22. MASTER PLAN

22.1 Channel Capacity

22.1.1 Number of Calling Vessels and Navigation Conditions

The number of calling vessels in the year 2000, 2007 and 2025 according to the traffic forecast for each type of vessel, is shown in Table 22.1.1. The explanation of the Base Case & High Public Cases, is given in section 22.8.

The purpose of this chapter is to calculate the vessel waiting time in the access channel taking into account with the specific navigation conditions. If the simulation yields an excessive waiting time, some measures will need to be taken and suggested.

The navigation conditions of the Batang Hari River are shown in Table 22.1.2.

A numerical simulation model “WITNESS 2000” was employed to evaluate the above.

The detailed explanation of the simulation model is given in section 22.12.

Table 22.1.1 Number of Calling Vessels

Berth	Vessel Type	2000 (nos./year)	2007 (nos./year)		2025 (nos./year)	
Public Berth (Talang Duku)	General Cargo	720	60		120	
	Container	260	73		552	
	CPO	0	238		597	
	Coal	0	274		374	
Other Private Berth (Jambi)	General cargo & Container	592 & 480	Base	346	Base	1,041
			High	290	High	674
	CPO	0	238		597	
	Coal	0	55		125	
Public Berth (Muara Sabak)	General Cargo	-	85		48	
	Container	-	Base	134	Base	294
			High	200	High	474
Private Berth (Muara Sabak)	General Cargo	-	945		284	
	Coal	-	50		217	

Source: IPC II Jambi Office & JICA Study Team

Table 22.1.2 Navigation Conditions of Batang Hari River

<table>
<tr><th>No.</th><th colspan="3">Navigation Conditions</th></tr>
<tr><td rowspan="3">1.</td><td rowspan="3">Maximum Vessel Size</td><td>to Muara Sabak</td><td>LOA = 115.0m, Draft = 6.50m</td></tr>
<tr><td rowspan="2">to Jambi</td><td>LOA = 75.0m, Draft = 5.0m (Rainy Season)</td></tr>
<tr><td>LOA = 75.0m, Draft = 3.5m (Dry Season)</td></tr>
<tr><td>2.</td><td colspan="3">Vessels of over 3.0 draft, when passing the Kelamak Channel, is requested to wait until about 3 – 5 hours after the high tide at the following places :
1) Vessels going into the Talang Duku should berth at the Muara Sabak/Sabak Indah.
2) Vessels going out from Talang Duku should berth at the Simpang Tua/Keramat Orang Kayo Itam.</td></tr>
</table>

Source : IPC II Jambi Office

22.1.2 Vessel Waiting Time in Batang Hari River Channel

Two scenarios have been drawn up for the Short Term Plan (target year 2007) and Master Plan (target year 2025) of Jambi: “Case 1 (Base Case Scenario)” and “Case 2 (High Public Case Scenario)”. Further explanation of each scenario is given in section 22.8.

The simulation results over a span of one year are shown below. The average waiting times for each are given in Table 22.1.3 and Table 22.1.4.

According to the simulation result, the channel waiting times of all vessels are about 1.5 hours. This shows that the vessel waiting time in the channel is affected by the tidal conditions only.

The navigation conditions showed in Table 22.1.2 will be necessary to be discussed.

Table 22.1.3 Average Vessel Waiting Time at Muara Sabak (All vessels going up to Talang Duku)

Berth Type	Scenario / Vessel Type	Case 1 (Base)		Case 2 (High Public)	
		2007	2025	2007	2025
Public Berth (Talang Duku)	General Cargo	79 min.	79 min.	79 min.	79 min.
	Container	94 min.	95 min.	94 min.	94 min.
	CPO	100 min.	94 min.	100 min.	94 min.
	Coal	93 min.	91 min.	93min.	91 min.
Other Private Berth (Jambi)	General Cargo & Container	87 min.	95 min.	87 min.	83 min.
	CPO	98 min.	86 min.	98 min.	86 min.
	Coal	101 min.	100 min.	101 min.	100 min.

Source: by "WITNESS 2000" Simulation Result

Table 22.1.4 Average Vessel Waiting Time at Simpang Tua (All vessels going down from Talang Duku)

Berth Type	Scenario / Vessel Type	Case 1 (Base)		Case 2 (High Public)	
		2007	2025	2007	2025
Public Berth (Talang Duku)	General Cargo	37 min.	123 min.	37 min.	123 min.
	Container	44 min.	53 min.	44 min.	53 min.
	CPO	111 min.	74 min.	110 min.	78 min.
	Coal	103 min.	93 min.	103 min.	93 min.
Other Private Berth (Jambi)	General Cargo & Container	101 min.	102 min.	95 min.	96 min.
	CPO	108 min.	100 min.	108 min.	100min.
	Coal	89 min.	101 min.	89 min.	101min.

Source: by "WITNESS 2000" Simulation Result

22.2 Channel Sedimentation

22.2.1 Maintenance dredging

A large sandbar (Outer Bar) with the width of over ten kilometers is located alongshore and 7 – 10 km on-offshore in the estuary area of Batanghari River. The navigation channel to Port of Jambi is laid out through Outer Bar and maintained by dredging (see Figure 22.2.1).

The design section of the navigation channel has the following dimensions: bottom width: 80 m, depth: LWS -4.5 m and side slope: 1:8.0.

The average yearly volume of the dredging in the navigation channel of Port of Jambi is about 350,000 m^3 and most of the volume is from the dredging in the channel on the Outer Bar. The dredging work is carried out by trailing suction hopper dredger and the dredged material, mainly silt, is disposed of at a dumping site located 12 km offshore, north of the river mouth (refer to Table 22.2.1 and Figure 22.2.1).

Table 22.2.1 Record of Maintenance Dredging in the Estuary of Batanghari River

Year	Unit	1994/1995	1995/1996	1996/1997	1997/1998	1998/1999
Length	m	7,900	9,500	11,000	-	8,700
Width	m	60	80	70	-	70
Depth	LWS, m	-4.5	-4.5	-4.5	-	-4.1
Slope		1:4.0	1:8.0	1:8.0	-	1:8.0
Dredging Volume	m^3	231,825	326,280	350,000	-	350,000
Total Cost	Rp	591,153,750	832,014,000	892,500,000	-	1,015,000,000
Unit Cost	Rp/m^3	2,550	2,550	2,550	-	2,900
Unit Cost	USD	1.10	1.07	0.55	-	0.19
Expense of		DGSC/MoC	DGSC/MoC	DGSC/MoC	-	IPC2

Maintenance dredging of the navigation channel was not executed in the fiscal year of 1997/1998, but the dredging work of the next year (1998/1999) was executed with the co-finance of DGSC and IPC2 on the following conditions:

Borne by IPC2: Channel width 70 m, depth up to LWS-4.1 m,
Dredging volume 350,000 m^3

Borne by DGSC: Channel width 70 m, depth from LWS-4.1 m up to LWS-4.5 m,
Dredging volume 371,400 m^3
Total 721,400 m^3

Work Period: 75 days from 27 April 1998

Dredger: Timor
(Trailing Suction Hopper Dredger; hopper capacity 2,000 m^3)

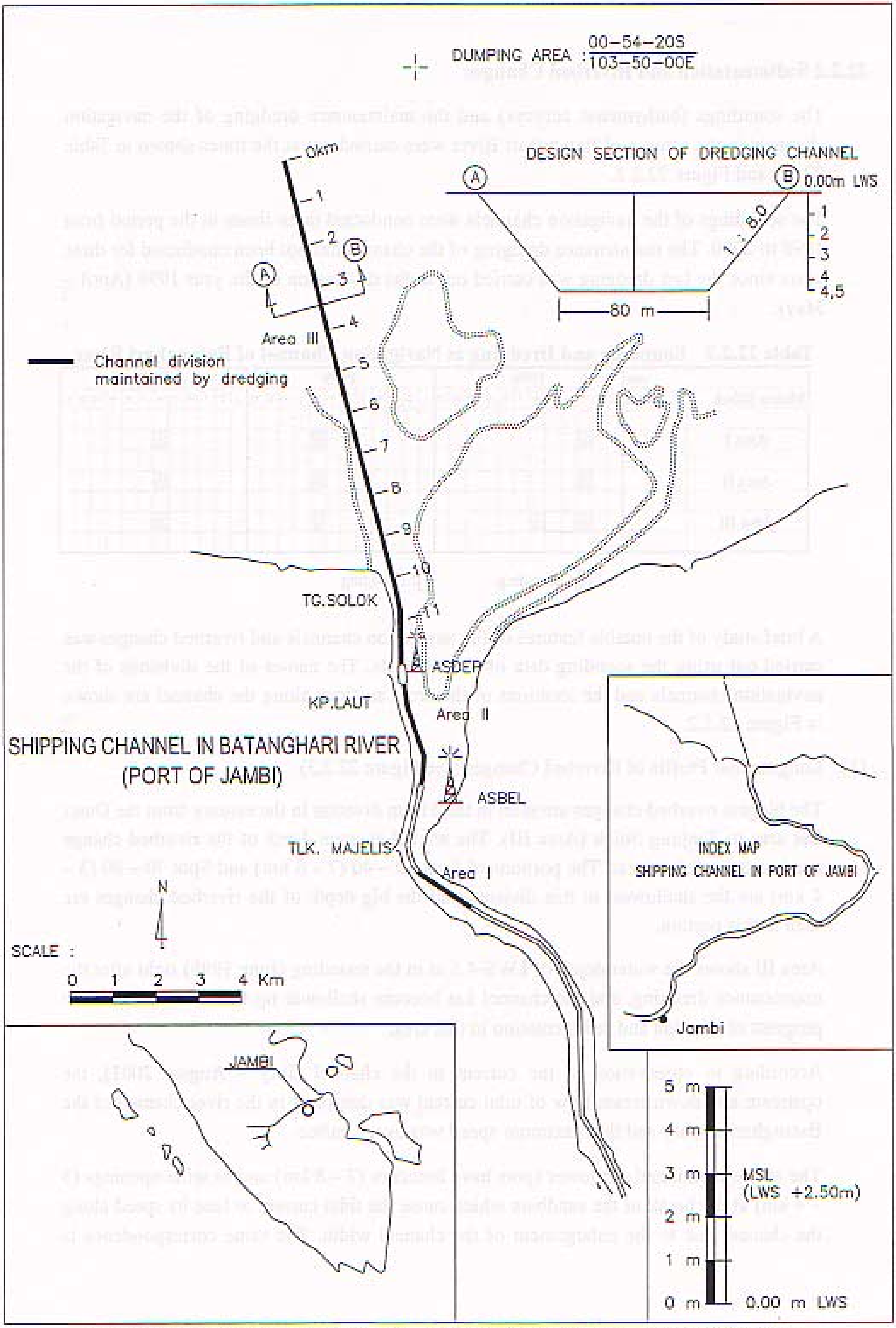


Figure 22.2.1 Channel maintained by dredging in the Estuary of Batanghari River

22.2.2 Sedimentation and Riverbed Changes

The soundings (bathymetric surveys) and the maintenance dredging of the navigation channels in the estuary of Batanghari River were carried out at the times shown in Table 22.2.2 and Figure 22.2.2.

The soundings of the navigation channels were conducted three times in the period from 1998 to 2000. The maintenance dredging of the channel has not been conducted for three years since the last dredging was carried out in the dry season of the year 1998 (April – May).

Table 22.2.2 Sounding and Dredging at Navigation Channel of Batanghari River

	year	1998												1999												2000											
Muara Sabak	month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Area I				■																	■										■						
Area II				■																	■										■						
Area III				■	□	□	■														■										■						

■: Sounding □: Dredging

A brief study of the notable features of the navigation channels and riverbed changes was carried out using the sounding data of the channels. The names of the divisions of the navigation channels and the locations of the cross sections along the channel are shown in Figure 22.2.2.

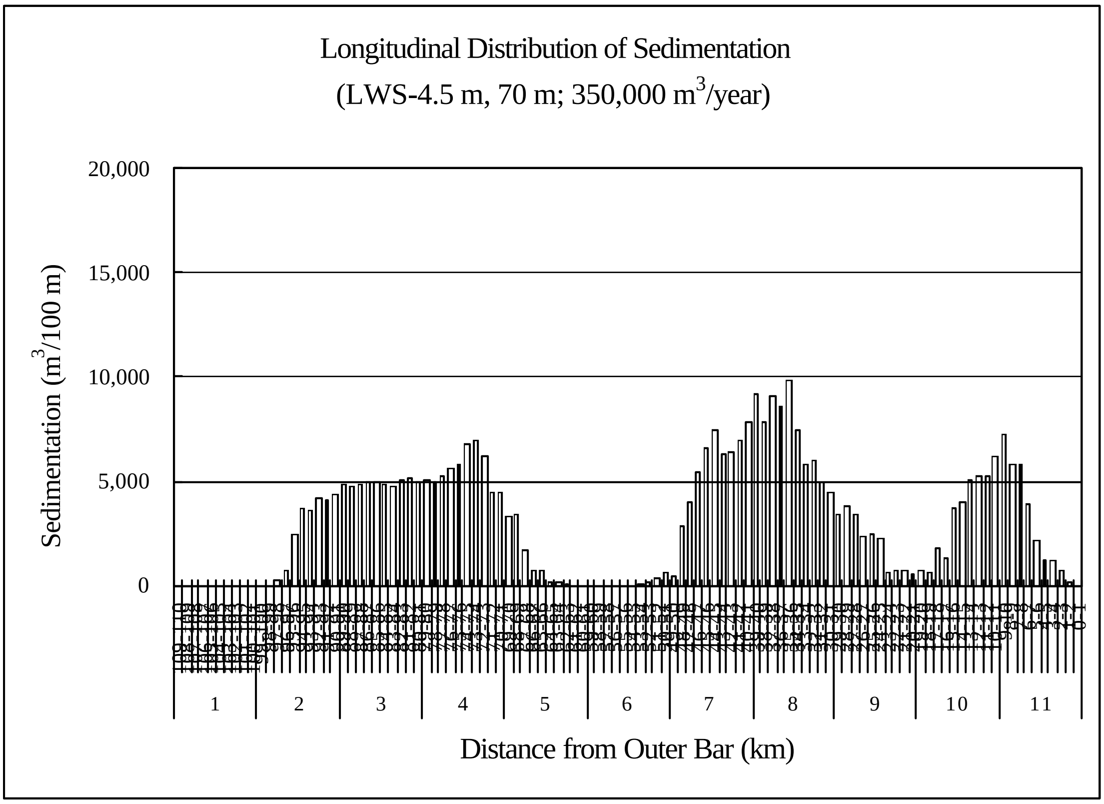
(1) Longitudinal Profile of Riverbed Changes (see Figure 22.2.3)

The biggest riverbed changes are seen in the 11 km division in the estuary from the Outer Bar area to Tanjung Solok (Area III). The annual average depth of the riverbed change reached 0.3 – 0.6 m/year. The portions of Spot 30 – 40 (7 – 8 km) and Spot 70 – 80 (3 – 4 km) are the shallowest in this division and the big depth of the riverbed changes are seen in this portion.

Area III shows the water depth of LWS-4.5 m in the sounding (June 1998) right after the maintenance dredging, and the channel has become shallower up to LWS-3 m with the progress of siltation and sedimentation in this area.

According to observation of the current in the channel (July – August 2001), the upstream and downstream flow of tidal current was dominant in the river channel of the Batanghari estuary and the maximum speed was over 1 m/sec.

The above-mentioned shallower spots have branches (7 – 8 km) and/or wide openings (3 – 4 km) at the break of the sandbars which cause the tidal current to lose its speed along the channel due to the enlargement of the channel width. The same correspondence is seen in the longitudinal distribution of the sedimentation in Area III (see next graph).



Area I and Area II are the sections of the narrow channel of Batanghari River where maintenance dredging has not been conducted. The annual average depth of the riverbed change is about 0.2 m/year in those sections.

Due to the flushing effect of the tidal current with a speed over 1 m/sec that flows up and down everyday, the water depth of LWS -4 to –4.5 m is maintained even in the shallower portions there.

(2) Cross Section Profile of Channel

The representative cross sections in Area III and their profile changes are shown in Figure 22.2.4.

Section No.90 is located on the offshore side of Outer Bar. In this section, the shape of the navigation channel formed by the maintenance dredging in May 1998 does not appear in the profile of June 1998. The profile of August 1999 (maintenance dredging was not conducted in this year) appears deeper than that of 1998.

It is understood that the big riverbed changes take place due to the strong effect of the longshore tidal current and also the riverbed changes are dynamically stable in this portion of the channel.

In Section No.75, the shape of the navigation channel formed by the maintenance dredging remains in the profile of June 1998.

The alignment of the navigation channel in this portion appears off center to the right-hand side (the shallower side) of the river channel. The right-hand side of the channel is shallower and also the depth of riverbed change appears bigger here and therefore the volume of the maintenance dredging is larger.

In Section No.35, the riverbed changes look bigger on the left-hand side of the river and the alignment of the navigation channel appears off center to the left-hand side.

In Section No.20, the water depth LWS -4.5 m is almost maintained even in the profile of August 1999 one year after the dredging. The fluid mud and/or the sediment have been flushed away due to the effect of the strong tidal current in the river channel here.

(3) Cross Section Profile of Channel

The common features are seen in the riverbed changes in Area II (see Figure 22.2.5, Area II) with Section No.20 of Area III above. This is the portion of the river channel where maintenance dredging has not been conducted. The depth of sedimentation at the bottom was about 10 – 15 cm and the water depth of LWS-4.5 to –5 m is maintained at the center of the channel.

It is understood that the fluid mud and/or the sediment have been flushed away due to the effect of the strong tidal current in the river channel and the riverbed changes are dynamically stable in this portion of the channel.

(4) Recommendations

Riverbed changes have very complicated aspects even in the channel at the mouth of Batanghari River where the meandering is relatively gentle.

There are some portions of the channel where the alignment appears off center to one side (the shallower side). Therefore, studies of riverbed changes to obtain the optimum alignment of the navigation channel may be effective as a measure to optimize maintenance dredging.

The tendency of riverbed change is different along each portion of the river channel. The possibility of optimum alignment of the navigation channel should be studied corresponding to the tendency of the riverbed changes.

It is recommended, therefore, that bathymetric survey should be conducted periodically in the navigation channel from the river mouth up to Muara Sabak and the characteristics of the riverbed changes should be captured.

