of the river is about CDL-20.0m.
- The typical section of river side at the site is shown in Figure. 5.4-5.



(Prepared by the Study Team)

Figure 5.4-4 Topographic Survey Result of the Area

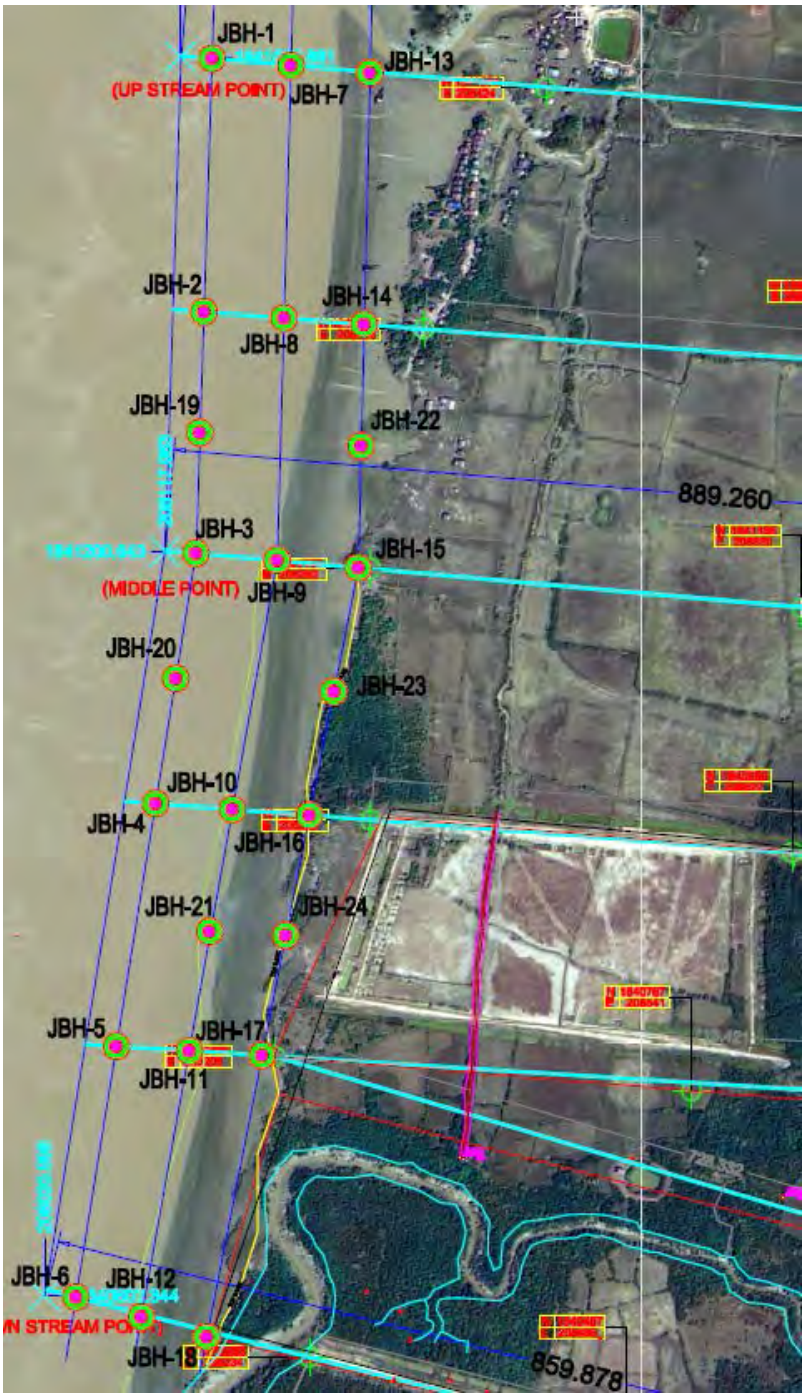


(Prepared by the Study Team)

Figure 5.4-5 Typical Cross Section of the River Side

②Geotechnical conditions

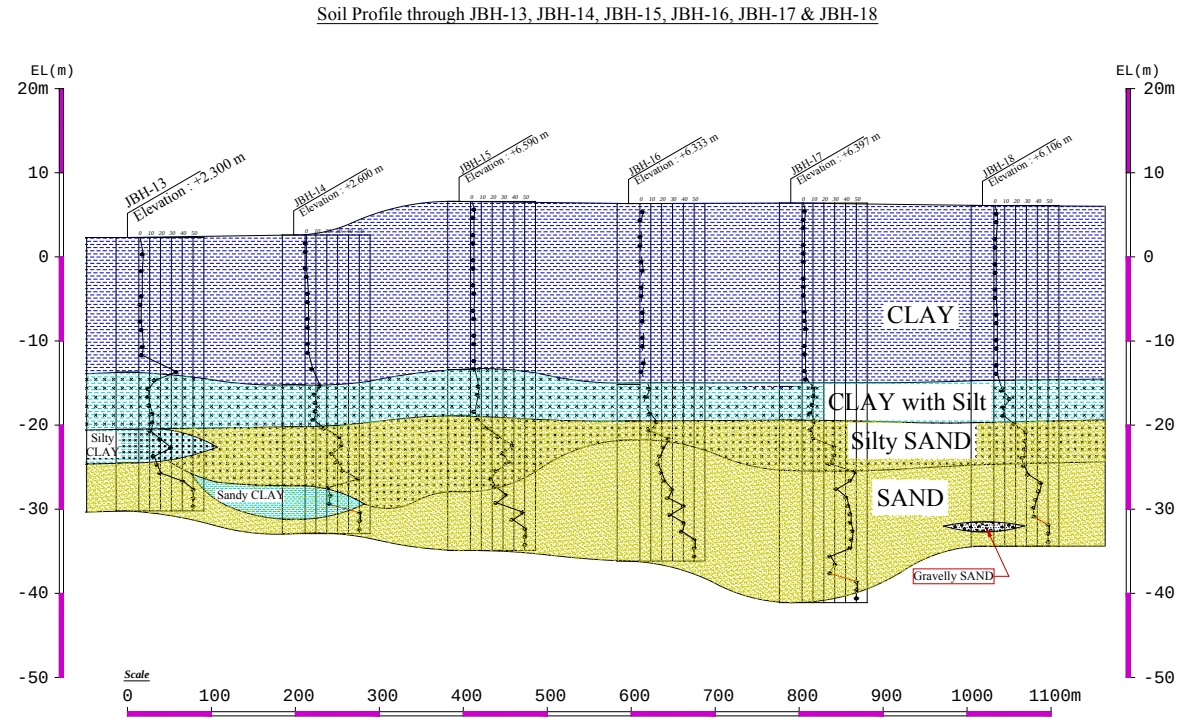
The geological survey locations of the site are shown in Figure. 5.4-6.



(Prepared by the Study Team)

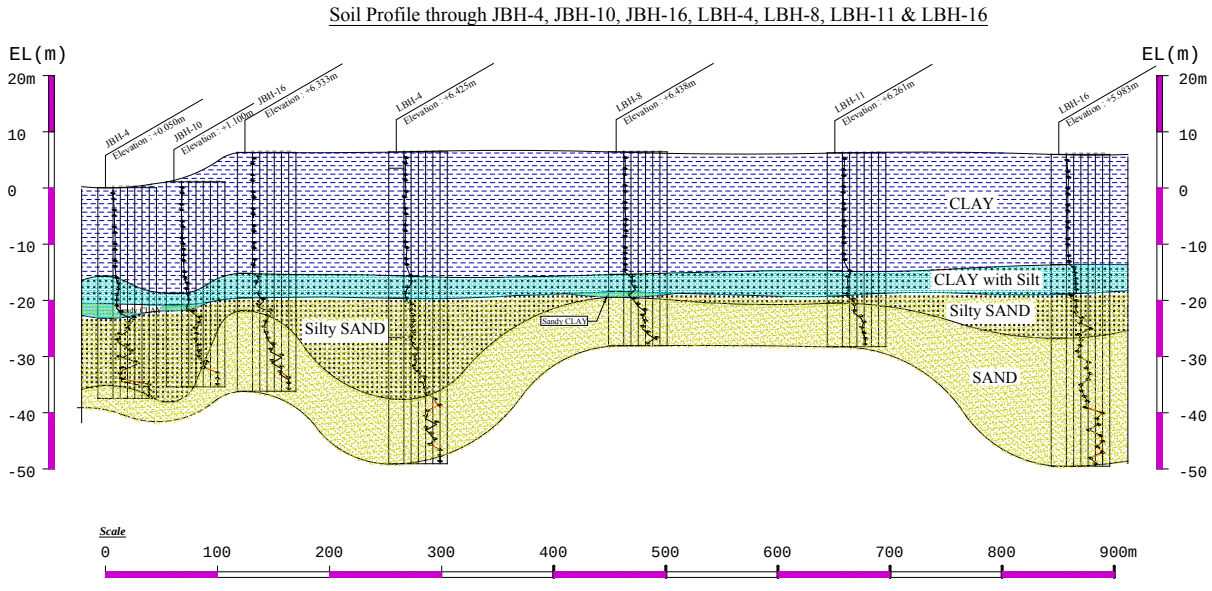
Figure 5.4-6 Geological survey locations of the site

Geological cross section is shown Figure 5.4-7 and Figure.5.4-8.



(Prepared by the Study Team)

Figure 5.4-7 Soil Profile（Longitudinal profile along the berth face line）



(Prepared by the Study Team)

Figure 5.4-8 Cross Section Soil Profile（Berth Area）

The geological condition of the site is as follows: The layer from surface down to CDL-23m is very soft silt. A loose silt mixture sand exists from CDL-23m to CDL-27m. The layer deeper than CDL-27m is relatively firm sand layer and at CDL -35 m the N-value is more than 50.

- Average N value of each layer is as follows.
  - N- value of a very soft layer is 1~3.
  - N- value of loose sand is 10~30.
  - N-value of comparatively firm sand is more than 30.
- Design foundation composition

From the geological survey result, the design foundation composition is set up as follows.

Design Geological Condition

Table 5.4-4 Design Geological Condition

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

(Prepared by the Study Team)

③Hydrographic conditions

- **Tide level**

The tide levels computed by a harmonic analysis based on tide level observation in the Thilawa area for one year (2009-2010) are summarized in the following Table.

Table 5.4-5 Tide Level

TIDE	HEIGHT
HHWL	+7.10m
HWL	+6.24m
MWL	+3.28m
LWL	+0.33m
CDL	+0.00m

(Prepared by the Study Team)

- **Current**

No current observation record of the site is available, thus the design current is based on the record of the Yangon Port:

The flow velocity

Max velocity : 6kt = about 3.1 (m/s)

Current Direction

The current direction of the maximum current is ebb tide flow.

- **Wave**

The open sea wave does not reach to site, as the site is located 16-km from the mouth of the river. As the river is wide, wind waves occur at the site. The height and period of wind wave is

evaluated from Wind Hind-casting Diagram of the S-M-B method. Design maximum-wind-speed for wind wave: 40 m/s. The height and period of drift wave at the site is shown in Table. 5.4-6

Table 5.4-6 Hind casting of drift wave

Direction	Effective fetch(Km)	Height H1/3(m)	Period T1/3(m)
S	2.50	1.5	3.2
SW	3.33	1.7	3.5
W	2.87	1.6	3.4
NW	3.32	1.7	3.5

Direction：Wave direction is same as wind.
(Prepared by the Study Team)

Table 5.4-7 Design Wave

Height H1/3(m)	H1/3=1.7m
Period T1/3(m)	T1/3=3.5s
Wave direction	SW,NW

(Prepared by the Study Team)

④Meteorological conditions

- **Wind**

There is no wind velocity observation record of the site when cyclone Nargis attacked.

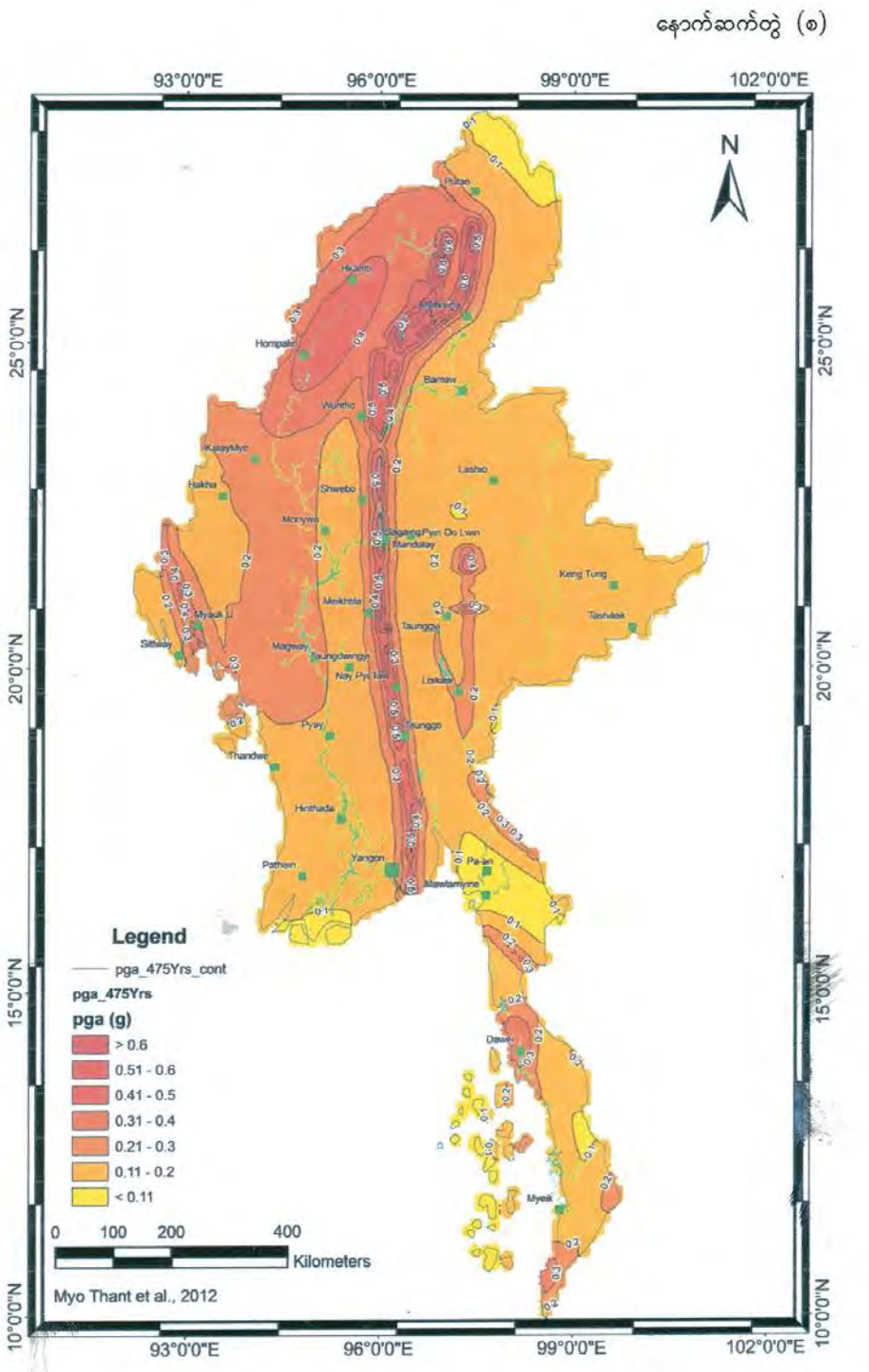
Wind record of Cyclone Nargis in Yangon is adopted instead which indicates the following;

Maximum wind velocity : 59.2 m/s
Maximum instantaneous wind velocity : 72 m/s

Therefore, it is considered that 60 m/s wind is the maximum wind velocity, and 72 m/s wind is the maximum instantaneous wind velocity.

- **Earthquake conditions**

According to the seismic zoning map of Myanmar, the lateral seismic coefficient in Thilawa is estimated.



Probabilistic Seismic Hazard Map of Myanmar for 10% probability of exceedance in 50 years (475 years recurrent interval), the seismic hazard is described in term of peak ground acceleration (PGA) in g (firm rock).

Source：Myanmar Geosciences Society

Figure 5.4-9　Seismic Zone Map

In the Seismic Zone Map, Thilawa area is located in the area Ⅲ.

Earthquake area : Ⅲ
Local seismic intensity: 0.20
Importance factor: 1.25
Modulus sub grade reaction: 1.2
Reduction coefficient with the structure: 0.5

The design horizontal seismic coefficient (Kh) for a structure is therefore set at 0.15 calculated from the above figures and factors.

Vertical seismic intensity is not considered based on the port standard of Japan.

Therefore, Kv=0.0.

ii) Berth Planning Conditions

① Face line of port facility

The berth face line in front of Plots 22-26 which was set by MPA has a bent at the boundary of the Plots 23 and 24. A continuous berth having a bent in the face line (see original berth line in Figure 5.4-10) is not convenient as a berthing facility.

The study team has therefore conducted a study to use a strait berth face line for the Plots 22~26.

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

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

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

c. Because the river of the site curves, the berth face line at the end plots (21& 27) will have been connected to the adjacent plots, when a straight face line is appealed with the study a red.

Following options for the straight berth face line are studied.

Option-1: To make the straight berth face line linked with the both ends of the plots 26 and 22 of the original plan.

In this case the water depth of the berth face line is deeper (-18m), and as a consequent the pier structures become up-sized.

Option-2: To extend the original line of plot 22-23 toward the plot 26, making a straight berth face line.

The distance from the berth face line of Plot 26 to the revetment is too short, and may cause

stability problem of the revetment by circular slip.

Option-3: The berth face line is instituted with a straight line started from the bank side limit of Plot 26 where revetment is kept stable, and pass the refraction point of the original plan.

By this arrangement, revetment stability will not be influenced, and dredging volume is a minimal.

Even though some gaps are to be formed with adjacent plots face line plan, the gaps should be within the accepted by MPA.

Therefore, Study Team proposes the Option-3. (Straight line passing through the refraction point of the original plan)

The Figure 5.4-10 shows the recommended face line of berth.

(Prepared by the Study Team)

Figure 5.4-10 Face Line of Berth

②Number of Berths

Four berths are required by the end of this plan from the estimated amount of cargo handling (refer to section 6.1). These berths are located in front of plot 23 to 26

② Design Vessel

Design vessel is a container ship of 20,000 DWT class. The 20,000 DWT container ship design specifications are shown in Table 5.4-8. Taking into account the actual records of calling vessels to Yangon Port the design ship is established as up to 1,000 TEU containers and max draft of 9.0m.

Table 5.4-8 Typical Dimensions of 20,000DWT Container Ship

Dead Weight Tonnage (DWT)	Length overall (m) (Loa)	Length between perpendiculars (m) (Lpp)	Molded breadth (m) (B)	Full load draft (m) (d)	Reference : Container carrying capacity (TEU)
20,000	177	165	27.1	9.0	1,000

Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan" 2007

④Berthing Force

Berthing velocity: The standard berthing velocity of the vessel is shown in the following table.

Table 5.4-9 Berthing Velocity

Dead Weight Tonnage (DWT)	Berthing velocity (cm/s)			
	General cargo ships	Container ships	Pure car carriers	All ships
1,000class	8.1	–	–	8.1
5,000class	6.7	7.8	–	7.2
10,000class	5.0	7.2	4.6	5.3
15,000class	4.5	4.9	4.7	4.6
30,000class	3.9	4.1	4.4	4.1
50,000class	3.5	3.4	–	3.4
All ships	5.2	5.0	4.6	5.0

Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan" 2007

The berthing velocity of the 20,000DWT class container ship shows less than 5 cm/sec in Table 5.4-9.

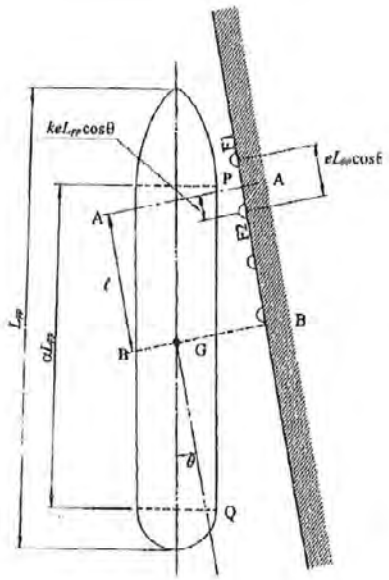
Considering berthing to river port under fast current condition, the design berthing velocity is set to10cm/s for safety. Calculation of berthing energy is indicated in Table 5.4-10.

Table 5.4-10 Calculation of Berthing Energy

Calculation of Berthing Energy

Key-in Data

Type of Vessel		Conteiner Vessel		
Deadweight Ton	DWT	20,000	ton	
Length (over all)	Loa	177.0	m	
Length (between perpendiculars)	Lpp	165.0	m	(Assumed)
Breadth	B	27.1	m	
Depth	D	14.3	m	
Draft (full)	d	9.9	m	
Displacement	Ws	29094	ton	(Assumed)
Berthing Angle	TH	10	degree	(Assumed)
Hydrodynamic coefficient	Cm	1.899		Cm=1+(pai/2Cb)(d/B)
Block coefficient	Cb	0.638		Cb=Ws/(LppXBXdX1.03)
Eccentricity coefficient	Ce	0.658		Ce =1/(1+(l/r)^2)
Radius of gyration	r	38.15	m	r=(0.19Cb+0.11)Lpp
Distance alongside the water line from the center of gravity of vessel to the berthing point	l	27.50 min(l1,l2)	m	l1=(0.5a+e(1−k))LppXcos(TH) l2=(0.5a−ek)LppXcos(TH)
Fender Spacing	Lf	10.00	m	(Assumed)
Coefficient of parallel side	a	0.40		
Coefficient of Fender interval	e	0.062		e=Lf/(LppXcosTH)
Coefficient of bertthing point	k	0.50		
Block coefficient	Cb	0.638		Cb=Ws/(LppXBXdX1.03)
Softness coefficient	Cs	1.0		
Berth configuration coefficient	Cc	1.0		
Berthing Velocity	V	0.10	m/sec	(Assumed)
Berthing Energy	E	181.8	kN-m	E=0.5XWsXV^2XCmXCeXCsXCc
Safety factor	Sf	1.10		(Assumed)
Abnormal Berthing Energy	Ea	200.0	kN-m	Ea = E × Sf



(Prepared by the Study Team)

Table 5.4-11 Absorbed energy and reaction force of a Cell type fender

CSS1000H		F4	F3	F2	F1	F0
0	E/A(kN-m)	143	171	204	243	290
	R/F(kN)	313	374	446	533	636
1	E/A(kN-m)	147	176	210	251	299
	R/F(kN)	322	385	460	549	655
2	E/A(kN-m)	152	181	216	258	308
	R/F(kN)	332	396	473	565	675
3	E/A(kN-m)	156	187	223	266	317
	R/F(kN)	342	408	488	582	695
4	E/A(kN-m)	161	192	229	274	327
	R/F(kN)	352	421	502	600	716
5	E/A(kN-m)	166	198	236	282	359
	R/F(kN)	363	433	517	618	788
Bolt Size: X6pcs		M30	M30	M30	M30	M36

Source : Manufacturer catalog

Using the above table, the berthing energy was calculated to be 200kN-m. The fender calculated with the referred standard are H 1000 mm of Cell Type, and is installed at 10m interval. The setting length of fender face pad is 6.0m considering the tidal range. The reaction load is about 750 kN/Fender from the performance curve of fender.

⑤Mooring Force

Typical Mooring tractive forces are shown Table 5.4-12

Table 5.4-12 Standards Vessel of Tractive Forces by Ships

Gross tonnage of ship (t)	Tractive force acting on mooring post (kN)	Tractive force acting on bollard (kN)
Over 200 and not more than 500	150	150
Over 500 and not more than 1,000	250	250
Over 1,000 and not more than 2,000	350	250
Over 2,000 and not more than 3,000	350	350
Over 3,000 and not more than 5,000	500	350
Over 5,000 and not more than 10,000	700	500
Over 10,000 and not more than 20,000	1,000	700
Over 20,000 and not more than 50,000	1,500	1,000
Over 50,000 and not more than 100,000	2,000	1,000

Source : Technical Standards and Commentaries for Port and Harbor Facilities in Japan" 2007

From the table, the mooring bollard of 700kN is selected for the 20,000DWT vessel.

⑥Quay surcharge load

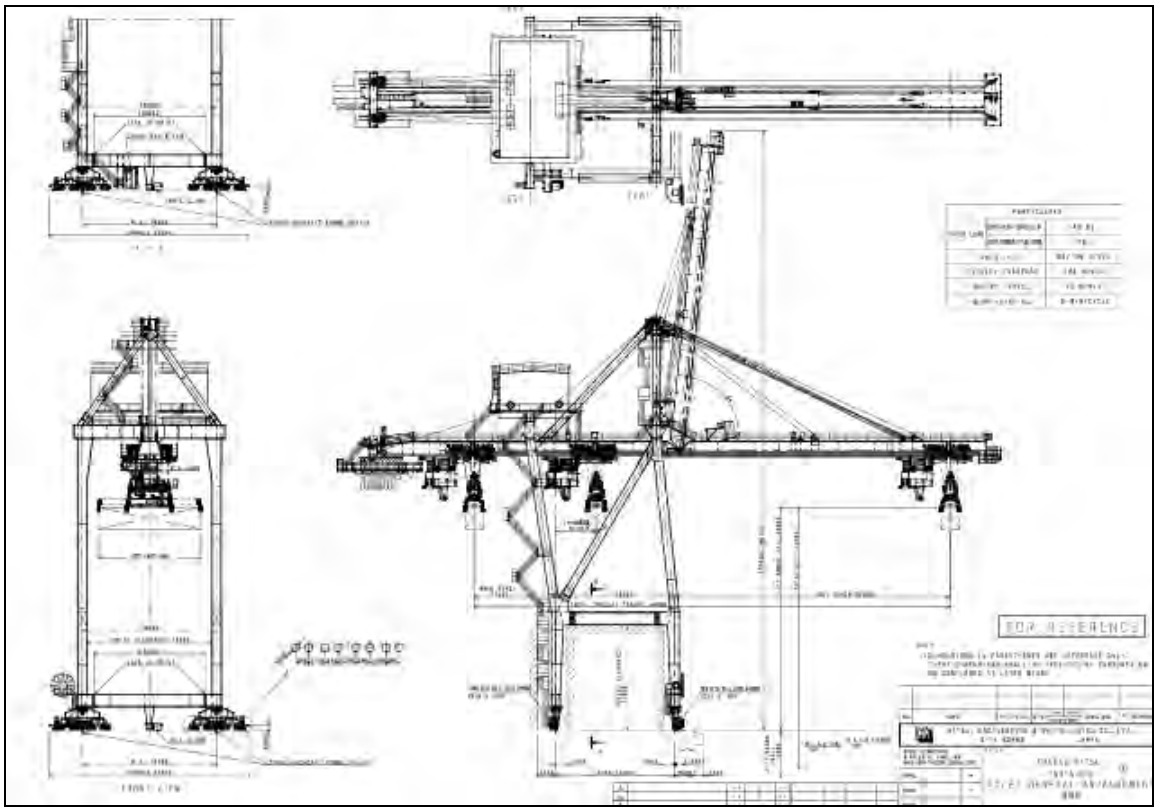
Surcharge load on a quay is considered as 20 kN/m2. The seismic condition is obtained by having the surcharge in normal condition:

- Normal condition : 20kn/m2
- Seismic condition : 10kn/m2

⑦Cargo handling equipment on berth

The gantry container crane for 20,000DWT vessel is to be used as the cargo handling equipment on the berth.

An example of the gantry crane for 20,000DWT container ship is shown in a Figure 5.4-11.



Source : Manufacture's standard design drawing

Figure 5.4-11 Example of the Gantry Crane for 20,000DWT Container Ship

The design wheel load of gantry crane for 20,000DWT container ship is set up as follows.

Table 5.4-13 Design Wheel Load of Container Crane

Condition	Wheel Load(Max)
Operating	450kN/wheel
Stowed	600kN/wheel
Seismic	450kN/wheel
Crane Total Weight	7000kN

(Prepared by the Study Team)

b) Basic Parameters of structure

i) ＊Dimensions of wharf

- **Length of Berth**

Berth length is calculated from the ship length and mooring length of design maximum vessel.

177m +2(27.1 m x sin45°) = 204.1m

The planned length of one Berth is decided to be 200m.

- **Depth of Berth**

Berth depth is calculated from the maximum draft of design ship with 10% of allowance.

9.0m x 1.1 = 9.9 m

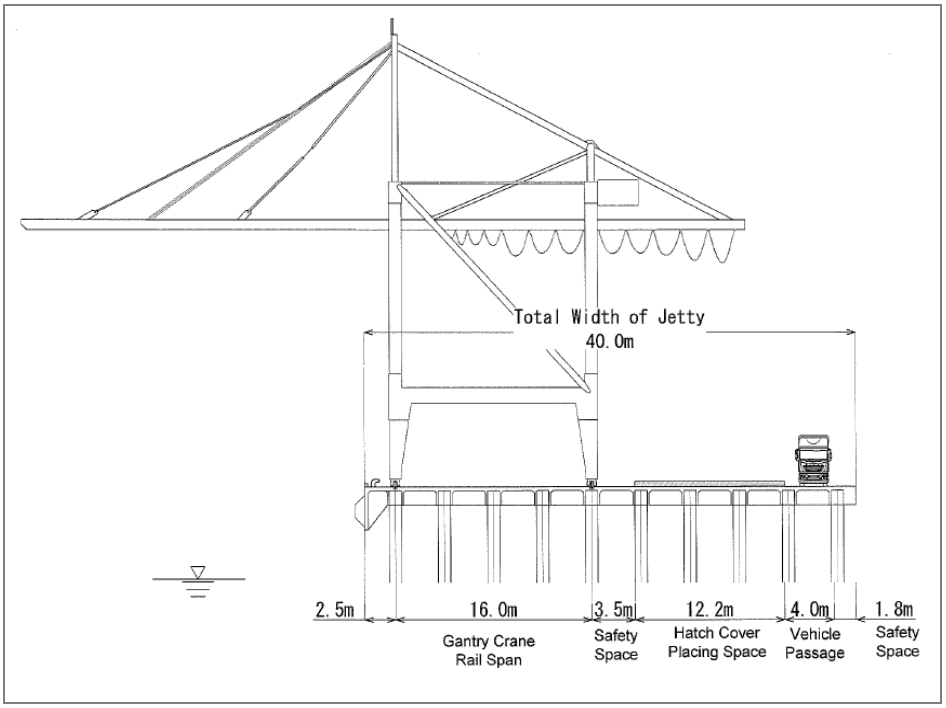
Therefore, berth design depth shall be 10.0 m.

- **Widths of Berth**

Berth apron width is estimated from typical area requirements as summarized below:

- Clearance between the side rail of the gantry crane and the berth edge : 2.5m
- Gantry crane rail span: 16.0m
- Clearance between the land side rail and hatch cover placing area : 3.5m
- Maximum width of hatch cover area : 12.2m
- Rear side passage : 4.0m
- Clearance behind the Rear side passage : 1.8m

From the above, the required width of berth is determined to be 40m.



(Prepared by the Study Team)

Figure 5.4-12 Berth widths

- **Berth Elevation**

Berth deck height is determined from tide level and tidal difference of the location.

Thilawa tide level

HWL=CDL +6.24m

LWL= CDL+0.33m

Therefore, a tide level difference is CDL+6.24 –CDL+ 0.33=5.91m

Calculation of the deck height is according to the Table 5.4-14.

Table 5.4-14 Standard Crown Height of Wharves

	When the tidal range is 3.0 m or more	When the tidal range is less than 3.0 m
Mooring facilities for large vessel (with a water depth of 4.5 m or more)	+ 0.5 ~ 1.5 m	+ 1.0 ~ 2.0 m
Mooring facilities for small vessel (with a water depth of less than 4.5 m)	+ 0.3 ~ 1.0 m	+ 0.5 ~ 1.5 m

Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan" 2007

From the above table, the deck height is calculated from DL+6.92m to+7.92m. Taking into consideration the economical view point and the existing pier height, the quay deck height is determined at DL +7.5 m. The difference of the height with yard height is adjusted at trestles.

c) Examination of the quay structure

i) Selection of berth structural type

Berth structural type is selected from the adaptability to the site conditions. The site conditions are as follows.

- **The soil condition**: The soil condition at the berth area is weak silt layer from river bottom to DL-20m. N -value of this layer is less than 3. Therefore, depending on the type of berth structure, soil improvement is required.
- **The river condition**: The riverside of the site is being eroded by the strong river flow. Therefore, changing of the flow velocity and direction by port facilities construction may have seriously affected the topographic conditions.

Standard structure type of a berth is classified as a gravity type, a pile deck type, a sheet pile type, and a cell type.

Comparison of the structural types by the site condition is shown in the following table..

Table 5.4-15 Comparison of Berth Structure Type

	Geographical conditions	River conditions	Comprehensive evaluation
Gravity type	C	C	C
Pile supported deck type	A	A	A
Sheet pile type	A	C	C
Cell type	B	C	C

A: suitable：adapt, B: less suitable, C: not suitable

(prepared by the Study Team)

The structural type which is suitable to this site is pile supported deck type.

ii) Options Study of Pile Supported Deck Type Structure

Vertical pile type and Batter pile type, Strut type, and Jacket type, are nominated for the comparison of pile deck type. These types have the following characteristics.

①Vertical pile type

It is a most common type constructed only with vertical piles. There are many constructions of this type in Yangon Port.

● **Characteristic**

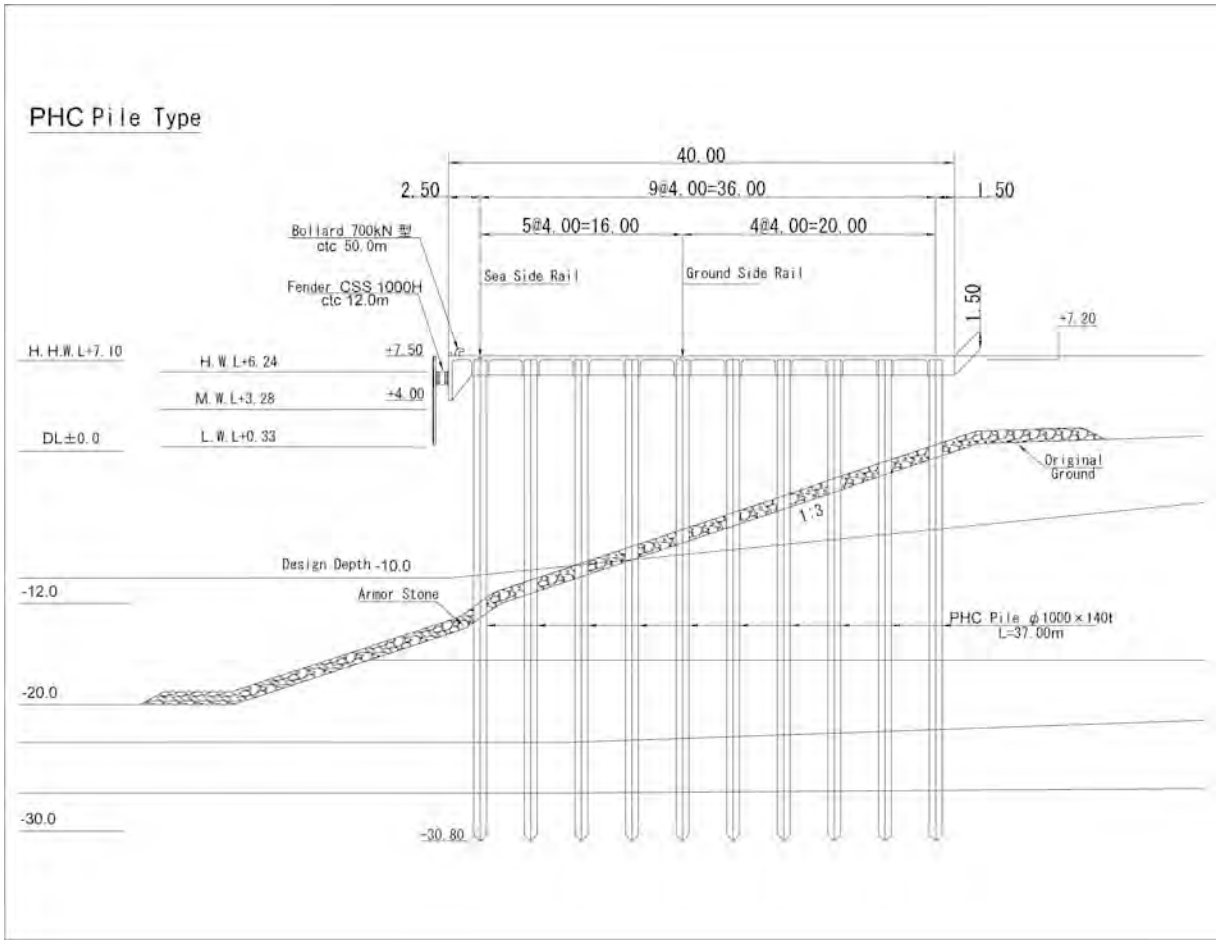
- As for the material of the pile, the use of economical PHC (Prestressed High-strength Concrete) pile is possible.

- Strength against horizontal force is limited.
- If free length of piles become large, increase in the number of piles and/or a larger sized pile are necessary.
- Casting of piles is easy.
- Horizontal displacement is large.

● **Design Section for comparison**

A PHC vertical pile type is chosen for a comparison section as this type has often been used in Yangon Port.

The typical cross section of the designed vertical pile type pier is shown in Figure 5.4-13.



(Prepared by the Study Team)

Figure 5.4-13 PHC Vertical Pile Type

②Batter pile type

The batter pile type pier is formed to resist with diagonal piles against horizontal forces.

This type of pier is also seen in the Yangon Port. (PHC pile)

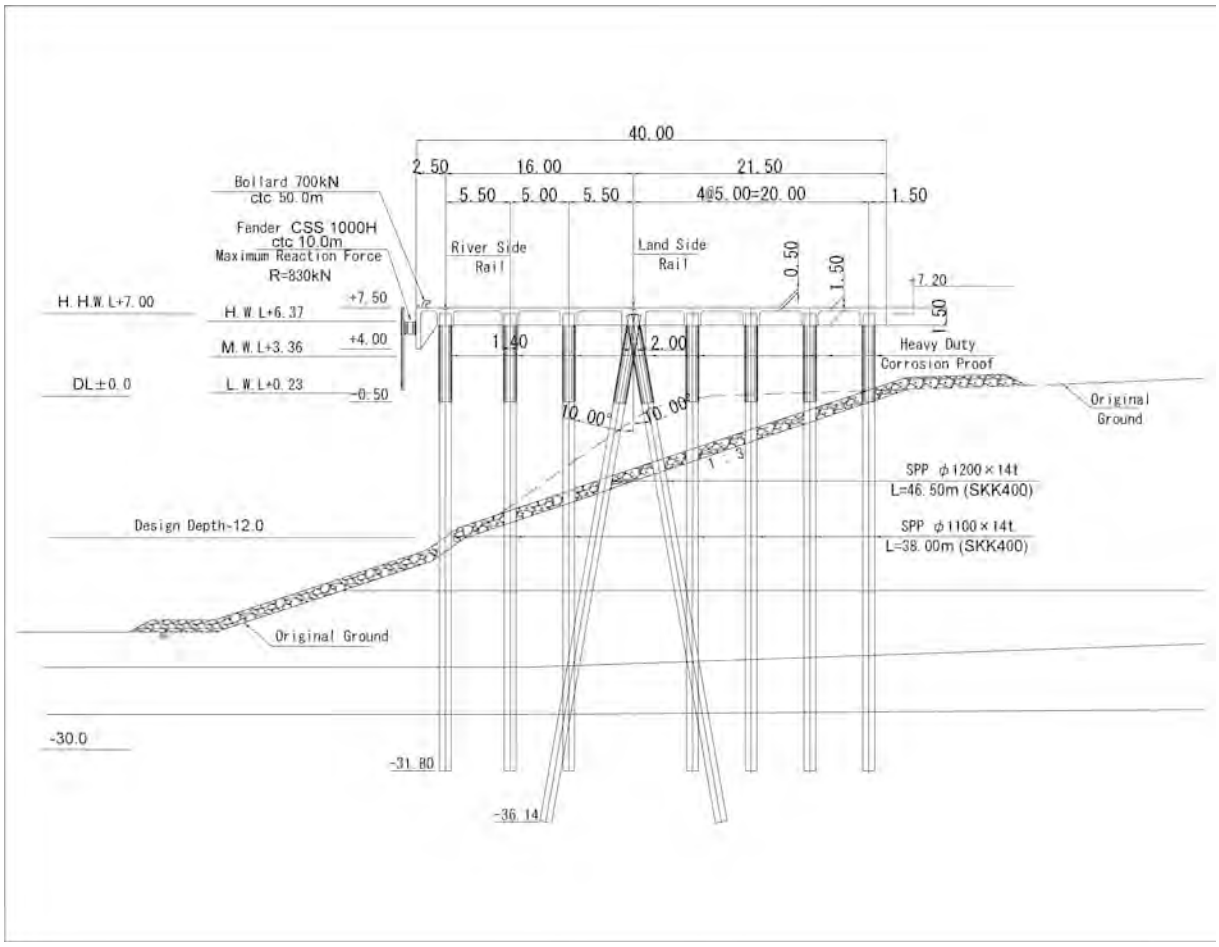
● **Characteristic**

- Steel pipe piles are used for the batter pile.
- Resisting strength against horizontal force is high.
- Decrease of pile number is not expected much in comparison with a vertical pile type.
- Special construction equipment is necessary for driving batter piles.
- Horizontal displacement is small.

● **Design Section for comparison**

Group piles are adopted using steel pipe pile for a comparison section.

The design cross section of the batter pile type pier is shown in Figure 5.4-14.



(Prepared by the Study Team)

Figure 5.4-14 Batter pile type

③Strut type pier

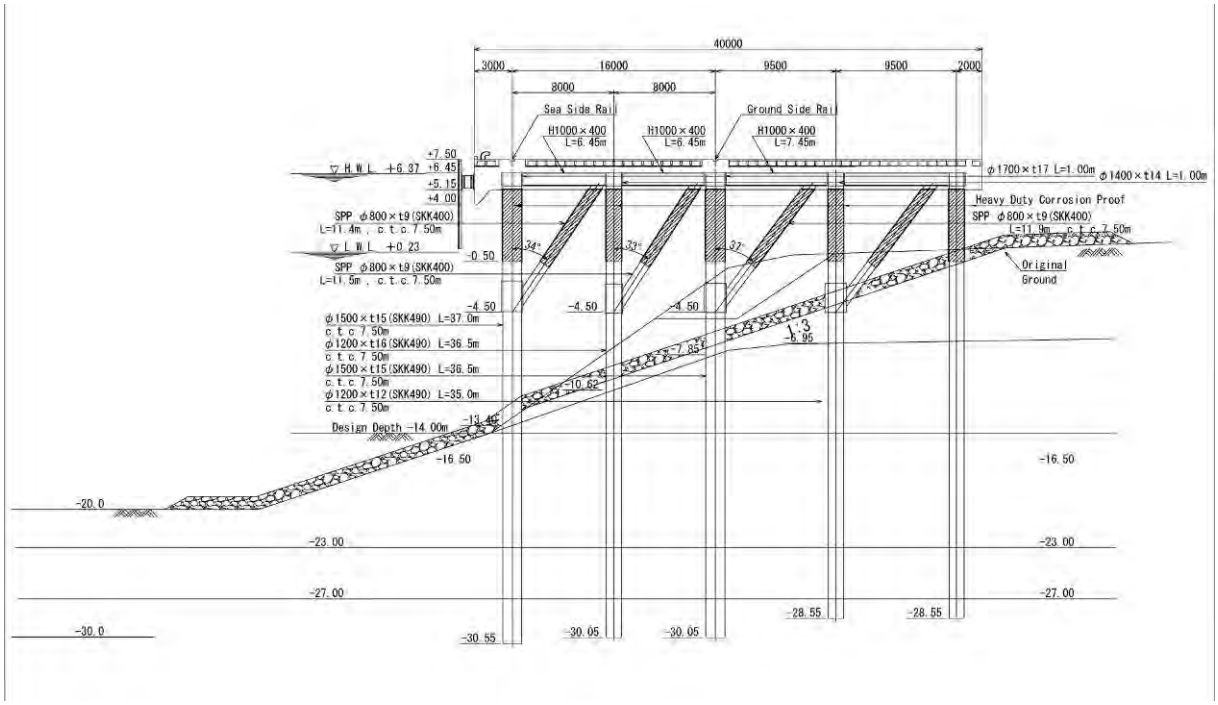
In this type of structure, a strut is attached to a pile, reinforcing the superstructure portion. It is

therefore possible to reduce number of piles compared to vertical pile type, thus construction duration can be minimized. No strut type piers exist in Yangon Port.

- **Characteristic**
  - Accuracy of pile casting is required.
  - Piles are tied up with a strut and are strong in resisting horizontal force.
  - Work to couple each pile with a strut at the site is necessary, thus time consuming.
  - If steel pipe piles are not used, coupling with a strut may be difficult.
  - As a pile and a strut can be separately constructed, a big crane is unnecessary for installation of the strut.
  - Horizontal displacement is small.

- **Design Section for comparison**

Elevation to connect strut to pile is assumed at level of LWL. Landside piles are also connected with a strut to reduce number of piles. The design cross section of the strut-type pier is shown in Figure 5.4-15.



(Prepared by the Study Team)

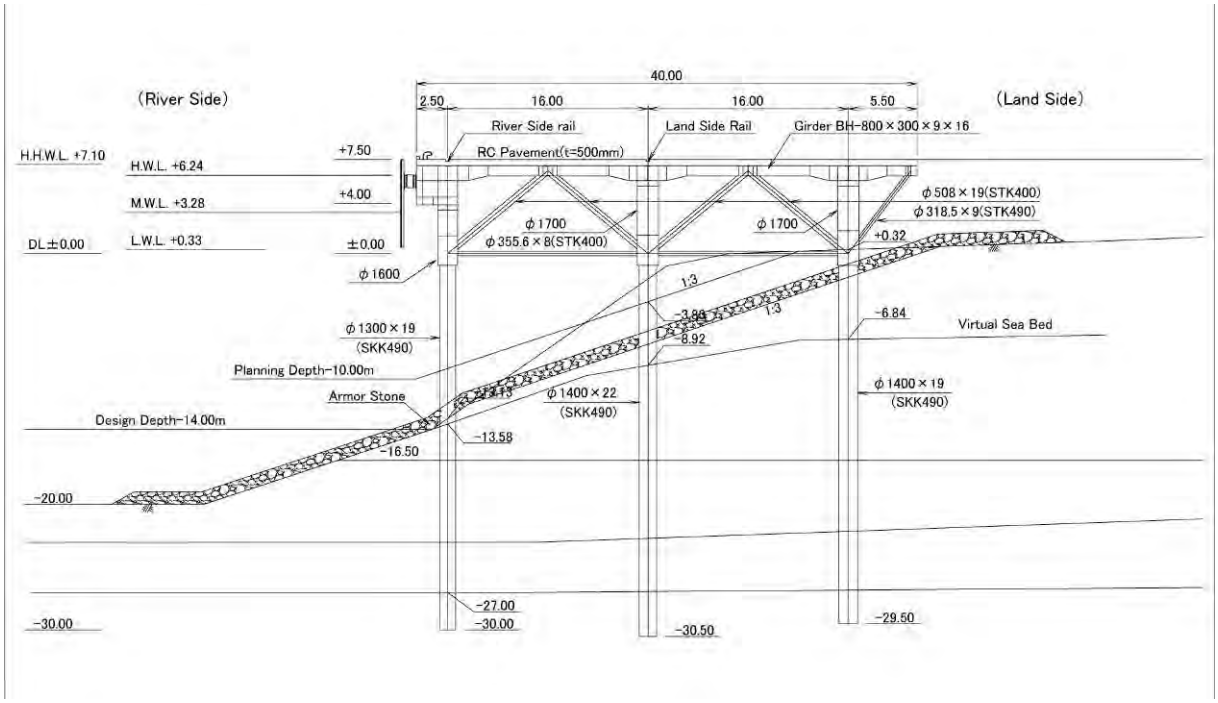
Figure 5.4-15 Strut Type Pier

④Jacket-type pier

Jacket pier is a structure connected the upper part of the piles with a jacket of truss frame. This type can reduce number of piles because the upper part is stiff. No jacket type piers are seen Yangon Port.

- **Characteristic**
  - Accurate pile casting and construction of jacket are necessary.
  - Because a superstructure is stiff, resistance against horizontal force is high.
  - Horizontal displacement is expected to be small.
  - Piles and the jacket are steel pipes.
  - A large crane is necessary for on-site installation of the jacket structure.
  - The number of the pile driving is small and the jacket is prefabricated in a outside factory, thus the construction duration is shortest among the listed types.
  - Construction duration of off-shore works can be shortened.
- **Design Section for comparison**

Jacket structure is designed with a minimum pile number. Jacket part production at site yard is assumed. The design cross section of the jacket-type pier is shown in Figure5.4-16..



(Prepared by the Study Team)

Figure 5.4-16 Jacket-type pier

iii) Selection of supported pile deck type wharf

From the following characteristics of the river, it will be very important to minimize the offshore- work duration:

- Flow speed is very fast, and flow changes the direction.
- The tide level differences are as large as 6m.
- The river water is very muddy, making underwater work difficult.
- Particularly, in monsoon season, these situations are worsened.

Because the operation of the port is expected to start at the end of 2015, it is necessary of complete one berth by then.

As a result of the comparison examined in stability, construction characteristics, economy, a jacket type structure is judged to be the most suitable. But, especially on the two remaining berths of a whole plan, since there are no restrictions of the time for completion, it is judged that an economical Batter pile type is advantageous.

The comparison table of the pile supported deck type is shown in Table 5.4-16.

Compared with other portions, as for an urgent improvement plan portion, the importance of evaluation of a construction period becomes large.

Therefore, it becomes economical to use a different structural type in an urgent improvement portion and other portions.

iv) Designed structure

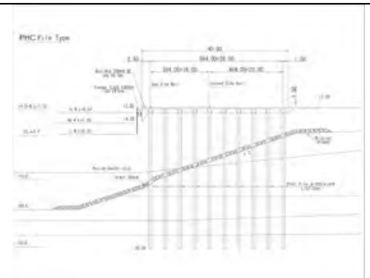
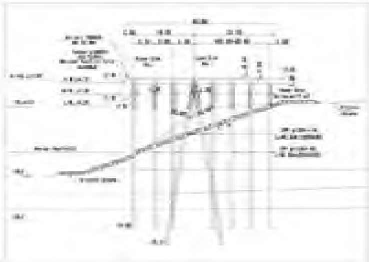
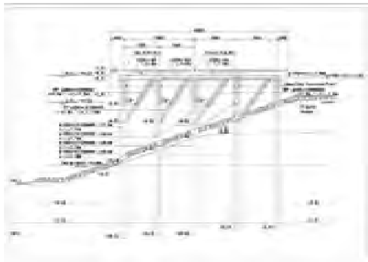
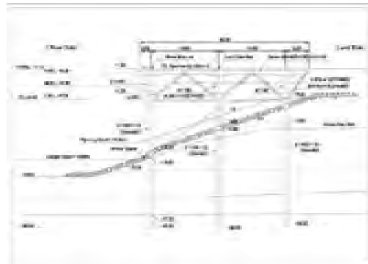
The following points are to be noted for the construction of the jetty:

- The existing ground higher than depth DL-10.0m is dredged.
- The river bank side from berth face line is dredged at 1:3 slope.
- As river current is fast, the front part of quay and slopes are protected with armor stones.

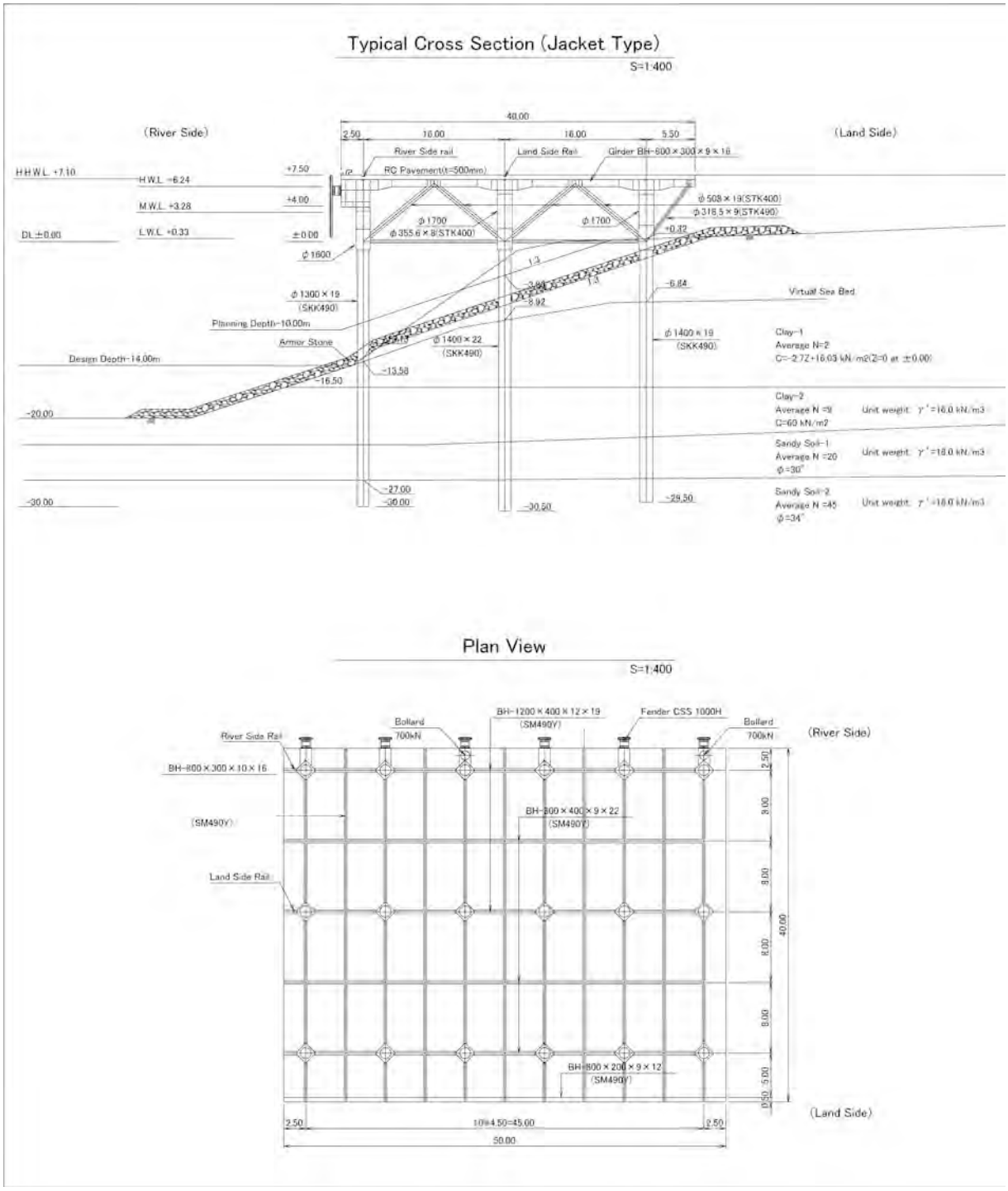
The design section of jacket type and batter pile type are shown in Figure5.4-17and Figure5.4-18.

Table 5.4-16 Comparison of pile type quay Wall

Comparison of pile type quay Wall

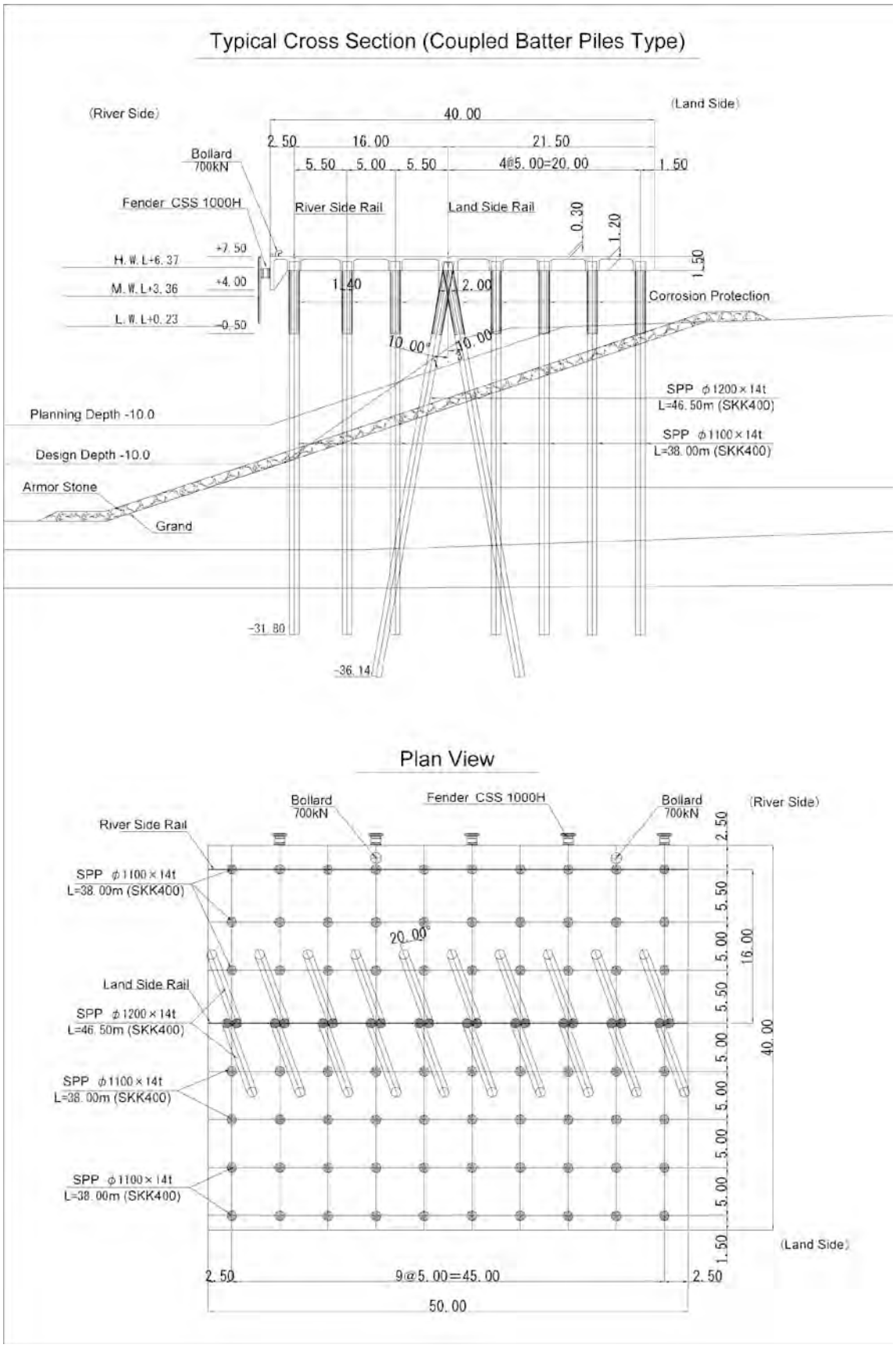
	Vertical pile type		Batter pile type		Strut type		Jacket type	
Typical Cross Section								
		Rate		Rate		Rate		Rate
Structural particulars	-Large number of piles is needed. -Kind of pile material is not retested - Horizontal displacement is large. (>10cm)	C	- Batter piles can reduce total number of 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/200 m)	-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	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)	**D**	**Recommendable** (a little high economical efficiency and a little long construction term)	**B**	**Not recommendable** ((high construction cost and hard construction)	**C**	**Most recommendable** (short construction term and good stability)	**A**

(Prepared by the Study Team)



(Prepared by the Study Team)

Figure 5.4-17 Jacket Typical Cross Section



(Prepared by the Study Team)

Figure 5.4-18 Batter pile Type Typical Cross Section

3) Revetment

a) Revetment design conditions

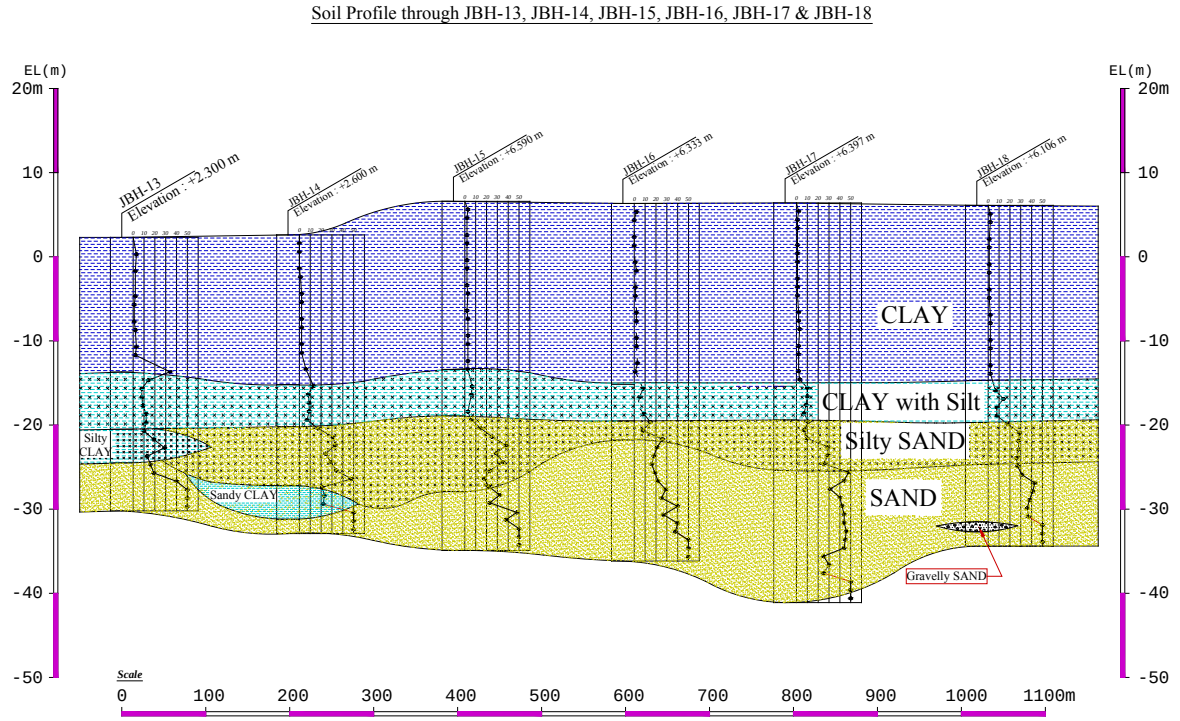
i) Natural conditions

＊Geographical feature conditions

The design ground elevation at revetment face line is CDL+6.0m.

＊Geotechnical conditions

Geological cross section of revetment is shown in Figure 5.4-19.



(Prepared by the Study Team)

Figure 5.4-19 Soil Profile（Longitudinal section along the revetment face line）

The geological condition of the site is as follows. Layer from surface to CDL-20m is very soft silt. A silt mixture sand is distributed from CDL-20m to DL-35m at the block 22, 23 and to CDL-25m at the plot 24,25,26. The silt mixture sand layer is taken as a bearing layer for the revetment design. Therefore, as the design supporting layer of the revetment, the bottom of the silt mixture sand layer is assumed to be CDL-27m. The design geological conditions are set in the following table.

Table 5.4-17 Design Geological Condition

	Layer	N value	γ (kN/m3)	γ (kN/m3)	C (kN/m2)	ϕ (°)
Surface	very soft silt	2	17	7	C=-1.46xZ+30.89 (Z=0 at 0.0)	-
-23.0m	silt mixture sand	22	19	10	-	30
-27.0m	Firm Sand	31	18	10	-	32

＊Other conditions

Other natural conditions are the same with those for Berth.

ii) Planning conditions

＊Revetment face line

Revetment face line of block 22-26 is assumed to be a straight line like a berth face line. The planned revetment face line is shown in Figure 5.4-10.

＊Surcharge load

The area behind revetment is planned as a road, therefore surcharge load of the road is set as 20 kN/m2.

b) Basic dimensions of revetment

i) Crown height of revetment

＊Allowable over topping wave

Permissible rates of wave overtopping over the revetment are set up as shown in the following table. As the area behind revetment(seawall) is paved, then permission rate of wave overtopping is set to 0.2 m 3/m /s.

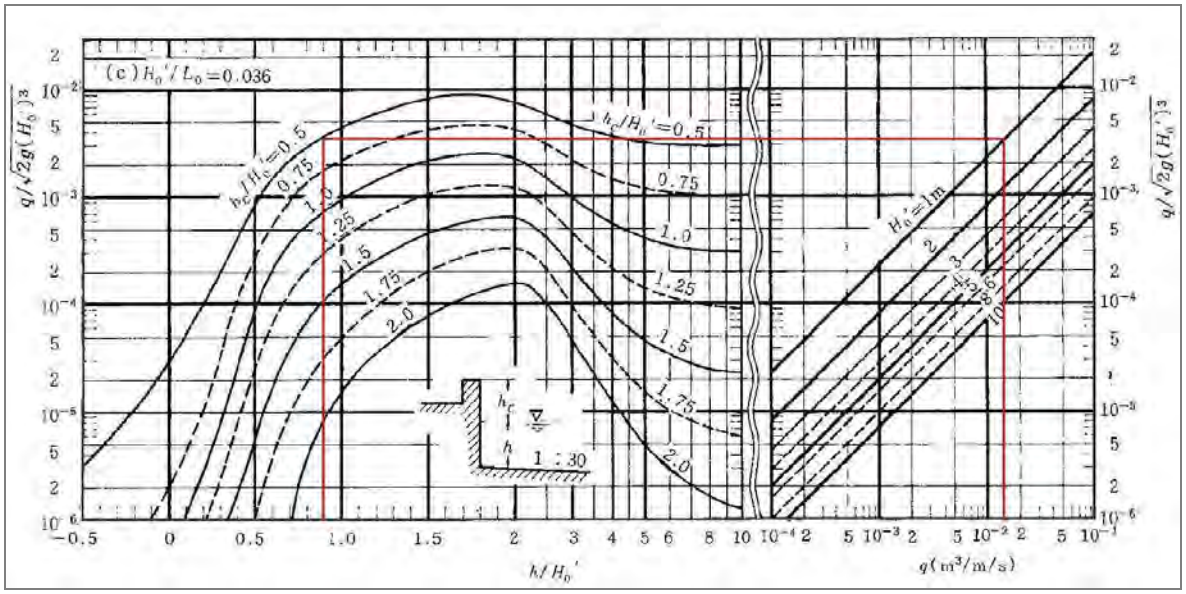
Table 5.4-18 Threshold Rate of Wave Overtopping for Inducing of Damage

Type	Armor Layer	Wave Overtopping Rate ($m^3/m/s$)
Seawall	Paved behind	0.2
	Not paved behind	0.05
Levee	Covered with concrete on 3 sides	0.05
	Crown paving/rear slope non constructed	0.02
	Crown not paved	0.005 or less

Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan" 2007

＊Calculation of wave overtopping

The rate of wave overtopping is calculated using Estimation Diagrams shown in Figure.5.4-20. from height and the front depth of revetment.



Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan" 2007

Figure 5.4-20 Diagrams for Estimating Wave Overtopping Rate for Wave-dissipating Type Seawall

Rate of wave over topping is calculated as 1.8x10-3m3-/m/s, and is within the permissible rate of wave over topping for revetment which is 2.0x10-1m3/m/s.

＊Crown height of revetment

Since the rate of wave over topping does not exceed the permissible rate of wave over topping, revetment crown height shall be the CDL+8.0m same as yard height.

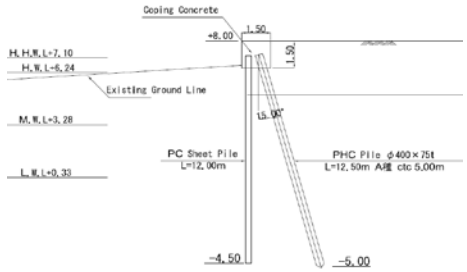
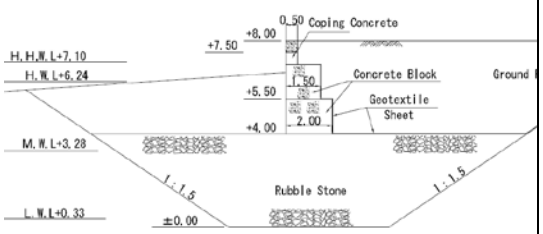
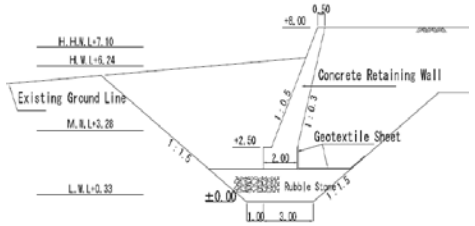
c) Selection of revetment type

Revetment structure types, examined are a sheet pile type, a gravity type, a wall type, and mound type. Comparison result is shown in Table 5.4-19. The comparison focused on construction term, since the revetment has to be completed before reclamation of yard. As the result of comparison, it has been judged that the sheet pile type is most suitable for this site. The front 30m section of the revetment constructs a mound in height of CDL+6.0 for stability at the ground improvement.

