CHAPTER 3 IMPROVEMENT PLAN OF NAVIGATION CHANNEL AND BASIN

3. IMPROVEMENT PLAN OF NAVIGATION CHANNEL AND BASIN

3.1 Nautical and Operational Aspects of Existing Port

The near-shore waves off the port are comparatively mild throughout the year. The predominant directions of waves to the port are in the range of 310 degree N to 30 degree N. The existing breakwaters protect the port against those waves, except in its eastern part, where parts of the breakwater are almost submerged during high tides due to settlement/ collapse of the structure. The currents in and around the port entrance are rather weak, resulting in no significant maneuvering problem for incoming/outgoing ships.

The port has two entrances, a western entrance and an eastern entrance. The east entrance is heavily silted and very shallow (around -5 m), and only small ships like fishing boats and tug boats are sailing in and out. The western entrance, with a water depth of 14 m and the channel width of 150 m, serves as a main entrance of the Port. Through the western entrance, two-way traffic is permitted to vessels shorter than 150 m in LOA, equivalent to 15,000 DWT in size.

The anchorage areas, which are located on the west and the east of the outer channel, extend from the vicinity of the port entrance to the offshore area where a pair of outermost navigation buoys is installed. Both anchorage areas are divided into several anchorage zones to accommodate several ship groups individually. The anchorage for large-sized domestic shipping freighters is located in the most offshore area to the east of the outer channel, and that for small-sized ships like tug boats in the most near-shore area to the west of the channel. All the zoning plans of anchorage are shown in Figure 3.1.1.

There are seven pilot boats, and 18 tug-boats that have the maximum capacity of 3,300 hp. The pilot service is operated by 30 pilots under two-shift operation, one from early morning to 18:00 and the other until early morning. The maximum ship allowed to enter the Port is limited, in principle, to less than 300m in LOA. In the meantime, the maximum ship size ever recorded to call in the Port was 325 m in LOA.

Photo 3.1.1 Port Entrance Area

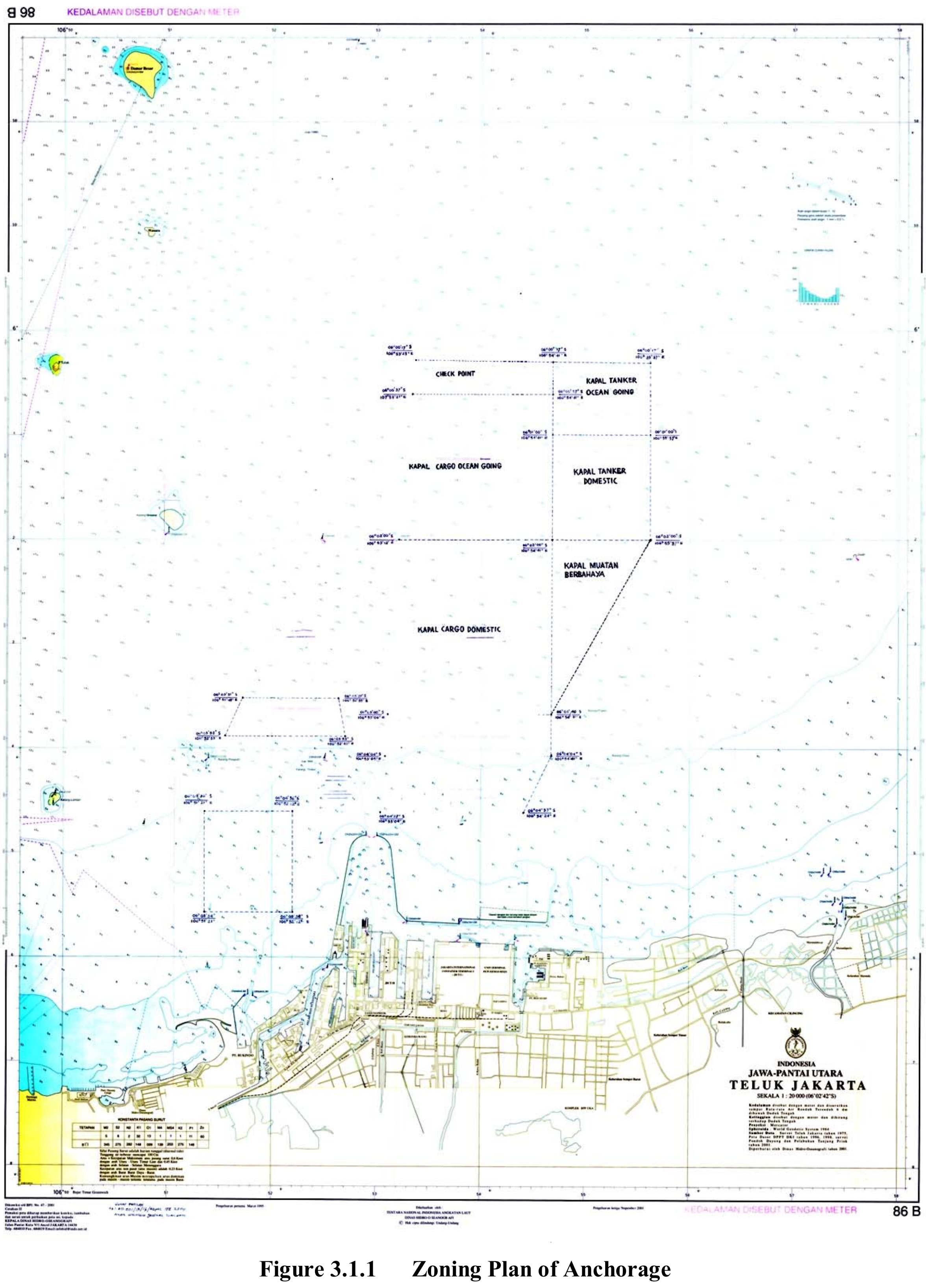


Figure 3.1.1 Zoning Plan of Anchorage

3.2 Ship Maneuvering Patterns

Generally, a pilot boards the ship 1.5 miles off the port entrance. Two tug boats stand by immediately offshore of the port entrance. For larger ships and under stormy sea condition, three tugs are occasionally employed (the third tug on the starboard quarter). A ship sails at 6-7 knots in the outer channel, and gradually speeds down to 3-4 knots near the port entrance. A forward-tug and back-tug are sailing with lines.

After passing the port entrance, she turns off main engine. Chiefly controlled by tugs' power, larger sized ships make a 180-degree turn in front of the Slipway I, and medium-small sized ships in front of Slipway II and III. On completion of their turnings, they are towed back to their quays for berthing. All ships, in principle, are berthed on the portside. Nevertheless, with advanced approval from the terminal, a ship can be berthed starboard side as well.

Several maneuvering patterns of in-coming ships in the port are illustrated in Figure 3.2.1, 3.2.2, 3.2.3 and 3.2.4. The sailing time from the port entrance to the berthing position averages about 1 hour 15 minutes to 1 hour 30 minutes.

A ship, when passing through a pair of offshore buoys, sails with an approaching bearing of 181-degree. In stormy weather when beam currents and high waves occur, she frequently speeds up to 9-10 knots with a radar angle of 10 degrees to maintain her steady approaching position. In this ship handling, she sails in directly up to deep inside the port without gradual maneuvering to the east, which generally takes place by tug assistance.

In order to guide approaching ships to the port, a pair of leading towers/lights is installed onshore. The front tower is located near "D101" and the rear tower near "GD 107", both of them situated in Pier-II facing "PELABUHAN SATU". There is a powerful lighting object near the rear tower, which is the night-illumination of "TANJUNG PRIOK PORT" that is mounted on the roof of the IPC-II building. It is so bright that the existing leading lights do not function well. Most of ships approaching the port prefer the illumination lights for their positioning.

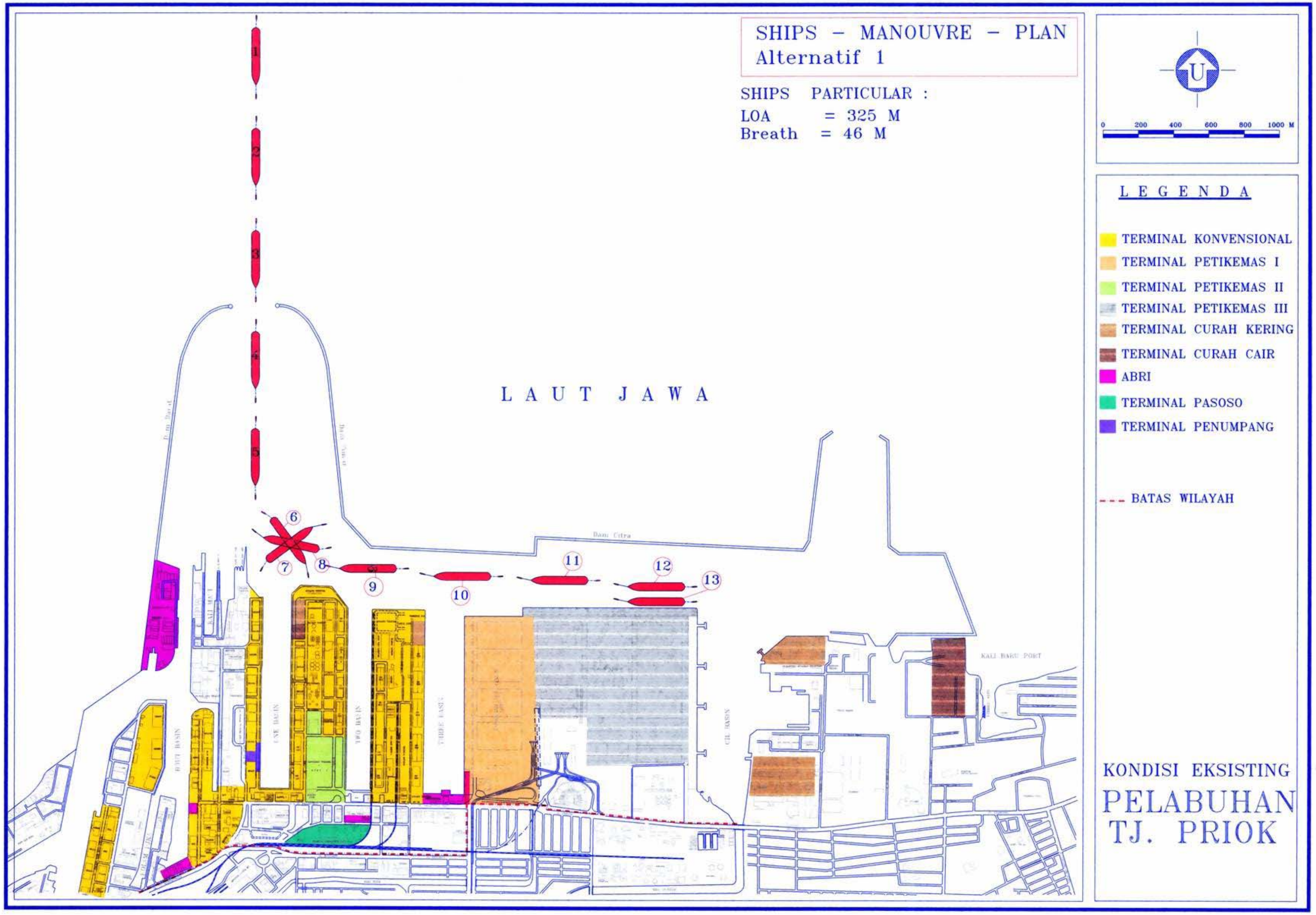


Figure 3.2.1 Ship Maneuvering Pattern (Alternative I)