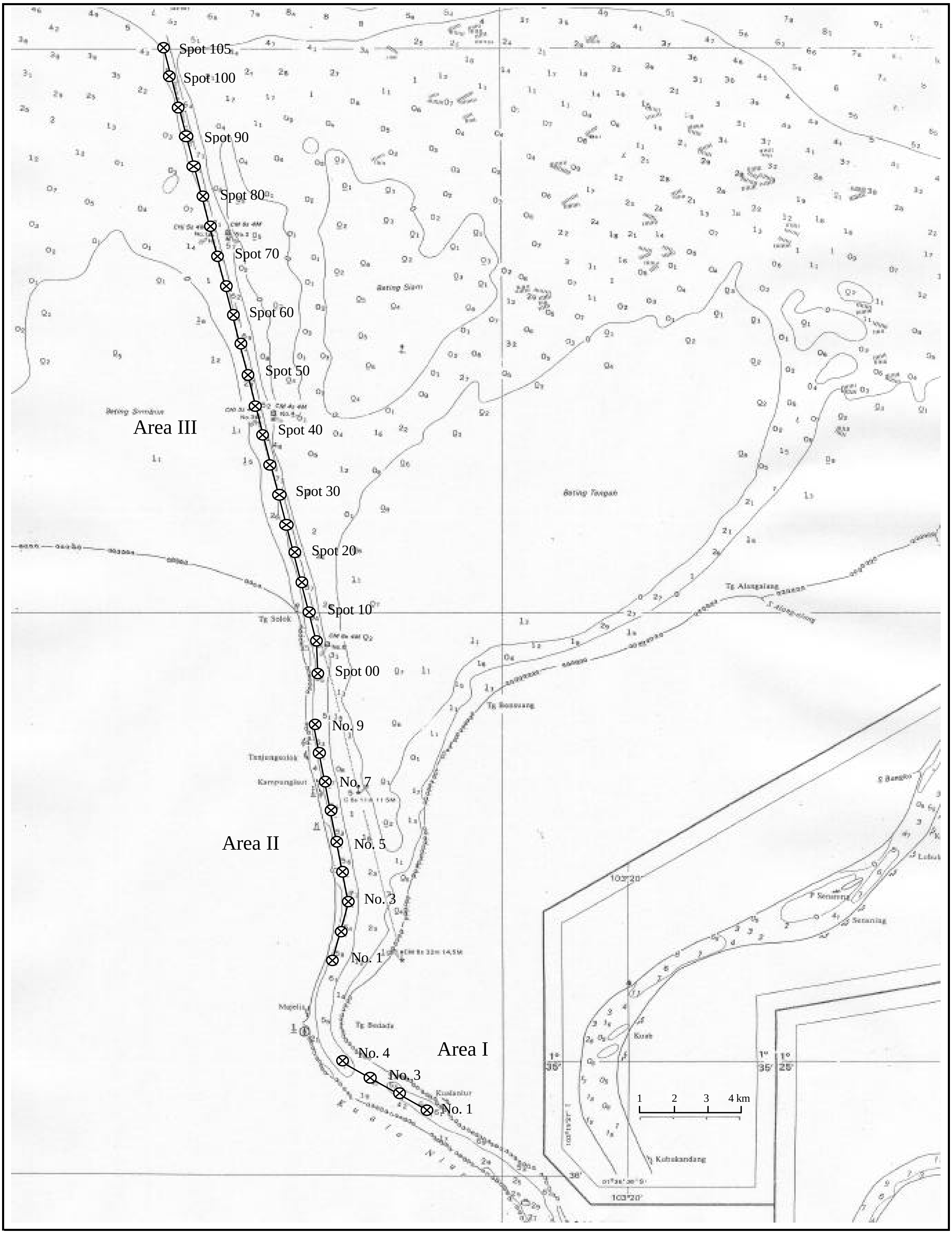


Figure 22.2.2 Location Map of Cross Sections of Channel
(Estuary of Sungai Batanghari; 500 m interval)

	No.	Distance (km)	(A) Feb - Mar, 1998	(B) Jun-98	(C) Aug-99	(D) May - Jun, 2000	(B) - (C)	(D) - (C)	(D) - (B)	Yearly Average (m)
Area III	110	0.0	-5.3	-5.2		-4.3			0.9	0.45
	105	0.5	-4.1	-4.2	-4.2	-3.9	0.0	0.3	0.3	0.15
	100	1.0	-3.5	-4.2	-4.2	-3.8	0.0	0.4	0.4	0.20
	95	1.5	-3.7	-4.2	-4.3	-4.2	-0.1	0.1	0.0	0.00
	90	2.0	-4.0	-4.2	-4.6	-4.3	-0.4	0.3	-0.1	-0.05
	85	2.5	-3.9	-4.2	-4.7	-4.5	-0.5	0.2	-0.3	-0.15
	80	3.0	-3.6	-4.3	-4.3	-3.3	0.0	1.0	1.0	0.50
	75	3.5	-3.4	-4.2	-3.9	-3.3	0.3	0.6	0.9	0.45
	70	4.0	-3.2	-4.3	-3.9	-3.1	0.4	0.8	1.2	0.60
	65	4.5	-3.3	-4.3	-3.9	-3.4	0.4	0.5	0.9	0.45
	60	5.0	-4.0	-4.3	-5.0	-4.2	-0.7	0.8	0.1	0.05
	55	5.5	-4.5	-4.3	-5.2	-4.6	-0.9	0.6	-0.3	-0.15
	50	6.0	-4.0	-4.3	-4.5	-4.3	-0.2	0.2	0.0	0.00
	45	6.5	-3.7	-4.2	-4.2	-3.9	0.0	0.3	0.3	0.15
	40	7.0	-3.1	-4.4	-4.3	-3.9	0.1	0.4	0.5	0.25
	35	7.5	-3.2	-4.3	-4.0	-3.7	0.3	0.3	0.6	0.30
	30	8.0	-3.8	-4.3	-4.1	-3.8	0.2	0.3	0.5	0.25
	25	8.5	-3.8	-4.3	-4.1	-3.7	0.2	0.4	0.6	0.30
	20	9.0	-3.6	-4.3	-4.4	-4.0	-0.1	0.4	0.3	0.15
	15	9.5	-4.0	-4.3	-4.7	-4.1	-0.4	0.6	0.2	0.10
	10	10.0	-5.0	-4.8	-5.3	-5.0	-0.5	0.3	-0.2	-0.10
	5	10.5	-6.4	-6.2	-6.7	-6.1	-0.5	0.6	0.1	0.05
	0	11.0	-8.5	-8.2	-8.4		-0.2			-0.17
		11.5							Average	0.16
		12.0								
Area II	8	12.5	-5.0		-4.9	-4.3	0.1	0.6	0.7	0.31
	7	13.0	-5.4		-5.0	-4.6	0.4	0.4	0.8	0.36
	6	13.5	-5.2		-5.2	-4.6	0.0	0.6	0.6	0.27
	5	14.0	-4.5		-4.6	-4.3	-0.1	0.3	0.2	0.09
	4	14.5	-4.1		-4.5	-4.0	-0.4	0.5	0.1	0.04
	3	15.0	-4.4		-4.5	-3.9	-0.1	0.6	0.5	0.22
	2	15.5	-5.1		-5.0	-4.7	0.1	0.3	0.4	0.18
	1	16.0	-6.5		-5.9	-5.8	0.6	0.1	0.7	0.31
		16.5							Average	0.22
		17.0								
		17.5								
Area I	4	18.0	-7.9		-7.6	-7.5	0.3	0.1	0.4	0.18
	3	18.5	-4.9		-4.8	-4.5	0.1	0.3	0.4	0.18
	2	19.0	-4.5		-4.4	-4.0	0.1	0.4	0.5	0.22
	1	19.5	-5.5		-5.3	-5.1	0.2	0.2	0.4	0.18
									Average	0.19

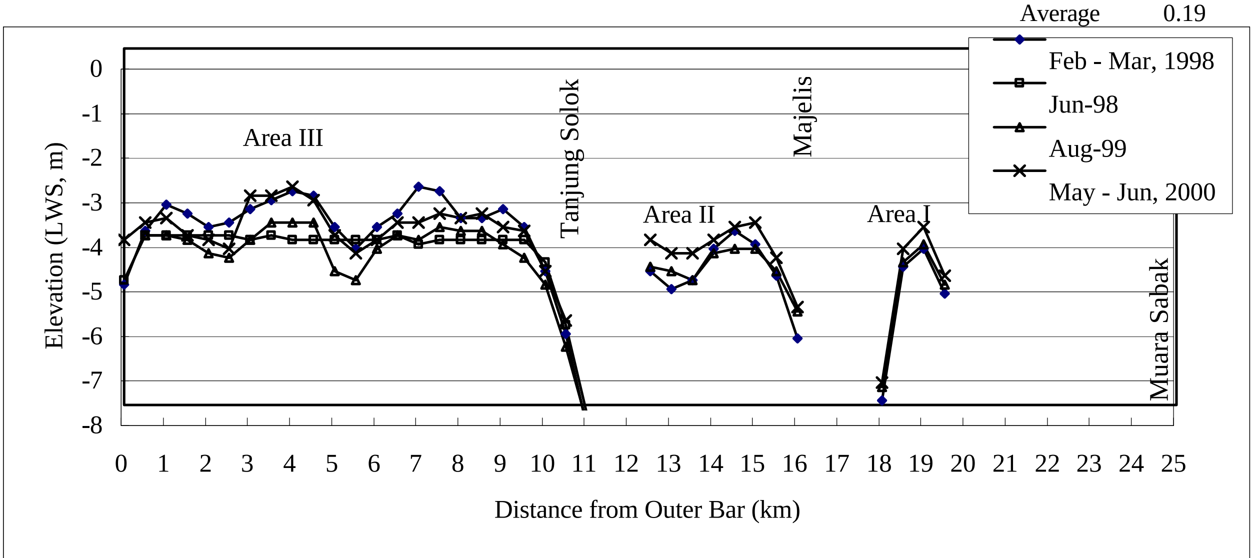


Figure 22 2.3 Longitudinal Profile of Riverbed Changes (Batanghari River, Center of Channel)

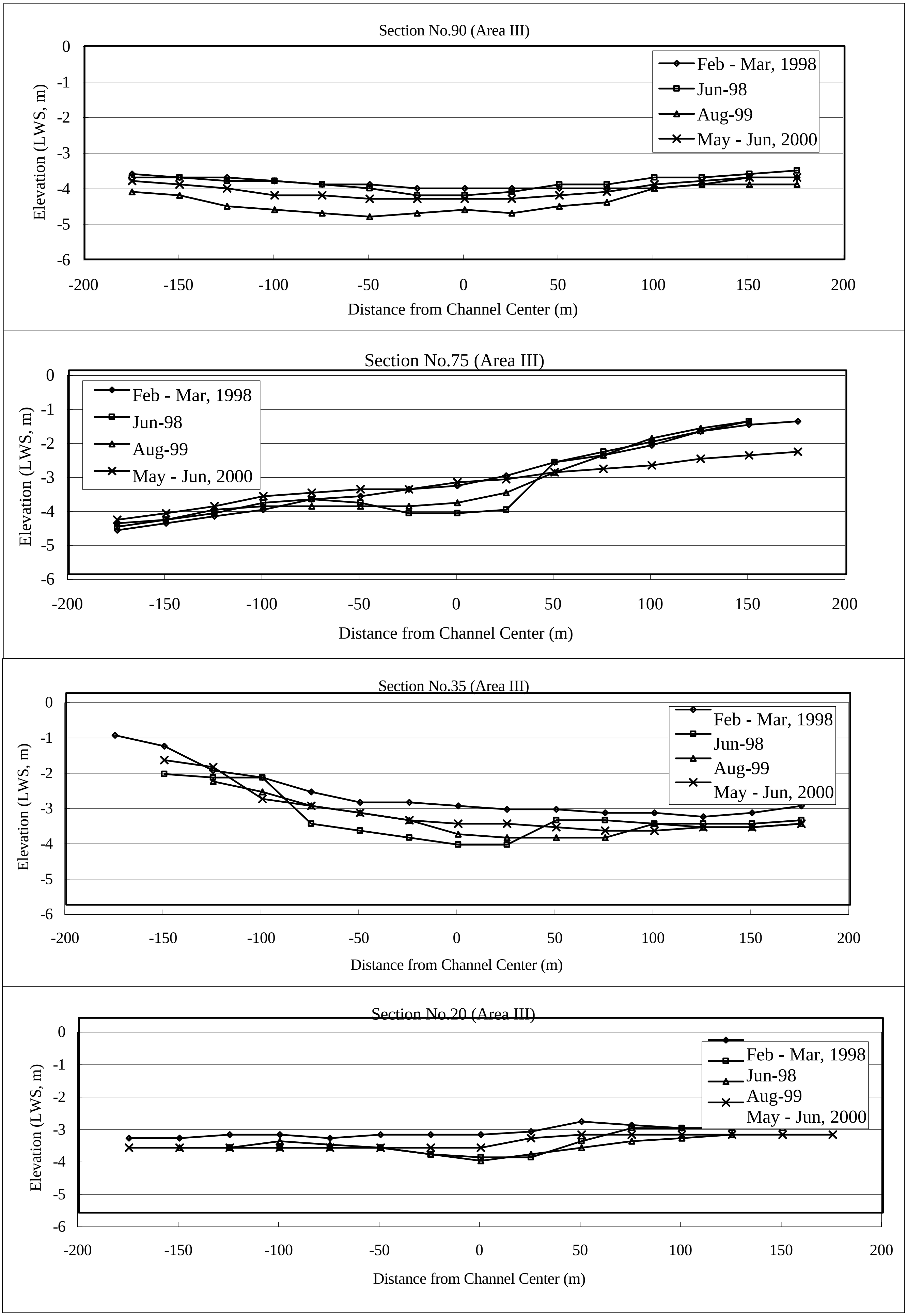
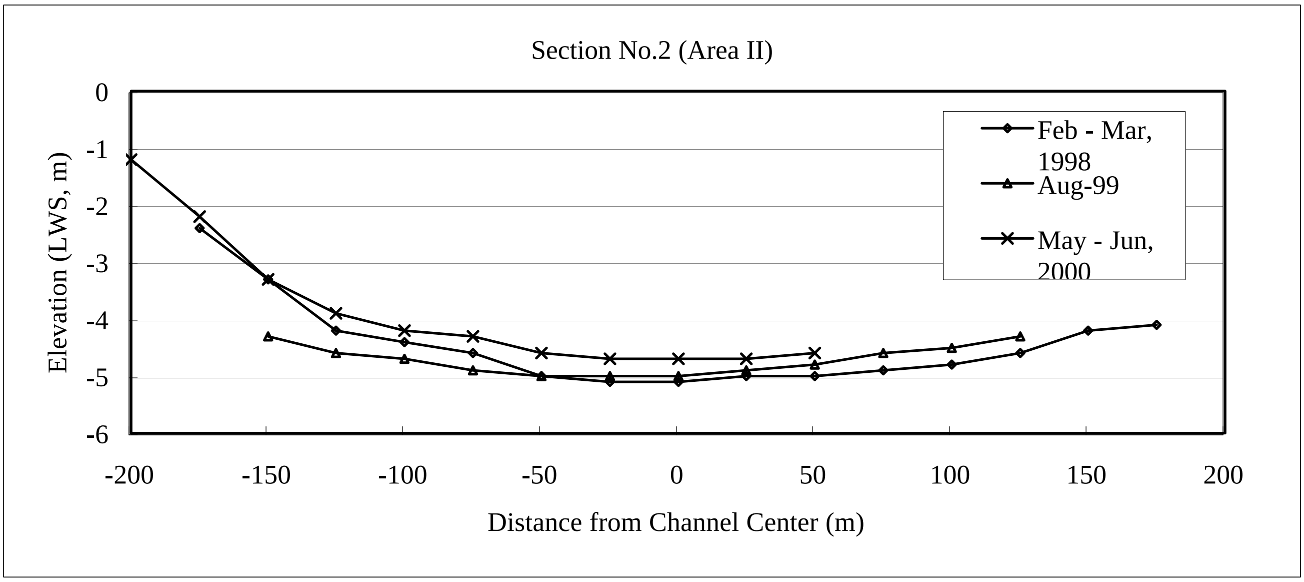
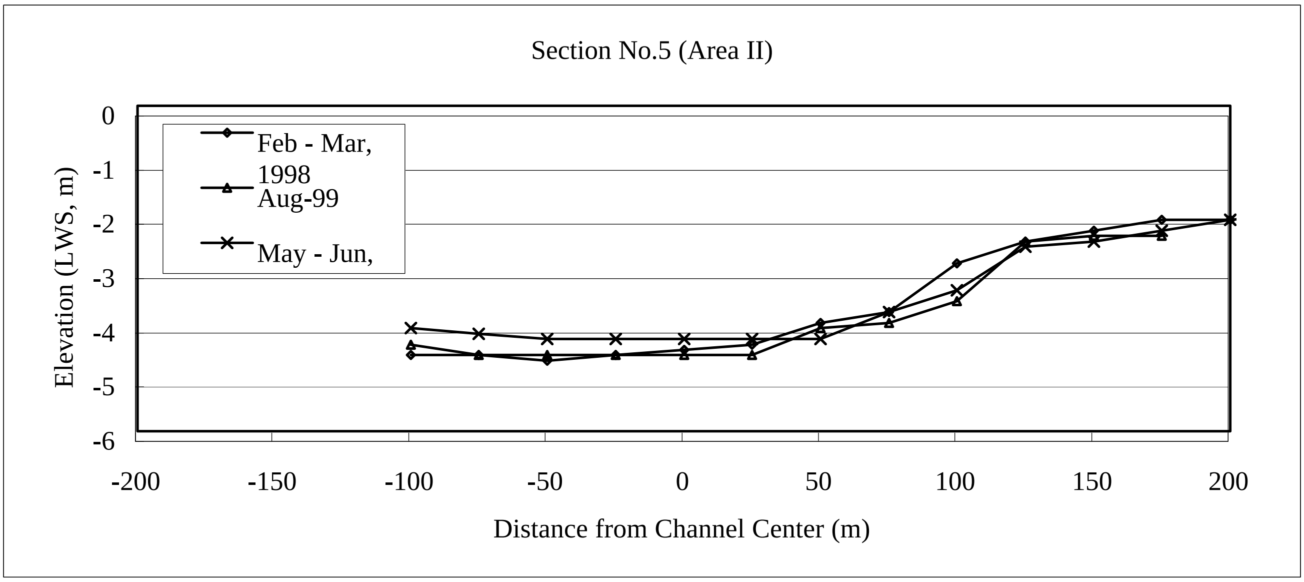


Figure 22.2.4 Cross Section Profile of Channel (Area III)





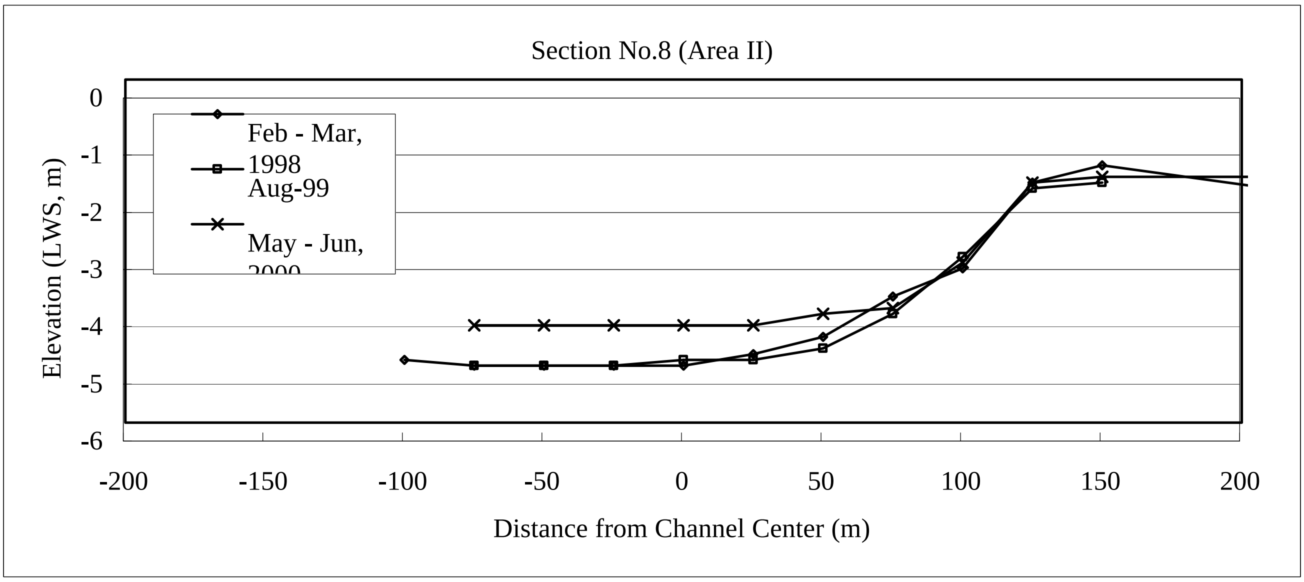


Figure 22.2.5 Cross Section Profile of Channel (Area II)

22.3 Optimum Dredging Plan and Countermeasures

22.3.1 Technical evaluation of dredging method

(1) Trailing Suction Hopper Dredger

The dredging method employed by the ports is the trailing suction hopper dredger.

The trailing suction hopper dredger (TSHD; shown in Figure 22.3.1) is a self-propelled vessel with suction pipes suspended from one or from both sides. The dredged material is delivered through the suction pipes to the hopper. When the hopper is full, the vessel proceeds to the dumping site remote from the work site.

This type of dredger is widely used in the maintenance of channels, where the ability to maneuver as a ship is a distinct advantage. It is effective in silts, sands, clays and relatively loose materials as would be found in maintenance dredging.

