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THE PALEMBANG PORT AND SHIPPING STUDY

VOLUME VII
PART I

EVALUATION OF ALTERNATIVE SOLUTIONS FUTURE PORT DEVELOPMENTS

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Evaluation of Alternatives

Deep Draft Port Developments

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EVALUATION OF ALTERNATIVES - DEEP DRAFT PORT DEVELOPMENTS

1.0 INTRODUCTION

In this study the physical data and factors applicable to all possible sites under consideration for port development are evaluated and analyzed to obtain a range of 'Alternatives for Deep Draft Port Development' to meet the long term needs of the Port of Palembang, particularly in the field of international shipping. A large number of possible sites were studied. Some of these, such as Boom Baru and Sungai Lais in the Musi River and Banyuasin Bay (Tanjung Api-Api) had been recommended by others before. Others such as Sungsang in the Musi River and various sites in the Bangka Straits, Tanjung Limau Bungkuk, Tanjung Selokan and Tanjung Tapah were also reviewed. It became evident that little up to date hydrographic and geological information was available and data had to be extracted from a multitude of sometimes conflicting sources.

Each potential port site was studied from a physical, environmental, development and economic point of view.

After a study of the navigational and feeder accessibility of a site, various dredging and protection alternatives were reviewed and one or more selected for each feasible ultimate depth at the port site. We next evaluated the meterological hydrographic and geological conditions pertaining to the site and its approaches and defined one or more preferred locations for the actual port development. Thereafter we developed various port alternatives consistency of combinations of fixed marginal wharves, island wharves, offshore wharves, floating wharves and more where the various potential types of wharves were assigned to general cargo, container, dry

bulk, liquid bulk or mixed operations. In this manner a number of port facility alternatives were developed for each site. Each facility alternative was designed to meet future port demand. Future port demand was established by major commodity flows and ship traffic on the basis of projected regional cargo and ship traffic and the effect of the cost effectiveness of a new deep draft port facility on the projected cargo and ship traffic.

Each alternative was costed out and the possible feeder transport determined (Figure VII-1.0-1). We then studied the feasibility, engineering, and cost of alternative feeder transports to particular facilities at each of the alternative sites. From the above we finally obtained an overall cost effectiveness and as a result cost benefit estimates for each of the possible port facility and feeder combination at all the potential alternative sites.

As various existing development plans compare alternatives for the establishment of a 1000 meters marginal wharf port, (basically a general cargo port facility), we also derived comparative costs of such a "standard" port.

It became evident from our deliberations, that there was little likelihood, that a 1000 m wharf deep draft port facility for general cargo was necessary or desirable at any time in the future but the comparative study of such facilities at alternative sites was found to be instructive.

In conclusion, this study determines the cost and benefit of different types of facilities and feeder transport established for the operation of a deep draft port at the various alternative port sites under consideration.

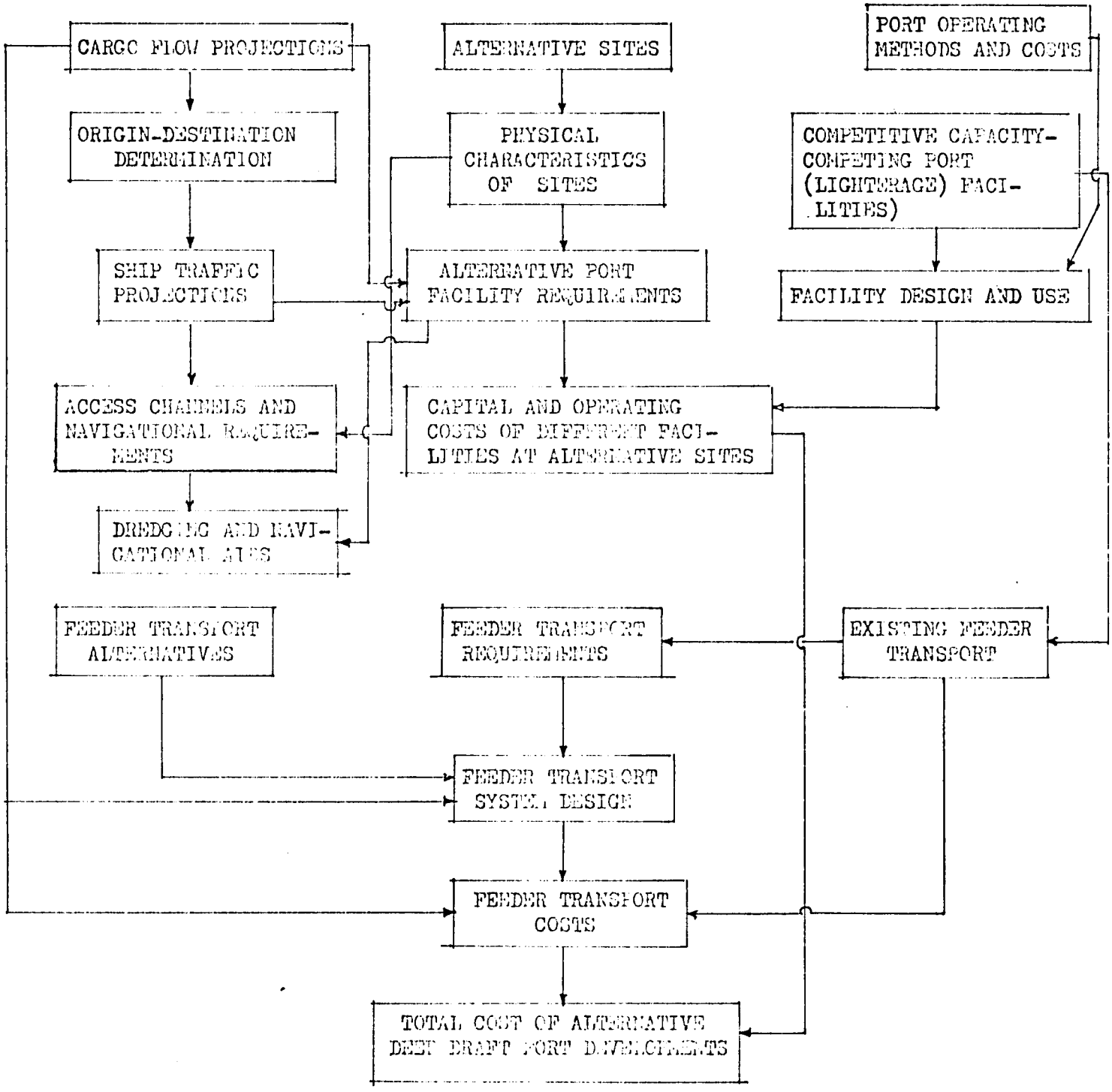


FIGURE VII-1.0-1

EVALUATION OF ALTERNATIVES DEEP DRAFT PORT DEVELOPMENT

General Study Logic

1.1 General Comments.

About 700 years ago Palembang was a seacoast port according to historians. Since that time, the Musi River delta has progressed toward the island of Bangka about 70 kilometers at an accretion rate estimated by some to have been as much as 100 meters per year. While the accretion rate has slowed considerably in recent years it is still estimated to be about 50 meters per year.