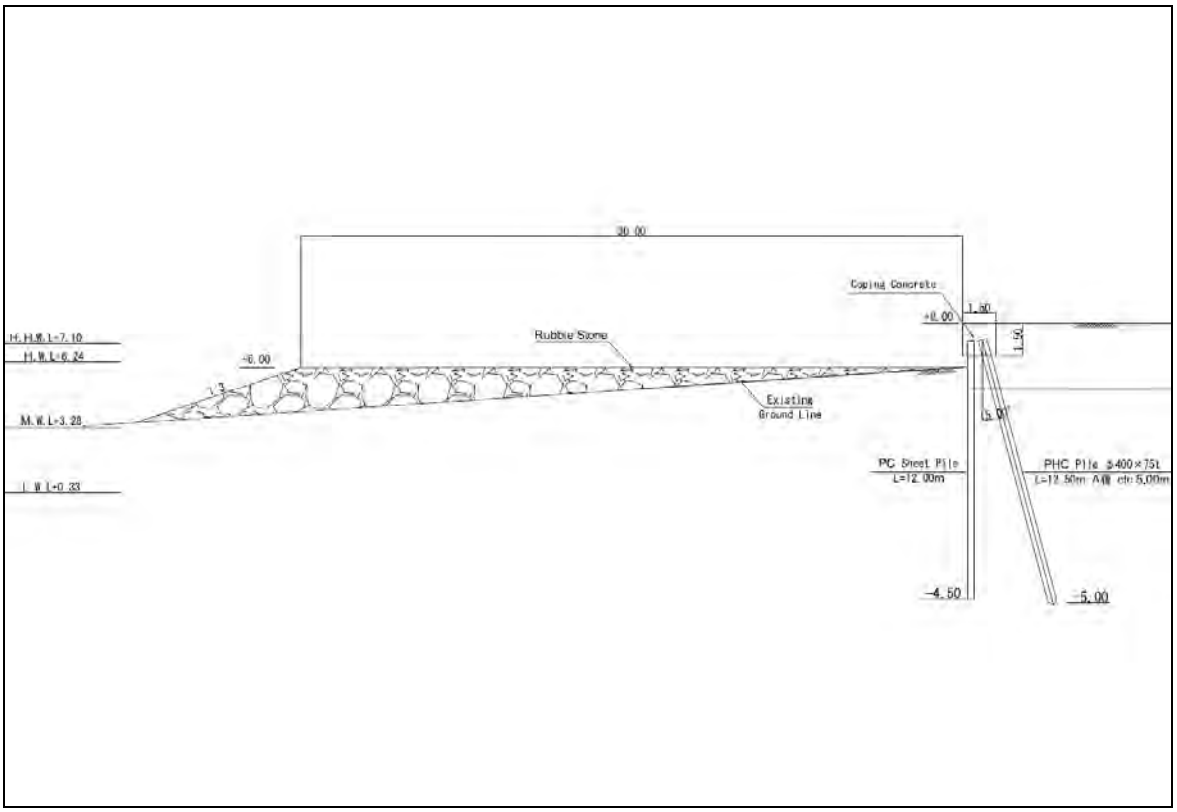
A standard cross section of the revetment is shown in Figure 5.4-21.

Table 5.4-19 Comparison of Revetment Type

Comparison of Revetment Type

	Sheet pile type revetment		Gravity type revetment		Lean retaining wall type revetment	
Typical Cross Section					
		Rate		Rate		Rate
Structural Stability	- Not so stable till the completion of a backfill. - There is no corrosion at PC sheet pile. -Soil improvement is unnecessary. -A long sheet pile needs to be placed for prevention of	A	- Ground excavation and rubble stone mound is required. - Soil improvement is required. -A prevention of settlement requires the foundation improvement to a deep position	A	-The excavation of base and a rubble mound are required. - It is necessary to make the foundation deeper to avoid circler sliding.	A
Characteristics for construction	-Care needs to be taken during construction. - Construction term is comparatively short. - A large construction yard is unnecessary.	B	- A large yard for fabrication and storage is required. - Construction is easy. -Foundation improvement requires large-scale temporary work. - The construction term is long.	C	- Large-scale temporary work is required for basic digging. - The construction term is long. - Temporary yard is unnecessary.	C
	Construction term：4.0M/400m		Construction term：9.6M/400m		Construction term：9.6M/400m	
Economical efficiency	- The conomical efficiency of sheet pile is relatively good	B	- Foundation improvement becomes large-scale. - Situation of application and economical efficiency are bad.	C	-A large-scale temporally work is required. -Economical efficiency is bad.	C
	Cost rate : 1.00 (5,020,000$/400m)		Cost rate : 1.35 (6,780,000$/400m)		Cost rate : 1.13 (5,652,000$/400m)	
Comprehensive valuation	-Structural stability and construction speed are good. - Economical efficiency is relatively good. -It is the suitable structure for this site.	A	- Soil improvement becomes large-scale. - Economical efficiency are bad. - It is not the suitable type in this site.	C	-The excavation of base becomes large-scale and economical efficiency are bad. - The possibility of settlement remains. - It is not suitable type for this site.	C
Evaluation	**Recommendable** (Short construction term, and good stability)	**A**	**Not recommendable** (Low cost・Long construction term)	**C**	**Not recommendable** (High cost・Long construction term)	**C**

(Prepared by the Study Team)



(Prepared by the Study Team)

Figure 5.4-21 Revetment Typical Section

4) Trestle

a) Design conditions

i) Natural conditions

＊Topographic conditions

The existing ground level at trestle is from CDL+6.0m to CDL+0.0m.

＊Other conditions

Other natural conditions are the same as those for the berth.

ii) Use conditions

＊Load

Imposed load on trestle is 20 kN/m2.

b) Trestle basic specifications

i) ＊The number of installation

In the urgent improvement plan, six trestles are planned to connect to the 800m long jetty.

ii) ＊Width of trestle

Width was decided to be 20m.

iii) ＊Length of trestle

As the revetment face line is not parallel with berth face line, the length of each trestle length is different. Average length of the trestle is 100m.

c) Trestle structure type selection

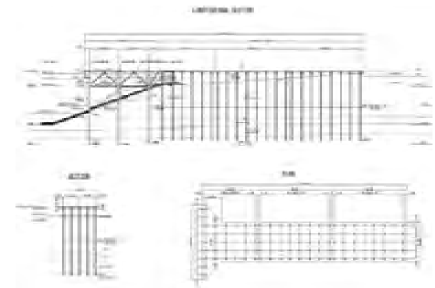
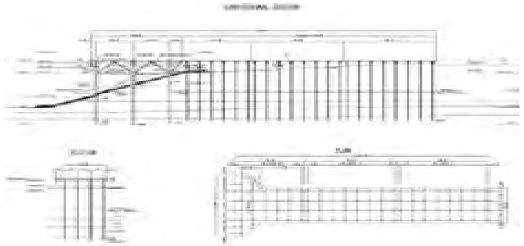
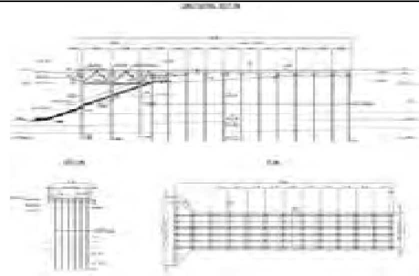
In structural types there are several options such as embankment type, a gravity type, sheet pile type, and others. A pile type that causes a minimum influence to river flow is considered as appropriate for trestle at the site.

d) Comparison examination of the Trestle structure proposal

Stability, economy and construction aspects have mainly been examined for the selection of type from the bridge type and pier type. The comparison table of trestle is shown in Table 5.4-20. As the result of the comparison, a pile supported deck type of steel pipe pile has been selected. The typical drawing of selected trestle is shown in Figure 5.4-22.

Table 5.4-20 Comparison of Trestle Type

Comparison of Trestle Type

	Pier type trestle（PHC pile）		Pier type trestle（SPP pile）		Bridge type trestle（PHC pile）	
Structural section						
		Rate		Rate		Rate
Structural Stability	- A pier type structure is stable against forces of all directions.	A	- A pier type structure is stable against forces of all directions.	A	Since it is bridge type, it is a little weak to a motion long the bridge axis direction.	A
Characteristics for construction	- Beam construction is complicated. - The construction term is long	B	- Construction of a beam is complicated for a pier type.	A	- The beam of a bridge is a PC beam. - PC beam needs to be made on the site.	B
	Construction term :8.0M/3Briges		Construction term : 4.5M/3Briges		Construction term : 7.5M/3Briges	
Economical efficiency	- Although many PHC pile, the piles, cost is not economical.	C	- Since it is a steel pipe pile, the pile material cost will be high. However the number of piles can be reduced.	A	- Since span can be flown in bridge type, a pile number is made less than pier type. - Since it is a PHC pile, the pile material cost is economical.	C
	Cost rate : 1.32 (12,750,000$/3 Bridges)		Cost rate : 1.00 (9,651,000$/3 Bridges)		Cost rate : 1.64 (15,813,000$/3 Bridges)	
Comprehensive valuation	- The construction term is long and a simultaneous construction with pier is hard. - Economical efficiency is not so good.	C	- The construction term is short and simultaneous construction with pier is possible. - Economical efficiency is good.	A	- The construction term is long and simultaneous construction with pier is hard. - Economical efficiency is bad.	A
Evaluation	**Not recommendable** （High cost・Long construction term）	**B**	**Recommendable** （Low cost・Short construction term）	**A**	**Not recommendable** （High cost・Long construction term）	**B**

（Preapared by th study team）

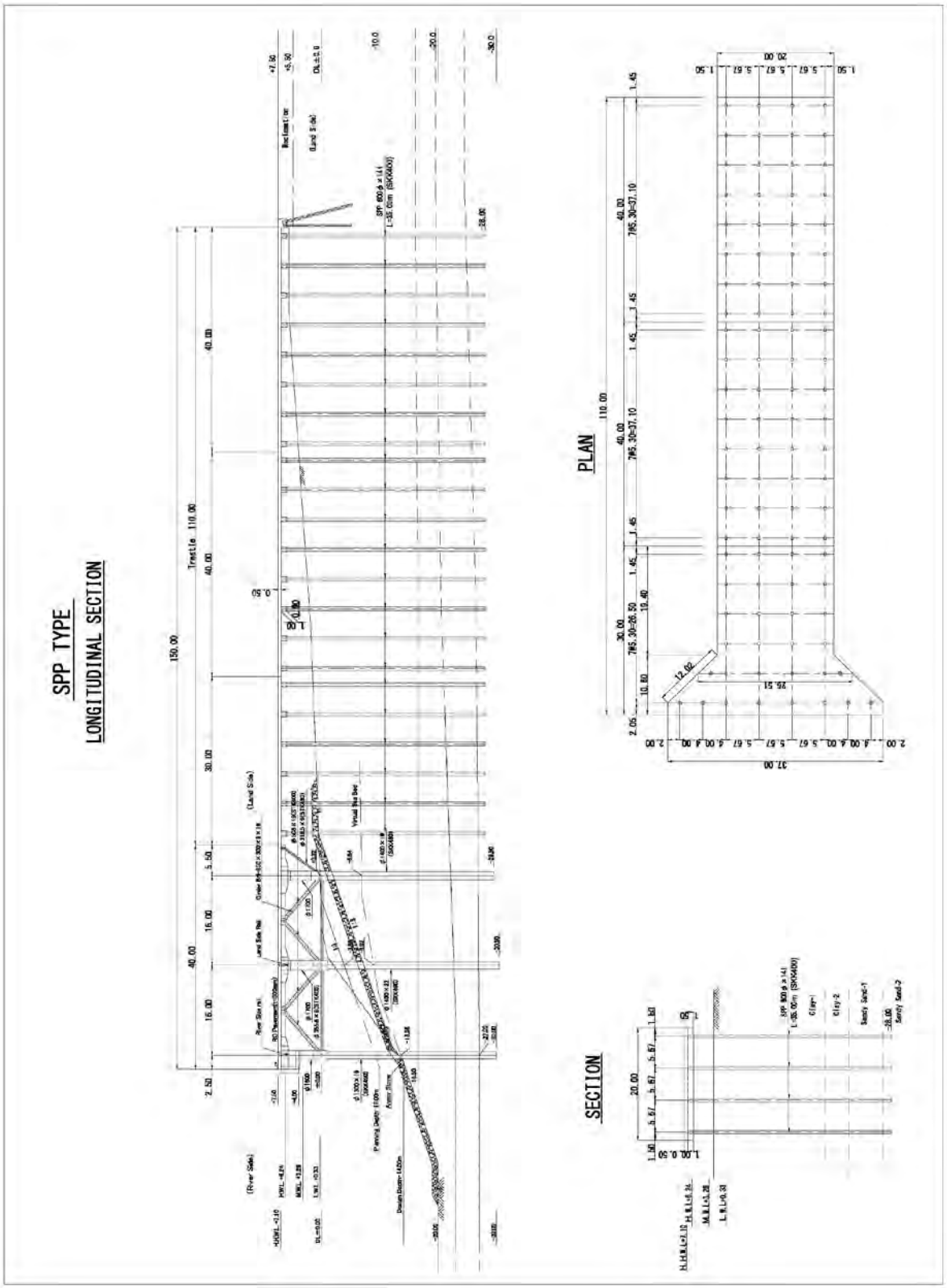


Figure 5.4-22 Trestle Typical Cross Section

5) Yard Design

Although a yard targets the whole area to the plots 23-26, the detailed plan of facility arrangement etc. is undecided in that area.

a) Yard design conditions

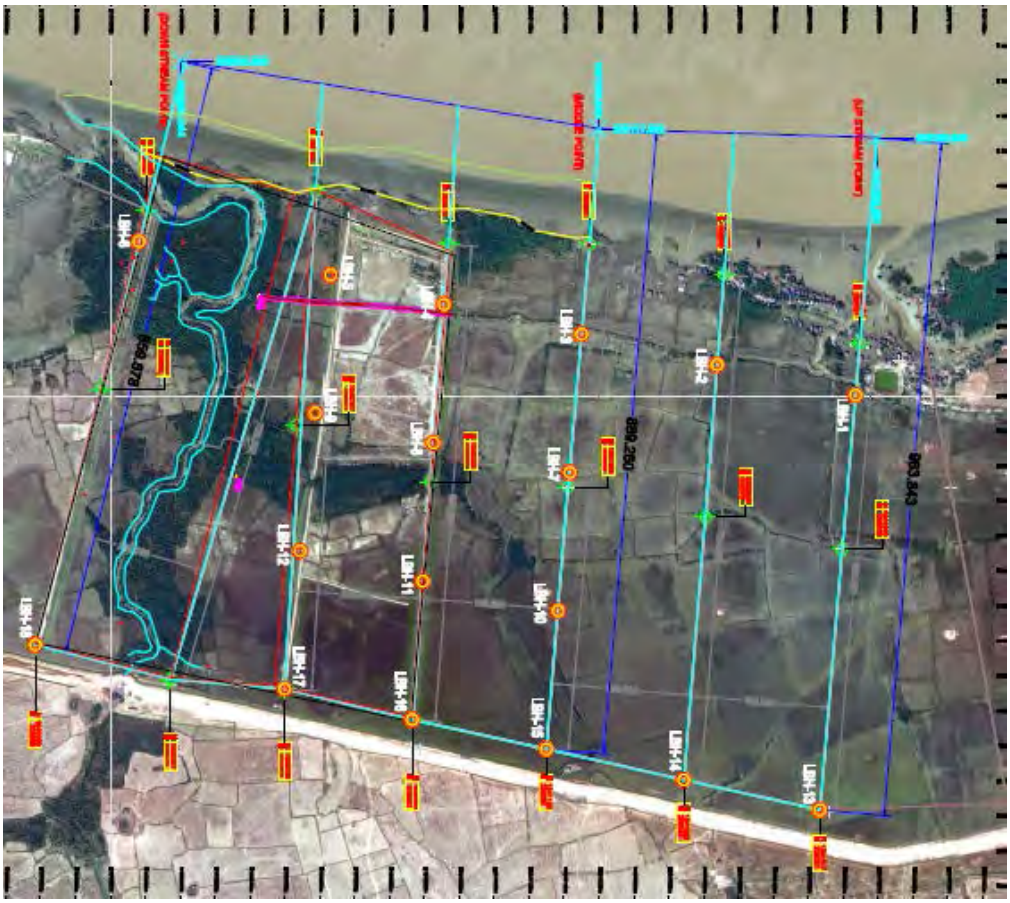
i) Natural conditions

① Topographic features

The land topographic features of the site is shown in Figure.5.4-4. The land height is about CDL+6.0m. The yard area is almost flat and it is used as paddy fields.

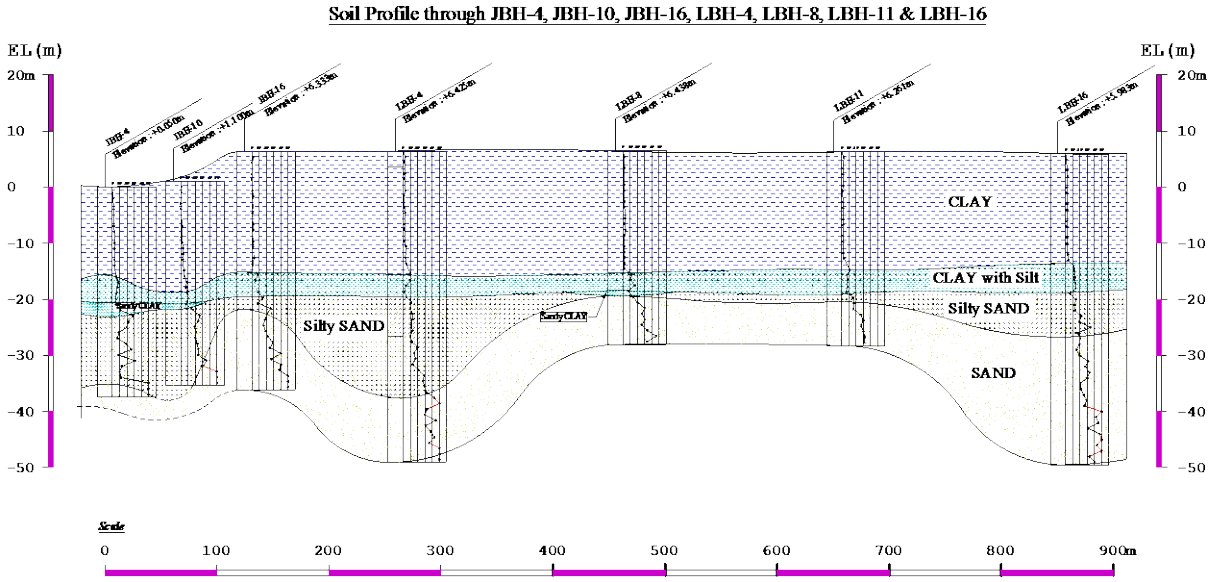
② Geology

Landside geological investigation locations are shown in Figure. 5.4-23.



(Prepared by the Study Team)

Figure 5.4-23 Geological Investigation Locations (Land Side)



(Prepared by the Study Team)

Figure 5.4-24 Soil Profile

ii) Planning conditions

① Layout of yard plan

The planned yard layout of the development plan is shown in Figure 5.4-25.

Source: Google Earth, Study Team

Figure 5.4-25 Planned yard layout plane

②Yard ground elevation

Yard ground elevation is established considering the planned road, and adjacent land development. The yard elevation is therefore set at CDL+8.0 m.

③Yard surcharge load

Surcharge load of the container yard is estimated as 4 tiers of container weight.

Table 5.4-21 Average Yard Surcharge

Container Type	Total Weight	Bottom Area	Weight of Unit area	Tier	Weight % in container	Average Surcharge Load
20ft Type	245kN	(6.06x2.44) 14.5m2	16.9kN	4	70%	47.3kN/m2
40ft Type	305kN	(12.2x2.44) 29.8m2	10.2kN	4	70%	28.6kN/m2

(Prepared by the Study Team)

Surcharge load of the yard is therefore 50 kN/m2 from the above table.

④Operation system

The container handling equipment to be used in the yard are RTG, trailer, chassis, reach stacker, and forklift. The reference drawing of RTG is shown below:

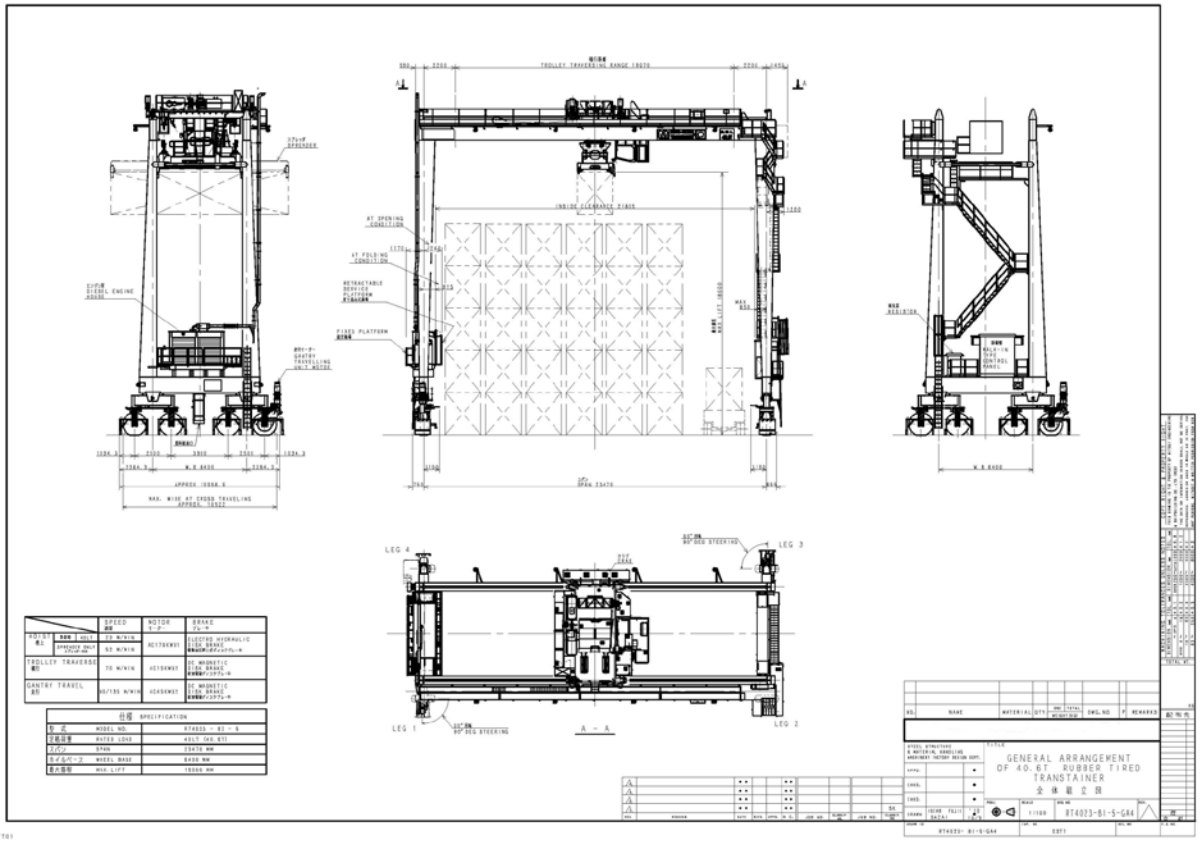


Figure 5.4-26 RTG General Arrangement (For reference only)

b) Design of yard leveling by reclamation

i) Construction plan of yard leveling

①Elevation of yard

The necessary height of the revetment is CDL+8.0m. The height of the existing yard and existing road is similar. CDL+8.0m is set as the height of yard .

②Reclamation volume

The reclamation volume of approximately 1.2 million m3 has been estimated after the topographical survey.

③Material for the reclamation

The material for the reclamation is river sand which is easy to procure and economical, however since no adequate quarries exist nearby the site land-transport is costly.

④Outline of construction plan

The yard leveling work will be done according to the following procedure:

1) Prior to the reclamation work, revetment and embankment of the block boundary are constructed.

2) After certain portions of the completion of the above works, reclamation work by pumping up of river sand is done, and the surface is leveled.

3) During the reclamation work, the overflow water shall be discharged with a proper management of sedimentation pond.

⑤Design of Soil Improvement

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.

＊Classification of Examination Area

The object area is roughly classified into three (3) types, a container yard, a building area and others. The feature of these three (3) area is as follows:

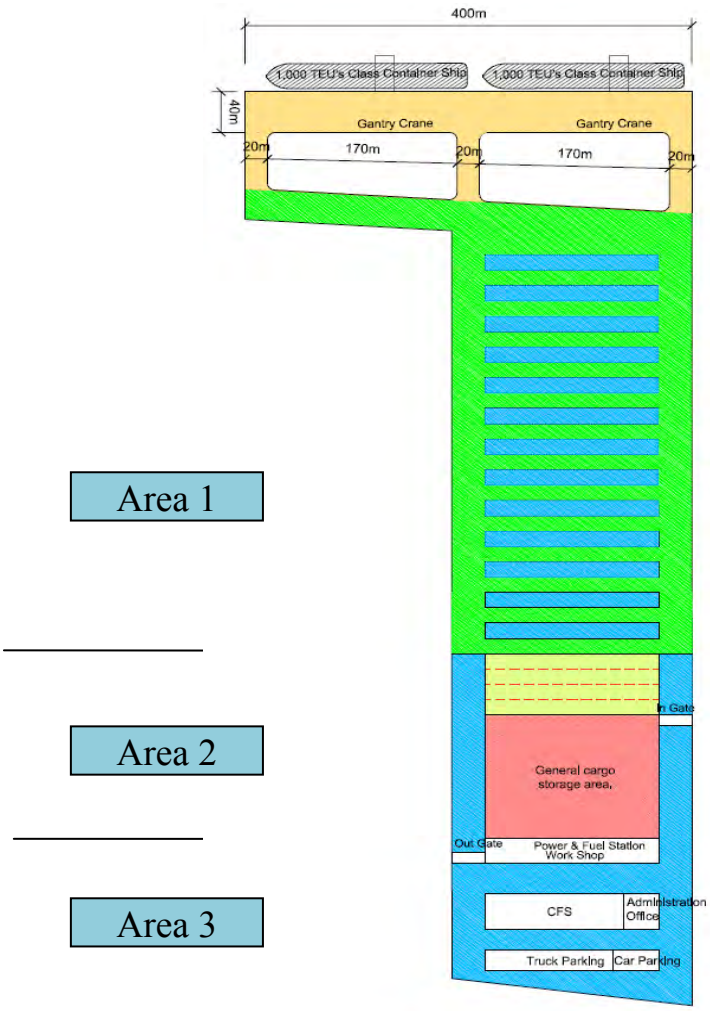
- Container Yard (Area 1): Container will be stored in this area. Substantial settlement occurs due to the load of fill and container (50kN/m^2). Moreover, since this area needs to be paved to handle containers, it is required to complete a settlement countermeasure work as early as possible.

- Building Area (Area 3): Constructions of a management office etc. is planned in this area. Since construction of buildings is required to be completed by the opening time of this port, it is also necessary to complete a settlement countermeasure as early as

possible.

- Others (Area 2): This area is reserved for the future expansion. This area is not required to be complete urgently except for road.

As mentioned above, the object area is classified as three (3) areas as Area-1 “Container Yard”, Area-2 “Others” and Area-3 “Building”



(Prepared by the Study Team)

Figure 5.4-27 Settlement Examination Area

ii) Design Condition of Soil Improvement

① Soil Parameters for original ground

The ground elevation was set to be CDL+6m on average at the examination area based on the topographic survey result. The soft cohesive soil layer, which is a object layer of settlement examination, is set to be Clay Layer with a thickness of 23m from ground surface. Clay with Silt Layer distributing under Clay Layer is hard Clay layer with about 10 blow of N-value, therefore, this

layer is not needed to be considered as a settlement examination layer. The soil parameters are set as shown in Table-5.4-22. according to the soil laboratory test results. The settlement analysis was carried out by Δe method.

Table 5.4-22 Soil Parameters used for Settlement Examination

Wet Unit Weight γ_t (kN/m^3)	Saturated Unit Weight γ_{sat} (kN/m^3)	e – logP curve	Coefficient of Consolidation		Coefficient of Secondary Consolidation Cε
			Cvo (cm^2/d)	Cvn (cm^2/d)	
17.0	17.0	Refer to Figure 5.4-1	500	50	0.0059

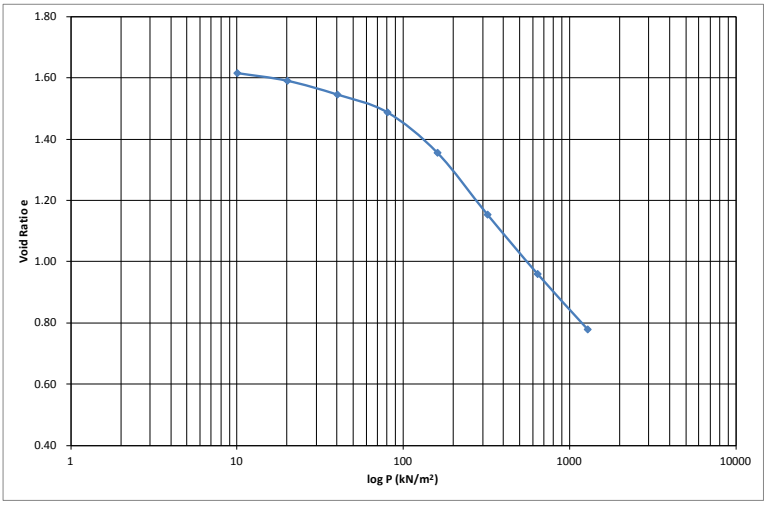


Figure 5.4-28 e – log P curve used in Settlement Examination

②Soil Parameters for Fill materials

The elevation of top of pavement is set to be CDL+8.0m and top of Fill is set to be CDL+7.5m. The soil parameters for fill material are set as follows.

Table 5.4-23 Fill Parameters used for Settlement Examination

Wet Unit Weight γ_t (kN/m^3)	Saturated Unit Weight γ_{sat} (kN/m^3)
18.0	20.0

③Load Condition

The load condition used for settlement analysis is set as follows.

- Area-1：50kN/m2（Assumed to be the container load.）
- Area-2：10kN/m2（Assumed to be traffic load）
- Area-3：10kN/m2（Assumed to be structure (CFS) load）

④Allowable Residual Settlement

- Residual settlement at opening of port : 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)

iii) Settlement Examination Results for Non-Countermeasure

The examination result for non-countermeasure is shown in Table 5.4-24.

Table 5.4-24 Examination Result for Non-Countermeasure

Area	Area-1	Area-2	Area-3
Consolidation Process	Primary	Primary	Primary
Settlement (m)	1.318	0.718	0.571
Residual Settlement (m)	1.248	0.642	0.485

As shown in Table 5.4-24, even the residual settlement for the primary consolidation can not be satisfied with the allowable residual settlement. Therefore, settlement countermeasure is definitely required for the area.

iv) Settlement Examination Results for Countermeasure

① Plastic Vertical Drain (PVD) Method

In this examination of PVD method, the spacing of PVD is set in consideration of the settlement amount, construction condition and utility of the area. As stated in "1) Classification of Examination Area", since pavement work in Area-1 and building construction in Area-2 need to be constructed at first, it is required to complete the settlement for both area as early as possible. Therefore, PVD spacing for the both area is set 1.25m. For the Area-2, only road needs to constructed by the time the port opens. Therefore, it is not considered to be a problem even if settlement remains to some extent (within allowable residual settlement). PVD spacing of Area-2 is set 2.0m. The examination results of settlement for PVD method is shown in Table 5.4-25.

Table 5.4-25 Settlement Examination Result for PVD Method

Area	Area-1		Area-2		Area-3	
Consolidation Process	Primary	Primary & Secondary	Primary	Primary & Secondary	Primary	Primary & Secondary
PVD Spacing (m)	1.25		2.00		1.25	
Settlement (m)	1.593	1.771	0.962	1.142	0.970	1.150
Residual Settlement (m)	0.135	0.290	0.136	0.294	0.019	0.179
Thickness of Fill (m) (Main+settlement+Preload) (m)	5.6		3.8		3.2	
Sand Mat (m)	1.0		1.0		1.0	
Removal Fill (m)	3.64		1.98		1.26	

② Sand Drain (SD) Method

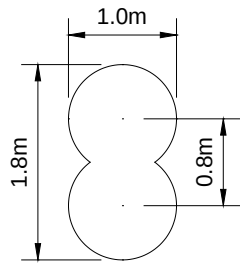
In the examination of Sand Drain (SD) method, the spacing of SD is set in consideration of the settlement amount, construction condition and utility of the area. According to such conditions, the spacing of SD is set 2.0m for Area-1 and Area-3 and set 3.0m for Area-2. The settlement examination result for SD method is shown in Table 5.4-26.

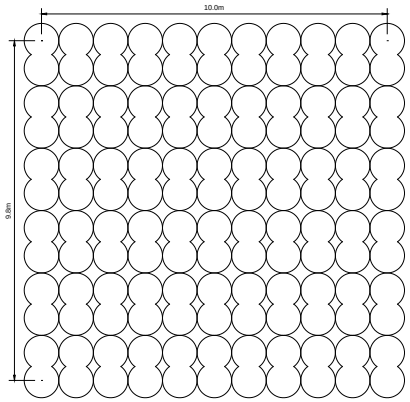
Table 5.4-26 Examination Result SD Method

Area	Area-1		Area-2		Area-3	
Consolidation Process	Primary	Primary & Secondary	Primary	Primary & Secondary	Primary	Primary & Secondary
SD Spacing (m)	2.0		3.0		2.0	
Settlement (m)	1.589	1.754	0.897	1.041	0.941	1.082
Residual Settlement (m)	0.134	0.281	0.160	0.295	0.009	0.138
Thickness of Fill (m) (Main+settlement+Preload) (m)	5.5		3.1		2.9	
Sand Mat (m)	1.0		1.0		1.0	
Removal Fill (m)	3.55		1.36		0.97	

③Deep Mixing Method (DMM)

Deep mixing method (DMM) is to support a fill load and a overburden load with cement improved piles and to reduce a settlement generation. Therefore, since this method is designed in the precondition that settlement is not generated, the settlement analysis is not carried out in the examination. As a calculation results of improved strength (taking account of Fs=2.0), it is Area-1: 200kN/m2, Area-2: 100kN/m2 and Area-3: 100kN/m2.





Type of Improved Pile:
2 Axis Lap Type
(20cm-Lap)

Improvement Ration: 83%

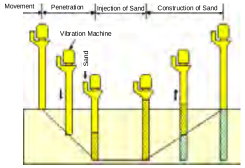
Length of Improvement: 24m
(Including 1m of Non-Cement)

Figure 5.4-29 Shape of DMM Pile Figure 5.4-30 Arrangement Pattern of improved Pile (showing a part of area)

v) Selection of countermeasure for settlement

Three methods as countermeasures for achieving the allowable residual settlement were examined. Based on a comparison of three methods, PVD method has advantage in terms of construction condition and economic efficiency and is thus recommended as the countermeasure method for soft ground. (Refer to Table 5.4-27). The typical cross section of PVD method is shown in Figure 5.4-31. The installation depth of PVD is set tobe the bottom of Clay Layer which is a settlement examination layer.

Table 5.4-27 Comparison of Countermeasure Method for Settlement

Comparison Items	PVD Preloading Method	Sand Drain (SD) Method	Deep Mixing Method (DMM)
Photos of Each Method	 Installation of PVD  Preloading	 	 
Outline of Method	This is a vertical drain method used to accelerate the consolidation in the cohesive soil ground. In this method, vertical plastic boards are installed into the cohesive soil ground as a drain material. The consolidation is accelerated by reducing the drainage distance of pore water. It can be applied together with other methods such as Sand Mat Method and Slow Surcharge Method.	This is one of the vertical drain methods to accelerate the consolidation in the cohesive soil ground. In this method, vertical sand columns are created in the cohesive soil ground by utilizing vibration hammer. The consolidation is accelerated by reducing the drainage distance of pore water. It can be applied together with other methods such as Sand Mat Method and Slow Surcharge Method.	This is one of the replacement methods by creating cement-soil mixing columns in the cohesive soil ground. The mixing rod with mixing blade shall be double rod type with a diameter more than 1000mm to secure high-quality column. And also, the machine shall be strong enough to rotate the mixing blade at an appropriate speed for stabilization. The settlement can be reduced by creating these improving bodies in the ground.
Numbers of Work Record (For Large-Scale Port)	A Many work experiences	B This method had many experiences before, but it have been replaced for PVD method recently	B Mainly applied to a partial countermeasure, rarely used for overall ground improvement
Technical Advantages and Disadvantages	Advantages ・Construction equipments are relatively small compared with other vertical drain method. ・The construction is efficient and considered to be economical. ・The applied press-fit method is proof against noise and vibration. ・The quality of drain material is secured because of being manufactured at factory ・Installation speed of PVD is high (7,000-8,000m/day/machine). ・Penetration depth can be achieved more than 40m in deep. ・PVD method is theoretically and practically reliable due to a lot of actual site experiences. Disadvantages ・It needs preload embankment construction to accelerate consolidation settlement and removal of preload is necessary after achievement of required consolidation settlement completed. ・It is necessary to leave the preload at required height for totally 6 months to achieve the required consolidation degree. ・It is necessary to secure the quality of sand mat as a drainage layer. ・Secondary consolidation settlement between 10cm and 20cm will be left after completion of primary consolidation settlement. ・Penetration requires N<8.and it is necessary to use the assistance method as water jet and pre-boring in case of penetrating in the soil layer with N value of 8 or more.	Advantages ・Since a drain diameter is large, there is little settlement delay. ・In order to use a large size vibration machine, penetration capacity is high. ・Construction for deep depth is possible by using of large size construction machine. Disadvantages ・Construction equipments are relatively large. ・Pilling speed is not so high (1,000-1,500m/day/machine). ・It needs preload embankment construction to accelerate consolidation settlement and removal of preload is necessary after achievement of required consolidation settlement completed. ・It is necessary to leave the preload at required height for totally 6 months to achieve the required consolidation degree. ・It is necessary to secure the quality of sand mat as a horizontal drainage layer. ・Secondary consolidation settlement between 10cm and 20cm will be left after completion of primary consolidation settlement. ・Vibration and noise are big. ・Because a construction machine is large size, additional countermeasure is required separately in very soft ground.	Advantages ・Deformation of ground can be reduced. ・Preload is not necessary. (Earth work can be reduced so much.) ・Leaving period is only one month for hardening of DMM piles. ・Almost no residual settlement come out after treatment by DMM piles. ・Construction efficiency is high due to the large scale of construction equipment. ・By making the ground solidified, the settlement generated by the embankment is small, accordingly the displacement of surrounding area is also small. Disadvantages ・Forming speed of DMM pile is low (600-700m/day/machine). ・Laboratory soil-cement mixing test should be conducted in advance of actual improvement work. ・One(1) month for curing period after creating column is required before embankment. ・Since quality control of the created column is important during the construction, the quality check of the column such as check boring must be conducted.
Construction Planning	A (PVD Interval d=1.25m or 2.0m, Preload Height H=3.2m -5.6m) Easy installation by light machine. Control Point is as follows; 1) Verticality of mandrel shall be kept. 2) Termination depth of PVD installation is easily confirmed. 3) Consolidation process shall be checked by monitoring the settlement.	B (SD φ=0.4m, Interval d=2.0m or 3.0m, Preload Height H=2.9m-5.5m) Easy work but a lot of sand shall be procured for SD and Preload. Sand piles are installed by heavy machine. Control Point is as follows; 1) Material characteristics shall be checked by soil test such as grain size analysis or permeability test. 2) Quality of sand pile is confirmed by sand volume or weight. 3) Consolidation process shall be checked by monitoring the settlement.	B (DMM Pile Rap type φ=1.0m, Improved ratio Ap= 83%) Easy forming but quality control (many core boring of piles) is necessary. Huge quantities of cement shall be procured. DMM piles are constructed by heavy machine. Control Point is as follows; 1) Verticality of mixing axes shall be kept. 2) Addition of cement shall be decided by trial mixing test in laboratory. 3) Quality of DMM pile is confirmed by check borings.
Construction Period	A Shorter than other method (About 110 days / 4 machines)	B Longer than PVD (About 300 days / 4 machines)	C Longer than other method (About 740 days / 4 machines)
Construction Cost	A Reasonable (PVD+Preload)	B More expensive (SD+Preload) than (PVD+Preload)	C Most expensive (DMM)
Comprehensive Evaluation	**Recommended**	**Not Recommended**	**Not Recommended**

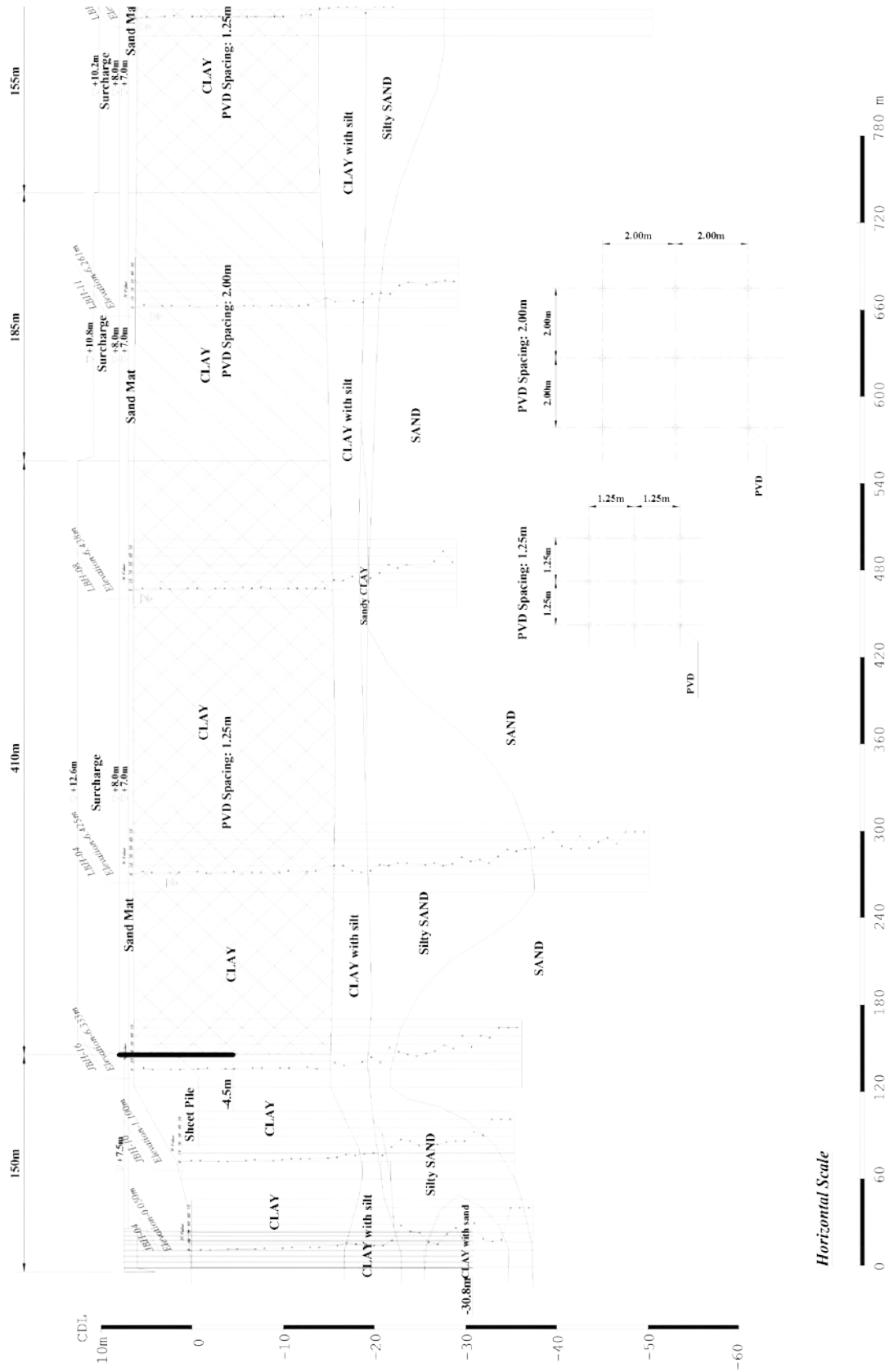


Figure 5.4-31 Typical Cross Section of PVD Method

c) Design of pavement

A general pavement structure is described in this section.

i) Classification of yard pavement

The pavement classification is to be determined by a use plan of the yard. Although a detailed use plan is not yet finalized at this stage, the pavement will be in general divided into the following three pavement types.(see Figure 5.4-32)

①Container stacking yard

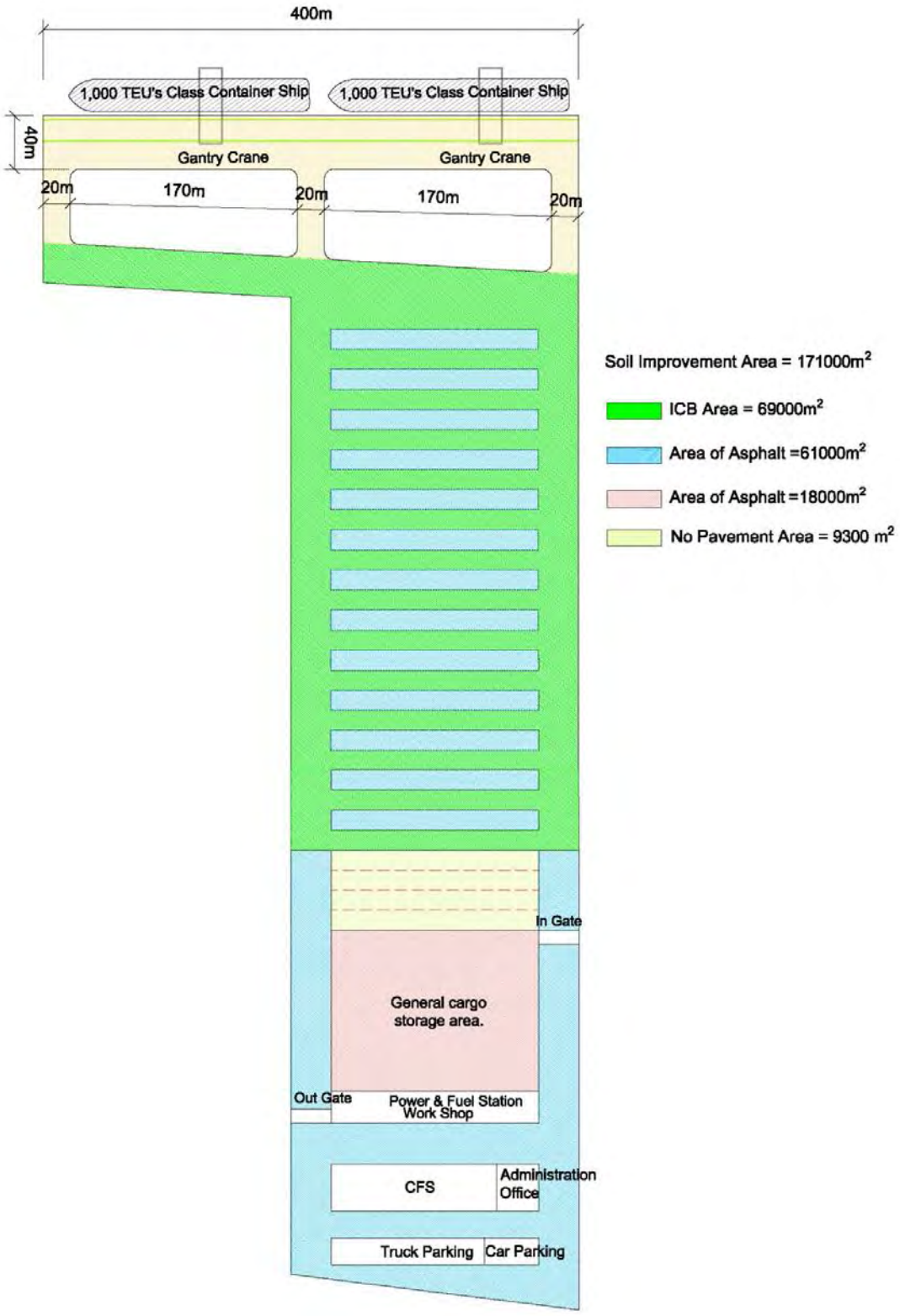
Container stacking yard is defined as a laden container stacking yard. Concrete stacking blocks are provided for the laden container stacking yard, and the areas between container stacking blocks are paved with macadam paving of asphalt surfaced.

②Road and Hauling area

The road and hauling areas are designated areas for trucks and container handling equipment (e.g. Chassis trucks and Reach stackers). These areas are paved with interlocking concrete blocks (ICB) as it is easy to carry out maintenance when settlement or damage occurs.

③No pavement area

The area being left unpaved portions and to be used for empty container storage or other purposes, where soil improvement only provided.



(Prepared by the Study Team)

Figure 5.4-32 The Pavement Arrangement Plan of the Yard

ii) Composition of pavement

The pavement composition is designed as follows.

①Container stacking yard

The concrete block pavement and composition of macadam paving with asphalt surfacing for container stacking yard.

＊RC container stacking block

Standards type : 1.5m x0.8m x0.3m　Amount of steel bar：100kg/m3

②Macadam Paving (with asphalt surfacing)

sub base (rubble)	:	150mm
base（crushed rock）	:	200mm
asphalt pavement	:	50mm

③Road and hauling area

The following pavement structure for the road and hauling areas are made considering design traffic loads;

ICB

sub base (rubble)	:	150mm
base (cement stabilization)	:	200mm
inter locking block pavement	:	80mm

Asphalt

sub base (rubble)	:	150mm
base (cement stabilization)	:	200mm
asphalt binder course	:	50mm
asphalt surface course	:	50mm

d) Design of drainage

A drainage outline plan is described in this section.

i) Drainage Plan

Yard drainage system is such that surface rain water will be collected and drained into open ditch and culvert, and discharged into river.

As staged construction of yard is planned, the drainage system will also be completed each construction stage.

ii) ＊Surface drainage in a yard

Surface rain water will be flowed by slope of pavement or ground into open ditches and pits constructed in the yard and drain to culverts.

iii) ＊Rain water drainage

At yard boundary culvert type drainage is provided. Surface water will be collected and drained into the culvert drainage. A simple treatment facility, such as oil separator, may need to be provided at the end part of the culvert before discharging the surface water into the river. The design catchment area for rain water is limited to the yard area.

5.4.2. Cargo Handling Equipment

(1) Equipment Arrangement

As described in previous sections, a container terminal of capacity 800,000 TEU/yr has to be developed by 2019/2020. Since the container terminal development will be implemented in a phased manner according to the forecast cargo demand, the cargo handling equipment will also be arranged according to the phased plan.

In designing the arrangement of Cargo handling equipment, it is normally done in a way that an economical cargo handling system is firstly studied and selected according to the planned cargo demand, and then the system will be improved or reinforced as necessary. In this development plan however, it is important to arrange equipment types with due consideration of the target capacity of the terminal, as the target completion of full capacity (Phase III, 800,000 TEU/yr) is relatively short from the first Phase completion (at year 2015). In this sense, a RTG system is recommended as this system has been typically adopted in modern container terminals.

1) Quayside Crane

STS (Ship to Shore) Gantry Crane of size and capacity to be adequate for 20,000 DWT class container ships will be designed as minimum, but taking also into account future ship sizes possibly to call. Each 200 m berth requires two(2) STS Gantry Cranes from the estimation described in the previous sections.

2) Yard Operation System

As discussed, RTG with Tractor & Chassis system is adopted.

Although a RMG (Rail Mounted Gantry) system may be applicable instead of RTG, it is recommended to select RTG system as this system is mostly adopted in Yangon Port.

3) Empty Container Handling Equipment

Many equipment types are used for this purpose such as Truck crane, Forklift, Top lifter, Reach stacker and so on. In this plan, Reach Stacker is recommended as efficient utilization is possible (including laden containers handling), and as mostly used in the operating container terminals in Yangon Port.

4) CFS Equipment: 3.0~3.5 t Forklift is to be used as typically adopted.

Typical features of the above equipment are shown in the following Figure as reference.

Gantry Crane

RTG

Reach Stacker

Tractor and Chassis

Forklift (3 ton ~ 3.5 ton)

Figure 5.4-33 Cargo Handling Equipment

Table 5.4-28 summarizes the equipment arrangement plan according to each phase and based on the estimation described in "6.2 Urgent Development Plan of Facilities and Equipment".

Table 5.4-28 Equipment Arrangement Plan

Description	unit	Phase			Remarks
		Phase I	Phase II	Phase III	
Design Capacity	TEU	200,000	200,000	400,000	Total: 800,000 TEU/yr
Berth Length	m	400	-	400	Total: 800 m
Quayside Gantry Crane	unit	2	2	4	Total: 8 units
RTG	unit	6	6	12	3 units/ gantry crane
Reach Stacker	unit	3	3	6	Empty container ratio: 30 %
Tractor and Chassis	unit	6	6	12	3 units/ Gantry crane
Forklift	unit	2	2	4	CFS use

(2) Design Requirements of Equipment

The following requirements are to be considered in designing respective cargo handling equipment, and the detailed specifications are described in " 6.2.3 Cargo Handling Equipment".

1) Quayside Gantry Crane (STS Crane)

Considering also a future improvement case, the crane will be capable to cope with a Panamax class container ship, which carries12 rows of container cargo on board (width =32.2m).

Rated lifting capacity therefore, will be not less than 40 tons, and the crane gauge is 16 m.

2) RTG

Nominal lifting capacity should be not less than 40 tons. From the planned yard arrangement,

RTG is of a type capable to handle 6 rows and 5 stacking height (5+1) of containers, by which 23.47 m Rail Span and Hoisting height of no less than 18 m will be required.

3) Reach Stacker

Being used at CFS (Container Freight Station) and Empty container handling, the rated capacity will be minimum 40 tons and capable to handle the containers of 3 rows and 5 stacking height (at nearest row).

To this end, the max. Boom height should be not less than 18 m, and its turning radius should be not more than 8.3 m considering an effective use in container yards.

4) Tractor and Chassis

Rated carrying capacity of 40 tons of type appropriate for use in the container yard.

The overall length of the equipment should therefore be as follows;

- Overall length of Tractor: Not more than 6.8 m
- Overall length of Chassis: Not more than 12.72 m

5) Forklift

Rated lifting capacity 3.0~3.5 t type as appropriate in CFS use.

5.4.3. Working Vessel

(1) Tugboat

1) Tugboat Design Requirement

a) Operation Requirement

Under the natural condition of vicinity of Yangon Port in Thilawa Area, tugboats to be deployed at Yangon Port in Thilawa Area shall be capable to assist the calling ship's approach operation, berthing, un-berthing and turning its hull safely and efficiently. Tugboats can be used from the outer bar for towing on line or for assisting at the calling ship's side. Tugboats can easily change, when towing over the tugboat's bow, to a pushing at the calling ship's side or for push-pull operation while berthing. A towing winch is useful to enable the towing line always to be a suitable length or to pick up any slack in the line. Tugboat is mainly used to assist the calling ship's turning in front of the berth on line or pushing by the bow fender to keep the minimum turning circle of 1.0-1.5 times of the calling ship length and the position for berthing safely. In accordance with the berth design condition with 10cm/sec of the maximum berthing speed, tugboats shall slack off the calling ship's berthing

speed as much as possible by push-pull operation. Addition to it, taking account of wind and current, tugboats shall assist the calling ship's berthing in parallel with the berth by push-pull operation on towline at bow winch or at bow fender.

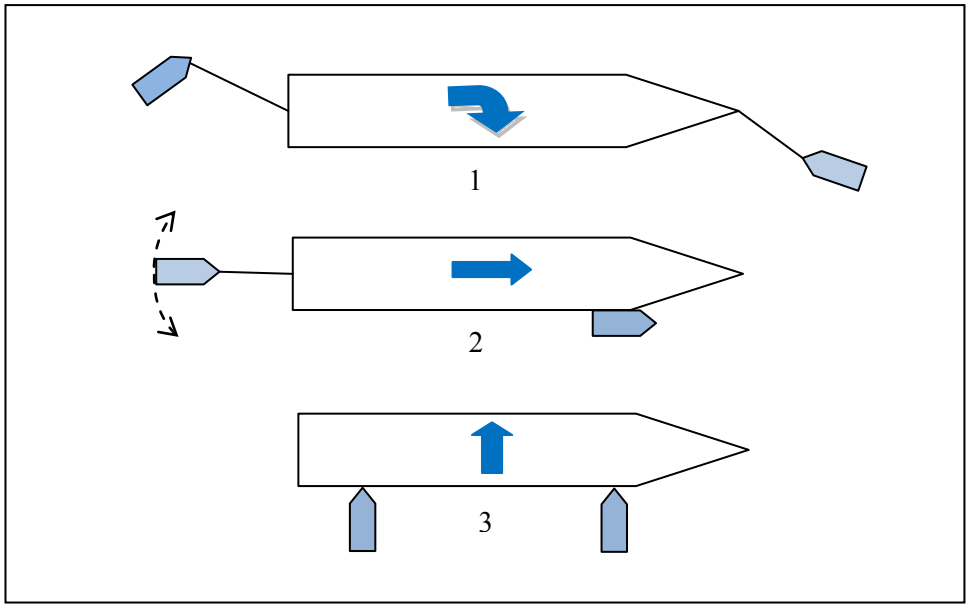


Figure 5.4-34 Assisting Methods with Tugboat

(2) Rule and Regulations

Rules and regulation to be applied to the new building ships registered in Myanmar shall be;

- Maritime Regulations of Myanmar Government
- International Classification Society

Department of Marine Administration (MDA) is the authority for inspection, issuing certificate and registration of ship in Myanmar. MDA has assigned International Classification Society for inspection on behalf of MDA when the ship is built in foreign countries.

a) Environmental and Social Considerations

International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL) by International Maritime Organization (IMO) shall not apply to tugboat, however, the planned tugboat shall be built in compliance with MARPOL.

b) Required Tugboat Power for Assisting the Calling Ship

Following ships are selected for examination for the requirements of power of tugboat. Tugboats shall be enabling to assist the selected ships which are sized with a maximum draft of 9m to enter the channel to Yangon Port in Thilawa Area.

i) Typical Dimension of Calling Ship

Table 5.4-29 List of Ship as Reference

	Type and Dimensions of Ship						
	Type of Ship	Loaded Condition	Gross Tonnage	Loa (m)	B(mld) (m)	D(mld) (m)	D(mld) (m)
1	Container （19,000DWT）	Full	15,500	171.0	25.0	13.6	9.0
2	Multi-Cargo	Full	17,500	161.0	25.0	12.8	8.4
3	Container/Cargo	Half	18,400	184.0	27.5	14.7	7.4
4	Tanker	Half	30,000	183.0	32.23	19.1	8.0

ii) Required Power of Tugboat for Assisting Berthing

In accordance with the berth design condition with 10cm/sec of the maximum berthing speed, tugboats shall slack off the calling ship's berthing speed as much as possible by push-pull operation for safety berthing.

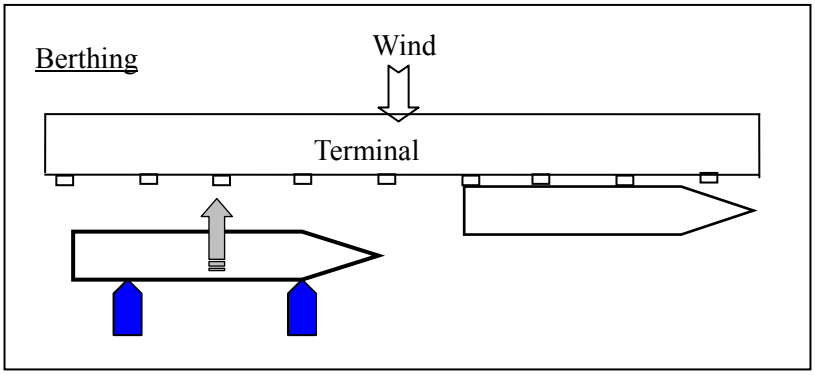


Figure 5.4-35 Assisting Berthing Operation

The calling ship shall be moved to the terminal in parallel with the terminal by push-pull operation by tugboats on towline at bow winch or at bow fender against to the wind and current. The required force (Te) of tugboat for transverse movement of calling ship shall be;

Te≧Resistance of Ship Transverse Movement + Wind and Current Pressure

$$Te \geqq {}^{1}/_{2}\rho_{w} L d C_{w90} (U_0 + V_c)^2 + {}^{1}/_{2}\rho_{a} B_a C_{a90} V_a^{\,2}$$

Te	Required Power of Tugboat（kN)
w	Density of Water
Þa	Density of Air
L	Ship Length

d	Draft
Ba	Lateral Ship Area
Cw90	Resistance Coefficient of Ship Transverse Movement
Ca90	Resistance Coefficient of Lateral Wind Pressure
Uo	Ship Transverse Movement Speed
Vc	Current Velocity
Va	Wind Velocity

As a result, required power of tugboat for assisting berthing operation is 900PS against 5m/s of wind velocity, 2,500PS against 10m/s of wind velocity and 5,500PS against 15m/s of wind velocity. Maximum mean wind velocity in the vicinity of Yangon Port in Thilawa Area is approximately 10m/s. Taking account of wind gust ratio of 1.3, the required power of tugboat is 4,200PS against 13m/s of wind velocity.

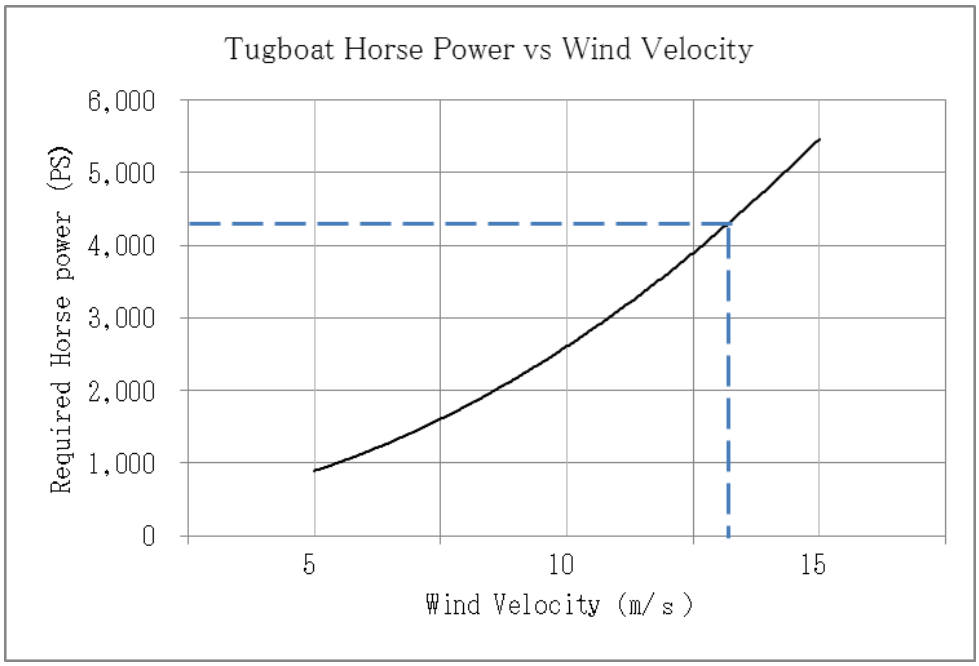


Figure 5.4-36 Required Power of Tugboat Against Wind Velocity

iii) Required Power of Tugboat for Control Ship's Berthing Speed

Tugboat shall slack off the calling ship's berthing speed as much as possible by push-pull operation. Figure 5.3-37 shows the required power of tugboat to control ship's berthing speed ranging from 0m/s to 0.10m/s during the wind velocity from 5m/s to 15m/s.

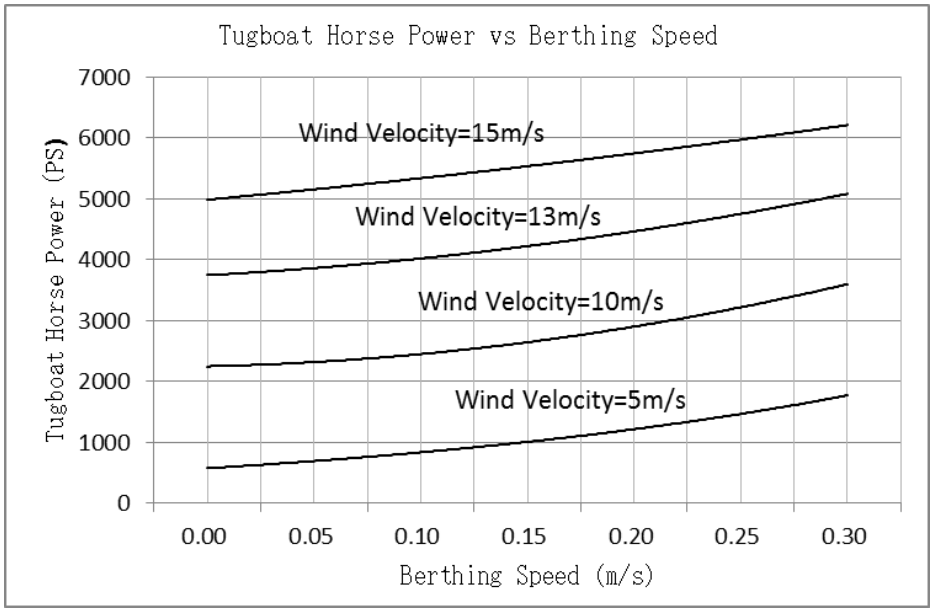


Figure 5.4-37 Required Power of Tugboat for Control of Berthing Speed

iv) Required Power for Tugboat for Course Keeping Against Current Pressure

Required power for course keeping against current pressure changes depending on the relative angle to the ship. Tugboat needs 6,000PS for course keeping of the ship when the ship is approaching against the relative current angle of 60 degrees with 1.5 knots speed.

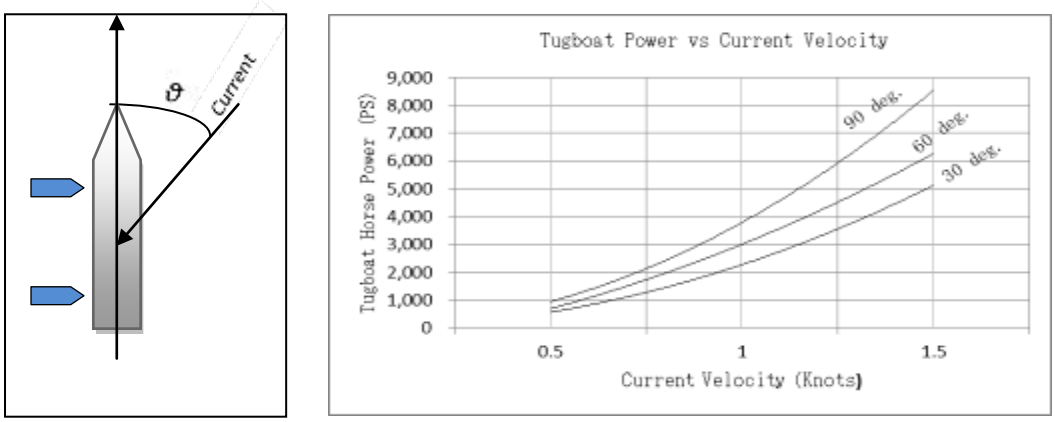


Figure 5.4-38 Required Power of Tugboat for Course Keeping under Current Pressure

v) Required Power of Tugboat for Course Keeping of the Ship with Dead Slow Speed under Wind Pressure

Assuming the condition of the ship by approaching with dead slow speed of less than 2.0 knots under wind velocity of 10m/s and 15m/s, required power of tugboat to assist course keeping is simulated as follows;

<Conditions of Simulation>

Ship Type : 18,400GRT Container/Cargo
Length (mld) : 185.0m
Breadth (mld) : 27.6m
Draft (mld) : 9.0m
Lateral Area : 3,510m^2

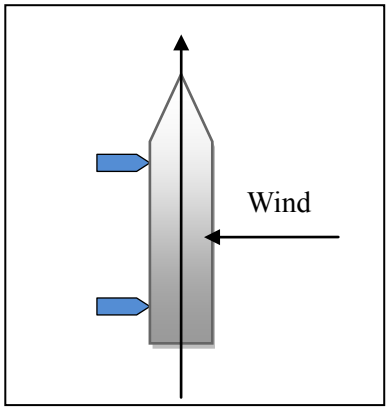
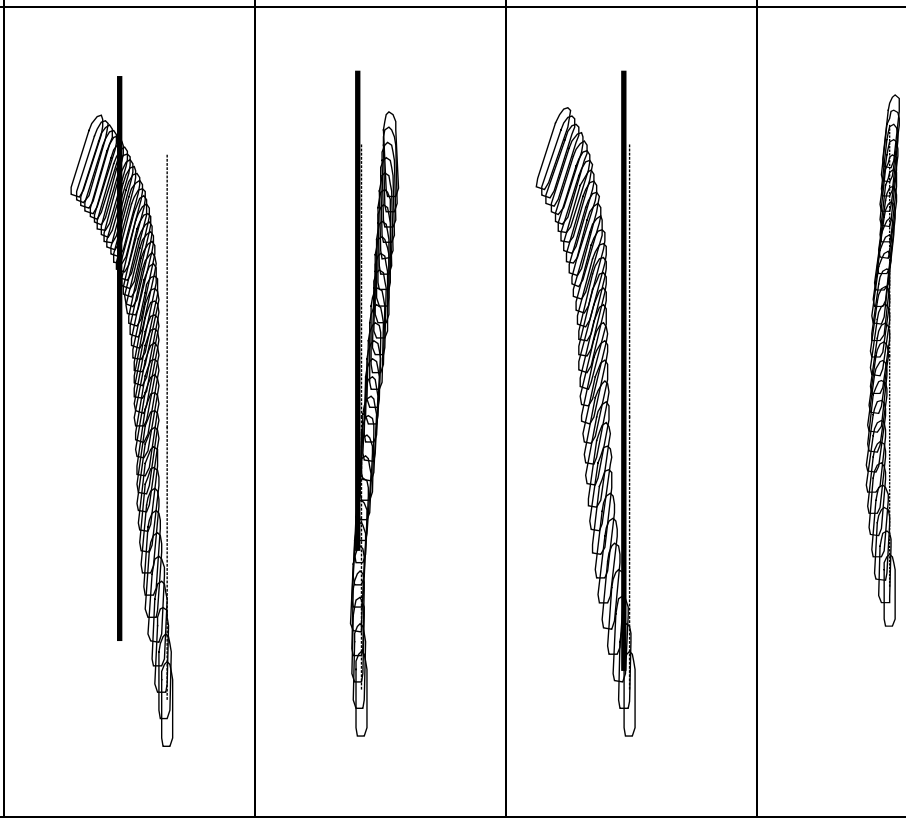


Figure 5.4-39 Course Keeping Simulation

Wind Velocity : 10m/s, 15m/s
Thrust by Tugboat : 15t, 20t under Wind Velocity 10m/s
: 35t, 40t under Wind Velocity 15m/s
Distance of Sailing : 1,200m at 2 knots
Propeller RPM : Equivalent to 1.5 knots at Wind Velocity 10m/s
: Equivalent to 2.6 knots at Wind Velocity 15m/s

Extractive Characteristic: Deviation, Remained Speed, Maximum and Mean Rudder Angle

Table 5.4-30 Result of Simulation for Course Keeping

Wind Velocity	10m/s	10m/s	15m/s	15m/s
Thrust of Tugboat	15t	20t	35t	40t
Deviation	170m	78m	163m	16m
Remained Speed	0.2 knots	1.1 knots	0.4 knots	1.2 knots
Max. Rudder angle	25 deg.	16 deg.	22 deg.	20 deg.
Mean Rudder Angle	16 deg.	11 deg.	14 deg.	13 deg.
Trace				

As a result of simulation experiment for course keeping under the critical wind velocity for pilot service as 15m/s, required power of tugboat to assist the ship for course keeping at dead slow speed is approximately 3,000PS equivalent to thrust of 40 ton.

c) Deployment Plan

As a summary of the study on the tugboat for assisting the ship, total required power of tugboat is;

- Approximately 2,900PS for berthing operation under the maximum mean wind velocity of 10m/s

- Approximately 4,200PS for berthing operation under gusty wind velocity of 13m/s
- Approximately 5,000-6,000PS for course keeping operation under current
- Approximately 3,000PS for course keeping operation under wind pressure

Based on above result, two (2) units of 3,000PS tugboat is necessary at the Yangon Port in Thilawa Area, as one (1) tugboat for berthing operation under nominal wind pressure, two (2) tugboats under gusty wind pressure and one (1) or two (2) tugboats is for course keeping at approaching operation with the dead slow speed under current and wind pressure.