In addition, since they are self-propelled, they can work in congested areas with minimum disruption to shipping traffic. It can work in sheltered and unsheltered waters such as channel entrances far out to sea and under most weather and sea conditions.

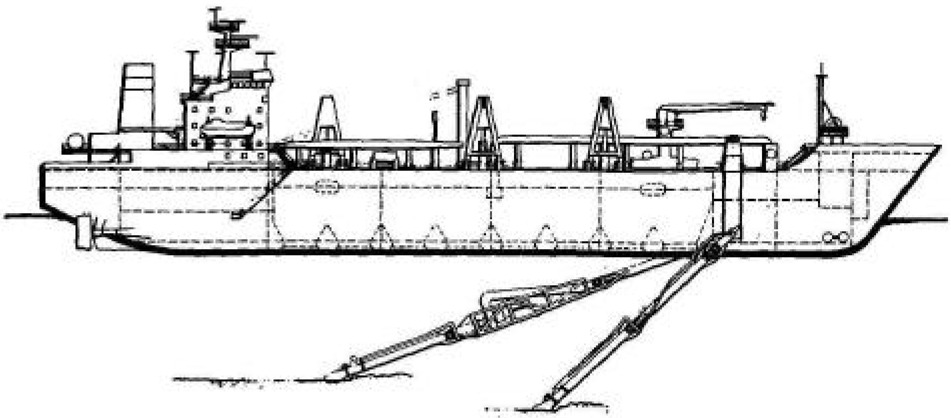


Figure 22.3.1 Trailing Suction Hopper Dredger (TSHD)

Therefore, employing TSHD for the maintenance dredging of the river channels is reasonable and appropriate. The problem area is the dimensions of TSHD.

Since the water depth in both Batanghari River and Mahakam River is shallow and limited, small - medium size dredger vessels are generally employed (hopper capacity: 2,000 - 4,000 m^3, loaded draught: 4 - 7 m).

Since the dredger has to go up and down between the work site and the dumping site frequently if the hopper capacity is small and limited, the Hopper capacity is closely related to the productivity of the dredging work. The performance of TSHD used in the maintenance dredging of the river channels is 6,500 - 9,600 m^3/day. Although this productivity may seem rather small, there are the limitations to adopting larger dredger vessels.

(2) Water injection / Agitation dredging

These methods are kinds of hydrodynamic dredging techniques that are limited to silts and unconsolidated clays and fine sands. They have been introduced as a relatively low-cost dredging technique for maintenance dredging.

The dredger uses water pressure to create a dense fluid mud from the bed material. The fluid mud is then transported from the excavation site by means of currents either induced by the density gradient between the fluid mud and that of water, or by naturally occurring currents within the dredging site, such as tidal current or river flow.

One of the fatal disadvantages of this method is lack of knowledge of the destination of the agitated bed materials. The main issues of concern are the possibility of the adverse impact on areas of fisheries or the chemical contamination within the sediments being redistributed.

The use of hydrodynamic techniques in river channel maintenance dredging will be limited to use in conjunction with conventional dredgers; to move the material from inaccessible areas (in the vicinity of the pier or jetty, for example) into the path of the main dredging plant, or to level the peaks and troughs caused by trailer suction dredgers.

(3) Riverbed material

According to Figure 19.4.1, the riverbed materials distributed in the estuary area of Batanghari River from Muara Sabak to Outer Bar range from clay or silt, fine sand to medium sand.

Fine and medium sand are distributed at the sampling points along the comparatively narrow channel (GS-06, 07, 11, 12, 13, 14), while silty clay and/or silty fine sand are distributed on Outer Bar (GS-01, 02, 03) and the divergent point of the channel (GS-05, 08). These features suggest that the riverbed materials are well sorted by the current in the channel.

Density-in-situ is estimated from the results of the physical test of the riverbed materials and has range from 1.28 to 1.64 g/cm^3 (1.5 g/cm^3 on average; water content: 85 %).

(4) Dumping Area of dredged Soil

According to government guidelines, the dumping area of dredged soil is to be established at a location with over twenty meters in water depth or over three nautical miles from the dredging work site. Also, the current pattern in the sea area is taken into consideration to prevent the returning of dumped soil to the dredging work area.

In the case of Jambi, the dumping site is set up in the eastern offshore area of the estuary, about 6.5 miles (12 km) from the end tip of the navigation channel (00°54’20”S, 103°50’00”E; see Figure 22.3.2).

As seen in the figure, the dominant direction of the tidal current is east-west at the mouth of Batanghari River. Some portion of dumped soil has been observed returning to the area of the dredged channel.

The dumping area should be relocated to the northern offshore position of the navigation channel; the recommended location is [00°52'00?S, 103°46'00?E]. The distance from the end tip of the navigation channel is about 6 miles (see Figure 22.3.2).

(5) Modification of Channel Alignment

There is a part in the river channel of Batanghari River or Mahakam River where the navigation channel runs through the shallower side of the river. It is not impossible technically to modify the channel alignment, and it is obvious that the maintenance dredging volume will decrease if the navigation channel runs through the deeper side of the river.

However, the discharge from river does not have the same pattern every year; there is a large fluctuation. The riverbed changes caused by the sediment transport and siltation will not be steady or constant. It is considered necessary to confirm the stability and fluctuation of the riverbed changes based on the results of channel surveys conducted over the whole area of the management channel for several years on a regular basis.

22.3.2 Unit Price of Maintenance Dredging

The following tables show the unit prices agreed upon between the Government and Rukindo and/or agreed between the Indonesian Port Corporations and Rukindo for the maintenance dredging of the navigation channel and harbor basin (see Table 22.3.1).

These unit prices do not include depreciation cost and repair and maintenance cost. Contract conditions are also considered negative factor for Rukindo business.

A case study and the cost estimate of the “market prices” of maintenance dredging was performed based on the actual work conditions of the river channel in Batanghari River and Mahakam River. The results are as follows.

Jambi	19,000 – 20,000 Rp./m^3
Samarinda	13,000 – 16,000 Rp./m^3

By contrast, the unit price proposed by Rukindo is 13,000 Rp./m^3 for maintenance dredging.

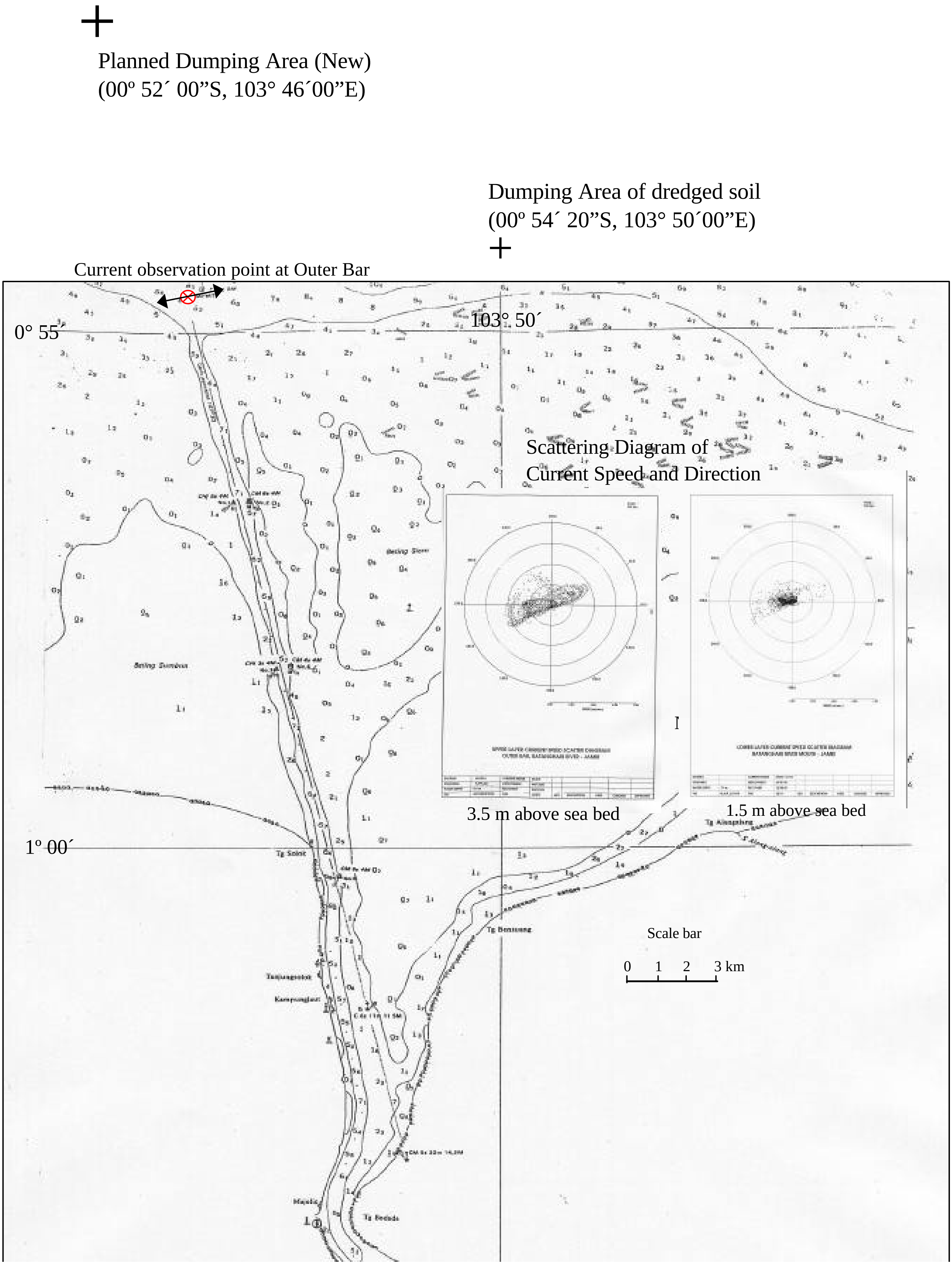


Figure 22.3.2 Tidal Current and Relocation Plan of Dumping Site

Table 22.3.1 Agreed Unit Prices of Maintenance Dredging

Unit Prices agreed between Government and Rukindo

No.	Equipment Item	Condition	Unit	Unit Price
1	Hopper Dredger	Shipping Channel	Rp/m^3	6,000
		Harbour Basin	Rp/m^3	7,500
2	Non Hopper		Rp/m^3	9,500
3	Mobilization/Demobilization of Non Hopper Dredger	Towed trailing	Rp./mile	148,000
		Unladen self navigation	Rp./mile	74,100

Unit Prices agreed between Port Corporations and Rukindo

No.	Equipment Item	Condition	Unit	Unit Price
1	Hopper Dredger	Shipping Channel	Rp/m^3	7,310
		Harbour Basin	Rp/m^3	9,140
2	Non Hopper (Clamshell)	Dumping site: Distance < 3 miles	Rp/m^3	10,460
		3 miles < Distance < 6 miles	Rp/m^3	11,460
3	Mobilization/Demobilization of Non Hopper Dredger	Towed trailing	Rp./mile	190,100
		Unladen self navigation	Rp./mile	95,000

22.3.3 Dredgers Fleet of Rukindo

TSHDs of Rukindo are the small - medium size dredgers with hopper capacities 2,000 - 5,000 m^3 and draught of 4 - 7m (see Table 3.11.4; Part2, Chapter 3). Their use is appropriate in the shallow water area in the river channel and/or Java Sea.

The relationship between hopper capacity of Rukindo TSHDs and the years built is shown in Figure 22.3.3. The age of the dredgers built in 1970s is over 25 years and most of the dredgers are 18 – 20 years old. The dredgers are vessels transferred free of charge from the Government to Perum Pengerukan (the forerunner of Rukindo; established in April 1983).

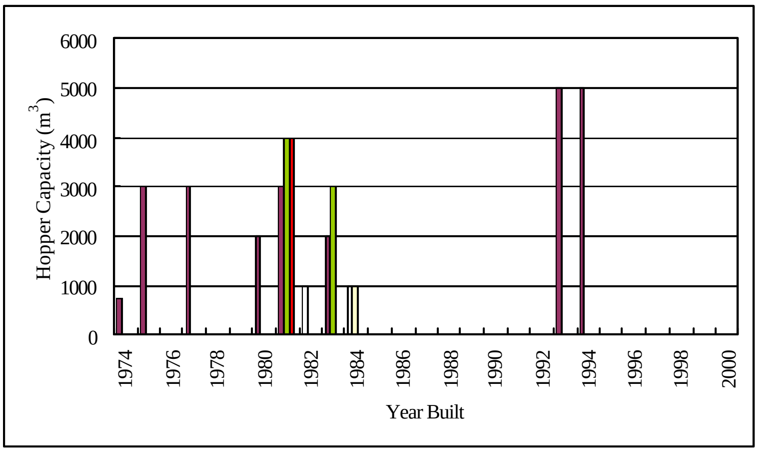


Figure 22.3.3 TSHDs of Rukindo and the years of building

The renewal of dredger vessels is inevitable in the near future in this state-owned company. However, the current contract prices for the maintenance dredging is not sufficient to finance the cost for the renewal, repair and maintenance of the owned dredgers. It is recommended that the contract prices should be modified to be close to the “market price”.

22.3.4 Maintenance dredging for port development

(1) Maintenance dredging for port development

An improvement plan of navigation channel is proposed for port development at Muara Sabak (depth: -6.0 m, width: 110 m, extension of channel: 26 km up to Muara Sabak). The volume of the maintenance dredging of the improved channel is estimated as 1,350,000 m^3/year by numerical simulation of siltation.

(2) Effect of structural countermeasure

The effect of the river structures to decrease the dredging volume is studied based on the actual riverbed changes and also using numerical simulation of siltation.

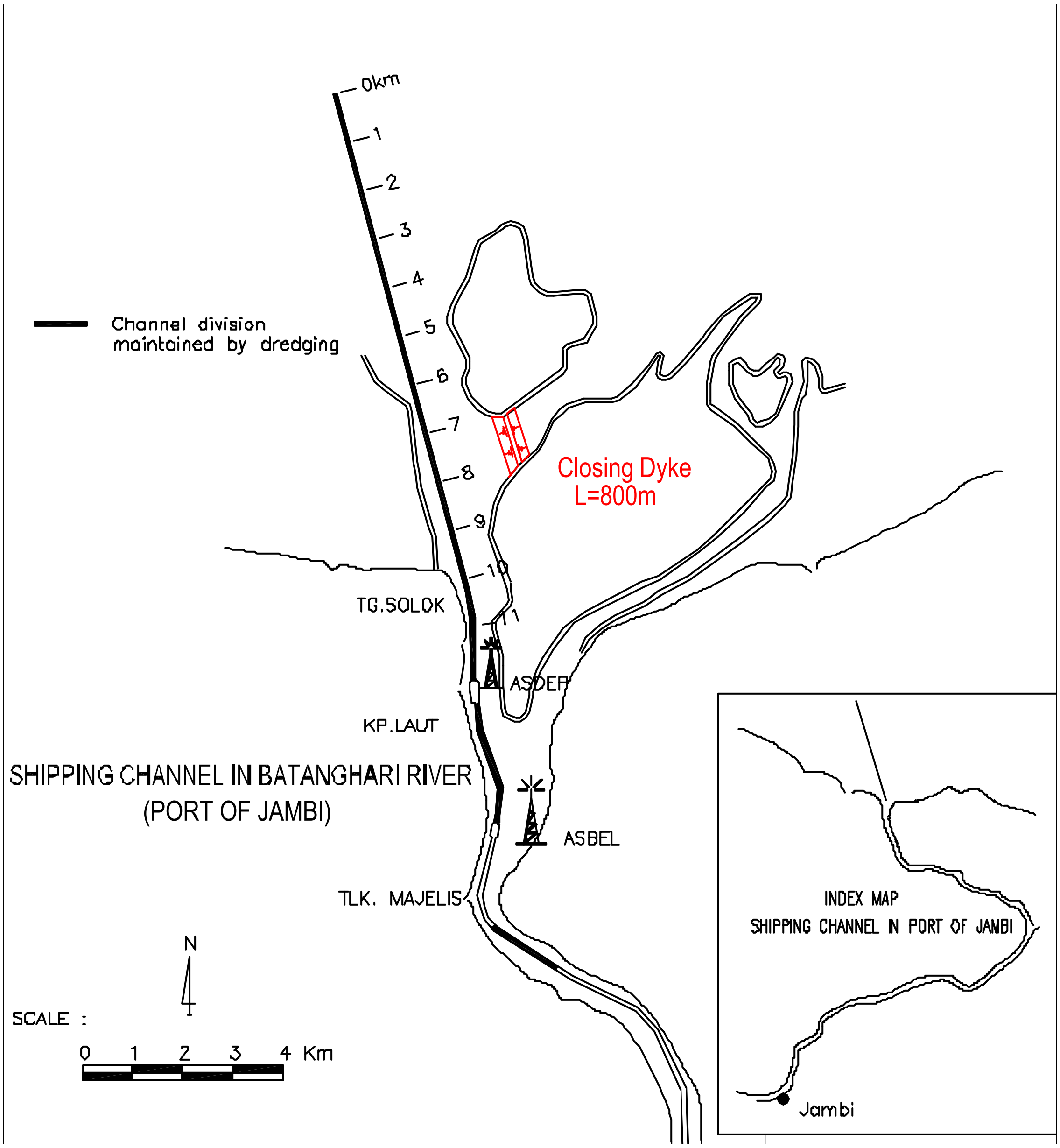
The river channel on the Outer Bar area has a branch channel which loses its flow and speed along the channel at the branch. Hence, significant deposition is taking place in this part of the navigation channel (see Figure 22.2.3).

To block the branch channel with a Closing Dyke is considered in order to concentrate the river flow into the main stream of the channel and to decrease the volume of deposition. The location and cross section of the Closing Dyke are assumed as shown in Figure 22.3.4. The extension of construction is assumed as 800 m in length (construction cost: 5.6 million USD).

The effects of river structures to decrease the dredging volume are very limited. The reduction of the maintenance dredging volume by the Closing Dyke is estimated as 150,000 m^3/year（about 0.20 million USD/year）. The construction cost of the Closing Dyke is equivalent to the maintenance dredging cost over 28 years.

An economic analysis on the cost and benefit of the closing dyke was carried out. The present values of the cost and benefit balance after 50 years of the construction under the condition of the discount rate: 1 %.

The merit from the siltation prevention measures with river structures is evaluated very limited and small considering the restriction to the use of the river channel and the miscellaneous environmental risks.



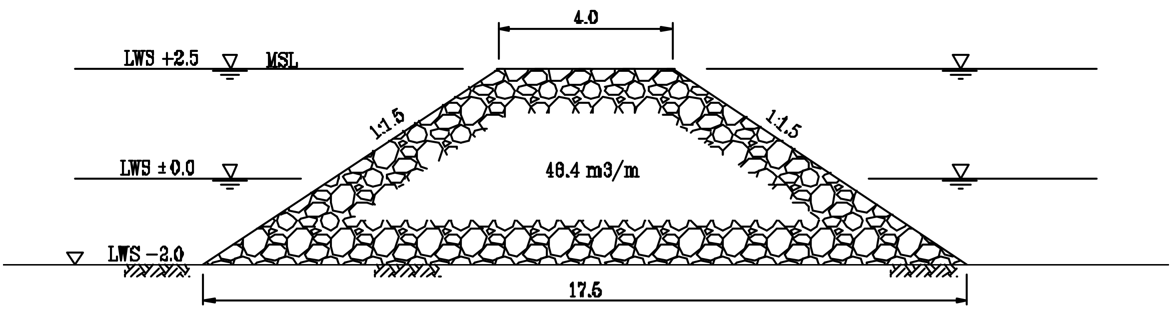


Figure 22.3.4 Location and Cross-section of the assumed Closing Dyke in Batanghari Estuary

22.4 Channel Dredging Scheme

22.4.1 Channel Management

IPC II Jambi branch office serves as the port authority and manages the Jambi port. On the other hand, Jambi ADPEL is responsible for the safe navigation in Batang Hari River. Kuala Tungkal ADPEL is responsible for the safe navigation in Tungkal River. The Port Working Area and the Port Interest Area in these rivers and around their river mouth should be reviewed to come up with an appropriate cost sharing scheme for dredging among the concerned parties as well as to respond to the principles of the new port regulation (Government Regulation No.69/ 2001).