In the medieval days Palembang was undoubtedly a major seaport in all respects and this is undoubtedly why the port was the capital of the Kingdom of Sriwijaya.

In those days the ships were small and required very little in the way of port facilities. Any port with a depth of several meters was sufficient for handling all ships of that period. As sea transportation developed, the size of ships increased rather slowly and Palembang remained a major first class port capable of handling ships of all sizes.

Up until about the turn of the century Palembang was able to accommodate most of the world's ships. However, as the watershed area of the Musi River was denuded of its original vegetation and replaced by farmland etc. not capable of absorbing the water runoff in the area, the sedimentation in the river has increased and the depth of the river has decreased. This is not an unusual phenomenon, it occurs quite frequently. Progress is progress and one of its penalties is a shoaling of many rivers, the Musi River is no exception.

The additional development of land as the transport infrastructure expands and the conversion of mangrove swamps into farming land will further increase the sediment content of the Musi River and will produce additional dredging requirements to keep Palembang a port capable of meeting its transport needs.

Palembang, as a port, can now accommodate ships up to about 170 meters in length, 185 meters with tug assistance in the Musir River's bend and with a maximum draft of about 6 meters at LWS and about 8 meters at HWS.

While the depth capabilities of the Port of Palembang are being strained by the requirements for inter-island transportation of oil, coal and fertilizer, much of the ports foreign trade is being handled at deeper seacoast ports, by small inefficient ships, or by larger but partially loaded ships.

Needless to say it is in the interests of the economy of the RI that the size and tonnage capabilities of its ports be reviewed and increased where economically feasible.

During the last century the size of ships in world trade have increased greatly and in the last 30 years the size of ships particularly tankers have increased ten fold in deadweight carrying capacity to 573,000 Dwt and in draft from about 30 feet to a present maximum of about 90 to 100 feet.

While the size of the regular cargo ship has not matched that of the tanker it has grown considerably in size particularly the dry bulk carrier which in this day and age has reached a maximum size of 280,000 Dwt. Large fast container ships have a Dwt up to 60,000, and a draft of up to 44 feet, while liner type cargo ships are now in the 20,000 to 25,000 Dwt classification and have drafts up to about 37 feet.

In general the cost of marine transportation has increased quite rapidly during the same period and the shipping companies are finding that there are substantial cost savings to be gained by increasing the size of ships. Marine transportation is becoming increasingly capital intensive. While the Dwt capacity of a ship is almost cubed

as the dimensions increase linearly, the cost varies about as the square and the fact remains that crew costs rise much more slowly. Consequently the trend has been to larger and larger ships for lower shipping costs per ton mile.

These modern day ships represent major investments and it is mandatory that the turn around for them be rapid for the daily cost of the modern ship is such that it cannot pay its way unless it can be loaded and unloaded at a rapid rate. In other words its turn around time must be fast or the owner will not make a profit and without a profit the normal shipowner will withdraw his ship from an unprofitable trade and place his vessel in a trade where his ship can make a profit.

The same principle applies to a public as well as a private shipping company, although there may be certain unprofitable routes which a Government will maintain for other reasons such as national development, inaugurating a new service or providing a service essential to the defence or development of the country.

At the present time most of the worlds ports are incapable of accommodating the recent very large crude carriers (VLCC's), the large dry bulk carriers and the large fast third generation container ships which are now operating on the major international trade routes.

An important consideration is the fact that the cost of port facilities is usually a large multiple of the cost of ships using the port. Ships come usually in much smaller capacity units than ports and as a result we see a continuous addition of ships and changes in ship technology, while ports are usually built or rebuilt at great intervals. When a new port is built it must be designed to meet the demand and technology developments of 20 or more years hence. Otherwise it will be obsolete long before the end of its economic life.

Palembang has been the principal port of the Province of South Sumatra for many many years. It has been the primary trading and industrial center of the State and remains so today. All signs point to Palembang remaining the trading and industrial center of South Sumatra and among the fastest growing ports of Indonesia. As such South Sumatra will require a constantly increasing flow of goods to support its rapidly expanding industrial base. That there will be a steady increase in the cargo flowing into and out of the Musi-Banyuasin River deltas is a foregone conclusion, supported by the various studies covering transport needs in Sumatra including the Sumatra Regional Planning Study.

While there is almost universal agreement that commerce in the Province of South Sumatra will increase, as will the demand for additional transport and terminal capacity, there is no agreement as to where additional deep water port facilities should be constructed in order to most efficiently and cost effectively satisfy the projected demand for new port facilities.

2.0 CHANNELS AND NAVIGATIONAL CONSIDERATIONS

2.0.1 General Regional Oceanology

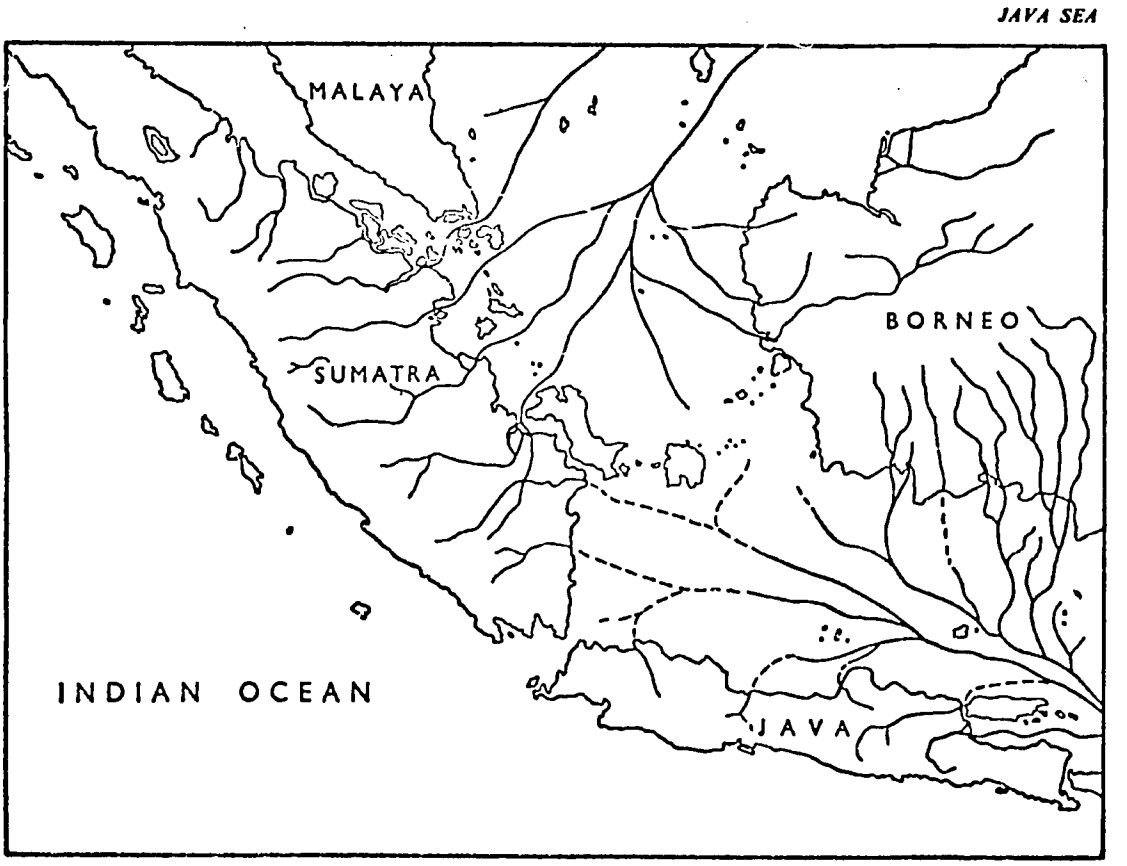
The Java Sea covers part of the largest shelf area in the world, the Sunda Shelf, which covers 1.8 millions km^2.