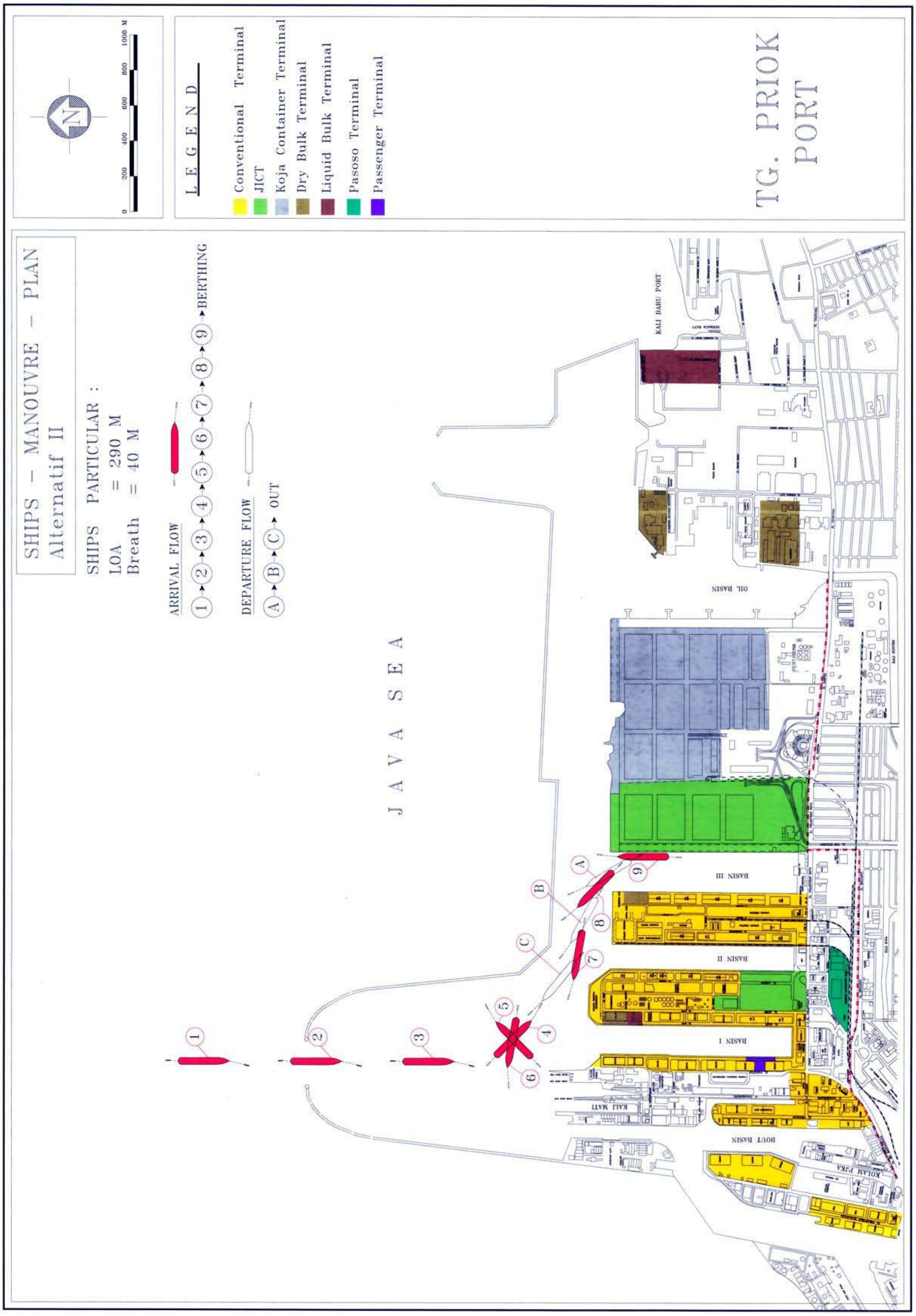


Figure 3.2.2 Ship Maneuvering Pattern (Alternative II)

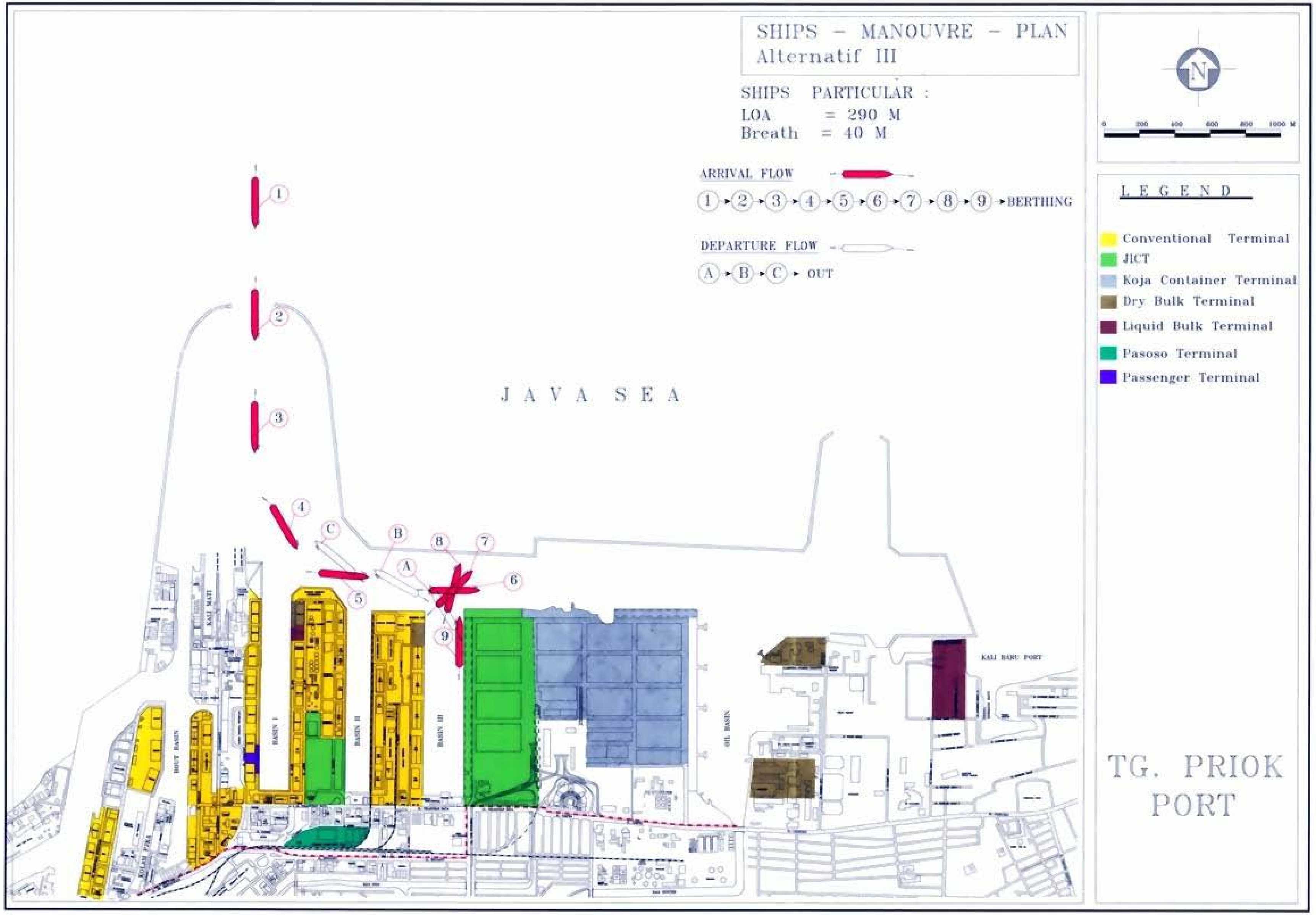


Figure 3.2.3 Ship Maneuvering Pattern (Alternative III)

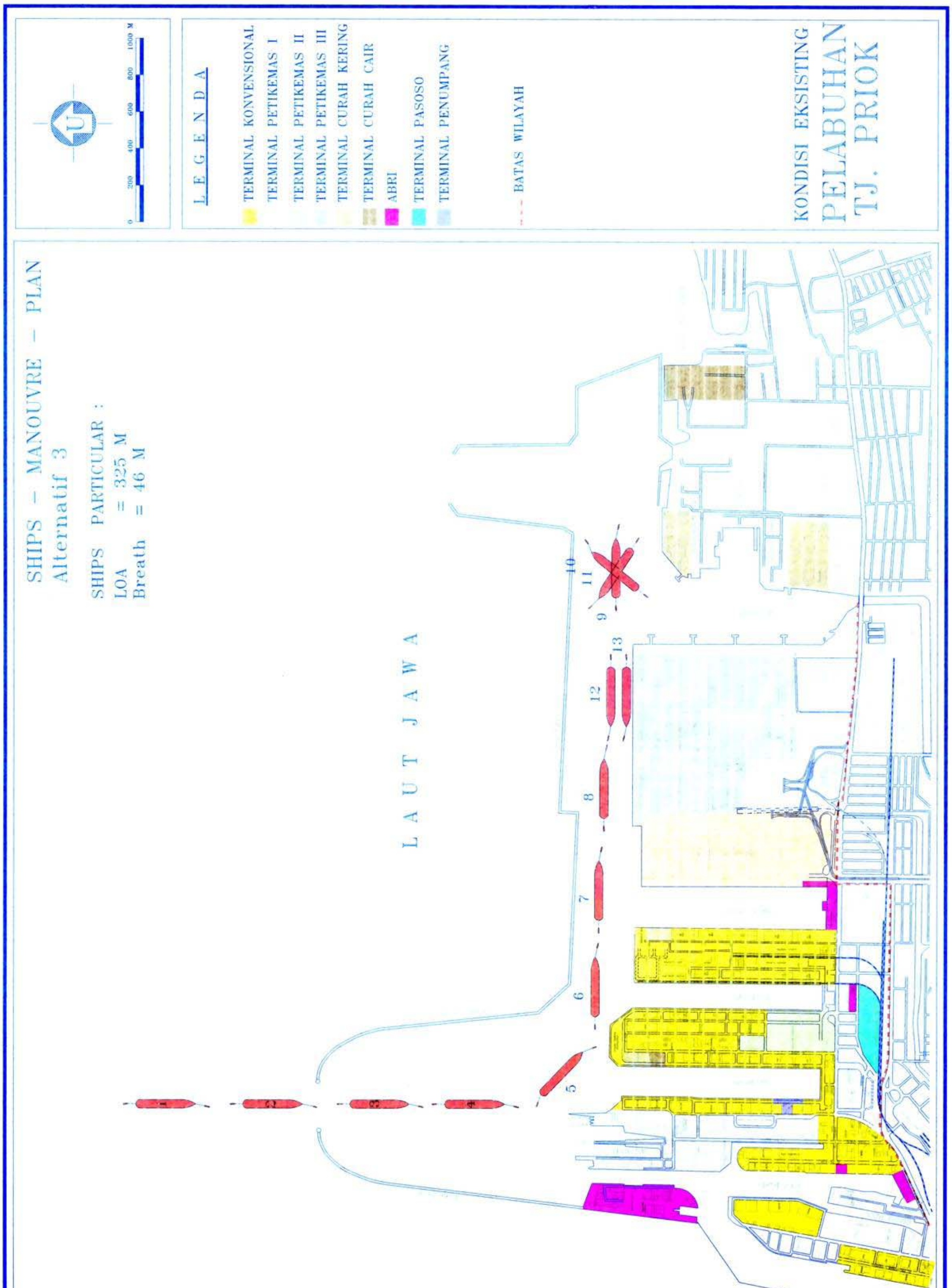


Figure 3.2.4 Ship Maneuvering Pattern (Alternative IV)

3.3 Planning Criteria for Channel/Basin Improvement

In the Feasibility Study of JICA, the maximum size of ships calling at the port was determined as the container ship of 50,000 GT, whose particulars are 280m in LOA (length of overall of vessel), 32.7 m in beam and 12.7 m in draft. To receive this size of vessel, the basic space requirements of the navigation channel and basin was determined in accordance with the international standards, including PIANC.