Assuming the berthing speed as 0.10m/s, critical wind velocity and berthing speed to be controlled by 3,000PS tugboat are obtained as shown in the Tables below.

One (1) 3,000PS tugboat is able to control the berthing speed of 0.10m/s under 10m/s wind velocity, and two (2) 3,000PS tugboats are necessary under 13m/s gusty wind velocity.

Table 5.4-31 Critical Wind Velocity within Berthing Speed of 0.10m/s

	Type of Ship	Loaded Condition	Berthing Speed	
			0.10m/s	
			3,000PS x 1	3,000PS x 2
1	Container (19,000DWT)	Full	11.5	16.4
2	Multi-Cargo	Full	13.4	19.1
3	Container/Cargo	Half	11.9	17.0
4	Tanker	Half	11.8	16.9

Table 5.4-32 Maximum Berthing Speed under Wind Velocity of 10m/s and 13m/s

	Type of Ship	Loaded Condition	Wind Velocity		
			10m/s	13m/s	
			3,000PS x1	3,000PS x1	3,000PS x2
1	Container (19,000DWT)	Full	0.26	N/A	0.43
2	Multi-Cargo	Full	0.36	0.16	0.56
3	Container/Cargo	Half	0.30	N/A	0.50
4	Tanker	Half	0.29	N/A	0.47

d) Basic Design of Tugboat

Berthing operation at the Yangon Port in Thilawa Area will be vulnerable to current effects due to its deep water of 18m in front of the terminal. It may become more difficult during falling current since the ship shall turn its hull and berth at port side under the current effect from stern and side. In

order to cope with the current and wind pressure, tugboat shall be designed to have functions of pushing forward and pulling backward with a towline from the winch located at stem.

Berthing & Un-Berthing Operation at Yangon Port in Thilawa Area

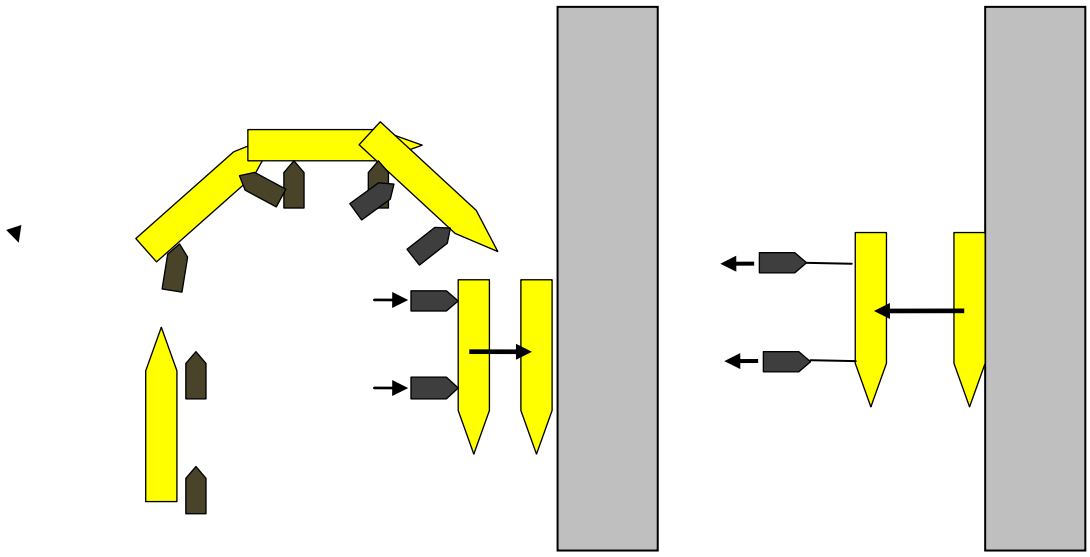


Figure 5.4-40 Berthing and Un-Berthing Operation at Yangon Port in Thilawa Area

i) Model of Tugboat

The tugboat shall be designed and built as steel-hulled twin screw tugboat equipped with twin diesel propulsion engines and Azimuth Propellers in Kort nozzles.

The tugboats operational area will be vicinity of the Yangon Port in Thilawa Area, where the tugboat will be used for handling the calling ship. The tugboat must be capable of being safely operated while performing its required duties in both benign and adverse weather and sea conditions.

Therefore, the tugboat must have excellent capabilities for calling ship from the stern, from the bow on a long towline, from alongside and in push-pull operation mode. Optimum maneuvering capabilities are required in any expected weather condition.

The Vessel shall have suitable towing force, stability and maneuverability for the purpose intended, and to have suitable strength and arrangement. The tugboat shall be of flush deck with raked stern having deckhouse amidships. The exposed upper deck shall be equipped with rubber fenders, mooring gears and towing gears.

ii) Propeller

For the main function of tugboat as assisting the calling ships safely and efficiently, the tugboat shall be designed to equip azimuth propellers in Kort nozzle in order to develop the maximum thrust

to any direction for quick maneuvering.

iii) Tank Capacity

Tank capacity of fuel oil and fresh water shall be designed to keep enough endurance for tug operation, fire-fighting operation, and search and rescue operation in the coastal line of Myanmar.

iv) Towing Gear

Combined hawser winch and windlass gear shall be equipped at fore side of upper deck. Gypsy for chain and hawser drum shall be operated independently by change-over of the clutch. Hauser drum has a capacity of winding towline of 100m x ¢90 mm with a brake force of 150% of bollard pull. Hauser winch shall be remotely controlled from the wheelhouse for safe operation. Towing hook shall be equipped at the stern of upper deck with a towing force of 150% of bollard pull.

v) Crew

Number of crew shall be in accordance with the rule and regulation of Department of Maritime Administration in Myanmar.

Captain	: 1
Chief Engineer	: 1
Crew	: 10
Total	: 12

Lifesaving equipment (inflatable life raft and life jacket) and accommodation shall be equipped for12 persons.

vi) Radio Equipment

GMDSS Radio equipment, VHF international radio telephone, Automatic Identification System (AIS), Emergency Position Indicating Radio Beacon (EPIRB), Two-way VHF and Radio Search and Rescue Transponders (SART) shall be equipped.

vii) MARPOL

Oily water separator and Sewage treatment plant in accordance with MARPOL shall be equipped.

Sewage treatment system comply with MARPOL IV will be equipped to discharge sewage to outboard or onshore facility.

Main engine shall be equipped with a certificate in accordance with MARPOL Annex VI.

viii) Search and Rescue

2 kW and 1 kW Search light shall be equipped at the top of the mast and wheelhouse for search and rescue operation. Rescue boat shall be equipped on the top of poop deck.

ix) Fire-Fighting Equipment

Fire-fighting system with a fire monitor on the mast shall be equipped.

x) Oil Dispersant Equipment

Oil dispersant system with portable nozzle shall be equipped.

e) Outline of Tugboat

Length (OA)	Approx. 31.0-34.0 m
Breadth (mld)	Approx. 9.20 m
Depth (mld)	Approx. 3.90 m
Designed Draft (mld)	Approx. 2.80 m
Service Speed	12.5 knots
Bollard Pull (100%MCR)	40 tons
Crew	12 persons
Main Engine	1,500PS x 750RPM x 2units
Propulsion Unit	Azimuth Propeller
Registry	Yangon Port, Myanmar
Classification	Class NK
Navigation Area	Harbor (Non-International Voyage)
Rules & Regulations	Class NK Maritime Regulations of DMA

(3) Pilot Boat

1) Deployment Plan of Pilot Boat

Pilot boat deployed at the pilot station in the outer bar shall send a pilot to calling ships at the meeting point located is 1.5 miles away from the floating pilot station in the open sea. For this purpose, pilot boat shall be appropriately designed for assisting pilotage service with suitable speed and safety operation by its high seaworthiness and stability in the rough sea conditions. Pilot boat shall have enough strength of construction for pilot to get on board from either upper deck or top of the wheelhouse.

Three (3) units of new pilot boat shall be deployed at the pilot station. Including one (1) of them is used as a stand-by pilot boat. Pilot boat shall be designed with a function of crew boat carrying 6

pilots to pilot station.

2) Outline of Pilot Boat

Length (OA)	Approx. 20 m
Breadth (mld)	Approx. 5.9m
Depth (mld)	Approx. 2.7m
Draft (mld)	Approx. 1.5m
Service Speed	20 knots
Crew	3
Passenger	6
Accommodation Bed	4
Main Engine	Approx. 1,074PS x 2
Registry	Yangon Port, Myanmar
Classification	Class NK
Navigation Area	Coastal（Non-International）
Rules and Regulations	Class NK Maritime Regulations of DMA

5.4.4. Maintenance of Navigation Channel and Dredger

Deepening and widening of navigational channel with the information of necessary dredging volume and maintenance dredging volume would be an important issues for the future development plan of Yangon Port as well as the urgent development plan of Yangon Port in Thilawa Area. Bathymetric survey along the channel centerline and 20 transverse directional surveys from Yangon Port up to the open sea channel end which were shown in Figure 5.4-41 are going to be done by the Survey Team.

(Prepared by the Study Team)

Figure 5.4-41 Bathymetric Survey Location by the Survey Team

Figure 5.4-42 shows the longitudinal cross-section of navigational channel from Yangon Port in Thilawa Area to the end of channel at the open sea. According to this figure, shallowest water depth of CD-6.0m appears at the Elephant Point so-called Outer bar and sea water with water depth of CD-6.0m to CD-7.0m was continued more than 10km from Elephant Point to the outer sea area.

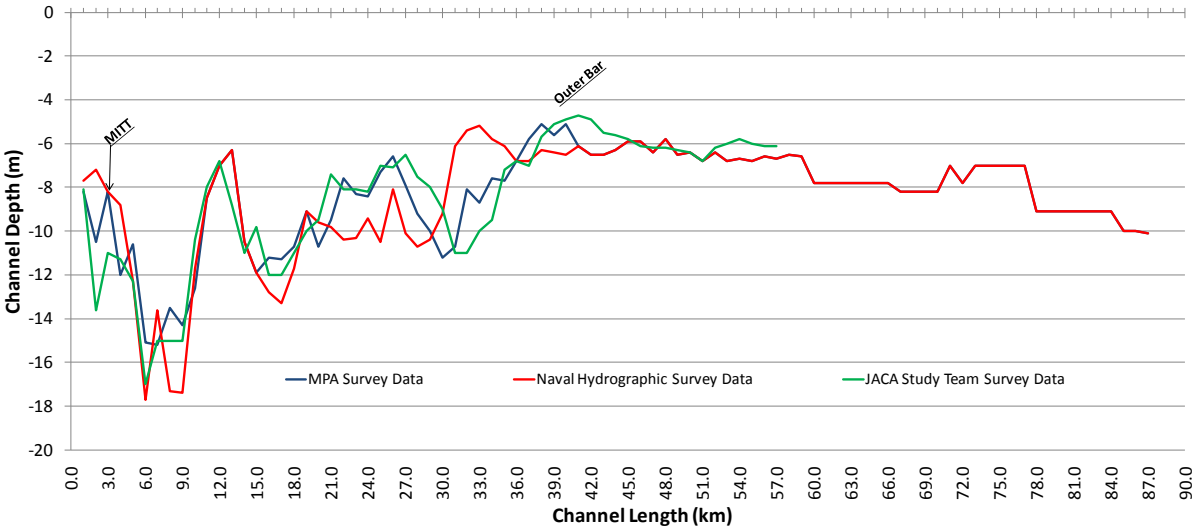
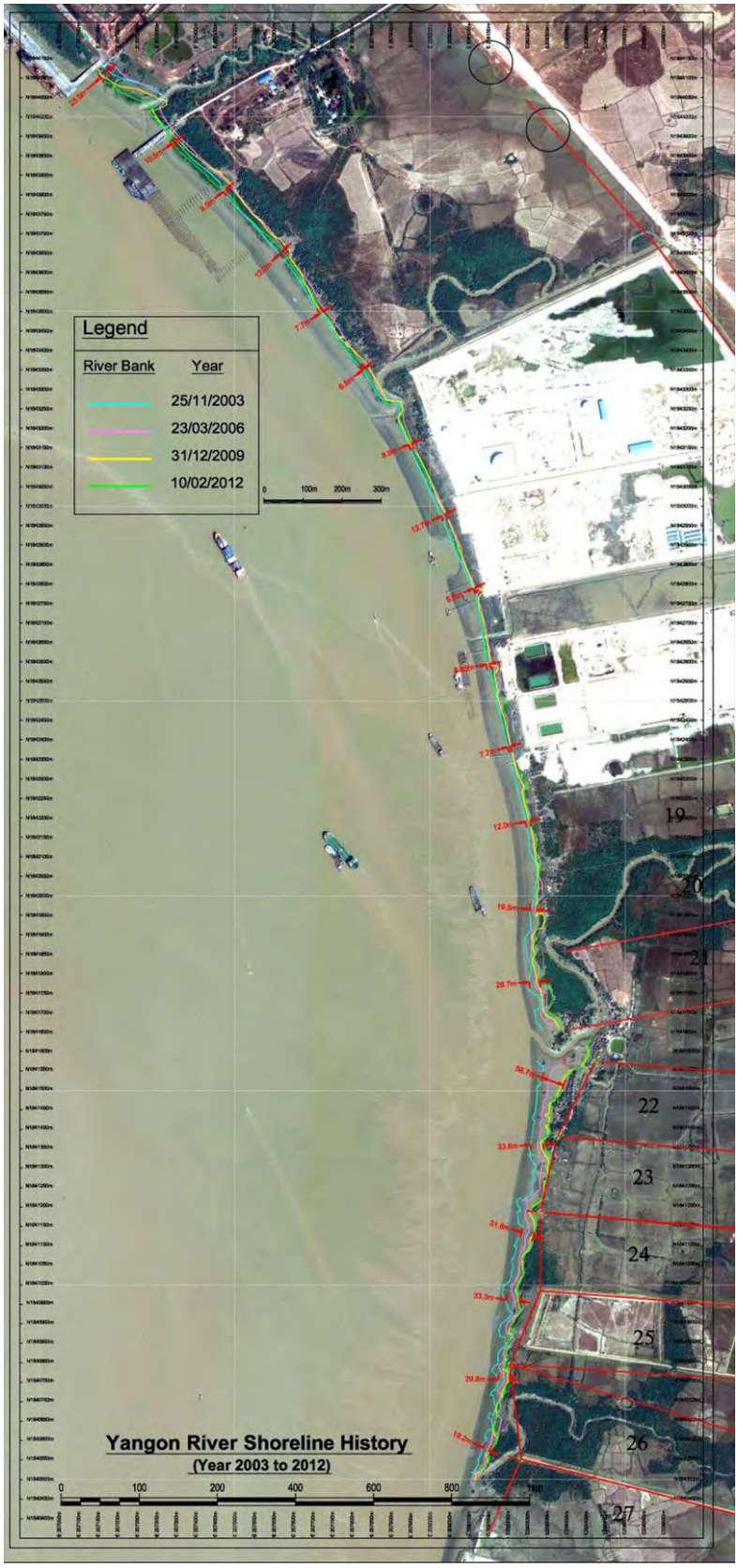


Figure 5.4-42 Longitudinal Profile of Navigation Channel along the Centerline

(1) River Bank Erosion and Accretion

1) Current Conditions

Comparison of river bank vegetation boundary line which can be considered to show the inclination of river bank erosion and/or accretion has been done by using the aerial photos presented by Google Map dated Feb. 2012, Dec. 2009, Mar. 2006 and Nov. 2003. Figure 5.4-43 shows the comparison of river bank vegetation boundary line change of Yangon Port in Thilawa Area. According to this figure, maximum erosion around 40m (=4m/year) during this period can be seen in front of Plot-24 and Plot-25. These erosion have occurred due to the inherent nature of river bank erosion which occur at the river elbow portion. On the other hand, rather stable condition of river bank vegetation area can be seen upstream from Block-20 to upstream of premise of MITT. Figure 5.4-44 and Figure 5.4-45 show the current conditions of river bank in front of Plot-24 and Plot-25 where river bank erosion and accompanied loss of vegetation area.



(Prepared by the Study Team)

Figure 5.4-43 Comparison of River Bank Vegetation Boundary Line

(Prepared by the Study Team)

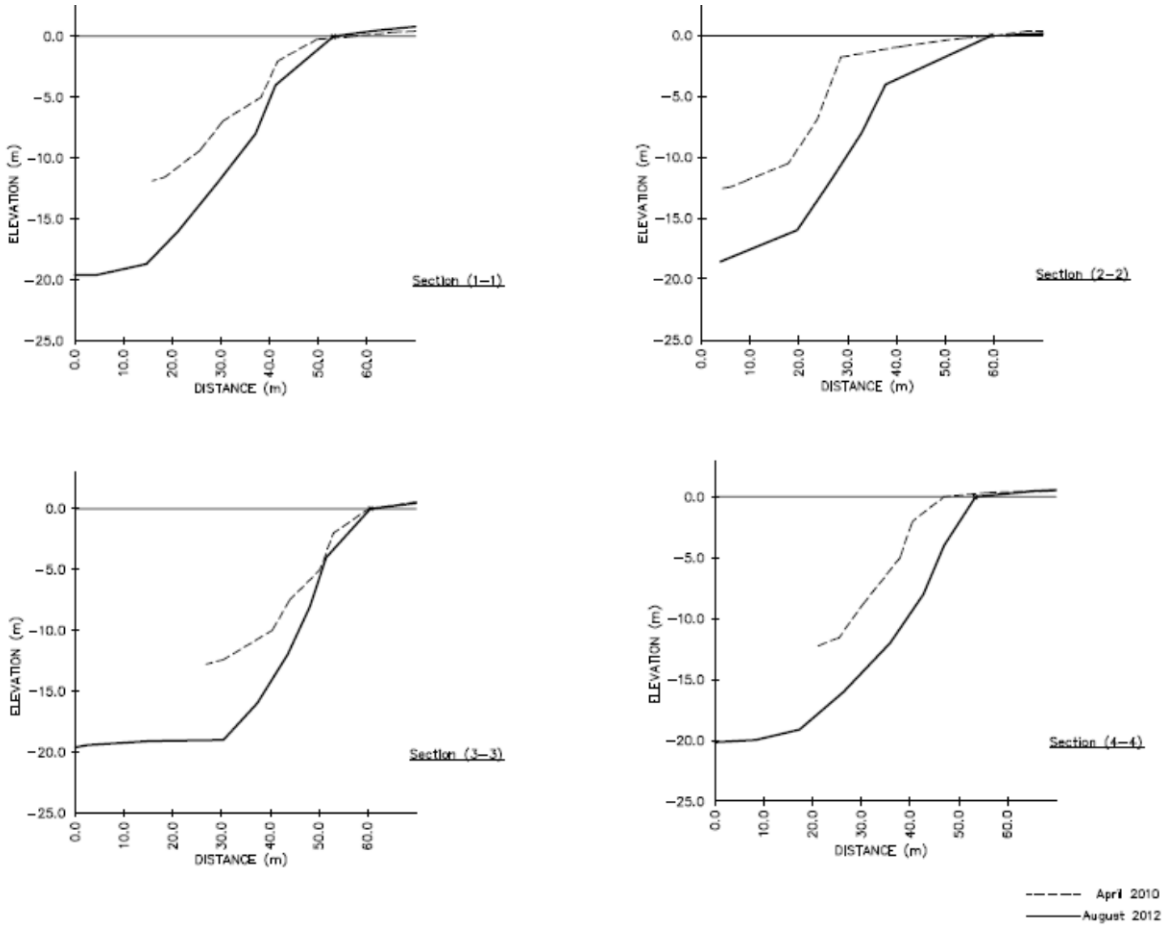
Figure 5.4-44 Current Condition of River Bank at Plot-24

(Prepared by the Study Team)

Figure 5.4-45 Current Condition of River Bank at Plot-25

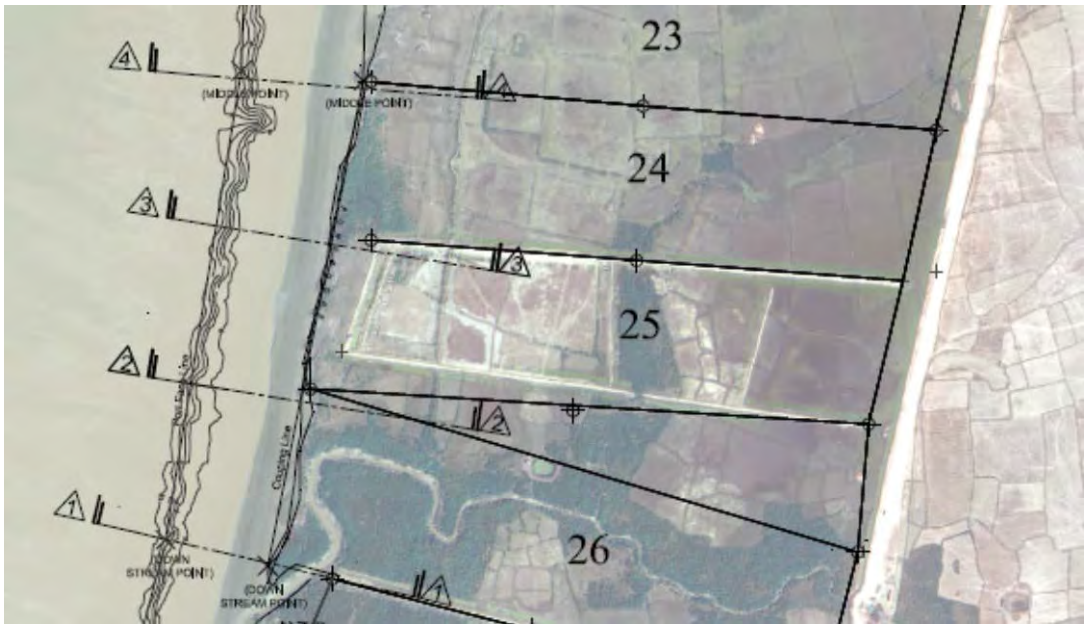
Comparison of bathymetric survey data has been also done by using the data of 2010 surveyed by MPA and Aug. 2012 by JICA Survey Team. Figure 5.4-46 shows the comparison of cross sectional profile of 4 locations between Plot-22 and Plot-26. Figure 5.4-47 shows the location of the cross sections.

According to these figures, steep slope of nearly 1:1 can be seen with water depth from CD+0.0 to CD-9.0m. Formation of this steep slope was due to the river flow erosion because the topographical characteristics of river elbow portion which are apt to suffer the inherent erosion. During the period of 2 years, maximum backward movement of 20m had been seen at Plot-25 which clearly indicates the necessity of countermeasures against erosion at this river elbow area.



(Prepared by the Study Team)

Figure 5.4-46 Comparison of Cross sectional Profiles at 4 lines



(Prepared by the Study Team)

Figure 5.4-47 Location of Cross Sectional Profiles Drawing

2) Effect of Construction of Detached Pier Structure along the River Bank

Detached type pier structure will play the role of spur dike structure which control the river flow and reduce the river flow by the existence of slap supporting piles in the water and contribute to the protection of river bank from erosion by river current. Reduction of river flow speed contributes the vegetation in the muddy land near the bank and the sedimentation between the detached berth and river bank. Figure 5.4-48 and Figure 5.4-49 show the current situation of MITT where the construction of detached pier had been done in 1997 and vegetation in the muddy flat and siltation behind the berth had been seen.

(Prepared by the Study Team)

Figure 5.4-48 Current Conditions behind the MITT Detached Pier

(Prepared by the Study Team)

Figure 5.4-49 Current Conditions behind the MITT Detached Pier

Effect of the construction of detached type pier structure to the adjacent river bank downstream and upstream were considered the same as was considered just behind the structure. River flow at the downstream and upstream of the structure will be affected by the existence of the structure and the river flow velocity near the river bank will be reduced. Stable river bank situations rather than the occurrence of erosion will be expected. Figure 5.4-50 shows the current situation of downstream of the MITT's berth structure where the vegetation in the muddy flat can be seen. Figure 5.4-51 shows the comparison of the plan view of both downstream and upstream area in 2003 and 2012 and Figure

5.4-52 shows the upstream area. In these figures, forward movement of the vegetation area were clearly seen.

(Prepared by the Study Team)

Figure 5.4-50 Current Conditions of Downstream Side of MITT's Berth

source: Google Earth

Figure 5.4-51 Comparison of Aerial Plan View of Downstream of MITT between Nov. 2012 (left) and Feb. 2003 (right)

source: Google Earth

Figure 5.4-52 Comparison of Aerial Plan View of Upstream of MITT between Nov. 2012 (left) and Feb. 200 3(right)

3) Countermeasures against Erosion

There are two categorized countermeasures for river bank erosion. One is to strengthen the river bank itself by employment of protection work such as riprap revetment and the other is the employment of the river flow control structure such as spur dike.

Employment of river bank protection work was expected to show the direct effect on protection of the river bank from erosion in a short time. On the other hand, employment of river flow control structure such as spur dike was expected to change the river flow magnitude along the river bank and flow patter change and the decrease of the river flow velocity eventually contribute the protection of river bank. Usually stable river bank conditions were expected by deployment of several consecutive spur dikes and significant period after the deployment of those structures were necessary for the realization of stable conditions. There are many past experiences of construction of spur dike in Japan from the era of Edo and the names of the structure are different at each local district.

As was mentioned before, maximum erosion of 4m/year at river bank vegetation area has been seen at Block-22 in Yangon Port in Thilawa Area and similar inclination of erosion was also seen in the bank of deeper section. This phenomenon was not due to the construction of detached pear structure near the site but is rather the natural phenomenon occurred due to the inherent river flow effects which are apt to occur at the river bend location.

Although the river current velocities will be reduced in some amount as was written in the previous section, protection work against erosion of the bank in the deeper section just under the structure should be employed. Rubble mound protection work which can resist the river current would be one of the possible counter measures. Rubble mound can also be worked as the countermeasures against local scouring around the slab supporting piles.

(2) Dredger

a) Dredger Design Requirement

i) Soil at Yangon River in the Vicinity of the Yangon Port in Thilawa Area

Soil survey has been done at seven (7) locations in the Yangon River, vicinity of the Yangon port in Thilawa Area. Locations and result of soil survey is shown in Figure 5.4-53 and Table 5.4-33.

Result of soil survey shows the soil is mainly silt and clay, and natural moisture content is approximately 60%.

Source: Google, Study Team

Figure 5.4-53 Locations of Soil Survey

Table 5.4-33 Result of Soil Survey

No.	Location	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Specific Gravity	Natural Moisture Content (%)	Soil Type
ST1	N16°40'59.2" E96°13'59.09"	37.0	61.0	2.0	0.0	2.69	56.42	Silty clay loam
ST2	N16°39'36.0" E96°15'08.0"	21.5	76.5	2.0	0.0	2.67	69.44	Silty loam
ST3	N16°38'00.9" E96°15'28.08"	33.5	65.5	1.0	0.0	2.69	61.2	Silty clay loam
ST4	N16°36'54.04" E96°15'28.08"	36.5	61.5	2.0	0.0	2.67	61.73	Silty clay loam
ST5	N16°39'38.0" E96°14'21.0"	56.0	43.0	1.0	0.0	2.70	51.14	Silty clay

(Prepared by the Study Team)

ii) Maintenance Dredging Volume

MPA has been dredging Monkey Point (Inner Bar) and Elephant Point (Outer Bar) by four (4) units of Trailing Suction Hopper Dredger shown in Table 3.4-6. Total annual dredging volume is 2.4 million m^3/year and average dredging volume is estimated approximately 0.6 million m^3 /year per one (1) dredger.

iii) Hopper Capacity

Based on the assumption of 330 operation days per year, five (5) cycle dredging per day and 0.30-0.35 loading factor per hopper capacity of 1,000m^3, one (1) dredger's dredging capacity will be approximately 495,000-578,000m^3, which is nearly equal to present average dredging volume of 600,000m^3 per dredger.

Since the dredging volume for maintenance of the navigation channel of Outer Bar of the Yangon Port in Thilawa Area is 0.4 million m^3/year. The dredging volume for maintenance of navigation channel centered on Elephant Point the hopper capacity of 1,000m^3 will be suitable for the same operation at Monkey Point since the hopper will be fully loaded by two (2) suction pumps of capacity of 3,000-3,300m^3 in half an hour by a dredging speed of 2-3knots for 1.6miles of one (1) line.

iv) Deployment Plan

Necessary maintenance dredging volume at navigation channel at Outer Bar for the Yangon Port in Thilawa Area is 0.2-0.4 million m^3 will be dredged by same size of present dredger with a hopper capacity of 1,000m^3. As four (4) dredgers have been dredging at Monkey Point and Elephant Point with amount of 2.4 million m^3 of total annual dredging volume, maintenance dredging amount of 0.4 million .m^3 volumes for navigation channel to the Yangon Port in Thilawa Area can be done by present dredgers. For this operation, good repair and maintenance is necessary for four (4) dredgers. As two (2) aging dredgers out of these four (4) dredgers is 23 years old, and shall be considered for replacement in the near future.

v) Ship Model

Required functions and performance for planned dredger is maintenance dredging for navigation channel and high maneuverability to avoid collision with ships in the dredging are during dredging operation.

Considering these functions and performance as well as dredging capacity and operation system suitable for the Yangon River, same model as present dredger, trailing suction hopper dredger, is most appropriate from the following point of view;

- New dredger can be operated easily by crew due to same main equipment and system with present dredger.

- Easy On-the-Job-Training for new crew by skilled crew.
- Reduction of operation and maintenance cost due to common spare parts and components.

vi) Outline of Dredger

Planned dredger shall be split type trailing suction hopper dredger, and shall dredge mud and sand on the bed of the river and sea. Dredger shall be of steel construction, propelled by two (2) units of controllable pitch propeller driven by diesel engine with twin (2) rudders.

Two (2) sets of suction pump driven by diesel engines shall be installed in the dredging pump room at fore part of the dredger and two (2) drug arm and head controlled by hydraulic system are equipped at both sides of dredger. Accommodation and engine room shall be located at aft side of ship and hopper of 1,000m3 shall be constructed at fore part of the dredger.

Registry	Yangon, Myanmar
Classification Society	Class NK
	NS* (Hopper Dredger, Coastal Service), MNS*
Length （Loa）	Approximately 68m
Length (Lpp)	Approximately 65m
Breadth (mld)	Approximately 14m
Depth (mld)	Approximately 5.15m
Draft (mld)	Approximately 3.85m
Deadweight	Approximately 1,650 t
Hopper Capacity	Approximately 1,000m3
Speed	Approximately 10 knots
Crew	28 Persons
Officer (Upper)	6 Persons
Officer (Lower)	5 Persons
Crew	7 Persons
Suction Pump	Approximately 3,300m3/hr x 16.5mTH x 2
Main Diesel Engine	Approximately 1,500PS x 2

Propeller Controllable Pitch Propeller x 2

5.4.5. Navigation Safety Planning

(1) Present Situation and Problem of Port Operations

1) Size restriction of vessels

As shown in Table 5.4-34 MPA restricts on the vessels calling at Yangon Main Port and Thilawa Area Port due to the narrow width and the shallow water depth of the Yangon river passage. Thilawa Area Port accommodates larger vessels than Yangon Main Port because the area is closer to the estuary of the Yangon River and the vessels calling at the port avoid Monkey Point Channel, the shallowest in Yangon river channel. In recent years, the size of vessels have been increasing rapidly and the typical draft of the large containers and tankers are 15m and 20m respectively. Furthermore, the typical LOA of the large vessels is 300m or more. Considering the trend towards the use of larger vessels, Yangon Port is regarded as limited in accessibility and the port for the middle and small size vessels.

Table 5.4-34 Size restriction on vessels in Yangon Port

Location	LOA	Draft（max）	DWT
Yangon Main Port	167m	Dry Season 8.5m Rain Season 9.0m	15,000
Thilawa Area Port	200m	9.0m	20,000

(Prepared by the Study Team)

2) Channel and Navigation Aids

In the navigation channel from the mouth of the Yangon River to Thilawa Area Port, there are buoys set around Elephant Point and Monkey Point to help large ships navigate safely. Meanwhile, other channels have a limited number of navigation buoys.

The area where the depth of the water is enough for a large vessel to access is illustrated by the white on the chart (BA833). Can be seen on the chart, the channel is narrow and winding. As Thilawa Area Port is 31 miles far from the pilot station at the mouth of the Yangon River, it usually takes four hours from the pilot station where a pilot gets on board a vessel to berth.

Due to the shallow water depth of the channel, only vessels with 9 meters draft are accessible during high water and tide.

A critical problem of the channel is the absence of Vessel Traffic Management System (VTMS) such as ENC, AIS and SSB, and the deficiency of hardware such as buoys, leading lights, lighthouse, and radar. For the safety navigation in the channel, it is urgent to improve the port facilities and equipments.

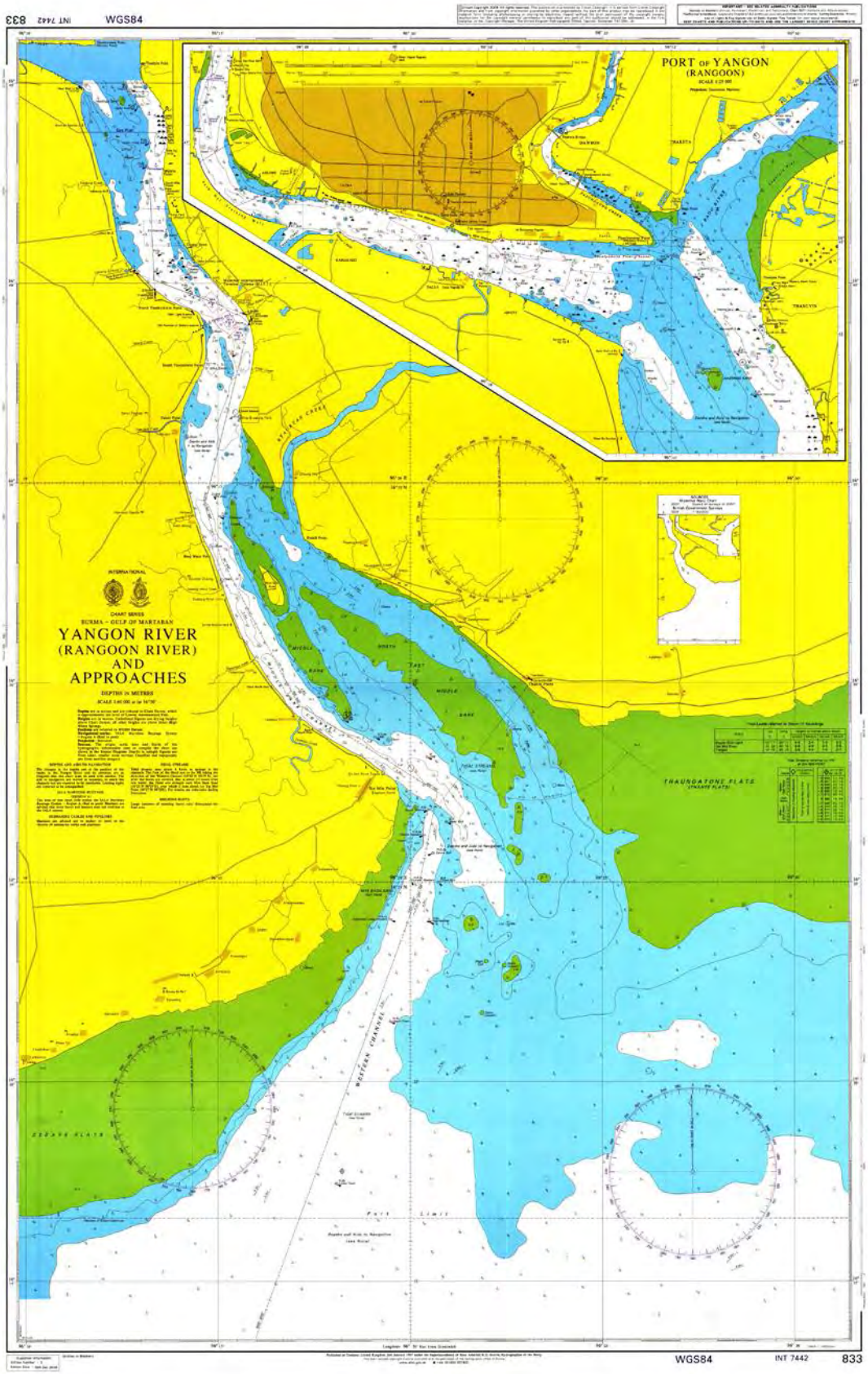


Figure 5.4-54　Yangon River（BA833）

3) Channel Dredging

MPA possesses 4 dredgers as shown in Table 3.4-6 and conducts bathymetry surveys.

In Monkey Point Channel, the survey is conducted every week and dredging is being executed everyday to keep the area's water depth of 13.5 feet. Dredging location, target depth and frequency are indicated in Table 5.4-35. MPA also monthly measures the depth of Western Channel off the Elephant Point.

Table 5.4-35 Dredging Location and frequency

No.	Location	Target Depth(Feet)	Frequency	Dredger Type
1	Monkey Point Channel	13.5	Everyday (Dry Season: Day &Night)	Trailing Suction Hopper Dredger
2	Yangon Port (Foreshore area)	5 - 12	Occasionally	Grab & Hopper Barge
3	Thilawa Port (Front of berth)	>30	Occasionally	Grab & Hopper Barge
4	Middle Bank Channel	Nil		
5	Western Channel (Elephant Point)	Nil		
6	Outer Bar	Nil (>15)	Occasionally (1 ~ 2 year interval)	

Source: MPA

The problems regarding channel dredging in Yangon Port are taking countermeasures to siltation in Monkey Point Channel, maintaining and dredging in Thilawa Area Port where the further development is expected, and MPA's two dredgers which have been used for the past 23 years and needs to be replaced.

4) Natural Environment of the Channel

The natural conditions of the navigation channel in Yangon River is as follows.

- Sea Level： Average 19.3 feet (5.85 m)

  Minimum 8.4 feet (2.55 m)
- Current speed：4~6 knots
- Wave Height： 2m or less

Source:MPA

5) Wind and Weave in Outer Bar

Because Outer Bar where the pilots get on board and off the vessels is open sea, wind swell in the area is larger than in the navigation channel. Though the natural condition around Outer Bar has

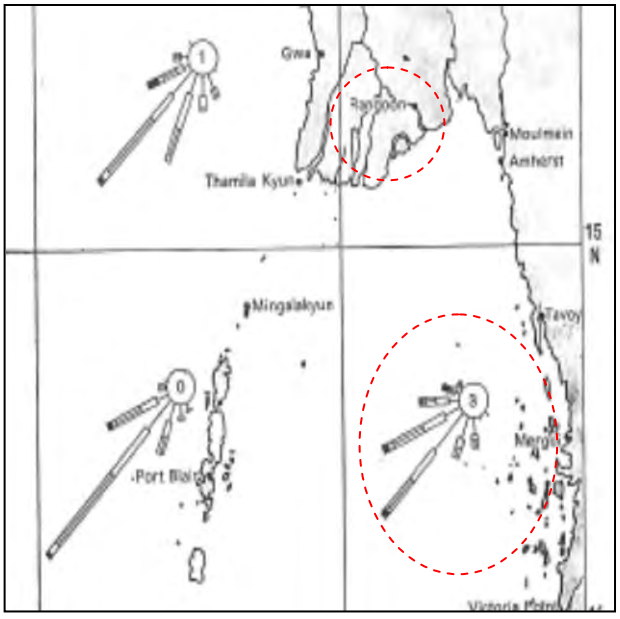
not been precisely observed yet, Admiralty Sailing Direction “Bay of Bengal Pilot” provides the following wind condition observed in the Bay of Bengal including Off Yangon during southwest monsoon season, July (Figure 5.4-55)

The arrows on the Figure 5.4-55, depicted in the west of Mergui, 180 miles south of the pilot station at Outer Bar represent wind directions and their frequencies. The percentage of the southwest wind and the west-southwest wind is 37% and 25% respectively. Table 5.4-36 shows the wind speed and wave height with their frequency. (beaufort wind scale).

Table 5.4-36 Beaufort Wind Scale in the West of Mergui (July)

Scale	Speed(m／sec)	Wave Height(m)	Frequency
1-3	0.3～6	0～1	35%
4	6～8	1～2	27%
5-6	8～13.8	3～4	28%
7	13.9～17.1	4～5.5	3%
8	17.2～20.7	5.5～7.5	7%

Source:Bay of Bengal Pilot



Source : Bay of Bengal Pilot

Figure 5.4-55 Winds distribution of Bengal Bay July

6) Pilot Service

Pilot Service is one of the most important services provided by Marine Department. Stop of the pilot services due to, for instance accidents at sea, strong wind or high waves, will result in the port close and no vessel will be allowed to move through Yangon Port. The present condition of pilot service in Yangon Port is following.

- The Number of Pilots：34　(increased from 24 in 2009)
- Pilot Service：For vessels of 200 GT or larger, pilotage is compulsory

It usually takes 3 to 4 hours to travel from the pilot station at Outer Bar to the berth in Thilawa Area Port, 4 to 5 hours from the berth in Thilawa Area Port to the pilot station. The problems of pilot service involve with the pilot vessel and the pilot boat. The pilot vessel is anchored at all time at the pilot station. Despite the great importance of providing services to arriving and departing vessels, the pilot vessel is small and aging. Furthermore, the pilot boat, which has been used to take a pilot to an arriving and departing vessel, is so small (LOA 5m) that it cannot embark and disembark a pilot when the wave height reaches 2m or higher. Can be seen in Table 5.4-36, 44% (27/2+28+3%=44.5%) or more waves are higher than 1.5m during the monsoon season. The countermeasures to the high waves, therefore, must be taken so that the safety pilots services are secured. As countermeasures, it should be considered replacing the pilot vessel by a fixed pilot station at Outer Bar, and preparing a large pilot boat or a helicopter.

Figure 5.4-56　Pilot Boat

Figure 5.4-57　Pilot Vessel

(2)　Navigation Channel in Yangon River

1)　Present Situation

In Yangon Port, pilots engage in both navigating in the channels in Yangon River and berthing/unberthing. Pilotage for deep draft vessels are provided only on flood tides. The distance between the pilot station at Outer Bar and Yangon Main Port is 42 miles (64km), while the distance between the pilot station and Thilawa Area Port is 31 miles and 10 miles shorter than the former rout, thus making the travel time one hour less. On the way to Thilawa Area Port from the pilot station, all vessels pass through Western Channel and Middle Bank Channel, which are both narrow routs.

As shown in Figure 5.4-58, Western Channel requires extreme caution in traveling. The channel width is 500m at a minimum, and the tide current is 4 to 5 knots. In addition, the course sharply turns

and it is approximately 70 degrees. In this part of the channel, there are a number of fishing boats. For the safety navigation, MPA restricts the channel to a one-way traffic rout. Also there are 8 buoys on the passage between Additional Lower Western buoy and Upper Western buoy off the Elephant Point. The four buoys with green light are set on the right while another four buoys with red light on the left, facing the river head. The combination of the light colors with the direction is opposite to the colors in Japan.

Myanmar is categorized as "A area" of IALA buoy system, that the combination of the light colors with the direction is opposite to the colors in Japan. Survey team confirmed that all buoys are normally lighted up (Nov. 10th , 2012). Though, these are so aging that lost their colors. At present, it is difficult to discriminate red or green buoys during the day. They are being bald and difficult to be recognized during daytime. In the navigation safety perspectives, MPA is required to conduct bathymetric survey and give concise information on water depth for a pilot and vessels, establish aids to navigation such as buoys and lighthouse, introduce VTMS that enables vessels to navigate during nighttime.

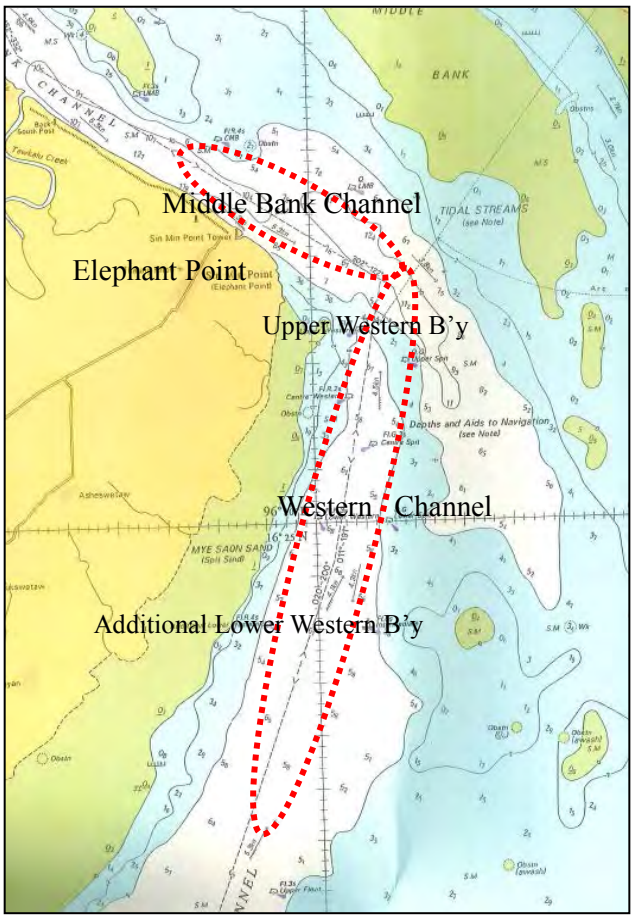


Figure 5.4-58 Western Channel (BA833)

2) Berthing and Unberthing at Yangon Port

Figure 5.4-59 shows the typical patterns for berthing at Yangon Port. Tug boats are applied for

berthing and unberthing for large size vessels. In berthing at Yangon Port, a vessel usually sets her head against the current. The speeds of the current around the port area, though they are varied by seasons, are more than 2 knots and strong enough to affect the difficulty of the ship handling.

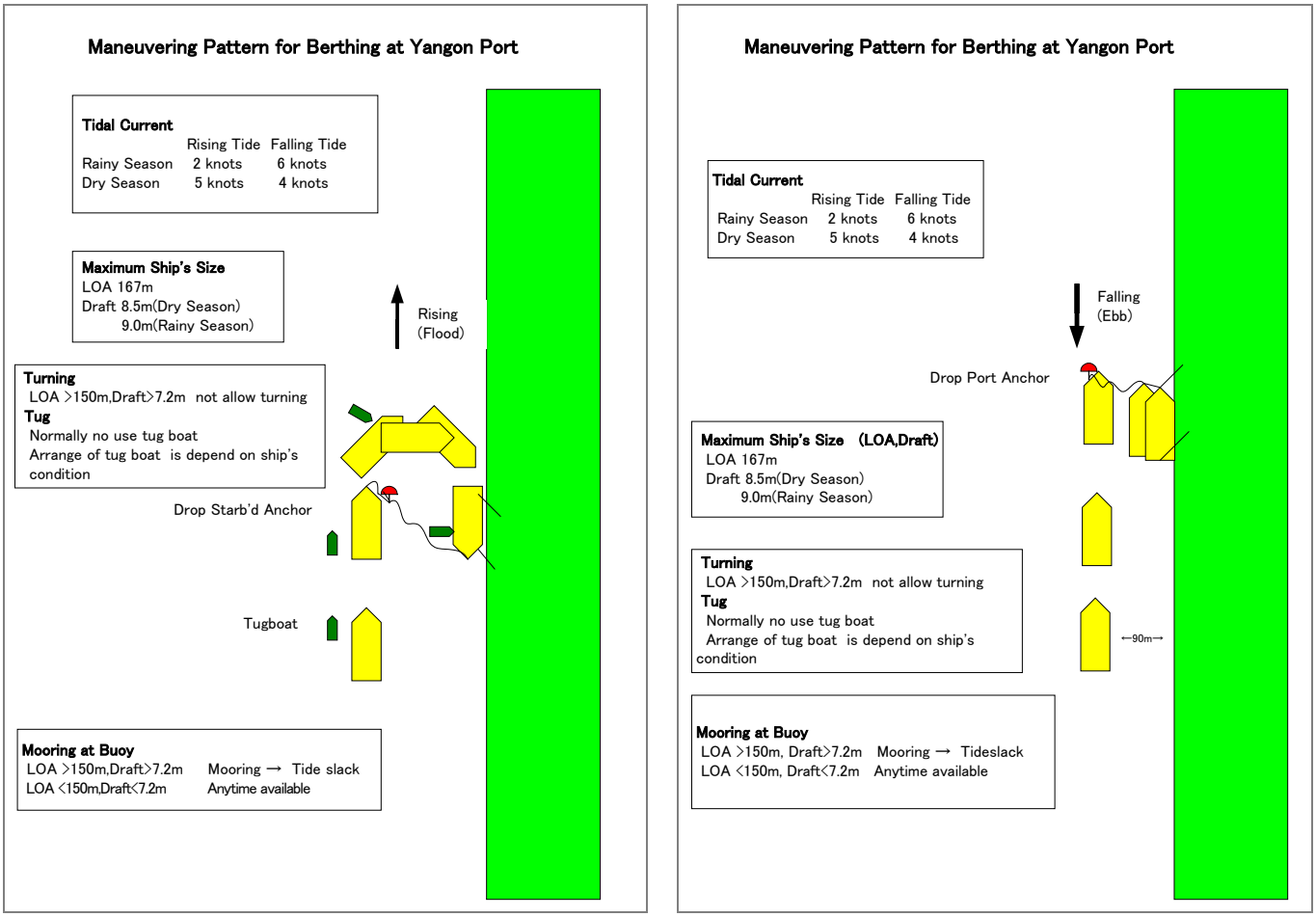


Figure 5.4-59 Typical ship maneuvering for berthing at Yangon Port（flood and ebb）

(3) Field Survey of Vessels Entering Yangon Port

In order to capture the conditions (e.g. movement, draft, etc) of the vessels calling at Yangon Port, relating documents and information were gathered, collected, and analyzed through the field survey. Objectives and subjects of the survey are as follows.

1) Objectives of Survey

This study was undertaken to gain following information on vessels calling at Yangon Port.

- Navigation status of vessels (waiting in the offing, time from the pilot station to the berth, and laytime at the berth)
- Navigation time (navigation after pilot on board -> day or night, rising and falling tide)
- Gross tonnage

- Draft (Mean Draft, 9m or more)

2) Subjects of Survey

- The study area was divided into three, Yangon Main Port, Thilawa Area Port and Yangon Port, the entire area of Yangon Main Port and Thilawa.
- The names, gross tonnage, draft of vessels entering Yangon Port and the berth they used
- Navigation status of vessels and natural condition
  - Time of arriving out of the port, time of embarking a pilot, time of berthing and unberthing, time required to shift from one buoys to another
  - Time when vessels enter and depart from a port (daytime/nighttime)
  - Tidal Current in Entering and Departing Port (flood or ebb)
- The survey was conducted from the time when the pilot boarded in August 1st 2012 till the time when the pilot boarded in September 4th
- Data source: MPA Shipping Agency Department

Procedure of Survey

The project team made data matrix and finalized the format based on the discussion with MPA's Shipping Agency Department. The data necessary for the survey were provided by MPA and then analyzed by the project team.

3) Results of Survey

a) Number of Surveyed Vessels

During the one month of survey, 129 vessels were surveyed in Yangon Main Port, while 26 vessels in Thilawa Area Port, and it totaled up to 155. Domestic vessels and vessels in the sea around Yangon were excluded. The data considered irregular or inappropriate for the analysis were removed. As a result, the number of samples applied to the analysis may be varied in respect to the subjects of the survey.

b) Navigation Status

Although the original plan intended to trace the time of each vessel arriving at outside of the port, embarking a pilot, arriving at a berth, departing, and disembarking a pilot, when the field survey was executed, it was found that the available data excluded the time in respect to arriving at outside of the port and disembarking a pilot. Furthermore, it was found the available data included some recording failures and they were removed from the data set for analysis. Consequently, the data

analysis is based on the currently available and effective data.

c) Subjects of Analysis

a) The study area was divided into two, Yangon Main Port and Thilawa Area Port. The area comprising both areas was named Yangon Port.

b) Waiting in offing (the time waiting for a pilot get on board after the vessel arrives outside a port)

c) The period time between embarking a pilot and arriving at a berth

d) The period of time between berthing and unberthing (laytime)

e) The period of time between arriving outside the port and unberthing (duration of stay in a port)

d) Results of Analysis

i) Summary

Table 5.4-37 Navigation of Vessels in Yangon Port（Aug. 2012）

Area	Item	Outer Bar－Pilot (A-D)		Pilot－Berth (B-A)		Berth－Sail (C-B)		Outer Bar－Sail (C-D)	
		Hour	Days	Hour	Days	Hour	Days	Hour	Days
Yangon Main Port	Average	53.3	2.2	7.2	0.3	97.1	4.0	147.3	6.1
	Maximum	609.8	25.4	72.9	3.0	694.0	28.9	841.3	35.1
	Minimum	0.0	0.0	0.8	0.0	15.4	0.6	5.1	0.2
	Nos. of Vessels	114		124		120		108	
Thilawa Area Port	Average	96.0	4.0	9.0	0.4	95.5	4.0	186.8	7.8
	Maximum	670.7	27.9	126.5	5.3	424.5	17.7	1095.9	45.7
	Minimum	0.0	0.0	0.4	0.0	15.5	0.6	27.5	1.1
	Nos. of Vessels	26		26		25		25	
Yangon Port	Average	61.2	2.6	7.5	0.3	96.8	4.0	154.7	6.4
	Maximum	670.7	27.9	126.5	5.3	694.0	28.9	1095.9	45.7
	Minimum	0.0	0.0	0.4	0.0	15.4	0.6	5.1	0.2
	Nos. of Vessels	140		150		145		133	

A:Pilot on board Time B:Berthing Time C:Sailing Time from Berth D:Arraived Time at Outer Bar

ii) Frequency Analysis

Based on the Table 5.4-37, the time in each period and the number of corresponding vessels are

shown graphically as follow.

- Waiting in offing (the time waiting for a pilot get on board after the vessel arrives outside a port)

Yangon Main Port

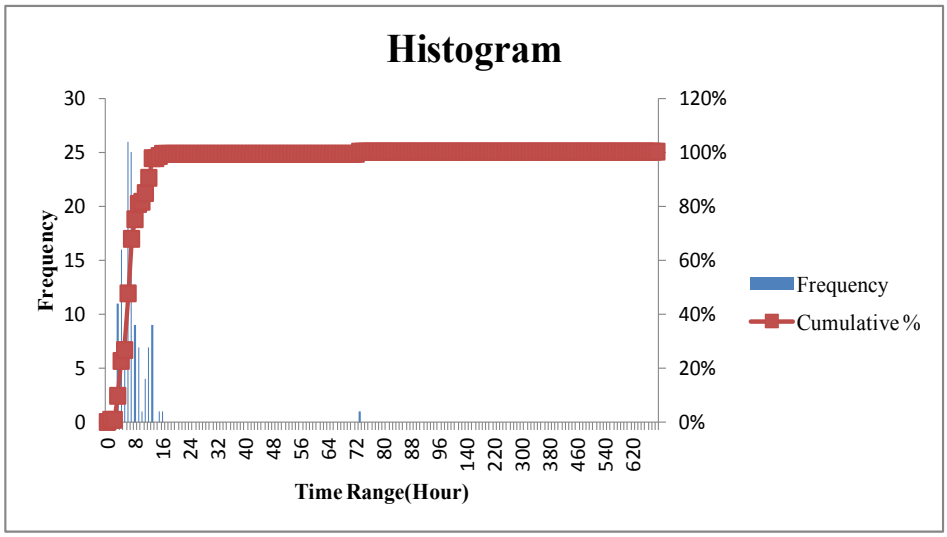


Figure 5.4-60 Yangon Main Port

It was found that 99% of a sample of 144 vessels waited 16 hours or less in offing. The Mode of the data is 6 hours and the number of vessels in the range is 26. The second largest range shows 7 hours and the number is 25. The waiting time is considered spent for the time waiting for the high tide after arriving at Outer Bar.

Thilawa Area Port

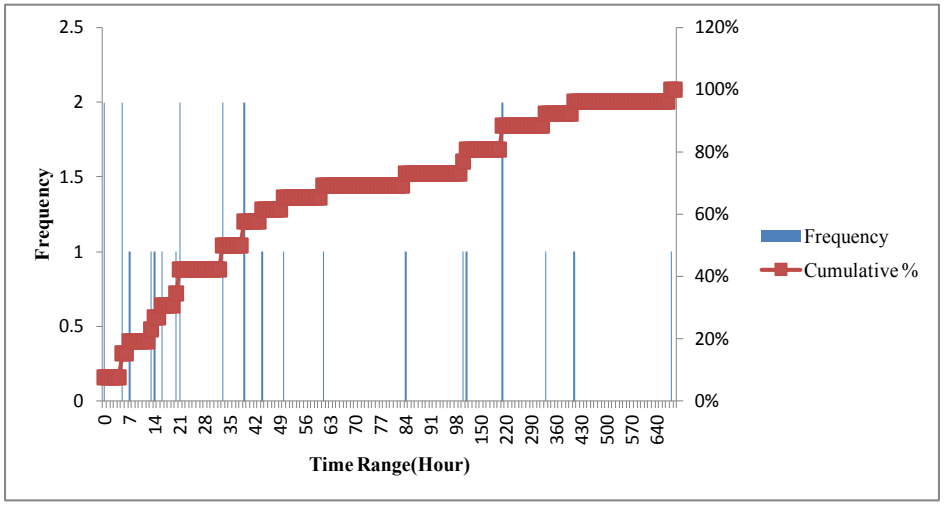


Figure 5.4-61 Thilawa Area Port

It shows that a vessel calling at Thilawa Area Port was more possible to wait in offing longer than in Yangon Main Port. Although the sample number is relatively small (26), it is shown that some

vessels waited 670 hours (28days). It is considered that the extraordinary wait time is caused by the problems of the vessels or their shipping operators.

Yangon Port

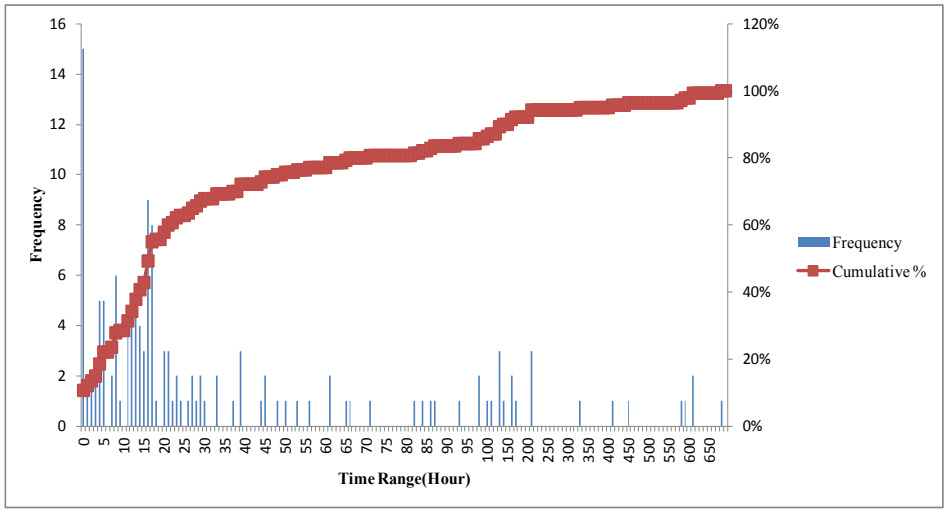


Figure 5.4-62 Yangon Port

It was found that 60% of a sample of 140 vessels waited 21 hours or more. It is considered that the time waiting for the high tide and the prohibition of the night time navigation would be the main cause of the long wait time.

- The period of time between berthing and unberthing (Berthing time)

Yangon Main Port

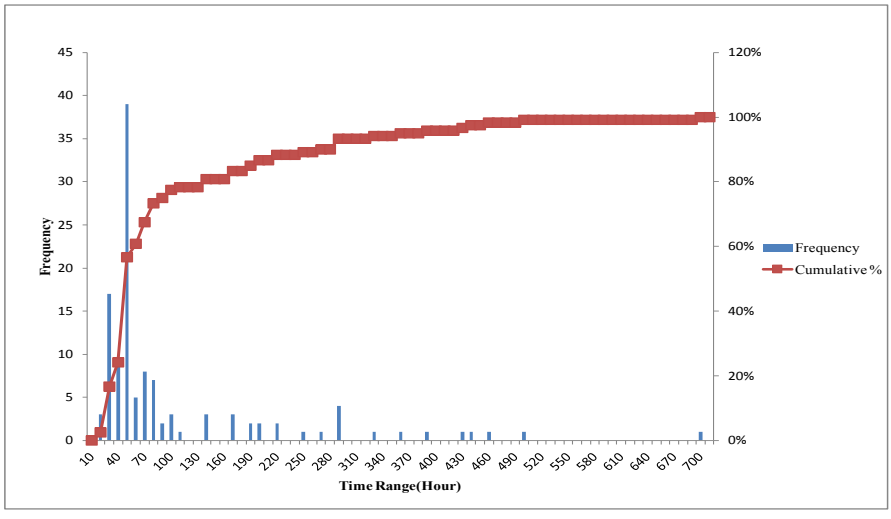


Figure 5.4-63 Berthing time (Yangon Main Port)

The time between berthing and unberthing is assumed to be spent for cargo handling after berthing a vessel. It was found that 75% of a sample of 110 vessels waited 140 hours (5.8 days) or less.

The mode of the data was 70 hours and the number of the vessels in the range was 18. Although the size allowance was relatively small (15,000 DTW), the period of berthing time was relatively longer.

Thilawa Area Port

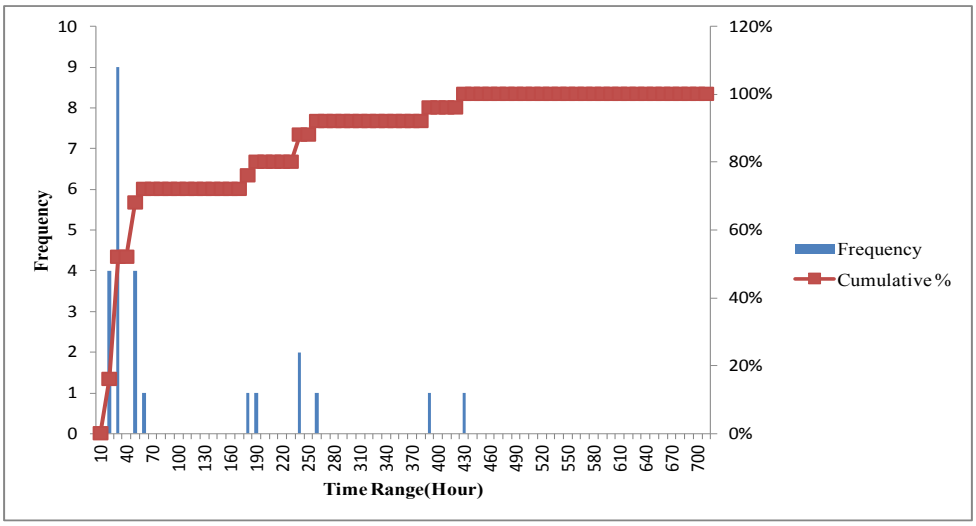


Figure 5.4-64 Berthing time (Thilawa Area Port)

Although the number of a sample was relatively small (24), it was found that 9 vessels, 4 vessels, and 4 vessels waited for 30, 20, and 50 hours respectively. The berthing time is relatively short. There would be two reasons to be considered, which are that the size allowance is larger than the size in Yangon main port and that the vessels are mainly RO/RO vessels such as container and car carrier vessels.

Yangon Port

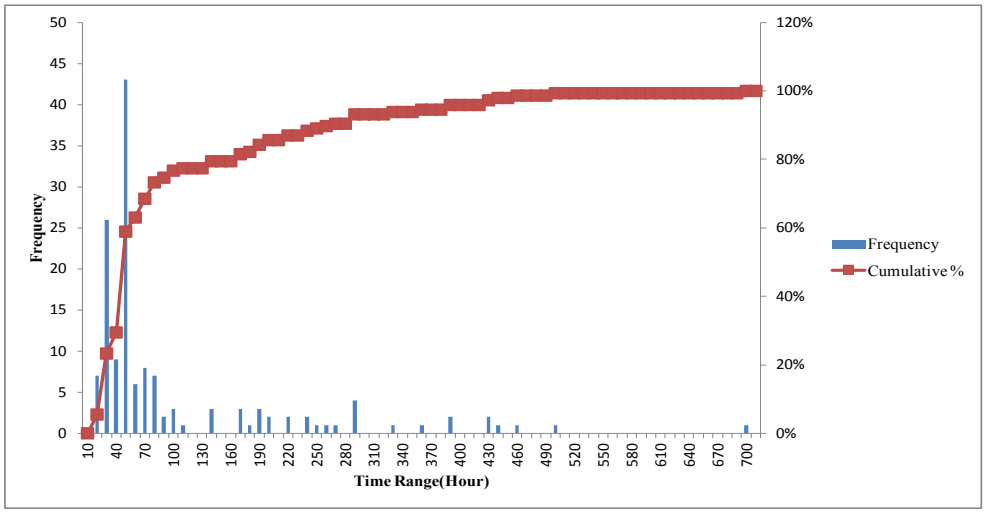


Figure 5.4-65 Berthing time (Yangon Port)

The mode of the data, a sample of 145 vessels, was 50 hours (2.1 days) and the vessels in the range were 43. In the second largest group, the berthing time was 30 hours and the number was 26. It also shows that the 76.7% of vessels waited for less than 100 hours (4.2 days)

- The period of time between arriving outside the port and unberthing (duration of stay in a port area)

The following analysis supposes that the period of time of a vessel staying in Yangon Port is equivalent to the period of time between the vessel's arriving outside the port and unberthing, which includes the time spent for waiting a pilot, navigating to its destining port, birthing, loading, unloading, and departing from the berth.

Yangon Main Port

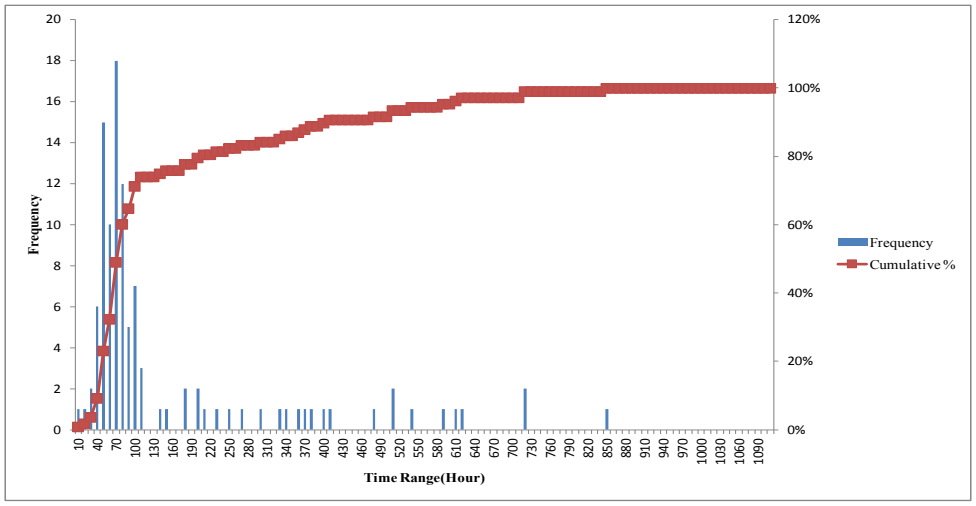


Figure 5.4-66 Duration of Stay in a Port (Yangon Main Port)

It was found that 71.3% of a sample of 108 vessels, which was 77 vessels, stayed in the port area for 100 hours (4.2 days) or less in the port area. The Mode of the data was 70 hours (2.9 days) and the number of the range was 18.

Thilawa Area Port

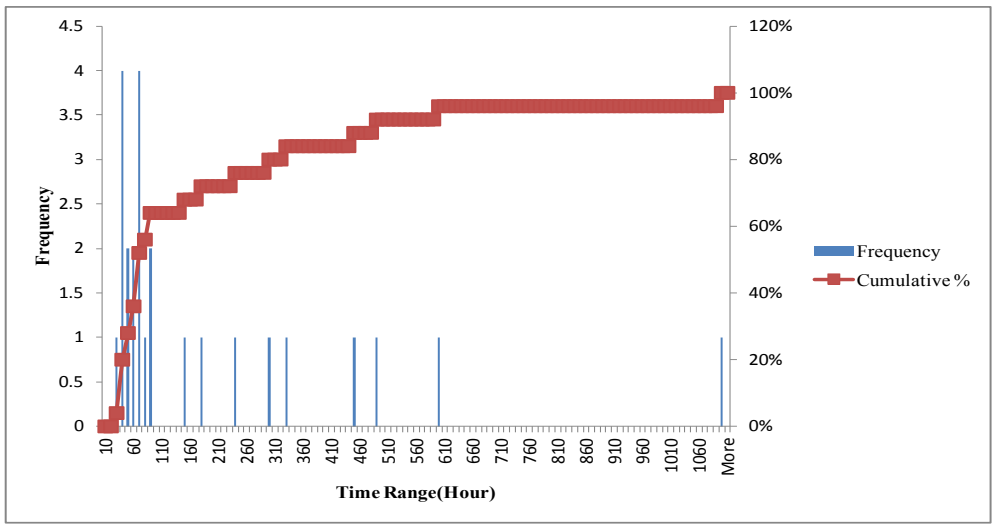


Figure 5.4-67 Duration of Stay in a Port (Thilawa Area Port)

It was found that 64 % of a sample of 24 vessels, which was 16 vessels, stayed in the port area for 90 hours (3.8 days) or less. There were two Mode of the data, which were 40 and 70 hours. The number of vessels in the ranges was 4. The duration of stay in Thilawa Area Port is shorter than the duration in Yangon Main Port. Two characteristics of the vessels calling at the port are considered to contribute to the duration reduction. One is the larger size allowance of the vessels. It reduces the number of calling vessels and is considered to reduce the time vessels waiting for berth. The other is that the portion of container vessels and Pure Car Carriers (PCC) is larger than the portion in Yangon. It reduces the average loading and unloading time and contributes to reduce the time vessels waiting for berth.