In the east, the Java Sea is bounded by the Makasser Straits, Flores Sea and Bali Sea, with the eastern limit as coinciding with the edge of the Sunda Shelf; Kangean Island to Makassar Straits and the Little Paternoster Island. The area is 433,000 km^2, with a mean depth of 46 m and total volume of 20,000 km^3.

The Java Sea thus defined borders the south coasts of Kalimantan (Borneo) and closely approximates the eastern shelf edge from Makassar Straits to Bali Straits, then follows the north coast of Java, and the east coasts of Sumatra as far as Bangka.

The general depth of the Java Sea is 40-50 m. The bottom of the Java Sea has an extremely low relief in which channels have been found, thanks to many early hydrographic surveys. These channels have been traced (by Molengraaff) to river mouths in East Sumatra and Malaya, west and south Kalimantan, and the north coast of Java. Two large river systems seem to have existed: The North Sunda River having headwaters in Sumatra and flowing northeast into the South Sea, with its tributaries rising on Malaya and West Kalimantan; the South Sunda River also rising on Sumatra both flowing eastward into the present Makassar Straits receiving tributaries from South Kalimantan and Java (Figure VII-2.0.1-1) The area is assumed to have been continental during the late Pleistocene eustatic "lows".

Besides the channels belonging to the two Sunda rivers, many "blind" channels are located within, and at the entrances of, the major straits leading to the Java Sea and also across submarine ridges and between



Drowned river system of the South China Sea and Java Sea (North Sunda and South Sunda River: together the "Molengraaff River system") (from Umbgrove, 1949).

FIGURE VII-2.0.1-1

Drowned River System of the South China Sea and Java Sea

coral reef platforms. This type of channel is invariably deepest where the strait is narrowest, as in Bangka Strait, where the channel depth is 11 m deeper than the general depth of the Strait (10 m). These "blind" channels are the result of scouring by marine currents in the soft, unconsolidated bottom sediments.

Surface Properties and Meteorology

Winds are typically monsoonal, blowing north-south near the equator, whereas in the Java Sea proper they alternate between east-southeast and north-northwest. The coral islands reflect a marked influence of the monsoons.

Table VII-2.0.1-1 showing the surface properties and meteorology of the Java Sea have been derived from a publication by the Royal Netherlands Geographical Society (1922) and also partically from recent meteorological notes.

Currents and Tides

Surface currents in the Java Sea are westward for eight months, from September through May, with six months uninterrupted flow. During the remaining months the currents are reversed (Figures VII-2.0.1-2 and 3) The influence of the predominant westward current is shown by the river mouths on the north coast of Java; many of them are deflected toward the west. The influence of the seasonal shift of the geostrophic winds on the mean sea level in the Philippines is well illustrated in Figure VII-2.0.1-4, as compared with the Indian Ocean coast of Java. A maximum contrast in level develops about August accompanied by an important transport from north to south (over 4 million m^3/sec) mainly through the South China Sea and the Java Sea.

Table 2.0.1-1

Surface Properties and Meteorology of the Java Sea

	Dec.-Feb.	Mar.-May	June-Aug.	Sept.-Nov.
Temperature, °C	27.5-28.8	28.0-29.1	27.0-29.0	27.8-28.3
Wind toward	ESE	Unsteady	NW	NW
(Beaufort)	1.5-3.4		1.5-4.4	0.5-2.4
Air pressure, cm	756.6-757.0	756.2-757.0	756.6-757.8	757.0-758.0
Salinity, %	31.0-32.0	29.5-32.0	31.0-33.5	32.5-33.5

SURFACE CURRENTS IN NAUTICAL MILES PER DAY IN THE JAVA SEA
(DIRECTION OF SET)

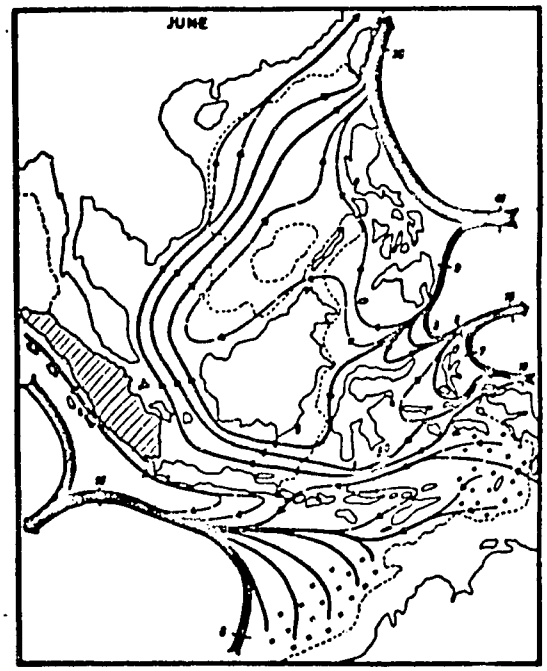
	Dec.-Feb.	Mar.-May	June-Aug.	Sept.-Nov.
Java Sea	to W 5-10	to W 1-10	to E 1-15	irregular

MAXIMUM TIDAL CURRENTS IN KNOTS

Toward		Java Sea
(a) Sunda Straits	2.2	N4°E and reversed
(b) West channel	1.4	N
to Surabaja	1.9	S
(c) Bangka Strait		
North entrance	1.9	S67°E and 1.0 reversed
South entrance	1.4	S45°E and 1.8 reversed