22.4.2 Cost Sharing for Maintenance Dredging

Judging from the past records, maintenance dredging of 350,000 m3 is required every year. Accordingly, if a unit price is set at 13,000 Rp/m3, about 4,550 million Rp is required for dredging per year. On the other hand, the IPC II Jambi Branch Office currently earns only Rp.7,166 million a year, out of which it uses Rp.6,130 million a year for port operation. Consequently, the Branch Office will have to spend about 60% of its income for dredging if the central government discontinues the subsidy. In this case, there will be no funds left for port development.

As the decentralization process progresses, local governments and the private sector are expected to play a greater role in realizing regional development.

The Team proposes a new cost-sharing scheme for maintenance dredging taking into account the practices in several countries (Table 22.4.1) (Table 22.4.2). It is necessary to review the Port Working Area and Port Interest Area in Jambi port in line with the new scheme.

The central government entrusts the port authority with the management of the "Outer Channel".

In this scenario, the port authority (IPC II) manages the port interest area including the "Outer Channel" and anchoring area. A similar practice is under taken in Japan. The Japanese government constructs major port facilities and entrusts the port authority with their management.

The port working area will be limited inside the river reaching as far as the river mouth. IPC II manages the "river channel" where dredging cost is comparatively small. In addition, IPC II will get the port charge for the "outer channel" and anchoring area. The central government and IPC II share the dredging cost of the “Outer Channel” through negotiation. It is also necessary to examine whether the existing port charges on special wharves should be revised.

Table 22.4.1 Distribution of the Responsibility for Maintenance Dredging

Channel	Owner	Management	Revenue	Dredging Cost
River Channel	IPC II	IPC II	IPC II	IPC II
Outer Channel	Central Government	IPC II (entrusted by the central government)	IPC II	IPC II and Central Government

Table 22.4.2 Conceptual Dredging Cost Sharing Scheme for Jambi Port Master Plan (Long-term)

Parties concerned	Current Scheme (until 1998)	Provisional Scheme (1999-2001)	Future Scheme (Draft)				Note (unit : million Rp)
			Maintenance Dredging 13,000m3/Rp.		Initial Dredging 25,000m3/Rp.		
			River Channel 700,000m3	Outer Channel (16 km) 650,000m3	River Channel 1,930,000m3	Outer Channel (16 km) 2,690,000m3	
River Channel							
Central Government	0 % (50%)	0%	0%		0 %		
Port Authority I PC II	100 % (50%)	100 %	4,550 (50 %)		48,250 (100%)		
Local Government	0 %	0 %	3,640 (40 %) *-2		*-4		*-1
Related Business Circles (beneficiaries)	0 %	0 %	455 (5 %) *-2		*-5		Beneficiary charge *-3
Calling vessels (greater than 105 GRT)	0 %	0%	455 (5 %) *-2		*-5		Channel use charge *-3
Sub-total	100%	100%	9,100 (100%)		48,250 (100%)		
Outer channel							
Central Government	0 % (50%)	0%		4,225 (50%)		67,250 (100%)	
Port Authority I PC II	100 % (50%)	100 %		4,225 (50%)		0	
Sub-total				8,450 (100%)		67,250 (100%)	

Note: *-1 Subsidy (within the budgetary limitation) from Province and Municipality

Note: *-2 Share is conceptual. Thorough review is needed after the available amount of the balancing fund is determined.

Note: *-3 Beneficiaries include the owners of special ports and vessels larger than 105t

Note: *-4 IPC II may ask for financial support after the available amount of the balancing fund is determined.

Note: *-5 IPC II may ask for financial support after private industries start operation around Muara Sabak.

22.5 Navigation Channel and Vessel Dimensions

22.5.1 Navigation Rules and Indonesian Fleet

Each port has its own Navigation Rules. Concerning vessel dimensions, the Navigation Rules regulate vessel overall length (L_{OA}) and draft. The regulated L_{OA} is defined mainly by the curvature of the channel and the draft is defined by the water depth of the channel.

These two figures are usually defined independently. Therefore, for one ship L_{OA} restriction is very severe and draft restriction is not and vice versa may be possible.

Relations between L_{OA} and draft (designed, full load) of the Indonesian fleet are extracted from the register book of B.K.I. (Indonesian Classification Society). The relations between L_{OA} - draft for the study port regulated by the Navigation Rules are also show in the same figure (refer to Figure 22.5.1).

From this figure, the following is observed:

1) Samarinda and Muara Sabak ports can accept larger vessels if the navigation channels approaching to those ports can be maintained at the deeper water depth. In other words, if the ports stay at the present depth of the channel, a shorter L_{OA} vessel can be put into service to its designed (full load) draft, but a longer L_{OA} vessel can only be put into service to a shallower draft than its designed (full load) draft.
2) Pekanbaru port cannot accept larger vessels even if it deepens the channel as it cannot ease off the curvature of the river channel.
3) In order to make Perawang and Talang Duku ports able to accept larger vessels, they have to ease off the curvature of the river channel and also deepen the channel.

In the case of the vessel which cannot be put into service to its designed (full load) draft due to water depth restriction of the channel, the amount of DWT figure decrease is estimated (refer to Figure 22.5.2).

Since Draft - DWT relation differs between ships, this estimation was made for the several sample ships for which the detailed design data were available. Using these figures, "Attainable DWT by Navigation Rules" is obtained (refer to Figure 22.5.3).

The above explanations are only applicable to L_{OA} and draft relation; in actual cases, other relations such as L/B and B/d, etc. must be considered (refer to Figure 8.3.3).

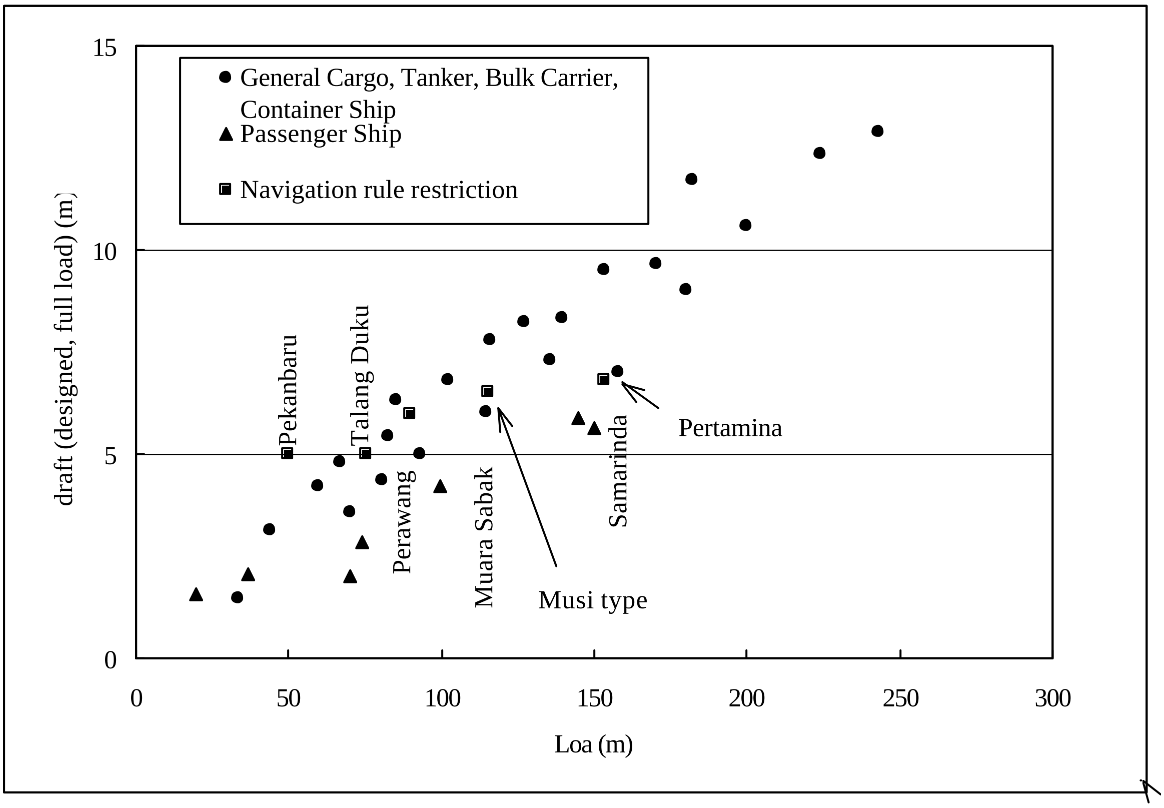


Figure 22.5.1 Relationship between L_{OA} and draft (designed, full load)

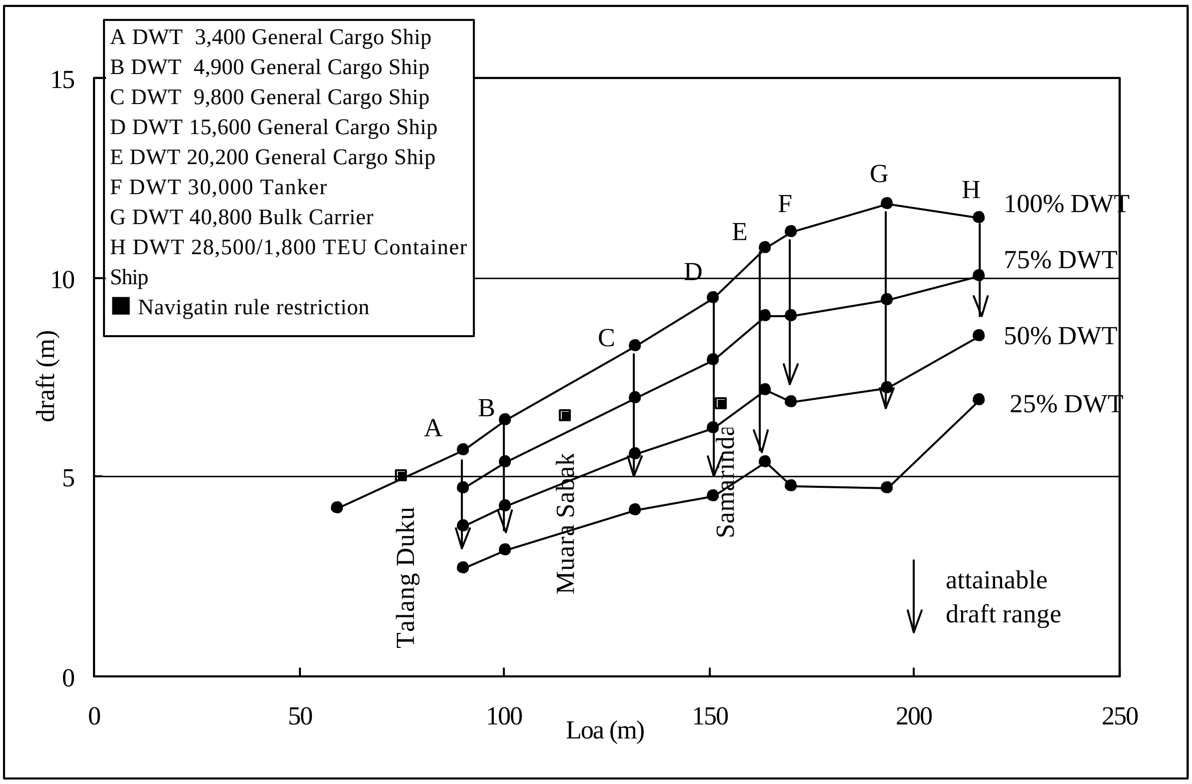


Figure 22.5.2 Relationship between Draft and DWT

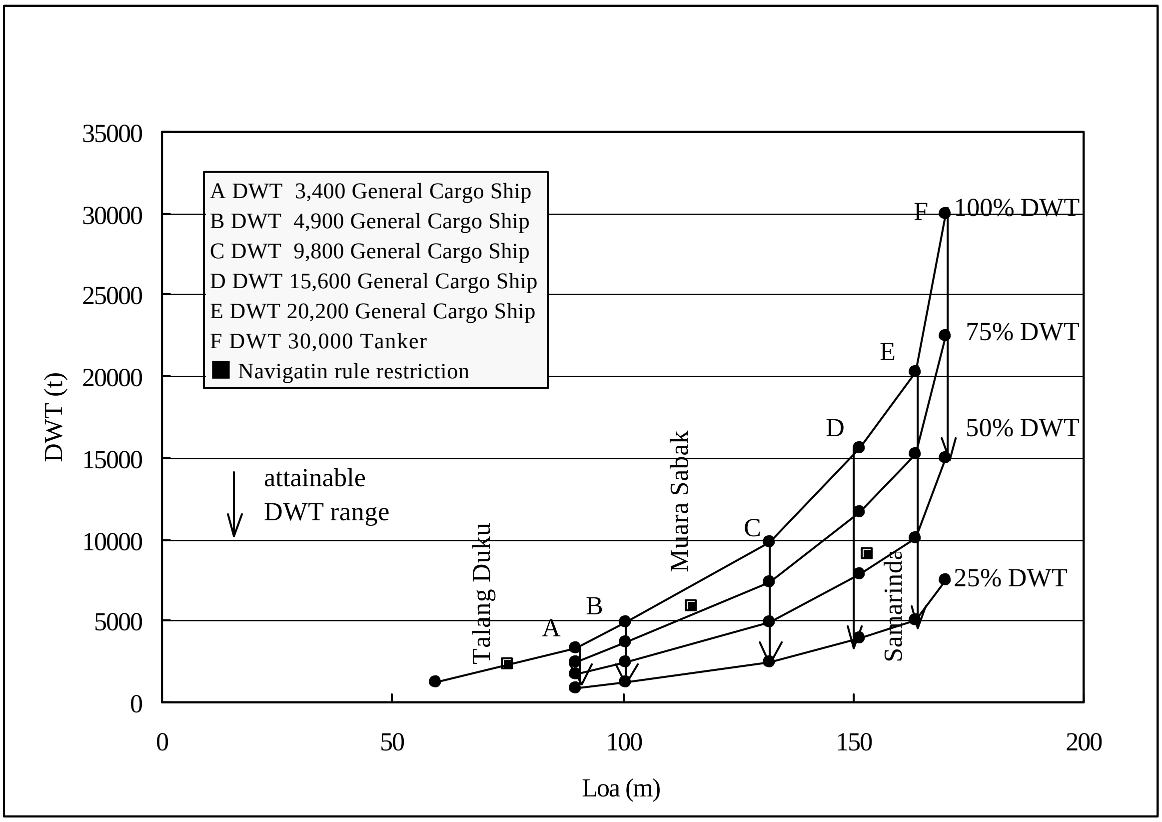


Figure 22.5.3 Attainable DWT by Navigation Rules

22.5.2 Idea for accepting the longer L_{OA} Ship

To ease off the curvature of the meanders of the river channel may not be easy from the practical point of view.

However, if the vessel improves its turning ability using side thruster and/or special rudder (such as Becker rudder, Shilling rudder, etc.), there is a possibility to lengthen the L_{OA} restriction with the smaller transfer of the vessel in the turning operation (refer to Figures 22.5.4, 22.5.5 and 22.5.6).

In general, the transfer of the vessel is about 2.5 x L_{OA}, and if this value can be reduced to $1/\alpha$ by the improvement of turning ability, at a certain point, the maximum value of L_{OA} which is critical to this point may be increased by α times.

Then the figure of L_{OA} regulated by Navigation Rules may be lengthened to α x L_{OA}.

Note: transfer = the transverse distance of deviation from the original course at the time a vessel turns to 90 degrees after the helm is ordered.

22.5.3 Container Transport by Barge

Container transport for Talang Duku is carried out mainly by 50 - 100 TEU barges, and other cargoes are also transported by barge. In barge transport for Talang Duku, the pulling system (towing system) is used.

On the other hand, the pushing system is said to have better maneuvering performance for turning, stopping and going astern over the pulling system. Hence, the pushing system seems has advantage for Talang Duku (which has many meanders of the river channel) even though the pushing system has some technical problems in the connecting method of pusher and barge.

When the barge line (total length of tug boat, tow line and barge) becomes longer than the L_{OA} of ordinary vessel and sailing speed becomes slower, it disturbs other navigating vessels and is also likely to cause shipping accident.

Many problems, that are not solved, are reserved for the improvement of barge line maneuverability.

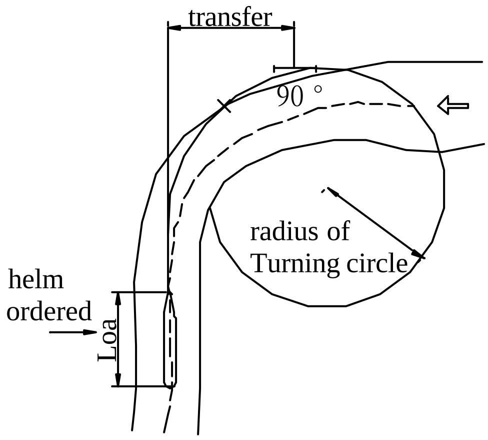


Figure 22.5.4 Transfer of the Turning Operation of Vessel

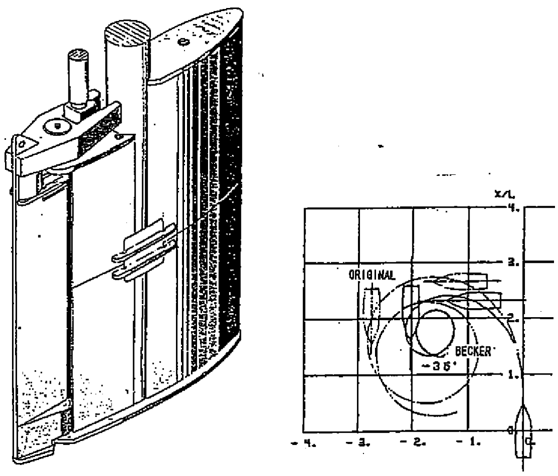


Figure 22.5.5 Becker rudder

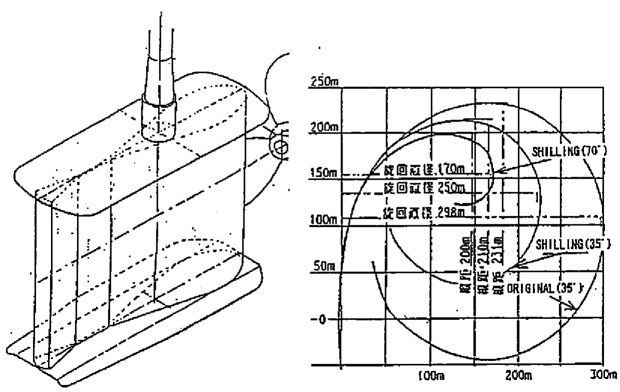


Figure 22.5.6 Shilling rudder

22.5.4 Vessels for Muara Sabak and their Cost for Container Transport

(1) Conceptual design of vessels for Muara Sabak route

The conceptual design for following three feeder service container vessels has been carried out. Particulars of these vessels are shown in Table 22.5.1.

1) Ordinary type vessel, for water depth 6m
2) Ordinary type vessel, for water depth 4.5m
3) Shallow draft vessel, for water depth 4.5m

Table 22.5.1 Conceptual Design of Vessels and Their Particulars

		Ordinary type vessel, water depth, 6m	Ordinary type vessel, water depth, 4.5m	Shallow draft vessel, water depth, 4.5m
Carrying capacity	(TEU)	350	130	200
Annual carry. cap.	(TEU)	82,810	30,760	47,320
L_{OA}	(m)	149.0	110.0	120.0
Breadth	(m)	18.0	13.0	16.0
Draft	(m)	5.5	4.0	4.0
GRT		5,700	2,840	3,840
DWT	(t)	6,300	1,850	2,780
Main engine	(HP)	4,600	2,400	4,360
Speed	(knot)	13.5	13.5	13.5

Conceptually designed plans of general arrangement and midship section for 1) vessel is attached (refer to Figure 30.5.1, Chapter 30, Part 6).