Yangon Port

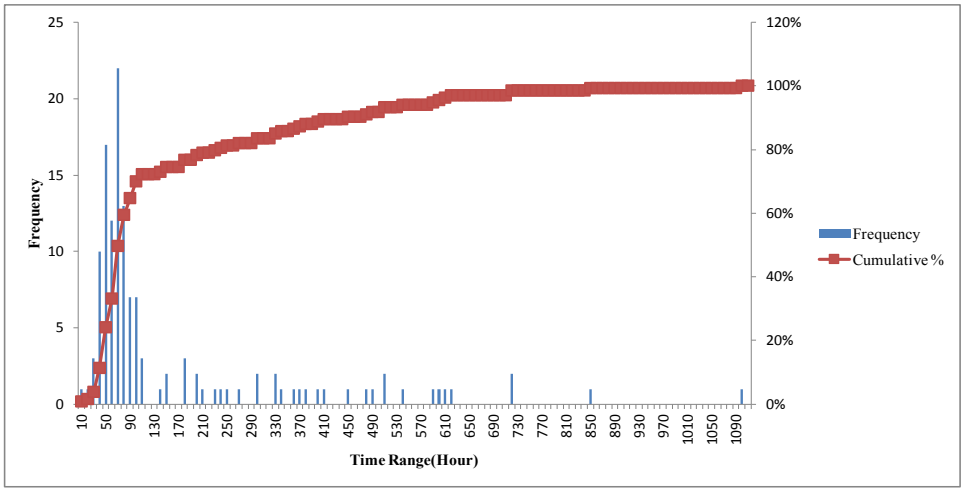


Figure 5.4-68 Duration of Stay in a Port (Yangon Port)

It was found that 69.9 % of a sample of 133 vessels stayed in the entire Yangon port area for 100 hours or less. The mode of the data was 70 hours (2.9 days) and the number of vessels in the range was 22.

- Time for Entering and Departing a Port

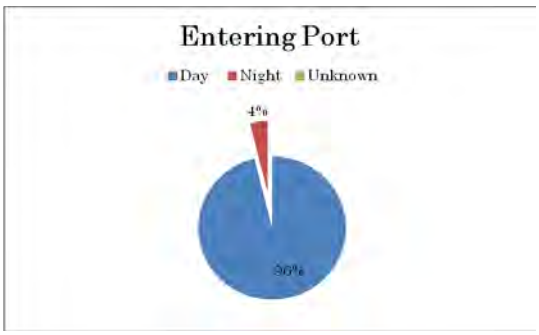
The following report shows the number of the vessels entering and departing from Yangon Port and Thilawa Area Port with their navigation time respectively. The objective here is to gain an understanding of port entry during nighttime. In this survey, the daytime is supposed to be the time between 5:30 and 18:00 and the night time is supposed to be the time between 18:00 and 5:20 respectively although sunrise and sunset time are varied by seasons.

- Time of Entering Port（Yangon Port）

Day Time/Night Time	Nos.of Vessels
Day	95
Night	57
Unknown	3
Total	155

- Time of Entering Port (Thilawa Area Port）

Day Time/Night Time	Nos.of Vessels
Day	25
Night	1
Unknown	
Total	26



61% (95 vessels) and 37% (57 vessels) of a sample of 155 vessels entered Yangon Port during daytime and nighttime respectively. Meanwhile, 96% (25 vessels) of a sample of 26 vessels entered Thilawa Area Port during daytime although only one vessel entered during nighttime.

- Time of Departing Port（Yangon Port）

Day Time/Night Time	Nos.of Vessels
Day	144
Night	5
Unknown	6
Total	155

- Time of Departing Port（Thilawa Area Port）

Day Time/Night Time	Nos.of Vessels
Day	25
Night	0
Unknown	
Total	25

93% of a sample of 155 vessels (144 vessels) departed from Yangon Port during daytime although only 5 vessels (3%) departed during night time.

➢ Gross Tonnage of the calling vessels

Table 5.4-38 shows the gross tonnage of vessels entering Yangon Main Port, Thilawa Area Port, and Yangon Port. The average tonnage of the vessels that entered Thilawa Area Port was approximately twice larger than the average of Yangon Main Port.

Table 5.4-38 Gross Tonnage of Entering Vessel

Area	Item	Gross Tonnage
Yangon Main Port	Average	6,601
	Maximum	17,736
	Minimum	1,297
	Nos. of Vessels	123
Thilawa Area Port	Average	14,080
	Maximum	43,810
	Minimum	2,986
	Nos. of Vessels	26
Yangon Port	Average	7,906
	Maximum	43,810
	Minimum	1,297
	Nos. of Vessels	149

➢ Draft of the vessels calling at Thilawa Area Port

Table 5.4-39 shows the average, maximum and minimum drafts of the vessels calling at Thilawa Area Port. The maximum draft for entering and leaving were 8.9m and 8.8m respectively.

Table 5.4-39 Drafts of vessels calling at Thilawa Area Port

	Entering		Departing	
	Fore Draft	Aft Draft	Fore Draft	Aft Draft
Average	5.8m	6.8m	4.9m	6.2m
Max	8.4	8.9	7.5	8.8
Min	3.8	4.8	2.4	4.3

- Tidal Current in Entering and Departing Port

Table 5.4-40 shows that the tidal conditions and their corresponding time of the vessels entering and departing from Thilawa Area Port. 23 of the 25 sampled vessels embarked a pilot at Outer Bar in flood when they entered the port. Meanwhile, 8 and 17 of the 25 sampled vessels embarked a pilot in food and ebb respectively when they departed from the port.

Table 5.4-40 Drafts of ships entering and departing from Thilawa Area Port

	SHIP'S NAME	Draft(m) Entering		Pilot Onboard Date/Time	Flood /Ebb	HW/LW	Draft(m) Sailing		Sailing/Shifting Date/Time	Flood /Ebb	HW/LW
		Fore	Aft				Fore	Aft			
1	GENIUS STAR X	4.5	6.3	2012/8/28 11:12	↑	HW13:05	4.0	5.9	2012/8/29 15:30	↓	LW22:47
2	CHAO ANOMA	6.0	6.5	2012/8/29 11:40	↑	HW13:05	2.4	4.4	2012/8/30 16:30	↓	LW23:39
3	ASIAN LEADER	5.3	6.0	2012/8/17 12:24	↑	HW15:15	5.2	5.9	2012/8/18 10:00	↓	LW12:18
4	DELPHNIUS	6.2	6.4	2012/8/19 14:20	↑	HW16:22	5.5	6.2	2012/8/21 12:00	↓	LW14:16
5	CHAO ANOMA	6.2	6.2	2012/8/19 11:35	↑	HW16:22	2.4	4.3	2012/8/20 14:00	↓	LW13:36
6	POSITIVE PIONEER	8.4	8.4	2012/8/25 5:30	↑	HW08:30	7.5	7.8	2012/8/27 13:30	↓	LW20:28
7	A HANDY	4.3	5.9	2012/8/5 12:00	↓	LW12:11	6.0	7.0	2012/8/13 11:00	↑	HW13:15
8	BANGLAR MOOKH		5.6	2012/8/11 17:18	↑	HW22:39			2012/8/29 10:30	↑	HW14:51
9	PAC STAR		8.8	2012/8/12 8:35	↑	HW11:00			2012/8/22 12:30	↓	LW14:55
10	ATTAR		6.1	2012/8/16 9:30	↑	HW14:43				↓	
11	CHOLLADA NAREE		6.0	2012/8/21 3:00	↑	HW05:22		5.5	2012/8/28 14:30	↓	LW21:45
12	BANGLAR MONI		5.4	2012/8/22 16:00	↑	HW18:19		8.8	2012/9/7 15:30	↑	HW20:08
13	IPANEMA		8.8	2012/8/30 15:00	↓	LW21:49		5.6	2012/9/9 14:30	↓	LW16:31
14	AN XIN JIANG		8.4	2012/8/27 14:30	↓	LW18:43		5.4	2012/9/7 8:30	↓	LW15:12
15	BRILLIAXIT	7.5	8.5	2012/8/3 11:54	↑	HW16:08	7.3	8.1	2012/8/4 11:00	↓	LW13:15
16	OCEAN WINNER	6.3	6.6	2012/8/4 12:15	↑	HW16:44	6.2	6.6	2012/8/5 14:30	↑	HW18:13
17	POSITIVE PASSION	7.9	7.9	2012/8/13 10:22	↑	HW12:28	6.4	7.1	2012/8/15 7:30	↓	LW10:01
18	ZEE TEE	6.6	7.0	2012/8/14 7:30	↑	HW13:27	2.4	4.4	2012/8/15 10:30	↑	HW15:03
19	ZAMBALES	5.5	6.1	2012/8/15 11:35	↑	HW14:08	4.4	5.8	2012/8/16 8:30	↓	LW10:54
20	ASIAN INNOVATOR	6.0	6.2	2012/8/16 12:45	↑	HW14:43	5.5	6.2	2012/8/17 9:00	↓	LW11:38
21	GENIUS STAR X	4.5	6.3	2012/8/28 11:25	↑	HW13:05	4.0	5.9	2012/8/29 15:30	↓	LW22:47
22	CHAO ANOMA	6.0	6.5	2012/8/29 11:40	↑	HW13:56	2.4	4.4	2012/8/30 16:30	↓	LW23:39
23	PAC AQUILA	5.2	7.2	2012/8/2 11:42	↑	HW15:29	5.8	7.5	2012/8/4 14:00	↑	HW17:37
24	GATI PRIDE	4.0	4.8	2012/8/2 13:12	↑	HW15:29	6.0	7.0	2012/8/4 11:00	↓	LW13:15
25	PAC AQUILA	7.1	8.4	2012/8/15 10:54	↑	HW14:08	5.0	7.0	2012/8/16 11:30	↑	HW15:40
26	GATI MAJESTIC	3.8	5.8	2012/8/15 8:24	↑	HW14:08	4.1	5.7	2012/8/16 11:30	↑	HW15:40
	Average Draft	5.8	6.8		↑	HW 23	4.9	6.2		↑	HW 8
	Max. Draft	8.4	8.9		↓	LW 3	7.5	8.8		↓	LW 17
	Min. Draft	3.8	4.8				2.4	4.3			

4) Current Conditions and Problems of Vessels in Yangon Port

Through the data gathering and analyzing, some remarkable features were found as follows in respect to the vessels calling at Yangon Main Port and Thilawa Area Port.

a) Vessel Traffic Volume

This survey, only focusing on vessels on international voyage, did not include domestic or coastal vessels. During 35 days of the field survey, which was executed between August 1st and September 4th, 155 ocean-going vessels were observed and the average was 4.6 vessels per a day. According to MPA Shipping Agency Department, approximately 5 to 10 ocean-going vessels enter and leave Yangon Port every day.

b) The time waiting in the offing

Generally speaking, immediate after a vessel arrives outside a port, a pilot gets on board the vessel and navigate it to the designated berth. The study shows that the average duration for waiting in the offing is 2.2 days and 4 days in Yangon Main Port and in Thirawa Area Port respectively. Consequently, the duration staying in the port becomes longer. The possible reasons for the long waiting time is considered as follows.

- Pilot is not able to get on board due to the disturbance of the heavy weather.
- Waiting for berth (A prior vessel delays in departure)
- Communication system and methods among a vessel, its agency and MPA is not established well
- Others (problems with ship's owner, company or vessel itself)

c) Average laytime between berthing and unberthing

The average laytimes of the vessels calling at Yangon Main Port and Thilawa Area Port are both 4.0 days. As mentioned earlier, the average size of vessels entering Thilawa Area Port is twice larger than the vessels calling at Yangon Main Port and the cargo volume transported to Thilawa Area Port, which would be proportional to the vessel size, is considered larger than in Yangon Main Port. In spite of a larger amount of cargo handled in Thilawa Area Port, the average laytimes in Thilawa Area Port and Yangon Main Port are almost same amount. It means that the cargo handling operation of Thilawa Area Port is more efficient than the operation of Yangon Main Port. The higher efficiency of Thilawa Area Port results from the higher container vessels and PCC (Pure Car Carrier) proportion to the all accepting vessels. Although Thilawa Area Port is more efficient than Yangon, their average laytimes are 4 days and still relatively long. The possible reasons are considered as follows.

- Problem with MPA's operating system including customs clearance

- Problems of Port Control and Management System (documents and procedures for customs and port control)
- Delay in containerization
- Ineffectiveness of cargo handling operations regarding the vessels and the stevedore, storing in yard and goods shed, and carrying in and carrying out

d) Period of time between arriving outside the port and unberthing (duration staying in a port area)

The average period of time a vessel staying in Port area is 6.1, 7.8, and 6.4 days in respect to Yangon Main Port, Thilawa Area Port, and Yangon Port respectively. The statistics shows that 71.3 % and 64 % of calling vessels stays for 4.2 days in Yangon Main Port and for 3.8 days in Thilawa Port Area respectively. From the statistics, it seems that the duration is slightly shorter than the average. Considering that the size of the vessels is relatively small and that the volume of cargo handling is not large, the duration is much longer than the duration of the main ports in other countries. The possible reasons are considered as follows.

- Long duration for waiting in the offing
- Navigation restriction during nighttime
- Inefficient cargo handling due to the large proportion of general cargo vessels to the all vessels
- Delay in containerization
- Insufficient communication system and methods among a vessel, its agency and port

e) Entering and Departing during Nighttime

As mentioned previously, the number of vessels accessing to Yangon Port during nighttime is very small. Only one of 26 sampled vessels entered Thilawa Port Area during night and none of 25 sampled vessels departed from the port. The restriction on the night navigation is considered a crucial factor influencing to the efficient operations in Yangon Port.

(4) Countermeasures for Improving Yangon Port Operation

The study reveals that the average period of time staying at Yangon Port is 6.4 days. If this poor condition lasts long, because of the low profitability, it is highly possible that the shipping companies will hesitate to allocate their vessels to this area. There could be considered the following suggestions regarding port operation in Yangon.

1) Problem-1

The present pilot vessel is small and aging. The pilot boat is so small (LOA 5m) that it cannot embark or disembark a pilot at Outer Bar when the wave height gets 1.5 m or larger in the heavy weather.

Suggestion: It is required to replace the current pilot vessel anchored at Outer Bar by a fixed pilot station. In addition, the present pilot boat needs to be replaced by a larger (LOA 16m) and faster boat.

2) Problem-2

Waiting for berthing (A prior vessel delays in departure), inefficient cargo handling, and delay in containerization.

Suggestion: Containerization of the present general cargo should be promoted rapidly. Entire redeveloping plan including Yangon Main Port and Thilawa Area Port must be examined and executed.

3) Problem-3

Insufficient Communication system and methods among a vessel, its agency and MPA

Suggestion: New management system should be built. The port management system and VTMS should be introduced to handle cargos and control vessels, respectively.

4) Problem-4

Almost none of vessels arriving or departing during night time

Suggestion: The possible solution to this problem includes constructing a fixed pilot station, preparing larger pilot boats, providing aids to navigation such as lighthouse and buoys, and introducing VTMS.

5.4.6. Facilities for Navigational Safety

In this section, a safety navigation plan that must be applied and executed for the future Thilawa Area Port operations is examined considering the present problems and the possible countermeasures of the Thilawa Area Port described previously.

MPA, as a port authority of the Thilawa Area Port, is obligated to secure the safety navigation for the all vessels calling at the port. They are responsible for the water area including the anchorages at Outer Bar, the navigation channel approaching from the pilot station to the port, and the anchorages off the port and for the facilities and equipments of the port.

This survey revealed multiple number of the problems regarding the target water area as described in the section 3.3. The problems are regarding the shallow depth of the navigation channel, the absence of the electrical nautical charts, the deficiency of aids to navigation, and the small size and the degraded condition of the pilot vessels and the pilot boats.

In this survey, the movements of the vessels calling at the port were observed for a specific month regarding the time when they arrived at Outer Bar, picked up a pilot, arrived at the port berth, and departed from the berth. As a result, the analysis derived from the observed data revealed that the port operation efficiency was extremely low because no vessels were arriving at or departing from the port during the night time.

Based on the results described above, the objective of the safety navigation plan is defined as increasing the number of the vessels accessing to the port during the night time in order to improve the port operation efficiency. The countermeasures for achieving the objective are shown in Table 5.4-41.

Table 5.4-41 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 Manmar 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 equipments, 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.

(1) Aids to navigation

1) Visual Aids to Navigation

It is necessary to rehabilitate Visual Aids to Navigation such as lighthouses, light beacons, lighted buoys and leading lights to have safe navigation from Outer Bar anchorage area or the pilot station to Thilawa Area Port. The Visual Aids to Navigation are examined by dividing the following 3 sites, 1)Pilot Station, 2)Western Channel and 3)Thilawa Area Port since the navigational channel is extremely long

a) Pilot Station

3 kinds of Visual Aids to Navigation are considered necessary on the newly planned pilot station.

a) Land mark for vessels to approach the pilot station

b) Indication of the jetty for the pilot boat

c) Indication of the pilot station as off-shore structure including construction period

Specifications of Visual Aids to Navigation plan on the Pilot Station are shown in Table 5.4-42

Table 5.4-42 Specifications of Visual Aids to Navigation on the Pilot Station

	Type	Specification	Example
a	Lighthouse	Body : Aluminum Modular Panels Light Color : White Light Source : LED Power Source : Solar System Range : more than 10NM Accessory : AtoN AIS	
b	Light Beacon	Body : Aluminum Pole Light Color : Yellow Light Source : LED Power Source : Solar System Flashing : Synchronized	
c	Light System operated in unison	Light Color : White Light Source : LED Power Source : Solar System or AC Power with Backup System Flashing : Synchronized	

It is considered to complete appropriate designing, examining and fabricating Visual Aids to Navigation within about six months after design conditions including the features of Yangon such as cyclones and swift currents are determined. Installation including foundation work and erection is expected to finish less than one month because these types can be easily handled without cranes and heavy machines.

b) Western Channel

Elephant point in Western Channel is the second dangerous point after Monkey Point. The narrowest point is about 500m width (BA chart 833) and it is curved at about 70 degrees.

There were leading lights and lighted buoys installed. But the leading lights have been quite damaged by Cyclone Nargis and the lighted buoys also deteriorated with the paintings peeled off.

3 kinds of Visual Aids to Navigation are considered necessary for Western Channel.

f) Landmark

g) Leading lights as rehabilitation

h) Lighted buoys as rehabilitation

Specifications of Visual Aids to Navigation plan for Western Channel are shown in Table

5.4-43

Table 5.4-43 Specifications of Visual Aids to Navigation for Western Channel

	Type	Specification	Example
a	Lighthouse	Body : Aluminum Modular Panels Light Color : White Light Source : LED Power Source : Solar System Range : more than 10NM Accessory : AtoN AIS	
b	Leading Light	Body : Aluminum Alloy Light Color : White Light Source : LED Power Source : Solar System Flashing : Synchronized	
c	Lighted Buoy	Body : Swift Current type Light Color : Green or Red Light Source : LED Power Source : Solar System Flashing : Synchronized	

It is considered to complete appropriate designing, examining and fabricating Visual Aids to Navigation within about six months after design conditions including the features of Yangon are such as cyclones and swift current are determined. Installation including foundation work and erection is expected to finish less than one month.

c) Thilawa Area Port

There are two turning points and two narrow channels between Western Channel and Thilawa Area Port. There were leading lights installed for this navigation route. However Cyclone Nargis damaged them in May 2008 and remained without any rehabilitation. Rehabilitation of the leading lights as well as a new lighthouse, lighted buoys and light beacons for Thilawa Area Port shown Table 5.4-44 are considered necessary.

a) Landmark for Thilawa Area Port

b) Leading lights as rehabilitation

c) Lighted buoys for Thilawa Area Port

d) Light beacons for Thilawa Area Port

Table 5.4-44 Specifications of Visual Aids to Navigation for Thilawa Area Port Area

	Type	Specification	Example
a	Lighthouse	Body : Aluminum Modular Panels Light Color : White Light Source : LED Power Source : Solar System Range : more than 10NM Accessory : AtoN AIS	
b	Leading Light	Body : Aluminum Alloy Light Color : White Light Source : LED Power Source : Solar System Flashing : Synchronized	
c	Lighted Buoy	Body : Swift Current type Light Color : Green or Red Light Source : LED Power Source : Solar System Flashing : Synchronized	
d	Light Beacon	Body : Aluminum Pole Light Color : Yellow or White Light Source : LED Power Source : Solar System Flashing : Synchronized	

It is considered to complete appropriate designing, examining and fabricating Visual Aids to Navigation within about six months after design conditions including the features of Yangon are such as cyclones and swift current are determined. Installation including foundation work and erection is expected to finish less than one month.

(2) Vessel Traffic Management System (VTMS)

a) Background and Purpose of introducing VTMS

Background

Many facilities of Yangon port are old and the repair of the facilities damaged due to cyclone NARGIS in 2008 are limited to the minimum. At present, it is a quite high priority for the government of Myanmar to maintain the safety of navigation for vessels. The Government of Myanmar has

decided expansion of Thilawa Area Port at 20km downstream from Yangon Main Port in accordance with the increase of port handling cargo volume. In connection with the expansion of Thilawa district, it is important to provide the facilities to keep the safe navigation on the Yangon river route and improve the safety of navigation prior to the port operation is started in its full swing.

Purpose

The government of Myanmar deems the Yangon river approach navigation route as the vital lifeline of the nation. Especially, it is a quite high priority issues to maintain the safe navigation to Thilawa Area Port, reinforce the monitoring of oceanic pollution due to sea accidents, and to reduce CO2 emissions from increasing vessel traffic and transportation.

The government of Myanmar can deal with decrease of sea accidents, early detection of suspected vessels and protection of marine environment by avoidance of vessel accidents, by newly installing the VTMS including AIS for maintaining the safety of vessels sailing in the Yangon river and the coastal water.

b) Outline of VTMS Project

i) Establishment of VTMS

Radar sites will be constructed to cover the approach routes from Thilawa Area Port to the Outer Bar Pilot Station as well as the mouth area of the Yangon river. The Vessel Traffic Monitoring System(VTMS) and the Automatic Identification System(AIS) will be newly installed . At the same time, the Advanced Navigation System equipped with the Oceanic Environment GIS(Geographic Information System) will be installed at MPA. These VTMS, AIS and GIS will be operated and maintained by MPA.

ii) System Configuration

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.

iii) Introduction of the Advanced Navigation System

The circumstances at sea are becoming severer in recent years because MPA pilots and ship’s crews are facing many problems to solve including environmental issue, energy saving, goods transportation at higher speed, combat against piracy for safety of navigation.

To solve or alleviate these problems, it is essential to provide the navigation support from shore

to ships. In providing the navigation support from shore, it is necessary to collect and analyze a wide range of information including ship status information, oceanographic and meteorological information and sea traffic flows and to provide appropriate advice to ships.

The Advanced Navigation System designed to collect, manage and analyze a diversity of information on ship operations in an efficient and integrated way for making development on navigation support. The introduction of the Advanced Navigation System provide vessels with optimum route and navigation information, and allow the operation control center to guide vessels on the GIS, thereby contributing to the higher safety and efficiency of navigation in port waters and narrow or congested channels.

Role of Advanced Navigation System

The Advanced Navigation System will play the role of integrating the present development efforts in different fields (sea, shore and research fields) to contribute to the future improvement of R&D and educational activities.

Associated Fields

- high-capacity ship-shore communications system
- ship navigation and operation support
- oceanographic and meteorological forecasting system

Expected Associated Systems

- optimum route selection system
- collision and grounding avoidance system
- berthing aid system
- integrated sea-land transportation information system

Configuration of Advanced Navigation System

The Advanced Navigation System consists of subsystems including a GIS data management system:

- GIS data management system
- Storage system
- Data collection system
- Data analysis system
- Supervision and display system
- Mobile system

The information from ships and shore radar stations (AIS stations), meteorological/oceanographic information and hull characteristics information are managed as GIS database in the high-capacity storage.

The ship-shore transmission links are provided in a wide range of ocean broadband system via

satellites, wireless LANs and Internet.

Various types of data can be retrieved, compiled, downloaded and uploaded for use in analytical processing and forecast calculations.

Application screens can be displayed on large- and medium-type monitors and are provided with the functions of overlaying images and data as the ocean GIS.

The support activity information on board and in ship operation companies can be simulated by providing the information to the simulator station and the appropriateness of the information can be verified.

iv) System Composition of Project

This Project will be implemented in the following processes as a solution for enhancing the safety, reliability and efficiency of vessel traffic.

a) Radar Site Construction

A total of 4 radar sites will be constructed along the Yangon River to install the VTS and AIS and the radio transmitting/receiving station will be installed at each radar site. The radars are expected to cover the ranges as follows.

Yangon Radar site	10 miles-range	(Figure6-1)
Thilawa Radar site	10 miles-range	(Figure6-2)
Elephant Radar site	20 miles-range	(Figure6-3)
Outer Bar Pilot Station Radar site	20 miles-range	

b) VTS and AIS Networking

The operation control center will be installed at Thilawa Port to collect and process the vessel, route and port information transmitted from VTS and AIS. The VTS simulator will be installed at Myanmar Maritime University for training of personnel.

c) Installation of the Oceanic Environment GIS

Installation of the Navigation System fitted with the Oceanic Environment GIS at MPA

v) Project Outline Image Diagram

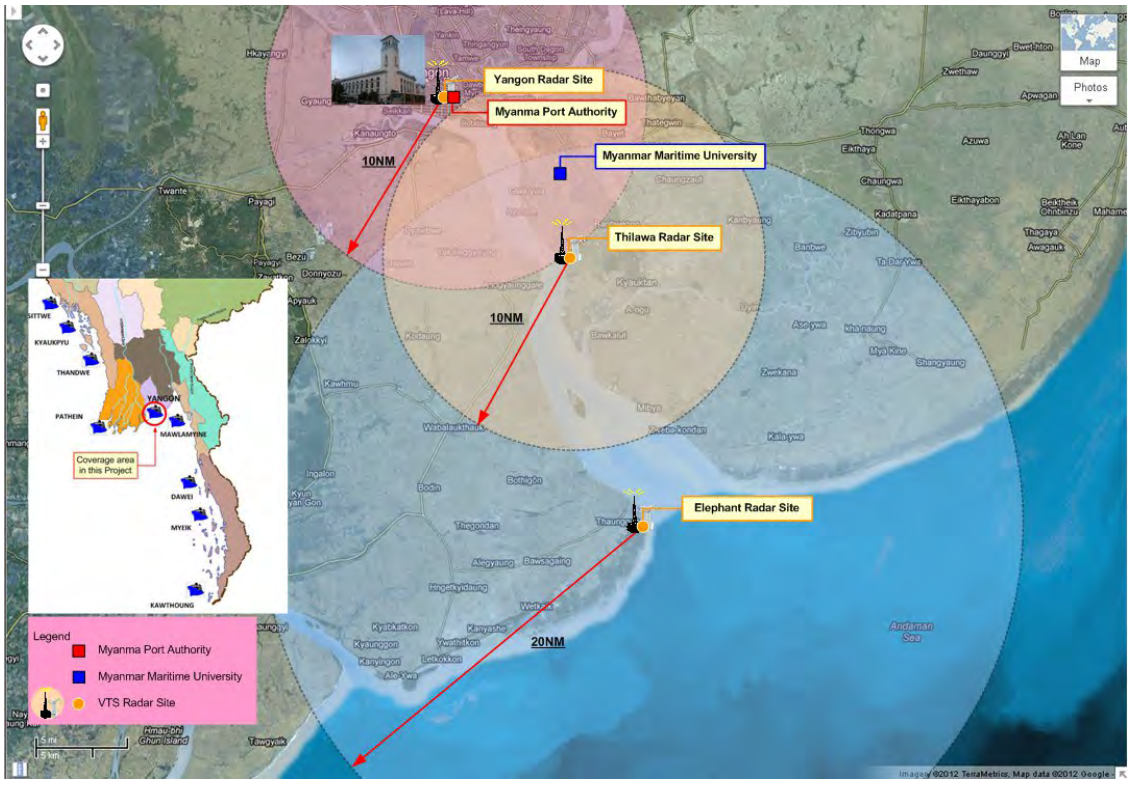


Figure 5.4-69 Project Outline Image Diagram (1)

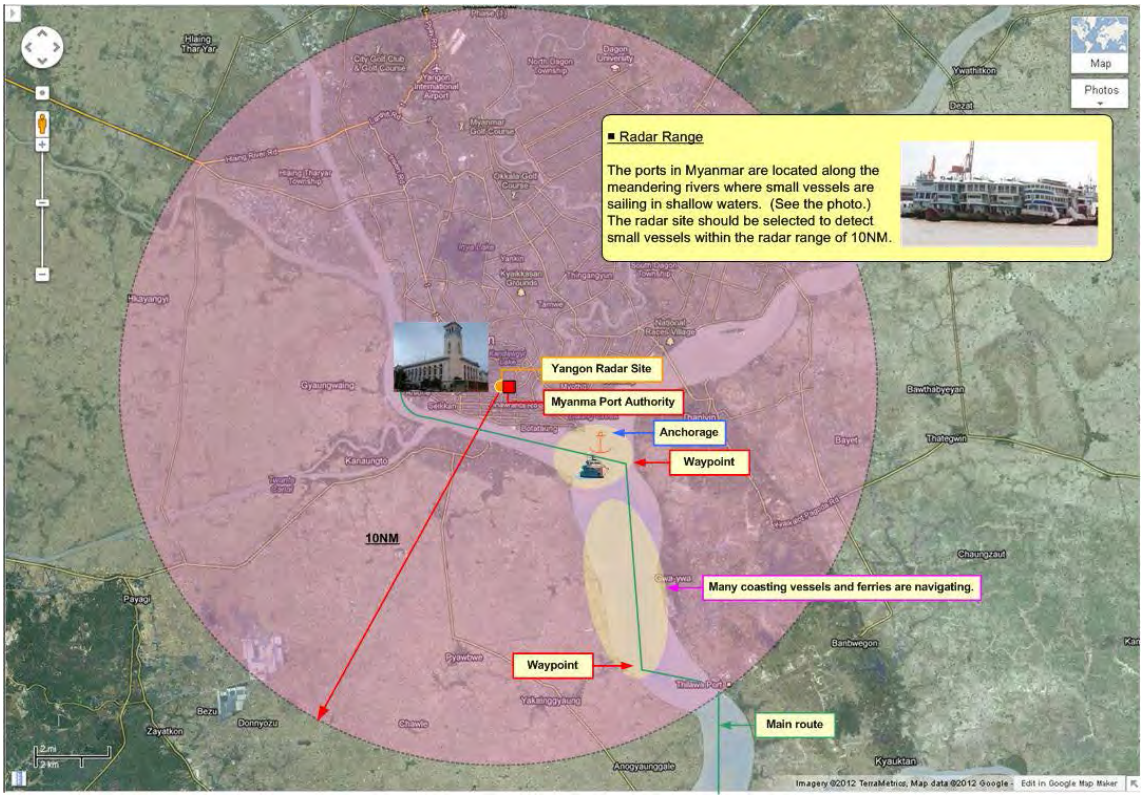


Figure 5.4-70 Project Outline Image Diagram (2)

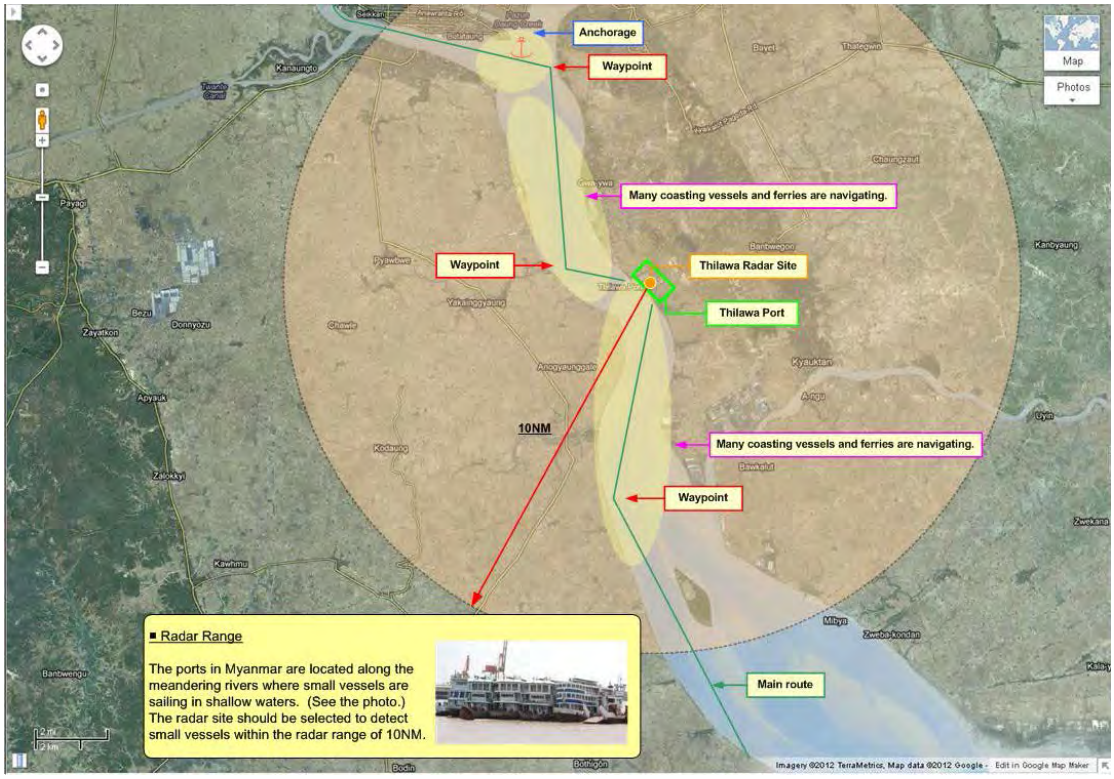


Figure 5.4-71 Project Outline Image Diagram (3)

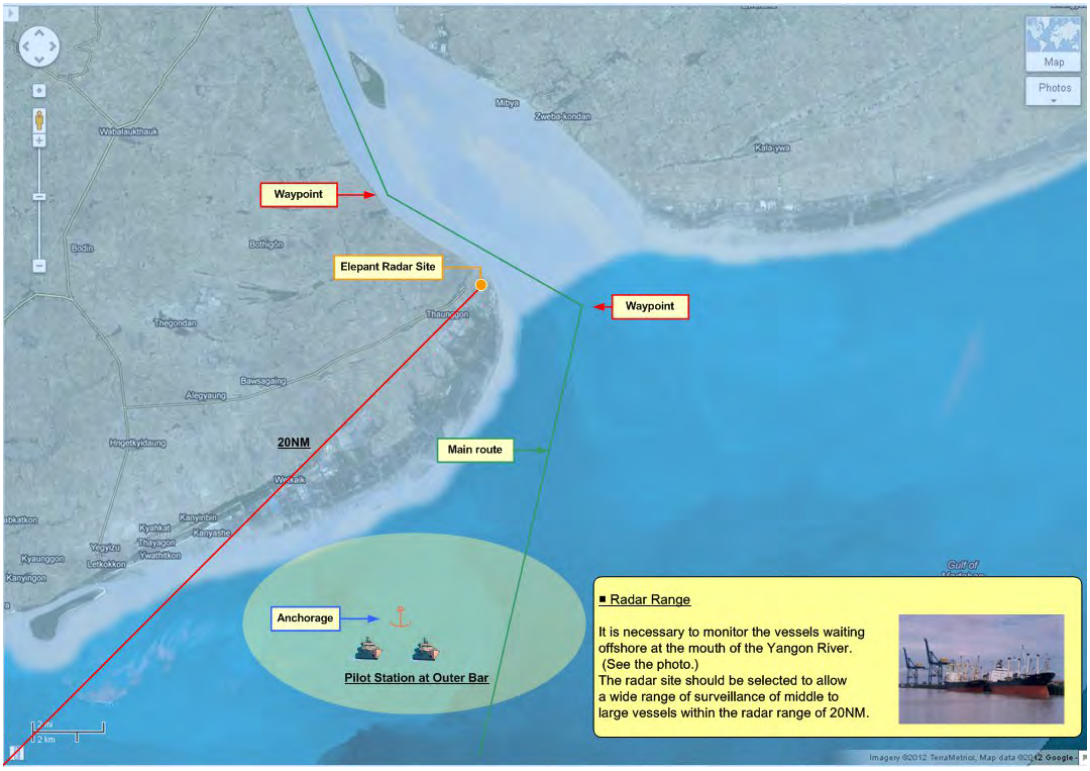


Figure 5.4-72 Project Outline Image Diagram (4)

vi) System Configuration Example

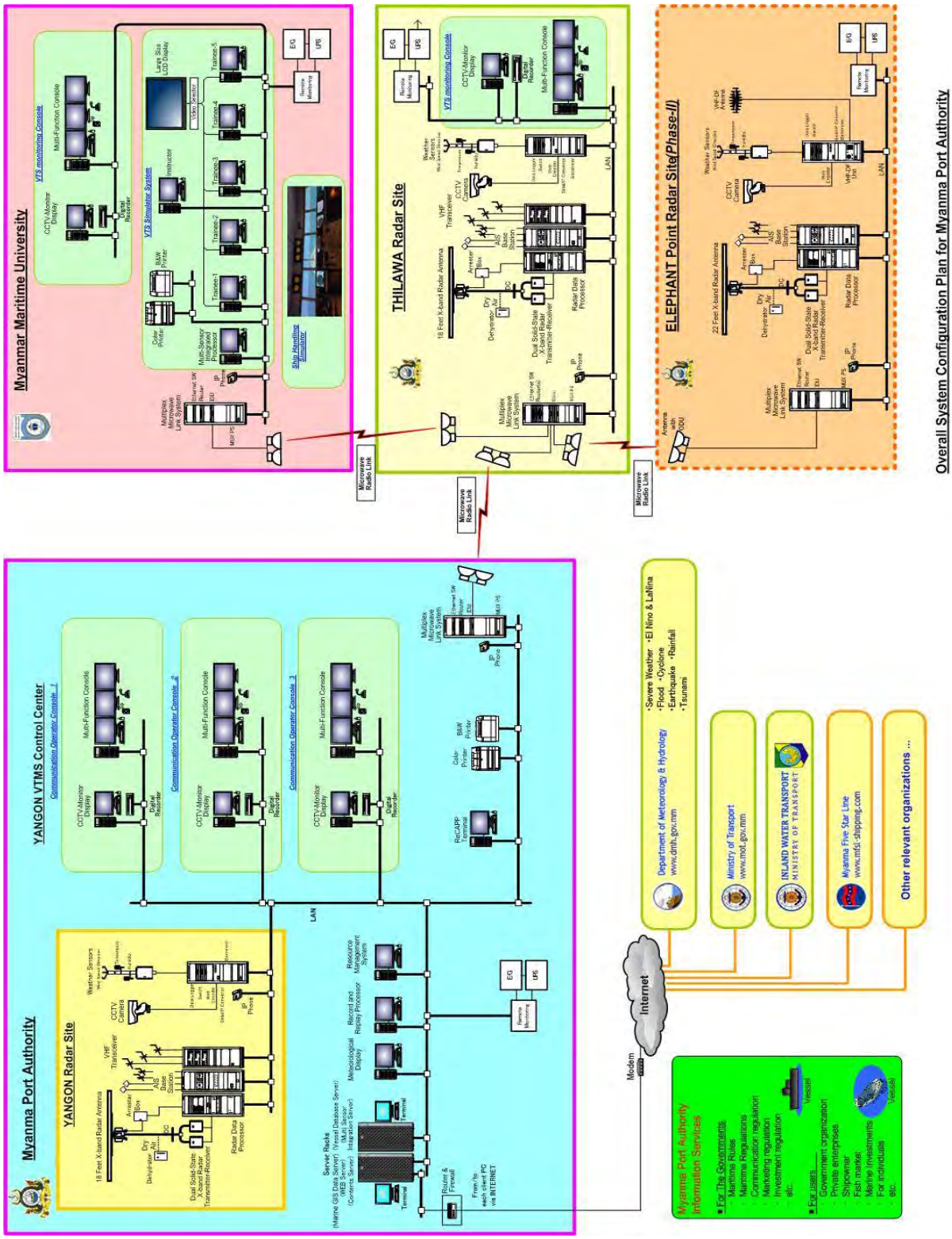


Figure 5.4-73 System Configuration Example by Location

vii) System Details (Draft)

Facilities and equipment at each site are as follows:

- Tilawa Area Port
  - VTMS Control Center
  - Oceanic Environment GIS Center
  - VHF Radio Base Station
- Thilawa Radar Site
  - VTS Radar, AIS Base Station, Microwave Link, Station House and Tower
- Elephant Radar Site
  - VTS Radar, AIS Base Station and Station House and Tower, and Power Supply System
- Outer Bar Pilot Station
  - VTS Radar, AIS Base Station and SSB, Microwave Link, Station House and Tower, and Power Supply System
- Myanmar Port Authority
  - VTMS Monitoring Center
  - AIS, VHF Radio Base Station, Microwave Link, Station House and Tower, and Power Supply System
- Yangon Radar Site
  - VTS Radar, AIS Base Station, Station House and Tower
- Myanmar Maritime University
  - VTS Simulator

viii) Organization of Myanmar Government for Project

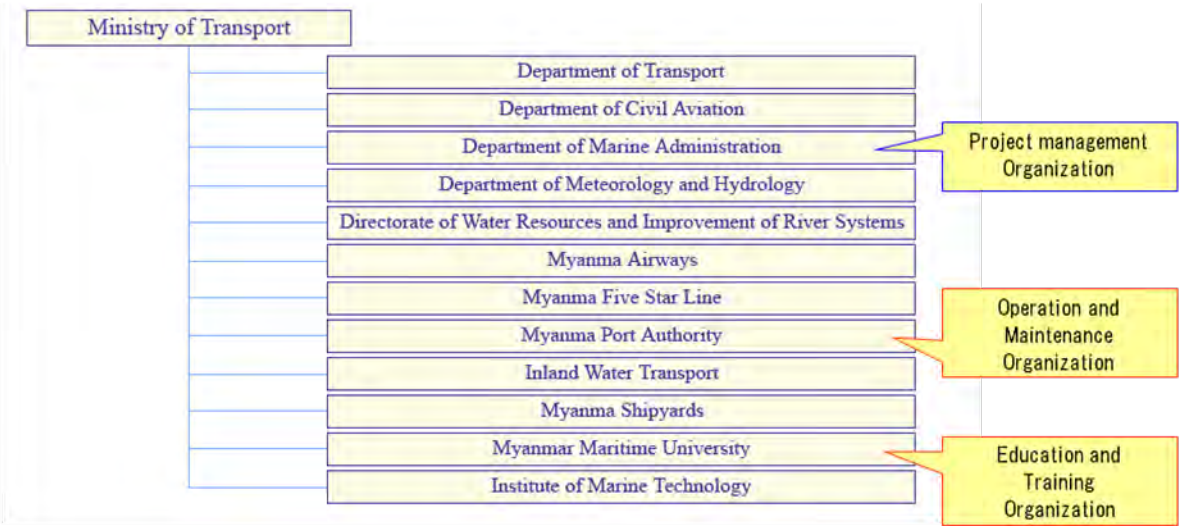


Figure 5.4-74 Organization of Myanmar Government for Project

- Project Management: Carried out in the Department of Marine Administration
- Operations Management: Myanmar Port Authority and Inland Water Transport
- Maintenance Management: Myanmar Port Authority
- Education and Training: Myanmar Maritime University

ix) Economic Impacts on Myanmar

1) The Vessel Traffic Service System (VTS), Automatic Identification System (AIS) and Oceanic Environment GIS are designed to effectively function for maintaining safety of vessel navigation and alleviating the congestion in port waters and narrow channels. The integrated network system will build up the capacity for safety of marine transportation and contribute to improving the environment for investment in Myanmar and for export from Myanmar.

2) The integrated network system is expected to decrease the sea accidents that have occurred every, contributing to reducing the economic loss due to such accidents.

3) The industry in Myanmar highly depends upon sea transportation. By securing the safety of sea transportation, the lead time of agricultural and industrial products will be shorter and the frequency of transportation will be higher, thereby activating the movements of people and goods and promoting the economic growth in Myanmar.

4) Myanmar is located at the strategic point of sea transportation to connect Japan to the Southeast Asia. If the safe navigation of vessels in the coastal waters of Myanmar is secured, the spin-off effect on the economic growth in the surrounding ASEAN countries will be expected. (Japan will support the Oceanic ASEAN Economic Corridor Concept.)

5) The efficient vessel energy management will control and reduce the CO2 emissions from vessels navigating in the waters of Myanmar, bringing a large economic effect on the environmental aspect.

(3) Pilot station

1) Purpose and reason

In the pilot services, the pilots are in most danger when they get on board the pilot boats from the pilot station and the vessels. The geographical feature of Outer Bar where the pilot vessel is anchored, concentrates the power of the monsoon winds and waves and consequently produces large swells. The swells shakes the pilot vessel so violently that the pilots are quite difficult to get on board and off the pilot boats and as a result the pilot services are unable to provide. It means that all large vessels calling at Yangon port stop and the port gets malfunction. In order to avoid the critical situation and keep the sustainable pilot services, the best proposed countermeasure is to replace the pilot vessels by the fixed pilot station as MPA desires strongly.

a) Roles of the pilot station

The pilot station by the pilot vessel is applied only to provide the pilot service for the vessels arriving at and departing from the port. Addition to the pilot services, the proposed fixed pilot station is applied as a landmark with lighthouse or light beacon and facilities for the safety navigation and communication with a radar. The roles of the proposed pilot station are as follows.

- Pilot service

  Achieving the capability to provide the pilot service in heavy weather condition during the monsoon season with the fixed pilot station and the large pilot boats

- Landmark (aids to navigation)

  Functioning as aids to navigation for the vessels approaching to the pilot station with the lighthouse or light beacon equipped on the fixed pilot station

- Vessel Traffic Service (VTS)

  The proposed fixed pilot station installs a radar and it Provides and exchanges the information listed as follows.

  -The locations of anchored and the situation of the other vessels around the anchorages during the vessels waiting in the offing

  -When and where a pilot get board on

  -The situation of the scheduled berths for the calling vessels

  -Meteorological and oceanographic phenomena

  -Other information relating to the safety navigation

i) Operations and required facilities

Although the outlines of the operations and the required facilities regarding the proposed pilot station must be defined through the discussion with MPA, a currently proposed outline is shown in Table 5.4-455.

Table 5.4-45 Operation and required facilities

Roles	Operations	Require facilities
Pilots	On duty: 8 pilots Off duty: 7 pilots (in rest) 15 pilots are in the station	A waiting and office room, 10 nap rooms for the pilots off duty, A locker room, A communication facility, A shower room, A rest room, A salon
Pilot boats	On duty (12 hour shifts): 6 crews =2 crews/boat * 3 boats Off duty: 6 crews + 2 extra crews Total 14 crews (1 week shifts)	3 pilot boats and their mooring facilities composed of a wave protection and an access to the boats, Fuel, parts, equipments, expendables, and their storage, Boat davits for repairing, Bed rooms for 14 crews and 4 messmen.
Control center	On duty: 3 staffs, 3 shifts a day, total 9 staffs (1 week shifts)	Control rooms for radar, VHF, AIS, SSB, and other communication facilities, Bed rooms for 9 staffs, A locker room, A rest room, A shower room, A messroom, Parts and expendables for the facilities above.
Roof	Managed by the control center staffs	Radar scanner, lighthouse, communication antenna
Food supply	Cook and deliver: 4 messmen on duty (1 week shifts)	A messroom, A kitchen, A food storage, Dishes
Water and power supply	Private power generator is installed and maintained by the boat crews. Water is supplied periodically and managed by the messmen.	Power generators (diesel, Sola power, or wind power would be considered in future), Fuel tanks, Water tanks

ii) Outline of the pilot station

The conceptual idea of the pilot station is represented in Figure.5.4-75. The roof floor is equipped with a lighthouse facility, a radar scanner, and a communication antenna. Third floor is occupied with a control center. Second floor is occupied with the rooms for the pilot such as waiting room and nap rooms. First floor is the rooms for the pilot boat crews and messmen. On the sea, three pilot boats and a jetty as their mooring facilities are required. It is also equipped with the facilities for

protecting from the waves during the heavy weather condition of the monsoon. It is also expected to get board on or off the calling vessels by the helicopter addition to the pilot boats, it, therefore, should be considered where to locate the heliport in the pilot station.

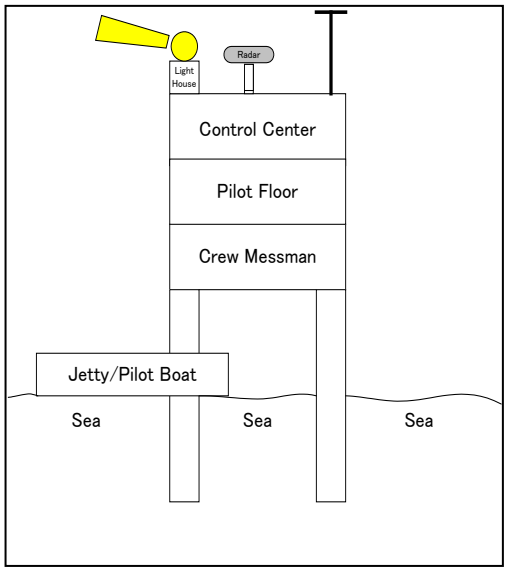


Figure 5.4-75 Conceptual design of the pilot station

iii) Pilot station of the Bangkok port

PAT (Port Authority of Thailand) respectively locates 5 pilot station at Bangkok Bar, Laemchabang, Mab Taput, Songkla, and Puket, which are the main ports of Thailand. The pilot station at Bangkok Bar is the only offshore station although the others are the on land stations. The Bangkok Bar pilot station is a reinforced concrete and offshore structure that is located at the estuary of Chao Phraya river and 18 kilometers from the coast line. Its construction started in December 1973 and ended in July 1978. It is 31.2 meters high from the mean sea level (MSL). It has a lighthouse on its roof, which is 38.38 meters high from the roof, and is applied as a “aids to navigation” for the vessels calling at the Bangkok port. From 2004 to 2005, a breakwater, a heliport, and additional communication facilities were added and its accommodation space was reformed.

MPA has been considering to construct an offshore pilot station because the Bangkok pilot station is located at the estuary and its geographical feature is similar to the surroundings of the Yangon port.

Figure 5.4-76 Location of the Pilot Station

Figure 5.4-77 Bangkok Bar Pilot Station

Figure 5.4-78 Pilot Boat

Figure 5.4-79 A set of the mooring facilities

2) Design of Pilot Station

The design of pilot station requires following examinations and investigations.

1. Formulation of utilization plan

2. Setup of the optimal plan point.

3. Field Investigations.

Geographical Investigation (Sounding survey)

Geological Investigations (Drilling survey, soil tests)

Oceanographic Investigations (wave, Tide, Current)

Meteorological Investigations (Temperature, Wind, Rain, Cyclone)

In this study, the roughly design of the pilot station was performed supposing a utilization plan

and natural conditions.

a) Roughly Design

The roughly design was made as following conditions.

b) Natural conditions

The natural conditions for roughly design are as follows.

Water depth : CDL-6.0m

Tide level : Same as Thilawa

Wave : H=2.0m T=12.0s

Ground : Sand (N>10)

i) Use condition

Use conditions are shown in Table 5.4-46.

ii) A necessary institution and area

A necessary institution and area is shown in following table

Table 5.4-46 A necessary institution and area

Name		Dimension	Area
Stay Room	Pilot	16m x 16m	256m2
	Crew	12m x 12m	192m2
	Controller	8m x 8m	64m2
	Staff	8m x8m	64m2
Dining Room		14m x 14m	196m2
Kitchen		5m x10m	50m2
Office		10mx10m	100m2
Sub-total			922m2
Optional area	20% of Sub- total		198m2
Sum-total			1,030m2

(Prepared by the Study Team)

＊Building Area

Two floors 25m x 20m = 500m2

The first floor is taken as a workplace and equipment place, such as a tank.

＊Vessel place Area

4 vessels 21m2 x 4 = 84m2

＊Deck Area

Deck Area is total Building Area, Corridor Area, and Ship place area. 35m x 29m

＊Height of Deck

Height of the deck was assumed from the tide level and wave height.

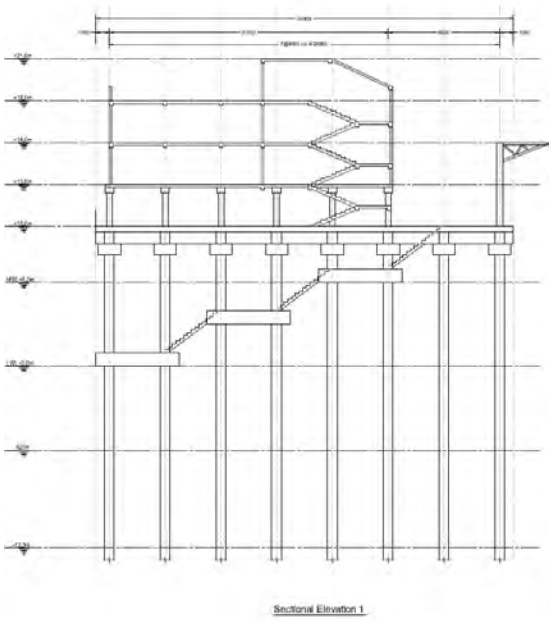
CDL+6.0m + 4.0m = CDL+10.0m

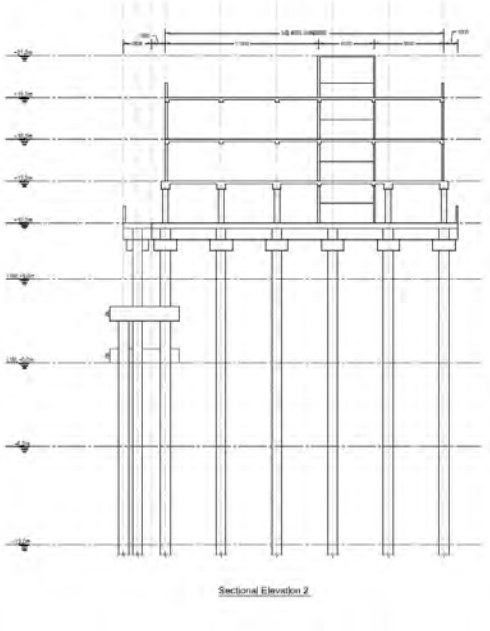
iii) Mooring facility

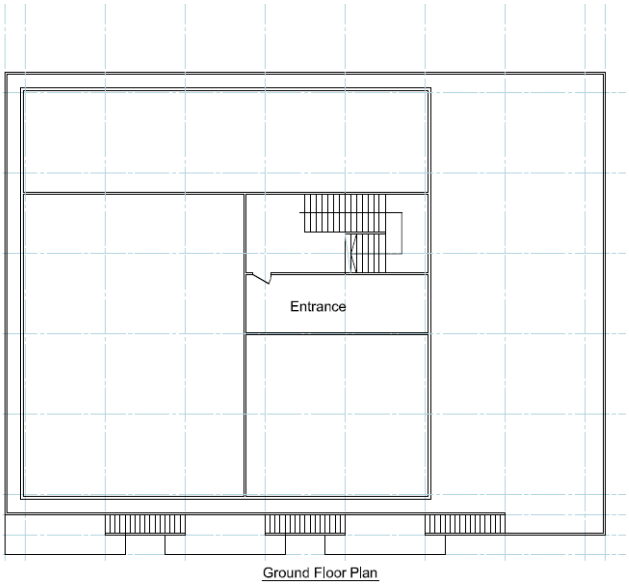
Since the tide level difference was large, the mooring facility was taken as three steps of platforms.

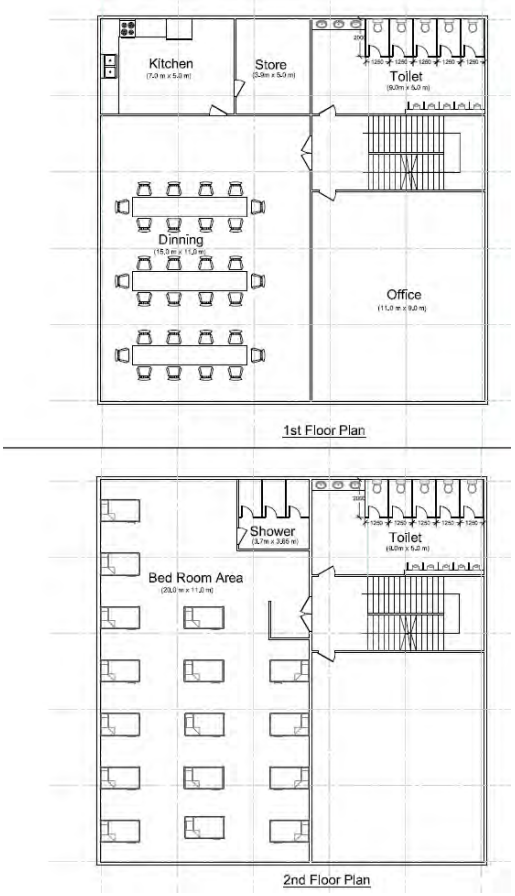
iv) Drawing

The pilot station assumption Drawing is shown in Figure 5.4.80.









(Prepared by the Study Team)

Figure 5.4-80 Roughly Drawing of Pilot Station

5.5. Environmental and Social Consideration

5.5.1. Baseline Information of Environmental and Social Conditions

(1) Natural Environment

1) Meteorological Phenomena

Project site Thilawa Area belongs to tropical monsoon climate zone, which is separated into hot season (From End of Feb. to Middle of May), rainy season (From End of May to Middle of Oct.) and dry season (From End of Oct. to Beginning of Feb). Although there is no statistical data of meteorological phenomena in Thilawa Area, data in Yangon (Kaba Aye) of monthly precipitation, mean temperature, mean humidity and mean wind speed/direction are shown in Table 5.5-1 to 5.5-4.

Table 5.5-1 Monthly Precipitation in Yangon (Kaba Aye) (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2006	0	0	N/A	156	341	411	780	634	366	147	N/A	0
2007	0	0	0	N/A	837	559	700	446	774	260	16	0
2008	5	7	25	169	656	431	541	474	448	301	6	0

Note: "N/A" The amount of rainfall could not be measured.

Source: Department of Meteorology & Hydrology, Ministry of Transport

Table 5.5-2 Monthly Mean Temperature in Yangon (Kaba Aye) (℃)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2006	23.8	26.1	28.5	28.8	26.7	26.0	25.1	26.4	27.5	29.3	29.0	26.0
2007	25.9	27.3	29.2	31.9	28.1	27.7	26.6	26.7	26.1	27.0	27.2	25.0
2008	25.5	26.1	29.2	29.9	27.1	26.6	26.0	25.8	26.1	27.0	26.4	24.5

Source: Department of Meteorology & Hydrology, Ministry of Transport

Table 5.5-3 Monthly Mean Humidity in Yangon (Kaba Aye) (%)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2006	84	75	77	75	84	91	95	93	92	84	78	75
2007	74	67	70	69	89	91	92	91	94	87	81	92
2008	78	68	71	78	87	89	90	97	92	85	76	72

Source: Department of Meteorology & Hydrology, Ministry of Transport

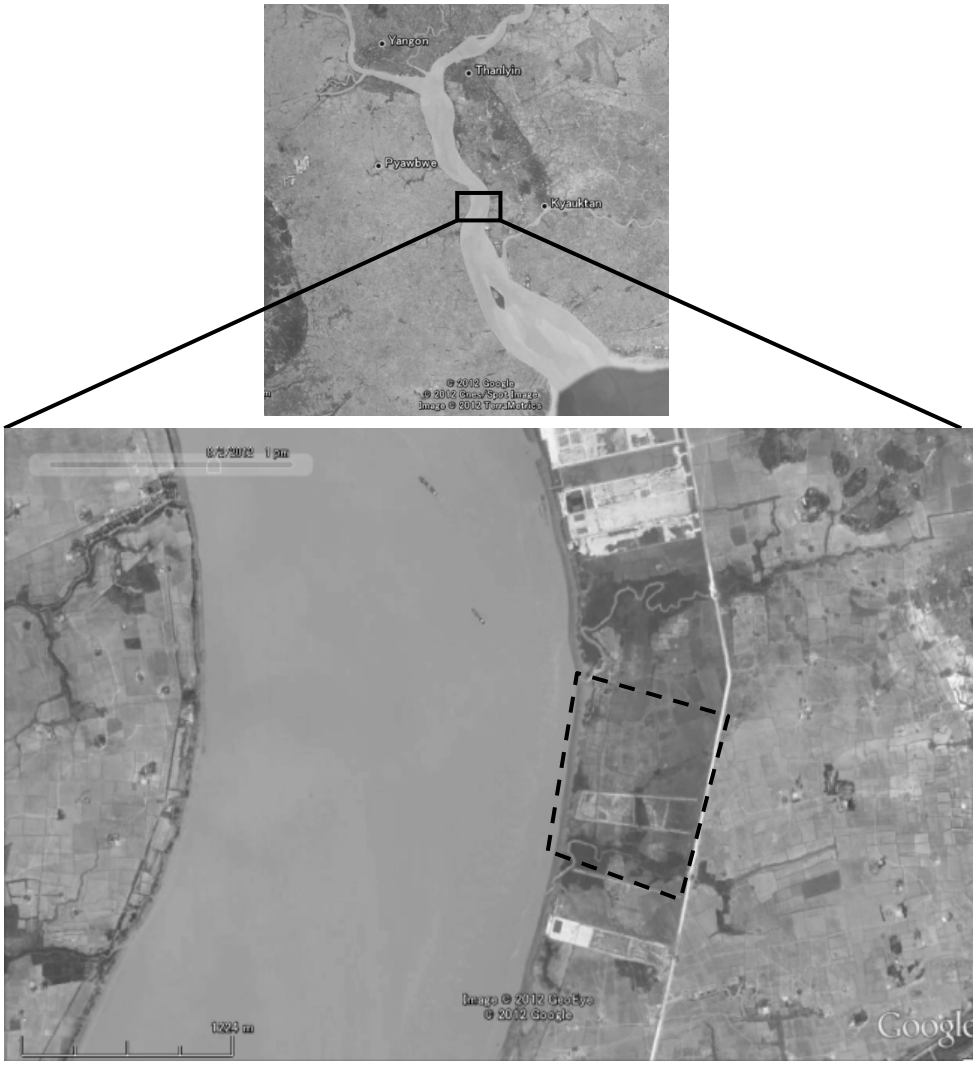
Table 5.5-4 Monthly Mean Wind Speed in Yangon (Kaba Aye) (m/s) and Direction

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2006	0.49	0.49	0.63	0.63	0.76	0.67	0.67	0.76	0.67	0.58	0.67	0.67
	NE	W	SE	SW	SW	SW	SW	SW	SW	SW	NW	N
2007	0.49	0.58	0.67	0.98	0.94	0.85	0.76	0.76	0.63	0.58	0.63	0.58
	NW	W	NW	SW	SW	SW	SW	SW	SW	W	NW	NW
2008	0.54	0.54	0.72	0.72	1.56	1.03	1.07	0.85	0.76	0.58	0.72	0.67
	NE	SE	SW	SW	SW	SW	SW	SW	SW	SW	E	NE

Source: Department of Meteorology & Hydrology, Ministry of Transport

2) Geography

Project site is located approx. 16km south from Yangon City and on the left bank of the Yangon River. This site is located on the outer side of s-shaped river and always subject to erosion. There are 2 creeks on both the north and south sides of the site.



Source: Google

Figure 5.5-1 Project Area and Geography

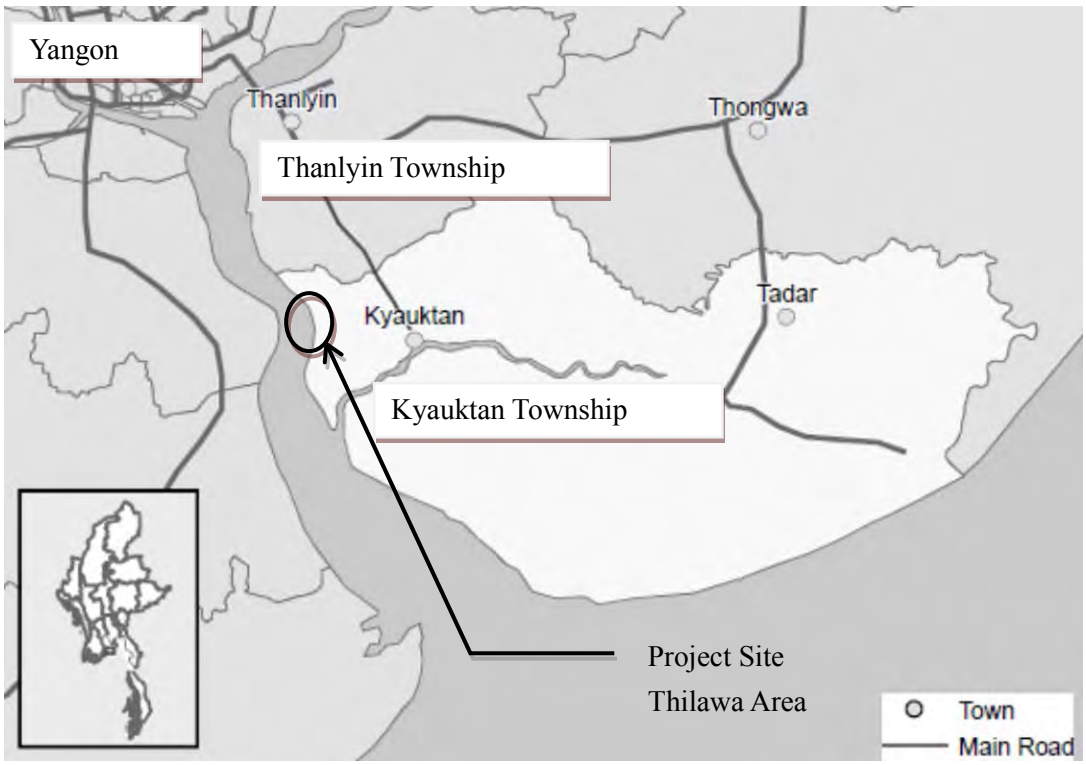
3) Ecological System and Natural Reserves

There are a lot of areas of untouched nature in Myanmar, and 48% of national land is covered with forests. Creatures so far identified are about 250 kinds of mammals, over 1,000 birds, over 370 reptilians, and over 7,000 plants, and among them 45 kinds of birds, 21 reptilians and 38 plants have been designated as a world endangered species. From the standpoint of conservation of biodiversity, 43 sanctuaries (35 designated and 8 under proposal) are designated or will be designated in Myanmar, however the area in or around the project site is not designated as a sanctuary. (Myanmar protected areas, BANCA, 2009)

(2) Social Environment

1) Population

Project Site Thilawa Area is located in Kyauktan Township, a suburb of Yangon City. On the access route between Kyauktan Township and Yangon City, there is Thanlyin Township. Two townships are not under control of Yangon City and Yangon City Development Committee (YCDC) but directly governed by Yangon Region Government. The locations of both Thanlyin and Kyauktan townships are shown in Figure 5.5-2.



Source: Myanmar Information Management Unit (MIMU)

Figure 5.5-2 Location Map of Thanlyin/Kyauktan Township

Yangon City has 39 townships and among them 33 townships are under control of YCDC. YCDC has a population of 5.14 million and city area of 794km2 (population density is 6,470person/km2). On the other hand, Thanlyin and Kyauktan townships located in suburban of Yangon City have population statistics as shown in Table 5.5-5.

Table 5.5-5 Population Statics for Thanlyin/Kyauktan Township

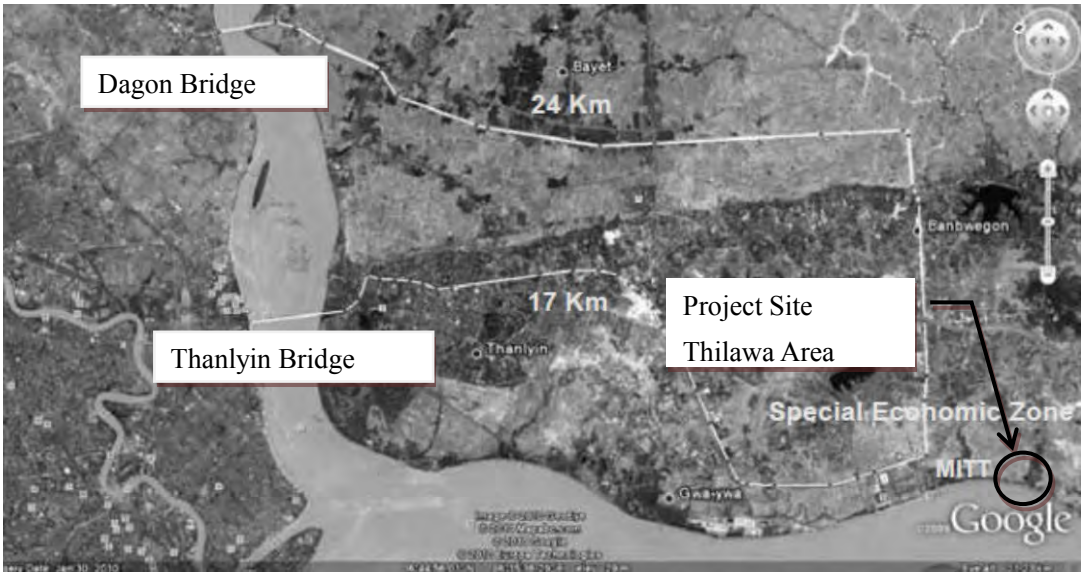
Name of Township	Population (1,000Person)	Township Area (km2)	Density (Person/km2)
Thanlyin	181	350.5	520
Kyauktan	108	832.8	130

Source: Myanmar Information Management Unit (MIMU) April 2009

Downtown area of Kyauktan Township is regarded as a densely populated area with a population density of 2,500 person/km2, however it is located 5km from the Project Site and is not a strategic zone of logistics. On the other hand in Thanlyin Township, there are mainly two strategic zones of logistics called Dagon Bridge route and Thanlyin Bridge route (Refer to Figure 5.5-3). Although there is no densely populated area along the Dagon Bridge route, Thanlyin Bridge route is running through the downtown area of Thanlyin Townships which is a densely populated area (population density of 5,000 persons/km2).

2) Logistics (On-land Transportation)

There are two access routes from Thilawa Area to Yangon City as shown in Figure 5.5-3. Because Thanlyin Bridge has a weight limit (trucks over 36 tons cannot pass it), loaded trucks are instead taking Dagon Bridge route and empty trucks and other standard-sized cars are mainly taking Thanlyin Bridge route.