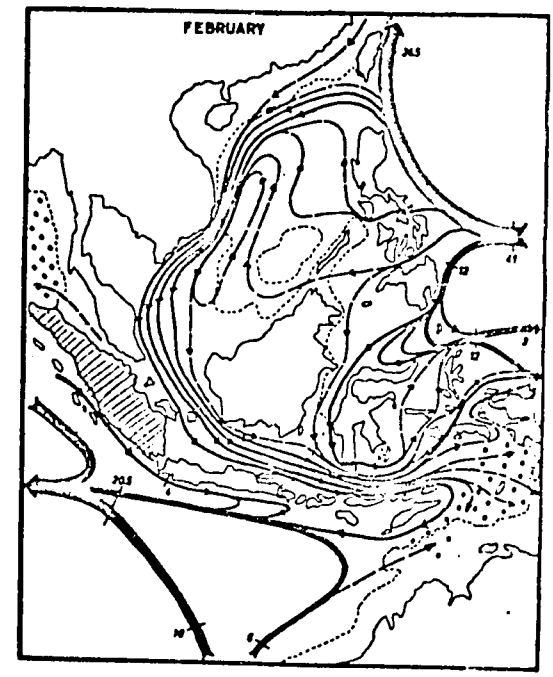
TIDAL RANGE IN METERS

1.0	Average of 4 stations on Java's north coast
1.4	Sampit Bay, South Kalimantan (Borneo)



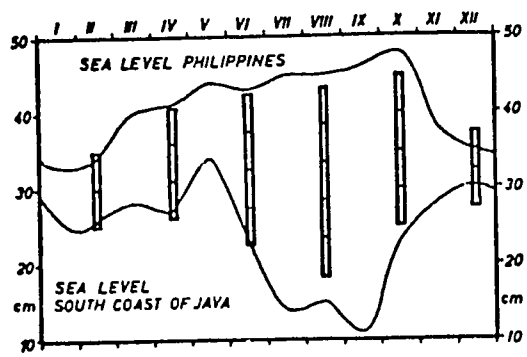
The June surface circulation in the East Indies. leading to a westerly set in the Java Sea. Transports in western Pacific and northeast Indian Ocean are given in million cubic meters per second. Note upwelling (+ + +) off Sahul Shelf (from Wyrtki, 1961).

FIGURE VII-2.0.1-2



The February circulation, showing easterly setting currents in the Java Sea, under the influence of the Asiatic (northwest) Monsoon. Transports are given in million cubic meters per second. Note sinking replaces upwelling along the edge of Sahul Shelf.

FIGURE VII-2.0.1-3



Annual variation in sea level between the Philippines and the south coast of Java. Transport is shown in vertical bars, each fraction corresponding to 0.5 million m^3/sec. Note how sea level is lowered along the Java coast from June to October during the southeast monsoon, but raised during the northwest monsoon. There is always a net transport from the western Pacific to the northeast Indian Ocean.

FIGURE VII-2.0.1-4

Chemistry

Owing to the shallow water, mostly less than 50 m, and heavily watered marginal lands, the salinity is normally low, and less than $32^0/00$. During the northwest monsoon, however, a tongue of high salinity enters from the South China Sea (see Figure VII-2.0.1-5)

Bottom Sediments

The bottom sediments of the Sunda Shelf have been divided into ten sedimentary petrographic provinces by Van Baren and Kiel (1950). The characteristic features of each group shown on Figure VII-2.0.1-6 are listed below, from youngest to oldest.

(1) Krakatau group: Hornblende, augite and abundant hypersthene still possessing glassy films.

(2) Deli group: Augite, hypersthene and 80-92% hornblende still possessing glassy films.

(3) Bawean group: Hypersthene, hornblende and 79-98% augite still possessing glassy films.

(4) Java group: Type I has less augite than Type II (49-90%) but is otherwise similar in mineral composition (hornblende, augite, hypersthene) without glassy films and with ragged edges.

(5) Kalimantan group (Borneo): Andalusite; Type II is richer in epidote than Type I.

(6) Meratus-Pulau Laut group: Epidote, glaucophane, zircon and rutile.

(7) Mixture of groups 5 and 6.

(8) South China Sea group: Coarse-grained epidote and blue-green hornblende, many different mineral associations probably implying closeness to sources.

(9) Malacca group: Similar to group 8 but with more ragged hypersthene.

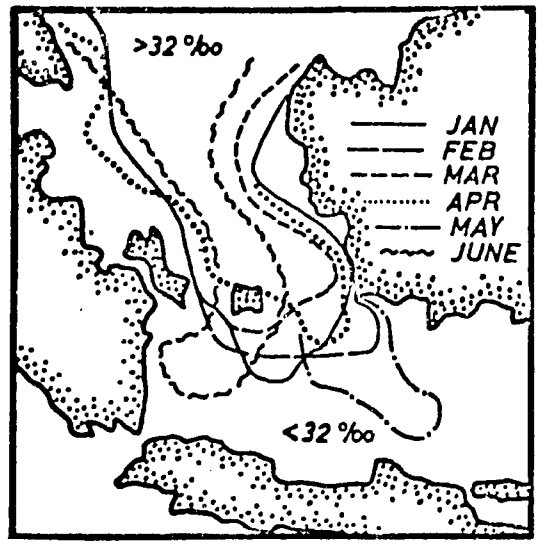
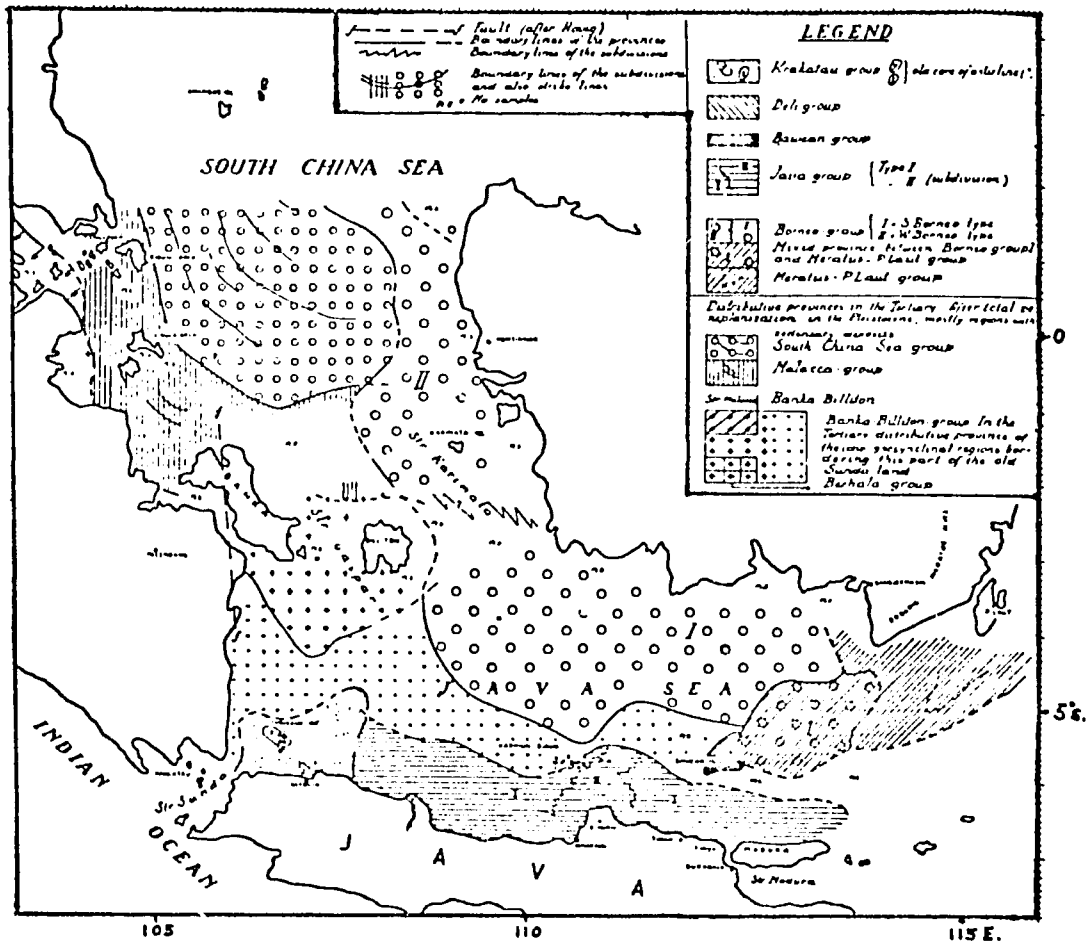