To allow two-way traffic of 50,000 GT vessels, the navigation channel was set at 300 m (9.17 times as large as beam) in width and 14 m (1.1 times of draft) in depth. It is understood that the channel width is quite sufficient in international standard, and the water depth requirements are reasonable, considering local natural conditions, so that in the Detailed Design, these key dimensions have been followed.

The alignment of the navigation channel in the bending portion was determined, following the recommendations stipulated in "Technical Standards and Commentaries for Port and Harbor Facilities in Japan". It suggests that the intersection angle of channel centerlines at a bend should not exceed approximately 30 degrees. When the angle exceeds 30 degrees, the centerline at the bend should be made as an arc having the radius of curvature larger than four times LOA.

It also recommends that the turning circle, with tug assistance, should be of a diameter of two times of LOA.

3.4 Improvement of Channel and Basin

The improvement plan of the channel and basin has been developed, satisfying the planning criteria mentioned above, and also considering valuable advice from the Pilot Office of the Tanjung Priok Port. The basic approach in setting out the alignment of channel and basin can be summarized below.

3.4.1 Orientation of Channel

(1) Initial Plan

At present, the outer channel (outside the breakwater) is aligned with the bearing of 181 degrees. In the meantime, the inner channel has the bearing of 177 degrees. In consultation with the Pilot Office, it has initially been determined that the navigation channel would be aligned in a straight line entirely from the outer channel to the inner channel with the orientation of due north (0-180 degree). A general plan of the initial proposed navigation channel is shown in Figure 3.4.1.

A simple straight line will provide an easier approach when steering the ship even under stormy weather, and the stopping distance under these conditions can be well secured, about 1000 m, (about 3.5@LOA) inside the breakwater and more than 2000 m (about 7@LOA) including a part of the outer channel portion.

The centerline of the navigation channel set out as above will run on the tip of the western arm of the existing breakwater "Dam Barat". In this way, most of the existing 150 m wide navigation channel will serve as the eastern half of the new 300 m wide channel. This channel alignment will also provide an advantage that most of the dredging work in the western half of the channel will be carried out without interruption to the ongoing traffic, and ensures safe sea traffic movements in to and out of the port.

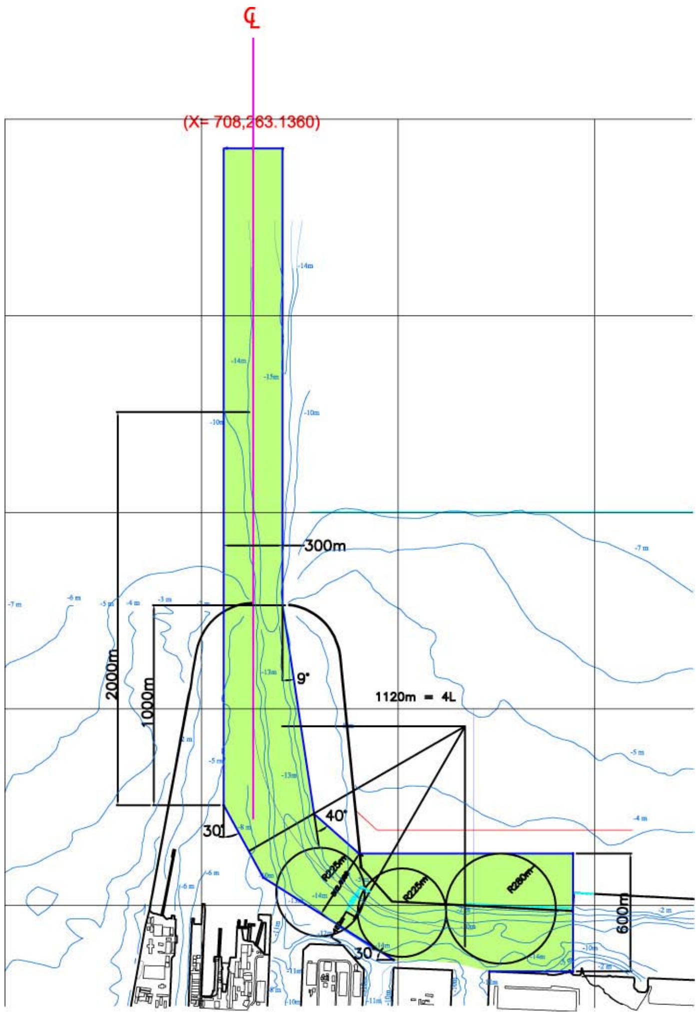


Figure 3.4.1 Initial Proposed Navigation Channel and Basin Plan

(2) Final Plan

In the Basic Design, the orientation of the outer navigation channel was set at the direction of due north with the centerline of the channel passing over the tip of the existing breakwater "Dam Barat". Under this condition, the shoreward extension of the centre line of the channel will travel over the shipyard, which means that the beam of the leading lights discharged from the leading tower will pass over the shipyard. The geographical relationship of the channel and the shipyard is shown in Figure 3.4.2.

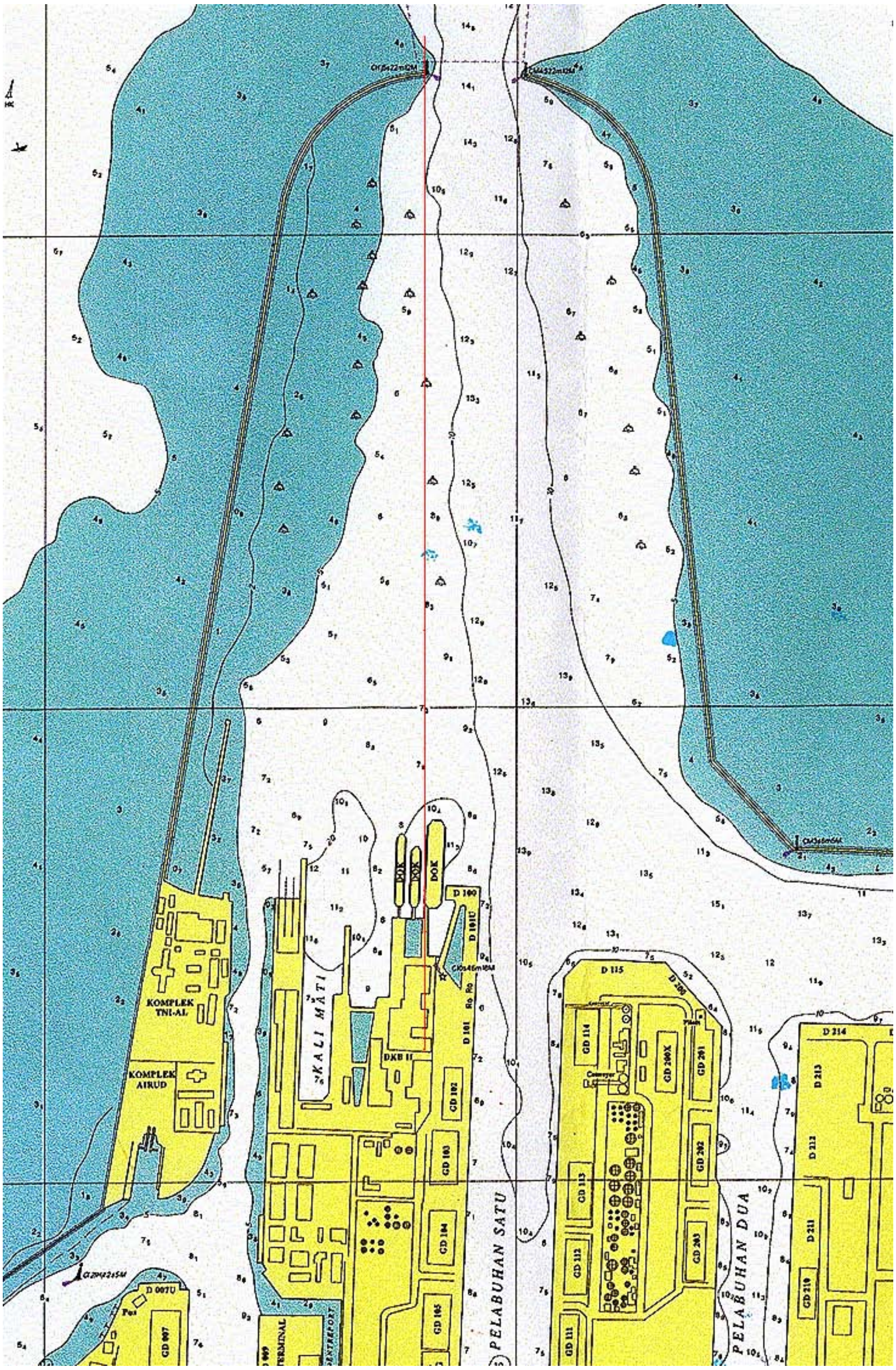


Figure 3.4.2 Position of Shipyard and tip of Dam Barat (existing breakwater)

The existing shipyard consists of three floating docks, named DOK III, DOK IV and DOK V. The outline dimensions of these docks are illustrated in Figure 3.4.3. The largest one is DOK IV, which is located in the east side and it can receive to maximum load of 20,000 DWT. The maximum ship occasionally docking in is a passenger ship, one of them named "KM RINJANI". The ship particulars of KM. RINJANI are 144 m in LOA, 24 m in beam, 5 m (6.5 m) in draft and 10.8 m in depth.

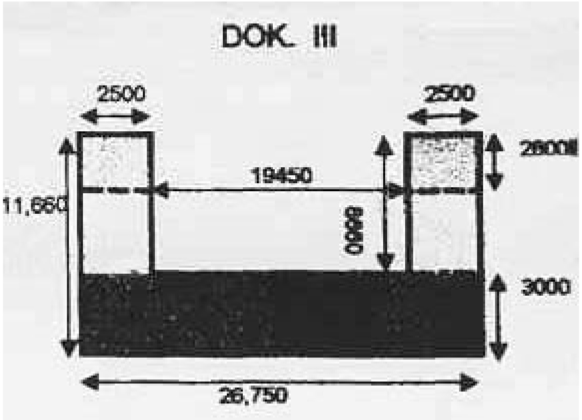
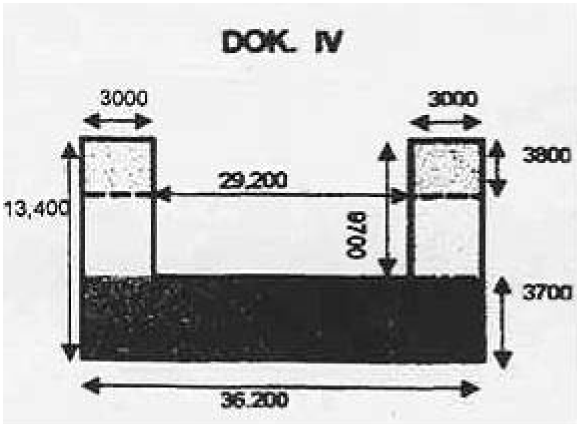
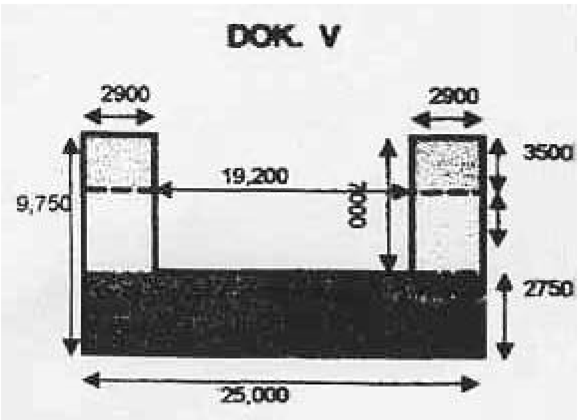
	DOK III Length =130.00 m Outside Width =26.75 m Inside Width =19.45 m Overall Height =11.66 m Height of Pontoon =3.00 m Safety Deck to Top Deck =2.80 m Number of Pontoon =7 Initial Capacity =6.000 TLC Current Capacity =4.000 TLC Maximum Draft =4.50 m
	DOK IV Length =165.618 m Outside Width =36.20 m Inside Width =29.20 m Overall Height =13.40 m Height of Pontoon =3.70 m Safety Deck to Top Deck =3.80 m Length of each Pontoon =22.809 m Number of Pontoon =7 Initial Capacity =12.000 TLC Current Capacity =10.000 TLC Maximum Draft =5.50 m
	DOK V Length = 100.00 m Outside Width = 25.00 m Inside Width = 19.20 m Overall Height = 9.75 m Height of Pontoon = 2.75 m Safety Deck to Top Deck = 3.50 m Length of each Pontoon = Number of Pontoon = 4 Initial Capacity = 3.500 TLC Current Capacity = 3.200 TLC Maximum Draft = 5.00 m

Figure 3.4.3 Floating Dock Data

When KM. RINJANI is docked and repaired, top elevation of her furnace is 37.5 m above the sea level. (When berthing, it is 35 m – 5 m = 30 m above the sea level). In addition to the floating docks, stationary lifting cranes are also in operation at the shipyard. The tower height of the cranes is about 30 m, and the jib cranes swing at the maximum elevation of 10 m above the tower, so that the top elevation of the jib cranes is 41.5 m plus, including the pier height of 1.5 m above the sea level. The height obstructions are illustrated in Figure 3.4.4.