Source: Google, MITT

Figure 5.5-3 Route from Thanlyin/Kyauktan Township to Yangon City

The Study Team carried out an interview survey with each tollgate of Dagon Bridge and Thanlyin Bridge with respect to one day traffic volume (on both back and forth sides of the road). According to the results of the interview, traffic volume of Dagon Bridge was 400 to 600 cars/day and among it percentage of large-sized vehicle such as cargo truck was approx. 80% (320 to 480 cars/day). Traffic volume of Thanlyin Bridge was 12,000 cars/day and percentage of large-sized vehicle was unknown.

MITT is currently under operation in Thilawa Area, and their amount of cargo handled is 3 million tons/year almost all of which are transported on land to Yangon City. If the average load of a truck is assumed to be 20 tons, the traffic volume is calculated to be 411 cars/day.

3) Employment and Industry

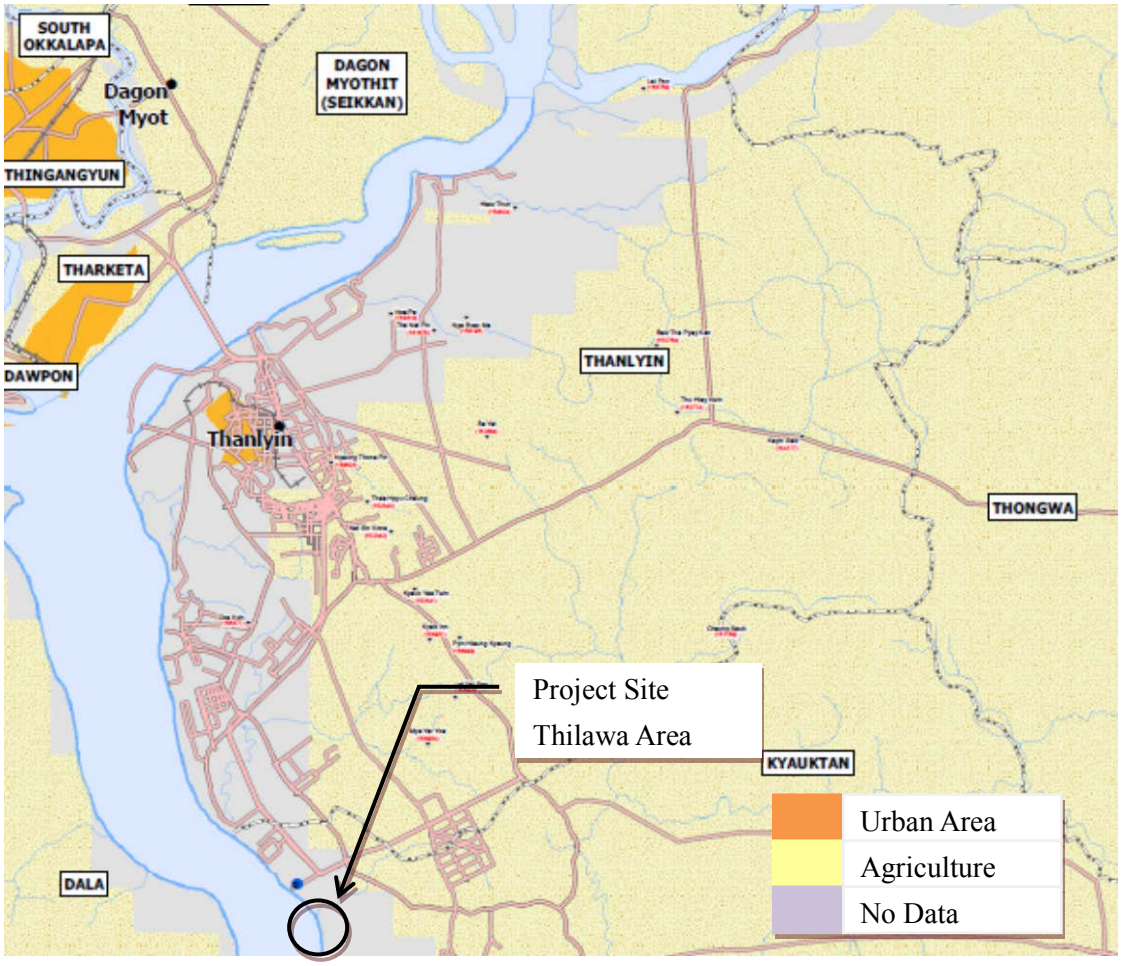
In Myanmar, GDP per person in fiscal year 2010 is USD702. In Thanlyin and Kyauktan Township, GDP is USD1,450 and USD1,150 respectively, and each of them is 106% and 64% higher than the national average.

By industry in Thanlyin and Kyauktan Township Production accounts for 70% of GDP, Service 5% and Trade 25% in Thanlyin Township, and Production 67%, Service 5% and Trade 28% in Kyauktan Township. Main commodities are cotton in Thanlyin and agriculture, cotton industry, fishery/livestock in Kyauktan. Main occupations are farmer, fisherman, and government employee, followed by livestock breeder, short-term labor, and company owner. [1]

4) Land Use

Statistical data for land use in Thanlyin and Kyauktan Township is summarized and opened to the public by Myanmar Information Management Unit (MIMU) based on the statistics of Ministry of Home Affairs (MOHA). According to the data, there are 17 Urban Wards and 28 Village Tracts in Thanlyin Township, and there are 17 Urban Wards and 28 Village Tracts in Kyauktan Township. Almost whole land is used for agricultural purposes and small remaining land represents the urban area as shown in Figure 5.5-4 and Figure 5.5-5. Project Site is classified in “No Data” area.

[1] Department of Human Settlement and Housing Development, Ministry of Construction



Source: Myanmar Information Management Unit (MIMU)

Figure 5.5-4 Land Use in Thanlyin Township

Source: Myanmar Information Management Unit (MIMU)

Figure 5.5-5 Land Use in Kyauktan Township

5) Public Services

a) Electricity Supply

Yangon City Electricity Supply Board (YESB) of Ministry of Electric Power II (MOEP-2) is in charge of distribution of electric power in Yangon City and Project Site. The current percentage of distribution of electric power in Thanlyin and Kyauktan Township is up to 45% and 25% respectively because of lack of sufficient supply capacity. In each village tract where electric power is not distributed, electric power is supplied to each household by individual generators. [2]

b) Water Supply and Sewage System

Engineering Department - Water and Sanitation in YCDC control and operate water supply and sewage system in Yangon, however each township office controls and operates them in Thanlyin and Kyauktan Township. Current water resources in these townships are reservoir or water well. There are three reservoirs including Thilawa Reservoir, Bantbwekone Reservoir and Zarmani Reservoir and their daily consumption volumes are 5,000m^3/day, 6,400m^3/day, 17,045m^3/day (in total 28,445m^3/day) respectively. Coverage of water supply is up to a few dozen percent in these townships. [3]

With regard to sewage system, because sewage pipes for polluted water and rain water are not installed except for a part of urban ward and because sewage collecting system is not provided enough, coverage of sewage system is less than 10% in these townships. A few households and construction site have their own septic tanks, but others directly drain to the river.

c) Waste Management

Waste management in Yangon City is operated according to “Pollution Control and Cleansing Rules 2001”. The department in charge of waste management is Pollution Control and Cleansing Department (PCCD) which has set up specific procedures to collect, transport and dispose wastes and has also set rates and penalties. However, because Thanlyin and Kyauktan Township is not under control of the department, they have their own waste management system. Myanmar and Yangon Region Government do not set up specific procedures for waste management and the townships do not have their own waste facility, so they directly dispose of wastes in each township area. In case of medical or industrial wastes, PCCD can dispose the wastes instead upon requests from townships.

6) Medical Services

According to WHO statistics, there are 987 hospitals in Myanmar in 2011, all of them public. The number of beds in Myanmar is 54,503 which means that 0.87 beds/1,000 persons are available on average given that Myanmar’s total population is 6.2 million. This is much less than the 5.0

[2] Department of Human Settlement and Housing Development, Ministry of Construction
[3] Study team of the information collection and confirmation study of urban planning sector in Yangon

beds/1,000 persons recommended by WHO.

There is a hospital with 100 beds, 16 medical clinics and a private hospital in Thanlyin Township and 2 hospitals with 50 beds, 43 medical clinics in Kyauktan Township. Neither township have enough medical facilities and depend on other townships in YCDC as only 0.55 beds/1,000 persons and 0.92 beds/1,000 persons are available respectively in each township. [4]

With respect to infectious diseases, according to statistics in Myanmar in 2010, leading causes of morbidity are other virus diseases (4.4%) and malaria (4.1%). Moreover, leading causes of mortality are HIV diseases (7.0%) which rank first, malaria (4.2%) in fourth and respiratory tuberculosis (3.7%) in sixth. Statistical results are assumed to be similar in Thanlyin and Kyauktan Township.

7) Education

Basic education in Myanmar starts from age 5; elementary schooling spans 5 years, junior high schooling 4 years and high schooling 2 years. Higher education (university or college) spans 2 to 7 years depending on educational courses. There are 36 universities and 112 colleges, all of which are national schools.

There are 47 elementary schools, 5 junior high schools and 11 high schools in Thanlyin Township and 111 elementary schools, 10 junior high schools and 6 high schools in Kyauktan Township. Three universities (Myanmar Maritime University, the University of East Yangon and Technological University) are also located in the townships, with Myanmar Maritime University being one of the more famous and renowned universities in Myanmar.

Enrollment ratio in schools is 100% for elementary, junior high and high schools in Thanlyin Township, however it is 62% for elementary, 30% for junior high and 8% for high school in Kyauktan Township. Literacy rate is 89.9% in Myanmar (over the age of 15, September 2006) and it is assumed to be almost same in the townships. [4]

5.5.2. System and Organization for Environmental/Social Considerations in Myanmar

(1) Laws/Regulations related to Environmental/Social Considerations

1) Brief Overview of Environmental Laws/Regulations

Constitution of the Republic of the Union of Myanmar was newly enacted in 2008. In this Constitution, there are several statements for environmental and social considerations and they state, “The Union shall protect and conserve natural environment” in Article 45 of Chapter I, and say, “Every citizen has the duty to assist the Union in carrying out the following rules – (b) Environmental

[4] Depertment of Human Settlement and Housing Development, Ministry of Construction

Conservation" in Article 390 of Chapter VIII.

In addition, the Constitution states, "The Pyidaungsu Hluttaw shall have the right to enact laws for the entire or any part of the Union related to matters prescribed in Schedule One of the Union Legislative List. (Schedule One: Article 6. Energy, Electricity, Mining and Forestry Sector (g) Environmental protection and conservation including wildlife, natural plants and natural areas.), and "The legislative power relating to the matters listed in Schedule Three for respective Divisions or Zones are allotted to the Self-Administrated Division or Self-Administrated Zone Leading Bodies. (Schedule Three: Article 8. Preservation of Natural Environment in accordance with Law Promulgated by the Union)

In terms of other Laws/Regulations related to environmental and social considerations, Ministry of Environment Conservation and Forestry (MOECF) was newly established in September 2011, and The Environmental Conservation Law (The Pyidaungsu Hluttaw Law No. 9/2012) was enacted in March 2011. The Law is constituted from 14 chapters, and it states, "The Union shall form the Environmental Conservation Committee …" (Article 4 of Chapter III) and "The powers of the committee are (g) laying down or carrying out the Myanmar national environmental policies and other environmental policies for conservation and enhancement of environment with the approval of the Union." (Article 6 of Chapter III) In addition, it also states, "The duties and powers relating to the environmental conservation of the Ministry is" to establish environmental policies/plans/standards, monitoring programmes, procedure to approve EIA/SIA in the Union/Regions. (Article 7 of Chapter IV)

It is not confirmed at the time of October 2011 if basic environmental policy in Myanmar will be again established, however in 1994 National Commission of Environmental Affairs (NCEA, it is currently inactive) opened the basic policy to the public in official Gazette (Gazette Notification No. 26/94 dated 5 December 1994) as follows.

"The wealth of a nation is its people, its cultural heritage, its environment and its natural resources. The objective of Myanmar's environment policy is aimed at achieving harmony and balance between these through the integration of environmental considerations into the development process to enhance the quality of life of all its citizens. Every nation has the sovereign right to utilize its natural resources in accordance with its environmental policies; but great care must be taken not to exceed its jurisdiction or infringe upon the interests of other nations. It is the responsibility of the State and every citizen to preserve its natural resources in the interests of present and future generations. Environmental protection should always be the primary objective in seeking development ".

In order to specifically implement the basic policy above, Myanmar Agenda 21 and National Sustainable Development Strategy (NSDS) in August 2009 was established by NCEA. NSDS vision for Myanmar is to achieve "well-being and happiness for all people of Myanmar" within a 15-year time-frame and NSDS also aims to achieve this vision through following three integrated goals (Sustainable Management of natural resources, Sustainable economic development, Sustainable social

development). NSDS is officially approved by the Ministry of National Planning and Economic Development (MNPED).

It is assumed that instead of by NCEA specific laws/regulations/standards related to environmental and social considerations will be established by MOECF based on Environmental Conservation Law and NSDS, however the schedule is currently unknown.

Other existing laws related to the environment are as follows.

- Myanmar Mines Law 1994 (The State Law and Order Restoration Council Law No.8/94.1994)
- Conservation of Water Resources and Rivers Law 2006 (The State Peace and Development Council Law No. 8/2006)
- Myanmar Forest Law 1992 (The State Law and Order Restoration Council Law No.8/92.1992)
- Protection of Wildlife, Wild Plants and Conservation of Natural Areas Law 1994 (The State Law and Order Restoration Council Law No.583/94.1994)
- Freshwater Fisheries Law 1991 (The State Law and Order Restoration Council Law No.1/91)
- Marine Fisheries Law 1990 (The State Law and Order Restoration Council Law No. 9/94)
- Water and Air Pollution Prevention Plan1995 (Ministry of Industry Standing Order No.3)
- Foreign Investment Law 2012

2) Environmental Standard in Myanmar

Although the Environmental Standards shall be established in accordance with Environmental Conservation Law, they have not been completed yet. Currently, the guideline values are specified by the related authorities according to need. The Ministry of Industry issues Water and Air Pollution Prevention Plan in which it has established its own quality standard of discharged water. At the Mingaladon Industrial Park, discharge water is controlled using an independent quality standard.

3) Yangon Region Government (Thilawa Area, Kyauktan Township, Yangon)

Environmental Laws/Regulations/Standards specifically established by Yangon Region Government do not exist as of October 2012. Environmental measures have been examined according to Yangon Concept Plan 2040, however the department in charge is Pollution Control and Cleansing Department (PCCD) and they do not examine overall environmental measures but waste management

system. Because of this current situation, this Project needs to follow the laws/regulations/standards/ procedures to obtain EIA/SIA approval, which will be established by MOECF.

4) Related Organizations

There are about 40 international NGOs in Myanmar actively working for Natural/Social Environment as of October 2010. Moreover, there are also several domestic NGOs such as those below, advising the Government and carrying out EIA for some projects.

<Domestic NGOs>

- FREDA（Forest Resource Environment Development and Conservation Association）
- BANCA (Biodiversity and Nature Conservation Association)

Programmes of the United Nations such as UNDP (United Nation Development Programme) and UNEP (United Nation Environment Programme) are also actively working to establish NSDS and environmental Laws/Regulations/ Standards/Guidelines with Domestic NGO.

(2) Approval Procedure for Environmental and Social Considerations (EIA, Disclosure of Information, Resettlement and Site Acquisition)

1) Flow for Approval Procedure of EIA/SIA (Social Impact Assessment)

Laws or Guidelines for approval procedure of EIA/SIA (Environmental Impact Assessment/Social Impact Assessment) have not been established as of December 2013, however MOECF and MNPED are planning to establish a Myanmar Project Appraisal Procedure including the approval procedure of EIA/SIA. The procedure is being established according to ADB (Asian Development Bank) guideline.

2) Rules/Regulations/Guidelines of Resettlement and Site Acquisition

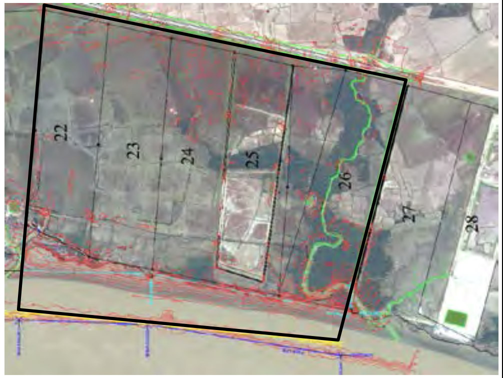
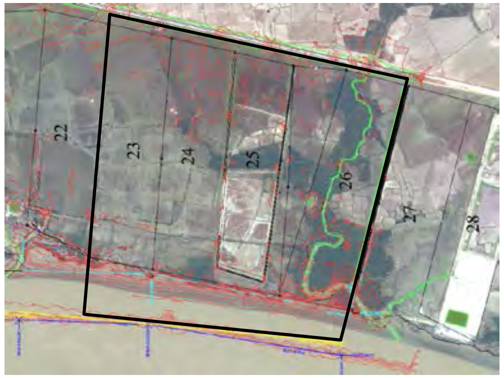
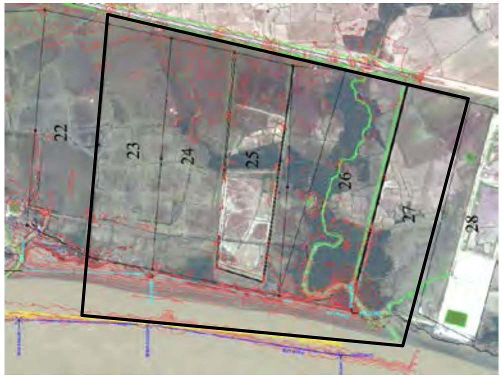
With respect to resettlement and site acquisition, there is no clear rule/regulation/guideline in Myanmar as of December 2013, and it will be contained in the project appraisal procedure and Environmental Conservation Rules above. According to interview survey to MNPDE and MOECF, general administration office of Ministry of Home Affair (MOHA) and Region Government have been responsible for these matters, however the right of resettlement and site acquisition will be transferred to MOECF at the same time of establishing the Rules. However, timing of establishing the Rules is also unclear because there are a lot of matters to be settled with MOHA and Region Government and capacity of MOECF to implement the Rule is still uncertain.

5.5.3. Examination of Alternatives

(1) Terminal Location

Thilawa Area Port is comparted from Plot 1 to Plot 37, and Project Site is given 5 plots from Plot 22 to Plot 26. 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 5.5-6. 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 was optimum based on an appraisal of all aspects.

Table 5.5-6 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.	D	✓ Relocation of 42 residents in Plot 23 is still needed, but relocation of 220 residents in Plot 22 can be avoided.	B	✓ Relocation of 42 residents in Plot 23 is still needed, but relocation of 220 residents in Plot 22 can be avoided.	B
	✓ Current use of 75.4 acre paddy field needs to be examined according to the above JICA Guidelines.	B-	✓ Current use of 57.9 acre paddy field needs to be examined according to the JICA Guidelines.	B	✓ Current use of 77.9 acre paddy field needs to be examined according to the JICA Guidelines.	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	

(2) Urgent Development Layout

Although overall plant layout is decided from Plot 23 to Plot 26, urgent development layout also needs to be decided to cope with future demands in 2015. The urgent development layout is shown in chapter 6.3.

(3) Zero Option

In case that the project is not implemented, negative environmental impact becomes the minimum. SEZ (2,400ha) is planned at land-side of Thilawa Area Port, and it is expected that the total volume of containers will increase to about 900 thousand TEU in 2015 when the first phase of SEZ is completed. Economic development could be hampered without expansion of Thilawa Area Port by this time. In order to develop the regional/national economy, Thilawa Area Port needs to be continuously developed but at the same time it will be necessary to consider environmental and social impacts.

5.5.4. Scoping and TOR for Environmental and Social Considerations

(1) Scoping for Development Plan for Thilawa Area Port

Scoping is defined to set scopes of evaluation items and decide their survey methods considering social/natural environmental impacts to the items which are serious and assumed to be serious. Table 5.5-7 and Table 5.5-8 show the result of scoping and TOR for urgent development plan at the stage of Interim Report. Based on the scoping and TOR, survey results, impact assessment and mitigation measures and monitoring plan are subsequently shown below.

Table 5.5-7 Scoping Results

Classification	No.	Evaluation Items	Assessment		Reason for Assessment
			Before /Under Construction	After Operation	
Pollutions	1	Air Pollution	C	C	**Under Const.:** Temporary negative impact to air is assumed due to the operation of construction equipment/machines. **After Operation:** Negative impact to air is assumed due to the increase of exhaust gas associated with the increase of traffic volume of cargo transportation.
	2	Water Pollution	B-	B-	**Under Const.:** River water is assumed to be polluted with generation of turbid water or inflow of waste water due to offshore and land works. **After Operation:** River water near the port is assumed to be polluted because of sewages from ships and port facilities.

Classification	No.	Evaluation Items	Assessment		Reason for Assessment
			Before /Under Construction	After Operation	
	3	Wastes	B-	C	**Under Const.:** Disposal of dredged materials from channel/basin, surplus soil and wastes from construction work is assumed to be necessary. **After Operation:** In case maintenance dredging of channel/basin is required, disposal of dredged materials, non-industrial/industrial wastes from port facilities/ships is assumed to be necessary.
	4	Soil Contamination	C	D	**Under Const.:** Potential soil contamination is considered in case of harmful substance included in the reclaimed soil. **After Operation:** Any activity or construction of port facilities triggering soil contamination is not assumed.
	5	Noise/Vibrations	B-	B-	**Under Const.:** Noise from construction equipment/machine is assumed. **After Operation:** Noise from port operations such as loading machines and vehicles is possible to have an impact on surrounding environments.
	6	Ground Subsidence	D	D	Any activity or construction of port facilities triggering ground subsidence such as use of a large quantity of underground water is not assumed.
	7	Offensive Odors	D	D	Any activity or construction of port facilities triggering offensive odors is not assumed.
	8	Sediment	C	C	**Under Const.:** In case sediment at project site contains harmful substances, diffusion of them associated with river bed dredging and offshore works is assumed. **After Operation:** Organic contamination of sediment associated with water pollution and bottom sediment pollution associated with port operation are possible.
Natural Environment	9	Protected Areas	D	D	There is no protected area such as national park and sanctuary around project site.
	10	Ecosystem	B-	C	**Under Const.:** In case precious ecosystems exist, it is considered that they will disappear. **After Operation:** Ecosystem could be affected by water pollution associated with sewer water from port facilities and ships.
	11	Hydrology	C	C	**Under Const.:** <River current>Any activity triggering a significant change of river current is not assumed. <Land drainage> Land drainage system could be affected by land filling of the creek. **After Operation:** <River current>River current speed is

Classification	No.	Evaluation Items	Assessment		Reason for Assessment
			Before /Under Construction	After Operation	
					assumed to be decreased under jetty area although it varies depending on the jetty structure.
	12	Topography/ Geology	D	C	**Under Const.:** Any activity triggering a change of topography and geology is not assumed. **After Operation:** Decreased river current under jetty area is assumed to have a positive impact on river bank erosion.
Social Environment	13	Involuntary Resettlement/ Site Acquisition	B-	D	**Before Const.:** Project site is government-owned and it is assumed that there is no resident and that no resettlement is required, however it is possible that informal settlers could be found. According to presurvey using satellite photos, it is assumed that there are a few dozens households in Plot 23 and that their resettlement needs to be examined.
	14	Poor People	C	B+	**Before Const.:** In case there are irregular residents in the project site, such informal settlers could come under the category of Poor People. **After Operation:** In association with port operation, public (common) road, electricity supply, water supply, telephone, the internet will be provided. In areas where there is a large poor population, such social services and access to the market have a positive impact on them.
	15	Minority/Indigenous People	D	D	There is no minority or indigenous people around project site.
	16	Local Economy such as Employment and Livelihood	B+	B+	**Under Const.:** It is assumed that port construction works lead to new employment. On the other hand, a potential of water pollution associated with river dredging and drainage water from land works has a negative impact on fishery and agricultural activities **After Operation:** New employment associated with port operation is expected, and it contributes to improvement in living standards due to economic ripple effect.
	17	Land Use and Utilization of Local Resources	C	C	**Under Const.:** The impact on local resources associated with conversion of land use from paddy field to port project site is to be assessed. **After Operation:** Water pollution associated with sewer water from port facilities and ships has a negative impact on fishery resources.
	18	Water Use	D	C	**Under Const.:** Any impact on water use is not assumed because a large volume of water is not used in this project.

Classification	No.	Evaluation Items	Assessment		Reason for Assessment
			Before /Under Construction	After Operation	
					After Operation: A large volume of water is not used in this operation, but, current water use and necessary water consumption are to be confirmed.
	19	Existing Social Infrastructures and Services	C	C	**Under Const.:** Increase of vehicles for construction has a negative impact on heavy traffic and environments such as air pollution, noise and vibration. **After Operation:** As is the case with "Under Const.", increase of vehicles for port operation has a negative impact on heavy traffic and environments such as air pollution, noise and vibration.
	20	Social Institutions such as Social Infrastructures and Local Decision-Making Institutions	D	D	Social Infrastructures and local decision-making institutions are kept on after port construction starts, and there is no impact on them.
	21	Misdistribution of Damages and Benefits	D	D	There assumed to be no element to trigger misdistribution of damages and benefits because port construction/operation provides both damage (impact on fishery/farming) and benefit (new infrastructure/employment) around the project site.
	22	Local Conflicts of Interests	D	D	There is assumed to be no element to trigger local conflicts of interests.
	23	Cultural Heritage	D	D	There is no cultural heritage in and around project site
	24	Landscape	D	D	There is no special landscape in and around project site which requires consideration.
	25	Gender	D	D	There is assumed to be no negative impact on gender because of this project.
	26	Children's Rights	D	D	There is assumed to be no negative impact on children's rights.
	27	Infectious diseases such as HIV/AIDS	B-	C	**Under Const.:** There is a possibility that infectious diseases could spread due to the temporary increase of construction workers. **After Operation:** There is a possibility that infectious diseases could spread due to increase of laborers related to port operations.
	28	Work Environment (incl. Work Safety)	C	C	**Under Const.:** Work environment for construction labors needs to be considered according to laws in Myanmar. **After Operation:** Work environment for laborers related to port operations needs to be considered according to laws in

Classification	No.	Evaluation Items	Assessment		Reason for Assessment
			Before /Under Construction	After Operation	
					Myanmar.
Others	29	Accidents	C	C	**Under Const.:** Accidents during construction works and during land/water transport need to be considered. **After Operation:** Accidents could increase due the increase in water/land transport.
	30	Cross-Border Impacts and Climate Change	D	D	**Under Const.:** There is no impact on cross-border and climate change because construction works are temporary and limited around project site. **After Operation:** There is no impact on cross-border and climate change although associated with the increase of land/ water transport there is a possibility that an increase in greenhouse gases could be generated around the new port.

A: Significant negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C: Extent of impact is unknown. (Further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Table 5.5-8 TOR for Environment/Social Considerations

Environment Items	Survey Items	Survey Methods
Examination of Alternatives	① Examination of Terminal Location/ Layout ② Examination of Scope for Urgent Development Plan for Thilawa Area Port ③ Examination of Structure ④ Examination of Construction Method	①～④ Alternatives shall be comprehensively examined from survey results such as environmental/social considerations, future demands, technical issues and total costs, and contents of the discussion below. -Discussions with C/P -Steering Committee -Stakeholder Meeting
Air Pollution	① Current Traffic Volume ② Impact under Construction ③ Impact after Port Operation	① Literature/Interview Surveys ② Field Reconnaissance/Surveys ③ Demand Forecast of Transportation and Impact Forecast/Evaluation based on Interview Survey
Water Pollution	① Current Quality of River Water ② Impact under Construction and after Port Operation	① Field Survey ② Impact Forecast/Evaluation based on Field Survey
Waste	① Disposal Method of Construction Wastes ② Disposal Method of Non-industrial and Industrial wastes	① Interview Survey to related Organizations and Similar Case Research ② Interview Survey to related Organizations
Soil Contamination	① Sediment of sand pit for Reclamation	① Field Survey
Noise/Vibrations	① Current Volume of Transportation ② Impact under Construction ③ Impact after Port Operation	① Literature/Interview Survey ② Field Reconnaissance and Interview Survey ③ Demand Forecast of Transportation and Impact Forecast/Evaluation based on

Environment Items	Survey Items	Survey Methods
		Interview Survey
Bottom Sediment	① Current Bottom Sediment of River ② Impact under Construction and after Port Operation	① Field Survey ② Impact Forecast/Evaluation based on Field Survey
Ecosystem	① Current Ecosystem ② Impact under Construction and after Port Operation	① Field Survey ② Impact Forecast/Evaluation based on Field Survey
Hydrology	① Current Hydrology ② Impact after Port Operation	① Field Reconnaissance and Similar Case Research ② Field Reconnaissance and Similar Case Research
Topography/ Geology	① Current Topography/Geology ② Impact after Port Operation	① Field Reconnaissance and Similar Case Research ② Field Reconnaissance and Similar Case Research
Involuntary Resettlement/Site Acquisition	① Presence of Residents in Project Site and, if yes, it's Scale ② Laws/Regulations/Policy and other similar cases related to EIA/RAP in Myanmar ③ In case involuntary resettlement is required, availability of RAP, countermeasure by Myanmar Government, and it's gap with JICA Guideline ④ In case RAP is not available or RAP has a gap with JICA Guideline, request and support to make RAP(Abridged Edition)	① Satellite Photos of Project Site and Field Reconnaissance to confirm Presence of Residents, Land use, Livelihood (House, Lifeline, Occupation, Property, Income etc.) ② Information from the Internet, Literature Survey, Interview Survey to JICA and C/P and Interview Survey to the related Government and Environment NPO/NGO ③ Interview Survey to the related Government to confirm presence of RAP, and if yes, Confirmation of Consistency between RAP and JICA Guideline Field Reconnaissance and Interview Survey to Residents ④ Request and Support to make RAP (Abridged Edition) in according with Laws/Regulations/ Policy in Myanmar, JICA Guideline, WB Operation Policy 4.12 etc.
Poor People	① Livelihood (House, Lifeline, Occupation, Property, Income etc.) around Project Site and Dumping Site	① Literature Survey and Interview Survey to related Organizations Field Reconnaissance and Interview Survey to Residents
Local Economy such as Employment and Livelihood	① Livelihood (Current Situation of Farming/Fishery) around Project Site and Dumping Site	① Literature Survey and Interview Survey to related Organizations Field Reconnaissance and Interview Survey to Residents
Land Use and Utilization of Local Resources	① Water Quality/Aquatic Resources around Project Site	① Research of Water Quality/Aquatic Resources around Project Site by Subcontract Literature Survey and Interview Survey to related Organizations Field Reconnaissance and Interview Survey to Residents
Water Use	① Current Water Use and Necessary Water Consumption after Operation	① Literature Survey and Interview Survey to related Organizations
Existing Social Infrastructures and Services	① Traffic Volume around Project Site ② Air Pollution/Noise/Vibration around Project Site	① Literature Survey, Interview Survey to related Organizations and Field Reconnaissance ② Survey for Air Pollution/Noise/Vibration

Environment Items	Survey Items	Survey Methods
		around Project Site and Interview Survey to Residents/Neighbors
Infectious diseases such as HIV/AIDS	① Morbidity Rate of HIV/AIDS and other infectious diseases in Yangon Region and around Project Site	① Literature Survey and Interview Survey to related Organizations
Work Environment (incl. Work Safety)	① Laws/Regulations etc. related to Work Environment in Myanmar ② Other Project Cases	① Literature Survey, Interview Survey to JICA and C/P and Interview Survey to related Government and Environment NPO/NGO ② Interview Survey to other Projects
Accidents	① Traffic Volume around Project Site and along Main Routes ② Statistics of Water/Land Transportation Accidents	① Interview Survey to Tollgate of Main Routes ② Interview Survey to related Government and Police and Literature Survey

5.5.5. Survey Results of Environment/Social Considerations

The items that had been categorized into A through C under the scoping process have been surveyed regarding Environment/ Social Considerations in accordance with TOR, and the results are summarized in Table 5.5-9.

Table 5.5-9 Survey Results of Environmental/Social Considerations

Impact Items	Survey Results
Air Pollution	**<Interview Survey>** Thilawa area has been developed since 15~20 years ago, and oil storage facilities are currently under construction in the area (Plot 17,18) which is located about 500m north from the Project Site. Based on this situation, the Study Team carried out an interview survey concerning the time scales and locations below. （For details of the survey, refer to Chapter 7.4.4 ”Interview Survey”） ●Time Scale: 1.After Construction in Thilawa Area was implemented, 2. After Construction of Oil Storage Facilities was implemented ●Location of the Survey: 1.BayPauk, 2.Thanlyin Bridge Route, 3.Dagon Bridge Route ●Answers: 1.Bay Pauk: 13 people among 13 answerers answered, “No change of Air Quality after both time scales”. 2. Thanlyin Bridge Route: 10 people among 10 answerers answered, “No change of Air Quality after both time scales”. 3. Dagon Bridge Route: 10 people among 10 answerers answered, “No change of Air Quality after both time scales”. **<Traffic Volume and Prediction of Air Pollution Material>** According to the result of interview survey at tollgate of Dagon Bridge and Thanlyin Bridge Routes, the current traffic volume per day is as follows. ●Dagon Bridge Route: Large-sized Vehicle 400 nos., Small-sized Vehicle 100 nos. ●Thanlyin Bridge Route: Large-sized Vehicle 400 nos., Small-sized Vehicle 11600 nos. An environmental survey on air quality, noise and traffic volume has been conducted for “The Preparatory Survey on Thilawa Port and Logistic Depot Development” (hereafter PPP Survey). The results of the traffic volume per day are as follows. ANT-1 (represented as Dagon Bridge Route)

Large-sized Vehicle 217 nos., Small-sized Vehicle 255 nos.
ANT-2 (represented ad Thanlyin Bridge Route)
Large-sized Vehicle 366 nos., Small-sized Vehicle 1052 nos.
ANT-3 (represented as surrounding of the current project site)
Large-sized Vehicle 120 nos., Small-sized Vehicle 313 nos.

The numbers in the small-sized vehicles are different, however, the numbers in the large-sized vehicles that dominate the impact on air quality are largely the same, and therefore the results of PPP Survey are adopted.

1. Prediction for "Under Construction"
The filling soil and the most of construction material will be delivered by means of water transportation. It is assumed, in case of land transportation, that about 17,000 nos. of 10ton dump trucks for urgent development (2016) and about 50,000 nos of 10ton dump trucks for overall development plan (2019) are required in case of total volume of the construction material to be handled with 100,000m^3 and 300,000m^3 respectively. This means the traffic volume would increase by 19 nos./day and 34 nos./day, considering the construction period of 2.5 years and 4 years respectively.

2. Prediction for "After Operation"
According to the demand forecast of the Study Team, 190 thousand TEUs of containers will be handled in urgent development plan (Phase1, to be completed in 2016) and among them 135 thousand TEUs are for SEZ and remaining 55 thousand TEUs are transported to Yangon City in 2017. For overall development plan (Phase 3, to be completed in 2019), 800 thousand TEUs of containers will be handled and among them 226 thousand TEUs are for SEZ and remaining 574 thousand TEUs are transported to Yangon City in 2020.

The predicted traffic volume according to PPP survey and the above demand outlook are assumed as indicated in the Table below. During operation, traffic volume of large-sized vehicles increases 260 nos./day in Phase 1 and 1,096 nos./day in Phase 3 assuming that loading volume of a truck is 2 TEU and 365 working days a year. On the other hand the traffic volumes to Yangon City are estimated as 75 nos./day in Phase 1 and 786 nos./day in Phase 3. Ten percent annual increase is assumed for small-sized vehicles.

<table>
<tr><th rowspan="2">Time</th><th colspan="6">Traffic Volume (nos./day)</th></tr>
<tr><th colspan="3">large-sized vehicles</th><th colspan="3">small-sized vehicles</th></tr>
<tr><td rowspan="2">Present
(2013)</td><td rowspan="2">Survey
（ANT-3)</td><td rowspan="2">120
(whole
day)</td><td>97
(day time)</td><td rowspan="2">Survey
（ANT-3)</td><td rowspan="2">313
(whole
day)</td><td>274
(day time)</td></tr>
<tr><td>23
(night time)</td><td>39
(night time)</td></tr>
<tr><td rowspan="2">Phase1</td><td rowspan="2">Increase
190,000
TEU</td><td rowspan="2">380
(whole
day)</td><td>307
(day time)</td><td rowspan="4">Increase
by 10%
annum</td><td rowspan="2">378
(whole
day)</td><td>331
(day time)</td></tr>
<tr><td>73
(night time)</td><td>47
(night time)</td></tr>
<tr><td rowspan="2">Phase3</td><td rowspan="2">800,000
TEU</td><td rowspan="2">1,216
(whole
day)</td><td>983
(day time)</td><td rowspan="2">554
(whole
day)</td><td>484
(day time)</td></tr>
<tr><td>233
(night time)</td><td>69
(night time)</td></tr>
</table>

Source: the Study Team (Current condition from PPP Survey)

The concentrations of air pollution material are estimated with this traffic volume by using the Plume method specified in "Environment Impact Assessment Technique for Road Projects", and an average wind speed of 3 knots (about 1.5 m/s) based on the survey. From the results indicated in Table, it is clear that the change of the pollution material in Phase 1 and Phase 3 is small as compared with the present. In particular, the change at Bay Pauk which is located far from the road edge is within 1% for every material.

Unit: mg/m^3

		NO_2	PM10	CO	SO_2
Standard	Japan	<0.08-0.11	<0.10	<11.6	<0.11
	Thailand	-	<0.12	-	<0.32
Location	Condition				
Road Edge	Baseline (*1)	0.019	0.03	0.708	0.186
	Predicted (Phase1)	0.0201	0.0300	0.7090	0.1862
	Predicted (Phase3)	0.0223	0.0302	0.7107	0.1866
Bay Pauk 600m away from the road edge	Baseline (*2)	0.019	0.06	0.626	0.008
	Predicted (Phase1)	0.0190	0.0600	0.6260	0.0080
	Predicted (Phase3)	0.0191	0.0600	0.6261	0.0080

(*1) 24 hour average figures of survey at ANT-3 (Road edge)

(*2) 24 hour average figures of survey at AN-4(Near project site) except for NO_2 (at ANT-3)

Source: the Study Team (Results of PPP Study)

Water Pollution

<Turbidity>

According to the results of the water quality survey carried out by the Study Team, suspended solid (SS) density is high, ranging from 260～325mg/L at surface and 288～330mg/L at bottom of the river. Values at bottom tend to be higher than those at surface as soil at bottom is circulated due to the fast current of the river.

Turbidity is also high, ranging from 240~270NTU at surface and 245~316NTU at bottom of the river. This result shows that values at bottom tend to be higher than those at surface, the same as SS.

<Organic Contamination>

Among the results of water quality survey carried out by the Study Team (at falling tide), values of biochemical oxygen demand (BOD) are shown in the table below. BOD is high, ranging from 128~288mg/L, which indicates that organic contamination has progressed.

In case port operation gives a negative impact on water quality, values of BOD at S2, where MITT is under operation, are assumed to become higher than other points. However, the results do not have any tendency and values at S2 do not tend to be higher. Moreover, oil content is not found, and coliform bacteria is in the range of >16~21MPN/100mL which is under 400MPN/100mL of IFC sewer standard level.

BOD(mg/L)

Point	S1 Upstream	S2 MITT	S3 Project Site	S4 Downstream	S5 Dumping Site
Surface Layer	288	160	192	128	240
Bottom Layer	192	288	160	240	288

(Prepared by the Study Team)

(For details of the survey, refer to Chapter 7.4.1 "Water Quality Survey")

<Interview Survey>

According to interview survey to MITT about water pollution, they have their own sewage treatment facility in MITT area.

Wastes

<Interview Survey>

1. Construction Site of Oil Storage Facility

Interviews at the construction site of oil storage facility (Plot 17~Plot 18) yielded the following responses.

●Industrial Wastes: Combustible wastes are reused as wood or for fuel.

Incombustible wastes (Blocks, Concrete etc.) are reused as backfilling material.
●Other Wastes: They do not handle or dispose them.

2. Kyauktan Township
Interviews at the Administration Office of Kyauktan Township yielded the following information.
●There is no specific standard/rule for handling/disposing wastes in Kyaukan Township.
●Wastes from port construction/operation in Thilawa Area is out of scope and they do not know the current situation.

<Interview Survey by PPP Study Team>
According to the interview to MITT, the major waste generated during operation is general garbage which is collected by the municipality on a request basis. They explained that they can pass the treatment of the garbage from vessels to the municipality.
According to the interview to Thanlyin Township Municipality which collects the garbage, they are operating 7 trucks which transport the collected garbage to the land disposal area of 5 acres which 1.5 km from Thanlyin Bridge. They also explained that the garbage is collected on request call basis for a fee and without any especial procedure.

<Dredging spoil>
The maintenance dredging for this port will not be conducted due to large depth of -18.0m in front of the project area. The dredging volume in phase 1 will be 160,000m^3 for urgent development plan and 27,000m^3 for Phase 3.

Soil Contamination

The field survey for soil contamination at the planned land filling material and at the project site was conducted. 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.
There is no harmful material that exceeds the standards specified in the above laws in Japan detected at the sand pit and the site.

Table Result of Soil and Sediment Survey

Item		Criteria[1)]	Criteria[2)]	Project site (land)				Off Thilawa			Yangon Riv. Mouth		
				L1	L2	L3	L4	R1	R2	R3	R4	R5	R6
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
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)

Noise /Vibrations

<Interview Survey>
Concurrently with the interview survey of Air Pollution, the Study Team carried out an interview survey for Noise/Vibration regarding the time scales and locations below.
（For details of the survey, refer to Chapter 7.4.4 ”Interview Survey”）
●Time Scale: 1.After Construction in Thilawa Area was implemented, 2. After Construction of Oil Storage Facilities was implemented
●Location of the Survey: 1.BayPauk, 2.Thanlyin Bridge Route, 3.Dagon Bridge Route
●Answers:
1.Bay Pauk: 13 people among 13 answerers answered, “No change of Noise/Vibration after both time scales”.
2. Thanlyin Bridge Route: 10 people among 10 answerers answered, “No change of Noise/Vibration after both time scales”.
3. Dagon Bridge Route: 4 people among 10 answerers answered, “No change of Noise/Vibration after

both time scales", and 6 people among 10 answers answered, "Noise/Vibration has become worse after Time Scale 1".

Worsening of Noise/Vibration is not confirmed at Bay Pauk and Thanlyin Bridge Route (around Thilawa). Most trucks passing through Thanlyin Bridge Route do not handle cargoes. On the other hand, most trucks passing through Dagon Bridge Route are fully loaded and 60% of the people (Banbwegon Area) answered "Noise/Vibration has become worse."

<Prediction of Noise / Vibrations and Traffic Volume>

1. Prediction for "Under Construction"
The large-sized vehicle running during the construction would be increased by 19 nos./day and 34 nos/day (refer to "Air Pollution"). No impacts on noise / vibration due to the current construction equipment and traffic are confirmed in the above interview.

2. Prediction for "After Operation"
According to the results in PPP Study, the noise and vibration are estimated as in the Table below. In association with the increase of the traffic, the noise and vibration are also expected to increase in Phase 1 (to be completed in 2016) and Phase 3(to be completed in 2019). The noise and vibration at Bay Pauk, however, which is located far from the road edge, will remain lower than the standard at present. In this estimation, the survey result at ANT-3 is adopted for the present noise condition, and the increased noise due to the increased traffic is added to that. The vibration is estimated according to the traffic volumes.

Unit: dB

		Vibration (*1)		Noise (*2)	
		daytime	night	daytime	night
Standard	Japan	<70	<65	<60	<50
	Thailand			<70	<70
Location	Condition				
Road Edge	Present	42	24	71	55
	Predicted (Phase1)	50	38	71	57
	Predicted (Phase3)	56	48	72	60
Bay Pauk 600m away from the road edge	Present	36	24	53	39
	Predicted (Phase1)	40	34	54	40
	Predicted (Phase3)	44	39	54	43

Surveyed Noise at ANT3

(*1) predicted max. vibration level in 80% range
(*2) predicted equivalent noise level

Source: the Study Team (Results of PPP Study)

Sediment

As is the case with the Water Quality Survey, sediment survey is carried out at S1 to S5. The dredged material disposal standards (dumping at sea) in Australia which belongs to moderate climate and has an organized-dredging guideline are used for assessment of sediment pollution because there is no sediment standard in Myanmar or in Southeast Asia. In case of above screening level, a negative impact on creatures is possible. Screening level in Australia is generally intermediate of criteria (Level1) in the North Sea region.

<Physical Characteristic>
Silt portion is over 60% at S1~S4 and Clay portion is 56% at S5. Gravity is 2.67~2.70 and water content is in the range of 51.14～69.44%.

<Heavy Metal>
Values of Copper and Nickel are above the screening level. The values of Copper are above at S3~S5,

	and those of Nickel are above at S1~S5. **＜Organic Pollutants＞** DDT is above screening level at S2～S5. （For details of the survey, refer to Chapter 7.4.2 ”Bottom Sediment Survey”） According to the results of the survey carried out by the Study Team, values of copper and nickel among heavy metal and DDT of Organic pollutants are above screening levels, however the values are also in the same level at other survey points and at the dumping site. In case that bottom sediment becomes worse due to port operation, each value at S2 (in front of MITT, which is under port operation) is assumed to be worse. However, the results do not show that values at S2 tend to be higher.
Ecosystem	**<General>** According to the result of ecosystem survey carried out by the Study Team, it is confirmed that there is no threatened species designated in IUCN Red List. Around the Project Site, there is paddy field and the land which was once a paddy field; on river bank, tidal land appears at low tide. Natural vegetation remains only around the Creek and at a part of river bank. The Study Team focuses on the mangrove area and the creek in Plot 26 because the remaining natural vegetation is most important for assessing the impact to the ecosystem. **(For details of the survey for other ecosystem, refer to Chapter 7.4.3 “Ecosystem Survey”)** **<Mangrove Area>** Total area of the project site between Plot23 to 26 (including delta between 25 and 26) is 63.4ha.Vegetation area is 14.2ha and mangrove area is 1.2ha in the total area. Mangrove is growing popularly along the Yangon river and Hmawan river. **<Current Situation of Creek>** The creek in Plot 26 is running 1km from Yangon River to the main route running north-south on the east side of the Project Site and 1km from the main route to land-side paddy field. The total length is approximately 2km. The width of the creek is 8~10m at the mouth of the creek and 2~5m at the main route at the time of survey in rainy season and at high tide. Width of the creek changes depending on tidal level, so that the width is assumed to be less than half during the dry season and at low tide. Water source of the creek mainly comes from Yangon River due to the difference of tidal levels, however the creek also plays a role in draining rain or farming water from land. **<Ecosystem Survey Results of Creek>** Ecosystem survey was carried out using Line Transect Method for plants and Casting Net at 3 points (up/middle/downstream, 3times/points) for fishes from 11 to 15 August, 2012. The survey confirmed the following. 1. Plants: There are mangroves and other bushy trees growing along the creek. Sixteen Families and 21 Species are confirmed, and among them it is confirmed that there is no threatened species designated in IUCN Red List. In terms of Mangroves, 3 species of major, 1 species of minor and 5 species of associated mangroves are found according to Tomlinson’s Definitions (1986). (Coverage of mangrove is currently studying) 2. Fishes: 3 Families and 3 Species of Fishes and 1 Families and 1 Species of Prawns are confirmed, and among them it is confirmed that there is no threatened species designated in IUCN Red List. Small fishes (Catfish) with the size of around 10cm and small prawns were found during survey, however only 0~1 fish per 1 casting net were caught as the fish population is small.
Hydrology	**<Erosion>** Project site is located on the outer side of s-shaped river and always subject to erosion due to the fast

	current of the Yangon River (4~6 knots at Spring Tide). According to satellite photos, river bank has been eroded about 40m for 10 years (4m/year) since 2003 at the s-shaped location of Plot 25 and Plot 26. In addition, according to the topographical survey by the Study Team, slope from river bank to river bottom is steep and approx. 1:1, and the deep portion of the slope has been eroded a maximum of 10m for 2 years (5m/year) since 2010 in front of Plot 25. **（For details of the survey, refer to Chapter 5.3.4 "Channel Maintenance and Dredger"）** **< Similar Case Research >** MITT port is constructed with pile-type jetty structure and it is confirmed that this structure contributes to mitigation of river bank erosion and vegetation regeneration, comparing river bank and vegetation area in MITT port area in 2003 to in 2010. This is because river current speed is decreased at the river bank due to the jetty construction. **<Land drainage>** There are 6 creeks including the creek on Plot26 in/around the project site and in SEZ development area. These creeks are planned to be used as discharge channels at the SEZ development. There is also an outfall channel at west side of the access road.   **Photo Creek on Plot 26** **Photo outfall channel at west side of the access road**
Topography/ Geology	Same survey results as "Hydrology"
Involuntary Resettlement/Site Acquisition	**<Current Situation>** On the north side of the Project Site (Plot 23~26), there is a village called Bay Pauk and 156 households/ 536 people are living in the village. (In this statement, "Village" means not necessarily recognized officially.) The village is spread to the north of Plot 23 and in Project Site, 11 households/42 people are living in Plot 23. Livelihood of the residents in Bay Pauk is mainly fishery and only 2 households are farmer with 1.5 and 0.6 ha (in total 2.1 ha, 21,200m2) of paddy field in Plot 21 and Plot 26. The basic data of Bay Pauk is shown in the table below. (under additional survey by MPA) In terms of Paddy Field in the Project Site, there are in total 23.2ha including the land owned by 2 farmers of Bay Pauk. 8 Indian Myanmar people (all of whom are not residents of Bay Pauk or in Project Site) use the other land as paddy field. (under additional survey by MPA)

Table Basic Data for Bay Pauk

Name of Place	Bay Pauk
Household	156
Population	536
Established Year	1994
Livelihood	Fishery Farmer(2)
Income	3,000 to 10,000 kyats/day
Education	Elementary: 30, Junior High: 20 High: 15 and University/College: 0 (not enrolled 50, Enrollment Ratio 57%)
Power Supply	Generator (6AM~9PM) Buying, 200 kyats/ day for Light
Water Supply	Pond Buying, 200 kyats/ 20 lit

Results of Interview Survey to MPA (MPA), Village Head/Residents of Bay Pauk (BP) and Administration Officer of Kyauktan Township (KT) are summarized as follows. KT is the office directly in charge of resettlement of Bay Pauk or other villages in Kyauktan Township.

<History of Resettlement of Bay Pauk Residents>

1. Bay Pauk Residents had been living in around MITT area (Plot 5~9) called Old Thilawa Village, however because of the development of the area they were resettled in the area on land side called Shwe Pyi Thar Yar Kwat Thite about 15~20 years ago. (MPA, BP, KT)

2. After the (first) resettlement, because almost all residents were fishermen, they sold the given land in Shwe Pyi Thar Yar Kwat Thite for 20,000~30,000kyat and moved to river-side land which is now called Bay Pauk. This move was officially approved by the government. (BP)

3. Other people who were not the residents of Old Thilawa Village and came from other villages are currently included in Bay Pauk. (KT)

<Compensation>

1. Compensation for resettlement from Old Thilawa Village was already agreed. (MPA, BP, KT)

2. Compensation covered for paddy field was 20,000kyat/acre and that for house was the similar land in Shwe Pyi Thar Yar Kwat Thite as Old Thilawa Village. (KT)

3. Supply of electricity and water well was included in the agreed compensation, however it was not provided. Moreover, some households have not received compensation of land so far. (BP)

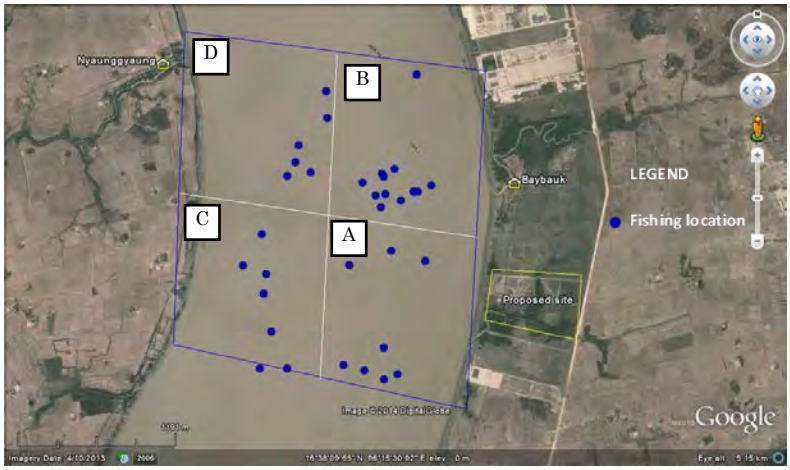
<Resettlement due to this Project>

1. Bay Pauk Residents obtained information of Thilawa Area Development Project and submitted a letter to Township addressed the President in February 2012. The contents of the letter are as follows.

1) History of the Previous Resettlement
They moved from Thilawa Village where they had been living since olden days. They were first given in-land area called Shwe Pyi Thar Yar Kwat Thite, however after discussions with the Dept. of Human Settlement and Housing Development they were permitted to move to Bay Pauk.
2) The government promised to provide electricity and water supply to Shwe Pyi Thar Yar Kwat Thite, however so far none of this has been provided in Bay Pauk and Shwe Pyi Thar Yar Kwat Thite.
3) Compensation for house was just land and they erected their house by themselves without any financial assistance from the government. If there is a new project and they need to be resettled again, they want the government to consider financial assistance (resettlement place on river-side). Moreover, because they have been received discrimination and prejudice from the government, they request to

	improve the situation of the next resettlement for the new project. They recognize the need to resettle, however they would like to be relocated to the river side rather the in-land side. (BP) 2. The department directly in charge of resettlement is Administration Office of Kyauktan Township. They carried out the survey for the actual situation of the statement in the letter above, and reported it to Yangon Region Government in April 2012. However, as of September 2012, it is not clear what action the upper government is taking. (KT) 3. In terms of the resettlement conducted 15~20 years ago, compensation had been agreed upon including provision of new lands on land-side. Moreover, the Project site is owned by MPA and MPA recognizes that there is no problem for resettlement for this Project. (MPA) **<Project Site Plot 23>** There are 11 households/42 residents in Plot 23. Livelihood of all the residents in Plot 23 is fishery. There is no livestock in this area. The current situation of their livelihood, fishery, is as follows. ●Fishing Place: Yangon River, River in front of the Project Site ●Fishing Method: Fixed Net, Bottom Trawling, Casting Net ●Fishing Amount: 30,000Viss/Month (1Viss=about 1.633kg) ●Fishes: Catfish, Soldier Croaker, Hilsa, Seabass etc. According to the result of the Interview Survey, the minimum income of Bay Pauk fisherman is 3,000Kyats/day (3.45USD/day), and considering their workday is 20day/month, their annual income is calculated to be 830USD/year. This is assumed to be the same in Plot 22 and 23. Moreover, each house is wooden stilted house with a size of 30m2, and paddy fields are 17.5acres in Plot 22 and 15acres in Plot 23. **<Plot 25~26 in Urgent Development Plan(Phase1)>** There are no residents in Plot 25~26 which is the area used for the urgent development plan. Some areas of the Project Site are used by farmers as paddy fields. (MPA survey results) According to the Interview Survey to Indian Myanmar people (one of the people who has a paddy field in Plot 25 and 26), the following was revealed. 1. Indian Myanmar People started using this land as a paddy field in 1994~1998. (2 other people started since olden days.) 2. Compensation (20,000Kyats/acre) was made and received for the resettlement 15 years ago. However, they continued their farming at the same location (Plot 25~26) because no project has been started so far. 3. They are not aware of the new Project (Development Plan for Thilawa Area Port). (See ANNEX Resettlement Action Plan(Draft))
Poor People	**<Bay Pauk>** As stated in “Involuntary Resettlement/Site Acquisition” above, the minimum income of Bay Pauk fisherman is 3,000Kyats/day (3.45USD/day), and considering their workday is 20day/month, their annual income is calculated to be 720,000 Kyat (about 830 USD/year). With reference to one of Indexes of Poor People, Access to infrastructure such as electricity and water etc., electricity is supplied from private generators from 6AM to 9PM, and its rates are 300Kyats/day for TV and 200Kyats/day for lighting. Daily life water is stocked in a pond located in the center of the village. The stocked water can be used until 2~3 months later after rainy season and during the other period (3 months/year) or throughout the year they purchase drinking water at a cost of 200Kyats/20liters. In addition, with reference to education level, the number of students is Elementary: 30, Junior High: 20

	High: 15 and University/College: 0, and enrollment Ratio is 57%, which is assumed to be almost same or a little less level compared to that in the other regions. **<Paddy Field User>** The estimated annual income of Indian Myanmar cultivating paddy field in Plot 25 and 26 is 1,675,123 ～4,973,022kyat. The poverty line in Myanmar as defined by UNDP (2011) is 376,151 kyat / person, therefore, the persons in the Project Site are not categorized as 'poor.' (See ANNEX Resettlement Action Plan(Draft))
Local Economy such as Employment and Livelihood	**<Bay Pauk Residents>** According to the Interview Survey, livelihood of 536 residents in or around Project Site (Plot 21~23, Bay Pauk) is mainly fishery. Other livelihoods are farming/domestic livestock breeding for self-sufficiency and/or for additional income. **<Paddy Field User>** Eight Indian Myanmar people are using the land in Plot 23~26 as paddy field. They are also using approximately the same size of lands at the other side of main road as paddy field. (See ANNEX Resettlement Action Plan(Draft)) **<Fishery Activities>** An interview survey was conducted to fishermen from Aouk Taw area and Chaung Wa area. The major fishing method is a gill net and the major fishing ground is around the Aouk Taw area for Aouk Taw fishermen, and river mouth of the Hmaw Wunn Chaung creek and the area from Chaung Wa to Outer-Bar in the Yangon River for the Chaung Wa fishermen.  **Figure Fishing Grounds of Aouk Taw Area and Chaung Wa Area** A monitoring survey was conducted to study a detail fishing activity around the project site from 21st December 2013 to 4th January 2014. Fishermen from Bay Pauk, Nyaung gyaung Thakutpin and Thatkaikwin were found in the survey period. The major fishing method is a gill net on fishing boats and the major fish species are hilsa, soldier croaker and cat fishes. Fishing is conducted all over areas of A, B, C and D with the average number of boats per day are 20, 45, 11 and 24 at each area respectively. The fishing ground is at least 400m from the project site and no fishing activity is found at the river bank of the project site such as beach seine net or set net. Hence, a boat fishing is conducted in the whole area in the Yangon river and no fishing activity which exclusively conducted at the project site is found.

	 **Figure Locations of Fishing Boats in the Survey Area**
Land Use and Utilization of Local Resources	As to Land Use, there is Bay Pauk residential area including house,, pond for water reservoir, boat slip etc. and its size is around 4ha. And there are paddy fields in Plot 23~26 with the total size of 23.2ha. As to Utilization of Local Resources, main utilizations are rice farming using rainfall and water resources (fishery) in Yangon River
Water Use	Three reservoirs, Thilawa , Banbwegon, and Zamani for irrigation and daily water use are found around Thilawa area. The capacities of these reservoirs are 1,360,000m^3, 1,890,000m^3, 6,630,000m^3, and these reservoirs currently generate 5,000m^3/day, 6,400m^3/day, and 17,045m^3/day, respectively. (Total supply 28,445m3/day) (Ministry of Development Affairs) The estimated daily water consumption of the Project is 500 m^3/day for Phase 1, and 1,200 m^3/day for Phase 3.
Existing Social Infrastructures and Services	**<Traffic Volume>** According to the result of the PPP Study,the current traffic volumes of Large-sized Vehicle passing through Thanlyin and Dagon Bridge route are 366 nos/day and 217 nos/day respectively. The increments of traffic volume are 19nos under Construction and 75nos (towards Yangon city) during Operation in urgent development plan (2016) and 34nos under Construction and 786nos (towards Yangon city) during Operation in overall development plan (2019). (See "Air Pollution" and "Noise/Vibration") Loaded trucks are passing through Dagon Bridge route and empty trucks are passing through Thanlyin Bridge route. Therefor the daily increments of trucks of each route halve as 10nos under Construction and 38nos during Operation in urgent development plan (2016) and 17nos under Construction and 393nos after Operation in overall development plan (2019).
Infectious diseases such as HIV/AIDS	**<HIV/AIDS>** Population living with HIV in Myanmar increased rapidly in the 1990's but has tended to decrease after peaking in 2004. However, it is estimated that around 216,000 people are living with HIV in Myanmar as of 2011 (of which 36% were female), 18,000 people died of AIDS‐related illness and 8,000 people were newly infected in 2011[1)] . In addition, data of the Ministry of Health states that HIV was responsible for the largest number of deaths by diseases in 2011[2)]. 1): Global AIDS Response Progress Report Myanmar, National AIDS Programme, 2012. 2): Health in Myanmar 2013, Ministry of Health. Based on statistical data of National Blood Center (NBC) from blood donors, infection rate of HIV/AIDS is 0.25% in 2010 and 0.15% in 2011, which shows a decreasing trend from the 0.55% figure recorded in 2005. There is no specific data in the Project Site, Thilawa Area, however using the data above, it is assumed that there are 12~13 infected persons in case that the total number of laborers becomes 5,000.

<table>
<tr><td></td><td>
<Malaria>
The number of cases of Malaria in 2011 is 3,631 (Outpatient) and 453 (Inpatient), and the number of deaths due to Malaria is 15.
Hotspots of Malaria are 3 townships (Taikkyi, Hlegu and Hmowbi). (Source:JICA Yangon office)

<Dengue Hemorrhagic Fever (DHF)>
The statistics in Yangon Region (not YCDC) are as follows. (Source:JICA Yangon office)

<table>
<tr><th>Area</th><th>Year</th><th>Cases</th><th>Deaths</th></tr>
<tr><td rowspan="5">Yangon Region</td><td>2007</td><td>4786</td><td>54</td></tr>
<tr><td>2008</td><td>3604</td><td>31</td></tr>
<tr><td>2009</td><td>3333</td><td>38</td></tr>
<tr><td>2010</td><td>3162</td><td>21</td></tr>
<tr><td>2011</td><td>576</td><td>4</td></tr>
</table>

The dengue fever, which has hemorrhagic tendency, is generally called DHF, however there is no rigid distinction of DHF in Myanmar.

<Tuberculosis>
The statistics of Yangon Region in 2011 are as follows. (Source:JICA Yangon office)

<table>
<tr><th>Case
(Absolute)</th><th>Case
(per 100,000)</th><th>Smear-Positive Case
(Absolute)</th><th>Smear-Positive Case
(per 100,000)</th></tr>
<tr><td>22,547</td><td>373</td><td>7,672</td><td>127</td></tr>
</table>
"Case of Tuberculosis (absolute)" is calculated by adding together the number of "Smear-Positive Case", "Retreated Case" and so on.

Myanmar is one of 22 high Tuberculosis countries, 27 high multidrug resistance countries and 41 high TB/HIV countries.
According to the survey of morbidity prevalence, the rate in rural areas is higher than that in urban areas. (330.7/100,000people vs. 216.1/100,000people)
</td></tr>
<tr><td>Work Environment (incl. Work Safety)</td><td>As to Work environment during construction and port operation, there is currently no law/regulation in Myanmar related to work environment and work safety. The related laws in Myanmar are as follows. Minimum Wages Law is drafted and Labor Standard Law or Labor Law is examined including name of the law at the time of September 2012.
- Labor Organization Law (2011)
- Settlement of Labor Dispute Law (2012)
- Social Security Law (2012)</td></tr>
<tr><td>Accidents</td><td>The increases of traffic volume are assumed to be10 nos/day during the construction period and 38 nos/day after port operation in urgent development plan and 17 nos/day during the construction period and 393 nos/day after port operation in overall development plan (See Existing Social Infrastructures and Services). Hence, the number of accidents is also assumed to increase.</td></tr>
</table>

5.5.6. Environmental Impact Assessment

The environmental impact on the items that had been categorized into A through C under the scoping process have been assessed on the basis of the environmental survey, and the results are shown in Table 5.5-10.

Table 5.5-10 Environment Impact Assessment based on Survey Results

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
Pollutions	1	Air Pollution	C	C	B	D	**<Under Const.>** According to the Interview Survey to Bay Pauk residents, impact on air pollution associated with the current operations of construction equipment/machines near Bay Pauk is very little. Most of the construction equipment and materials for the Project will be delivered by water transportation and the volume of land traffic increasing in the Project is estimated to be only 34 vehicles/day. Therefore this project will only have a small impact on air pollution. However, countermeasures against dust pollution should be implemented when a large amount of land transportation is necessary to deliver the removed vegetation (at site clearance) or removed surcharge soil after soil improvement. **<After Operation>** According to the Interview Survey, it is not confirmed that there is negative impact on air pollution associated with the increase of traffic volume (cargo trucks) due to the current port operations in Thilawa Area. Also the change in deterioration of air quality due to increase of traffic has been estimated as less than 1% at Bay Pauk area. Hence, the impact on the air quality of the project is limmited.
	2	Water Pollution	B-	B-	B-	B-	**<Under Const.>** Turbid water is anticipated during dredging works at the riverbank (27,000 m^3), disposal of dredged soil, and dredging for collection of land filling materials. Also turbid and muddy surplus water is assumed to flow out from surcharge soil. Yangon River in front of the Project Site is always turbid due to the fast current. Although it is thought that there is little impact on turbidity of river water associated with the construction works, some measures are considered to control excess turbidity (particularly from the viewpoint of preventing accumulation of silt and dispersion of contaminant in the river bed). There is a risk of washing water being discharged into the river at the concreting works, and a risk of oil spill from construction equipment such as pile drivers. Appropriate sewerage treatment is required since up to 250 persons will be engaged in the construction works. **<After Operation>** BOD at the location where MITT is under operation is not high compared to other locations. Moreover, oil content is not found at all locations. Impact on water pollution due to this Project is considered to be small based on comparisons

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							with MITT which is a similar in scale to this Project. However, because MITT has their own sewage treatment facility, drainage from the facilities and the handling yard or oily water generated during operation of this Project also needs to be appropriately treated. The discharge of oil and harmful liquid substance from vessels is regulated under MARPOL Annex II which has been ratified by Myanmar. The impact from the surplus water out of the filling soil will be small because it will be discharged appropriately during the construction phase.
	3	Wastes	B-	C	B-	B-	**<Under Const.>** The wastes such as felled trees, dredged soil, removed soil of land filling, concrete fragments, and oil waste from construction equipment are assumed to be generated. There is no regulation for wastes in Thilawa Area, however proper handling and disposal of construction wastes are required. (For dredging soil during construction , See "Sediment") **<After Operation>** To dispose dredged material for channel maintenance is not included in this Project. However proper handling and disposal of the waste from port facilities and unloaded from ships shall be appropriately treated.
	4	Soil Contamination	C	D	D	N/A	**<Under Const.>** No excess level of contaminant over the standard is detected in the river sand planned to use for reclamation, therefore the risk of soil contamination is low.
	5	Noise /Vibrations	B-	B-	B-	B-	**<Under Const.>** According to the Interview Survey to Bay Pauk residents, impact on noise/vibrations associated with the current operations of construction equipment/machines near Bay Pauk is very small, and the estimated volume of land traffic increasing due to the Project is only 34 vehicles a day. Therefore, the impact on noise/vibrations is expected to be minimal. On the other hand, the noise level of 70 dB at the road edge is observed at present, and there are residences along the way to Yangon, therefore the impact shall be reduced as much as possible. **<After Operation>** According to the Interview Survey, impact on noise/vibrations associated with the current port operations of equipment/machines in Thilawa Area is very small. The predicted noise/ vibrations at Bay Pauk associated with the increase of traffic volume is so lower level than the standards that the impact is considered to be limited. On the other hand, the traffic towards Yangon is estimated to increase by 786 vehicles a day (increase by 393 vehicles

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							a day in Thanlyin Bridge route and Dagon Bridge route respectively), and there is a residence along the way, therefore the impact is to be reduced as much as possible.
	6	Ground Subsidence	D	D	N/A	N/A	N/A
	7	Offensive Odors	D	D	N/A	N/A	N/A
	8	Sediment	C	C	B-	B-	**<Under Const.>** The soil derived from the dredging of this project will be disposed the dumping site around the project site. According to the sediment survey carried out by the Study Team, values of copper and nickel among heavy metal and DDT of Organic Pollutants are above screening level. However the risk by soil dumping may be small because of following reason. London Convention stipulates that soil dumping to freshwater is at country's discretion. Dumping of dredged soil in a river is usually conducted because London Convention is not ratified and there are no regulation on it in Myanmar. According to Australian guideline (Sea Dumping), it is able to dump the dredged soil if the contaminants are lower than the concentration in background even though they are upper than the screening levels. The measured metals and organic pollutants of sand pit were almost same level of the other survey points and dumping site, moreover dredging volume is small with 27,000m^3. Even so, it is required to implement mitigation measures to minimize sedimentation of silt or the spread of contaminated bottom sediment at dredging and disposal of dredged soil. **<After Operation>** Because survey results do not show that values of bottom sediment in front of MITT tends to be higher than those at the other survey points, impact by port operation is considered to be small. Even so, countermeasure for water pollution is required to reduce the sediment pollution (refer to "Water Pollution" above)
Natural Environment	9	Protected Areas	D	D	N/A	N/A	N/A
	10	Ecosystem	B-	C	B-	B-	**<Under Const.>** According to the result of the ecosystem survey carried out by the Study Team, it is confirmed that there is no threatened species designated in IUCN Red List. Moreover, as tidal land is maintained because of jetty type berth structure, the lost area of habitat is thought to be

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							limited. Few mammals which might be affected by noise and vibration are living in the project site because the major portion of the project site is paddy field Birds may be able to escape easily from the noise and vibration because major portion of adjacent area also is paddy field. From these facts, impact on ecosystem due to this Project is considered to be small. Moreover the impact by filling the creek is considered to be small due to the following reasons. 1.There are only small vegetation area(14.2ha) and mangrove area (1.2) in the project area(63.4ha) 2. Mangrove is growing popularly along the Yangon river and Hmawan river 3. There is no threatened species designated in IUCN Red List and the number of fishes is also small in the creek. Therefore, the creek is not thought to play an important role in the important habitat. 4. Small organisms are considered to be able to live because the five other creeks are existed in/around project sites However, In case of land filling using dredged soil, or reclamation and diversion of the creek, some measures are required to control and mitigate turbidity from surplus water and outflow of contaminated materials.(See water pollution) **<After Operation>** Impact for the habitat might be small same as under construction phase. But counter measures for water pollution is required to reduce the impact by water pollution to ecosystem.
	11	Hydrology	C	C	B-	B+	**<Under Const.>** <Land drainage> The creek plays serves as a discharge channel for agricultural and rainfall drainage. This function shall be maintained, as it is planned to be used the discharge channel of SEZ in future. The waterway at the west side of the road is to be secured as well. **<After Operation>** <River flow> It is considered that pile-type Jetty structure contributes to mitigation of river bank erosion because current speed decreases along the river bank due to jetty construction.
	12	Topography/ Geology	D	C	N/A	B+	**<After Operation>** It is considered that pile-type Jetty structure contributes to mitigation of river bank erosion because current speed decreases along the river bank due to jetty construction.