FIGURE VII-2.0.1-5

Tongues of high salinity (32 %) enter the Java Sea during the northwest monsoon and favor coral reef growth toward the northwest.



Sedimentary petrology of the Java Sea (Van Baren and Kiel, 1950).

FIGURE VII-2.0.1-6

(10) Bangka-Billiton group: Tourmaline, zircon and rutile.

Coastal accretion on the east coast of South Sumatra and on Java's north coast, beyond the spheres of influence of large rivers, ranges between 12 and 30 m annually. Near large river mouths and particularly in deltas, coastal growth is tremendous. Recorded figures range between 75 m (Jambi, Central Sumatra) and 200 m (Bodri River, Java) annually. In spite of the high rate of sedimentation, "drowned" estuaries are common on the coasts of Sumatra and South Kalimantan. Cuspate deltas are significant on the coast of Java, while West Kalimantan has a digitate delta at the mouth of the Kapuas River, the longest river in Indonesia (1143 km).

The Java Sea is largely too muddy (and in places too fresh) for corals, but rich reef growths are found in the areas of strong currents, northwest of Java, in the Thousand Islands and in the Bay of Jakarta (Batavia).

Geophysics and Geological Structure

The Java Sea and the Sunda Shelf in general are in isostatic equilibrium with small positive gravity anomalies below 50 mgal. However, subsidence and uplift mark its periphery particularly where the shelf borders the miogeosynclines (Umbgrove's "idiogeosynclines") of East Sumatra, North Java, etc. In North Kalimantan, late Miocene peneplains have been found up to heights of about 650 m.

A profile from the Java Sea to the Indian Ocean reveals earthquake foci increasing in depth from south to north. The epicenters located below the Java Sea reach depths of 650 km. The geological interpretations of such distributions of foci in Indonesia have been discussed by Vening Meinesz, Berlage,

The southwestern side of Bangka Straits are formed by the coast of Sumatra which is low-lying, densely wooded, and has no useful marks other than several points that can be distinguished only from short distances. The entire length of the Sumatra coast is bordered by a mud flat, comparatively narrow of the various points along the coast, but from 1 1/2 to 7 miles wide in some of the bights between the points. The depths on the mud flat are 3 fathoms or less. The depths in Bangka Straits are considerably deeper on the Bangka side than on the Sumatra side, and the bottom harder and even rocky in places.

Numerous rivers discharge into the Strait, the Air Banyuasin and the Air Musi, the two largest, flow through the Sumatra coast into the northwestern end of the strait. Both are navigable for a considerable distance, and provide the access for the substantial commerce of the Province of South Sumatra. Because of the accretion and resulting changing mud flats, vessels proceeding through Bangka Straits are advised to mark on the Bangka side for determining position rather than those on the Sumatra side. It was reported (1959) that the soundings in Bangka Straits were less than charted and that the lights (1966) in this vicinity were unreliable.

Winds - The influence of the land and sea breezes is noticeable in the strait. During the northwesterly monsoon the winds are stronger in the daytime than during the night, by reason of the fact that the land and sea breezes blow in the same direction. During the southeasterly monsoon the local breezes blow almost at right angles to the monsoon; during the day the winds are easterly, and at night more southerly when wind and sea are opposite in direction high seas have been observed in the strait.

Storms and squalls usually occur at night during the northwesterly monsoon, but seldom occur during the south-easterly monsoon.

Gutenberg and others (see Van Bemmelen, 1949); also in the last decade by Benioff and others.

The uniform depth and the presence of former stream channels have been advanced as proofs that the Sunda Shelf bottom represents an extensive peneplain upon which the present, predominantly granitic (Triassic) islands form the monadnocks. The denudation most probably took place during several periods of progressively lower sea level during the Pliocene and Pleistocene. The lowest stage was probably during the last glaciation (wisconsin). The extremely small gradient of the Sunda Rivers indicates that the central part of the shelf has been largely stable since its submergence. During the Pleistocene glaciations, the bottom of the Sunda Shelf served as a migration route for the fauna of southeast Asia, Sumatra, Java, and Kalimantan (Borneo).

2.0.2 Navigational Condition in Bangka Straits

The following information relative to the navigation of ships in the Bangka Straits was obtained from the U.S. Naval Hydrographic Office, H.O. Publication 71, Sailing Directions for Soenda Strait and the Western and Northeast Coasts of Borneo and Off-lying Islands - Fifth Edition 1951.

Bangka is an irregularly shaped island approximately 20 to 60 miles wide and 120 miles long, and lies off Southeast Sumatra, and forms the Bangka Straits separating Sumatra and Bangka. These straits, about 120 miles long, turn irregularly northwestward from its southern entrance, and are available to vessels drawing up to 11 meters. Bangka Straits are considered the best route between Singapore and Sunda Straits.

The northeasterly monsoon blows approximately from December to March and the southeasterly from May to November. Often there is a haze during the months of August and September.