2) vessel container 4 rows, 4 tiered and 10 bays
3) vessel container 5 rows, 4 tiered and 11 bays
B / d = 4.0 (refer to Figure 8.3.3)

(2) Estimation of transport cost

The cost of the container transport for the following route has been analyzed. Cost of the container transport is shown in Table 22.5.2

Muara Sabak ~ Singapore (155 nautical miles, 118.3 round / year)

1) The cost of transporting one TEU container using shallow draft vessel (water depth 4.5m) is higher than that of transporting by ordinary type vessel (water depth 6m) by about 30%. It is necessary to compare this transporting cost with the dredging cost of the channel from 4.5m to 6m.
2) In ordinary type vessel, the cost of transporting one TEU container using vessel of 4.5m water depth is higher than that of 6m water depth vessel by more than 60%.

Table 22.5.2 Cost Estimate for the Container Transport (Muara Sabak Route)

		Ordinary type vessel, water depth 6m	Ordinary type vessel, water depth 4.5m	Shallow-draft vessel water depth 4.5m
Carrying capacity	(TEU)	350	130	200
Annual carry. cap.	(TEU)	82,810	30,760	47,320
L_{OA}	(m)	149.0	110.0	120.0
Breadth	(m)	18.0	13.0	16.0
draft	(m)	5.5	4.0	4.0
GRT		5,700	2,840	3,840
DWT	(t)	6,300	1,850	2,780
Main engine	(HP)	4,600	2,400	4,360
Speed	(knot)	13.5	13.5	13.5
Ship price	(million Rp)	72,800	37,100	52,800
Depreciation	(million Rp/year)	4,368	2,226	3,108
Interest	(million Rp/year)	3,185	1,622	2,265
Administration	(million Rp/year)	1,477	1,454	1,458
Insurance	(million Rp/year)	294	86	130
Manning	(million Rp/year)	11,375	11,375	11,375
Repair & Maint.	(million Rp/year)	917	425	750
Lubricant oil	(million Rp/year)	182	94	171
Store	(million Rp/year)	609	590	594
Tax	(million Rp/year)	49	33	46
Bunker	(million Rp/year)	2,246	1,637	2,181
Port cost	(million Rp/year)	22,393	22,393	22,393
Terminal cost	(million Rp/year)	61,039	22,673	34,880
Total cost	(million Rp/year)	108,134	64,608	79,351
Cost / TEU	('000 Rp)	1,306 (100)	2,100 (161)	1,677 (128)

Reference : "Strategy and Profitability in Global Container Shipping" Drewry 1991
"Global Container Markets" Drewry 1996 , etc.

22.6 Capacity Requirements

22.6.1 Assumptions

In order to estimate the capacity requirements of the public ports, the Study Team assumed the following:

1) Traffic Projection (summarized in Table 22.6.1)
2) Distribution of the port functions among the three public ports, Talang Duku, Muara Sabak, and Kuala Tungkal
3) Distribution of functions on container handling between public wharves and private wharves (Table 22.6.2)
4) Baseline Productivity (Table 10.1.1)
5) Capacity of the existing port (Section 10.1)

Table 22.6.1 Traffic Projection Summary

(Cargoes in million ton)

Cargoes	2000	2007	2025	Annual Growth Rate (Average)	
				2000-2007	2007-2025
International Cargo	1.06	1.6	4.0	6.1 %	5.2%
Domestic Cargo	2.45	4.0	9.6	7.3 %	4.9%
All Cargo	3.51	5.6	13.4	6.9 %	5.0%
Of which:					
Batan Hari River (Public and Private)	2.57	4.3	11.3	7.6 %	5.5%
Kuala Tungkal (All Private)	0.95	1.3	2.1	4.6%	2.7%
Of which:					
Containers (TEUs)	37,000	79,000	406,000	11.4 %	9.5%
Coal	0.0	0.6	0.0	-	8.0%
Logs and Timber	1.2	1.3	2.0	1.2 %	0.8%
Products	0.3	0.8	1.5	7.1 %	
CPO	0.4	0.6	1.8	15.0 %	4.6%
Pulp			1.4	6.0%	4.8%
Passengers	134,000	245,000	590,000	9.7 %	5.0%

Source: JICA Team

Table 22.6.2 Alternative Container Traffic Scenarios

(TEUs)

Cargoes	2000	2007	2025	Annual Growth Rate
Total Containers	37,000	79,000	406,000	10.0 %
Scenario 1 Base Public Case				
Proportion of Public Containers	30 %	35 %	50 %	
Total Public Containers	13,000	28,000	203,000	12 %
Muara Sabak (65 % of Public Containers)	0	18,000	132,000	12 % (2007-2025)
Talang Duku (35 % of Public Containers)	13,000	10,000	71,000	7 %
Remaining Public General Cargo (t)	86,000	117,000	309,000	5 %
Scenario 2 High Public Case				
Proportion of Public Containers	30 %	45 %	70 %	
Total Public Containers	13,000	36,000	284,000	13 %
Muara Sabak (75 % of Public Containers)	0	26,000	213,000	12 % (2007-2025)
Talang Duku (25 % of Public containers)	13,000	10,000	71,000	7 %

Source: JICA Team

22.6.2 Talang Duku

(1) Container

Demand will temporarily exceed the existing capacity before 2007 and sharply decrease later on due to the opening of Muara Sabak. Toward the target year, throughput will be increasing again, reaching 71,000 TEU in 2025.

Short-term

The Team suggests that the terminal should deal with the temporary increase by reducing the berthing time. In order to reduce ship days, port users will be requested to bring in outbound containers on schedule.

Long-term

Capacity Requirement for the Long-term = 71,000 TEU –20,000 TEU = 51,000 TEU/year
Capacity with Additional 2 berths = 3 berths (dedicated to container) x 365 days / 2 days (time at berth) x 200TEU (maximum cargo volume per call) x 0.6 (berth occupancy ratio) + 1 berth (shared with CPO) x 365 days / 2 days x 200TEU x 0.4 (berth occupancy ratio, 0.2 for CPO) = 80,000 TEU/year

Hence, two new berths will be needed for the long-term.
Ground Slots = 71,000 TEU x 4 days (dwelling time) / 0.6 (yard operation ratio) / 365 days / 3 tiers (SC)

= 433 TEU
Container Terminal Area = 433 TEU / 300 TEU/ha (land use ratio) / 0.6 (yard area ratio) = 2.4 ha

(2) General cargo

Assuming the split of general cargo between Talang Duku and Muara Sabak is the same as container, Talang Duku's demand is estimated to be 35 % of the total public, 41,000 t/year in 2007 and 108,000 t/year in 2025
Capacity requirement = (Demand) – (Existing capacity)

Short-term

The existing capacity is greater than the demand for 2007 and thus sufficient for the short-term

Long-term

Capacity Requirement for the Long-term = 108,000 t – 84,000 t = 24,000 t/year
Capacity with an Additional Berth = 2 berths x 365 days x 16 hours x 0.8 (work time ratio) x 22.5 t/hour/gang x 2gangs x 0.5 (berth occupancy ratio) = 210,240 t/year

Since the capacity with an additional berth far exceeds the estimated demand, it is recommended that the cargo exceeding the capacity of the existing berth be transferred to Muara Sabak. In this case, the split of general cargo is 27 % (Talang Duku) and 73 % (Muara Sabak), which is close to the container split in the High Public Case.

22.6.3 Muara Sabak

(1) Container

1) Base Case

Demand is estimated at 18,000 TEU/year in 2007 and 132,000 TEU/year in 2025
Capacity requirement = (Demand) – (Existing capacity)

Short-term

The existing capacity is greater than the demand for 2007 and thus sufficient for the short-term

Long-term

Capacity Requirement for the Long-term = 132,000 TEU
The existing jetty will be used for general cargo.
Total Capacity with 3 berths with a Gantry = 3 berths x 365 days x 16 hours/day x 0.8 x 20 TEU/crane x 0.55 (three-berth group) = 154,000 TEU

Hence, three new berths with a gantry will be needed for the long-term
Ground Slots = 132,000 TEU x 5 days / 0.6 (yard operation ratio) / 365 days / 4 tiers (RTG)
= 753 TEU
Container Terminal Area = 753 TEU / 260 TEU/ha (land use ratio) / 0.6 (yard area ratio) = 4.8 ha

2) High public case

Demand is estimated at 26,000 TEU/year in 2007 and 213,000 TEU/year in 2025
Capacity requirement = (Demand) – (Existing capacity)

Short-term

Capacity of a Berth with a Gantry = 1 berths x 365 days x 16 hours x 0.8 x 20 TEU/hour x 0.4 = 46,720 TEU/year

Hence, a new berth will be needed for the short-term.

Long-term

Capacity of Four Berth with a Gantry = (4 berths x 365 days x 16 hours/day x 0.8 x 20 TEU/crane) x 0.6 (four-berth group) = 224,000 TEU

Hence, four new berths will be needed for the long-term.
Ground Slots = 213,000 TEU x 5 days / 0.6 (yard operation ratio) / 365 days / 4 tiers (RTG) = 1,215 TEU
Container Terminal Area = 1,215 TEU / 260 TEU/ha (land use ratio) / 0.6 (yard area ratio) = 7.8 ha

(2) General Cargo

Assuming Muara Sabak handles the remainder of public general cargo, Muara Sabak's demand is estimated to be 76,000 t/year in 2007 and 225,000 t/year in 2025
Capacity Requirement = (Demand) – (Existing Capacity)

Short-term

Capacity of a Berth = 1 berths x 365 days x 16 hours x 0.8 x 22.5 t/hour/gang x 2 gangs x 0.4 (berth occupancy ratio) = 84,000 t/year

Hence, a new berth will be needed for the short-term.

Long-term

Capacity with an additional berth = 2 berths x 365 days x 16 hours x 0.8 (work time ratio) x 22.5 t/hour/gang x 2gangs x 0.5 (berth occupancy ratio) = 210,240 t/year
Since the existing jetty will be used for general cargo, the berth created in the short-term will be enough.

22.6.4 Kuala Tungkal

(1) Passenger

Demand is estimated at 245,000 passengers/year in 2007 and 590,000 TEU/year in 2025
Capacity Requirement = (Demand) – (Existing Capacity)

Capacity of the Existing Wharf = 657,000 passengers

Short-term

The existing capacity is greater than the demand for 2007 and thus sufficient for the short-term

Long-term

Extension of the passenger jetty is not needed for the long-term either.

22.6.5 Summary

Distribution of public cargoes and capacity requirements are summarized below (Table 22.6.3, 22.6.4). Distribution of bulk cargoes is analyzed in Section 22.8.

Table 22.6.3 Throughput Summary

Port	Cargo	2007 (Short-term)	2025 (Long-term)
Talang Duku	Container (TEUs)	10,000	71,000
	General Cargo (t)	41,000	84,000
Muara Sabak	Container (TEUs) Base Case High Public Case	 18,000 26,000	 132,000 213,000
	General Cargo (t)	76,000	225,000
Kuala Tungkal	Passenger	245,000	590,000

Table 22.6.4 Capacity Requirements Summary

Port	Facility	Additionally Required Berths	
		2007 (Short-term)	2025 (Long-term)
Talang Duku	Container	0	2 (with Mobile Crane)
	General Cargo	0	0
Muara Sabak	Container Base Case High Public Case	 0 1 (with a Gantry)	 3 (with a Gantry) 4 (with a Gantry)
	General Cargo	1	1
Kuala Tungkal	Passenger	0	0

22.7 Alternative Layouts

22.7.1 Talang Duku

Since a new coal terminal is being created in the upstream of the existing general cargo wharf, the remaining area for further development is between the general cargo wharf and container wharf (Site A) or in the upstream of the coal terminal (Site B) (Figure 22.7.1). According to the traffic projection, two container wharves are needed at Talang Duku in the long term (See Section 22.6.5). Coal has the potential to increase too, though it will depend on the business plan of the coal company.

Site A is suitable for container handling as it can provide a linear and level quay alignment together with the existing pontoons. Site A is also in front of the existing container yard. On the other hand, Site A is rather narrow in length and can accommodate only two berths at best. Consequently, some other area will be needed to handle container and general cargo, if containers in Talang Duku increase more than the projected volume. For this reason, a part of Site B needs to be reserved for those cargoes.

Site B is suitable for bulk cargo handling as this area is next to the new coal terminal. Although the traffic projection indicates that coal and CPO will remain within the capacity of the existing facilities, throughput of bulk cargo could widely fluctuate depending on the business model of private companies. It is therefore recommended to reserve a part of Site B for bulk cargo as well.

Since the most important task of the public port is to cater for the needs of common users, the Study Team recommends that the authorities concerned should take a thorough review of the economic environments before actually determining to allocate Site B to special users.

22.7.2 Muara Sabak

Muara Sabak has three potential sites (Site A, B, and C) for development within the port area (Figure 22.7.2). Site A is upstream of the existing jetty and located at the southern most of the port area. Two small rivers merge with the Batang Hari River to the south of Site A, causing a considerable amount of sedimentation. This site is therefore not suitable for a port facility requiring a deep draft. Site A could rather serve as a storage area or a passenger jetty linking both sides of the river. Site B is at the middle of the port area including the existing jetty. In order to focus public investment, the first stage of the development should be carried out in this area. According to the traffic projection, a general cargo wharf is needed in the short-term. In addition, a container wharf needs to be constructed in the "High public case".

Site C is a large undeveloped area and suitable for the development of deep-draft wharves. If a bulk terminal is to be created within the port area, Site C is the most promising area for that. The Study Team learned that the local government had a hope to invite a coal terminal to Muara Sabak. However, the traffic projection for the "High public case" requires Muara Sabak to have four container berths in total in the long-term (See Section 22.6.5). On the other hand, Site B cannot accommodate four berths. Since the most important task of the public port is to cater for the needs of common users, the Study Team recommends that the authorities concerned should take a thorough review of the economic environments before actually determining to allocate Site C to special users.

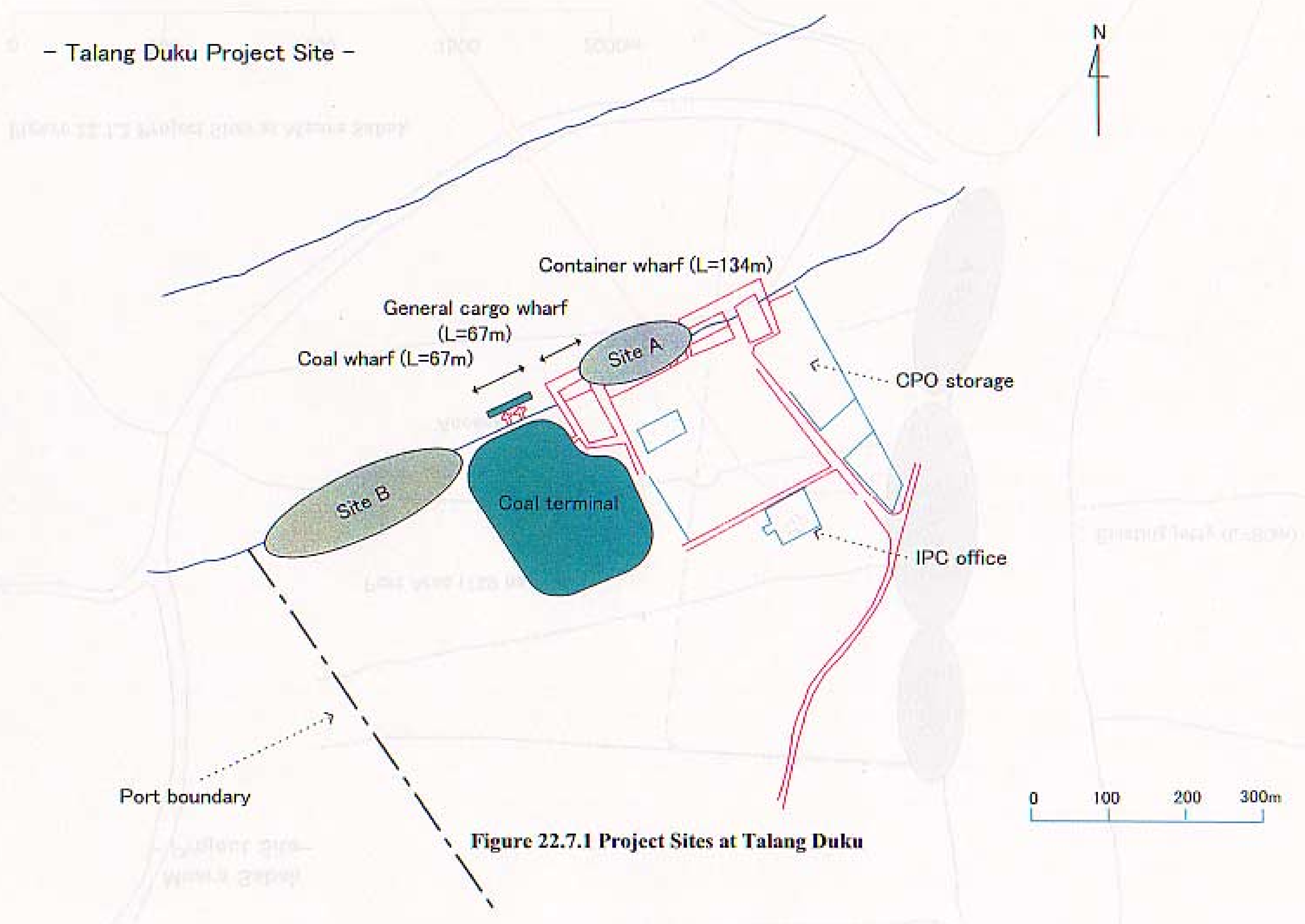


Figure 22.7.1 Project Sites at Talang Duku

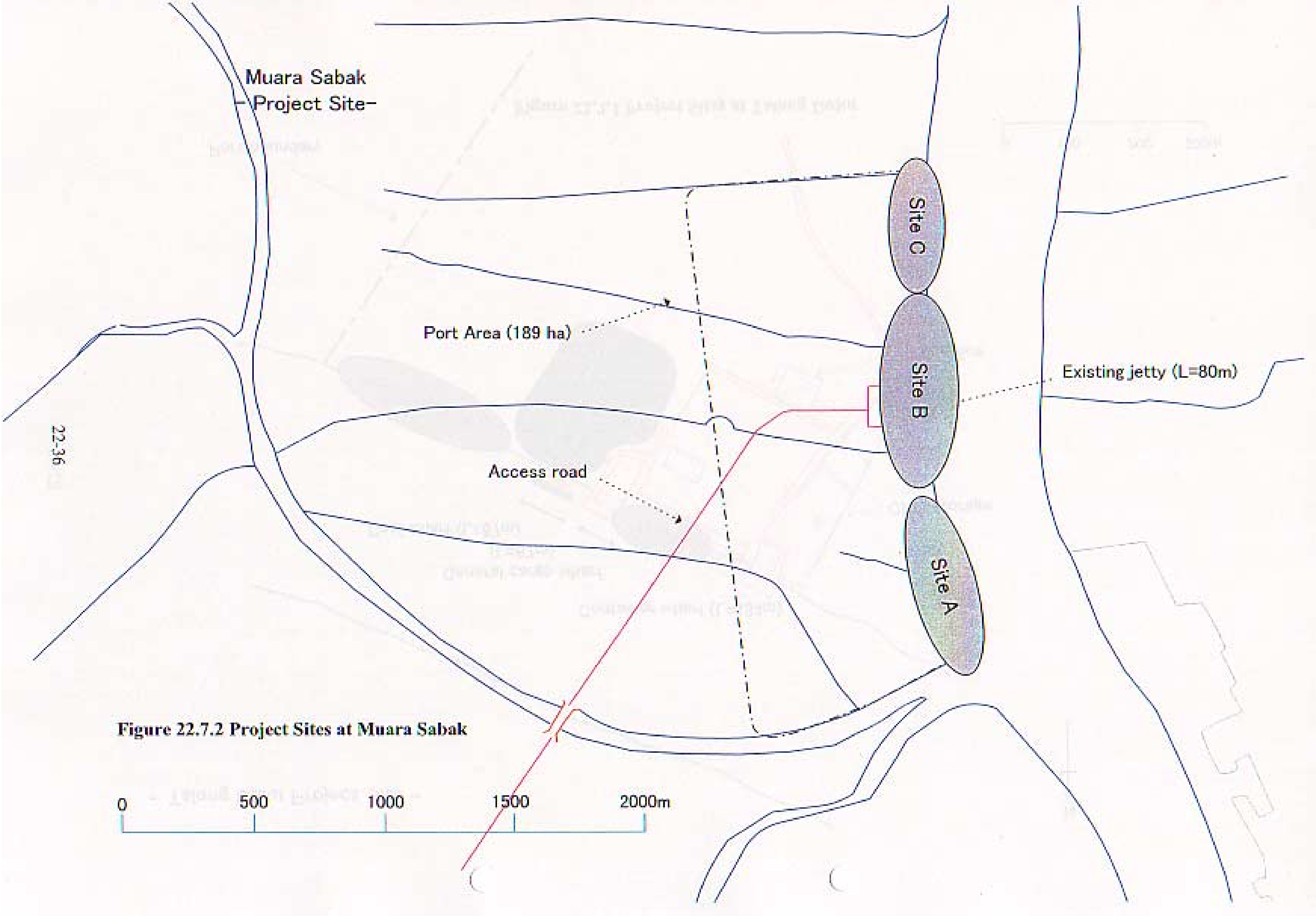


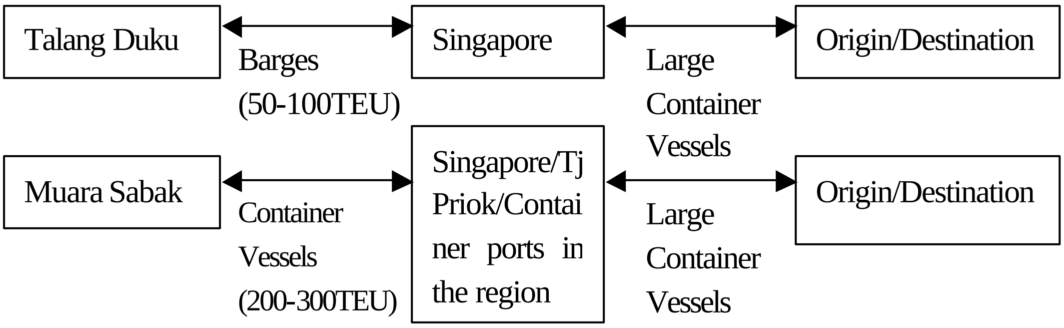
Figure 22.7.2 Project Sites at Muara Sabak