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
Social Environment	13	Involuntary Resettlement/Site Acquisition	B-	D	B-	N/A	**<Before Const.>** <Resettlement in Plot 23> Land acquisition/Resettlement plan is required because 42 residents (11households) are living in Plot 23 < Land Acquisition > Land acquisition/Resettlement plan is required because some lands are used as paddy fields in Plot23~26
	14	Poor People	C	B+	D	D	According to the survey results, there are no Poor people in and around the Project Site.
	15	Minority/Indigenous People	D	D	N/A	N/A	N/A
	16	Local Economy such as Employment and Livelihood	B+	B+	B+	B+	**<Under Const.>** <Job Creation> This Project creates new employment during construction works. <Impact on Fishery Activities> It is assumed that the area approx. 100m from the berthing line becomes off-limits during the construction period. However, since fishing can be carried out on the whole Yangon River, the impact on fishery activities is limited. Marine traffic of dozens of barges a day for sand delivery to the site is assumed in the reclamation plan of the yard, therefore care has to be taken to avoid interference with the fishing activities. Because Yangon River is always turbid, there exist several species such as siluroid, or *Polynemus paradiseus*, etc. which are resistant to turbidity. For this reason, it is considered that the impact on the fishery activities is limited, however, monitoring needs to be conducted. <Impact on Agricultural Activities> Land acquisition/Resettlement plan is required because some lands are used as paddy fields in Plot23~26 **<After Operation>** <Job Creation> Positive impacts on local economy due to new employment during construction and port operation are expected. <Impact on Fishery Activities> Fishery is conducted throughout the Yangon River including surrounding area of the site, and the frontal area of the site is not a special fishing ground. Fishing with gill nets is observed on the water 400m away from river bank, and seine or fixed net are not observed on the river bank of the project site. Approx. 2 or 3 vessel calls a day are expected during operation, and large vessels will pass over

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							installed nets daily. The interview to the residents at Bay Pauk was carried out by the Study Team on September 2012, and it was confirmed that there will no significant impact on the fishery during the construction and operation of the project. Accordingly, impact on the fishery activities is thought to be limited.
	17	Land Use and Utilization of Local Resources	C	C	B-	B-	**<Under Const.>** Although the paddy field will be converted to the port area, the concerned area is 60 ha, therefore the impact on agricultural resources is small. It is necessary to consider surplus water from filling and drainage during construction to prevent a harmful impact on paddy fields. The pile-type Jetty structure will help to minimize the impact on fishery resources. To control excess impact on fishery resources, some measures for water turbidity are considered. (refer to "Water Pollution" and "Ecosystem") **<After Operation>** No activities affecting agricultural resources are anticipated. The impact on water turbidity is considered to be small based on a comparison with MITT which is similar in scale to this Project. Although there is little impact on agricultural resources as well, some measures to control excess water turbidity are required. (refer to "Water Pollution")
	18	Water Use	D	C	N/A	C	**<After Operation>** The estimated daily water consumption for the Project is 1,200 m^3/day. The specific water supply is under study by MPA. To ensure the water supply is provided in a safe manner, the actual supply method shall be determined through the discussions with MOC, MOI, etc.
	19	Existing Social Infrastructures and Services	C	C	D	D	**<Under Const.>** The increment of traffic volume by the construction related truck is predicted to be only 17 vehicles in Thanlyin and Dagon bridge route. Therefore the impact to existing social infrastructures is limited. **<After Operation>** The increment of traffic volume by the cargo truck is predicted to be 393 vehicles in in Thanlyin and Dagon Bridge route respectively. Therefore the impact on existing social infrastructures is limited.
	20	Social Institutions such as Social Infrastructure s and Local	D	D	N/A	N/A	N/A

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
		Decision-Making Institutions					
	21	Misdistribution of Damages and Benefits	D	D	N/A	N/A	N/A
	22	Local Conflicts of Interests	D	D	N/A	N/A	N/A
	23	Cultural Heritage	D	D	N/A	N/A	N/A
	24	Landscape	D	D	N/A	N/A	N/A
	25	Gender	D	D	N/A	N/A	N/A
	26	Children's Rights	D	D	N/A	N/A	N/A
	27	Infectious diseases such as HIV/AIDS	B-	C	B-	B-	**<Under Const./After Operation>** The infection rates of HIV, DHF and Tuberculosis show a decreasing tendency, however they are still higher than other countries. HIV infections and so on have the potential to spread through employing construction labors and port workers.
	28	Work Environment (incl. Work Safety)	C	C	B-	B-	**<Under Const./After Operation>** Because there is currently no law/regulation in Myanmar related to work environment and work safety, it is required to establish the standards to be used in the Project.
Others	29	Accidents	C	C	B-	B-	**<Under Const./After Operation>** Statistics of both water/land traffic accidents are not clear. The mitigation measures are required for the increase of traffic accidents associated with the increase of traffic volume during construction and after port operation.
	30	Cross-Border Impacts and Climate Change	D	D	N/A	N/A	N/A

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

5.5.7. Mitigation Measures

The mitigation measures required to be carried out during construction and operational phase are indicated in Table 5.5-11 for the items with categories of A through C in the environmental impact assessment.

Table 5.5-11 Mitigation Measures

No.	Impacts	Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
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.	Contractor	MPA	To be included in the construction cost
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.	Contractor	MPA	①③④⑤To be included in the construction cost ②Determined at Detailed Design
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.	Contractor	MPA	①②To be included in the construction cost
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.)	Contractor	MPA	①②To be included in the construction cost
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.	Contractor	MPA	①Nil （included in the cost for "Water Quality"） ②Determined at Detailed Design
10	Ecosystem	①To install green-belt in the yard ②To conduct water pollution counter measure to reduce ecosystem deterioration	①MPA ②Contractor	MPA	To be included in the construction cost

No.	Impacts	Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
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 access road	Contractor	MPA	To be included in the construction cost
13	Involuntary Resettlement/Site Acquisition	To prepare land acquisition/Resettlement action plan before commencement of the project The following counter measures are assumed at current moment ①Residents in Plot23 Although the residents need to move before project starts, the following mitigation measures is required to avoid a rapid change in their living arrangement. Compensation items are assumed to be relocation of housing and installing infrastructures. Moreover, restoration of livelihood may be prepared as necessary ②Paddy Fields in Plot23~26 They use not only paddy fields in Plot 23~26 but they also use those located on east-side of main route and Their income is enough (a few thousands USD) compared to other residents. But, because living standard must be maintained restoration of livelihood will be prepared.	MPA	MPA	Determined at Detailed Design
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	①②Contractor ③MPA	①②MPA ③MPA	①②To be included in the construction cost ③Determined at Detailed Design
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")	Contractor	MPA	To be included in the construction cost
27	Infectious diseases such as HIV/AIDS	To educate construction workers on prevention against infectious diseases (HIV/AID etc.) at safety induction course	Contractor	MPA	To be included in the construction cost
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.)	Contractor	MPA	To be included in the construction cost
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,	Contractor	MPA	To be included in the construction cost

No.	Impacts	Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
		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	① ② MPA ③ ④ Port Operator	MPA	To be included in the operation cost
3	Wastes	①To prohibit disposal to the river and any place without permit and direction ②To promote recycle and handle waste properly	①MPA ②Port Operator	MPA	②To be included in the operation cost
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.)	Port Operator /Forwarder	MPA	N/A
8	Sediment	To conduct water pollution counter measure to reduce deterioration of sediment	Port Operator	MPA	To be included in the operation cost
10	Ecosystem	To conduct water pollution counter measure to reduce ecosystem deterioration	Port Operator	MPA	To be included in the operation cost
17	Land Use and Utilization of Local Resources	To conduct water pollution counter measure to reduce impact on agricultural resources	Port Operator	MPA	To be included in the operation cost
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	MPA	MPA	-
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	Port Operator	MPA	To be included in the operation cost
28	Work Environment (incl. Work Safety)	To establish and comply with safety standards for operation site	Port Operator	MPA	To be included in the operation cost
29	Accidents	To plan and comply with on-land and marine traffic regulation/rules for project	Port Operator	MPA	To be included in the operation cost

5.5.8. Monitoring Plan

The monitoring plans required before and during construction and during operation are summarized in Table 5.5-12.

Table 5.5-12 Monitoring Plan

Items	Monitoring Items	Monitoring Points	Frequency (Duration for Operation Phase)	Implementation Organization
【Before Const. 】				
Involuntary Resettlement/Site Acquisition	Progress of resettlement and income restoration measures	-	1~4 times a year	MPA
Local Economy such as Employment and Livelihood	Progress of resettlement and income restoration measures	-	1~4 times a year	MPA
【During Const. 】				
Air Pollution	Countermeasures for dust prevention	Construction site	once a month	Contractor
Water Pollution	①During riverbank dredging, disposal of dredged soil to river, and dredging for the collection of landfill material a. turbidity survey (temperature, turbidity in SS, pH, and salinity) b. countermeasures for turbid water at disposal to river c. other countermeasures for turbidity	a. Upstream & downstream at working site b,c. working site	a. once a week at working site b,c. once a month	Contractor
	②a. Turbidity survey of surplus water from land filling (temperature, turbidity in SS, pH, salinity, and visual check on oil content) b. Countermeasures for securing drainage at construction (discharge channel, etc.)	a.b. Drainage and upstream & downstream of Yangon River	a. once a week at working site b,c. once a month	Contractor
	③Condition of waste water during washing concrete works, etc.	Construction site	Once a Month	Contractor
	④Maintenance of construction equipment and prevention measures for oil spill	Construction site	Once a Month	Contractor
	⑤Condition and maintenance of temporary toilets and septic tanks	Construction site	Once a Month	Contractor
Wastes	①Records for types/amount/disposal methods of Industrial Wastes	Construction site	Once a Month	Contractor
	②Countermeasures for turbid	the same as	the same as “Water	Contractor

Items	Monitoring Items	Monitoring Points	Frequency (Duration for Operation Phase)	Implementation Organization
	water when disposing dredged materials in river (the same as "Water Pollution")	"Water Pollution"	Pollution"	
Noise/Vibrations	①Maintenance condition of construction equipment	—	Once a month	Contractor
	②Situation of route setting, consideration to the inhabitants and road users (ensuring of strict abidance of speed limit and avoidance of unnecessary revving/idling near residential area, etc.)	—	Once a month	Contractor
Sediment	①Countermeasures for turbid water (the same as "Water Pollution")	the same as "Water Pollution"	the same as "Water Pollution"	Contractor
	②Sediment monitoring before/after disposal (Specific gravity, Water content, Grain size, TOC, Arsenic, Cadmium, Chromium, Lead, Copper, Nickel, Zinc, DDT)	Dumping site	3 times before/intermediate/after disposal	Contractor
Ecosystem	①Condition of installed green-belt in the yard	Installation site	Per Construction Specification	MPA
	②Countermeasures for turbid water (the same as "Water Pollution")	the same as "Water Pollution"	the same as "Water Pollution"	Contractor
Hydrology	Condition of securing cross-sectional area of discharge to the creek and the drainage	Location of installation	Per Construction Specification	MPA
Involuntary Resettlement/Site Acquisition	Progress of income restoration measures	—	1-4 times a year	MPA
Local Economy such as Employment and Livelihood	①Countermeasures for turbid water (the same as "Water Pollution")	the same as "Water Pollution"	the same as "Water Pollution"	Contractor
	②Extent to which fishery activities can be secured	—	Once a Month	Contractor
	③Progress of income restoration measures	—	1-4 times a year	MPA
Land Use and Utilization of Local Resources	①Condition of installed temporary discharge channel during construction	Construction site	Once a Month	MPA
	②Countermeasures for turbid water (the same as "Water Pollution")	Construction site	Once a Month	MPA
Infectious diseases such as HIV/AIDS	Achievement of the education of construction workers on prevention activities taken	Construction site	Once a Month	Contractor

Items	Monitoring Items	Monitoring Points	Frequency (Duration for Operation Phase)	Implementation Organization
	against infectious diseases (HIV/AID etc.) at safety induction course			
Work Environment (incl. Work Safety)	Site condition according to the safety standards for project site	Construction site	Once a Month	Contractor
Accidents	Achievement of the plan and marine traffic regulation/rules for project	Construction site	Once a Month	Contractor
【Operation Phase】				
Water Pollution	①Condition of installed septic tank, etc.	Location of installation	Per Construction Specification	MPA
	②Condition of preparation of oil separator, etc.	Location of installation	Per Construction Specification	MPA
	③Maintenance of septic tank and oil separator, etc.	Location of installation	Once a year (during 3 years)	Terminal operator
	④water quality at drainage or surrounding of the port (temperature, turbidity in SS, pH, salinity, oil content, BOD, COD, Bacillus coli)	Drainage outlet (2 points or more), in front of the port (2 points or more upper & lower layers)	4 times a year (during 3 years)	Terminal operator
Wastes	Records for types/amount/disposal methods of Industrial Wastes	Port Facility	4 times a year (during 3 years)	Terminal operator
Noise/Vibrations	①Maintenance condition of cargo truck	―	Once a year (during 3 years)	Terminal operator
	②Situation of consideration to the inhabitants and road users (ensuring of strict abidance of speed limit and avoidance of unnecessary revving/idling near residential area, etc.)	―	Once a year (during 3 years)	Terminal operator
Sediment	Countermeasures for turbid water (the same as “Water Pollution”)	the same as “Water Pollution”	the same as “Water Pollution”	Terminal operator
Ecosystem	Countermeasures for turbid water (the same as “Water Pollution”)	the same as “Water Pollution”	the same as “Water Pollution”	Terminal operator
Land Use and Utilization of Local Resources	Countermeasures for turbid water (the same as “Water Pollution”)	the same as “Water Pollution”	the same as “Water Pollution”	Terminal operator
Water Use	Method of water supply and water consumption	―	Once a year (during 3 years)	Terminal operator

Items	Monitoring Items	Monitoring Points	Frequency (Duration for Operation Phase)	Implementation Organization
Infectious diseases such as HIV/AIDS	Achievement of the education of port workers on prevention activities taken against infectious diseases (HIV/AID etc.) at safety induction course	―	Once a year (during 3 years)	Terminal operator
Work Environment (incl. Work Safety)	Site condition according to the safety standards for project site	Operation site	Once a year (during 3 years)	Terminal operator
Accidents	Achievement of the plan and marine traffic regulation/rules for project	Operation site	Once a year (during 3 years)	Terminal operator

5.6. Port Management and Operation System

In Thilawa Area, several port development projects are under way and only eight plots are vacant and available for new port development (Table 5.5-1). Consequently, the development scheme for the five plots targeted in this Study should be examined bearing in mind that they are precious waterfront for Myanmar. PPP (Public Private Partnership) schemes adopted in Asia are analyzed below to come up with recommendable port management schemes for Thilawa Area Port.

Table 5.6-1 Current situation of Thilawa Area

Plot No.	Owner's Name	Situation	Main Cargo
1	Myat Myatta Mon Company Limited {PLOT 1,2(A)} Apex Gas & Oil Public Co., Ltd. {PLOT 1,2(B)}Shwe Taung Company Ltd.{PLOT 1,2(C)}	Under Construction	Fuel
2			
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	General Terminal
29	Myanma Agricultural & General Development Public Co., Ltd. {PLOT29}	Document Processing	General Terminal
30	Diamond Star Co., Ltd. {PLOT 30}	Document Processing	General Terminal
31	MPA Plot ⅔ {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

5.6.1. Emergence of PPP as Alternative Port Management System

PPP scheme is widely applied in the port sector in both developed countries and developing countries. The background behind this is summarized as follows:

- ✧ Lack of public funds for infrastructure development
- ✧ Inefficient management by the public sector
- ✧ Need of rapid infrastructure development/improvement and flexible management
- ✧ Competition with neighboring ports

PPP scheme has several advantages over conventional ways in port development and management. PPP benefits the general public in realizing rapid development of infrastructure with public and private funds as well as efficient management supported by entrepreneurship. Governments also enjoy benefits of PPP through the saving of public funds and, in some cases, transfer of infrastructure after the concession period. The private sector finds merit in PPP through acquiring business opportunities in terminal management on the one hand and reducing business risks by public involvement on the other hand.

5.6.2. PPP in the Port Sector

(1) Port management schemes

The various of port management schemes applied in ports in the world can be categorized into four groups: public service port, tool port, landlord port, and private service port.

1) Public service port

Public service port is a kind of port where the public sector is responsible for all areas of port development and management including master plan, construction of infrastructure (wharf, land reclamation, dredging, and breakwater), procurement of superstructure (equipment/warehouse), land ownership, port management, and terminal operation. On the other hand, the private sector is not involved in port development and management. This scheme is not adopted in Japan because the private sector is responsible for cargo handling in Japanese ports.

2) Tool port

In tool ports, the private sector is responsible for terminal operation and the rest of port activities are taken care of by the public sector such as master plan, construction of infrastructure, procurement of superstructure, land ownership, and port management. This scheme is adopted in public terminals in Japanese ports managed by prefectural/municipal governments.

3) Landlord port

Landlord port concept is widely applied in privatized ports around the world. In this scheme, the public sector is responsible for master plan, land ownership, port management, and, in Pattern A, construction of infrastructure. The private sector, on the other hand, takes care of procurement of superstructure, terminal operation, and, in Pattern B, construction of infrastructure. Pattern A is adopted in container terminals in major Japanese container ports. Pattern B is increasingly adopted in container terminals developed by mega operators such as Phase-2 of Suez Canal Container Terminal (SCCT) in East Port Said developed by APMT.

4) Private service port

Private service port is the opposite concept of public service port where the public sector is not involved in port development and management. The private sector is responsible for master plan, construction of infrastructure, procurement of superstructure, land ownership, port management, and terminal operation. This concept is not applied in Japan because the public sector (central government and local government) is responsible for master plan.

(2) Alternative means of private sector participation

There are various alternatives to invite private sector participation in the port sector. In some tool ports, the government and private companies make a management contract with which the public sector pays a management fee to a private operator. In some other tool ports, the government issues a license to a private company for terminal operation. For a landlord port (pattern A), a lease contract can be applied with which private companies pay a lease fee to the government. For a landlord port (pattern A and B), a concession contract can be applied with which private companies pay a fixed lease fee and variable fee depending on the revenue to the government. Typical concession period is 30 years. In pattern B, transfer of facilities to the public is expected upon completion of the contract (BOT).

(3) Asian experiences

1) Indonesia

Indonesia established new maritime act in April 2008. Former omnipotent public corporation (Indonesian Port Corporation I-IV) was converted to a terminal operator and thus public service ports gave way to landlord ports. Indonesian Ministry of Transport acts as a landlord. Koja Container Terminal in Tanjung Priok (Jakarta) is operated based on the agreement established in 1994 between Indonesian Port Corporation II (Pelindo II) and a private company (PT Humpuss Terminal Petikmas). The agreement for the construction and management of the terminal is effective for 20 years starting from the operation commencement in 1998. Humpuss later sold the business to Hutchison Port Holdings. Currently, Pelindo II has the ownership of 52.12 % with the remaining 47.88 % is owned by

PT Huchison Ports Indonesia.

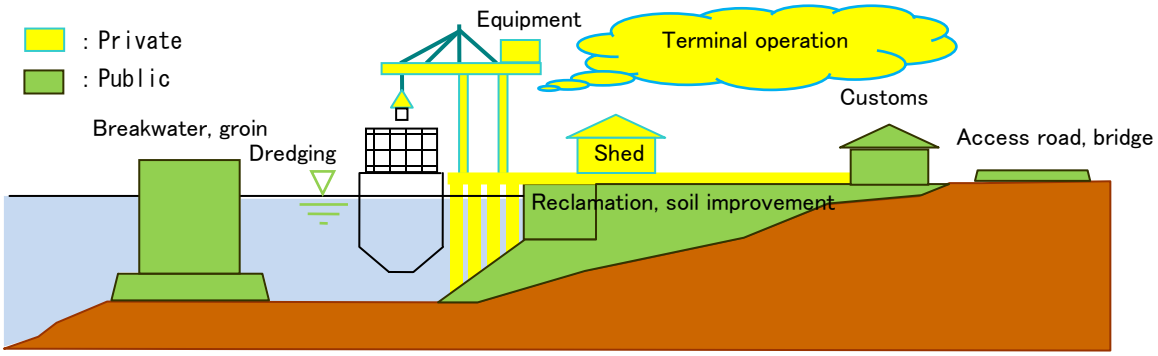
2) Vietnam

Public service ports are giving way to landlord ports in Vietnam as well. Concession process is underway in major ports, Lach Huyen in the north and Cai Mep-Chi Vai in the south. Different PPP schemes are underway in the two ports taking advantage of Japanese ODA loan (Table 5.5-2, 3, Figure 5.5-1, 2). A marked difference between the two schemes is which party (public or private) is responsible for the construction of the jetty and procurement of the equipment. This should be determined by financial analyses so that the project would be beneficial to both parties. Experiences in Vietnam can serve as good references for the PPP policy to be applied in Myanmar.

Table 5.6-2 PPP scheme for Lach Huyen Port in Vietnam

Project components	Specification	Project costs/Project schedule	Investment/PPP scheme	Operator
Container terminal	2 berths (750 m in length with the alongside depth of 14 m)	160 billion yen (21 billion yen of yen loan) Construction starts in 2013 and will be completed in 2016	Public (reclamation and dredging) Private (jetty and equipment) 50-year concession agreement (jetty and equipment will remain the property of the private investor)	Hai-phong International Container Terminal (JV established by Japanese companies and Vinalines
Breakwater	3,230 m		Public	
Sediment control groin	7,600 m		Public	
Access road	16 km (including a 5-km bridge)		Public	

Source: MLIT



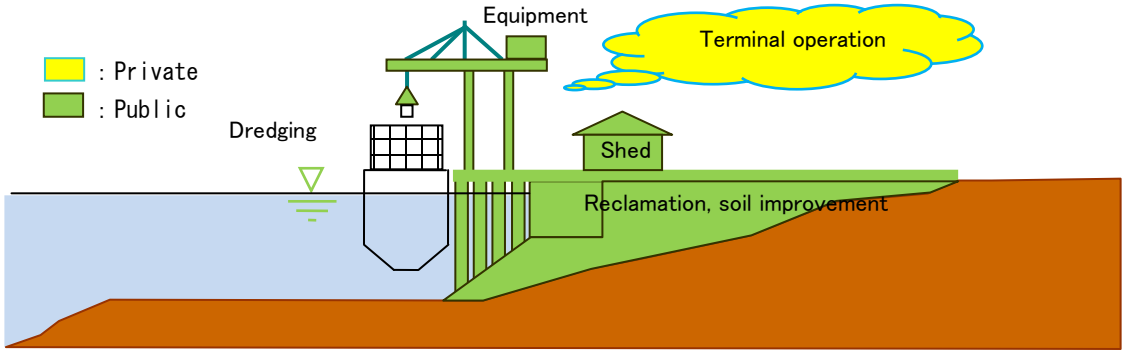
Source: MLIT

Figure 5.6-1 PPP scheme for Lach Huyen Port in Vietnam

Table 5.6-3 PPP scheme for Cai-mep Chivai Port in Vietnam

Project components	Specification	Project costs/Project schedule	Investment/PPP scheme	Operator
Container terminal	2 berths (600 m in length with the alongside depth of 15 m)	36 billion yen (yen loan) Construction starts in 2008 and will be completed in 2013	Public (reclamation, jetty and equipment) PPP scheme is under consideration	Private (to be determined)
Multi-purpose terminal	2 berths (600 m in length with the alongside depth of 12 m)			
Access channel	Channel depth of 14 m		Public (dredging)	

Source: MLIT



Source: MLIT

Figure 5.6-2 PPP scheme for Cai-mep Container Terminal in Vietnam

5.6.3. Port Management System Recommendable for Thilawa Area Port

(1) PPP schemes to be examined

As described in the previous section, various schemes have been adopted for port privatization in Myanmar. BOT is adopted in MITT in Thilawa Area and sellout is adopted in Bo Aung Gyaw Terminal. A JV composed of MPA and a private company is expected to carry out the renovation of Sule Pagoda Terminal. Some plots of Thilawa Area were also sold out to a private company. In order to support the future economic expansion of Myanmar, it is imperative for the Myanmar Government to ensure sufficient cargo handling capacity in Thilawa Area. If a plot is sold out to a private company, the government would not be able to prevent the company from converting the waterfront to a non-transportation function. On the other hand, the government and private sector can enjoy a win-win situation in a BOT scheme or JV scheme (Table 5.5-4). In this regard, the Myanmar Government is recommended to retain ownership of the target plots.

Table 5.6-4 Port privatization schemes in Myanmar

Terminal	Privatization scheme	Advantages		Disadvantages	
		For the government	For the private sector	For the government	For the private sector
MITT, AWPT, MIP	BOT of various contract duration	Retention of land ownership, revenue of lease fee, efficient operation by entrepreneurship	Phased investment responding to the cargo volume		
Bo Aung Gyaw	Sellout	Revenue of sale, no need for budgetary allocation, decrease of the public workforce, efficient operation by entrepreneurship	Total managerial control of the terminal, no intervention from the government	Loss of the land ownership and managerial control of the terminal, no future revenue from the terminal	One-time large expenditure for the buyout
Sule Pagoda Terminal No. 1, 2, 3, 4 (plan)	JV (MPA and a private company)	Retention of land ownership, revenue of lease fee and terminal operation, efficient operation by entrepreneurship	Reduction of the political risk such as changes in laws by means of the formation of JV with a government entity		

Source: JICA Study Team based on interviews with terminal operators

Although no government investment is so far involved in the existing BOT terminals in Myanmar, the Government can reduce the business risk of the private sector by incurring infrastructure and superstructure development costs. To assist the governments of developing countries in this regard, the Japanese Government has extended ODA loans in several port development projects as exemplified in the previous section. In these examples, the Government in developing countries incurred infrastructure and/or superstructure development costs with Japanese ODA loan of concessionary conditions. This scheme is recommendable for a project which entails large development costs and a moderate level of business risks for the private sector. It also has variations depending on the distribution of components between the two parties (Table 5.5-5). Case-1 and 2 can be further divided into two subcases each depending on the owner of the private components upon completion of the concession contract.

In order to come up with the most appropriate PPP scheme, the financial implication of these cases needs to be examined through financial analyses. As of February 2013, the Japanese side and Myanmar side are discussing the application of Case-4 to the Urgent Development Plan of Thilawa Area.

Table 5.6-5 Variations of PPP schemes for container terminals

Case	Public components	Private components	ODA loan	Example	Advantages over Case-1
Case-1	None	Reclamation, jetty, equipment, pavement	None	MITT, AWPT, MIP, Sule Pagoda (plan)	
Case-2	Reclamation, soil improvement	Jetty, equipment, pavement	Japanese yen loan	Lach Huyen (Vietnam)	● Reduction of terminal charges due to the low interest finance ● Reduction of business risks for the private sector
Case-3	Reclamation, soil improvement, jetty, quayside gantry, RTG, pavement, building	Yard equipment	Japanese yen loan	Cai-mep (Vietnam)	● Reduction of terminal charges due to the low interest finance ● Reduction of business risks for the private sector ● Smooth coordination of civil works and equipment installment
Case-4	Reclamation, soil improvement, jetty, quayside gantry, RTG, yard equipment, pavement, building		Japanese yen loan		

(Prepared by the Study Team)

(2) Selection of the Operator in the renovation of Sule Pagoda Terminal

In considering contracting procedure for PPP port projects, Sule Pagoda Terminal Upgrading Project (Figure 5-6-3), now under the tendering process to choose the JV partner with MPA, serves as a good reference. An example of container terminal operation by JV composed of the port authority and a private company is seen in Koja Container Terminal in Tanjung Priok, Jakarta (See 5.6.2 (3)). The procedures applied in Sule Port Project are described below. As of January 2013, they are in stage f). Since the highest ranking bidder failed to submit the required documents, MPA is now negotiating with the second-highest ranking bidder. These procedures were not taken in the development of MITT. The BOT contract was signed following a proposal from the Hutchison Group in 1996, when foreign investment to Myanmar was rare.

a) Announcement of the tender in newspapers two months before the tender opening date

b) Both local and foreign investors are eligible

c) Open the tenders in front of the bidders and media

d) The Tender evaluation committee (Chairman/MOT Deputy Minister, Member: MD of Shipyard, MD of MPA, DG of DCA, GM of MPA, Heads of Department of MPA, Deputy Chief Civil Engineer) evaluate tenders based on the criteria announced to the bidders

beforehand

e) Evaluation result is submitted to the Management Committee of MOT

f) MPA starts contract negotiation with the winning bidder in the order of the evaluation score. The bidder is requested to submit relevant documents (company profile, financial statement and architectural design). After they reach an agreement, the contract needs to be confirmed by the Attorney General and approved by MIC.

The following criteria are applied to evaluate tenders:

a) Requested documents and tender guarantee are submitted

b) JV equity ratio (higher ratio of MPA is rated higher)

c) Investment amount of a private company (larger amount is rated higher)

d) Land lease rate (larger amount is rated higher)

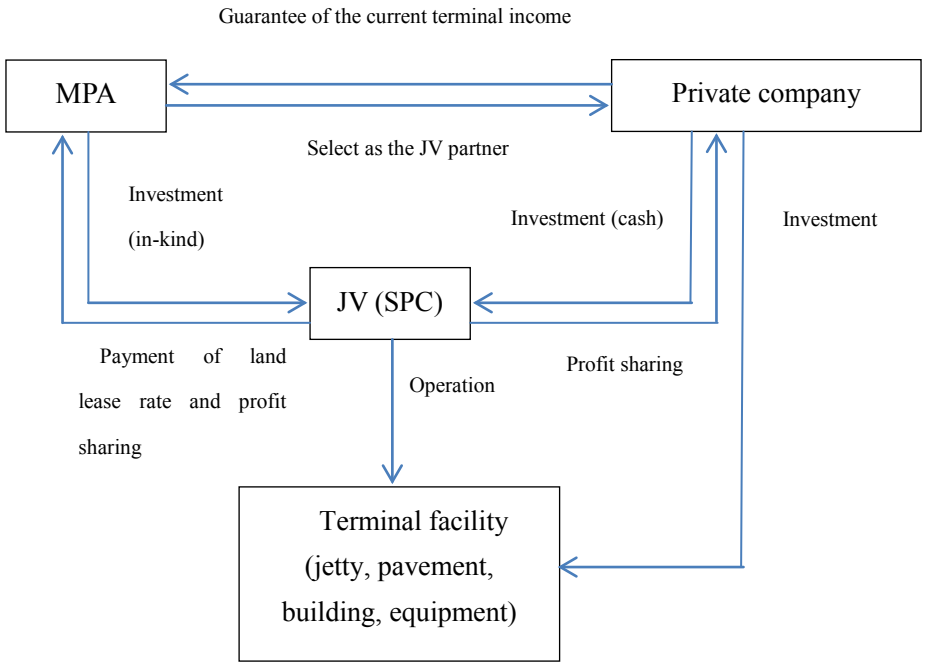


Figure 5.6-3 PPP Scheme for Sule Pagoda Terminal Renovation Project

(3) PPP scheme and selection of the operator for Urgent Development Plan of Thilawa Area

JV scheme (composed of MPA and a private company) is expected to be applied to the renovation of Sule Pagoda Terminal and Urgent Development Plan of Thilawa Area. In the former project, the risk MPA takes is small because a private company is responsible for the construction/procurement of jetty, pavement, and equipment (corresponding to Case-1 in Table 5.5-5) and MPA receives the fixed land lease rent and guaranteed terminal revenue. On the other hand, if

Case-4 is applied to Urgent Development Plan of Thilawa Area, its PPP scheme should be designed to ensure the repayment of interest and principal of Japanese ODA loan by MPA. Another difference between the two projects is that MPA earns revenue from the existing Sule Pagoda Terminal but not from Urgent Development Plan of Thilawa Area which is a new development. Bearing these in mind, 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 5.6-4). JV (SPC) is expected to pay the fixed fee as is the case with Sule Pagoda Terminal.

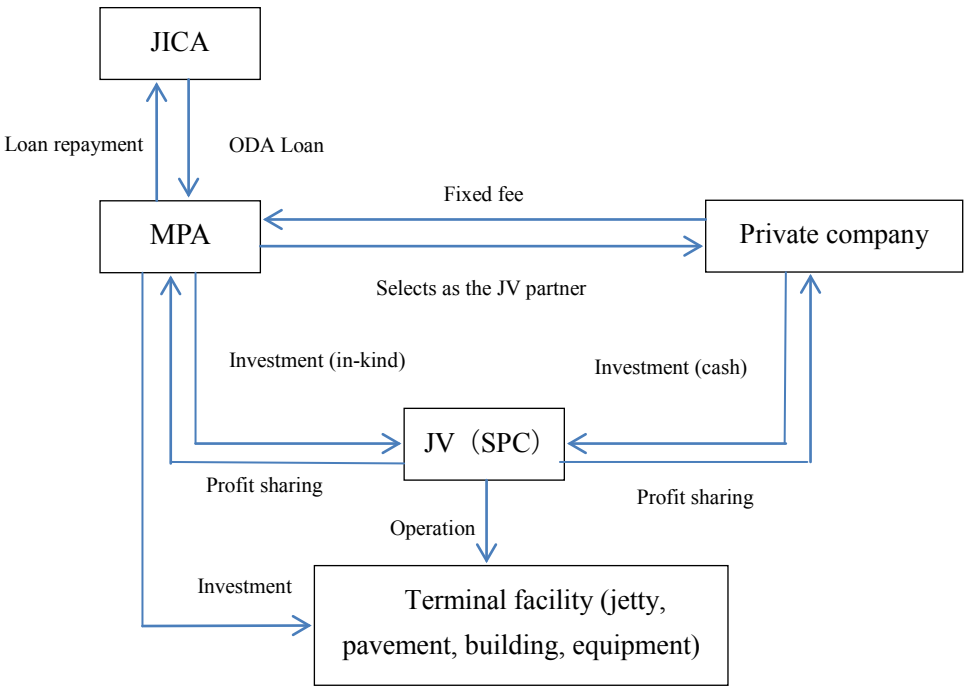


Figure 5.6-4 PPP scheme for Urgent Development Plan of Thilawa Area (JV scheme)

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.

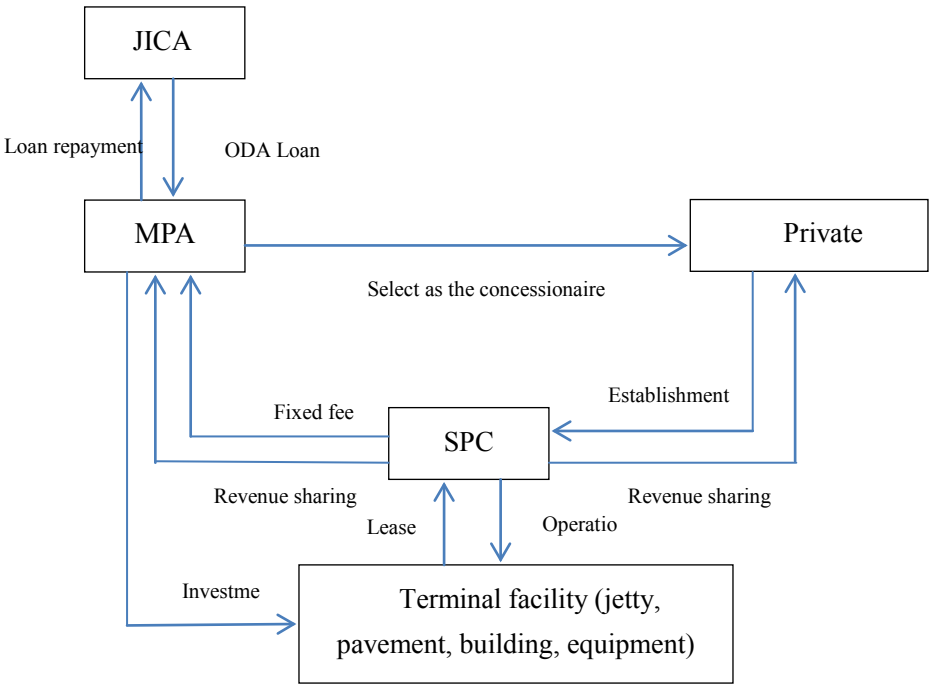


Figure 5.6-5 PPP scheme for Urgent Development Plan of Thilawa Area (lease scheme)

5.6.4. Public Private Partnership Scheme Application to Thilawa Area Terminal

(1) Reduction of Start-up Risks

Development and operation of a port terminal in developing countries entails a variety of risks. In order to encourage foreign investment, reduction of start-up risks is particularly important. Considering the economic and social conditions relative to Thilawa Area Port development, JICA Study Team identified major risks and proposes their countermeasures (Table 5.6-1).

Table 5.6-6 Measures to Reduce Private Sector's Risks for a PPP terminal in Thilawa

Risks	Countermeasures	Remarks
Insufficient cargo volume in the early stage of operation	✓ Discount of the fixed portion of the concession fee in the early stage for sharing the risk among the contracting parties ✓ Steady development of SEZ and its cargo generation	✓ No operator can make profits until the volume reaches a certain level ✓ Coordination with SEZ development is required
Exercise of the "exclusivity clause" of the MITT concession contract	✓ Close monitoring of cargo demand for Thilawa Area Port	✓ Threshold of the "exclusivity clause" fluctuates depending on the number of gantries installed in MITT
Competition with other terminals resulting in handling charge discount	✓ Provision of high-quality logistics services	✓ Terminal operator has to compete with MITT currently providing inland transportation services with its own trucks
Development of competing terminals in the adjacent area	✓ Inclusion of the right of first refusal on a new container terminal development in the concession contract ✓ Inclusion of the exclusivity clause in the concession contract	✓ Oversupply of terminal capacity in the region is harmful for the financial soundness of the PPP terminal ✓ Consistency with the exclusivity clause of the MITT concession contract is required
Unfair treatment of privatized terminals	✓ Fair treatment of all terminals by MPA	✓ Currently, kyat-based port tariff is applied for Myanmar shipping companies whereas dollar-based tariff is applied for foreign shipping companies
Delay in the port infrastructure development by the government	✓ Arrangement of reliable financing source for the government development components ✓ Compensation for the loss	✓ Finance by yen loans can provide reliable financing source

	incurred by the concessionaire	
Negligence of maintenance dredging leading to the loss of the required draft	✓ Pledge of steady maintenance dredging by MPA	
Delay in the related infrastructure development (road, rail, power, water, SEZ) by the government	✓ Pledge of related infrastructure development by the government	
Slowdown of the economic development	✓ Steady development of SEZ and its cargo generation	✓ Coordination with SEZ development is required
Political risks (example) ✓ Change of laws and regulations ✓ Currency convertibility restriction ✓ Prohibition of fund repatriation	✓ Appropriate risk sharing scheme needs to be established in the concession contract ✓ Inclusion of corresponding clauses such as force majeure and resulting contract modification ✓ Establishment of JV with a government entity	✓ New Foreign Investment Law was enacted in November 2012

(Prepared by the Study Team)

(2) Establishment of a PPP Entity

Before entering port-related PPP business in Myanmar, foreign investors have to establish a locally-incorporated company. The two ways to establish a company in Myanmar are briefly described below5.

1) Foreign Investment Law

A foreign investor can establish a local company in Myanmar in accordance with the Foreign Investment Law. In this case, the foreign investor should ask the Myanmar Investment Commission (MIC) for the permission of investment and receive a business license from the Ministry of National Planning and Economic Development. According to the new Foreign Investment Law (November 2, 2012), the foreign company is allowed to own up to 99% of the established local company's equity. The new law allows the establishment of a company by 100% foreign capital only in the business categories approved by MIC, though it was allowed by the previous law (November 30, 1988) without restrictions. A company established in accordance with the Foreign Investment Law can count on incentives such as the exemption of corporate income tax for a certain period of time after the start of the operation. The new law extends the period to five years from the previously applied three years. The new law allows overseas remittance of profits in dollars converted from kyats, which was previously virtually impossible.

[5] Myanmar Business Guidebook (2011-2012), JCCY/JETRO Yangon Office

On the other hand, the new law designates business areas prohibited for foreign investment such as “those impacting traditional culture and custom” and “those impacting natural resources, environment, and ecosystem”. The new law obliges the employment of Myanmar nationals: 25 % of the workforce in two years from the establishment of the company, 50 % in 4 years, and 75 % in 6 years respectively. Non skilled labors are limited to Myanmar nationals. These obligations might have negative impacts on foreign investment.

2) Myanmar Company Act

A foreign investor can establish a local company in Myanmar in accordance with the Myanmar Company Act without the permission of MIC. A company established in this way cannot receive the incentives mentioned above. The Act stipulates the minimum amount of capital for each business category.

5.7. Port Security Measures

5.7.1. Design principle

(1) Basic policy

The restricted area shall be enclosed and access control shall be conducted at the gate to ensure the terminal security. Surveillance of restricted area shall be conducted by both manpower monitoring by security guards and mechanical monitoring by CCTV cameras. Equipment supply planning shall be planed considering communication system and power backup system.

With regard to the performance of the equipment, specifications to serve the role of each equipment depending on the installation location shall be considered.

(2) Basic plan

Security facilities corresponding to the basic policy of the design are as follows.

Table 5.7-1 Design policy and security equipment

	Obligatory matters	Corresponding security facilities
1	Restriction of comings/goings to port facilities	Fence, gate
2	Surveillance of comings/goings to port facilities	CCTV camera monitoring system
3	Surveillance of port facilities	CCTV camera monitoring system
4	Surveillance of suspicious person (car) entering the restricted area	CCTV camera monitoring system
5	Communication device for emergency announcements	Public Address (PA) system
6	Maintenance of surveillance function and data during power failure	Uninterruptible Power supply (UPS), Emergency Power Generator
7	Inspection of container cargo	X-ray inspection system

(prepared by the Study Team)

Given that preventing terrorism is the central aim, following equipment is selected to meet the above needs and to satisfy the requirements of the port security plan.

1) Fence and gate

The restricted area shall be surrounded by a fence to clarify the area to which access by individuals who do and do not need to enter is controlled, for the purpose of ensuring security of the facility in question

Outriggers facing outside and barbed wire shall be installed as a psychological deterrent and delay effect against intrusion.

2) CCTV camera monitoring system

Medium distance visibility swing type CCTV cameras shall be installed around the restricted area and also short distance visibility fixed type CCTV cameras shall be installed at the container gates and other gates.

Since the container yard will have many blind spots as containers are piled, and all of the areas cannot be thoroughly monitored, CCTV cameras shall be installed along the fence to monitor suspicious persons and intrusion from the fence to secure the restricted area. A swing type CCTV camera can display necessary images by panning, tilting and zooming up. Fixed type CCTV cameras shall be suitable to monitor vehicles and drivers at the entrance and exit gates. The restricted area shall be monitored by security guards' patrolling.

Swing type CCTV cameras around the restricted area shall be installed inside the fence. Fixed type CCTV cameras shall be installed at places suitable to monitor container gates and gates for

vehicles other than container truck and personnel.

Monitoring control equipment digitizes images and control signals of plural CCTV cameras transmitted by signal transmission converter and display selected images on a monitor. A hard disc recorder shall be installed to record all camera images for a certain period.

3) Security lighting equipment

Security lights shall be installed around the restricted area and at the gates. The illuminance of the lights shall be sufficient for CCTV cameras and security guards to identify abnormalities. Lighting the surrounding of the restricted area should offer psychological deterrent effect against intrusion.

4) PA system

Loudspeakers shall be installed to announce emergency to people inside the restricted area and ships moored in the port. They could be installed on light poles.

5) UPS

UPS shall be provided to supply power to CCTVs, monitors and recorder to keep mechanical surveillance in case of unexpected power outage.

6) Emergency power supply (Generator)

Emergency power supply shall be provided to supply power to CCTVs, monitors and recorder during sudden interruption of electric power before UPS power supply reaches a limit. The system shall include an automatic transfer switching unit to start automatically by shut down of power and stop automatically in release of power.

7) X-ray inspection system

Chances for Myanmar to be exposed directly to terrorism may be low, but illegal exporting of goods, such as mass destruction weapons to dangerous countries, and terrorism aimed the US and Europe could occur via Myanmar. By providing container x-ray inspection system and strengthening the security system of customs could decrease the possibility of Myanmar becomes the hotbed of terrorism, help maintain domestic peace, and contribute to counter-terrorism in surrounding Southeast Asian countries.

(3) The functional requirements and the standard specifications

1) Fence and gate

The fence is to distinguish borders and prevent unnecessary personnel for entrance. Entrance

can be prevented by the structure and the surrounding condition offering psychological deterrent. Delaying of intrusion can be addressed by the structure of the fence.

Functional requirements:

- It must have certain height
- It must have outriggers and barbed wires
- The mesh must be less than a certain size
- Trees and electric posts, which may help intrusion, must not be placed near the fence (Secure a clear zone)

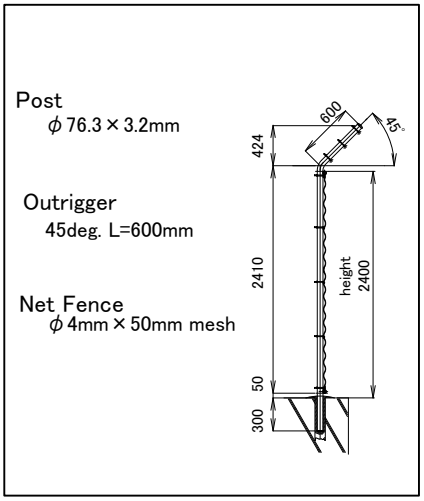
Standard specifications

Specifications of the fence shall be as follows, referring to the standard in Japan and that adopted by the US Coastal Guard Pacific Area (USCG PACAREA).

- The fence shall be 2400mm high, and the outrigger shall be 600mm long.
- Three lines of barbed wire shall be installed on the outrigger
- The mesh of the fence shall be smaller than 53mm to make it difficult for anyone to climb up the fence
- The diameter of the fence wire shall be more than 3.2mm (exclude coating)

Specifications of the gate shall be the same as those of the fence.

If a grid type fence is to be implemented, it shall be less than 50mm wide, and cross beams shall be installed inside to make it difficult for anyone to climb up the fence



ource: The Ports and Harbours Association of Japan (PHAJ)

Figure 5.7-1 Fence

2) CCTV camera monitoring system

Installing CCTV cameras around the restricted area and the gates could offer psychological deterrent against intrusion and also help identify intrusion preparation and/or intrusion.

Functional requirements:

- All the boundaries of the restricted area shall be covered for surveillance.
- It must have an automatic surveillance system.
- With the combination of security lights, it must be able to identify movements of suspicious person in black at night.
- It must have enough swing speed to chase an intruder (swing type cameras).
- It must be lightning-proof and rain-proof.
- It shall be capable of recording camera images for a certain period of time.

Standard specifications:

- The turning range shall be 360 degrees to allow surveillance of the pier, boundary areas and the inside of the yard.
- It must have a preset function and with a preset turning speed at around 180 degrees/second or more horizontally and 60 degrees/second or more vertically. It must have the turning speed that can chase running personnel during manual operation.
- The camera and lens shall be able to identify motions of a man in black with the horizontal illuminance of 3 lux during night at a maximum shooting range.
- Camera images shall be in color.
- The monitor shall be 20 inches or over and in consideration of winds, rain, humidity and temperature changes, the cameras should be equipped with wiper, defroster and other devices for securing visibility or the structure should be able to allow installation of such devices.
- Sufficient consideration shall be given against potential lightning strikes.
- The recorder must be able to preserve surveillance images for the period of transportation to the destination plus about one week or longer.
- Swing type CCTVs along the border of the restricted area shall be installed 1to 1.5m from the fence inside the restricted area.

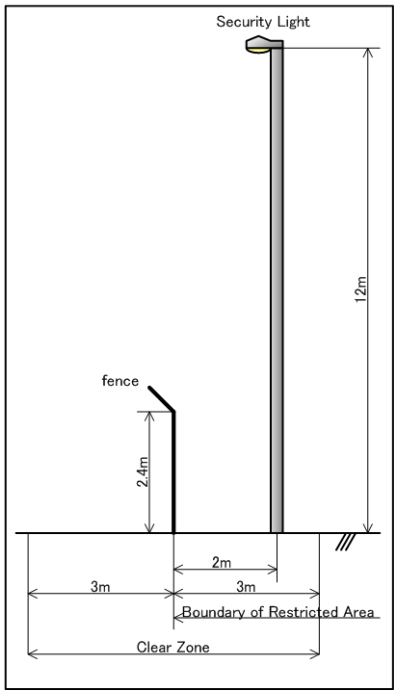

Figure 5.7-2 Swing type CCTV

3) Security Light

By illuminating the border of the restricted area, psychological deterrent against intrusion and illuminance for CCTV cameras and patrolling shall be secured. Therefore security lights shall be installed inside the restricted area and facing outside.

Functional requirements:

- The lighting shall provide an illuminance allowing surveillance for suspicious person by the security guard in person or through surveillance cameras.
- The height of the lighting shall be considered so no light source will be within the scope of the cameras.
- Emergency power source shall be provided to secure the certain illuminance for surveillance cameras in case of power outage.
- A sufficient level of illuminance at the gate to check ID card shall be provided.
- Standard specifications:
- Space out the lightings to secure horizontal illuminance of 3 lux.
- The height of the lighting shall be 10 to 12m as a standard.
- Electric power shall be supplied from the generator in case of power outage.
- Illuminance at the gates shall be 30 to 50 lux.



Source: PHAJ

Figure 5.7-3 Security lights

4) PA system

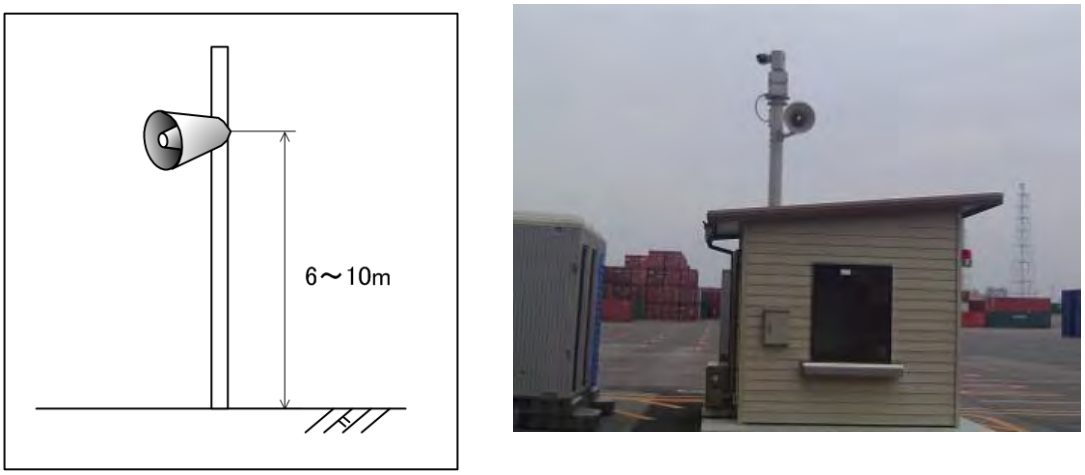
PA system (a loudspeaker) shall be provided for emergency announcements in the restricted area.

Functional requirements:

- The broadcast must be heard simultaneously throughout the restricted area.
- The broadcast must be heard simultaneously on the bridge of the anchoring ships.

Standard specifications:

- The loudspeakers shall be arranged to the acoustic pressure requirement of 75db within the restricted area. (from Japanese Fire Services Act stipulation)
- Acoustic pressure of 85db shall be secured on the bridge of the anchoring ships.
- The loudspeakers shall be basically installed on the pole of illumination lights, security lights or surveillance cameras.



Source: PHAJ

Figure 5.7-4 Loudspeaker

5) UPS

UPS shall be provided to supply power to CCTV surveillance system in case of unexpected power outages.

Functional requirements:

- The UPS must supply power for sufficient time to shift the system's power to the generator, communication for emergency and evacuation.

Standard specifications:

- The output rating shall be 10KVA and the back-up time shall be 10 minutes or longer

6) Emergency power supply (Generator)

The UPS is to supply power only when the power failure occurs, so it cannot support for a long time. Hence, power supply shall be secured by a combination of the UPS and a power generator. Although the generator can supply power for a long time, the start-up takes some time, so the UPS shall supply power to prevent a block-out until the generator can begin operation.

Functional requirements:

- Since the UPS would be of a burden for the generator, sufficient capacity, including load of UPS, shall be provided.

Standard specifications:

- Considering the capacity of UPS, security lights and monitoring system, the output rating must be more than 25KVA
- It must have a fuel tank enough to run consecutively for more than two hours to have enough time for investigation and handling into the cause of electric failure and

evacuation.

- It must be capable of starting automatically by a shutdown signal of power supply from automatic transfer switching unit, and stopping automatically by release of power.

7) X-ray inspection system

Cargo safety can be ensured by a non-destructive X-ray inspection system (fluoroscopy) to a container cargo. And also by this inspection, cargo volume to be inspected per hour shall be increased and storage term in bonded warehouse shall be shortened.

Functional requirements:

- It must have penetration ability that can be transmitted a substance which thickness is 330mm or over.

Standard specifications:

- X-ray energy shall be 4 to 6 Mev.

Figure 5.7-5 Large Size and Mobile Medium Size X-ray Inspection System

5.7.2. Equipment deployment plan

(1) Deployment plan

The draft of the security equipment deployment plan is shown in Figure 5.7-6.

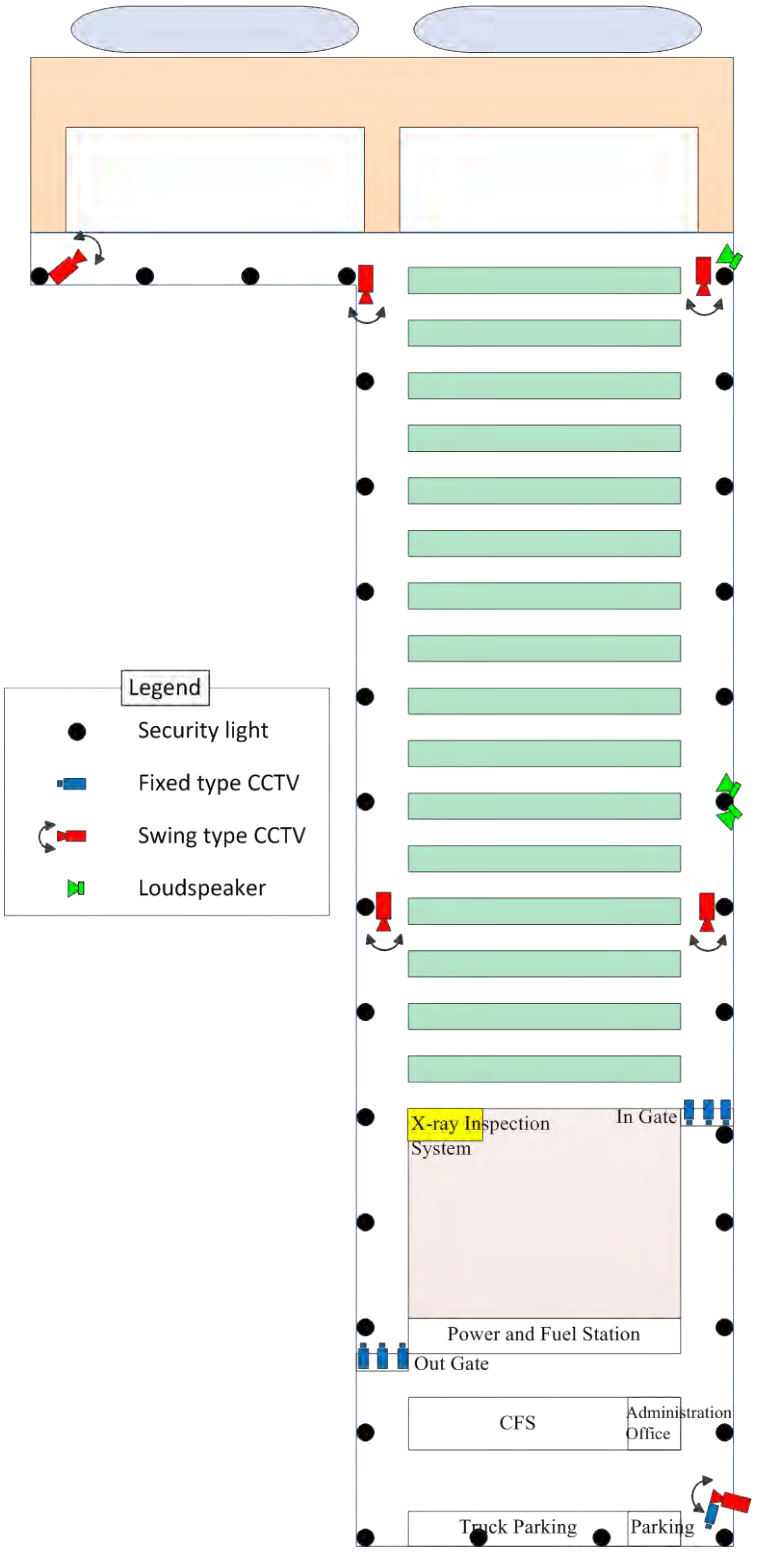


Figure 5.7-6 The Draft of Security Equipment Deployment Plan

1) CCTV Camera

CCTV cameras shall be installed around the restricted area to monitor unauthorized intrusion from the fence or quay as shown in Table 5.7-2. CCTV cameras shall be installed along the fence by this objective not making any blind corner. Surveillance of the quay shall be conducted by the upper left camera of the figure shown in Figure 5.7-6, because a camera installed on the quay shall get in the way of the mooring ropes. Fixed cameras shall be utilized for container gates and for non-container vehicle and personnel gates.

CCTV cameras shall be installed 1.5 to 2m away from the fence to monitor places within the operation range and detect intruders early, give warnings and provide a deterrence effect or retreat effect. Surveillance images shall be preserved for two weeks or longer considering transportation time plus one week for all cameras.

Table 5.7-2 Basic Idea for Installation of CCTV Camera

Monitoring Position	Purpose	Installation condition
Quay	・Monitor intrusion from quay ・Identify the specific activities of suspicious person	・Can see far into apron and monitor unauthorized access to a ship ・Location of setting a camera shall be decided considering maintenance, vibration, theft and damage to camera ・In case cameras are installed at the quay, they must be set not to disturb loading/unloading and mooring ropes
Along the fence	・Monitor intrusion from the fence ・Identify the specific activities of suspicious person	・Monitor inside the restricted area ・Monitor along the fence ・Height of a camera shall be decided considering maintenance, vibration, theft and damage to camera
Gate	・Record the people and vehicles going in and out ・Identify the specific activities of suspicious person	・Install a camera where face of the driver and a plate number of the car can be monitored ・Basically install a camera on the gatehouse or gate post

(Prepared by the Study Team)

2) CCTV monitor

If images from several different cameras are allocated to one monitor, each image would be very small, so four cameras shall be allocated per monitor, and another monitor shall be implemented for zooming in as the standard in Japan.

3) Lighting equipment

Security lights should be installed to provide sufficient illumination for monitoring the restricted area (more or less 3 lux). Security lights are expected to offer psychological effect to prevent intruders.

4) PA system

Loudspeakers shall be installed to communicate with security personnel, workers and ships in the restricted area for alerting or ordering evacuation in case of emergencies and also to intimidate intruders. Speakers shall be installed on an illuminating light, security light or CCTV camera pole.

5) Monitor room

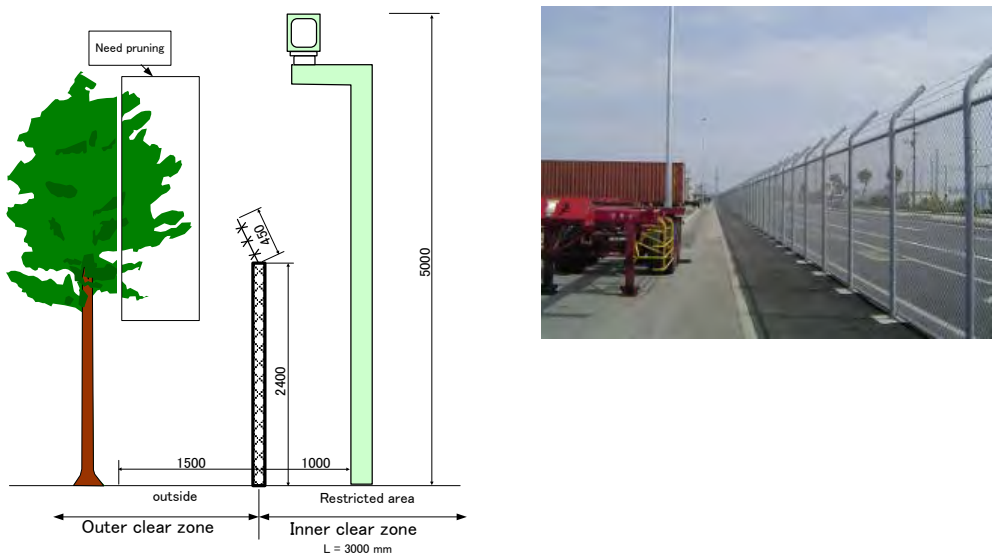
A monitor room shall be provided to conduct surveillance for 24 hours a day. Camera images shall be recorded to a video recorder. A microphone shall be installed to broadcast simultaneously in the restricted area in case of emergencies. It is recommended that a telephone is provided to communicate security personnel and outside and also TV to gather information. The monitor room shall be placed in the office beside the CFS.

Table 5.7-3 Required Equipment

Equipment	Specification	Unit	Number	Remarks
CCTV Camera (Swing type)	visibility 350m	no.	6	
CCTV Camera(Fixed type)	visibility 50m	no.	7	
Monitor for CCTV	more than 20 inches	no.	5	
Image Recorder		no.	1	
Security Light		no.	31	
Loudspeaker		no.	3	
X-ray Inspection System		no.	1	
UPS	10KVA	no.	1	
Emergency Power Supply (Generator)	25KVA	no.	1	

6) Clear Zone

Certain width of space shall be secured on both sides of the fence for early detection of unauthorized intrusion. Leaving some space will help secure visibility of surveillance camera and patrolling by security guard and will also mean that there will be nothing near the fence that can be used for intrusion.



Source: PHAJ

Figure 5.7-7 Clear Zone

The draft image of the security Equipment deployment plan is shown in Figure 5.7-8.

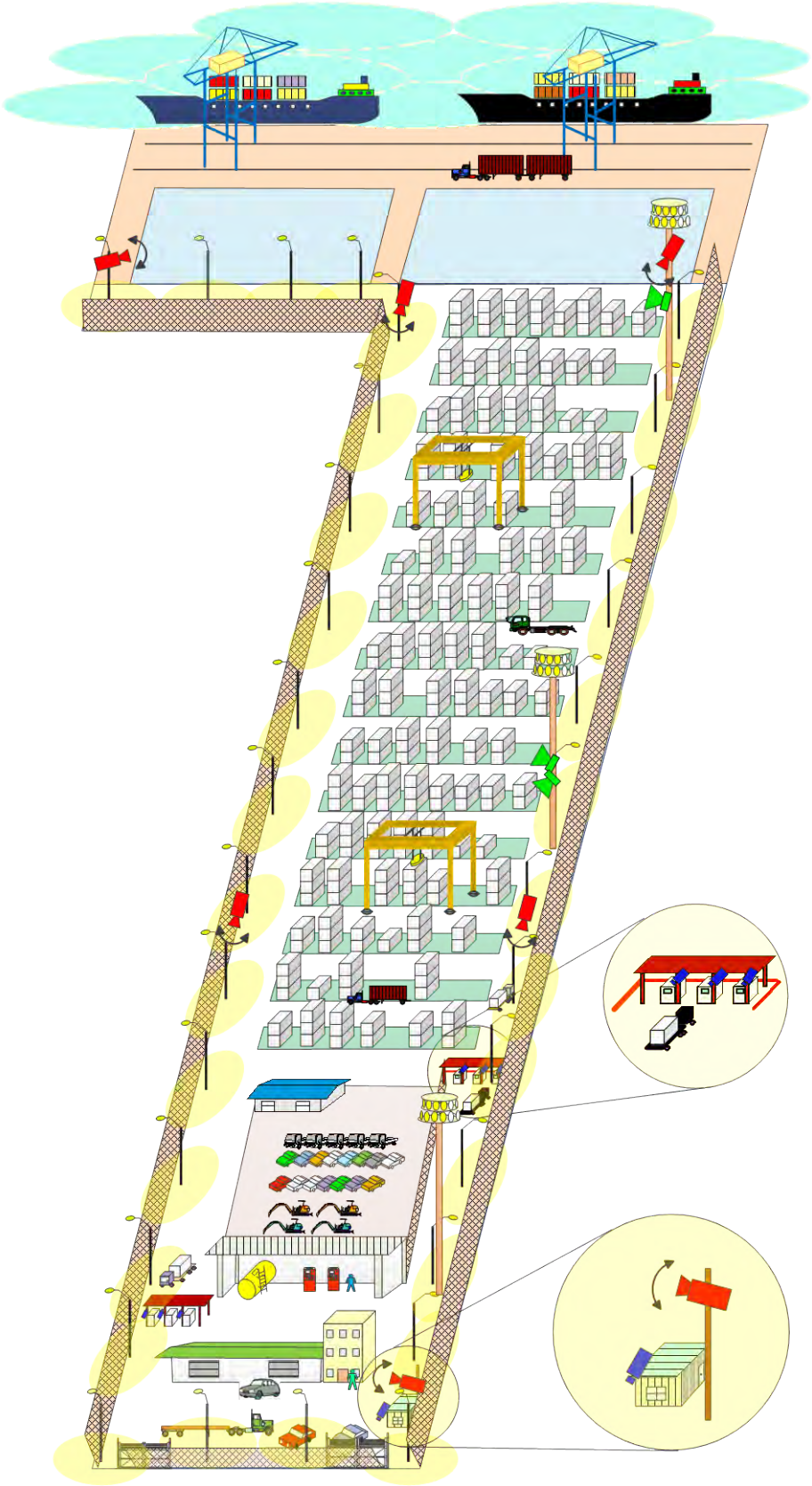


Figure 5.7-8 Deployment Image of Security Equipment(draft)

(2) Maintenance and inspection

Maintenance and inspection shall be targeted on fence, security light, surveillance camera, communication system, information system, and power units, as summarized in the following table.

Table 5.7-4 Maintenance and Inspection Items

Description	Items to be Checked	Daily Inspection	Periodical Inspection
Fence and Gate	Fence and gate	• Visual inspection during patrol	• Conduct monthly • Visual inspection and confirm by swaying that net is not loose • Repair, reinforce or replace, if necessary.
Security Light	Lighting condition	• Ensure that all security lights are illuminated by visual inspection during night patrol	• Conduct annually • Check mounting of lamp fitting • Cleaning, adjustment and check operation • Check cables and switch box
Monitoring System	CCTV camera Monitor	• Check brightness of the graphics • Check operation range of camera platform	• Conduct annually by the supplier • Cleaning, change consumables, measurement, calibration and check operation
Communication System	PA system VHF radio Telephone Fax Loudspeaker	• Check in daily usage	• Conduct annually by the supplier • Cleaning, change consumables, measurement, calibration and check operation
Information system	Communication device Server Terminal	• Check in daily usage	• Conduct annually by the supplier • Cleaning, change consumables, measurement, calibration and check operation
Power Unit	Distribution panel	Monthly Inspection • Check operation,	• Conduct annually • Greasing

		appearance (damage, rust, discoloration and deformation) • Abnormal confirmation in contact part, occurrence of allophone or unusual odor	• Check damage, discoloration, disconnection of wire and loosening of the terminal

(Prepared by the Study Team)

5.7.3. Port security implementation Plan

(1) Access control

Access control of the terminal shall be as follows.

- Access control shall be conducted by the security personnel based on the security level to all people seeking to enter this terminal.
- People who refuse to receive access control, are uncooperative, cannot pass the access control shall not be allowed to enter.
- While in the facility, everybody shall be required to wear an ID card or a visitor card. The visitor card shall be returned and exit time shall be recorded at the gate.
- Vehicles must carry a car pass.
- Access control shall consist of identity verification, verification of purpose of visit, booking confirmation, baggage inspection and vehicle inspection.

(2) Surveillance inside the restricted area

Surveillance inside the restricted area by security personnel shall be as follows. The security personnel shall change the patrolling course each time and patrol in random time.

Table 5.7-5 Security Items

Security	Location	Surveillance Method	Surveillance Items
Monitor Observer	Monitor Room	The observer will constantly surveil the monitor	・Border Surveillance: Presence of suspicious person or object around the fence ・Entrance/Exit gate: Presence of suspicious person or object near the gates ・In the yard: Presence of suspicious behavior of temporary visitor. ・Water area: Presence of suspicious boat and object ・Stored cargo: Presence of suspicious access
Gate Guard	Gate	Visual monitoring from the gate	・Presence of breakage or wrecking of fence ・Presence of suspicious person, object and vehicles near the fence ・In the yard: Presence of suspicious behavior of temporary visitor
Patrolling	Patrolling inside the restricted area	Visual monitoring	・Presence of breakage or wrecking of fence ・Presence of suspicious person, object and vehicles near the fence ・In the yard: Presence of suspicious behavior of temporary visitor ・Water area: Presence of suspicious boat and object ・Stored cargo: Presence of suspicious access. Cargos are stored in an orderly manner or not.

(Prepared by the Study Team)

(3) Cargo control

In this terminal, the following shall be achieved by defining management procedure.

- To prevent illegal items from being carried into the restricted area
- To prevent illegal entry of goods to the cargo stored temporary in the restricted area until shipping
- Final control of cargo to be loaded onto the ship
- Cargos shall be classified into the following four types and determine in accordance with the specific procedures for each security level, respectively

- Container
- Cargos other than container
- Ship store
- Hand baggage

(4) Trainings

The ISPS Code specifies that drills shall be conducted at least once every three months and exercises shall be conducted at least once in calendar year within an 18 months interval. Hence following contents of training shall be conducted.

1) Drills

The following are possible content of the training.

- Confirmation of the migration procedure for increase of security level
- Confirmation of communication procedure between PFSO and security personnel
- Confirmation of communication procedure between ship and DMA
- Confirmation of reporting procedure to police, fire station and other related institution
- Confirmation of evacuation procedure in the restricted area
- Confirmation of how to respond threatening phone call
- These procedures shall be confirmed by repetition in two persons and confirm knowledge by workshop or questioning

2) Exercise

Intended trainee and joint prospective participants are as follows.