Tidal Currents - The tidal currents in Bangka Straits are strong and irregular, and are greatly influenced by the monsoon streams. The following horizontal water movement may be accepted as a general summary.

In Bangka Straits a combination of semidiurnal and diurnal effect and monsoon current is experienced. When the spring tide sets southeastward, the maximum velocities of the two tides may coincide, in consequence of which the greatest velocities expected to occur to the southeastward (monsoon) average about 3.8 knots around June and December respectively. The maximum velocities occurring in the northeastward (monsoon) may be expected to average about 2.5 knots during the diurnal spring tides.

Monsoon Current - From May to November, the monsoon current is continuously northwest with a velocity of more than 1/2 knot. Neither the maximum velocities at spring tide to the southeastward nor those to the northwestward can coincide.

Freshnets - Between Batakarang punt and Tandjoeng Limau Boengkoek after heavy rains, the ordinary currents are considerably accelerated and diverted by the freshnets from the many rivers in the vicinity in the direction of Tandjoeng Kalian until they reach mid channel; these should be carefully guarded against at night.

Tide rips are frequently found abreast the island Poelau Nangka Besar, and are probably brought about by the meeting of the constant current setting southeastward along the Sumatra shore in the northern part of the strait and the current setting northwestward along the Bangka shore in the southeastern part of the strait. Vessels must guard against being set into or out of the entrance to the

Banyuasin River.

2.1 Improvements of Musi River

In this part of our report we concentrate on showing what could physically be done to improve the navigational depth of the Musi River. In particular we assess the amount of dredging that would be required, both initially (capital dredging) and annually (maintenance dredging) thereafter, to maintain given depths. We do not consider the alternative method of improving river condition - training of the river bed - because:

a) river training projects require particular, detailed analysis which is beyond the scope of this study;

b) we believe that in rivers that are unstable, good results can be achieved by training of the bed only if the training is done throughout major lengths of the river, and not only in localized places. Almost invariably this would be prohibitively expensive;

c) expenditure on localized river training would, in any case, be normally very similar to the cost of dredging to identical result.

A third method of physically improving the waterways involves a system of low, i.e. small hydrostatic head, dams designed to be used only during the low water stage and capable of being disassembled in some way as the water level rises. The dams require locks in order to permit river traffic to pass, so the total costs associated with a dam can be quite high. Usually these dams can be economically justified only when there are combined benefits in the three areas of water transport, irrigation, and flood control.

It is important to stress that this work is an essential part of an attempt to optimize the water transport system. Available depths of the Musi River through the year are of significance only because they determine the loaded drafts of vessels. Optimal depths are those that in conjunction with the vessel drafts they allow give the least-cost solution to the integrated transport system, including port transfer, or, more widely, the greatest net benefits to the economy as a whole.

We should stress that our calculations are approximate, because of both the limited information available and the limited time at our disposal for this part of our study. Nevertheless, the results are, we consider, sufficient for what one might inelegantly call the pre-feasibility stage of project preparation.

2.1.1 Methodology Used in the Calculation of Volumes of Dredging

Definition of Dredging Volumes

It is difficult to estimate accurately the amount of dredging, because the relationship between the depth of the river and the behavior of the river is very complex. The depth of the river depends on the nature of the soil of the river bed, the discharge and seasonal variation of this discharge, the speed at which the level of the water rises and falls, the velocity of water and the water level gradient, when the water level is high in the main and its tributaries, and finally tidal flows. All these factors vary for the river at different times and locations. Therefore, the volume of dredging changes each year and not in a constant way. For example, if

in a particular year, the speed of the fall of the water is greated than in a previous year, the water will be shallow for a longer time, and the volume of dredging will be greater.

There are two ways in which a general estimate of the volume of dredging can be made. One is through extrapolation from past trends, where one examines the empirical relationship between actual volume of dredging and actual depth of the river bed. The other involves computations based on hydrographic surveys and the relationship between the indicators of river stability and the volume of dredging. The first methods can be used when there is no intent to dredge deeper than has been done historically and where there are sufficient historical data. Because of the limited dredging data available, the trend method will be employed in combination with the second method though more difficult.

The dredging volume associated with maintenance dredging consists of two parts - the primary volume and the repair volume - and is usually expressed as

$$V_m = V_{pr} + V_{rp}$$

The primary volume is the volume that must be removed from a shallow area - a shoal or bar - as the water level is falling or when it has fallen, in order to keep the channel open to navigation at a required depth or to restore it to that depth. The repair volume is that volume which must be removed over the course of the low water season, when bottom buildup is relatively slow. In stable rivers, where the location of shoals is relatively constant and known, it is possible and advisable to remove the

primary volume during the period when the water level is falling though still relatively high.

Repair volume dredging can be executed at the same time as primary volume dredging, as a reserve, or it can be done later preferably during the low water stage. We feel that if dredging is done on a more regular basis, however, it will be possible to implement the second method, in which the repair volume is dredged at low water. This method has the disadvantage of requiring more movement of the dredging fleet, but this is offset and overcome by the fact that it avoids highly intensive work during the short falling water/ early low water periods and instead spreads the dredging work more evenly over the year.

Primary volume of dredging (Vpr) is related to the geometrical volume (Vg); technology reserves (Vr); Slope volume (Vsl) and the uneven volume (Vun) by a coefficient Ψ which depends on how the channels survived the high water stage.

Thus $Vpr = \Psi\ (vg + Vr + Vsl + Vun)$

The geometrical volume is calculated by taking the product of the desired channel width (w), the length of the channel which must be dredged (l), and the depth of the required cut (d).

Technology reserve is a function of the type of dredging and technology utilized. For longitudinal dredging it is greater than for transverse dredging. Based on the experience of past dredging operations, we have selected the value of 1.0-1.5 feet, as the additional depth to be used in calculating the reserve volume.

Slippage volume is that which is involved in the establishment of a stable slope along the edge of the cut. It is equal to the product of the length of the channel, the square of the depth of cut and the cotangent of the angle of the slope . (x).

For the river bottoms being considered the value of the cotangent was assumed to be 5.

Uneven ground volume is the volume due to transverse variations in the bottom profile with respect to the longitudinal survey line. It is usually taken at 10 percent of the geometrical volume $V_{un} = 0.1V_g$.

The coefficient Ψ depends on the hydrological and morphological characteristics of the river (discussed below).

Repair dredging relationships can be described as follows:

$Vrp = \sigma\beta Vpr$

σ – The repair volume as a precentage of the primary volume in the first stages of the dredging, when dredging consists of only 10-20 per cent or less of the natural depth.

β = 1 during the first stages of dredging as above, but varies as a function of the ratios of dredged depth to natural depth during later stages.

The relationships between these various classes of dredging volume depend on the stability of the river bed and the extent of the dredging cut.