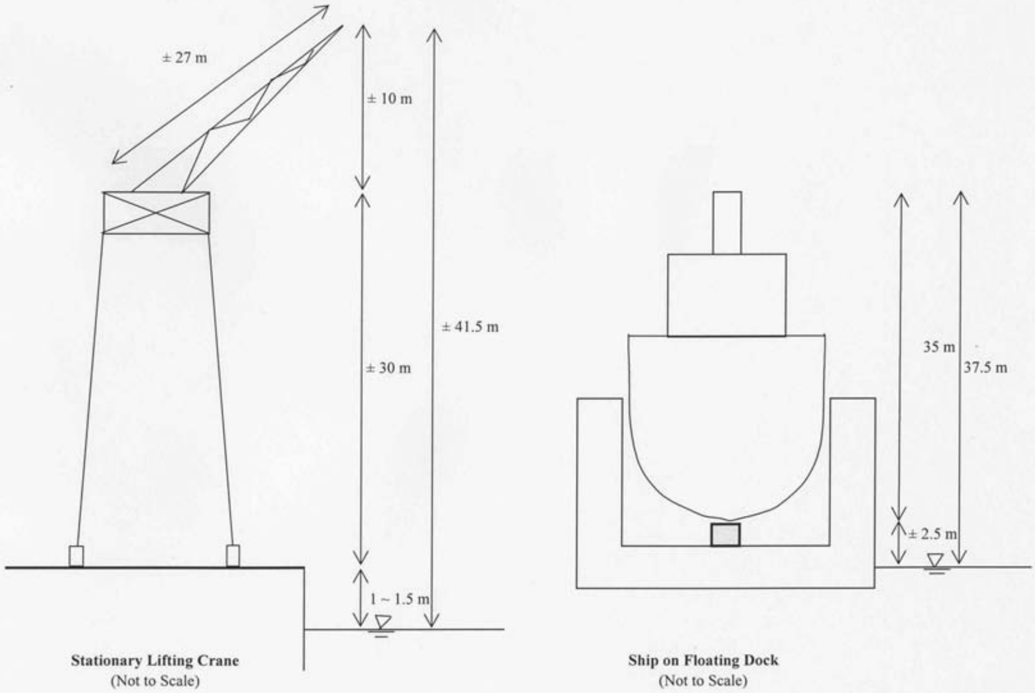


Figure 3.4.4 The Height Obstruction of Dockyard Facilities

The above high-standing structures pose a serious height obstruction for the beam of light. The existing leading tower is located at the elevation of 44 m for the rear and 22 m for the front. This kind of height combination will not be effective, requiring much higher elevation on both towers. In order to avert this vertical alignment problem of beam light, another solution would be that the channel orientation is to be slightly modified.

To avoid the passage of the beam light over the shipyard, comparative study on the orientation of the outer channel has been conducted. The change of the bearing from 360°, either to 357 ~ 358° (westward) or 2 ~ 3° (eastward) can clear the location of the shipyard. Therefore, both alternatives have been studied in terms of the dredging requirements.

As shown in Table 3.4.1 and Figure 3.4.5, the eastward shift of the outer channel can save the dredging volume about 1.7 ~ 3.4 %, compared to the original plan of due north direction, because this channel orientation more follows the existing channel alignment. On the contrary, the westward shift causes additional 2.6 ~ 3.9 % increase in dredging volumes. In terms of economy of the project, 3° eastward orientation will have an advantage. As such, the orientation of the navigation channel has been set at 3° east as shown in Figure 3.4.6.

Table 3.4.1 Volume of Dredging for Access Channel and Basin

Unit : m^3

Area	Original Due North	357° Westward	3° Eastward	358° Westward	2° Eastward
A-1	50,852	179,139	31,000	130,388	16,585
A-2	1,231,260	1,543,757	795,000	1,441,585	1,064,346
B	2,411,982	2,298,994	2,547,000	2,336,284	2,470,377
C	4,668,094	4,668,094	4,705,000	4,668,094	4,668,094
Total	8,362,188	8,689,984	8,078,000	8,576,351	8,219,402
Deviation Against Original	0	+ 327,796 (+ 3.9 %)	- 284,188 (- 3.4 %)	+ 214,163 (+ 2.6 %)	-142,786 (- 1.7 %)

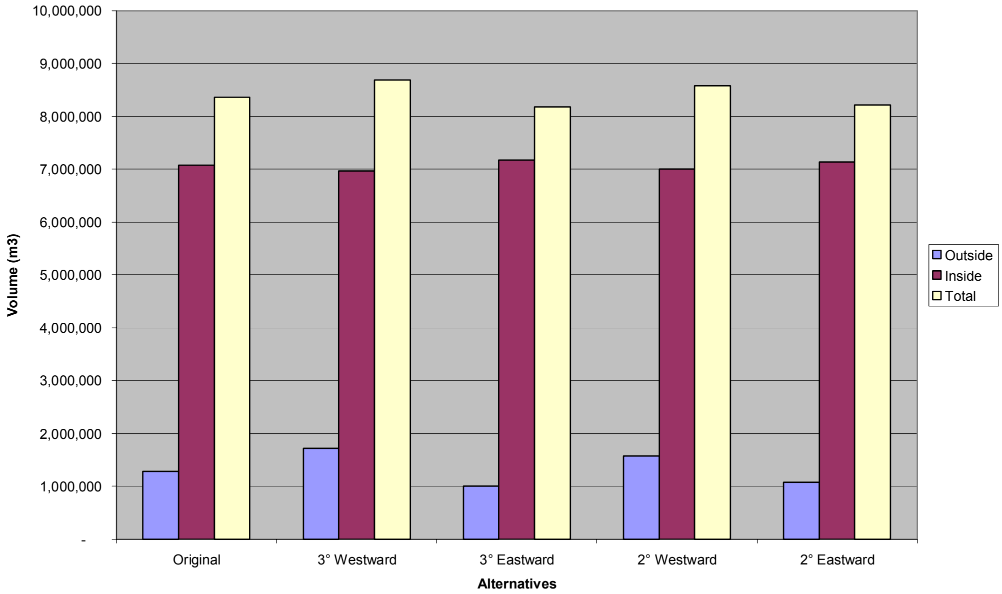
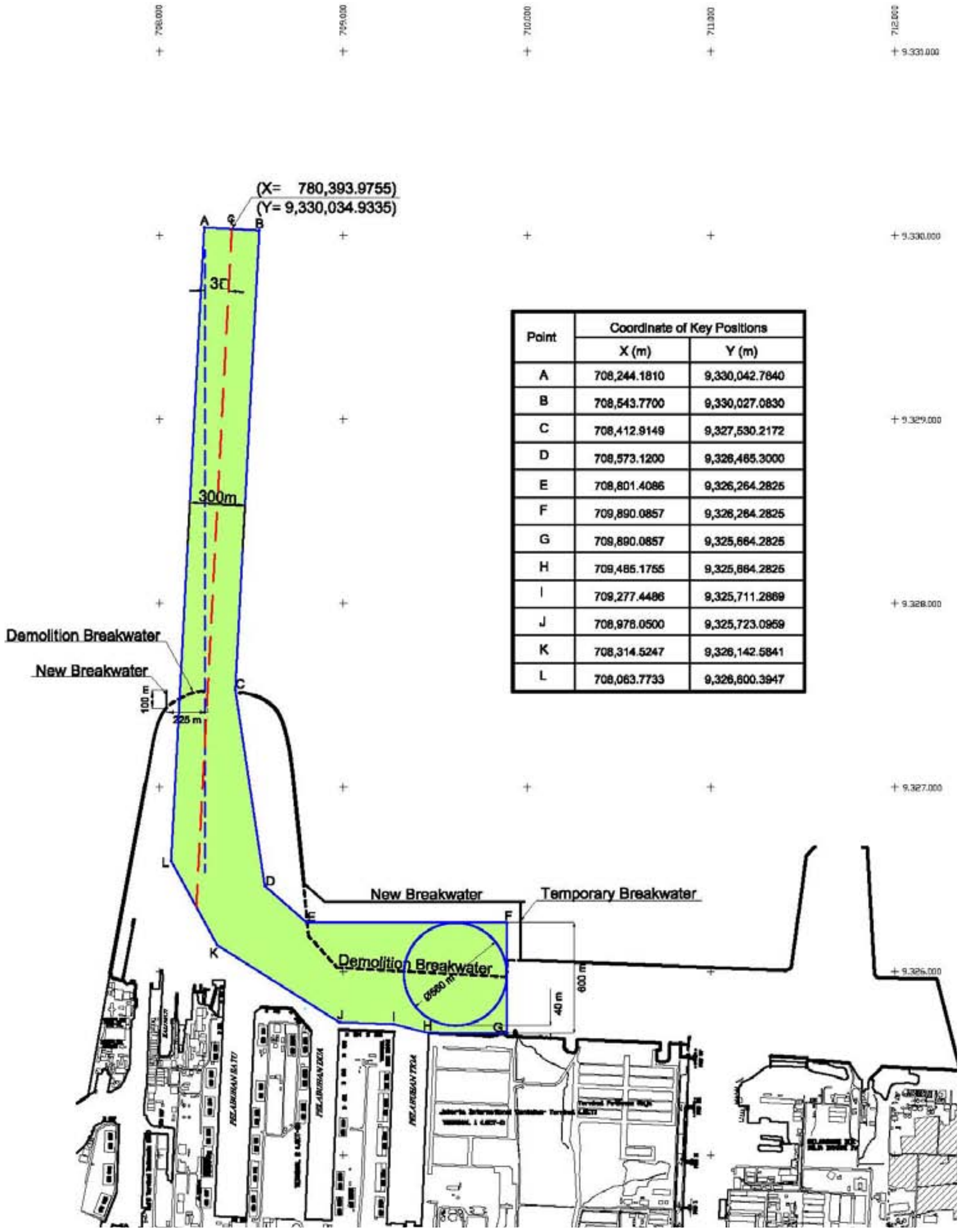


Figure 3.4.5 Volume of Dredging Inside (Area B & C) and Outside (Area A-1 & A-2) Port

In case of eastward modification plan, the rear leading light tower will be located to the west of the existing leading tower, which gives additional advantage for the ships approaching the port. Currently, the leading light is so closely located to the signboard light of the Port, which is mounted on top of the IPC-II building, so that the visual clearance of the leading light is rather weak.