22.8 Master Plan for 2025

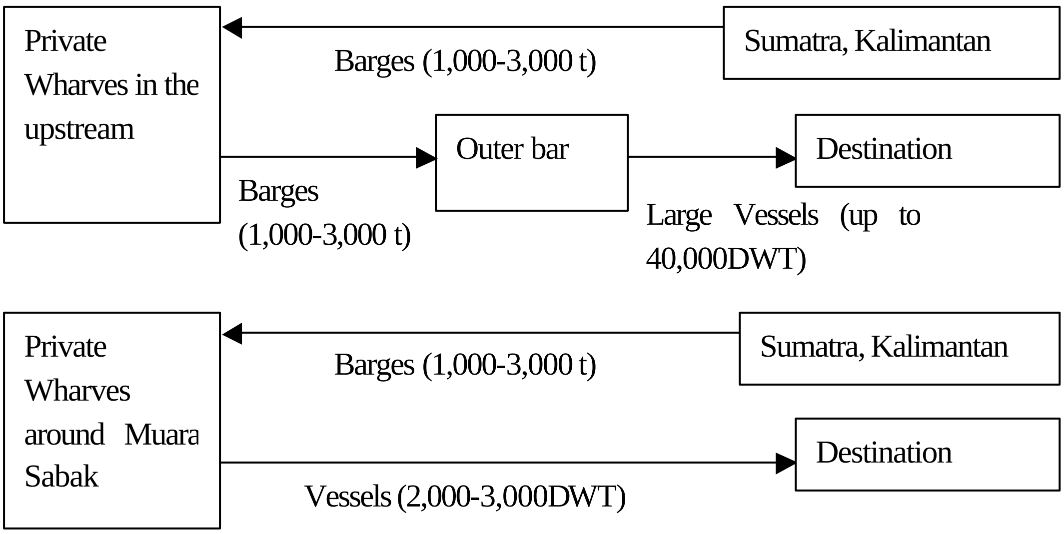
22.8.1 Vessel Calling Pattern

In order to define the roles of the development sites, the Study Team assumed the following vessel calling patterns for major cargo items. These assumptions are based on the topographical features of the Batang Hari River, evolution of the maritime environments, and interviews with port users. Since the approach channel to Talang Duku is very shallow (2.8-3.5m at some points in the dry season), barge transportation will continue to be prevalent for the Talang Duku cargo. Muara Sabak can provide a deeper draft, on the other hand. Accordingly, conventional vessels and container vessels with a deeper draft will be deployed for Muara Sabak to realize the economies of scale.

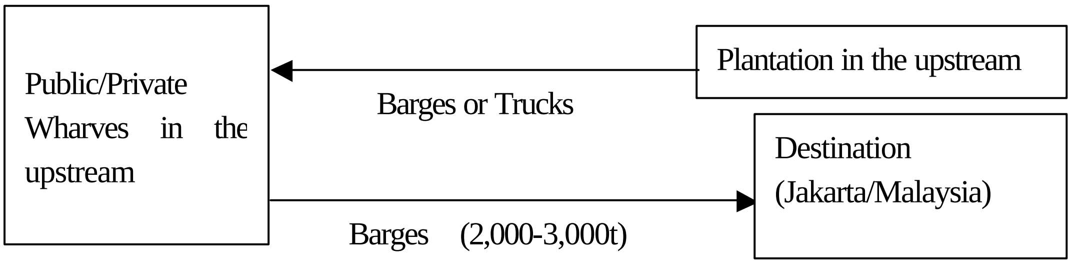
(1) Container

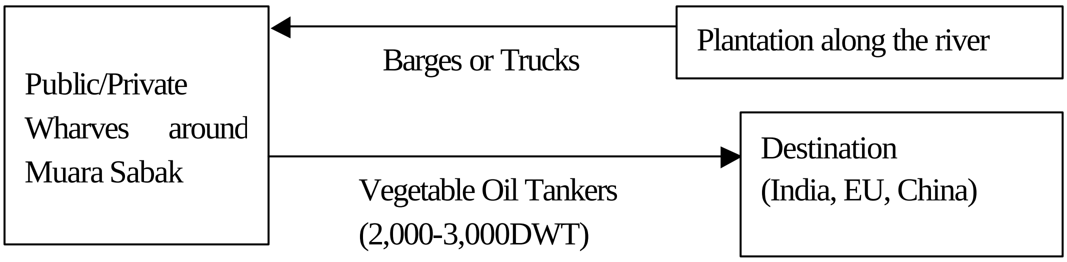


(2) Timber/Wood Products

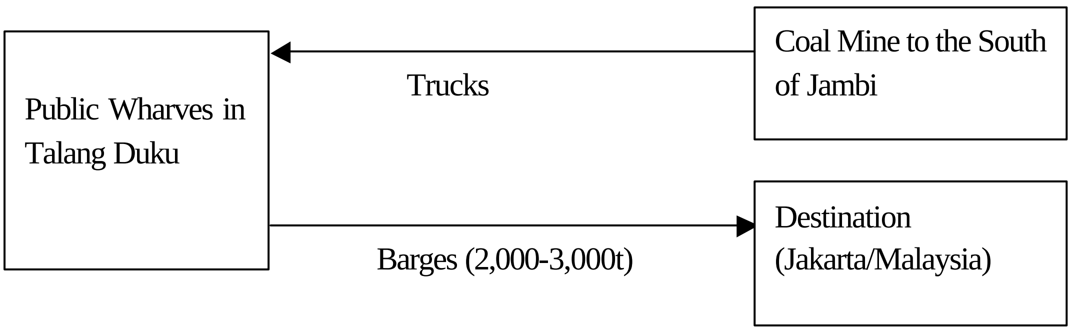


(3) CPO


Public/Private Wharves in the upstream
Plantation in the upstream
Barges or Trucks
Destination (Jakarta/Malaysia)
Barges (2,000-3,000t)


Public/Private Wharves around Muara Sabak
Plantation along the river
Barges or Trucks
Destination (India, EU, China)
Vegetable Oil Tankers (2,000-3,000DWT)

(4) Coal


Public Wharves in Talang Duku
Coal Mine to the South of Jambi
Trucks
Destination (Jakarta/Malaysia)
Barges (2,000-3,000t)

22.8.2 Talang Duku

(1) Project Profiles

The layout plan for 2025 is shown in Figure 22.8.1. Main components of the plan are shown in Table 22.8.1.Two berths for container will be created in the long-term between the existing container wharf and general cargo wharf. If coal exceeds the expected capacity of a new jetty (600,000 t/year), the coal terminal will be expanded to upstream. If CPO greatly increases and hinders the container handling, a wharf dedicated to CPO needs to be created either within or out of the IPC land area.

Table 22.8.1 Master Plan for Talang Duku (2025)

Facility	Dimensions
Additional Berths	2 Pontoons: 125m
Container Terminal	
Total Terminal Area	4 ha
Ground Slots	480 TEU
CFS	1,600m^2
General Cargo Terminal	
Shed	1,350m^2
Open Storage	2,500m^2
Handling Equipment	
Mobile crane (for container)	4
RTG	4
Yard Tractors	8
Container Handling Capacity	80,000 TEU/year
Total cost	Rp.126 billion

(2) Container Terminals

1) Design Vessel

Container barge: 50-100 TEU, Draft 3-4.5m, LOA 40-65m
Barges without a gear will be preferred in the long-term to increase their load capacity. Quayside operation by a ship gear will be replaced with mobile cranes.

Table 22.8.2 Container Barges in Operation at Talang Duku

Shipping Company	LOA (m)	Draft (m)	Loading Capacity (TEU)	Remarks
Samudera Indonesia	66	3.2	50	Geared
Sabang Raya Indah	N.A.	4.3-4.5	100	Geared
INDOEXPRESS	N.A.	N.A.	50	Geared

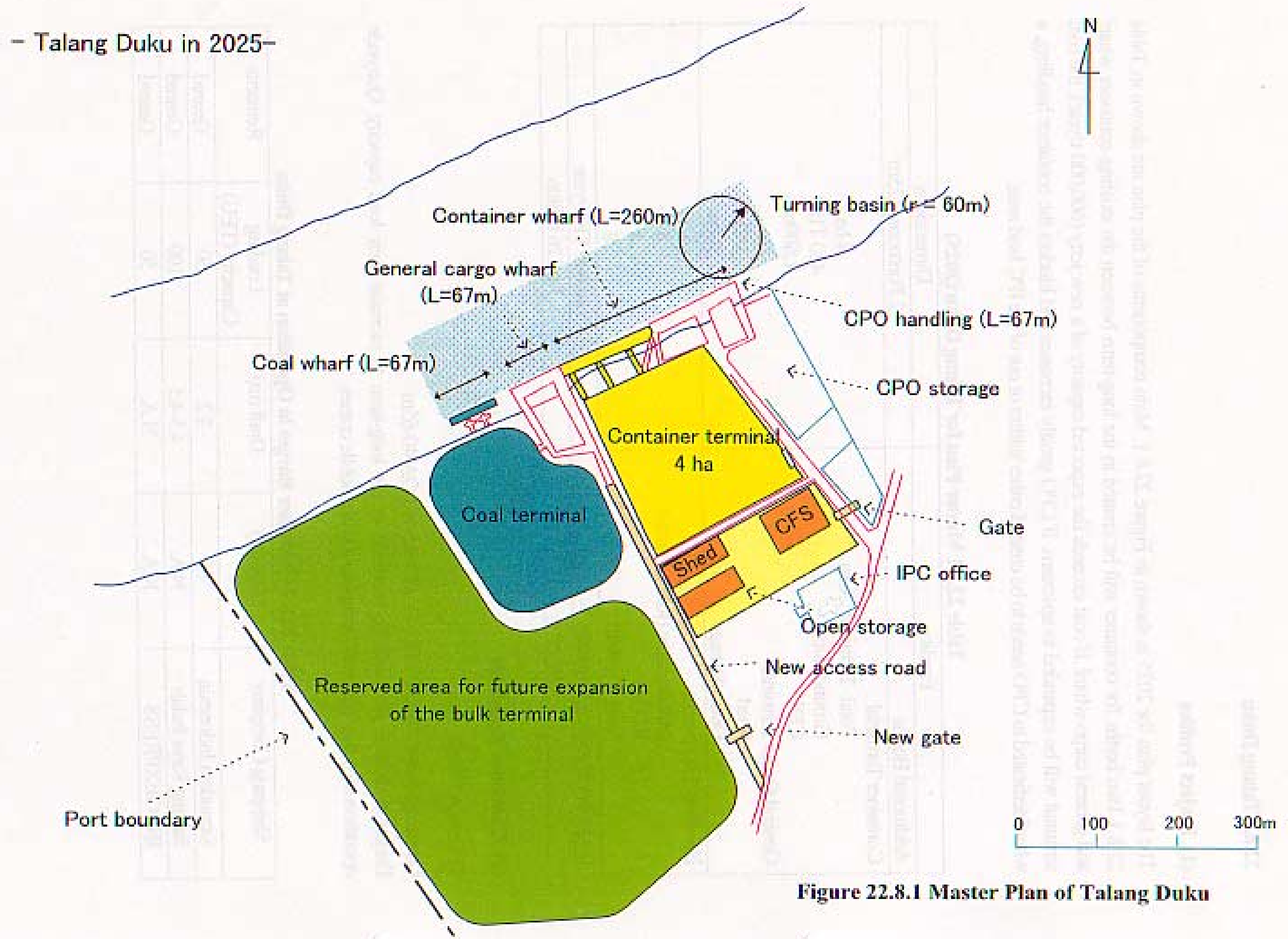


Figure 22.8.1 Master Plan of Talang Duku

Table 22.8.3 Typical Dimensions of Barges (without a gear)

Bay	LOA (m)	3 Boxes Across	4 Boxes Across	5 Boxes Across
		B = 10-11m	B = 13.5-14.5m	B = 17-18m
5	34-39	30TEU (2tiers) 45TEU(3tiers)	40TEU (2tiers) 60TEU(3tiers)	50TEU (2tiers) 75TEU(3tiers)
6	41-46	36TEU (2tiers) 54TEU(3tiers)	48TEU (2tiers) 72TEU(3tiers)	60TEU (2tiers) 90TEU(3tiers)
7	48-53	42TEU (2tiers) 63TEU(3tiers)	56TEU (2tiers) 84TEU(3tiers)	70TEU (2tiers) 105TEU(3tiers)
8	55-60	48TEU (2tiers) 72TEU(3tiers)	64TEU (2tiers) 96TEU(3tiers)	80TEU (2tiers) 120TEU(3tiers)

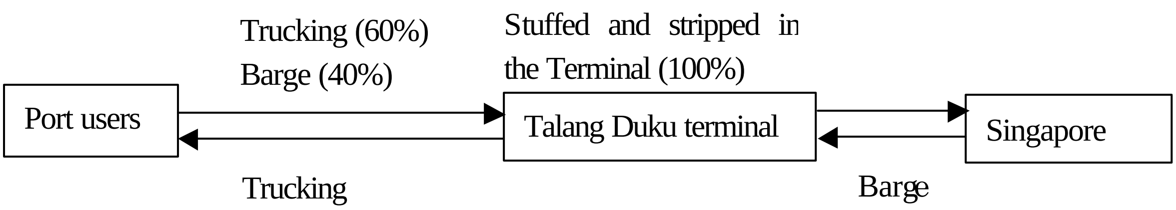
Draft is 2.5 m (2 tiers) or 3.5m (3 tiers).
LOA of a geared barge is 5m longer than this.

2) Terminal

The area for the proposed container terminals can be estimated with the following formulas.
Container Terminal Area = (Container yard area) / (Yard area ratio) = 3 ha
Container Yard Area = (Ground slots) / (Land use ratio) = 1.8 ha
Ground Slots = (Container volume) × (Dwelling time) / (Yard operation ratio) / 365 / (Stacking height) =405 TEUs
where:
Yard area ratio: 0.6 (CFS within the terminal)
Land use ratio: 300 TEU / ha
Dwelling time: 5 days
Yard operation ratio: 0.6
Stacking height: 4
Container volume: 71,000 TEU/year

3) CFS

Currently, most of the containers through Talang Duku are stuffed and stripped in the terminal (See the diagram below). Although those works are now carried out outdoors, a CFS will be needed in future. The area for the proposed container terminals can be estimated with the following formulas. In order to efficiently carry out the stuffing and stripping of containers, CFS should be located on dock.



S = (W x D x p) / (w x r x T)
where:

W: cargo volume for CFS (ton) = (container cargo volume) × (CFS cargo ratio)
D: average dwelling time (days)
p: peak ratio
w: average stacking weight in CFS (ton/m^2)
r = effective use ratio of floor area in CFS
T: annual operating days (days/year)
These parameters are assumed as follows:
W = 10,000TEU x 10t/TEU x 0.05 = 5,000t (in 2007)
= 71,000TEU x 10t/TEU x 0.05 = 35,500t (in 2025)
D = 5 days, p = 1.5, w=1.0, r = 0.6, T = 300 days, CFS cargo ratio = 0.05
On the above assumptions, S is calculated as follows:
S = 210 m^2 (in 2007)
S= 1,480 m^2 (in 2025)

Since the existing warehouse (2,040m^2) is underutilized, additional CFS will not be needed in the short-term. After the existing warehouse is demolished to make room for container handling, A CFS needs to be constructed at an appropriate site. Assuming the depth of CFS as 40m and the width of a bay as 8m, the actual area will be 1,600m^2.