An increase in the transit channels will naturally increase the volume of dredging in associated areas such as the approach channels to ports,

to ship yards and short cuts. We estimate on the basis of our analysis of the present statistical data, that the volume of this associated dredging is approximately 35 per cent of the transit volume.

The main problems are the values of the coefficients ψ, σ and β. These values are important because when the river is unstable the geometrical volume will probably not be more than 20-30 per cent of the maintenance volume as a whole. Conversely, in a stable river maintenance volume is less than the geometrical volume. The values of these coefficients are related to the stability of the river bed. Therefore, we first describe quantitatively the degree of river stability and then with the relationships between these indications and the dredging coefficients ψ, σ and β.

2.1.1.1 Method of Estimating River Stability, Dredging Coefficients and the Relationships Between Them

The degree of survival of the channels in the high water stage depends on the stability of the river bed, and especially on the character of the high water stage i.e. on its duration, on its amplitude, on the rate of change of water level after high water, amount of river bed material supply. In almost all rivers with relatively unstable beds and seasonal variations in water discharge rate, the channels after high water are nearly completely silted and the river bed has returned to its natural undredged condition. Therefore, in these rivers the coefficient $\psi = 1.0$. To this group of rivers of course belong most rivers with alluvial beds and seasonal sources.

In stable rivers with small water level gradients and relatively low seasonal variations in water discharge rate, part of the dredged channels survive after the high water stage. The Musi River belongs to this group.

Rivers of the first, unstable, type require intensive annual dredging work just before the low water stage; in the case of extremely unstable rivers only very close to the low water stage. Rivers of the second type may be dredged throughout the year, except at high water stage. In these rivers one can remove a greater volume in one year and thus create a reserve which may avoid the need for dredging in the subsequent year.

In the unstable rivers, with intensive river bed processes in the low water stage, even a small increase of channel depth relative to the natural depth may require a volume of repair dredging as high as 50 per cent of the primary volume. In this type of river the degree of siltation depends on the degree of depth, relative to natural depth, and an increase in depth causes a high increase in siltation rate.

In more stable rivers the volume of repair work is a smaller percentage of primary volume. The value of β will approach one and in exceptionally stable rivers can be less than one, where the river has a constant volume of bed material supply. The form of a stable river bed changes slowly.

Thus, there is a strong relationship between the stability of rivers and the result of dredging work. But the volume of dredging cannot be computed analytically with full precision, because many factors affect the river bed form, and because it is impossible to foresee how all

the factors will interact. For precise quantification, the relationships which determine the balance between supply of bed material, the transporting capacity of the river and depth have to be determined for several 'cross'-sections of the distance between the cross-sections has to be small, for local redistribution of river bed material can affect the calculations. For project planning purposes it is advisable to use indicators of river stability which are more characteristic of the gross behavior of large parts of a river. There are two ways to approach this problem. One is to use only the most important of the river's hydrological and morphological parameters, combined in approximate relationships which are reasonably correct quantitative indicators of the river's stability. The second way is to compare the indicators based on a more complete consideration of all of the factors contributing to river stability. Unfortunately the second method requires a great deal of computation. Therefore, in view of our time limitations, we use the first method.

This method involves the following steps:

a. determine the relationships between the most important hydrological and morphological parameters which determine the stability of the river bed;

b. select a small number of these relationships, which, taken together, will give a strong indication of the stability of the river;

c. with these relationships and a qualitative consideration of the river behavior, it is then possible to estimate the coefficients, ψ, σ and β.

The relationships we will use are:

$$P_1 = \frac{d50 \ .1000}{.W}$$

$$P_2 = \frac{Q0.5}{0.2.W}$$

$$P_3 = \frac{Q \ max}{Q \ min}$$

d_{50} = grain diameter, average, kilometers

= water level gradient

W = width of river, measured at the surface, kilometers for P_1 and meters for P_2

Q = discharge of water M^3/sec; Qmax. - high water, Qmin - low water

The first equation is an analytically derived but empirically modified relationship which has been shown to characterize the stability of flat rivers well. The second equation is an empirical relationship based on data obtained from rivers similar to those in this country, namely rivers with mountain sources and thick alluvial beds. The third indicator is self explanatory.

The relationships between the first two indicators of river bed stability (P_1, P_2) and the coefficients ψ, σ and β which permit calculation of dredging volume are based on broad experience with dredging work in many different rivers.

To calculate the river stability indicators, we use the parameters of the high water stage, because the form of the river bed is determined mainly during this period. In indicator P_2, the dominant river discharge rate with 0.75 probability of occurrences (based on 20 years' records) was used. Simultaneously, we also took

the hydraulic and morphological characteristics of the low water period, in order to have a better basis for estimating the coefficients σ and β.

This approach is adequate for rivers with ordinary behavior, but in rivers with unusual behavior (namely frequent changes in water level and backwater phenomena in which tidal effects or water level differences between a river and its tributaries may cause current reversals) the approach may produce somewhat erroneous results. This unusual behavior normally occurs in the upper regions of reservoir areas. Because of this behaviour, it is useful to compare the results of computations using the above approach with the results obtained using the other methodology, based on the integral indicators of river bed stability. The integral indicators are in turn based on the form of the cross-section of the river. One example of an integral indicator is the ratio between the increment in the logarithm of depth and the increment in the logarithm of width in a given cross-section of river, or

$$P_4 = \frac{\Delta \log a}{\Delta \log w}$$

Because of the possible influence of backwater phenomena on the approach we are using, we recommend that river stability estimates based on the integral indicators be made when time permits in order to verify the estimates of this report.

2.1.1.2 Physical Limits to Dredging

The volume of dredging, and therefore the cost, obviously increase with increasing depth of channel. Clearly then, there is a depth at which the

cost of dredging will equal the benefits to the commercial fleet and beyond which the costs will exceed the benefits. This point is the economic limit of depth, but sometimes it is not the economic limit but the physical limit, when dredging will basically change the river form, which determines how deep a channel can be dredged. The physical limit is reached when the cross-section of the dredged channel approaches 15 per cent of the cross-sectional area of the river itself. In this case, the lowering of the water level in the river will be followed by a corresponding lowering of the water level in the channels and the upper part of the river. The lowering of the water level can be calculated with the following formula:

$$Q^2 = a_o{}^3 w^2 C^2 \; o = a_o{}^3 w^2 C^2 = \frac{Zo}{l}$$

Where C is the Chezy coefficient[1]; a_o are, respectively, depth, water level gradient, and water level fall in a channel length before dredging.

After dredging to a depth of $a_o + \Delta a$ there is a fall in water level at the beginning of the link of an amount Δz, but at the end of the link the level does not change. If we take the Chezy coefficient and assume that the width of the river remains constant, then, after dredging, the depth is given by $a_o + \Delta a - \frac{\Delta Z}{2}$

and the water level gradient by $\frac{Zo - \Delta A}{l}$

Therefore, $Q^2 = (a_o + \Delta a - \frac{\Delta Z}{2})^3 w^2 C^2 \frac{Zo - \Delta Z}{l}$

[1]This coefficient relates to degree of roughness of the river bed.