Point	Coordinate of Key Positions	
	X (m)	Y (m)
A	708,244.1810	9,330,042.7840
B	708,543.7700	9,330,027.0830
C	708,412.9149	9,327,530.2172
D	708,573.1200	9,326,465.3000
E	708,801.4086	9,326,264.2825
F	709,890.0857	9,326,264.2825
G	709,890.0857	9,325,664.2825
H	709,465.1755	9,325,664.2825
I	709,277.4486	9,325,711.2869
J	708,976.0500	9,325,723.0959
K	708,314.5247	9,326,142.5841
L	708,063.7733	9,326,600.3947

Figure 3.4.6 Final Proposed Navigation Channels and Basin Plan

3.4.2 Inner Channel and Basin

The alignment of the inner channel and basin has been determined area by area, starting from the offshore part of the inner channel that is directly linked to the outer channel, followed by the turning basin areas located deep inside the port and the transition part linking the above two areas.

The western boundary of the inner channel will follow the straight line of the outer channel (N-S axle) for the distance of 1000m, while the eastern boundary of the inner channel will make a gentle skew of 12 degrees to the east to assist in-coming ships in making easy portside turns toward their final berthing positions, and vice-versa for out-going ships.

In front of the Jakarta International Container Terminal I (JICT-I), a turning basin of 560 m (280 m x 2) diameter will be provided with a 40 m wide space left to clear the ships mooring along the quays. When no ship is berthed alongside the quay, a turning basin of 600 m diameter will be secured. To the west of the 560 m-diameter basin, one more turning basin of 450m diameter will be provided. This basin arrangement will allow simultaneous turning of two ships, one for the maximum of 50,000 GT and another for the ship with the maximum LOA of 225 m, equal to 20,000-40,000 GT in ship size. The southern and northern boundaries of the E-W waterway will be set out, enveloping the proposed turning basins.

Between the straight portion of the inner channel (N-S axle) and the E-W waterway, the transition part will be provided with the radius of 4 times of LOA, equal to 1,120 m. The southern boundary line of the E-W waterway bends through 30 degrees from the NE corner of Pier-III, and another 30 degrees off the Pier-I, and linked to the N-S axle of the inner channel. In the meantime, the northern boundary of E-W waterway will be connected to the 12 degree skew line with a 40-degree bend. The narrowest channel width at the bending portion is about 362 m.

3.4.3 Anchorage Areas

With the improvement of the navigation channel executed, the existing anchorage areas need to be realigned. At present, thirteen (13) mooring buoys occupy the sea basin just inside the breakwater, all of them located on the west and east of the inner channel (The relocation plan of the existing mooring buoys are described in Chapter 6). The existing natural approach channel area expands offshore like a trumpet-shape. Outside this trumpet zone extends the offshore anchorage area. A part of the anchorage designation area outside the port should be modified, because the new outer channel will be aligned very close to the designated offshore anchorage areas.

3.4.4 Realignment of Waterways shallower than 14 m in Depth

Following the Scope of Works, the improvement plan of the navigation channel and basin has been limited to the waterway of -14m in the port. Nevertheless, the existing navigation zone shallower than -14m should be maintained to meet the water depth requirements designated for the respective basins of the Port.

3.5 Improvement of Navigation Aids

3.5.1 Existing Navigation Aids

At present, the navigation channel and turning basins of the port are marked by one entrance buoy, a pair of port entrance markers, two light beacons and a pair of leading tower. Their details are summarized below.

1) The entrance point of the outer channel is marked by one channel buoy with the following characteristics.

    - Location (S 06-02-00, E 106-52-23)
    - Flash Speed Characteristics (C. Hj 3 sec) Flashing, Green
    - Energy(-)
    - Height (-)
    - Eye Distance (4 miles)
    - Kind of Structure & Signal (Green Lighted Buoy)
    - Remarks (C. 0.5 G. 2.5) Flash 0.5 Period 2.5 sec

Formerly, a pair of the entrance buoys was installed, including the above green-colored buoy and one more red-colored buoy. The red-colored buoy disappeared.

2) The entrance point of the inner channel is marked by a pair of port entrance markers (red one and green one) with the following characteristics.

Red Port Entrance Marker:

- Location (S 06-04-50, E 106-52-55)
- Flash Speed Characteristics (C.M.P. 4 sec 0.08) Flashing, Red and White
- Energy (SC) Hybrid Panel
- Height (22 m)
- Eye Distance (12 miles)
- Kind of Structure & Signal (20 m high steel structure with top-shape, see photo-below)
- Remarks (C. 0.5 G. 3.5)

Green Port Entrance Marker:

- Location (S 06-04-50, E 106-52-48)
- Flash Speed Character (C.Hj 5 sec 0.08)
- Energy (A) Acetylene Carbit
- Height (22 m)
- Eye Distance (22 miles)
- Kind of Structure & Signal (20 m high steel structure with top-shape, see photo-below)
- Remarks (C.1.0 G 4.0)

Port Entrance Marker (Dam Barat)

Port Entrance Marker (Dam Timur)

Leading Tower (Front)

Leading Tower (Rear)

Western End of Dam Tengah

Eastern End of Dam Tengah

Photo 3.5.1 Existing Navigation Aids

3) The western end of Dam Tengah is marked by a light beacon marker installed on the top of the breakwater with the following characteristics.

- Flash Speed Characteristics (CM 3 sec) Flashing Red
- Height (6 m)

- Eye Distance (5 miles)

4) Leading Towers are stationed in the Pier with the following characteristics.

Front Leading Tower:

- Location (S 06-05-50, E 106-52-51)
- Flash Speed Character (Ph. S 2 sec) Isophase
- Energy (-)
- Height (27 m)
- Eye Distance (12 miles)
- Kind of Structure & Signal
- Remarks (C 1.0 G 1.0)

Rear Leading Tower:

- Location (S 06-06-25, E 106-52-51)
- Flash Speed Character (P.MpHj. 4 sec) white, red white, green
- Energy (-)
- Height (43 m)
- Eye Distance (12 miles) Kind of Structure & Signal
- Remarks (C 3.0, G 1.0)

At present, there is no marker beacon for positioning the boundary of individual anchorage zones, all of them located east/west of the outer channel. All the anchoring ships set their positions by use of GPS. As no radar system is applied in the port, the port control office cannot know the anchoring positions by themselves. In addition, the outer channel is open to the sea like a trumpet-shape. The channel is about 90 m net wide in the breakwater area, and gradually widened by use of natural water depth up to the entrance buoy.

3.5.2 Proposed Plan of Navigation Aids

As the navigation channel is widened from 150 m to 300 m, and the turning basin will also be widened, the existing navigation aids should be realigned accordingly. In full consultation with the Pilot Office, the following navigation aids is proposed. A final plan of navigation aids are shown in Figure 3.5.1.

1) The existing entrance buoy shall be relocated outside the new channel, and a new fairway buoy (Zero-buoy) shall be installed at the center of the new navigation channel. The revised coordinate of the buoy is X=708,535.943, Y=9,332,743.845.

2) The trumpet-shaped boundary of the anchorage area will be revised so as not to interfere with the new navigation channel. At the midway point between the Zero-buoy and the port entrance, a pair of outer channel buoys (Buoy No.1 and No.2) will be installed entrance beacons in lighting system.

3) The entrance beacon that is located on the tip of "Dam Barat" shall be demolished and replaced by a new green Entrance Beacon (No.4). The characteristics of entrance beacon will follow the exiting one except for the location.

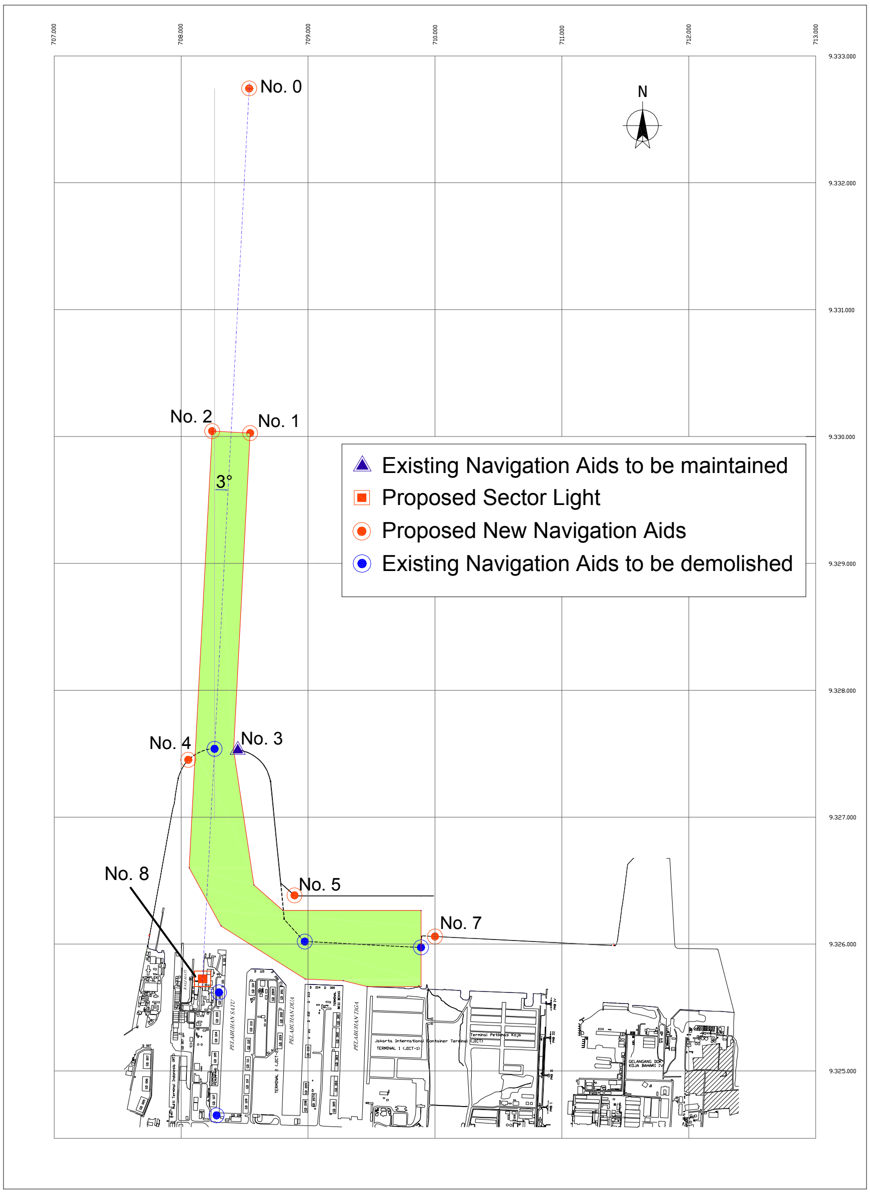


Figure 3.5.1 Proposed Navigation Aid

4) With the demolition of Dam Tengah, the existing light beacons shall be demolished. For the new breakwater, two light beacons will be installed, one at the western end of the new Dam Tengah and one at the western end of demolished part of Dam Citra, about 50 m away from the turning basin edge. Both of them will function as light beacons to show the boundary of the waterway (Marker Beacon No.5 and No.7).

5) The existing leading towers shall be abandoned and a new sector light will be installed to show the centerline of the channel.

Potential locations of a pair of leading lights have been sought from south to north on the eastern side of the Pier I, between basin of Pelabuhan Satu and Jl. Padamarang. The land in the east side of Jl. Padamarang, is occupied by the private sectors like container yard, warehouse, tank farm, etc, so that the land acquisition for installing leading light would require negotiation procedure for IPC-II. Closer to the sea, all the waterfront is also occupied by the shipyard "DKB".

The site inspection suggests that it is very difficult to find two well-coordinated locations, in the existing potential areas, one for front leading light tower and one for rear leading light tower. As such, it is a practical way to employ one tower system, which is a sector light.

The sector light could be installed inside the shipyard. One possible location is just behind the floating docks (Mark ● on Figure 3.5.2). In this case, the orientation of the outer navigation channel is set at due north as initially proposed. The location is shown in Photo 3.5.2 (Viewing seaward) and Photo 3.5.3 (Viewing landward).