Object person

- Security personnel of the terminal (security guards)

Joint prospective participants

- Adjacent or vicinal security personnel
- Captain of a ship engaged in international voyages and ship security officer
- Police officer, firefighters and CIQ officials

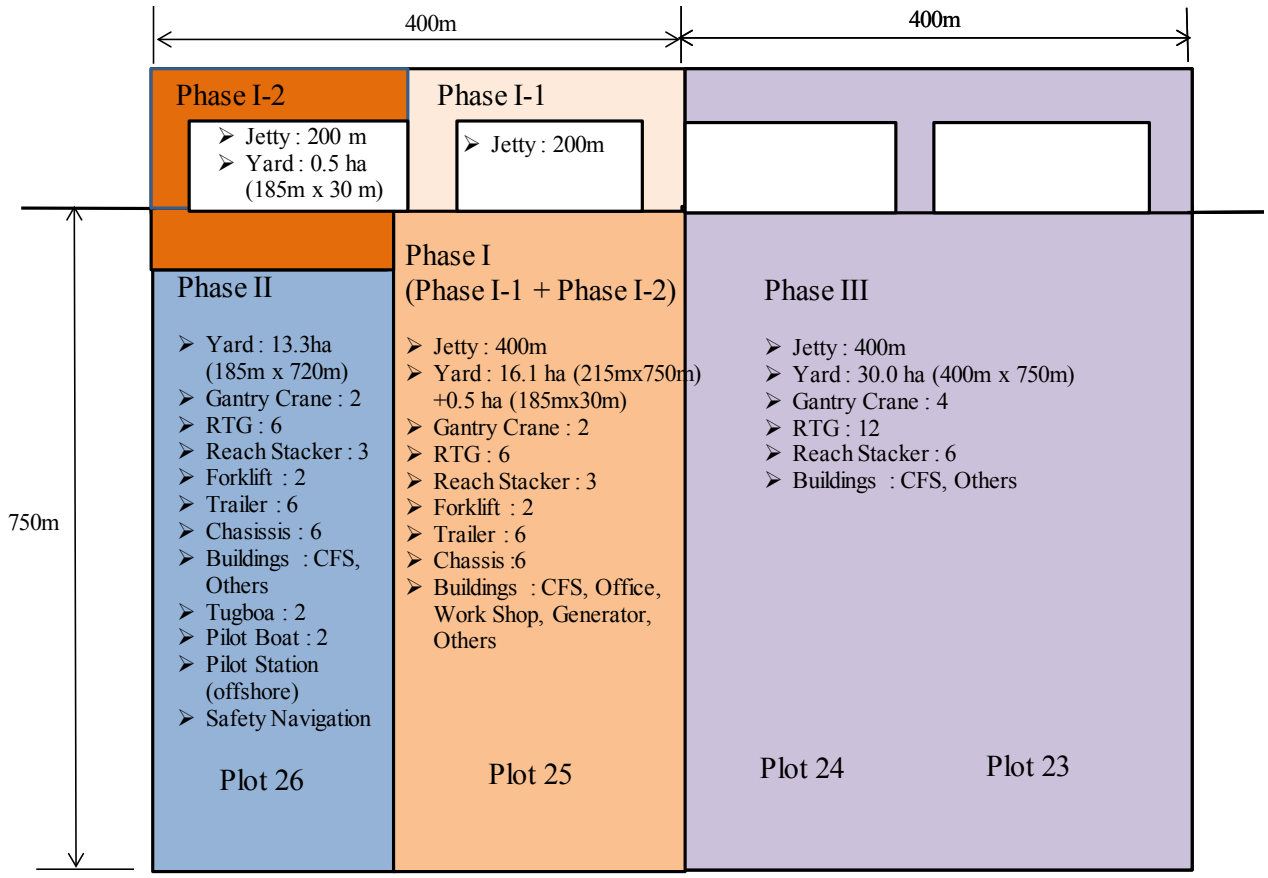
- DMA officials and MPA officials

The contents of the trainings can be considered as follows.

- Exercise for migration of security measures due to the increase of security level
- Communication training between PFSO and security personnel
- Communication between ships engaged on international voyages and DMA (The ships shall be required following two patterns)
  - Communication exercise from the the time that a ship determines to use a wharf until docking
  - Communication exercise while a ship is berthing after docking
- Alert exercise to the police, fire station and other related institution
- Evacuation exercise in the restricted area
- Exercise on the response when a suspicious person or object is found

5.8. Project Cost Estimation

The whole project is divided into three phases (I, II, and III). The following sketch depicts the scope of each construction phase.



(Prepared by the Study Team)

Figure 5.8-1 Scopes of Construction Phases

Cost estimation of each phase of the Development Plan of Thilawa Area (Plot 23 to 26) is summarized in Table 5.8-1.

Table 5.8-1 Cost Estimate Summary

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		**217**
	i. Wharf (400m) normal	100
	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	293

(Prepared by the Study Team)

The above cost estimate has been made with the following assumptions and conditions:

- All phases are financed by JICA loan.
- Costs are inclusive of both JICA loan portion (base cost, consulting service,

contingencies, and interests during construction) and MPA's financing portion (preparation cost, management cost, and taxes).

- Cost for design fee (consulting service) for Phase I is not included.
- Cost estimations are based on the market prices as of January 2013. Refer to Chapter 6.4 of this report for the financial indexes used for the const estimation.

5.9. Construction Planning

① **Site Preparation:** The present project site is swamp, and is partly covered with shrubs. During the rainy season, the site is often flooded due to the poor drainage. The pictures below were taken during the rainy season in August 2012.

	
River bank at Plot 25	From the access road along the eastern boundary

(Prepared by the Study Team)

Figure 5.9-1 Present Project Site (August 2012)

Prior to commencement of the filling work, the vegetations are removed from the project area. Depending on the subsoil conditions, soil improvement will be necessary. For the spoil improvement area, about one meter thick sand (sand mat) are placed on the surface, 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. However, if time allows, small sand dredging boats with hopper capacity of about 50m3, which is prevalent for the local construction, will be mobilized for the sand filling. The sand will be dredged from the sandbank in front of the site in the Yangon River. 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 method is applied for the soil improvement of the terminal area. PDV driving machines are mobilized to drive the plastic drain material into the about 30m (depending

on the subsoil characters) of the soft subsoil layer. 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 to the final reclamation elevations.

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, where 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:** Phase I is required to be completed urgently, and by the milestone of the 17th month, a part of the jetty (200m) is to be completed so that the port terminal can be operational in December 2015. Due to this constraint, jetty construction work is on the critical path. Thus, pre-fabricated jacket type jetty is selected such that the construction duration can be minimized. 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. As for Phase II and III, if there are no time constraints, standard type of the concrete deck is constructed. A concrete batching plant is established at the site to mix and provide the concrete for the project.

⑤ **Pavement and Building & Utilities:** As soon as the preload fill is removed, pavement, drainage, building and utility works are commenced.

5.10. Project Implementation Schedule

The commencement of each phase varies depending on the actual cargo volume increase. Table 5.10-1 depicts the container cargo forecast and the implementation schedule of the each phase.

Table 5.10-1 Container Cargo Forecast and Project Implementation Schedule

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													
		Phase I													
		Phase II													
		Phase III													
	middle case	Phase I -1													
		Phase I													
		Phase II													
		Phase III													
	low case	Phase I -1													
		Phase I													
		Phase II													
		Phase III													

Note : ; Construction and Procurement Period

(Prepared by the Study Team)

5.11. Economic and Financial Analysis

5.11.1. Economic Analysis

(1) Objective and Method used for the Economic Analysis

The economic analysis is done in order to examine the cost and benefit of the Project and to evaluate whether the benefit will exceed those from other investment opportunities.

In the economic analysis, a comparison is done between 'With' the development case and 'Without' case. The difference in cost and benefit between the 'With' and the 'Without' case, is calculated first in market price, and then it is converted to economic price.

In this study, an Economic Internal Rate of Return (EIRR) method is used to check the feasibility of the project. Sensitive analysis is also done.

The timeframe for the analysis is from the year which the first spending is made, to the year which is 30 years after the start of operation of the project.

(2) Details of the cases of comparison

In 'With' case, a new container terminal of 4 berths as shown in Figure 5.4-1 is constructed

based on the Thilawa Area Port Development Plan, and annual maximum of 800,000 TEU containers for international trade will be handled in the terminal as shown in Table 5.4-2.

In 'Without' case, there will be no development of new port facilities in Yangon Port, so if the demand exceeds the capacity (including future expansion plans) of the existing terminal, the containers for international trade will overflow. Myanmar is bordered by People's Republic of China and Thailand on land thus significant amount of consumer goods are imported crossing the land borders, however, it is unlikely that a new industrial investment is done in Myanmar on the basis of land border trade for the export of its products so this cannot be an alternative in responding to the demand, thus Myanmar will lose is exporting trade values for that much. Table 5.11-1 shows the cargo handling throughput of 'With' and 'Without' cases.

Table 5.11-1 Cargo handling throughput of 'With' and 'Without' cases

(Unit: TEU)

Year	Years from the start of operation	Estimated amount of International trade containers handled		Total handling amount (With Case)	Total Demand
		At existing terminals (Without Case)	At the new terminal in Thilawa		
2012		509,000	-	509,000	509,000
2013		615,000	-	615,000	615,000
2014		727,000	-	727,000	727,000
2015	1	781,000	24,000	805,000	853,000
2016	2	898,000	92,000	990,000	990,000
2017	3	1,063,000	79,000	1,142,000	1,142,000
2018	4	1,277,000	33,000	1,310,000	1,310,000
2019	5	1,491,000	4,000	1,495,000	1,495,000
2020	6	1,540,000	160,000	1,700,000	1,700,000
2021	7	1,540,000	383,000	1,923,000	1,923,000
2022	8	1,540,000	630,000	2,170,000	2,170,000
2023	9	1,540,000	800,000	2,340,000	2,441,000
2024	10	1,540,000	800,000	2,340,000	2,738,000
2025	11	1,540,000	800,000	2,340,000	3,064,000
2026	12	1,540,000	800,000	2,340,000	
2027	13	1,540,000	800,000	2,340,000	
2028	14	1,540,000	800,000	2,340,000	
2029	15	1,540,000	800,000	2,340,000	
2030	16	1,540,000	800,000	2,340,000	
2031	17	1,540,000	800,000	2,340,000	
2032	18	1,540,000	800,000	2,340,000	
2033	19	1,540,000	800,000	2,340,000	
2034	20	1,540,000	800,000	2,340,000	
2035	21	1,540,000	800,000	2,340,000	
2036	22	1,540,000	800,000	2,340,000	
2037	23	1,540,000	800,000	2,340,000	
2038	24	1,540,000	800,000	2,340,000	
2039	25	1,540,000	800,000	2,340,000	
2040	26	1,540,000	800,000	2,340,000	
2041	27	1,540,000	800,000	2,340,000	
2042	28	1,540,000	800,000	2,340,000	
2043	29	1,540,000	800,000	2,340,000	
2044	30	1,540,000	800,000	2,340,000	

(Source: The Study Team)

Please be noted that in the cargo demand forecast of this study, two cases of 'High' and 'Low' are considered, and based on this, the implementation schedules of Phase II and III have consideration of three cases, 'High', 'Middle' and 'Low'. For the cargo demand forecast, analysis on 'Low' case is

more critical in project feasibility, while for the implementation schedule, analysis on 'High' case is the most critical. If the project is feasible in the most critical case, then more benefit can be expected in other cases, hence in this analysis, the project is analyzed in 'High' implementation case with 'Low' demand case only.

The new terminal under this urgent development project will only be opened by December 2015 at the earliest. According to the demand forecast, in 2015, the demand will exceed the total container handling capacity of the whole Yangon port, and the excess amount in estimated as 72,000TEU in the low case. The opening of the terminal in December means, considering the forecast is done in fiscal year, which is from April to March both in Myanmar and Japan, the new terminal will be able to handle only 1/3 of the 2015 demand.

The demand forecast is done only up to 2025. This is sufficient since after 2023 (9 years after the start of operation of Phase I, and 5 years after the full opening of the terminal), forecasted demand exceeds even the overall capacity of 'With' case, so it is estimated that all the terminals, both existing and new, will operate to their full capacity.

(3) Benefit of the project.

For the economic benefit brought by constructing a new container terminal in Thilawa area port, following items are counted.

- Added value by the exported container cargo

We count the value added by the export container cargo as the benefit of the project, out of all the container cargo of 800,000 TEU maximum handled at the new container terminal. Actually, not only the export cargo but also the import cargo will contribute to create an adding value in Myanmar, however, in this EIRR analysis, only the value added by the export cargo is counted to be on the safer side. We suppose that the number of export and import containers is balanced, so the number of export containers is half of all containers handled. (Maximum 400,000 TEU)

For the value of the cargo in export containers, particularly in this report, we refer to those data of other ASEAN countries as the precedent case, since the current trade related data of Myanmar is under a large influence of imposed economic sanction thus not appropriate to refer to, and also the feasibility study for the adjoining Thilawa SEZ project in ongoing and no relevant data can be obtained at present.

By utilizing two data sources from Indonesian customs and Japanese government, the value of the cargo in export containers from Indonesia has been estimated as US$30,000 per TEU. Considering the difference in the stage of economic development between Indonesia and Myanmar, we apply the half rate of US$15,000 for the value of the cargo in export containers in this project. Percentage of the benefit to the total sales amount differs amongst industries and companies but average value of 7% from the interviewed sample is applied. Also, from this benefit amount, contribution of other development project has to be estimated and deducted. Since the total investment value to the adjoining SEZ project is not available, we temporary assume that 50% is the contribution of other

project and deduct from the estimated benefit.

(4) Cost of the Project.

Following items are counted as the cost to implement this Project.

- Construction cost of port facilities
- Purchasing cost of cargo handling equipment, yard vehicles and tug boat
- Maintenance and repair costs of port facilities
- Maintenance, repair and renewing costs of cargo handling equipment, yard vehicles and tug boat
- Operation and management cost of the container terminal

The project cost comprises jetty, soil improvement, yard paving, buildings in the yard, cargo handling equipment, security and utility arrangements, personnel and utility costs of the terminal, and indirect costs. The price of tug boats is included in the project cost since they are only utilized for the proposed new terminal, but for the pilot vessels, they are for improvement in navigation safety thus excluded, since they are not appropriate to be counted as the cost for the counted benefits of this project.

The construction of the four berths in this project is scheduled to be implemented in three phases. As mentioned before, the analysis is done in the most critical case of 'Low' demand and 'High' implementation schedule, so as shown in the 'High' case of Table 5.4-1/5.11-1 (same), Phase II will be constructed in two years of 2017 and 2018, and will be opened for operation at the end of 2018, Phase II will be constructed in four years from 2016 to 2019 and will be opened for operation at the end of 2019.

The personnel cost regarding the operation and management of the container terminal is estimated using the standard wage data in current Myanmar. The terminal is supposed to operate for 24 hours but with only 2 work shifts. This is to be more realistic to the situation of the Yangon port which the entry approach is limited only in up-tide hours which is twice a day, and there is always a long break in between when the vessels wait for the up-tide. For the utility cost regarding the operation of the terminal is counted as 1% of the purchasing cost of the equipment.

For the annual maintenance and repair cost, 0.2% of the initial investment for the construction of the jetty and the paving is counted, envisaging that only corrosion protection of the jetty and pothole repair of the paving is required. For the maintenance and repair cost of the cargo handling equipment, 5.0 US$ per TEU handled is applied. This amount includes the fuel fee for operation, and it is based on the data obtained from the other container terminals in neighboring countries. No dredging cost is counted since the river current is rapid in the front basin of the terminal so no sedimentation has been observed.

The cargo handling equipment is assumed to be replaced at the end of its service life. The years for the service life differ by equipment and for example, it is 20 years for the gantry crane, and 15 years for yard vehicles such as reach stacker and forklifts.

These costs are first calculated in market price, and converted to economic price by eliminating transferable items such as tax, and used for the analysis. In Myanmar, the official currency exchange rate which differed more than 100 times of the actual exchange rate was made out of use this April and currently there is not much difference between published and actual exchange rates, so no adjustment for shadow pricing is applied.

It should be noted that in the calculation of the EIRR in this report, the cost of Phase II and III is based on the rough estimate of the total construction cost, so conversion to economic price, estimation on consultant fees, and details of implementation are just roughly done. These details should be reexamined more precisely at the time of the materialization of each Phase.

(5) EIRR and Project Evaluation

EIRR is a discount rate which the total cost and the total benefit during the project period becomes the same value. A cash flow is calculated based on the assumptions given above and as presented in Table 5.11-2, the EIRR of the new container development is estimated to be 14.8%.

To check if the project would still have the economic appropriateness despite some change in conditions, sensitivity analysis is also conducted. In the condition that the cost increases 10% and the benefit decreases 10%, the EIRR was calculated to be 12.3%.

The EIRR of the project is compared with the opportunity cost of the country's capital and if the EIRR is considered higher, then the project is evaluated as economically feasible. There is no published data available for the opportunity cost of the capital in Myanmar, so by applying the World Bank's bench mark for project approval of 12%, this project's EIRR of 12.3% even in the worst case scenario is still higher than the opportunity cost.

Therefore, the proposed project is considered to be economically feasible.

Table 5.11-2 EIRR of the 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%

(Source: The Study Team)

5.11.2. Financial Analysis

(1) Objective of the Financial Analysis

In Financial Analysis, a net profit calculated by deducting the maintenance cost and tax from the revenue is defined as financial benefit, and the financial feasibility of the project is examined and evaluated based on the calculation of the Financial Internal Rate of Return (FIRR) by comparing the financial benefit with the project cost. In this report, the financial analysis is conducted on both public and private entities on the 4 different cases of PPP (Public Private Partnership) scheme shown in Table 5.6-5. The period of analysis is same with the economic analysis, which is from the year of first payment to the year which is 30 years after the start of the operation of the container terminal.

(2) Financial Benefit of the Project.

The revenue of the project is port charge (entry fee), lighthouse charge, berth usage fee, and berthing charge, which are charged per vessel (entry), and also the cargo handling charge and storage charge which are charged per container (TEU), and calculated based on the published tariff of Yangon Port stated by MPA, just as same with the current arrangement for the existing terminals. The container handling throughput of the new terminal is estimated in the same way as the economic analysis, which is that the new terminal only handles the demand exceeded the capacity of the existing terminal, up to the capacity of the new terminal which is maximum 800,000 TEU per year, and number of vessel call is calculated by assuming all the vessels are 1,000 TEU class container ships, which the size is 20,000 DWT or 18,000 gross tons, and drop off and pick up 900 TEU of containers per call, and the revenue is calculated based on these number of vessels called and containers handled. Furthermore for the calculation of the revenue, the ratio of LCL/FCL/Empty containers are estimated at 1:7:2, based on the current statistical data supplemented by information through interviews, and considering its proximity to SEZ industrial park, half of the FCL and Empty containers are assumed to be directly brought into and picked up from the terminal by shippers.

(3) The Cost of the Project

Regarding the project cost, the construction, maintenance and operation costs for the economic analysis are used as the base, but also included is the cost for the new pilot vessels. Regarding the operation of pilots (channel navigation) and tugs (berthing), the current rate in the MPA tariff is too cheap to pay the operation costs (especially the fuel) and the entire operation is not financially balanced. MPA has been suffering operational deficits these years. So these two items are excluded from the scope of the financial analysis of this project.

Addition to above, contingencies and price escalation are also counted in the cost.

In this project, tax imposed to directly imported materials are considered exempted when implemented by public sector, since foreign development fund such as Japanese ODA yen loan is assumed to be applied for the public financing of this project.

(4) FIRR and the Financial Feasibility of the Project

Table 5.11-3 FIRR of the 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%

(Source: The Study Team)

Based on the conditions and assumptions above, FIRR is calculated. First of all, FIRR for the case 4 in Table 5.5-5, which the whole project is implemented by one public entity, is as shown in Table 5.11-3 as 9.7%. Sensitivity analysis of 10% less benefit and 10% more cost delivers FIRR of

7.6%.

The official interest rate (discount rate) of the Myanmar Central Bank is now lowered to 10% from previous 12% this April, but still higher than the FIRR of the project, and the market rate is even higher than the official interest rate. Therefore, the project is financially feasible if only some low interest public fund is applied to certain portion of the project financing.

For other 3 cases of Table 5.5-5 involve more private financing which has higher interest rate, the feasibility will be lower than the above case. Since at the time of this report, Myanmar Government has already chosen to implement the Phase I as in the case 4, using Japanese Yen loan, and outsource some of the operation to a private or public-private joint terminal operator, FIRR for other 3 cases need not to be calculated at this time in this study, but rather, it will be further studied and calculated in the following studies, such as, planned PPP study on the Phase I of this terminal.

6. Urgent Development Plan of Thilawa Area

6.1. Urgent Development Plan of Facilities and Equipment

6.1.1. Port Facilities

(1) Layout Plan

As shown in **5.4.1(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. Layout plan of the terminal which needs to be developed urgently can be determined as below;

With factors given below, container handling capacity of one berth with a length of 200 m which is capable to accommodate the maximum ship size of 180 m LOA can be estimated at about 203,000 TEUs/year.

1. Number of gantry cranes = 2
2. Hourly container handling number of gantry cranes = 25 boxes/hour
3. Handling efficiency of the 2nd gantry crane = 0.9
4. Annual working days of gantry cranes = 365 days
5. Daily working hours of gantry cranes = 21 hours
6. Annual berth occupancy rate = 0.4
7. Ratio of 40 foot containers and 20 foot containers = 1.5
8 Box Ratio = 1.4

The yard capacity needed for handling 157,000 TEUs/year is estimated at 5,200 TEUs in accordance with factors given below. The slots required can be estimated at 1,500.

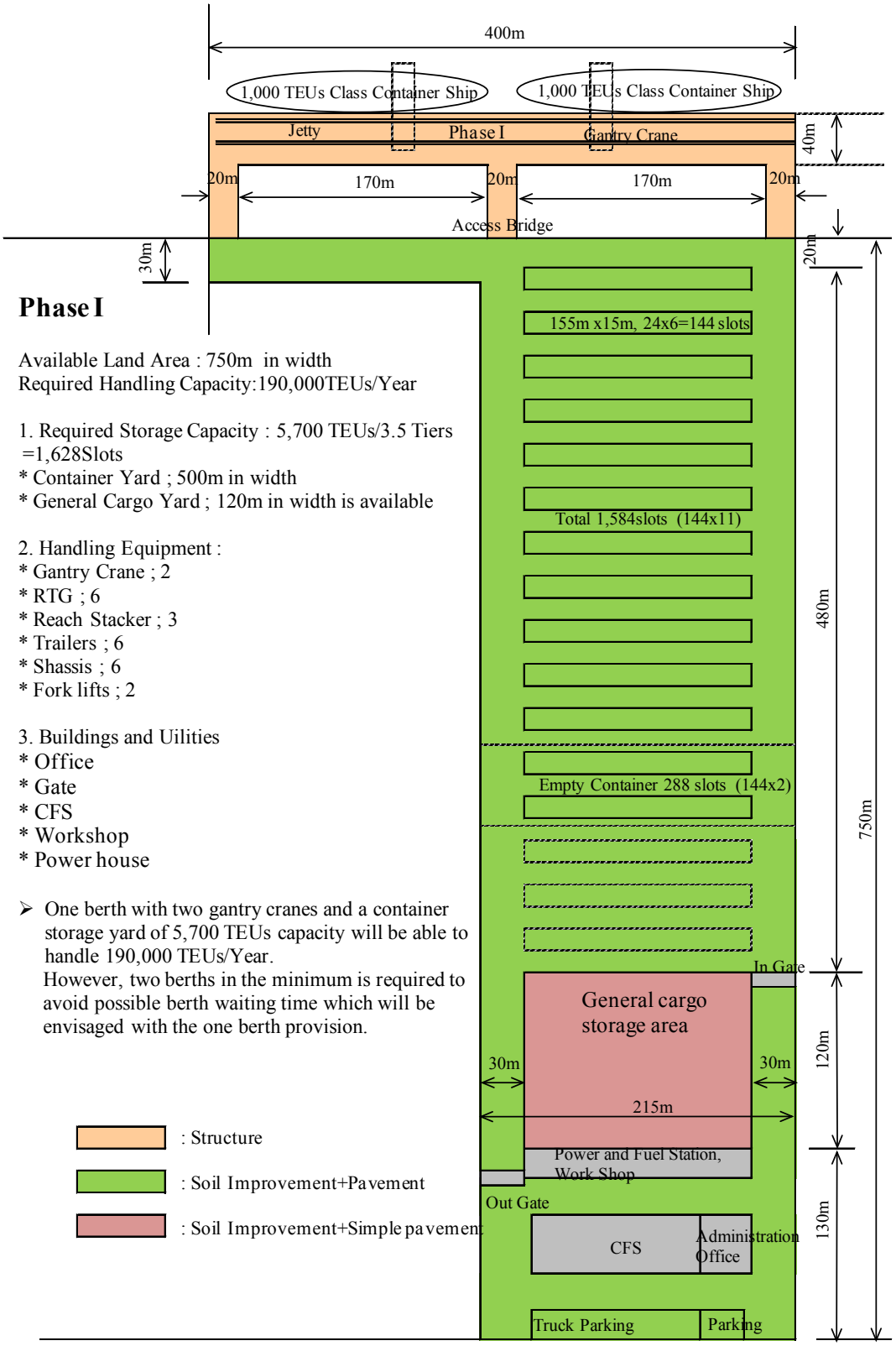
1. Container tacking height = 3.5
2. Usage rate of container storage capacity = 0.75
3. Ratio of the maximum container handling volume against weekly average = 1.4
4. Container dwelling days in yard = 7 days
5. Annual working days of yard = 365 days

Theoretically, the containers generated from the SEZ by 2020 are able to be handled at a terminal with one berth of 200 m and a storage yard with a capacity of 5,700 TEUs. Sixteen hours are needed to handle containers of 800 TEUs per ship by 2 gantry cranes. In addition to this, an average of 14 hours in total will be required for berthing/unberthing, waiting for the tide. Taking that into account, the berthing time of one ship can be estimated at about 30 hours. On the other

hand, 3 container ships need to call the port per week to transport 160,000 TEUs/year containers. Number of ships waiting to berth in case of 1 berth and 2 berths can be calculated at 0.62 and 0.02 respectively by using the conditions above. Thus, 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.

Thilawa Area Port terminal is expected to handle mainly containers generated from the SEZ relevant industries. It will be also necessary to handle general cargo such as construction materials for SEZ facilities at the terminal. Therefore, this terminal is required to prepare general cargo storage yard with a simple pavement at an area where future container yard expansion will be expected. In addition to this, at least 2 mobile cranes for general cargo handling on the jetty will be needed.

The layout plan of Thilawa Area Port terminal is given in Figure 6.2-1 taking into account the above.



(Prepared by the Study Team)

Figure 6.1-1 Layout Plan of Thilawa Area Port Terminal

Taking into account the following, an urgent development plan, namely Phase I, which

includes 2 berths of 400m in length and a yard of about 1 plot equivalent space shall be made on Plots 25 and 26.

- In order to develop the Phase I urgently, areas except Plot 22 which requires resettlement of people and Plot 26 which involves environmental issues shall be used.
- In order to allow for the efficient use of the Phase III facility, Phase III construction site should not divided by Phase I facility.

From the above considerations, a layout plan of the facilities at Thilawa Area Port is shown in Figure 6.2-2.

Source : Google Map ,Study Team

Figure 6.1-2 Layout Plan of Thilawa Area Port Terminal (Google Map)

6.1.2. The port facilities for a design

This preliminary design of port facilities includes a berth, yard, revetment, and trestle. The harbor-facilities design of an urgent improvement plan is the same as an overall plan. Therefore, only the main point of an urgent improvement plan is indicated especially here.

(1) Standards and Codes

Design standards and codes are the same as that of an overall plan.

(2) Berth Design

The jetty is designed for a container berth as well as for a multiple-purpose berth.

1) Design Conditions of berth

a) Site conditions

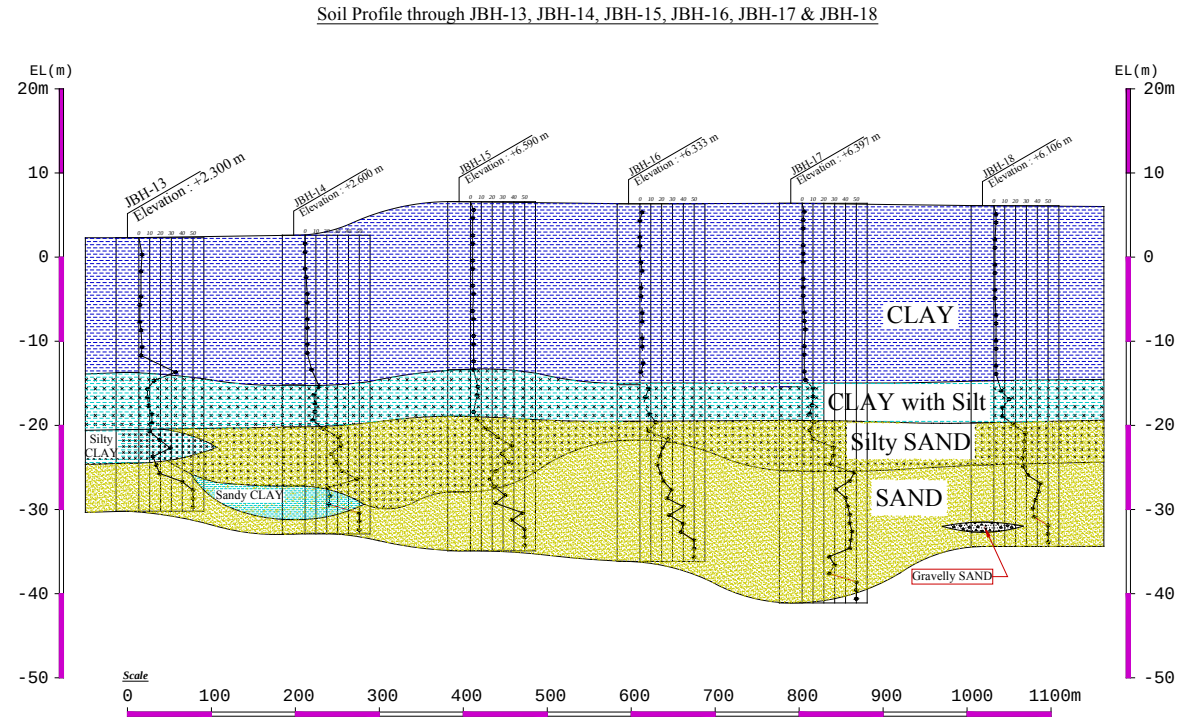
i) Geological condition

Geographical condition is the same as that of an overall plan.

ii) Geotechnical conditions

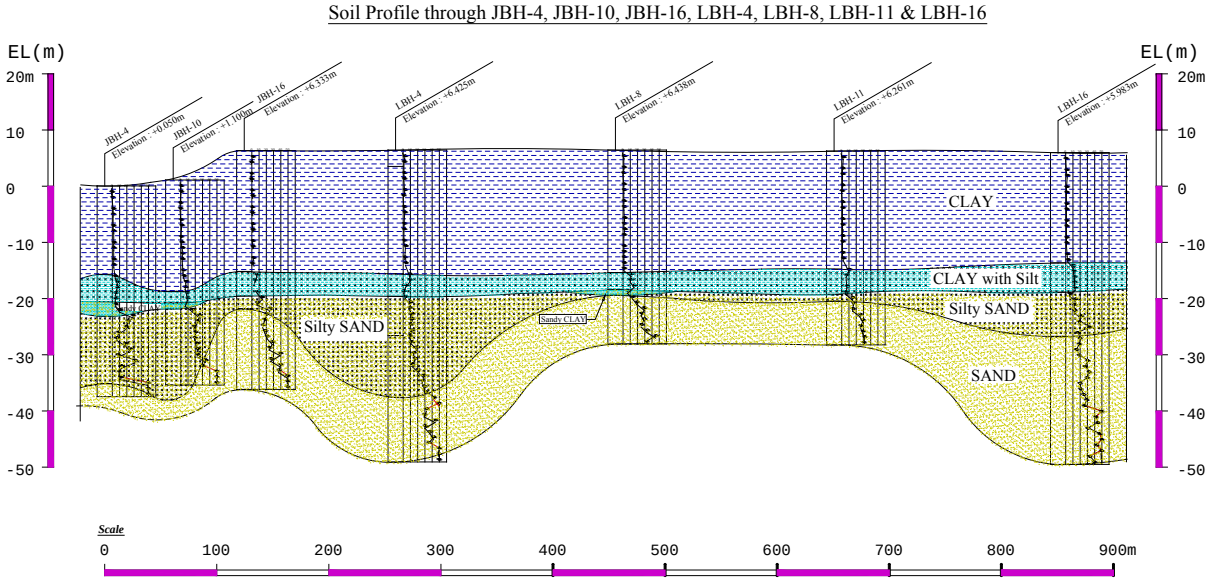
Geological cross section is shown Figure 6.2-3 and Figure.6.2-4.

An urgent improvement plan part is drilling NoJBH4 and JBH6.



(Prepared by the Study Team)

Figure 6.1-3 Soil Profile（Longitudinal profile along the berth face line）



(Prepared by the Study Team)

Figure 6.1-4 Cross Section Soil Profile（Berth Area）

The geological condition of the site is as follows: The layer from surface down to CDL-23m is very soft silt. A loose silt mixture sand exists from CDL-23m to CDL-27m. The layer deeper than CDL-27m is relatively firm sand layer and at CDL -35 m the N-value is more than 50.

- Average N value of each layer is as follows.
  - N- value of a very soft layer is 1~3.
  - N- value of loose sand is 10~30.
  - N-value of comparatively firm sand is more than 30.

- Design foundation composition

From the geological survey result, the design foundation composition is set up as follows.

Design Geological Condition

Table 6.1-1 Design Geological Condition

	Layer	N value	γ (kN/m3)	γ' (kN/m3)	C (kN/m2)	ϕ (°)
Surface -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)

b) The natural conditions other than geographical and geology

The natural conditions for an urgent improvement plan other than geographical and geology are shown in the following tables.

Table 6.1-2 Other natural conditions

Conditions	Items	Details		Note
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	―	
	Wave	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) Berth Planning Conditions

a) Face line of port facility

The berth face line of an overall plan in front of Plots 22-26 is shown in Figure 5.4-10.The berth face line in an urgent improvement plan is a portion of the plots 25 and 26 of the berth face line of an overall plan.

b) Planning conditions other than face line.

Table 6.1-3 Other planning conditions of berth

Conditions	Items	Details		Note
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 Parameters of structure

a) Dimensions of wharf

The dimension of wharf is shown in following table.

Table 6.1-4 Dimensions of wharf

Item	Value	Note
Length	urgent improvement plan 200mx2berth=400m	
Width	20.0m	
Depth	CDL-10.0m	
Height	CDL+7.5m	

4) Examination of the quay structure

a) Selection of berth structural type

The structure types of quay in an urgent improvement plan are stake types same as the overall plan.

b) Selection of supported pile deck type wharf

In the quay of the stake type, a strait pile type, a batter pile type, a strut type, and a jacket type were selected as a comparison proposal same as the overall plan. The overall plan of Chapter 5 described the feature and drawing of each section.

c) Comparison of structure type

The structure proposal compared about stability, viewpoint of construction, and economical efficiency.

In comparison selection, it made to have completed one berth at the end of 2015 besides the same relation condition as an overall plan, and to have started operation into primary importance conditions.

As a result, as for the structure proposal which can make available in 2015 and is suitable for this plan place, the jacket structure proposal was judged to be a recommendation structure type in an urgent improvement plan.

The comparison table of a structure proposal is shown in Table 6.2-4.

d) Designed structure

The following points are to be noted for the construction of the jetty:

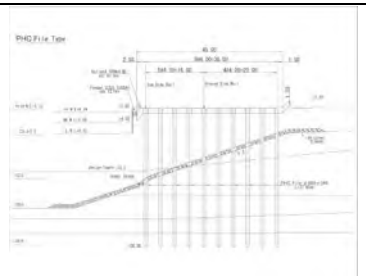
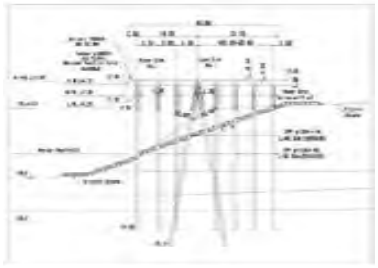
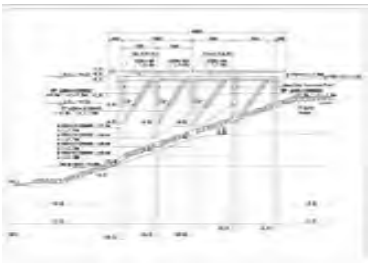
- The existing ground higher than depth DL-10.0m is dredged.
- The river bank side from berth face line is dredged at 1:3 slope.

- As river current is fast, the front part of quay and slopes are protected with armor stones.

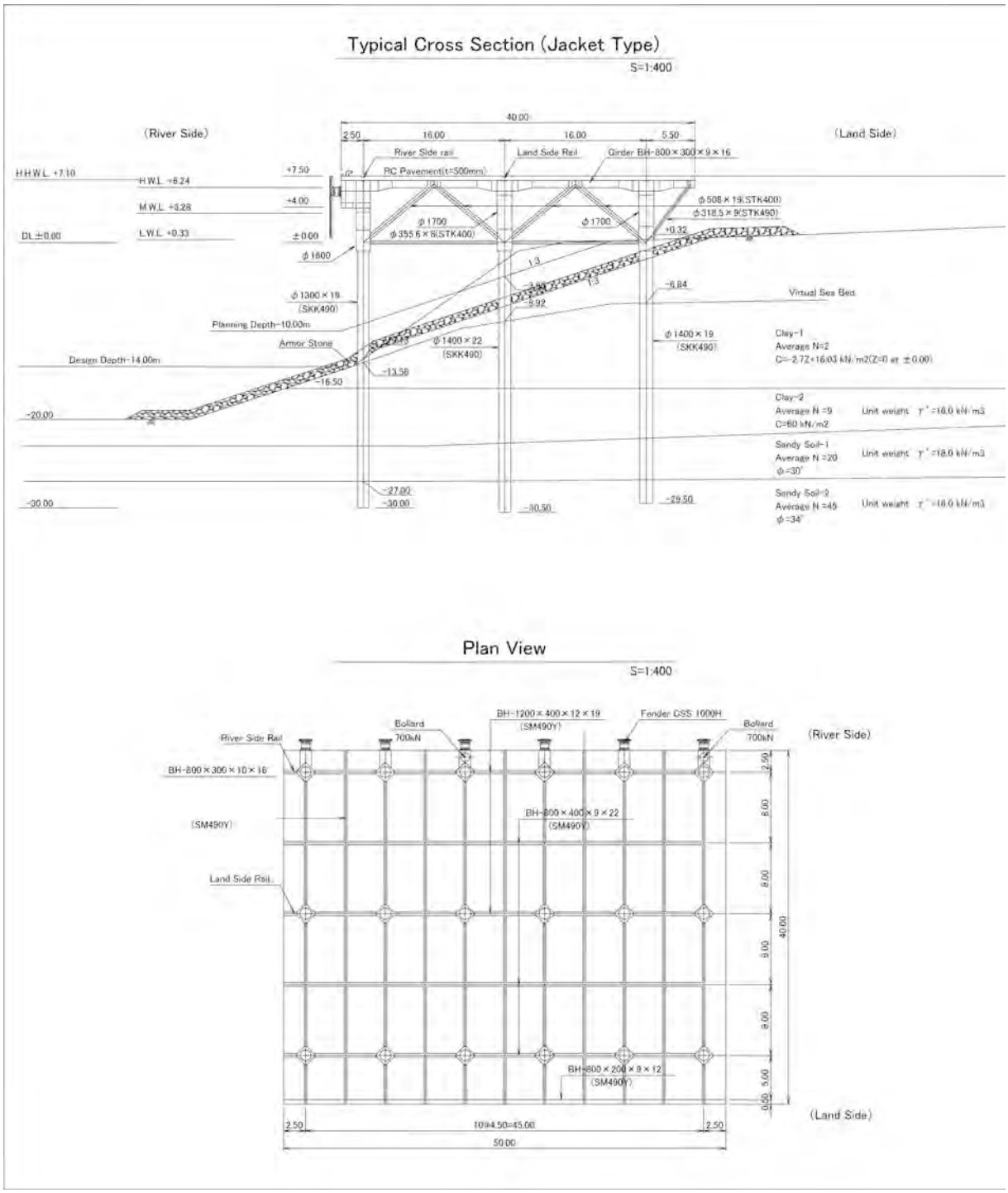
The design section of jacket type is shown in Figure 6.2-5

Table 6.1-5 Comparison of pile type quay Wall

Comparison of pile type quay Wall

	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/200 m)	-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	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)	**D**	**Recommendable** (a little high economical efficiency and a little long construction term)	**B**	**Not recommendable** ((high construction cost and hard construction)	**C**	**Most recommendable** (short construction term and good stability)	**A**

(Prepared by the Study Team)



(Prepared by the Study Team)

Figure 6.1-5 Jacket Typical Cross Section

(3) Revetment

Examination of revetment for urgent improvement plan is the same as that of an overall plan. Here, the examination result is indicated.

1) Revetment design conditions

a) Natural conditions

The average grand elevation along the revetment face line of an urgent improvement plan is CDL+6.0m. Other natural conditions are the same as that of a pier.

b) Planning conditions

Urgent improvement plan scope is the plots 26 and 25.

Table 6.1-6 Planning conditions

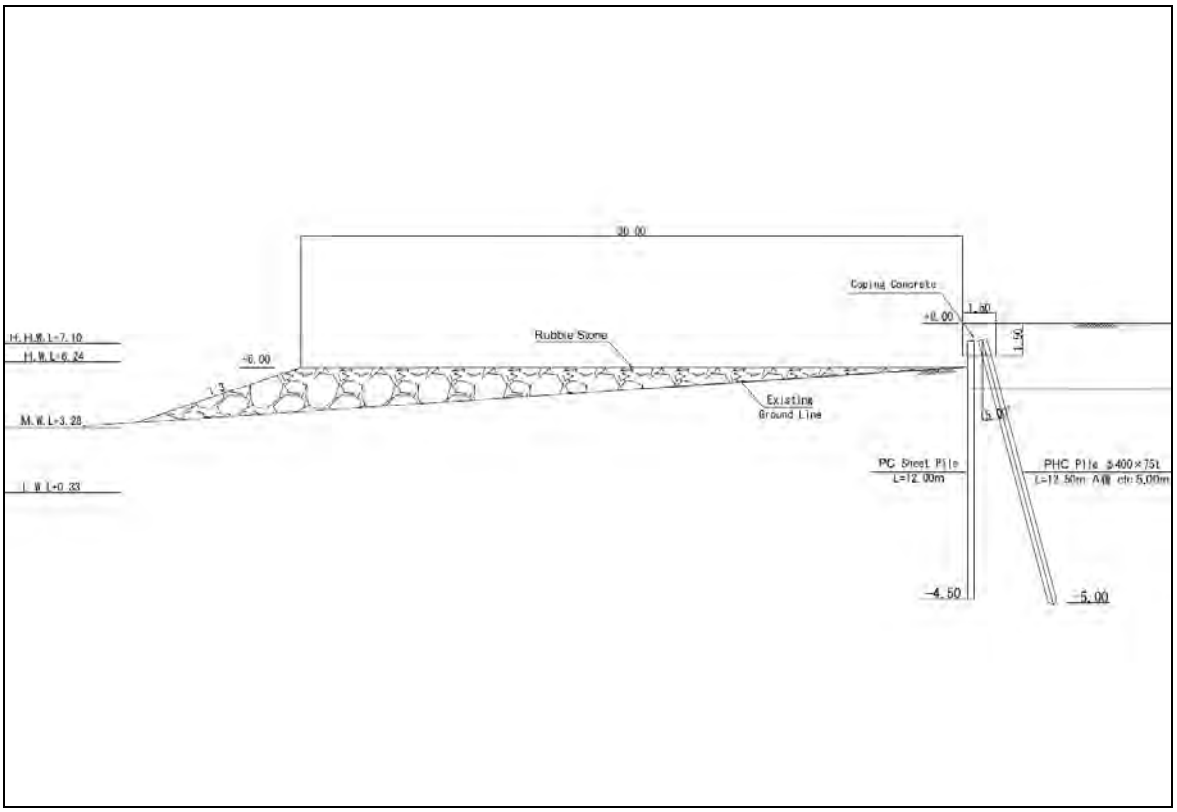
Items		Note
Length	200m	
Height	CDL+8.0m	

Surcharge load

The area behind revetment is planned as a road, therefore surcharge load of the road is set as 20 kN/m2.

2) Selection of revetment type

Revetment structure types in the overall plan, examined are a sheet pile type, a gravity type, a wall type, and mound type. Comparison result is same as the overall plan. A standard cross section of the revetment is shown in Figure 6.2-6.



(Prepared by the Study Team)

Figure 6.1-6 Revetment Typical Section

(4) Trestle

Examination of the trestle of an urgent improvement plan is the same as that of an overall plan, and indicates the examination result.

1) Design conditions

a) Natural conditions

The natural conditions of trestle of an urgent improvement plan are the same as that of an overall plan.

b) Planning conditions

The planning conditions of a trestle are as follows.

Table 6.1-7 Planning conditions of a trestle

Items		Note
Length of berth	200mx2berth=400m	
Widths of berth	20.0m	
Depth of Berth	CDL-10.0m	
Berth Elevation	CDL+7.5m	

c) Use conditions

i) Load

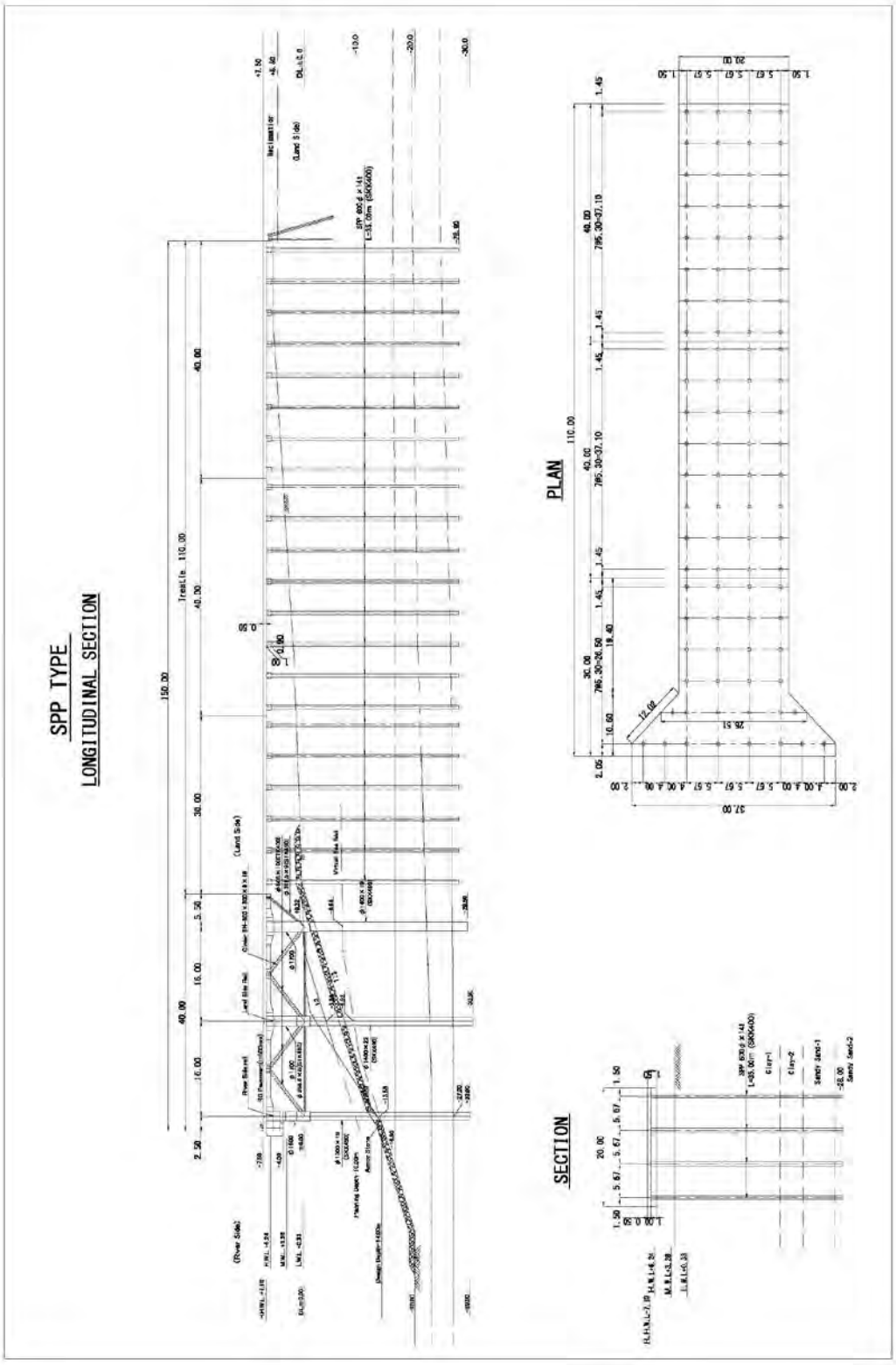
Imposed load on trestle is 20 kN/m2.

2) Trestle structure type selection

In structural types there are several options such as embankment type, a gravity type, sheet pile type, and others. A pile type that causes a minimum influence to river flow is considered as appropriate for trestle at the site.

3) Comparison examination of the Trestle structure proposal

In an overall plan, the pier type (steel pipe pile) is selected and an urgent improvement plan is also made into the same type. The typical drawing of selected trestle is shown in Figure 6.2-7.



(Prepared by the Study Team)

Figure 6.1-7 Trestle Typical Cross Section

(5) Yard Design

1) Yard design conditions

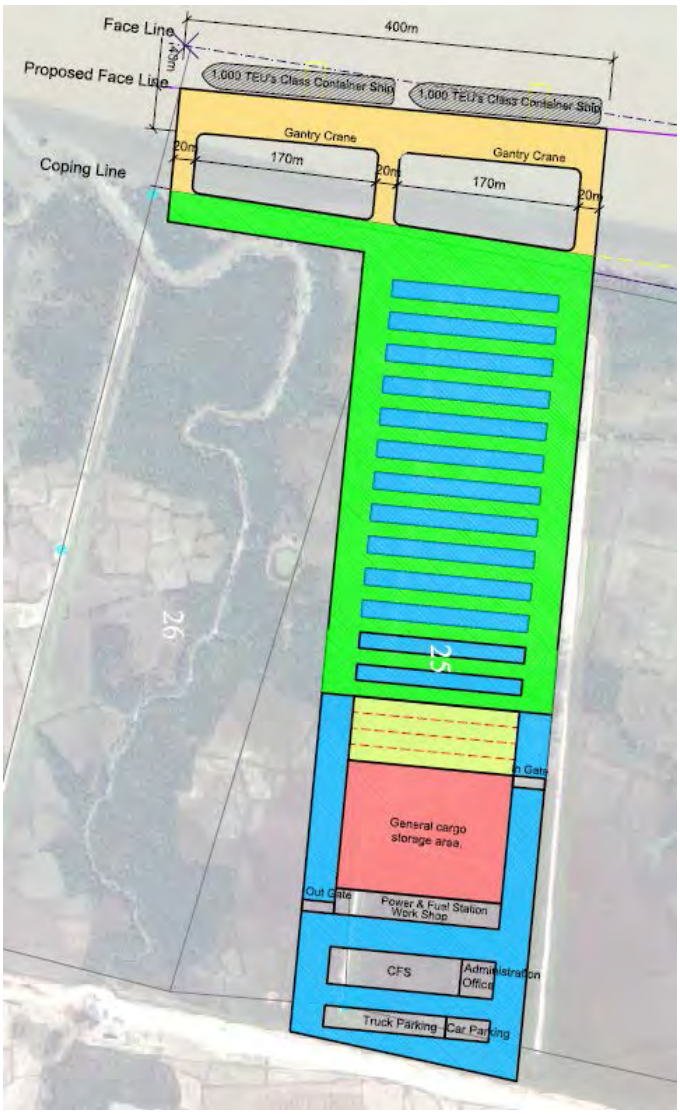
a) Natural conditions

Natural conditions are the same as the natural conditions of Chapter 5. The urgent improvement plan regions are the plots 26 and 25 of these.

b) Planning conditions

① Layout of yard plan

The planned yard layout of the urgent improvement plan is shown in Figure 6.2-8.



Source: Google Earth, Study Team

Figure 6.1-8 Planned yard layout plane

② Yard ground elevation

Yard ground elevation is established considering the planned road, and adjacent land development. The yard elevation is therefore set at CDL+8.0 m.

③ Yard surcharge load

Surcharge load of the yard is therefore 50 kN/m2 from the above table.

④ Operation system

The container handling equipment to be used in the yard are RTG, trailer, chassis, reach stacker, and forklift. The reference drawing of RTG is shown below:

2) Design of yard leveling by reclamation

a) Construction plan of yard leveling

i) Elevation of yard

The necessary height of the revetment is CDL+8.0m. The height of the existing yard and existing road is similar. CDL+8.0m is set as the height of yard .

ii) Reclamation volume

The reclamation volume of approximately 0.23 million m3 has been estimated after the topographical survey.

iii) Material for the reclamation

The material for the reclamation is river sand which is easy to procure and economical, however since no adequate quarries exist nearby the site land-transport is costly.

iv) Outline of construction plan

The yard leveling work will be done according to the following procedure:

1) Prior to the reclamation work, revetment and embankment of the block boundary are constructed.
2) After certain portions of the completion of the above works, reclamation work by pumping up of river sand is done, and the surface is leveled.
3) During the reclamation work, the overflow water shall be discharged with a proper management of sedimentation pond.

3) Design of Soil Improvement

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.

4) Design of pavement

A general pavement structure is described in this section.

a) Classification of yard pavement

The pavement classification is to be determined by a use plan of the yard. Although a detailed use plan is not yet finalized at this stage, the pavement will be in general divided into the following three pavement types.

Container stacking yard

Container stacking yard is defined as a laden container stacking yard. Concrete stacking blocks are provided for the laden container stacking yard, and the areas between container stacking blocks are paved with macadam paving of asphalt surfaced.

Road and Hauling area

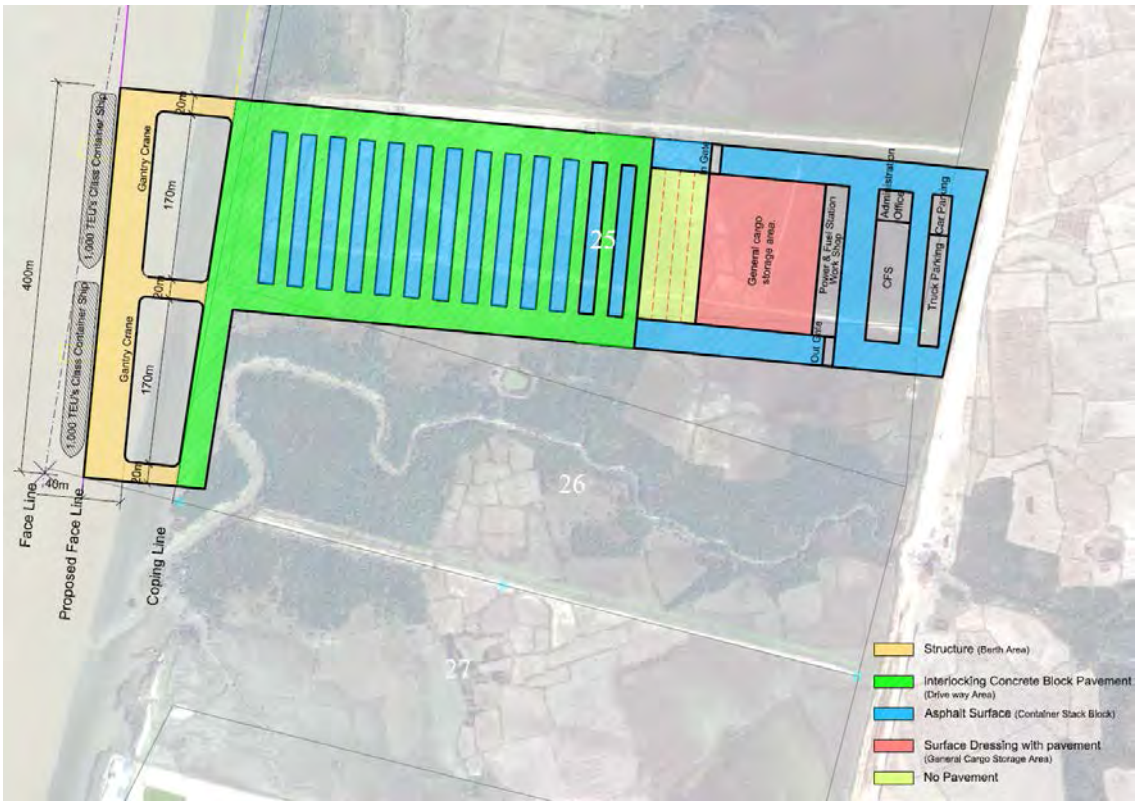
The road and hauling areas are designated areas for trucks and container handling equipment (e.g. Chassis trucks and Reach stackers). These areas are paved with interlocking concrete blocks (ICB) as it is easy to carry out maintenance when settlement or damage occurs.

No pavement area

The area being left unpaved portions and to be used for empty container storage or other purposes, where soil improvement only provided.

b) Plan of pavement area

The pavement plan of the yard is showed in Figure 6.2-9.



(Prepared by the Study Team)

Figure 6.1-9 The Pavement Arrangement Plan of the Yard

c) Composition of pavement

The pavement composition is designed same as an overall plan.

5) Design of drainage

A drainage outline plan is described in this section.

a) Drainage Plan

Yard drainage system is such that surface rain water will be collected and drained into open ditch and culvert, and discharged into river.

As staged construction of yard is planned, the drainage system will also be completed each construction stage.

b) Surface drainage in a yard

Surface rain water will be flowed by slope of pavement or ground into open ditches and pits constructed in the yard and drain to culverts.

c) Rain water drainage

At yard boundary culvert type drainage is provided. Surface water will be collected and drained into the culvert drainage. A simple treatment facility, such as oil separator, may need to be provided at the end part of the culvert before discharging the surface water into the river. The design catchment area for rain water is limited to the yard area.

6.1.3. Cargo Handling Equipment

(1) Design Parameters

1) Basic Conditions

In designing Cargo Handling Equipment, the following basic conditions are applied;

- Quay wall condition: Detached Pier Type, 400 m long, Design depth -10.0 m
- Design Vessel: Container Ship 20,000 DWT class (LOA=177 m, 1,000 TEU)
- Cargo Handling System:

  -Quay side crane: STS Gantry Crane

  -Container Yard: RTG with Tractor & Chassis system

  -For Empty container handling and CFS: Reach Stacker and Forklift
- Planned Container Handling Volume: 200,000 TEU/ yr.
- TEU/ Box Ratio: 1.4 (20': 40'= 1.5: 1.0)
- Empty container ratio: 30 % is assumed based on the current records of Yangon Port.

2) STS Gantry Crane

a) Design Specifications

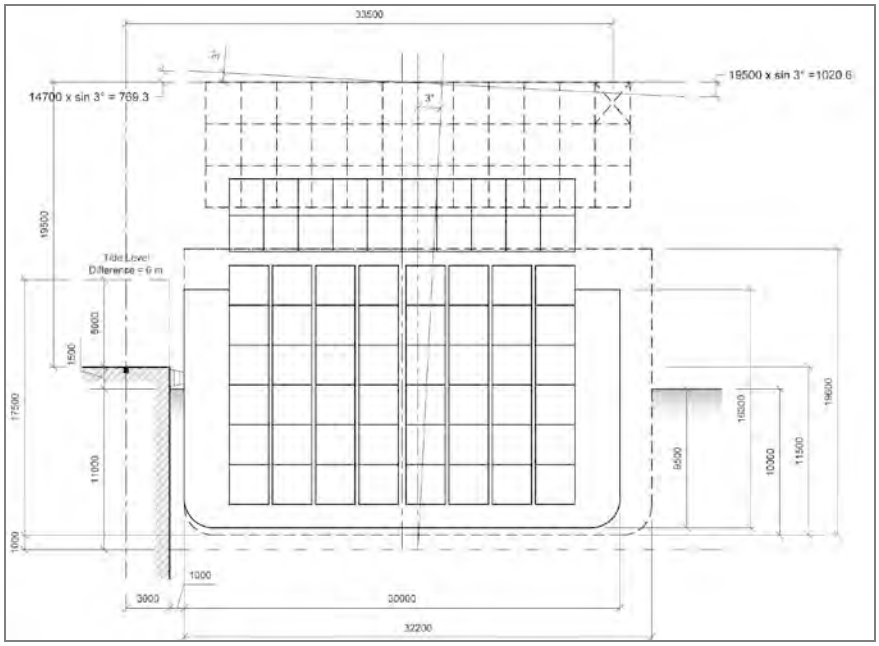
Considering a possible future increase of calling ship sizes and insignificant increase in beam width with the design ship, a STS Gantry crane of size for a Panamax size container ship is recommended, by which the following specifications will be designed;

- Target Vessel Beam: 32.2 m (12 rows)
- Rated Lifting Capacity: 40 t
- Crane Span: 16.0 m

- Outreach: 35 m Min.
- Hoisting height: 42 m (24 m above Rail, 18 m below Rail)
- Theoretical Handling Capacity: 40 box/hour

  Design Handling Capacity: 25.6 box/hour
- Assuming Effective operability ratio =0.8, and Working efficiency=0.8;

A diagram indicating the necessary dimensions of STS Gantry Crane is shown in Figure 6.2-10



(Prepared by the Study Team)

Figure 6.1-10 STS Outreach and Hoisting Height Estimation

b) Estimation of Necessary Units

- Handling Container Boxes: 142,857 boxes/yr. (200,000 TEU/ 1.4)
- Container Box Handling per week: 2,747 boxes/week (142,857/ 52 weeks)
- Container Box Handling per Ship: Average 900 TEU/ship = 643 boxes/ship
- Necessary Units of STS Gantry Crane

Assuming effective working hour is 18 hours, the required number of the STS is estimated as 2 Units. (643 boxes/ 18/25.6)= 1.4 units)

3) RTG (Rubber Tired Gantry)

a) Design Specifications: 6 rows with 5+1 stacking height Type

- Rated Lifting Capacity: 40 t
- Design Span: 23.47 m, Wheel Base span: 6.40 m
- Max. Hoisting height: 18.00 m
- Theoretical Handling Capacity: 40 boxes/hour (same with STS)

b) Estimation of Necessary Units

Work efficiency of the RTG depends on the allocated roles of the use, such as the container handling between STS (Crane) to/from CY(Container Yard) or Handling between CY to/from Gate. Average Handling Capacity of RTG applied is therefore based on the use as follows;

- Use for STS-CY Work: 20 boxes/hr. ;Considering RTG shifting time between container stacking lanes, trucks waiting time, and so on.
- Use for CY-Gate Work: 10~15 boxes/hr.; considering more time losses for trucks waiting which are at random-arriving.

Using the above work efficiencies, the required RTG units are estimated below;

Total container box to be handled by RTG is 70 % (considering the ratio of empty container is 30 %), therefore, 450 boxes/ship.

- For STS-CY Work: 450/ (16 hours x 20 box) = 1.4 units Thus, 2 units required.
- For CY-Gate Work: 142,857 boxes/yr x 0.7/ (52 weeks x 6 days x 12 hrs/day x 10~15 box) = 1.78~ 2.67 units. Thus, 3 units are necessary.

Taking into account relatively frequent idling time required for regular maintenance & repairs, total of 6 units of RTG is provided by adding 1 stand-by unit, which is a normal practice in International Container Terminals. (Generally speaking, 2~3 units per 1 STS Gantry Crane are to be provided)

4) Reach Stacker

Appropriate number of Reach Stackers of rated lifting capacity 40-42(t) are to be provided for the empty container handling and CFS works as follows;

- For Empty Container Handling: Since Empty container number per year is as small as 42,857 boxes (142,857 x 0.3), one unit of Reach Stacker for respective roles (STS-CY work & CY-Gate work) will be sufficient. Therefore, two(2) Reach Stackers are to be

provided.

- One (1) unit of Reach Stacker is to be arranged for CFS works.

Total of three (3) units of Reach Stacker is therefore required.

5) Other Cargo Handling Equipment

In addition to the above cargo handling equipment, the following equipment will also be provided as this is necessary for the planned Container Terminal Operation;

- Tractor + Chassis of 40' (2 x 20') container for boxes movement: Total of six (6) sets of Chassis (with Tractor) is provided as one STS needs min.3 chassis trucks according to its handling capacity (e.q. Assuming a chassis achieves 10 trips/hr.=10 boxes/hr, the required number is 25.6/10 =2.56 units).
- As minimum number, two(2) units of 3.5 t type forklift are suitable for CFS use.

For reference, the General Arrangement drawings of STS Gantry Crane and RTG are presented in Figure 6.2-11and Figure 6.2-12 respectively.

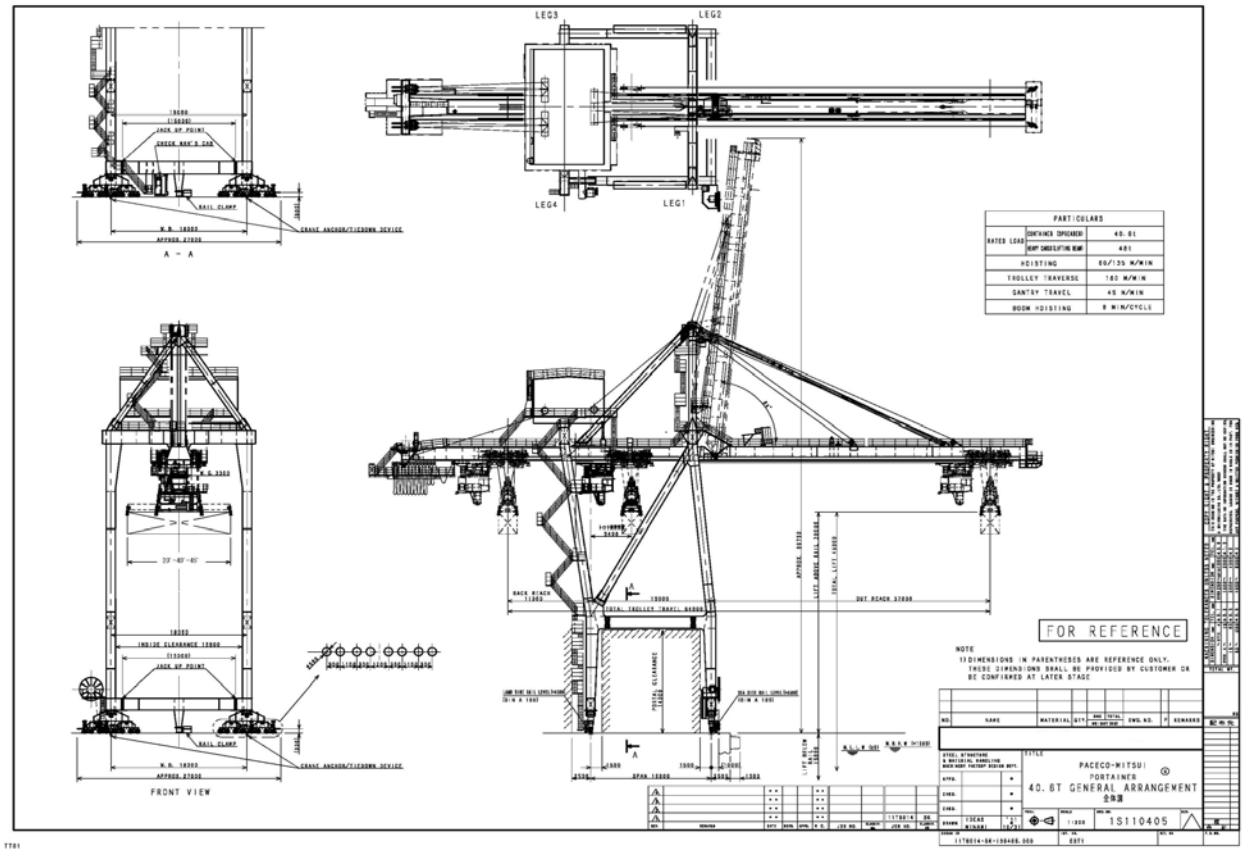


Figure 6.1-11 STS Gantry Crane General Arrangement (For reference only)

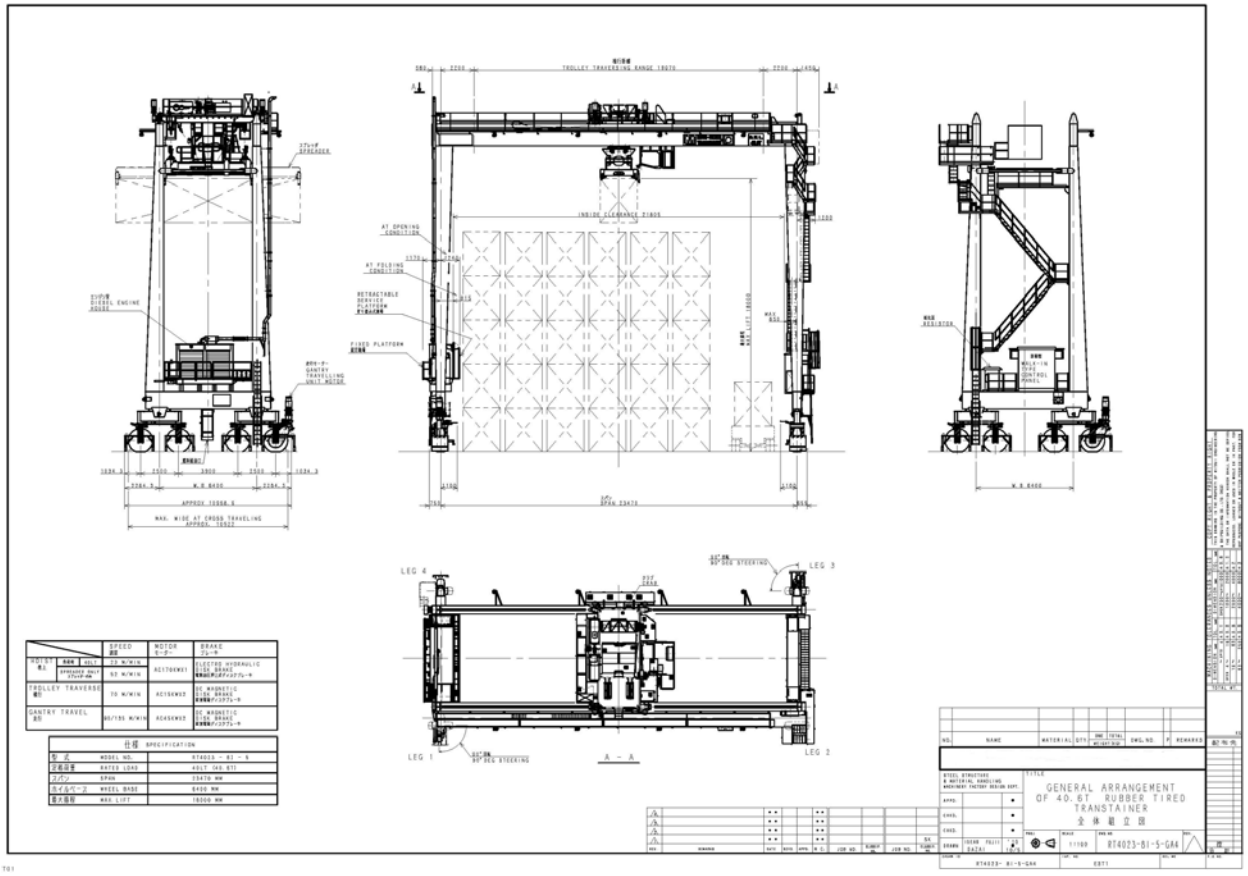


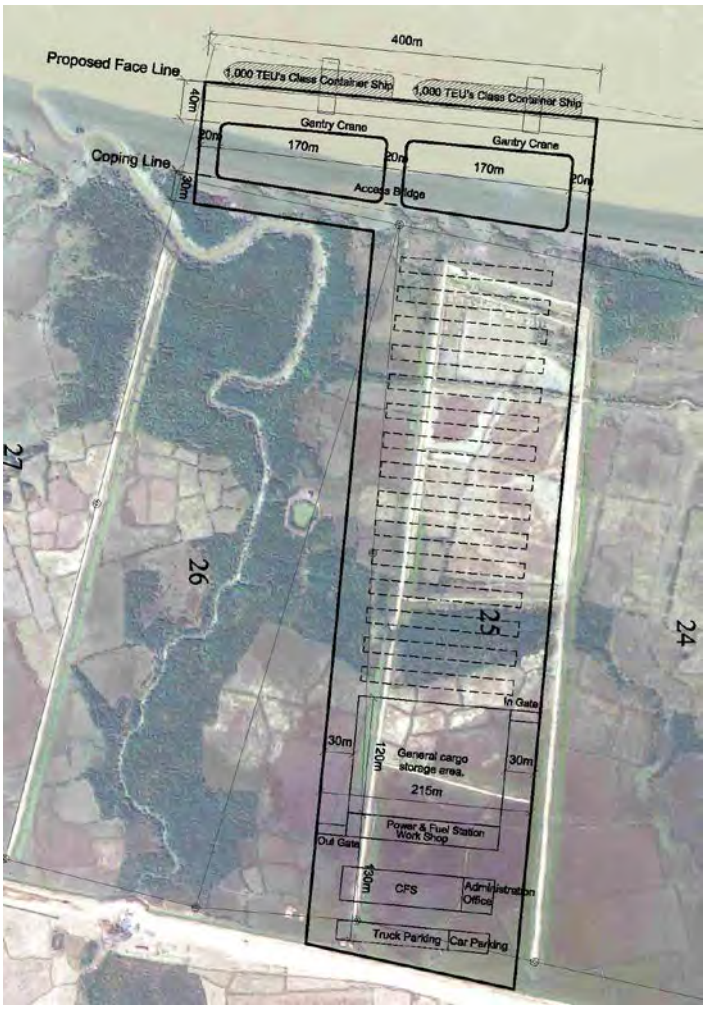
Figure 6.1-12 RTG General Arrangement (For reference only)

6.2. Environmental and Social Consideration

In this chapter, "Layout of Urgent Development Plan" and the followings of "Environmental Impact Assessment" are shown because the contents from "Baseline Information of Environmental and Social Conditions" to "Survey Results of Environment/Social Considerations" are same as chapter 5.4.