4) Handling Equipment

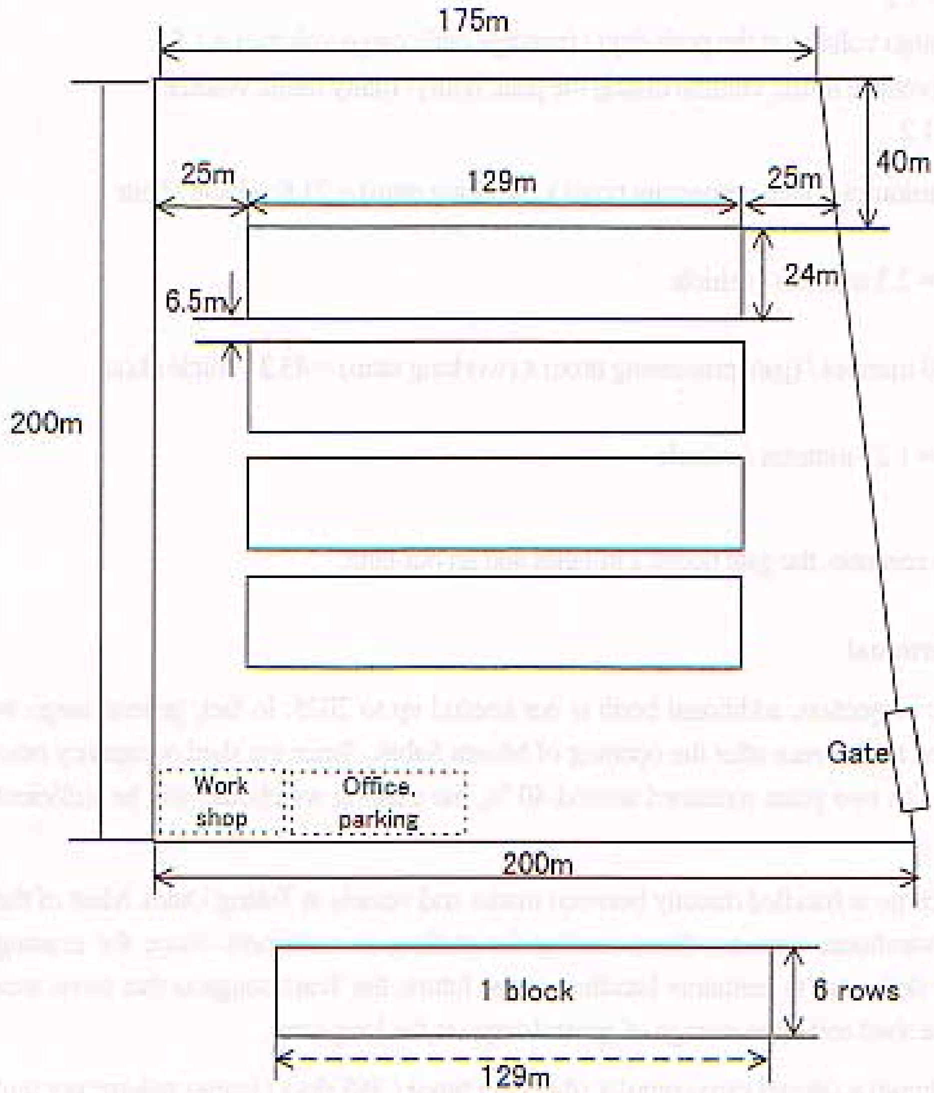
Taking into account the following factors, combination of yard tractors (quayside operation) and RTGs (yard operation) is recommended.

a. Small Throughput
b. Small Terminal Area
c. Steep Slope between the Wharves and Terminal
d. Phased Investment

In order to improve the low quayside productivity (7 TEUs/hour by a ship gear operation), mobile cranes will need to be introduced. Number of yard tractors (for quay-side operation) is estimated with the following formulas:
Yard Tractors = (number of crane) x (crane productivity)/(tractor productivity)
= 7 (in 2025)
where,
(Crane productivity) =10 TEU/hour
(Tractor productivity) = 6 TEU/hour

5) Gate

The Study Team carried out a simplified calculation with the following formula to identify traffic volume of container cargo:
(Traffic volume) = (Annual cargo handling volume) x (20ft container + 40 ft container)/ (20ft container + 2 x 40ft container) x β/12 x γ/30 x σ/12 = 32 vehicles/hour/each way



<u>Talang Duku Container Terminal</u>
RTG: 4 units (1 over 4 operation)
Ground slots: 480 TEUs

where:
(Annual cargo handling volume)=71,000 TEU
(20ft container + 40 ft container)/ (20ft container + 2 x 40ft container) = 0.9
β : Monthly variation = (cargo volume in the peak month) / (average monthly cargo volume)
= 1.2
γ : Daily variation = (cargo volume in the peak day) / (average daily cargo volume) = 1.5
σ : Hourly variation = (vehicle traffic volume during the peak hour) / (daily traffic volume)
= 1.2

(In-gate capacity) = 60 minutes / (gate processing time) x (working ratio) = 21.6 vehicle / hour
where:
(Gate processing time) = 2.5 minutes / vehicle
(Working ratio) = 0.9
(Out-gate capacity) = 60 minutes / (gate processing time) x (working ratio) = 43.2 vehicle / hour
where:
(Gate processing time) = 1.25 minutes / vehicle
(Working ratio) = 0.9

According to the above scenario, the gate needs 2 in-lanes and an out-lane.

(3) General Cargo Terminal

According to the traffic projection, additional berth is not needed up to 2025. In fact, general cargo in Talang Duku is expected to decrease after the opening of Muara Sabak. Since the shed occupancy ratio at Talang Duku for the last two years remained around 40 %, the existing warehouse will be sufficient up to the target year.

In most cases, general cargo is handled directly between trucks and vessels at Talang Duku. Most of the cargoes stored in the warehouse now are those waiting for stuffing to containers. Since the existing paved area needs to be dedicated to container handling in the future, the Team suggests that some area should be allocated for a shed and open storage of general cargo in the long-term.

Shed Area = (cargo volume) x (stored cargo ratio) x (dwelling time) / 365 days / (cargo volume per unit area) / (shed occupancy ratio) / (net area ratio)= 84,000 x 0.25 x 14 / 365 / 2 / 0.5 / 0.6 = 1,350 m^2

Open Storage Area = (cargo volume) x (stored cargo ratio) x (dwelling time) / 365 days / (cargo volume per unit area) / (yard occupancy ratio) = 84,000 x 0.25 x 30 / 365 / 1 / 0.7 = 2,500 m^2

22.8.3 Muara Sabak

(1) Project Profiles

The layout plan for 2025 is shown in Figure 22.8.2 and 22.8.3. Main components of the plan are shown in Table 22.8.4.Three-four berths for container will be needed depending on the traffic scenarios. One general cargo terminal needs to be added as well. Some area is reserved for bulk cargo handling.

Table 22.8.4 Master Plan for Muara Sabak (2025)

Facility	Base Case	High Public Case
Additional Container Berths	3: 125m/Berth, Draft 6m,	4: 125m/Berth, Draft 6m
Container Terminal		
Total Terminal Area	7.5 ha	10 ha
Ground Slots	753 TEU	1,152 TEU
CFS	2,880 m^2	4,480 m^2
Container Handling Equipment		
Gantry Crane	3	4
Mobile Crane	1	1
RTG	6	8
Yard Tractor	12	16
Reach Stacker	2	2
Container Handling Capacity	154,000 TEU/year	224,000 TEU/year
Additional General Cargo Berths	1	
General Cargo Terminal		
Mobile Crane	3	
Forklift	10	
Shed	3,600 m^2	
Open Storage	6,600 m^2	
Access Channel	Width = 110m, Depth = 6m	
Total Cost	Rp.626 billion	Rp.747 billion

(2) Container Terminals

1) Design Vessel

The Study Team proposes a container vessel with the capacity of 200 TEU as the design vessel so that Muara Sabak can acquire a clear advantage over the existing barge transportation in the Batang Hari River. Since little larger vessels are also expected to call at Muara Sabak at half draft, LOA of the design vessel is determined as 110m (Table 22.8.5).

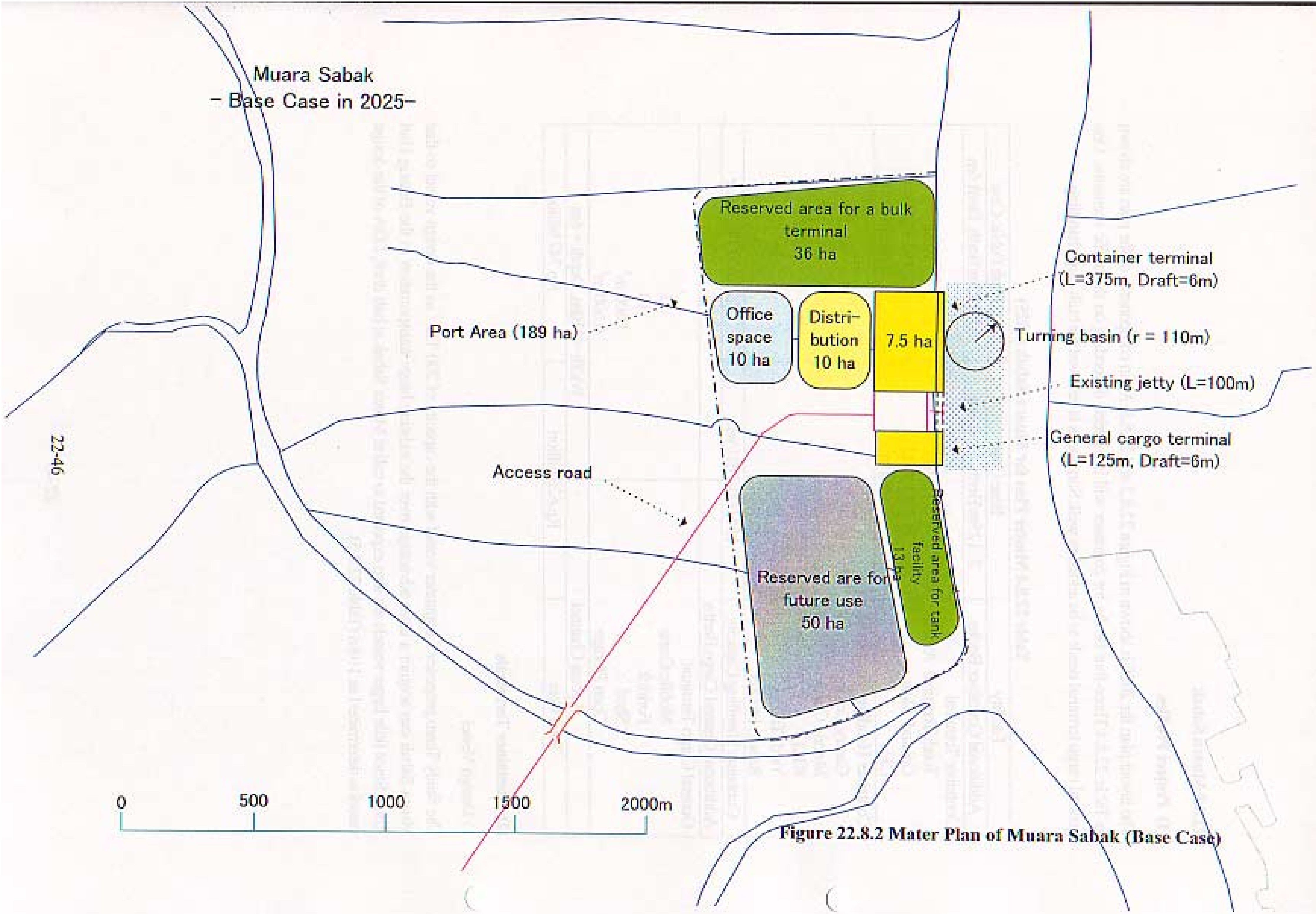


Figure 22.8.2 Mater Plan of Muara Sabak (Base Case)

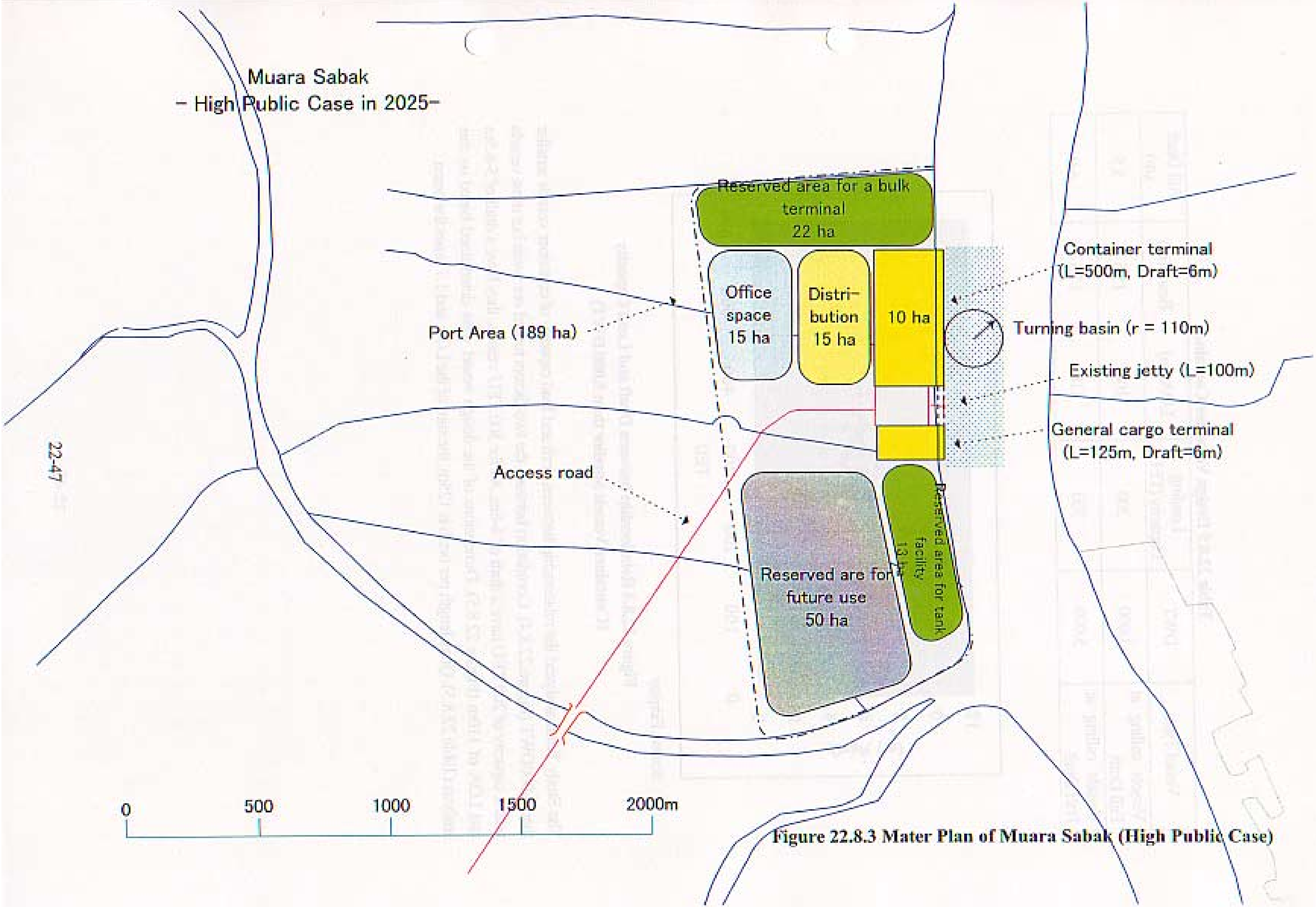
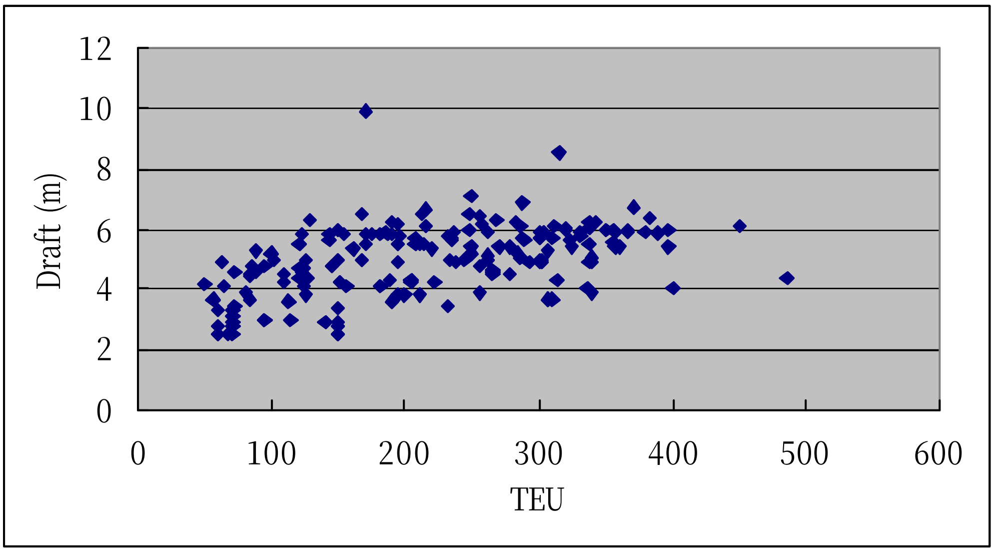


Figure 22.8.3 Mater Plan of Muara Sabak (High Public Case)

Table 22.8.5 Design Vessel for Container

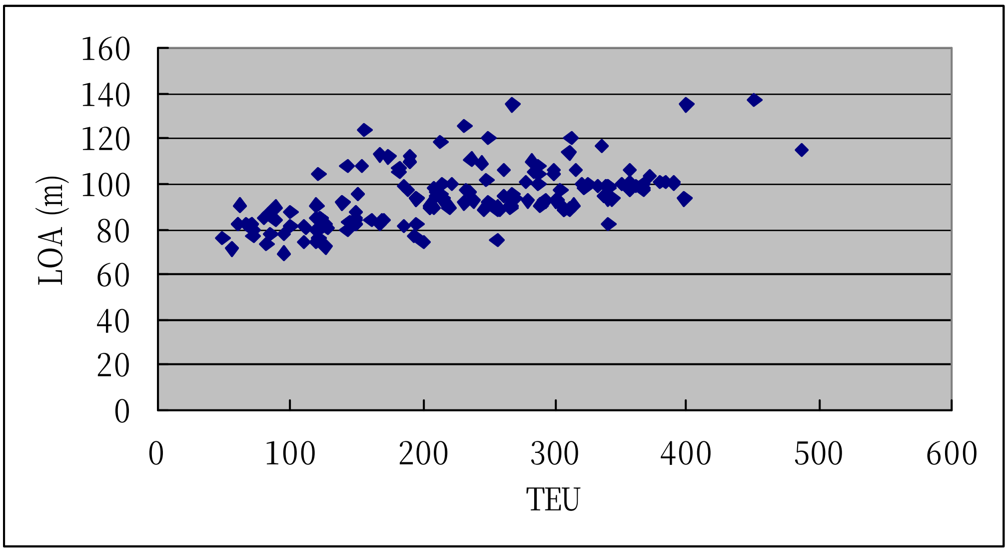
Vessel Type	DWT	Loading Capacity (TEU)	LOA (m)	Beam (m)	Full Draft (m)
Vessels calling at Full Draft	3,000	200	100	15.5	5.5
Vessels calling at Half Draft	5,000	300	110	17.5	6.0



Source: Fairplay

Figure 22.8.4 Relationship between Draft and Load Capacity
(Container Vessels Smaller than 5,000 DWT)

The Study Team analyzed the relationship between draft and load capacity of container vessels smaller than 5,000DWT (Figure 22.8.4). Correlation between the two factors turned out weak but most vessels with a capacity of 200 TEU have a draft of 4-6m. As for 300 TEU vessels, they have a draft of 5-6.5m and LOA of 110m (Figure 22.8.5). Dimensions of the design vessel were determined based on this analysis (Table 22.8.5). Quay length per berth is 125m, the sum of the LOA and 1.7 times the beam.



Source: Fairplay

Figure 22.8.5 Relationship between LOA and Load Capacity (Container Vessels Smaller than 5,000 DWT)

2) Terminal

The area for the proposed container terminals can be estimated with the following formulas.

Container terminal area = (Container yard area) / (Yard area ratio)
= 4.8 ha (Base case), 7.8 ha (High public case)

Container yard area = (Ground slots) / (Land use ratio)
= 2.9 ha (Base case), 4.7 ha (High public case)

Ground slots = (Container volume) x (Dwelling time) / (Yard operation ratio) / 365 / (Stacking height)
= 753 TEUs (Base case), 1,215 TEUs (High public case)

where:

Yard area ratio: 0.6 (CFS within the terminal)

Land use ratio: 260 TEU / ha (RTG system)

Dwelling time: 5 days

Yard operation ratio: 0.6

Stacking height: 4

Container volume: 132,000 TEU/year (Base case), 213,000 TEU/year (High public case)

However, a terminal with a RTG system needs to have a depth of at least 200m. The Team proposes 7.5 ha (Base case) and 10 ha (High public case) for the container terminal area.

3) CFS

Some portion of import/export container will be LCL requiring CFS. The area for the proposed container terminals can be estimated with the following formulas. In order to efficiently carry out the stuffing and stripping of containers, CFS should be located on dock.