Another possible location is near the eastern end of the bridge spanning over the water area (Mark ● on Figure 3.5.2). In this case, the corresponding channel orientation would be 3° to the east. That location is shown in Photo 3.5.4.

The seaside views from another possible point of the sector light are shown in Photo 3.5.5. The existing green port entrance marker that is placed on the edge tip of existing Dam Barat can be seen between two ship far behind (This position will serve as the center point of the new navigation channel).

In case of without modification of the 360° (due north) channel orientation, the front leading light should be more than 50 m high to clear the height obstruction of the shipyard, assuming that the height clearance of the shipyard is 41.5 m.

In case of 3° eastward change of channel orientation, the height of sector light would be lower than another alternative, because the seaside view will not be obstructed by the dock facilities. (See Photo 3.5.5). As explained earlier in section 3.4.1, a sector light will be installed to the west of the shipyard.

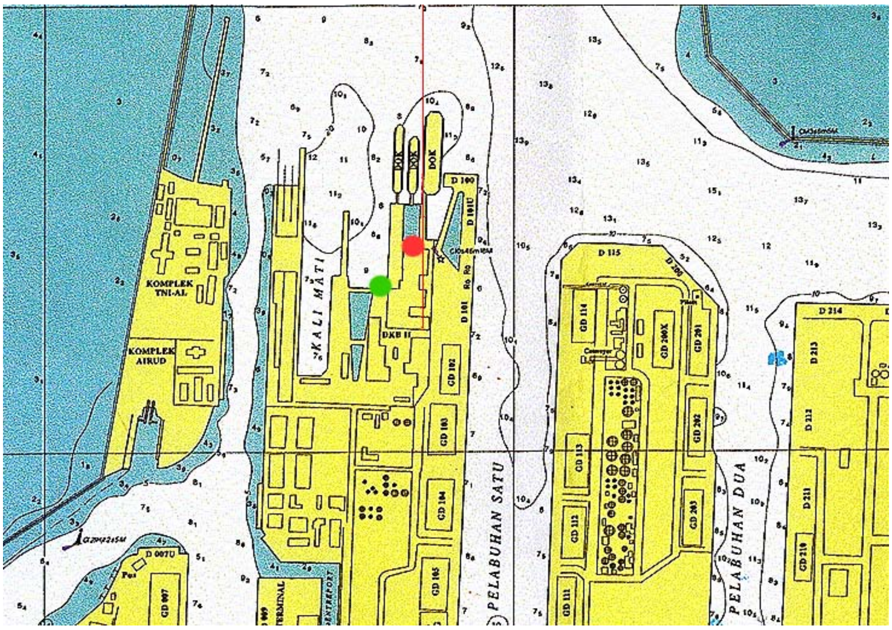


Figure 3.5.2 Possible Location of Sector Light

Photo 3.5.2 Possible Location for Sector Light Tower ●
(Viewing seaward)

Photo 3.5.3 Possible Location for Sector Light Tower ●
(Viewing landward)

Photo 3.5.4 Possible Location for Alternative Light Tower ●

Photo 3.5.5 Seaside View from the Alternative Location of Sector light

3.6 Proposed Scope of Channel Improvement

3.6.1 Dredging Requirements for Navigation Channel

The dredging requirements have been estimated by superimposing the proposed channel/basin improvement plan on the bathymetric survey map produced by the JICA D/D Team. The water depth for dredging has been set at -14 m, and side slope of the dredging section has been assumed to be 1 to 5.

The net volume of dredging requirements is summarized below. The location of each area is shown in Figure 3.6.1.

Volume of Area A-1:	31,000 m^3
Volume of Area A-2:	795,000 m^3
Volume of Area B:	2,547,000 m^3
Volume of Area C:	4,705,000 m^3
Total Volume:	8,078,000 m^3

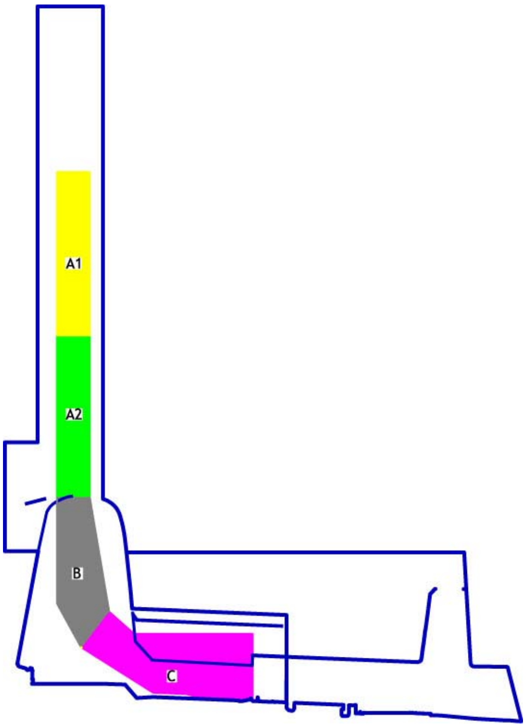


Figure 3.6.1 Dredging Area

3.6.2 New Navigation Aids

Preliminary study has been made for the specification of the navigation aids as shown in Table 3.6.1. These specification should be further reviewed and finalized by Directorate of Navigation, DGSC in due course.

Table 3.6.1 Navigation Aids Specification

No.	Type	Body Color	Light Color	Light Source	Light Character	Effective Luminous Intensity (cd)	Effective Luminous Range (N.M) (T=0.74	Top Mark	Mooring Chain
No. 0	Ø2.5m Dia. Lighted buoy	Red & White	White	LED	Mo(A) 10 sec	177	6.2	●	Ø36mm Stud Link chain (Grade 2)
No. 1	Ø2.5m Dia. Lighted buoy	Red	Red	LED	F1.3 sec	42	4.0	■	Ditto
No. 2	Ø2.5m Dia. Lighted buoy	Green	Green	LED	F1.3 sec	42	4.0	▲	Ditto
No. 3* No. 4	20m Height Light beacon	Green	Green	LED	F1.3 sec	446	7.8	▲	
No. 5	6m Height Light beacon	Red	Red	LED	F1.3 sec.	284	7.0	■	
No. 7	10m Height Light beacon	Red	Red	LED	F1.3 sec	284	7.0	■	
No. 8	Sector Light		White Red Green				**	-	

Note: * Navigation aid to be renamed.
Note: ** The sector light has a reaching capacity in the day time of 3.9 NM (green), 4.0 NM (red) and 5.9 NM (white), and 10 NM, 10.8 NM and 19 NM respectively at the night time.

3.6.3 Relocation of Existing Navigation Buoys

The widened inner channel will occupy the existing mooring areas inside the breakwaters, so that the existing mooring buoys should be relocated. The mooring buoys to be relocated are shown in Figure3.6.2.

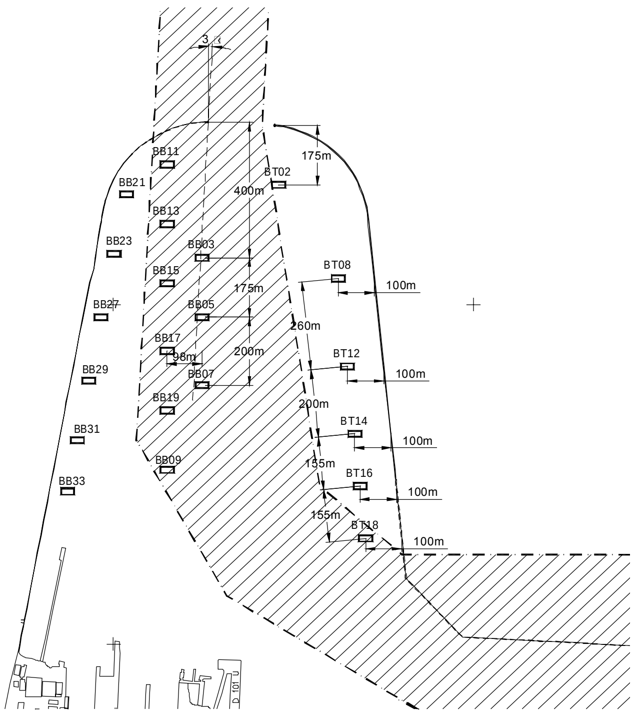


Figure 3.6.2 Mooring Buoys Relocated

CHAPTER 4 RELOCATION PLAN OF BREAKWATERS

4. RELOCATION PLAN OF BREAKWATERS

4.1 Existing Port Protection

Originally, the port had two port entrances, west and east. However, the east port entrance has been abandoned, because the entrance channel has been silted up, and eventually become non-navigable. So, the port has now one west entrance. The port, as shown in Figure 4.1.1, is protected by four breakwaters, namely Dam Barat (1,750 m), Dam Timur (1,479 m), Dam Tengah (1,260 m) and Dam Citra (1,548 m). Most of the breakwaters are heavily damaged due to aging and settlement. To sustain reliable basin calmness, maintenance/repair works have been intensively executed to keep the crest height.

The port entrance is protected by Dam Barat and Dam Timur. Each breakwater projects out to the sea perpendicular to the shore line with a right-angle return, terminating centrally about 200 m apart. A narrow port entrance and sufficient depth of inner basin (about 1.5 km) functions well to minimize the wave disturbance and sedimentation in the port basins.

The basin for the International Container Terminals is protected by Dam Tengah and Dam Citra, both of them located about 300-350 m away from the quay-walls. In the meantime, container ships recently calling the terminals become as large as 250-280 m in LOA. The space for the turning basin is so limited and narrow, so that container vessels should turn in front of Pier-2 or Pier-3, and towed back to the terminal. The widening of the turning space is required as close as possible to the front of the terminal.

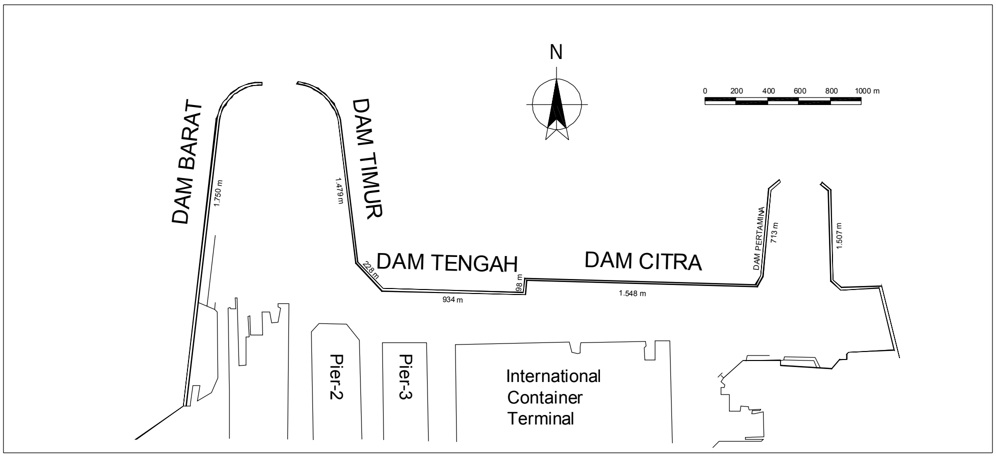


Figure 4.1.1 Configuration of Existing Breakwaters

Photo 4.1.1 Existing Breakwater (Dam Barat & Dam Timur)

Photo 4.1.2 Existing Breakwater (Dam Tengah & Dam Citra)

Photo 4.1.3 Existing Breakwater (Dam Tengah)

4.2 Configuration of New Breakwaters

In accordance with the improvement plans of navigation channel and basins (Chapter 3), the existing navigation channel and basins will be widened. Consequently, the existing breakwaters should be realigned accordingly. Basically following the Urgent Rehabilitation Plan proposed in the JICA Master Plan, the general plan of the relocated breakwaters is shown in Figure 4.2.1. The port entrance will be widened from 150m to 300 m in the bottom of the entrance channel. To this end, the head of Dam Barat shall be demolished.