6.2.1. Layout of Urgent Development Plan

Although overall plant layout is decided from Plot 23 to Plot 26, urgent development layout (Phase I) also needs to be decided to cope with future demands in 2015 as well as to consider the environmental and social impacts. There are residents in Plot 23 and a creek in Plot 26. Not only from environmental and social considerations, but also from flexibility to future demand, Plot 25 and river-side of Plot 26 are proposed by the Study Team as shown in Figure 6.2-1 as the urgent development layout (Phase I). This layout can avoid resettlement at the stage of urgent development plan, which is subject to ODA Loan, and maintain the creek.



Source : Google , JICA Study Team

Figure 6.2-1 Urgent Development Layout

6.2.2. Environmental Impact Assessment

The environmental impacts on the items that had been categorized into A through C under the scoping process have been assessed on the basis of the environmental survey, and the results are shown in Table 6.2-1.

Table 6.2-1 Environment Impact Assessment based on Survey Results

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
Pollutions	1	Air Pollution	C	C	B-	D	**<Under Const.>** According to the Interview Survey to Bay Pauk residents, impact on air pollution associated with the current operations of construction equipment/machines near Bay Pauk is very small. Most of the construction stuffs and materials for the Project will be delivered by water transportation, and the volume of land traffic will be increasing only by 19 vehicles a day. Therefore this Project will only have a small impact on air pollution. However, countermeasures against dust pollution should be implemented, when a large amount of land transportation is necessary to deliver the removed vegetation (at site clearance) or removed surcharge soil (800,000 cum) after soil improvement. **<After Operation>** According to the Interview Survey, it is not confirmed that there is negative impact on air pollution associated with the increase of traffic volume (cargo trucks) due to the current port operations in Thilawa Area. Also, the change in deterioration of air quality due to an increase of traffic has been estimated as less than 1% at Bay Pauk area. In addition, the major type of cargo handled in this terminal is container and bulk cargo is minor. Dusty coal or woodchips will not be handled because equipment and construction material are expected to be handled as bulk cargo. Because of this, it is considered that this Project also gives a limited impact on it.
	2	Water Pollution	B-	B-	B-	B-	**<Under Const.>** Turbid water is anticipated during dredging works at riverbank (160,000 m3), disposal of dredged soil, and dredging for collection of land filling materials (1 mil. m3). Also turbid and muddy surplus water is assumed to flow out from surcharge soil. Yangon River in front of the Project Site is always

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							turbid due to the fast current. Although it is thought that there is little impact on turbidity of river water associated with the construction works, some measures are considered to control excess turbidity (particularly from the viewpoint of preventing accumulation of silt and dispersion of contaminant in the river bed). There is a risk of washing water being discharged into the river at the concreting works, and a risk of oil spill from construction equipment such as pile drivers. Appropriate sewerage treatment is required, since up to 250 persons will be engaged in the construction works. **<After Operation>** BOD at the location where MITT is under operation is not high compared to other locations. Moreover, oil content is not found at all locations. Impact on water pollution due to this Project is considered to be small based on comparisons with MITT which is similar in scale to this Project. However, because MITT has their own sewage treatment facility, drainage from the facilities and the handling yard or oily water generated during operation of this Project also needs to be appropriately treated. The discharge of oil and harmful liquid substance from vessels is regulated under MARPOL Annex II which has been ratified by Myanmar. The impact from the surplus water out of the filling soil will be small because it will be discharged appropriately during the construction phase.
	3	Wastes	B-	C	B-	B-	**<Under Const.>** The wastes such as felled trees, dredged soil, removed soil of land filling, concrete fragments and oil waste from construction equipment are assumed to be generated. There is no regulation for wastes in Thilawa Area, however proper handling and disposal of construction wastes are required. (For dredging soil during construction , See “Sediment”) **<After Operation>** To dispose dredged material for channel maintenance is not included in this Project. However proper handling and disposal of the waste from port facilities and unloaded from ships shall be appropriately treated.
	4	Soil Contamination	C	D	D	N/A	**<Under Const.>** No excess level of contaminant over the standard is detected in the river sand planned to use for reclamation, therefore the risk of soil contamination is low.
	5	Noise	B-	B-	B-	B-	**<Under Const.>**

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
		/Vibrations					According to the Interview Survey to Bay Pauk residents, impact on noise/vibrations associated with the current operations of construction equipment/machines near Bay Pauk is very small. The volume of traffic increasing due to the Project is only 19 vehicles a day. Therefore, the impact on noise/vibrations is expected to be minimal. On the other hand, the noise level of 70 dB at the road edge is observed at present, and there are residents along the way to Yangon, therefore, the impact shall be reduced as much as possible. **<After Operation>** According to the Interview Survey, impact on noise/vibrations associated with the current port operations of equipment/machines in Thilawa Area is very small. The predicted noise/ vibrations at Bay Pauk associated with the increase of traffic volume is so lower level than the standards that the impact is considered to be limited. On the other hand, the traffic towards Yangon is estimated to increase by 75 vehicles a day (increase by 38 vehicles a day in Thanlyin Bridge route and Dagon Bridge route respectively), and there is a residence along the way, therefore the impact is to be reduced as much as possible.
	6	Ground Subsidence	D	D	N/A	N/A	N/A
	7	Offensive Odors	D	D	N/A	N/A	N/A
	8	Sediment	C	C	B-	B-	**<Under Const.>** The soil derived from the dredging of this project will be disposed the dumping site around the project site. According to the sediment survey carried out by the Study Team, values of copper and nickel among heavy metal and DDT of Organic Pollutants are above screening level. However the risk by soil dumping may be small because of following reason. London Convention stipulates that soil dumping to freshwater is at country's discretion. Dumping of dredged soil in a river is usually conducted because London Convention is not ratified and there are no regulation on it in Myanmar. According to Australian guideline (Sea Dumping), it is able to dump the dredged soil if the contaminants are lower than the concentration in background even though they are upper than the screening levels. The measured metals

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							and organic pollutants of sandpit were almost same level of the other survey points and dumping site. Even so, it is required to implement mitigation measures to minimize sedimentation of silt or spread of contaminated bottom sediment. **<After Operation>** Because survey results do not show that values of bottom sediment in front of MITT tends to be higher than those at the other survey points, impact by port operation is considered to be small. Even so, countermeasure for water pollution is required to reduce the sediment pollution (refer to "Water Pollution" above)
Natural Environment	9	Protected Areas	D	D	N/A	N/A	N/A
	10	Ecosystem	B-	C	B-	B-	**<Under Const.>** According to the result of the ecosystem survey carried out by the Study Team, it is confirmed that there is no threatened species designated in IUCN Red List. Moreover, as tidal land is maintained because of jetty type berth structure, the lost area of habitat is thought to be limited. Also the function of the creek in Plot26 will be maintained in the urgent development plan even with small diversion. Few mammals which might be affected by noise and vibration are living in the project site because the major portion of the project site is paddy field. Birds may be able to escape easily from the noise and vibration because major portion of adjacent area also is paddy field. From these facts, impact on ecosystem due to this Project is considered to be small. However, In case of land filling using dredged soil, some prevention measures against turbid water are required to preserve the ecosystem.(See water pollution) **<After Operation>** Impact for the habitat should be small for the same reason as described above under construction phase. But counter measures for water pollution is required to reduce the impact by water pollution to ecosystem.
	11	Hydrology	C	C	B-	B+	**<Under Const.>** <Land drainage> The current function of the creek in Plot26 shall be maintained even with a part diversion at creek mouth. The waterway at the west side of the road is to be secured as well.

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							<After Operation> <River flow> It is considered that pile-type Jetty structure contributes to mitigation of river bank erosion because current speed decreases along the river bank due to jetty construction.
	12	Topography/ Geology	D	C	N/A	B+	**<After Operation>** It is considered that pile-type Jetty structure contributes to mitigation of river bank erosion because current speed decreases along the river bank due to jetty construction.
Social Environment	13	Involuntary Resettlement/Site Acquisition	B-	D	B-	N/A	**<Before Const.>** <Resettlement> No resettlement is needed because there are no residents in the urgent development area. <Land acquisition> Some lands are used as paddy fields in the urgent development area. The compensation is not required because these area are used illegally. However, income restoration measures such as providing job opportunities and job training are required because there income will decrease due to decreasing their farm land. (See ANNEX Resettlement Action Plan(Draft))
	14	Poor People	C	B+	D	D	According to the survey results, there are no Poor people in and around the Project Site.
	15	Minority/Indigenous People	D	D	N/A	N/A	N/A
	16	Local Economy such as Employment and Livelihood	B+	B+	B+/-	B+	**<Under Const.>** <Job Creation> This Project creates new employment during construction works. <Impact on Fishery Activities> It is assumed that the area approx. 100m from the berthing line becomes off-limits during the construction period. However, since fishing can be carried out in the whole Yangon River, the impact on the fishery activities is limited. Marine traffic of about 50 barges a day for sand delivery to the site is assumed in the reclamation plan of the yard, therefore care has to be taken to avoid interference with the fishing activities. Because Yangon River is always turbid, there exist

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							several species such as siluroid, or *Polynemus paradiseus*, etc. which are resistant to turbidity. For this reason, it is considered that the impact on the fishery activities is limited, however, monitoring needs to be carried out. <Impact on Agricultural Activities> Income restoration measures are required for farmers concerned. (See ANNEX Resettlement Action Plan(Draft)) **<After Operation>** <Job Creation> Positive impacts on local economy due to new employment during construction and port operation are expected. <Impact on Agricultural Activities> Fishery is conducted throughout the Yangon River including surrounding area of the site, and the frontal area of the site is not a special fishing ground. Fishing with gill nets is observed on the water 400m away from river bank, and seine or fixed net are not observed on the river bank of the project site. Approx. 4 vessel calls a week are expected at the operation, and large vessels pass over installed nets daily. The interview to the residence at Bay Pauk was carried out by the Study Team on September 2012, and it was confirmed that there will no significant impact on the fishery during the construction and operation of the project. Accordingly, impact on the fishery activities is thought to be limited.
	17	Land Use and Utilization of Local Resources	C	C	B-	B-	**<Under Const.>** Although the paddy field will be converted to the port area, the concerned area is 15 ha, therefore the impact on agricultural resources is small. It is necessary to consider that surplus water from filling and drainage during construction to prevent a harmful impact on paddy field. The pile-type Jetty structure contributes will help to minimize the impact on fishery resources. To control excess impact on fishery resources, some measures for water turbidity are considered. (refer to “Water Pollution” and “Ecosystem”) **<After Operation>** No activities affecting agricultural resources are anticipated. The impact on water turbidity is considered to be small based on a comparison with MITT which is similar in scale to this Project.

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
							Although there is little impact on agricultural resources as well, some measures to control excess water turbidity are required. (refer to "Water Pollution")
	18	Water Use	D	C	N/A	C	**<After Operation>** The estimated daily water consumption is 500 cum/day, and this figure is rather small as compared with the water capacities of the existing three reservoirs. The impact on the current water use is likely to be insignificant. The specific water supply, however, is under study by MPA. To ensure the water supply is provided in a safe manner, the actual supply method shall be determined through the discussions with MOC, MOI, etc.
	19	Existing Social Infrastructures and Services	C	C	D	D	**<Under Const.>** The increment of predicted traffic volume by the construction related truck is assumed to be only 10nos in Thanlyin and Dagon bridge route. Therefore the impact to existing social infrastructures is very small. **<After Operation>** The increment of predicted traffic volume by the construction related truck is assumed to be only 38nos in Thanlyin and Dagon bridge route. Therefore the impact to existing social infrastructures is very small.
	20	Social Institutions such as Social Infrastructure s and Local Decision-Making Institutions	D	D	N/A	N/A	N/A
	21	Misdistribution of Damages and Benefits	D	D	N/A	N/A	N/A
	22	Local Conflicts of Interests	D	D	N/A	N/A	N/A
	23	Cultural Heritage	D	D	N/A	N/A	N/A
	24	Landscape	D	D	N/A	N/A	N/A
	25	Gender	D	D	N/A	N/A	N/A
	26	Children's Rights	D	D	N/A	N/A	N/A

Classification	No.	Evaluation Items	Assessment in Scoping		Assessment based on Survey		Reason for Assessment
			Before /Under Construction	After Operation	Before /Under Construction	After Operation	
	27	Infectious diseases such as HIV/AIDS	B-	C	B-	B-	**<Under Const./After Operation>** The infection rates of HIV, DHF and Tuberculosis show a decreasing tendency, however they are still higher than other countries. HIV infections and so on have the potential to spread through employing construction labors and port workers.
	28	Work Environment (incl. Work Safety)	C	C	B-	B-	**<Under Const./After Operation>** Because there is currently no law/regulation in Myanmar related to work environment and work safety, it is required to establish the standards to be used in the Project.
Others	29	Accidents	C	C	B-	B-	**<Under Const./After Operation>** The mitigation measures are required for the increase of traffic accidents associated with the increase of traffic volume during construction and after port operation.
	30	Cross-Border Impacts and Climate Change	D	D	N/A	N/A	N/A

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

6.2.3. Mitigation Measures

The mitigation measures required to be carried out during construction and operational phase are indicated in Table 6.2-2 for the items with categories of A through C in the environmental impact assessment.

Table 6.2-2 Mitigation Measures

No.	Impacts	Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
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.	Contractor	MPA	To be included in the construction cost
2	Water Pollution	①To monitor turbidity in the Yangon River during dredging, disposal of	Contractor	MPA	①③④⑤To be included in

No.	Impacts	Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
		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.			the construction cost ②USD 30,000 for Monitoring
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.	Contractor	MPA	①②To be included in the construction cost
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.)	Contractor	MPA	①②To be included in the construction cost
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.	Contractor	MPA	①Nil （included in the cost for “Water Quality”） ②USD 15,000 for Monitoring

No.	Impacts	Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
10	Ecosystem	①To install green-belt in the yard ②To conduct water pollution counter measure to reduce ecosystem deterioration	①MPA ②Contractor	MPA	To be included in the construction cost
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	Contractor	MPA	To be included in the construction cost
13	Involuntary Resettlement/Site Acquisition	To conduct income restoration measures and its monitoring (See ANNEX Resettlement Action Plan(Draft))	MPA (See ANNEX Resettlement Action Plan(Draft))	MPA (See ANNEX Resettlement Action Plan(Draft))	USD 15,000
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))	①②Contractor ③MPA (See ANNEX Resettlement Action Plan(Draft))	①②MPA ③MPA (See ANNEX Resettlement Action Plan(Draft))	①②To be included in the construction cost ③Nil （included in the cost for "Involuntary Resettlement/Site Acquisition"）
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")	Contractor	MPA	To be included in the construction cost
27	Infectious diseases such as HIV/AIDS	To educate construction workers on prevention against infectious diseases (HIV/AID etc.) at safety induction course	Contractor	MPA	To be included in the construction cost
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.)	Contractor	MPA	To be included in the construction cost
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.)	Contractor	MPA	To be included in the construction cost
Operation Phase					
2	Water Pollution	①To discharge sewer and domestic wastewater from the office after appropriate treatment	① ②MPA ③ ④ Port Operator	MPA	To be included in the operation cost

No.	Impacts	Mitigation Measures	Implementation Organization	Responsible Organization	Cost (USD)
		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	①MPA ②Port Operator	MPA	② To be included in the operation cost
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.)	Port Operator /Forwarder	MPA	To be included in the operation cost
8	Sediment	To conduct water pollution counter measure to reduce deterioration of sediment	Port Operator	MPA	To be included in the operation cost
10	Ecosystem	To conduct water pollution counter measure to reduce ecosystem deterioration	Port Operator	MPA	To be included in the operation cost
17	Land Use and Utilization of Local Resources	To conduct water pollution counter measure to reduce impact on agricultural resources	Port Operator	MPA	To be included in the operation cost
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	MPA	MPA	-
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	Port Operator	MPA	To be included in the operation cost
28	Work Environment (incl. Work Safety)	To establish and comply with safety standards for operation site	Port Operator	MPA	To be included in the operation cost
29	Accidents	To plan and comply with on-land and marine traffic regulation/rules for project	Port Operator	MPA	To be included in the operation cost

(Prepared by the Study Team)

6.2.4. Monitoring Plan

The monitoring plans required before and during construction and during operation are summarized in Table 6.2-3.

Table 6.2-3 Monitoring Plan

Items	Monitoring Items	Monitoring Points	Frequency (Duration for Operation Phase)	Implementation Organization
【Before Const. 】				
Involuntary Resettlement/Site Acquisition	Progress of income restoration measures (See ANNEX Resettlement Action Plan(Draft))	-	1~4 times a year	MPA
Local Economy such as Employment and Livelihood	Progress of income restoration measures (See ANNEX Resettlement Action Plan(Draft))	-	1~4 times a year	MPA
【During Const. 】				
Air Pollution	Countermeasures for dust prevention	Construction site	once a month	Contractor
Water Pollution	①During riverbank dredging, disposal of dredged soil to river, and dredging for the collection of landfill material a. turbidity survey (temperature, turbidity in SS, pH, and salinity) b. countermeasures for turbid water at disposal to river c. other countermeasures for turbidity	a. Upstream & downstream at working site b,c. working site	a. once a week at working site b,c. once a month	Contractor
	②a. Turbidity survey of surplus water from land filling (temperature, turbidity in SS, pH, salinity, and visual check on oil content) b. Countermeasures for securing drainage at construction (discharge channel, etc.)	a.b. Drainage and upstream & downstream of Yangon River	a. once a week at working site b,c. once a month	Contractor
	③Condition of waste water during washing concrete works, etc.	Construction site	Once a Month	Contractor
	④Maintenance of construction equipment and prevention measures for oil spill	Construction site	Once a Month	Contractor
	⑤Condition and maintenance of temporary toilets and septic tanks	Construction site	Once a Month	Contractor
Wastes	①Records for types/amount/disposal methods of Industrial Wastes	Construction site	Once a Month	Contractor

Items	Monitoring Items	Monitoring Points	Frequency (Duration for Operation Phase)	Implementation Organization
	②Countermeasures for turbid water when disposing dredged materials in river (the same as "Water Pollution")	the same as "Water Pollution"	the same as "Water Pollution"	Contractor
Noise/Vibrations	①Maintenance condition of construction equipment	―	Once a month	Contractor
	②Situation of route setting, consideration to the inhabitants and road users (ensuring of strict abidance of speed limit and avoidance of unnecessary revving/idling near residential area, etc.)	―	Once a month	Contractor
Sediment	①Countermeasures for turbid water (the same as "Water Pollution")	the same as "Water Pollution"	the same as "Water Pollution"	Contractor
	②Sediment monitoring before/after disposal (Specific gravity, Water content, Grain size, TOC, Arsenic, Cadmium, Chromium, Lead, Copper, Nickel, Zinc, DDT)	Dumping site	3 times before/intermediate/after disposal	Contractor
Ecosystem	①Condition of installed green-belt in the yard	Installation site	Per Construction Specification	MPA
	②Countermeasures for turbid water (the same as "Water Pollution")	the same as "Water Pollution"	the same as "Water Pollution"	the same as "Water Pollution"
Hydrology	Condition of securing cross-sectional area of discharge to the creek and the drainage	Location of installation	Per Construction Specification	MPA
Involuntary Resettlement/Site Acquisition	Progress of income restoration measures (See ANNEX Resettlement Action Plan(Draft))	―	1-4 times a year	MPA
Local Economy such as Employment and Livelihood	①Countermeasures for turbid water (the same as "Water Pollution")	the same as "Water Pollution"	the same as "Water Pollution"	Contractor
	②Extent to which fishery activities can be secured	―	Once a Month	Contractor
	③Progress of income restoration measures (See ANNEX Resettlement Action Plan(Draft))	―	1-4 times a year	MPA
Land Use and Utilization of Local Resources	①Condition of installed temporary discharge channel at construction	Construction site	Once a Month	MPA
	②Countermeasures for turbid water (the same as "Water Pollution")	the same as "Water Pollution"	the same as "Water Pollution"	Contractor

Items	Monitoring Items	Monitoring Points	Frequency (Duration for Operation Phase)	Implementation Organization
Infectious diseases such as HIV/AIDS	Achievement of the education of construction workers on prevention activities taken against infectious diseases (HIV/AID etc.) at safety induction course	Construction site	Once a Month	Contractor
Work Environment (incl. Work Safety)	Site condition according to the safety standards for project site	Construction site	Once a Month	Contractor
Accidents	Achievement of the plan and marine traffic regulation/rules for project	Construction site	Once a Month	Contractor
【Operation Phase】				
Water Pollution	①Condition of installed septic tank, etc.	Location of installation	Per Construction Specification	MPA
	②Condition of preparation of oil separator, etc.	Location of installation	Per Construction Specification	MPA
	③Maintenance of septic tank and oil separator, etc.	Location of installation	Once a year (during 3 years)	Terminal operator
	④water quality at drainage or surrounding of the port (temperature, turbidity in SS, pH, salinity, oil content, BOD, COD, Bacillus coli)	Drainage outlet (2 points or more), in front of the port (2 points or more upper & lower layers)	4 times a year (during 3 years)	Terminal operator
Wastes	Records for types/amount/disposal methods of Industrial Wastes	Port Facility	4 times a year (during 3 years)	Terminal operator
Noise/Vibrations	①Maintenance condition of cargo truck	—	Once a year (during 3 years)	Terminal operator
	②Situation of consideration to the inhabitants and road users (ensuring of strict abidance of speed limit and avoidance of unnecessary revving/idling near residential area, etc.)	—	Once a year (during 3 years)	Terminal operator
Sediment	Countermeasures for turbid water (the same as “Water Pollution”)	the same as “Water Pollution”	the same as “Water Pollution”	Terminal operator
Ecosystem	Countermeasures for turbid water (the same as “Water Pollution”)	the same as “Water Pollution”	the same as “Water Pollution”	Terminal operator
Land Use and Utilization of Local Resources	Countermeasures for turbid water (the same as “Water Pollution”)	the same as “Water Pollution”	the same as “Water Pollution”	Terminal operator

Items	Monitoring Items	Monitoring Points	Frequency (Duration for Operation Phase)	Implementation Organization
Water Use	Method of water supply and water consumption	―	Once a year (during 3 years)	Terminal operator
Infectious diseases such as HIV/AIDS	Achievement of the education of port workers on prevention activities taken against infectious diseases (HIV/AID etc.) at safety induction course	―	Once a year (during 3 years)	Terminal operator
Work Environment (incl. Work Safety)	Site condition according to the safety standards for project site	Operation site	Once a year (during 3 years)	Terminal operator
Accidents	Achievement of the plan and marine traffic regulation/rules for project	Operation site	Once a year (during 3 years)	Terminal operator

(Prepared by the Study Team)

6.2.5. Support to hold SHM

MPA, with the assistance of the JICA Study Team, held the Stakeholder Meeting (SHM) on 15th of February 2013 which was attended by the 3 affected persons who are using Plot 25 as a paddy field. The minutes of the meeting are attached in ANNEX Resettlement Action Plan(Draft)).

MPA subsequently held another SHM for all affected persons of the Port in Thilawa Area as listed below.

Table 6.2-4 Stakeholder Meeting by MPA

Time	Attendee	Major agenda
1 July 2013	Affected persons: about 200 Yangon local authority, media	Briefing of the project, Hearing affected persons' opinions
8 July 2013	Representatives of the affected persons: 8 MPA, media	Exchange of opinions with representatives of the affected persons
30 August 2013	Representatives of the affected persons: 20 MPA	Briefing of survey results carried out by MPA Confirmation of the list of the affected persons

6.3. Resettlement Action Plan

See [Appendix]

6.4. Project Cost Estimation and Procurement Package

6.4.1. Cost Estimate Summary

Outline of the cost estimation of the Urgent Development Plan of Thilawa Area, which is to be financed by a yen loan, is summarized in Table 6.4-1. Explanations in regard to tax and price escalation are added after the summary table.

Table 6.4-1 Cost Estimate Summary

Project name		Urgent Development Plan of Thilawa Area
Basic design		1. Basic Design 1) Civil ・ Jetty：length = 400m, width = 40m ・ Trestle：length = about 70m, width = 20m, 3 units ・ Land preparation: (reclamation and soil improvement)：17ha ・ Pavement and drainage: 14ha 2) Cargo Handling Equipment ・ STS Crane: 2 units ・ RTG: 6 units ・ Trailer: 6 units ・ Chassis: 6 units ・ Reach stacker: 3 units ・ Forklift: 2 units 2. Basic Design Drawing (included in this report) Terminal layout drawing Jetty plan and sectional drawings
Construction plan, Schedule, Procurement plan		1) Civil Construction Plan Included in the civil works are jetty, reclamation, and soil improvement. 2) Construction Schedule This project is required to be completed urgently, and by the milestone of the 17th month, a part of the jetty (200m) is to be completed so that the port terminal can be operational in December 2015. Due to this constraint, jetty construction work is on the critical path. Thus, the jetty structure type is selected such that the construction duration can be minimized. 3) Procurement Plan (i) Civil Major construction materials (such as steel pipe pile, plastic drain material, reinforcement bar, cement) are imported from the neighboring countries. Heavy construction equipment such as piling machine or dredger is also mobilized from around Singapore. (ii) Cargo Handling Equipment Taking account of the performance, quality, and punctual delivery, equipment is basically imported from Japan.
Cost estimate outline	Basic policy	1) Basic Policy This project is financed by a yen loan, and the contractor will be selected through international competitive bidding. It is assumed that the contractor is an international contractor, and the consultant is a Japanese consulting firm. 2) Procurement Method Bid method: International competitive bidding Payment method: Unit rate specified in the bill of quantities 3) Cost Estimate Item Grouped into two procurement and one consultant packages: (1) Civil Building and Building Works , (2) Procurement of Cargo Handling Equipment, (3) Consulting

		Service 4) Treatment of Tax It is assumed that commercial tax (5%) is applied, and the customs duty (when the contractor imports the materials and equipment) are exempted. 5) Applied Currencies ・ Local: US$ ・ Foreign: Japanese Yen (1 US$ = 83.64 Yen, 1 US$ = 858 Kyat) 6) Time of Cost Estimation January 2013
	Content of cost estimation	1) Procurement Cost (i) Civil Market prices of materials, equipment, and labour in Myanmar and neighboring countries will be investigated as much as possible to calculate the cost components. For the construction items that are not used in Myanmar, the unit prices in the neighboring countries are applied. (ii) Cargo Handling Equipment Manufacturing costs in Japan, and the transportation and its insurance costs are applied. In addition, the following costs are included: ・ Spare part (for about one year) ・ Training at the factory and in Myanmar 2) Detailed Design and Supervision The cost of Japanese consultant is applied. 3) Contingency ・ Price Escalation Contingency: 6.1% /year (Local), 2.1% /year (Foreign) ・ Physical Contingency: 6% (Construction and Procurement), 5% (Consulting service)
Unit price of major items		・ Jetty and Trestle: 89 million US$ ・ Reclamation and Soil Improvement: 24 million US$ ・ STS Crane: (1 unit): 8.6 million US$
Total project cost		205 million USD (Loan financed portion)

(Prepared by the Study Team)

(1) Taxes

Many taxes were revised in April 2012, and many more revisions are expected to come. So far major taxes related to the project expenditure are summarized in Table 6.4-2:

Table 6.4-2 Major Taxes in Myanmar

	Tax	Rate
1	Commercial Tax	5% flat. Similar to value added tax (VAT) levied on goods and services.
2	Corporation Income Tax	25% for the Myanmar or foreign company approved by Myanmar Investment Commission.
3	Personal Income Tax	Progressed rate from 1% to 20% levied on the annual income of the company staff for the amount exceeding 1,440,000 Kyat.
4	Customs Duty	Revised Customs Tariff of Myanmar was issued in the early 2012. Rates on the construction related are between 1% to 3%: cement (3%), reinforcement bar (1%), steel pipe pile (1.5%). Rates on the finished vessel are also low: tugboat (1.5%) and dredger (1.0%).

(Prepared by the Study Team)

Since this is the loan project, it is assumed that customs duty (when the contractor imports the materials and equipment) are exempted. Other taxes are assumed to be applied in accordance with the Myanmar tax system.

(2) Price escalation

Recent increase of the CPI (Consumer Price Index) is 22.5% (2008), 8.2% (2009), 8.2%(2010, and 4.2% (2011), and appears to be rather low and stable. Table 6.4-3 summarizes the changes of construction related prices:

Table 6.4-3 Construction Related Price

No.	Item	November 2010	August 2012	Increment
1	Common labour (1 day)	3,500	4,000	1.4
2	River sand (100 ft3)	4,500	7,500	1.7
3	Ready mixed concrete (1m3, 25N/mm2)	77,000	72,000	0.9
4	Cement (1 bag, Thai Diamond brand)	4,900	5,000	1.0
5	Rebar (1 ton, D12, made in China)	560,000	580,000	1.0
6	Diesel fuel (1 gallon)	3,000	3,500	1.2

(Prepared by the Study Team)

As shown in the table, the construction related prices have not increased drastically for the last two years. Especially, the prices of import goods such as cement and rebar have barely increased. This is partly due to the fact that the Kyat has appreciated against US Dollar, thus the nominal import prices in Kyat have lowered. On the other hand, the prices of the domestic goods such as labour and river sand have increased. Prices of domestic goods will increase steadily due to the expected construction boom in Myanmar.

As for the price escalation of the foreign portion, since the contractors are expected to import the materials and equipment from Thai, Malaysia, Indonesia, or Japan, the price escalation rates can be set rather low taking these countries' low inflation rates.

JICA announced in February 2013 "General Guidelines for 2012 Appraisal for Japanese ODA Loan Projects (Myanmar)" in which price escalation rate was set at the following rates:

- Foreign Currency Portion 2.1% p.a.
- Local Currency Portion 6.1% p.a.

The Study Team applies also these rates in the calculation of the project cost estimation.

6.4.2. Project Cost

(1) Project Cost Summary

Table 6.4-4 summarizes the project cost finance by yen loan.

Table 6.4-4 Project 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)

(2) Itemized Cost Breakdown

Cost breakdown of the two packages and consulting fee of the yen loan portion is summarized in Table 6.4-5.

Table 6.4-5 Itemized Cost Breakdown (yen loan portion)

Item		Unit	Q'ty	Rate (US$)	Amount (1,000 US$)	FC (1,000 US$)	LC (1,000 US$)
1. General Requirement					**168**	**0**	**168**
1A	Site Clearance	m2	166,800	0.4	68	0	68
1B	Environmental Monitoring	LS	1	100,000	100	0	100
2. Wharf					**89,389**	**70,679**	**18,709**
2A	Jetty (400m)	LS	1	76,782,185	76,782	61,466	15,316
2B	Trestle (approx. total 240m)	bridge	3	4,202,210	12,607	9,213	3,393
3. Reclamation & Soil Improvement					**24,243**	**17,580**	**6,662**
3A	Revetment	m	400	13,340	5,336	3,895	1,441
3B	Sand Mat	m3	230,006	12.7	2,917	2,334	583
3C	PVD	m	2,359,063	0.7	1,692	1,354	338
3D	Reclamation and Surcharge Fill	m3	729,998	17.1	12,498	9,998	2,500
3E	Removal of Surcharge	m3	446,087	4.0	1,800	0	1,800
4. Pavement & Drainage					**6,781**	**2,456**	**4,324**
4A	Interlocking Concrete Block	m2	58,494	57	3,349	1,674	1,674
4B	Asphalt Pavement	m2	78,294	27	2,114	423	1,691
4C	Concrete Block (container storage)	pc	864	368	318	159	159
4D	Drinage	LS	1	1,000,000	1,000	200	800
5. Buildings					**4,978**	**2,489**	**2,489**
5A	Gate	Unit	8	30,000	240	120	120
5B	Office	m2	3,000	500	1,500	750	750
5C	CFS	m2	4,000	700	2,800	1,400	1,400
5D	Workshop	m2	400	700	280	140	140
5E	Power House	m2	225	700	158	79	79
6. Utilities					**13,485**	**10,895**	**2,590**
6A	Fence	LS	1	100,000	100	0	100
6B	Landscape	LS	1	200,000	200	0	200
6C	Drinage	LS	1	1,000,000	1,000	200	800
6E	Power Generation Equipment (for emerg	LS	1	300,000	300	270	30
6F	Power Transmission, Lighting	LS	1	300,000	300	270	30
6G	Water Supply System (inc. 4km pipe line)	LS	1	1,300,000	1,300	1,170	130
6H	Waste Water Syetem	LS	1	300,000	300	240	60
6I	Fire Fighting	LS	1	200,000	200	160	40
6J	Communication	LS	1	200,000	200	160	40
6K	Truck Scale station	LS	1	200,000	200	160	40
6L	Fuel Station	LS	1	200,000	200	100	100
6M	Washing station	LS	1	100,000	100	50	50
6N	X-lay scan station	LS	1	8,467,599	8,468	7,621	847
6O	CCTV	LS	1	617,360	617	494	123
	Sum (1 to 6) Civil and Building				**139,042**	**104,099**	**34,943**
7. Cargo handling Euqipment							
7A	STS Gantry Crane	Unit	2	8,614,299	17,229	17,229	0
7B	RTG	Unit	6	1,779,452	10,677	10,677	0
7C	Trailer	Unit	6	199,267	1,196	1,196	0
7D	Chassis	Unit	6	71,736	430	430	0
7E	Reach stacker	Unit	3	1,020,245	3,061	3,061	0
7F	Forklift	Unit	2	85,485	171	171	0
	Sum (7) Cargo Handling Equipment				**32,763**	**32,763**	**0**
10. Consulting Service							
10A	Design	LS	0		0	0	0
10B	Supervision	LS	1	11,008,629	11,009	6,632	4,376
	Sum (10) Consulting Service				**11,009**	**6,632**	**4,376**
	TOTAL				**182,814**	**143,495**	**39,319**

(Prepared by the Study Team)

Table 6.4-6 summarizes the construction unit rates of major items:

Table 6.4-6 Construction Unit Rates

	Item	Unit Rate	Remark
1	Structure steel jacket for jetty	5 million US$/50m	Includes factory manufacturing, transport, and installation cost
2	Steel pipe pile driving	6,000 US$/piece	Diameter: 1200mm, Length: 40m Includes piling fleet, machine cost, and operation cost
3	Concrete	109 US$/m3	Includes concrete, transportation, and placing
4	River sand filling and grading	12.7 US$/m3	Assumes 20km to the borrow pit
5	PDV driving	0.8/m	Includes materials, machines, operation
6	Surcharge fill removal	4 US$/m3	Transporting by dump truck. Assume 500m
7	Interlocking concrete block (ICB) pavement	57 US$/m2	Includes subgrade, subbase, materials, manufacturing, and placement

(Prepared by the Study Team)

6.4.3. Disbursement Schedule

Following the calculation method used in JICA's Calculation Assistance System (MS Excel), yearly (fiscal year) disbursement schedule has been calculated. Table 6.4-7 summarizes the initial setting values for the calculation.

Table 6.4-7 Initial Setting for Disbursement Schedule

	Input item	Input sub-item	Input value
1	Currency	Name	Ks (Kyat)
		Ks/US$	858
		円/US$	83.64
2	Price escalation contingency	FC (Yen)	2.1% /year
		LC (US$)	6.1 % / year
3	Physical contingency	Construction and Procurement	6%
		Consultant	5%
4	Date of cost estimate		January 2013
5	Schedule	Start	2013
		End	2016
6	Consultant bidding rate	Pro-(A) FC (Yen)	2,700,000
		Pro-(B) LC (US$)	2,700
		Supporting staff (US$)	2,000
7	Tax	VAT	0%
		Import duty	5%
8	Project supervision		1.0% (MPA financed)
9	Interest during construction	Construction and procurement	0.01%
		consultant	0.01%
10	Commitment charge		0%
11	Method of payment for item 9 and 10		Loan eligible
12	Fiscal year		April to March

(Prepared by the Study Team)

Table 6.4-8 summarizes the yearly disbursement schedule by MPA (by yen loan)

Table 6.4-8 Annual Disbursement Schedule

Base Year for Cost Estimation: Jan, 2013
Exchange Rates: US$ = Yen 83.64
Price Escalation: FC: 2.1% LC: 6.1%
Physical Contingency: 6%
Physical Contingency for Consultant: 5%

FC & Total: million JPY
LC : million US$

Item		Total			2012			2013			2014			2015			2016		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION																			
I)	Procurement / Construction	12,619	42	16,110	0	0	0	0	0	0	4,310	12	5,296	5,362	17	6,757	2,947	13	4,057
	Civil	8,707	35	11,629	0	0	0	0	0	0	2,612	10	3,489	3,483	14	4,652	2,612	10	3,489
	Cargo Handling Equipment	2,740	0	2,740	0	0	0	0	0	0	1,370	0	1,370	1,370	0	1,370	0	0	0
	Working Boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Safety Navigation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Base cost for JICA financing	11,447	35	14,370	0	0	0	0	0	0	3,982	10	4,859	4,853	14	6,022	2,612	10	3,489
	Price escalation	458	4	829	0	0	0	0	0	0	84	1	137	206	2	353	168	2	338
	Physical contingency	714	2	912	0	0	0	0	0	0	244	1	300	304	1	382	167	1	230
II)	Consulting services	602	5	1,031	0	0	0	71	0	99	223	2	351	163	2	307	146	2	274
	Base cost	555	4	921	0	0	0	68	0	94	208	1	323	149	1	270	130	1	233
	Price escalation	19	1	61	0	0	0	0	0	0	4	0	11	6	0	22	8	0	28
	Physical contingency	29	0	49	0	0	0	3	0	5	11	0	17	8	0	15	7	0	13
Total (I + II)		13,222	47	17,141	0	0	0	71	0	99	4,533	13	5,647	5,525	18	7,064	3,093	15	4,331
B. NON ELIGIBLE PORTION																			
a	Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b	Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Base cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
c	Administration cost	0	2	171	0	0	0	0	0	1	0	1	56	0	1	71	0	1	43
d	VAT	0	2	196	0	0	0	0	0	1	0	1	56	0	1	77	0	1	62
e	Import Tax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (a+b+c+d+e)		0	4	367	0	0	0	0	0	2	0	1	112	0	2	148	0	1	105
TOTAL (A+B)		13,222	51	17,509	0	0	0	71	0	102	4,533	15	5,759	5,525	20	7,211	3,093	16	4,437
C. Interest during Construction		4	0	4	0	0	0	0	0	0	1	0	1	1	0	1	2	0	2
	Interest during Construction(Const.)	3	0	3	0	0	0	0	0	0	1	0	1	1	0	1	2	0	2
	Interest during Construction (Consul.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Commitment Charge		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL (A+B+C+D)		13,225	51	17,512	0	0	0	71	0	102	4,533	15	5,760	5,526	20	7,213	3,094	16	4,438
E. JICA finance portion incl. IDC (A + C + D)		13,225	47	17,145	0	0	0	71	0	99	4,533	13	5,648	5,526	18	7,065	3,094	15	4,333

(Prepared by the Study Team)

6.5. Construction Plan (Civil)

Major construction material and equipment to be used in the civil package are summarized in Table 6.5-1. The construction plan as well as the cost estimation has been established based on the list.

Table 6.5-1 Civil Major Material and Equipment

Category		Item	Purpose	Remarks
Equipment	1	Sep-type crane barge (barge size: 3600 ton)	Installation of jetty jacket, piling at jetty	Mobilize from Singapore
	2	Piling barge	Piling at jetty and trestle	Mobilize from Singapore
	3	Crane barge (150ton lift)	Upper structure at jetty and trestle	Mobilize from Singapore
	4	TSHD (trailer suction hopper dredger) 2,000 m3 hopper	Placing sand mat and surcharge	Mobilize from Singapore. Maximum hire 2. Assumes rental fee of 10,500 US$/day.
	5	Dump truck (10 ton)	Transport of surcharge material	Rental in Myanmar. 288 US$/day
	6	PDV driving machine	Driving of PVD material	Mobilize 4 machines from Vietnam. 0.77 US$/m for all inclusive cost.
Material	7	Cement	For concrete	Import from Thailand. Assumes Diamond brand. 5000 Ks/50kg bag
	8	Sand	For concrete	Dredged sand by small boat. 7500 Ks/100 ft3 at river bank.
	9	Steel pipe pile	Piles for jetty and trestle	Import from Indonesia. 1206 US$/ton
	10	Reinforcement bar		Import from Indonesia. 1300 US$/ton
Labour	11	Common labour		5000 ks/day
Transport	12	Bulk cargo	Steel pipe pile	69.7 US$/FT from Indonesia
	13	Container	Equipment originated in Japan	1791 US$/TEU for freight from Japan

(Prepared by the Study Team)

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.

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.

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.

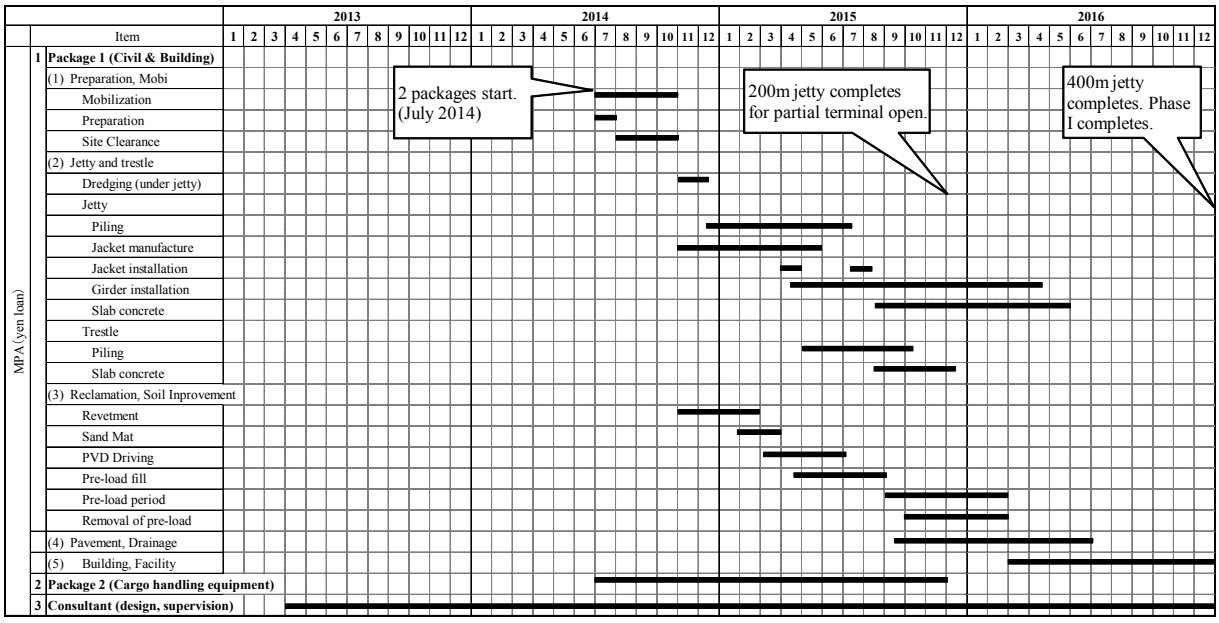
Jetty Upper Structure: Pre-fabricated jacket will be installed on the driven piles by a large crane barge (picture). The jacket is manufactured in a factory, and transported to the site by a barge. A concrete batching plant is established at the site to mix and provide the concrete for the project. Since 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.

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.

6.6. Project Implementation Schedule

Table 6.6-1. shows the implementation schedule of the Urgent Development Plan of Thilawa Area (Phase I).

Table 6.6-1 Project Implementation Schedule



(Prepared by the Study Team)

The consultant commences the detailed design in early 2013, and assists in bidding procedures. Two packages by a yen loan (Civil 6 building, Cargo handling equipment,) are scheduled to commence in July 2014. Civil package has the milestone at the 17th month, by which time 200m of the jetty is to be

completed such that the terminal can commence partial operation in December 2015.

6.7. Procurement Packages

Table 6.7-1 indicates Base case and three other options of procurement packages of the Phase I by the financing source. In the table, "MPA" denotes that MPA is the execution agency of the yen loan.

Table 6.7-1 Procurement Options

No.	Package content	Base case		OPTION-A		OPTION-B		OPTION-C	
		MPA	Private	MPA	Private	MPA	Private	MPA	Private
1	Civil (Jetty, land preparation, and pavement)	100%	-	100%	-	100%	-	-	100%
2	Building and facility	100%	-	100%	-	-	100%	-	100%
3	Cargo handling equipment	100%	-	STS crane	RTG, reach stacker, trailer, chassis	-	100%	-	100%
4	Consultant	100%	-	100%	-	100%	-		100%

In this Study, Base case is used to make economic and financial analyses. Selection of the procurement option is deferred to the JICA's PPP Study. During the study procurement option will be determined with due discussion with the Myanmar government referring to the economic and financial analyses made in this Study.

6.8. Economic and Financial Analysis

6.8.1. Economic Analysis

(1) Objective and Method used for the Economic Analysis

The economic analysis is done in order to examine the cost and benefit of the Project and to evaluate whether the benefit will exceed those from other investment opportunities.

In the economic analysis, a comparison is done between 'With' the development case and 'Without' case. The difference in cost and benefit between the 'With' and the 'Without' case, is calculated first in market price, and then it is converted to economic price.

In this study, an Economic Internal Rate of Return (EIRR) method is used to check the feasibility of the project. Sensitive analysis is also done.

The term for analysis is from the year which the first spending is made to 30 years after the start of operation of the project.

(2) Details of the cases of comparison

In 'With' case, the first phase of the new container terminal as shown in Figure 6.8.1 is

constructed based on the Thilawa Area Port Urgent Development Plan, and annual maximum of 160,000 TEU containers for international trade will be handled in the terminal. (As in the footnote of Table 5.4-2, the annual maximum handling capacity will temporary be 190,000 TEU in some years on the Hi case, however, when Phase II and III opens, the capacity will be back to 160,000 TEU. Hence, as in this analysis when Low case is assumed, the maximum handling capacity of the terminal under this Thilawa Area Port Urgent Development Plan will stay at 160,000 TEU throughout the analysis period.)

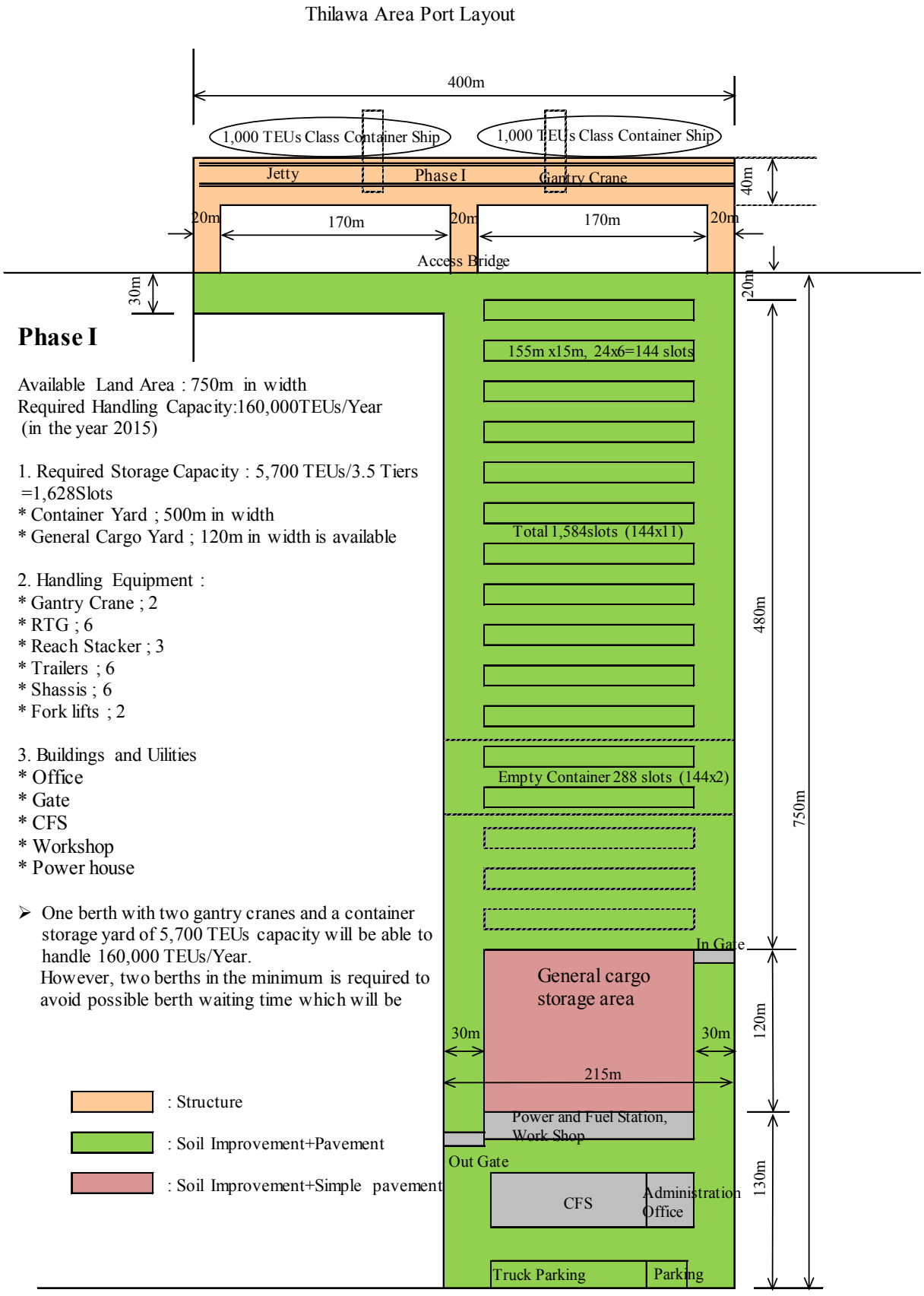


Figure 6.8-1 New Container Terminal of the Thilawa Area Port Urgent Development Plan.

In ‘Without’ case, there will be no development of new port facilities in Yangon Port, so if the demand exceeds the capacity (including future expansion plans) of the existing terminal, the containers for international trade will overflow. Myanmar is connected to People’s Republic of China and Thailand with land borders thus significant amount of consumer goods are imported through land borders, however, it is unlikely that a new industrial investment is done in Myanmar on the basis of land border trade for the export of its products so this cannot be an alternative in responding to the demand, thus Myanmar will lose is exporting trade values for that much. Table 6.8.1 shows the cargo handling throughput of ‘With’ and ‘Without’ cases.

Table 6.8-1 Cargo handling throughput of 'With' and 'Without' cases

(Unit: TEU)

Year	Years from the start of operation	Estimated amount of International trade containers handled		Total handling amount (With Case)	Total Demand
		At existing terminals (Without Case)	At the new terminal in Thilawa		
2012		509,000	-	509,000	509,000
2013		615,000	-	615,000	615,000
2014		727,000	-	727,000	727,000
2015	1	781,000	24,000	805,000	853,000
2016	2	898,000	92,000	990,000	990,000
2017	3	1,063,000	79,000	1,142,000	1,142,000
2018	4	1,277,000	33,000	1,310,000	1,310,000
2019	5	1,491,000	4,000	1,495,000	1,495,000
2020	6	1,540,000	160,000	1,700,000	1,700,000
2021	7	1,540,000	160,000	1,700,000	1,923,000
2022	8	1,540,000	160,000	1,700,000	2,170,000
2023	9	1,540,000	160,000	1,700,000	2,441,000
2024	10	1,540,000	160,000	1,700,000	2,738,000
2025	11	1,540,000	160,000	1,700,000	3,064,000
2026	12	1,540,000	160,000	1,700,000	
2027	13	1,540,000	160,000	1,700,000	
2028	14	1,540,000	160,000	1,700,000	
2029	15	1,540,000	160,000	1,700,000	
2030	16	1,540,000	160,000	1,700,000	
2031	17	1,540,000	160,000	1,700,000	
2032	18	1,540,000	160,000	1,700,000	
2033	19	1,540,000	160,000	1,700,000	
2034	20	1,540,000	160,000	1,700,000	
2035	21	1,540,000	160,000	1,700,000	
2036	22	1,540,000	160,000	1,700,000	
2037	23	1,540,000	160,000	1,700,000	
2038	24	1,540,000	160,000	1,700,000	
2039	25	1,540,000	160,000	1,700,000	
2040	26	1,540,000	160,000	1,700,000	
2041	27	1,540,000	160,000	1,700,000	
2042	28	1,540,000	160,000	1,700,000	
2043	29	1,540,000	160,000	1,700,000	
2044	30	1,540,000	160,000	1,700,000	

(Source: The Study Team)

In the demand forecast of this Study, two cases of 'High' and 'Low' is considered . If the project can foresee a certain amount of benefit produced in the Low case, it will definitely bring more benefit in the 'High' case, thus the economic analysis is done for the Low case only.

The new terminal under this urgent development project will only be opened by December 2015 at the earliest. According to the demand forecast, in 2015, the demand will exceed the total container handling capacity of the whole Yangon port, and the excess amount in estimated as 72,000TEU in the

low case. The opening of the terminal in December means, considering the forecast is done in fiscal year, which is from April to March both in Myanmar and Japan, the new terminal will be able to handle only 1/3 of the 2015 demand.

The demand forecast is done only up to 2025. This is sufficient since after 2021 (7 years after the start of operation), forecasted demand exceeds even the overall capacity of 'With' case, so it is estimated that all the terminals, both existing and new, will operate to their full capacity.

(3) Benefit of the project.

For the economic benefit brought by constructing a new container terminal in Thilawa area port, following items are counted.

- Added value by the exported container cargo
-

We count the value added by the export container cargo as the benefit of the project, out of all the container cargo of 160,000 TEU maximum handled at the new container terminal. Not only the export cargo but also the import cargo will contribute to create an adding value in Myanmar, however, in this EIRR analysis, only the value added by the export cargo is added. We suppose that the number of export and import containers is balanced, so the number of export containers is half of all containers handled. (Maximum 80,000 TEU)

For the value of the cargo in export containers, particularly in this report, we refer to those data of other ASEAN countries as the precedent case, since the current trade related data of Myanmar is under a large influence of imposed economic sanction thus not appropriate to refer to, and also the feasibility study for the adjoining Thilawa SEZ project in ongoing and no relevant data can be obtained at present.

By utilizing two data sources from Indonesian customs and Japanese government, the value of the cargo in export containers from Indonesia has been calculated as US$30,000 per TEU. Considering the difference in the stage of economic development between Indonesia and Myanmar, we apply the half rate of US$15,000 for the value of the cargo in export containers in this project. The Study Team will further search for more data, and try to come up with more reliable estimates for this value. Percentage of the benefit to the total sales amount differs amongst industries and companies but average value of 7% from the interviewed sample is applied. Also, from this benefit amount, contribution of other development project has to be estimated and deducted. Since the total investment value to the adjoining SEZ project is not available, we temporary assume that 50% is the contribution of other project and deduct from the estimated benefit. For this also, the Study Team will further examine and come up with more reliable percentage utilizing the data becoming available by the time of draft final report.

(4) Cost of the Project.

Following items are counted as the cost to implement this Project.

- Construction cost of port facilities
- Purchasing cost of cargo handling equipment and yard vehicles
- Maintenance and repair costs of port facilities
- Maintenance, repair and renewing costs of cargo handling equipment and yard vehicles
- Operation and management cost of the container terminal

The project cost comprises jetty, soil improvement, yard paving, buildings in the yard, cargo handling equipment, security and utility arrangements, personnel and utility costs of the terminal, and indirect costs. The price of tug boats is included in the project cost since they are only utilized for the proposed new terminal, but the pilot vessels are for improvement in navigation safety thus excluded, since they are not appropriate to be counted as the cost for the counted benefits of this project.

The personnel cost regarding the operation and management of the container terminal is estimated using the standard wage data in current Myanmar. The terminal is supposed to operate for 24 hours but with only 2 work shifts. This is to be more realistic to the situation of the Yangon port which the entry approach is limited only in up-tide hours which is twice a day, and there is always a long break in between when the vessels wait for the up-tide. For the utility cost regarding the operation of the terminal is counted as 1% of the purchasing cost of the equipment.

For the annual maintenance and repair cost, 0.2% of the initial investment for the construction of the jetty and the paving is counted, envisaging that only corrosion protection of the jetty and pothole repair of the paving is required. For the maintenance and repair cost of the cargo handling equipment, 5.0 US$ per TEU handled is applied. This amount includes the fuel fee for operation, and it is based on the data obtained from the other container terminals in neighboring countries. No dredging cost is counted since the river current is rapid in the front basin of the terminal so no sedimentation has been observed.

The cargo handling equipment is assumed to be replaced at the end of its service life. The years for the service life differ by equipment and for example, it is 20 years for the gantry crane, and 15 years for yard vehicles such as reach stacker and forklifts.

These costs are first calculated in market price, and converted to economic price by eliminating transferable items such as tax, and used for the analysis. In Myanmar, the official currency exchange rate which differed more than 100 times of the actual exchange rate was made out of use this April and currently there is not much difference between published and actual exchange rates, so no adjustment for shadow pricing is applied. This point also needs to be examined further until the time of the draft final report.

(5) EIRR and Project Evaluation

EIRR is a discount rate which the total cost and the total benefit during the project period becomes the same value. A cash flow is calculated based on the assumptions given above and as presented in Table 6.9-2, the EIRR of the new container development is estimated to be 14.6%.

To check if the project would still have the economic appropriateness despite some change in conditions, sensitivity analysis is also conducted. In the condition that the cost increases 10% and the benefit decreases 10%, the EIRR was calculated to be 12.0%.

The EIRR of the project is compared with the opportunity cost of the country's capital and if the EIRR is considered higher, then the project is evaluated as economically feasible. There is no published data available for the opportunity cost of the capital in Myanmar, so by applying the World Bank's bench mark for project approval of 12%, this project's EIRR of 12.0% even in the worst case scenario is still not lower than the opportunity cost.

Therefore, the proposed project is considered to be economically feasible.

Table 6.8-2 EIRR of the Thilawa Area Port Urgent 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)

6.8.2. Financial Analysis

(1) Objective of the Financial Analysis

In Financial Analysis, a net profit calculated by deducting the maintenance cost and tax from the revenue is defined as financial benefit, and the financial feasibility of the project is examined and evaluated based on the calculation of the Financial Internal Rate of Return (FIRR) by comparing the financial benefit with the project cost. In this report, the financially analysis is conducted on the assumption that one public entity implements the whole project. The period of analysis is same with the economic analysis, which is from the year of first payment to 30 years after the start of the operation of the container terminal.

(2) Financial Benefit of the Project.

The revenue of the project is port charge (entry fee), lighthouse charge, berth usage fee, and berthing charge, which are charged per vessel (entry), and also the cargo handling charge and storage charge which are charged per container (TEU), and calculated based on the published tariff of Yangon Port stated by MPA, just as same with the current arrangement for the existing terminals. The container handling throughput of the new terminal is estimated in the same way as the economic analysis, which is that the new terminal only handles the demand exceeded the capacity of the existing terminal, up to the capacity of the new terminal which is maximum 160,000 TEU per year, and number of vessel call is calculated by assuming all the vessels are 1,000 TEU class container ships, which the size is 20,000 DWT or 18,000 gross tons, and drop off an d pick up 900 TEU of containers per call, and the revenue is calculated based on these number of vessels called and containers handled. Furthermore for the calculation of the revenue, the ratio of LCL/FCL/Empty containers are estimated at 1:7:2, based on the current statistical data supplemented by information through interviews, and considering its proximity to SEZ industrial park, half of the FCL and Empty containers are assumed to be directly brought into and picked up from the terminal by shippers.

(3) The Cost of the Project

Regarding the project cost, the construction, maintenance and operation costs for the economic analysis is used as the base, but also included are the initial purchasing cost for the new pilot vessels. Regarding the operation of pilots (channel navigation) and tugs (berthing), the current rate in the MPA tariff is too cheap to pay the operation costs (especially the fuel) and the entire operation is not financially balanced. MPA has been suffering operational deficits these years. So these two items are excluded from the scope of the financial analysis of this project.

Addition to above, contingencies and price escalation are also counted in the cost.

In this project, tax imposed to directly imported materials are considered exempted, since Japanese ODA yen loan is going to be used for the financing of this project.

(4) FIRR and the Financial Feasibility of the Project

Table 6.8-3 FIRR of the 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)

Based on the conditions and assumptions above, FIRR is calculated as shown in Table 6.9-3 as 8.6%. Sensitivity analysis of 10% less benefit and 10% more cost delivers FIRR of 6.4%.

The official interest rate (discount rate) of the Myanmar Central Bank is now lowered to 10% from previous 12% this April, but still higher than the FIRR of the project, and the market rate is even higher than the official interest rate. Therefore, the project is financially feasible if only some low interest public fund is applied to certain portion of the project financing.

6.9. Overall Evaluation

6.9.1. Project Area

An area from Plot 22 to Plot 26 with one Plot length of 200m and width of 750m is designated as Thilawa Area Port Development among 37 Plots area with a total length of 7,400m. Although the area is owned by MPA, 262 people dwell in a part of Plot 22 and Plot 23 illegally. An area of 30 ha between Plot 22 and Plot 26 is illegally used for cultivating paddy by farmers. For the time being, Plot 22 where 220 people live is excluded from the planning area because it seems difficult to resettle the people from Plot 22 in a short time. A creek which drains rain water flows in Plot 26 but no rare species is found in the creek.

Taking into account the present environmental and social consideration, the area between Plot 23 and Plot 26 with the length of 800m is determined as the project site.

6.9.2. Project Schedule

Cargo handling volume in ports of Myanmar is expected to increase in accordance with the economic and social development of the country. Container handling volume which currently stands at approximately 400,000 TEUs currently is also expected to increase. In case of the high economic growth scenario, the container handling demands will reach 892,000 TEUs in 2015, 1,892,000 TEUs in 2020 and 4,014,000 TEUs in 2025 respectively. Among such container handling demands, the container volume relevant to the 2,400 ha SEZ which is planned to be developed behind the Thilawa area port is expected to reach 392,000 TEUs per annum in the year 2025. On the other hand, container terminals are developed in Yangon Main Port and Thilawa Area Port. The present container handling capacity of those terminals is expected to increase to 731,000 TEUs per annum and will eventually reach a maximum of 1,540,000 TEUs per annum taking into account the narrow land area in the Yangon Main Port.

Based on this demands forecast, Phase I terminal development with one 200m jetty and 16.8ha yard is needed by the year 2015/2016. Phase II terminal development with a 200m jetty and 13.3 ha yard and Phase III terminal development with a 400m jetty and 30ha yard are needed in the year 2018 and 2019 respectively.

6.9.3. Structure and Construction Method of the Terminal Facilities

Thilawa area port container terminal is expected to become operational in 2015 synchronizing with the commencement of the operation of the SEZ. Hence, it is required to develop Phase I-1 facilities (200m jetty with 16.3ha yard) as a part of Phase I development by the end 2015. Time for the preparatory process including detailed design and bidding relevant documents formulation works is needed before the execution of the construction. Such preparatory time will be about 13 months even if the works are conducted as an additional component of the current JICA study contract. Even if Phase I-1 development works begin in April 2013, there will only remain 17 months until November 2015 which is the target date of the operation of Phase I-1 facilities. In order to complete the Phase I-1 development in such a short time, a structure which can be constructed rapidly should be selected. Jacket Type structure is a suitable alternative among others to meet the above requirement.

The ground of the project site is composed of soft clay stratum of about 23m in thickness. Hence, it is necessary to improve the ground which will be used as a yard for handling containers as well as general cargo. PVD is an economical and reliable soil improvement method among others. It is appropriate to adopt PVD in this project.

6.9.4. Navigation Safety

The access channel to Yangon Port passes over the Outer Bar and the Inner Bar. Entering and leaving ships shall make use of tidal changes because the channel depth at both bars is about 6m. The maximum current velocity of Yangon River is about 6 knots which is considered a very high speed. Because of those natural conditions, the maximum size of ships which call Thilawa Area Port is 200m in LOA and 9m in the draft. In addition, pilotage is compulsory. Currently, sufficient navigation aids for securing the safe navigation of ships are not provided. In order to secure the safe navigation of ships in the channel, the provision of navigation aids, related facilities and equipment including a pilot station, pilot boats, tug boats and electronic devices are indispensable. Schedule of the introduction of the above depends on the securing of required funds.

6.9.5. Project Packaging

Major project components are civil works including jetty, yard and ancillary facilities such as drainage system, buildings, cargo handling equipment, working boats and navigation aids. It is necessary to select an appropriate investment package among several options including a sole MPA investment case, BOT contract with private port operation companies and the coupled investment of MPA with private entities. In the funding source selection, it is important to take into account the use of low interest ODA funds and the ownership of fundamental port facilities in view of national transport security.

6.9.6. Environment and Social Considerations

MPA acquired all 37 Plots in Thilawa Area from the Department of Housing in 1995. Some area has been occupied or cultivated illegally by people even after the acquisition of the land. A part of Plot 25 which will be used for the Urgent Development Project (Phase I) is used by 3 farmers illegally. MPA held stakeholder meetings with 3 Project Affected People (PAP) to negotiate the surrender of the farm land for the implementation of the Project. MPA prepares the Resettlement Action Plan (RAP) and take necessary action for its application. The RAP prepared by MPA including the Due Diligence of the past land acquisition and establishment of the Grievance Redress Mechanism is considered appropriate as prerequisite condition of the project (Phase I) implementation.

Regarding natural environment considerations, the application of the proposed mitigation measures is considered appropriate for the project implementation.

6.9.7. Economic and Financial Analysis

Economic analysis is conducted by evaluating Economic Internal Rate of Return (EIRR) of the project calculated by using the balance of cost and benefit in terms of economic value of "with the project case" and "without the project case". Economic benefit of the project is considered as "added value of export containers". The project cost is composed of construction, maintenance and repair cost of facilities, purchase, maintenance, repair and renewal cost of handling equipment and working vessels and operation cost of the terminal. EIRR during the project term of 30 years is calculated at 14.6% which is higher than the bench mark value of 12% applied by the World Bank. Thus this project is considered viable from the view point of national economy.

Financial analysis is also uses the same 'With' and 'Without' the project case, and based on the differences between the benefits and costs, an FIRR is calculated and the financial feasibility is evaluated on the assumption that one public entity implements the whole project. In this calculation, benefits are calculated from the revenue based on the MPA tariff applicable to all the terminals in Yangon Port. And the project cost comprises construction and maintenance of the port facility, purchasing, maintenance and repair cost of cargo handling equipment, construction and maintenance cost of navigation safety facilities and equipment, and operation cost of the container terminal. FIRR for the project period of 30 years after the start of the operation is estimated to be 8.6%, which is lower than the official interest rate of Myanmar Central Bank of 10%, but the project is still financially feasible if some low interest foreign development fund such as Japanese ODA yen loan is used for the certain portion of the overall financing.