$S = (W \times D \times p) / (w \times r \times T)$

where:
W: cargo volume for CFS (ton) = (container cargo volume) × (CFS cargo ratio)
D: average dwelling time (days)
p: peak ratio
w: average stacking weight in CFS (ton/m^2)
r = effective use ratio of floor area in CFS
T: annual operating days (days/year)

These parameters are assumed as follows:
W = 9,000t (Base case in 2007), 13,000t (High public case in 2007)
= 66,000t (Base case in 2025), 107,000t (High public case in 2025)
D = 5 days, p = 1.5, w=1.0, r = 0.6, T = 300 days, CFS cargo ratio = 0.05

On the above assumptions, S is calculated as follows:
S = 380 m^2 (Base case in 2007), 540 m^2 (High public case in 2007)
S= 2,750 m^2 (Base case in 2025), 4,460 m^2 (High public case in 2025)

Assuming the depth of CFS as 40m and the width of a bay as 8m, the actual area will be as follows:
S = 320 m^2 (Base case in 2007), 640 m^2 (High public case in 2007)
S= 2,880 m^2 (Base case in 2025), 4,480 m^2 (High public case in 2025)

4) Handling Equipment

Taking into account the following factors, a RTG system is recommended for the yard operation.

a. Large available area
b. Reliability of equipment
c. The terminal will be open to multiple users
d. The terminal requires high stowing capacity to maximize the operational income

In order to provide a quayside productivity of 20 TEU/hour/berth, each berth needs to have a gantry crane. Each gantry requires two RTG and four yard tractors.

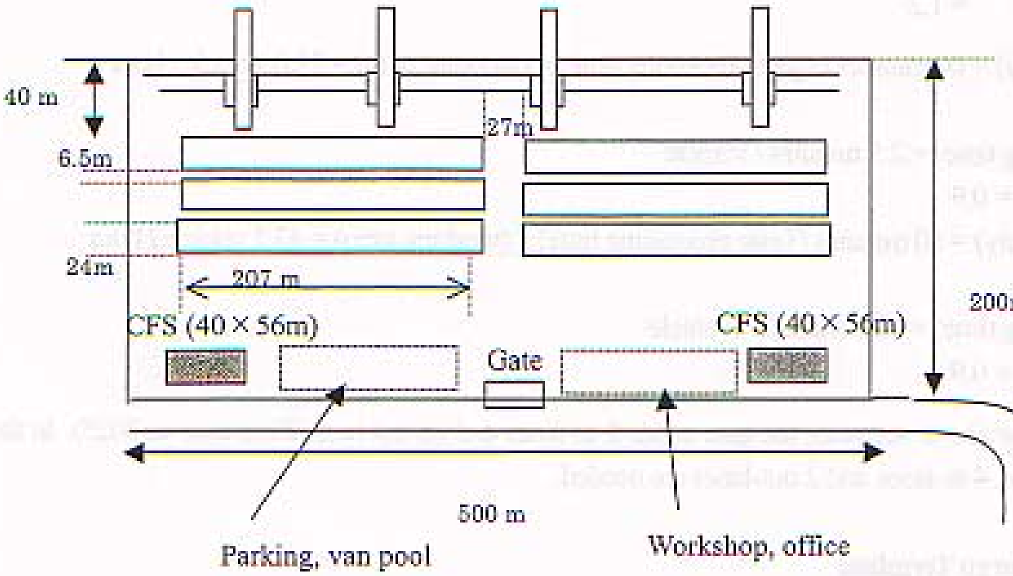
5) Gate

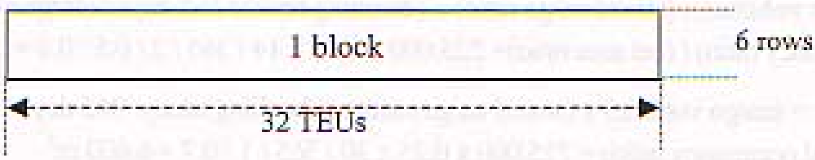
The Study Team carried out a simplified calculation with the following formula to identify traffic volume of container cargo:

(Traffic volume) = (Annual cargo handling volume) x (20ft container + 40 ft container)/ (20ft container + 2 x 40ft container) x β/12 x γ/30 x σ/12

= 44 vehicles/hour/each way (Base case in 2025), 71 vehicles/hour/each way (High public case in 2025)

where:





Muara Sabak container terminal (High Public Case)

- Gantry cranes: 4 units
- RTG: 8 units (1 over 4 operation)
- Yard tractors: 16 units
- Ground slots: 1,152 TEUs (192 TEUs/block)

(Annual cargo handling volume)=132,000 TEU (Base case in 2025), 213,000 TEU(High public case in 2025)

(20ft container + 40 ft container)/ (20ft container + 2 x 40ft container) = 2/3

β : Monthly variation = (cargo volume in the peak month) / (average monthly cargo volume) = 1.2

γ : Daily variation = (cargo volume in the peak day) / (average daily cargo volume) = 1.5

σ : Hourly variation = (vehicle traffic volume during the peak hour) / (daily traffic volume) = 1.2

(In-gate capacity) = 60 minutes / (gate processing time) x (working ratio) = 21.6 vehicle / hour
where:
(Gate processing time) = 2.5 minutes / vehicle
(Working ratio) = 0.9
(Out-gate capacity) = 60 minutes / (gate processing time) x (working ratio) = 43.2 vehicle / hour
where:
(Gate processing time) = 1.25 minutes / vehicle
(Working ratio) = 0.9

According to the above scenario, the gate needs 2 in-lanes and an out-lane (Base case in 2025). In the High public case, 4 in-lanes and 2 out-lanes are needed.

(3) General Cargo Terminal

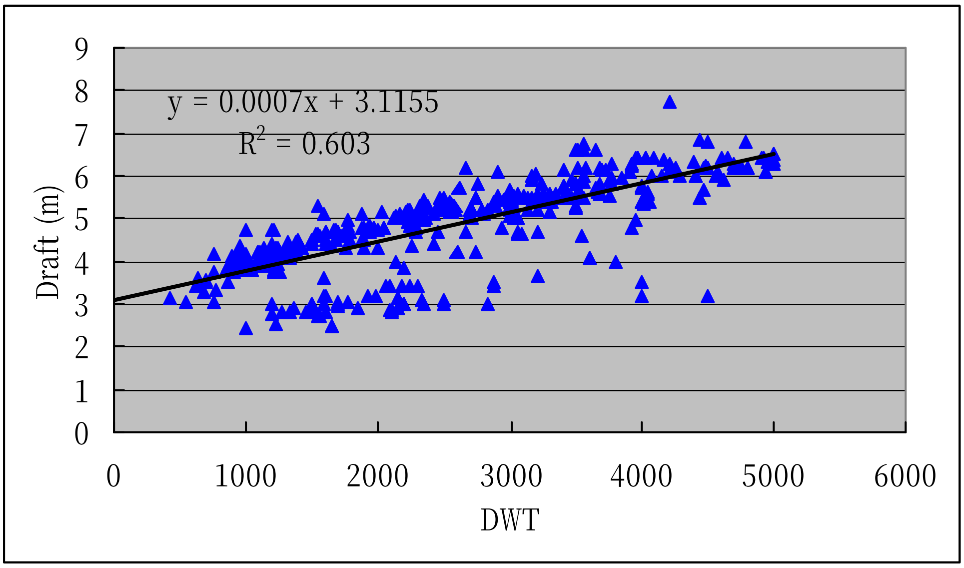
Assuming that a quarter of the cargo will go through sheds and another quarter will use open storage area, the following storage facilities are needed in the long-term.
Shed Area = (cargo volume) x (stored cargo ratio) x (dwelling time) / 365 days / (cargo volume per unit area) / (shed occupancy ratio) / (net area ratio)= 225,000 x 0.25 x 14 / 365 / 2 / 0.5 / 0.6 = 3,600 m^2

Open Storage Area = (cargo volume) x (stored cargo ratio) x (dwelling time) / 365 days / (cargo volume per unit area) / (yard occupancy ratio) = 225,000 x 0.25 x 30 / 365 / 1 / 0.7 = 6,600 m^2

In order to cater for the cargo in 2025 with four gangs, the general cargo terminal requires the following handling equipment:
3 mobile cranes
10 forklifts

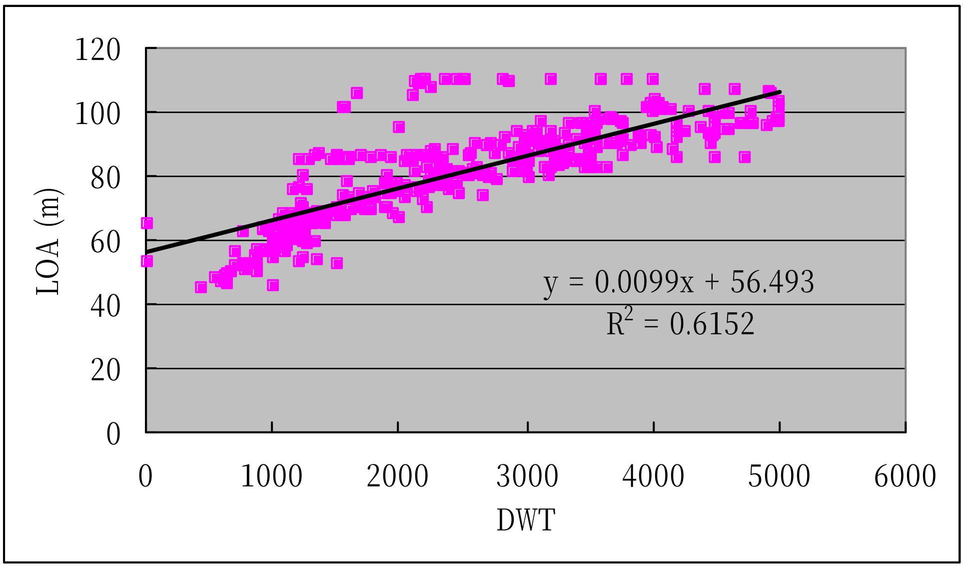
(4) Access Channel

Taking into account the dimensions of container vessels and CPO tankers, the Team proposes the design condition of the access channel as follows:
Width: 110m (1LOA of the design vessel (300 TEU container vessel))
Depth: 6m



Source: Fairplay

Figure 22.8.6 Relationship between DWT and Draft of Small Chemical Tankers



Source: Fairplay

Figure 22.8.7 Relations hip between DWT and LOA of Small Chemical Tankers

The Study Team examined the economic impacts of different types of vessels on the transportation costs. Assuming the ship costs given in Section 22.5 and the project costs, ordinary vessels requiring the depth of 6m turned out the most economical alternative for Jambi (Table 22.8.6).

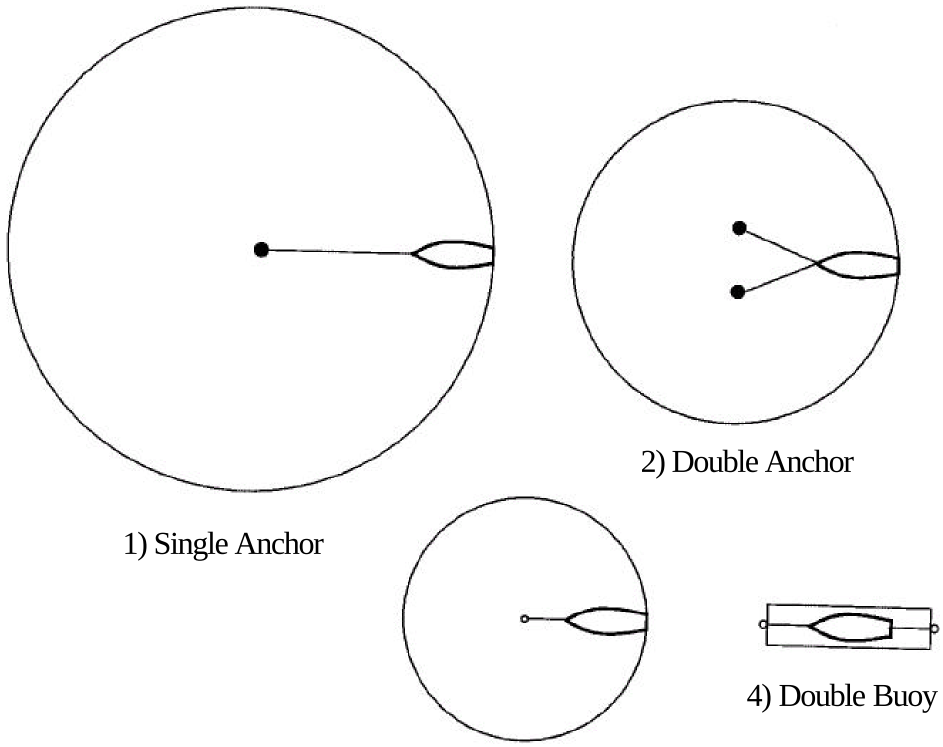
Table 22.8.6 Economic Implication of Ship Types

Costs	Ordinary Vessel requiring 6m Draft	Ordinary Vessel requiring 4.5m Draft	Shallow Draft Vessel requiring 4.5m Draft
Per TEU Transportation Cost (1,000 Rp.)	1,306	2,100	1,677
Container Throughput in 2025 (Base Case) (TEU)	132,000	132,000	132,000
Container Throughput in 2025 (High Case) (TEU)	213,000	213,000	213,000
Transportation Cost in 2025 (Base Case)	172,392,000	277,200,000	221,364,000
Transportation Cost in 2025 (High Case)	278,178,000	447,300,000	357,201,000
Annual Maintenance Dredging Cost (1,000 Rp.)	14,300,000	5,005,000	5,005,000
Total Annual Cost (Base Case)	186,692,000	282,205,000	226,369,000
Total Annual Cost (High Case)	292,478,000	452,305,000	362,206,000
Annual Benefits over the Scenario developing Ordinary Vessels requiring 4.5m Depth			
Base Case (1,000 Rp./year)	95,513,000	0	55,836,000
High Case (1,000 Rp./year)	159,827,000	0	90,099,000
Annual Benefits over the Scenario developing Ordinary Vessels requiring 4.5m Depth			
Base Case (1,000 Rp./TEU)	724	0	423
High Case (1,000 Rp./TEU)	750	0	423

22.8.4 Anchorage and Port Working Area

(1) Type of Anchoring

When anchoring is needed, vessels take various patterns to secure traction.



3) Single Buoy

(2) Area of Anchoring

The area needed for anchoring is different depending on the anchoring pattern (Table 22.8.7, 22.8.8)

Table 22.8.7 Anchoring Area

Type of Anchoring	Conditions of Sea Bed and Winds	Radius of Anchoring Area per Vessel
Single Anchor	Strong Traction	L + 6D
	Poor Traction	L + 6D + 30m
Double Anchor	Strong Traction	L + 4.5D
	Poor Traction	L + 4.5D + 25m

L: LOA (m), D: Water depth

Table 22.8.8 Buoy Anchoring Area

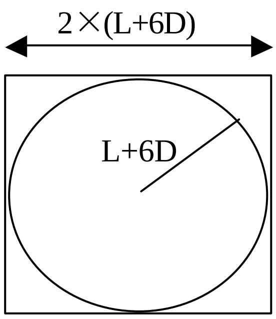
Type of Buoy	Anchoring Area per Vessel
Single Buoy	A Circle (L + 25m) in Radius
Double Buoy	A (L+50m)-by-L/2 Rectangular

L: LOA (m)

(3) Anchoring Area for Batang Hari River and Tungkal River

Currently, timber is transshipped from barges to large vessels of up to 40,000 DWT at the outer bar of Batang Hari River. Transshipment is carried out off the river mouth of Tungkal River as well, though it is between smaller vessels. This practice will continue well into the target year, requiring an anchorage at the two locations. The required area is estimated as follows:

Batang Hari River



Average of anchoring vessels at the outer bar = 4.5
Peak ratio = 1.5
Radius of the anchoring area per vessel = L+6D
L = 200m D = 12m (for 40,000 DWT vessels)
L+6D = 272m
A 544m-by-544m square is needed for one anchoring vessel.
Anchoring area = 4.5 x 1.5 x 544 x 544 = 2,000,000m^2 = 2 km^2

Tungkal River

Average of anchoring vessels at the outer bar = 3.9
Peak ratio = 1.5
Radius of the anchoring area per vessel = L+6D
L = 140m D = 8m (for 10,000 DWT vessels)
L+6D = 188m
A 376m-by-376m square is needed for one anchoring vessel.
Anchoring area = 3.9 x 1.5 x 376 x 376 = 827,000m^2 = 0.8 km^2

Taking into account the bathymetry, the Study Team proposes anchorage areas as shown in Figure 22.8.8. The proposed areas are circles 2km in radius, significantly larger than the results of the above calculations.

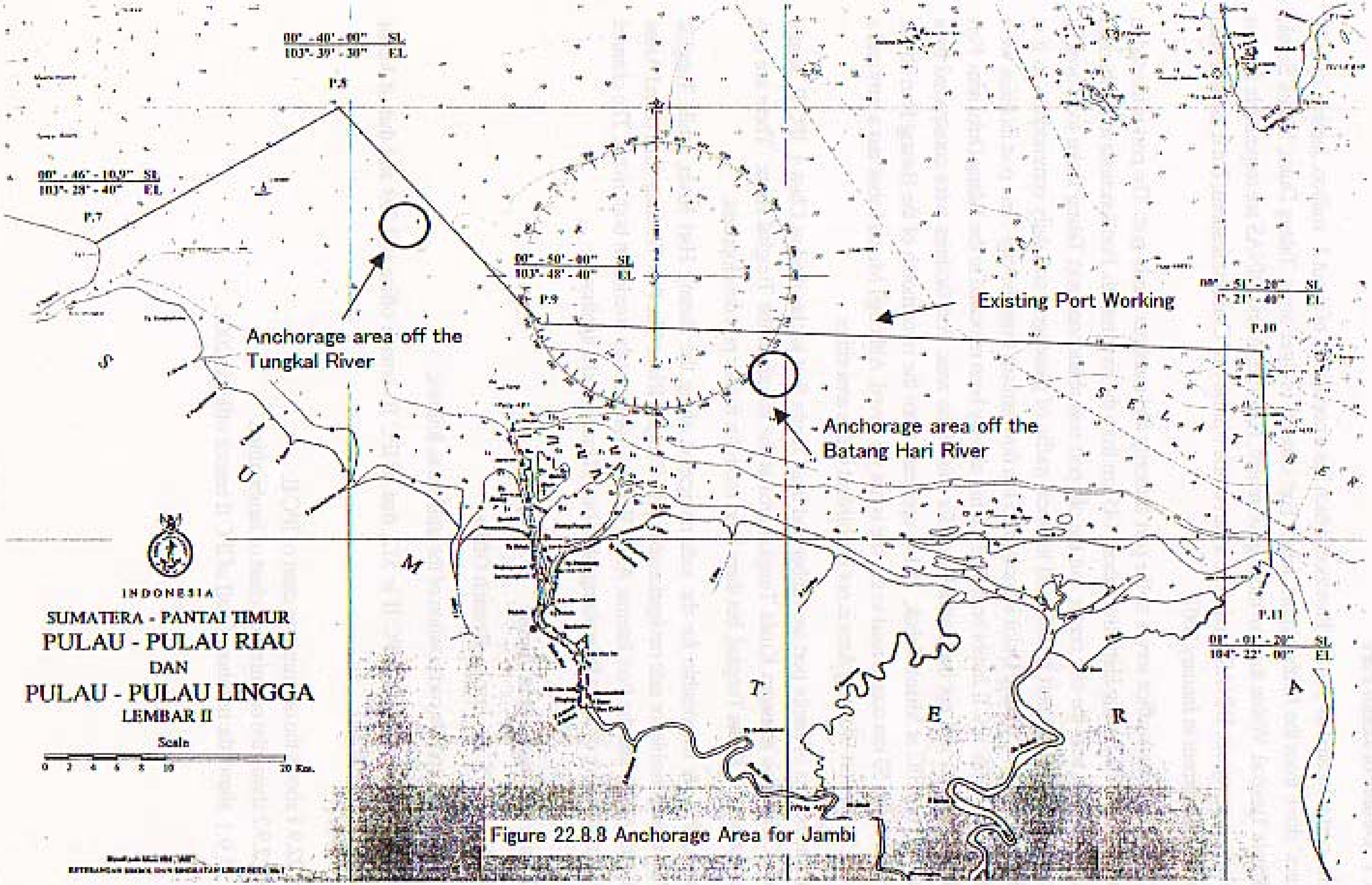


Figure 22.8.8 Anchorage Area for Jambi