To provide a 280 m radius turning basin in front of Jakarta International Container Terminal-I, the entire stretch of Dam Tengah and a part of Dam Timur will be demolished, and New Dam Tengah will be constructed about 400m seawards of the existing one. The net distance between the center of the new breakwater structure and the toe of the side slope of the dredged basin has been set at 115 m in consideration of the stability of the breakwater. To provide a safety navigation clearance at the eastern end of the basin, a part of Dam Citra that is linked to Dam Tengah will also be removed.

To provide a smooth transition of the waterway between the inner channel and the turning basin, the bending portion of the inner channel will be widened. As a result, a part of the existing breakwater of Dam Timur will be demolished, and the new Dam Tengah will be connected with the remaining part of Dam Timur. The connecting section of New Dam Tengah will be aligned with a skew, providing the safety distance of 150m from the edge of the widened navigation channel.

The above relocation plan of breakwaters, though satisfactory for ship handling space, still contains several issues. In the JICA Master Plan, a preliminary study was made for wave penetration, while no detailed analysis was addressed to sedimentation expected in the widened channel and enlarged basin. In this chapter, detailed analysis has been made for determining the layout of each breakwater, including, sedimentation in the channel and basin, review of wave/current effects on ships and future port development.

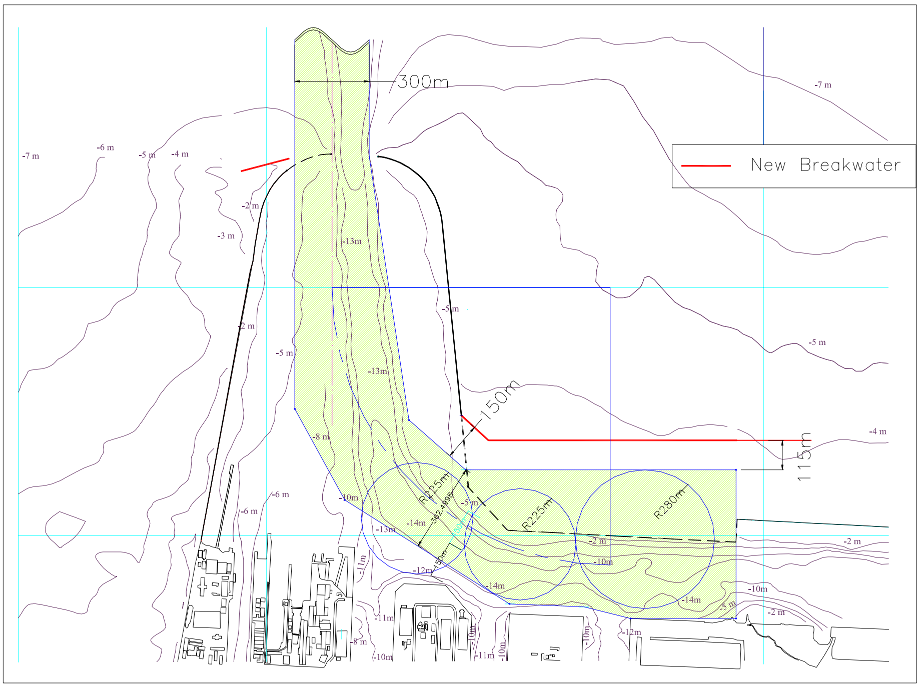


Figure 4.2.1 Configuration of New Breakwater

4.3 Breakwater Improvement Plans

4.3.1 Dam Barat (Port Entrance)

(1) Major Consideration Points

Though the width of the channel is 300 m at the bottom (-14 m), its actual width at the sea bed (about -4 m), where the foundation of the breakwaters are laid down, will be enlarged to 380 m, considering the safety distance for side slopes of dredging (1:5) and foundation stability of breakwaters. The widened port entrance may aggravate the wave disturbance in the port.

In addition to the wave disturbance, the breakwaters will face another problem. Once the tip of Dam Barat is demolished, breakwaters will not be aligned opposite each other. About 100 m gap will appear in the direction of the outer channel. The western arm (partially demolished Dam Barat) will be located more shoreward than the eastern arm. This alignment gap would trouble the pilots to maneuver their ships at the port entrance.

In the JICA Master Plan Study, the wave disturbance inside the port was analyzed with a detached breakwater being placed a bit offshore of the demolished breakwater. Under this condition, it was concluded that the calmness of the port basin was ensured to run efficient port operation. To avert these likely navigational issues, it could be understood that the JICA Master Plan Study proposed to construct a detached breakwater, where one light beacon will be installed exactly opposite to a coupled marker beacons in the port entrance.

One more reasoning would be that a detached breakwater will work as a gambit for the succeeding port development to the west, because this short breakwater section will form an integral part of the main breakwater that will protect the western port expansion scheduled up to 2025.

In the meantime, the JICA Master Plan did not address to the big issue of how far the sedimentation will occur in the channel and basin due to 300 m wide port entrance. This issue has been discussed in this chapter. It is also discussed whether the alignment of detached breakwater may work to reduce the sedimentation rate in the new channel and basin. These questionable points have been examined by comparing alternative port entrance plans.

(2) Alternative Breakwater Configurations

To evaluate the magnitude of sedimentation increase with wider port entrance, and to assess the value of the proposed detached breakwater, a proto-type configuration plus three alternative breakwater configurations with widened port entrance have been prepared as shown in Figure 4.3.1.

1) Proto-type layout:

Comprising a 150 m wide port entrance as it is.

2) Alternative layout-1:

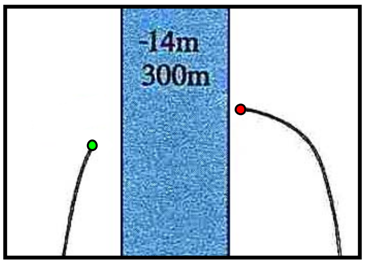
Comprising a 300 m wide port entrance, but without a detached breakwater. To mark the port entrance, a navigation light will be installed on the tip of the demolished Dam Barat.

3) Alternative layout-2:

Comprising a 300 m wide port entrance with a 200 m detached breakwater opposite the remaining Dam Timur (JICA Master Plan)

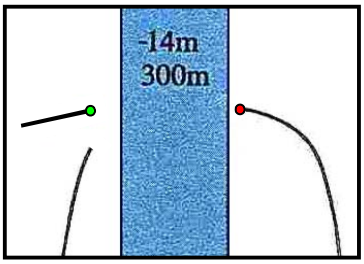
4) Alternative layout-3:

Comprising a 300 m wide port entrance with a 100 m long expansion of Dam Barat, running parallel to the channel, ending opposite the remaining Dam Timur.



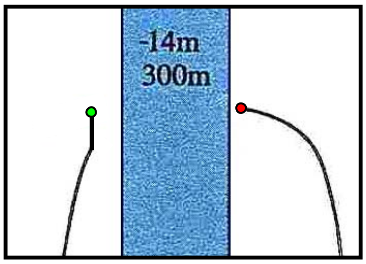
Alternative-1

Widened entrance channel
No additional protection



Alternative-2

Widened entrance channel
Extra 200m offshore breakwater provided with navigation light



Alternative-3

Widened entrance channel
Extended 100m Dam Barat provided with navigation light

Figure 4.3.1 Alternative Breakwater Configurations at the tip of Dam Barat

These plans have been framed into the numerical modeling (flow model and sedimentation model), through which different behaviors of currents and sedimentation patterns in and around the port entrance have been disclosed.

(3) Results of Mathematical Modeling Analysis

1) Wave Disturbance

The wave penetration model (Alternative-1) has been constructed to assess the wave disturbance when the port entrance channel is widened to 300m. The modeling was applied for the wave direction of N, which gives the most critical wave penetration into the Port. As shown in Appendix 4-B, with 300m wide port entrance, 1.0m high waves, after propagating into the port, diminish to 0.4m high in front of the ship yard (equal to the decay factor of 0.4), while, with the existing 150m wide port entrance, they decay to 0.1m in front of the ship yard. This result shows that after the widening of the port entrance, the wave disturbance will become a bit worse in the inner port area. This situation occurs particularly in NW monsoon seasons.

Generally it is accepted that 0.5m high waves inside the port is an allowable figure for safety and efficient port operation. Under the 300m wide port entrance, the northern waves larger than 1.25m gives 0.5m high waves inside the inner port area. As these near-shore waves occur for 2.3% of the time throughout the year, the total downtime in the port will not be critical on a yearly basis. As such, after widening the port entrance, wave disturbance inside the port, as already confirmed by the JICA Master Plan Study, will be maintained under the critical waves of 0.5m for more than 97.5% of the time throughout the year.

Though Alternative-2 and - 3 are slightly different from Alternative-1, it can be expected that no more adverse effects would occur for Alternative-B and - C, compared to Alternative-A. The above wave analysis suggests that all Alternatives (1, 2 and 3) could be accepted in terms of wave calmness requirements inside the port.

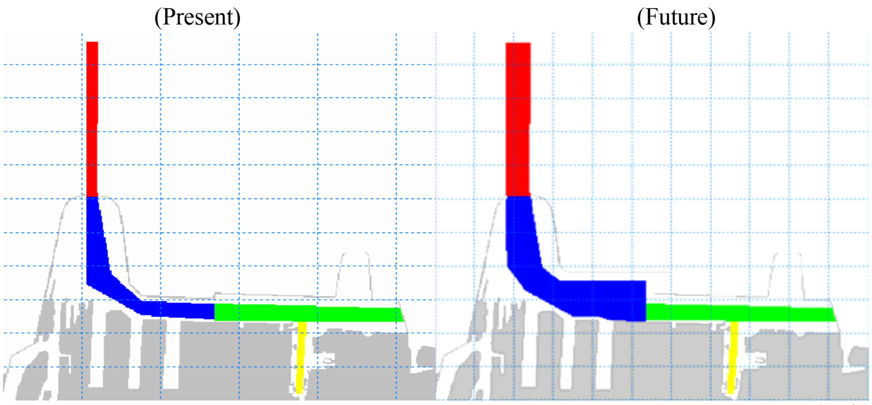
2) Sedimentation

The sedimentation rates in the port area except for the basins (I, II, III), have been projected as follows. The details are compiled in Appendix 4-C-1 and 4-C-2. The model scenarios have covered alternative plans of Dam Barat as well as alternative plans of Dam Tengah. The Dam Tengah improvement has two alternative plans, (i) to close the gap between the new breakwater and existing breakwater of Dam Tengah and (ii) to leave the gap open, which has been discussed in more detail in paragraph 4.3.3. Using the mathematical model, the sedimentation inside the port area has been estimated as below.

Present layout--365,000 m3 /year

Alternative-A: Alternative-1 + with gap--------------------620,000 m3 /year
Alternative-B: Alternative-2 + with gap--------------------596,000 m3 /year
Alternative-C: Alternative-3 + with gap --------------------596,000 m3 /year
Alternative-D: Alternative-1 + with no gap----------------495,000 m3 /year
Alternative-E: Alternative-3 + with no gap ----------------483,000 m3 /year

As easily understood from the above results, the plans with closing the gap produce less sedimentation. Among others, the Alternative-E (Alternative-3 with no gap) generates the least sedimentation.



(m3/year)

	Present		A	B	C		D	E
1	62,000		166,000	150,000	155,000		170,000	158,000
2	117,000		309,000	305,000	299,000		141,000	150,000
3	110,000		71,000	68,000	69,000		109,000	101,000
4	76,000		74,000	73,000	73,000		75,000	74,000
Total	365,000		620,000	596,000	596,000		495,000	483,000

Figure 4.3.2 Total Sedimentation Volumes for each Alternative

(4) Optimum Plan of Dam Barat Improvement

The JICA Master Plan recommended the relocation of the military base. Nevertheless, the navy is currently expanding their marine base both inside and outside the port. It is understood that the relocation of this military base, in the JICA Master Plan, was a very tactical and essential point to initiate the westward port expansion. In this sense, the proposed long-term plan of the Port may need to be reconstructed in due course.

In the meantime, the westward port expansion plan envisaged by Jakarta City has not been well settled, and the ongoing city master plan is substantially overlapped in land / water use with the JICA Master Plan. It is expected that ongoing activities staged in and around the Port will not easily be settled, consuming a considerable time by the finalization of various port development plans.

Under these circumstances, it would be necessary to reconsider the breakwater alignment of the western port development proposed by the JICA Master Plan and preferable to wait for the total consensus to be achieved for the westward port development. In this context, it can be said that it would be early to initiate the first component of westward expanding breakwater, which is recommended as Alternative-2. Instead, Alternative-1 that only demolishes the existing breakwater and without any additional breakwater expansion might be a more practical solution.

In addition to the long-term port development, safety ship handling in the port entrance is very essential and more urgent task for the port development. In terms of navigational safety, it is recommendable to place a pair of entrance beacon s opposite each other. Each of them is to be placed on the tip of the breakwater. Alternative-1 will provide a 100m north-south gap between two entrance beacons. The navigation group of DGSC and IPC-II, including pilots strongly object the existence of this gap.

Under such conditions, it has been decided to select Alternative-3, which will provide the most reliable position for the entrance beacon. Alternative-2 requires about 200m long construction of a detached breakwater, while Alternative-3 requires 100m long breakwater expansion, which gives more advantage to Alternative-3.

As the expected sedimentation rate for Alternative-3 is the least, and various judgments mentioned above is supportive to Alternative-3, Dam Barat will be designed in the form of offshore expansion of 100m, parallel to the proposed outer channel.

4.3.2 Dam Timur

The southern part of Dam Timur will be demolished and the remaining offshore part of Dam Timur will be linked to the New Dam Tengah-1. Without this demolition, the waves from N-NW are propagated into the port entrance and reflected by the Dam Timur. In the meantime, the partial demolition of Dam Timur as well as relocation of Dam Tengah may allow the waves approaching from N- NW to travel directly up to the enlarged basin. The effect of the wave disturbance in the basin was assessed in the JICA Master Plan Study, and calmness in the port basin was ensured.

4.3.3 Dam Tengah

(1) Major Consideration Points

The JICA Master Plan Study proposed that the new Dam Tengah would overlap with the existing Dam Tengah for the distance of 300 m. As detailed in Appendix 4-A, the minimum overlap of 160 m would be enough to protect the port and secure sufficient basin calmness, so that the JICA Master Plan's recommended 300 m overlap length would be judged too long for the protection of the Port. In the meanwhile the existing breakwater and the new breakwater (New Dam Tengah-1) will provide a 300 m gap in between. This open gap will easily receive the sedimentation from offshore particularly from westward running currents, resulting in higher maintenance dredging requirements. The soft clay consisting of shoals in front of the breakwater is likely to flow into the port. Here again, the sedimentation problem has been addressed through numerical modeling.

(2) Alternative Breakwater Configurations

To cope with likely problems, five alternative breakwater plans have been evaluated as explained in paragraph 4.3.1 (3) 2).

To more clearly visualize the layout of Dam Tengah configuration, two alternatives plans (without and with closure) are illustrated in Figure 4.3.3.

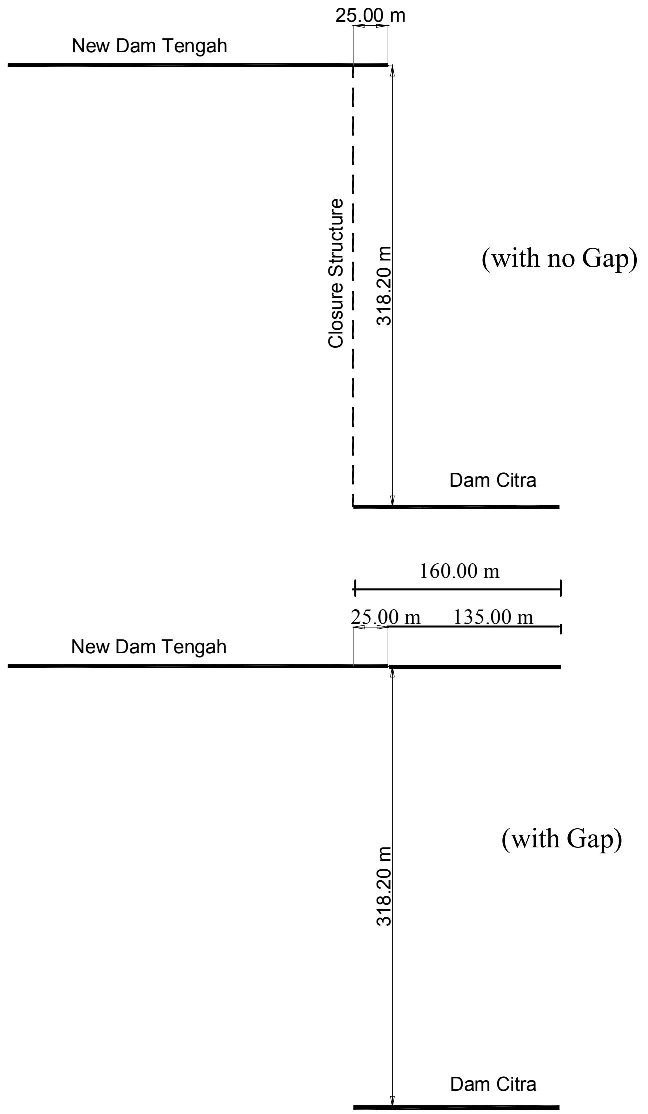


Figure 4.3.3 Alternative Breakwater Configurations of New Dam Tengah

The above plans have been released into the numerical modeling, and the sedimentation rates and distribution under the gap openings have been assessed. On this basis, the optimum breakwater configuration has been determined.

(3) Results of Mathematical Modeling Analysis

1) Wave Disturbance

As earlier explained in this chapter, Alternative-A, -B, -C, -D and -E can satisfy the calmness requirements inside the Port.

2) Sedimentation

As shown in the sedimentation analysis of the numerical modeling, the open gap plans will suffer higher sedimentation. The case with the gap open produces sedimentation of 596,000 ~ 620,000 m3 /year, while the case with the gap close produces 483,000 ~ 495,000 m3 /year. The difference between "with" and "without" is 113,000 ~ 125,000 m3 /year. In terms of dredging cost requirement, Alternative-D and –E, both of them closing the gap, are more recommended rather than the plans with gap open.

(4) Optimum Plan of Dam Tengah Improvement

The JICA Master Plan recommends further eastward port expansion after this project. The widened turning basin is to expand to further east. Under this planning concept, Dam Tengah would be continuously expanded eastwards without any closure or bending on its way.

In the meantime, without the closure of gap, the additional maintenance dredging will be 113,000 ~ 125,000 m3 /year. This additional dredging is a large financial burden to DGSC and IPC-II.

For the time being, the implementation schedule of the further eastward port expansion (after the project) is not certain, and in terms of environmental constraints, it would require more detailed consideration for the dredging eastwards in the Port. Under these circumstances, it is preferable to close the gap in an economical way, and minimize the port maintenance cost as much as possible. In this sense, a costly permanent structure cannot be recommended for gap closure. A more economical breakwater structure has been studied in Chapter 5.

4.4 Proposed Scope of Breakwater Relocation

(1) Length of Demolished Breakwaters

The length of demolished breakwater is illustrated in Figure 4.4.1. The tip of Dam Barat will be demolished for the length of 225 m. Dam Timur will be demolished for the length of 287 m. All the length of Dam Tengah (1,155 m) will be demolished. A part of Dam Citra will also be demolished for the length of 163 m. Total length of demolished breakwaters is 1,830 m.

(2) Length of New Breakwaters

The required lengths of new breakwaters as shown in Figure 4.4.1 are as follows;

New Dam Barat -- 100.0 m
New Dam Tengah-1 ------------------------------------- 1,243.0 m
New Dam Tengah-2 (Temporary Breakwater) --------- 318.2 m

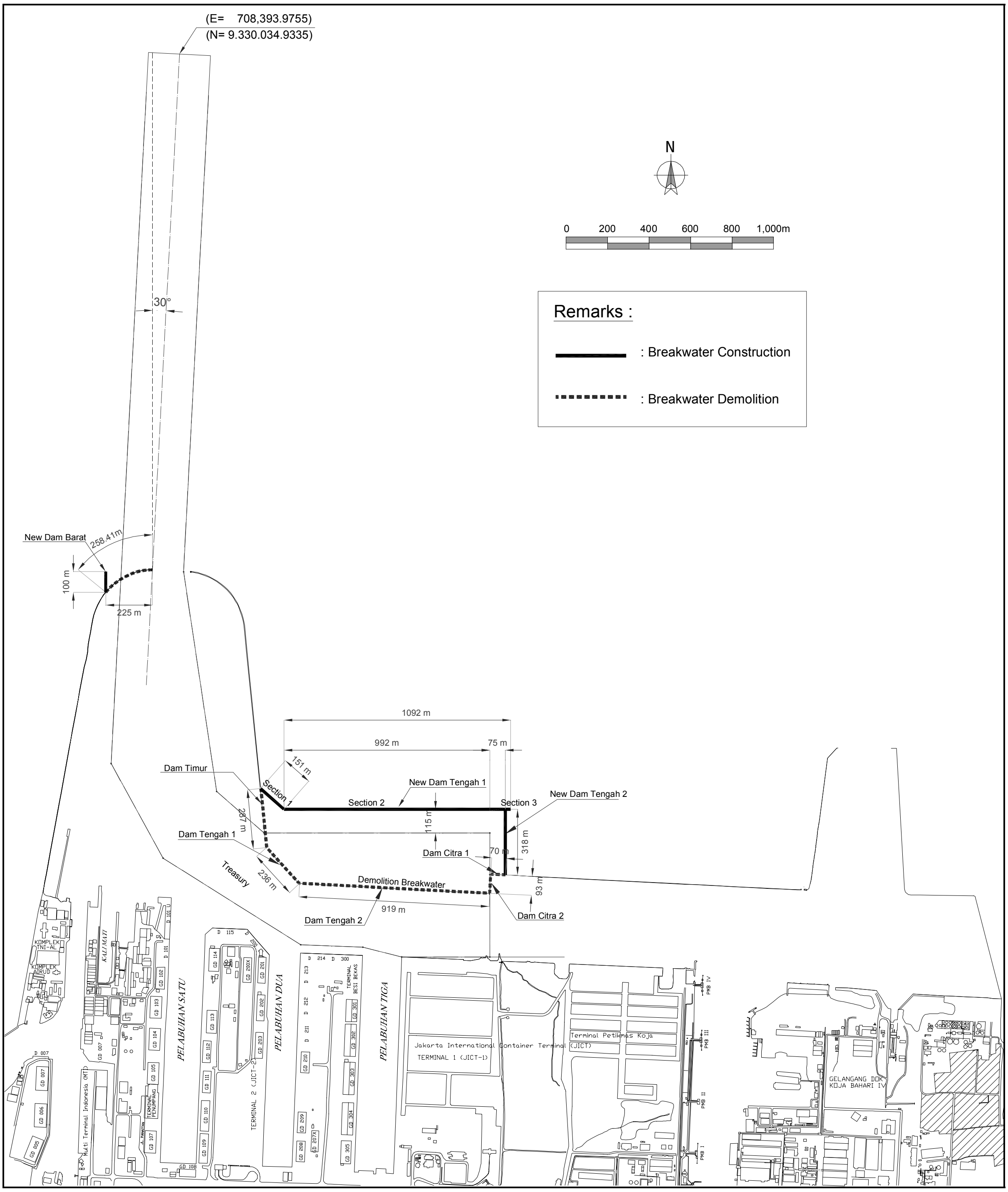


Figure 4.4.1 Breakwater Construction and Demolition