If we equalize then we have $(1 + \frac{\Delta a}{a_o} - \frac{\Delta Z}{2a_o})^3$

$$(1 - \frac{\Delta Z}{Z_o}) = 1$$

The average incremental depth can be estimated by

$$\Delta a = \frac{V}{W.I}$$

where V = Dredging volume
W = Surface width
L = Channel length

Clearly however the real depth is (a-Z) where a is the intended depth of the bottom at SLW. Thus, dredging becomes physically impractical, if the cross-sectional area of the channel equals a substantial portion of the cross-sectional area of the river, because the water level will fall nearly as fast as the river bottom is lowered.

Another indicator of the maximum channel depth that can be dredged is the average depth of the deeper parts of the river between the shallow parts. The average depth of the river depends on the river width and the relative hardness of the soil and can be estimated by

$$a = \frac{wk}{10}$$

Where K is close to 1 in hard soil and decreases to 0.5 in very soft soil.

2.1.1.3 Analysis of the Water Level Regime

Conditions of navigation depend on the water and level regimes of the rivers, and in particular on the relationships between (a) discharge rate and level of water - Q = F(h), (b) level of water and time h = F(t); and (c) level and depth - a = F(h).

The practical importance of the relationship Q=F (h) stems from the fact that there are various consumptions and uses of water and thus the water is continually changing. In particular, various irrigation projects will decrease the total annual water discharge as well as change water distribution in all seasons.

By using the above relationships we can calculate the degree to which changes in patterns of consumption will influence river navigability, though, for rivers such as the Musi and its tributaries, subject to tide these relationships become complex.

It is difficult to estimate the correlation between water level and depth. It is well known that an increase in water level does not necessarily produce an equivalent increase in depth. In most cases water level increases more than the depth. In unstable rivers the increase in depth is a smaller proportion of the increase in water level than in stable rivers; conversely a reduction in water level in unstable rivers produces a small proportional decrease in depth, since the water scours the river bed as the level falls. It is therefore advisable in unstable rivers to wait until the level of the water has fallen before beginning dredging. Figure VII-2.1.1-1 shows the empirical relationships between depth and level for the Musi River. The data points on the graphs are scattered because of the many factors which affect the relationship between depth and level, but the relationships indicated are sufficiently accurate for economic estimates.

Tide has a great influence on level and depth regimes. The amplitude of the tide is influenced by the sun, the moon, and by their relative position. The sun and moon each cause tidal effects which vary

Figure VII-2.1.1-1

Empirical Relationship Between Depth and Level

Musi River

To Be Completed for Final Report

sinusoidally with a period of about 12 hours. Because of phase and period differences between the solar and lunar tides, the net tidal effect observed is the result of interference or reinforcement effects and varies with a period of 15 days. The result of maximum positive reinforcement, the highest high tide, is called the spring tide and the result of maximum negative reinforcement, the highest low tide, is called the neap tide.

In South Sumatra the normal oscillation of the tide is predictable. In the Musi River the tide is affected by seasonal changes in discharge. Figure shows this interaction between discharge and tide for a particular place. The normal tide oscillation is not quite symmetric about the main water level but the assymetry is small and can be ignored.

2.1.1.4 Computation of Usable Average Depth

Dredging is undertaken primarily to increase the minimum guaranteed depth at SLW. The minimum guaranteed depth is that depth which is available for 95 per cent of the year. The depth may drop below this value for at most 18 days in a year. On the other hand, during much of the year the water level is greater than SLW, and during these periods ships with greater draft can use the waterway. In most cases, there is economic benefit in having ships with a fully loaded draft which is greater than the minimum guaranteed depth. The average depth which is usable by a vessel over a period of time depends on the:

a) character of water level changes[1];

b) the relationship between water level and depth;

c) the fully-loaded draft of the vessel

There are two ways of calculating average usable depth. The first method gives the average usable depth for a particular type of vessel during the year. Duration curves may be used for this calculation. This method can be used when the flow of the commodities is relatively constant. If the commodities are seasonal, the average value of depth can be calculated for a season, or for each month, using the second method. This second method requires the use of frequency curves.

The average usable depth a_{av} is calculated for a given type of vessel. It is equal to the average depth which the vessel can use over a period of time.. This usable depth is limited to a value less than or equal to the maximum depth which the ship can use, a_{max}, where a_{max} is equal to the fully loaded draft plus the required clearance between the keel of the ship and the river bottom.

For a given type of ship with specific a_{max} the average available depth is computed using the formula

$$a_{av} = a_{min} + \frac{W}{T} Z$$

Where

W = the area under the duration curve (method) or the area under the frequency curve (method 2) bounded by the constraints a_{min} and a_{max}. a_{min} = the minimum depth.

---

[1]The height of the water level depends on the amount of water discharge in a particular year. For the purpose of a preliminary analysis, the frequency curve on 50 per cent probability may be used.

T = the length of time over which W is computed; measured as percentage for duration curves or as days for frequency curves

Z = a discount factor (less than one) used to account for events which increase the measured depth but are too short to be used in regular navigation (e.g. rainfall), Z = 0.9.

This formula can be used to define a relationship between a vessel's fully-loaded draft and the average draft (depth minus clearance) for a period of a year or less.

The sequence of calculations as presented so far is:

1. determine water level duration (or frequency) curves;
2. derive water-level versus depth relationship;
3. derive depth duration curves;
4. determine average available depth for a vessel of a given fully loaded draft;
5. Derive the relationship between fully loaded draft and average available draft.

Several examples of this calculation are presented in the subsequent analyses of various channel alternatives.

A further important cyclic variation in available water depth arises in those rivers which show tidal effects. It is a particularly important variation because the change in available depth is exactly equal to the change in water level due to tidal effects. All of the seasonal water level data collected are average values for a day, i.e. the measured depth recorded each day is an average between the readings of high tide and of low tide. Because of this, the SLW level that is apparent from the data is, by convention, corrected to a lower level by subtracting

half the difference between the high tide and low tide readings. The SLW used in our subsequent calculation then corresponds to the low tide reading at the seasonal low water level over a number of years. Likewise, the seasonal water level data presented graphically throughout this report refer to the low tide levels.

Because of this convention, the depth available for navigation for a 6 or 12 hour period consists of three parts: the SLW depth, the seasonal increment, and a tidal increment. The tidal increment is added because, even though the high tide depth exists in principle for only an instant, in fact, there is a period of 6 hours (3 hours before and after high tide) during which the available depth is near the maximum and there is a longer period of 12 hours (6 hours before and after high tide) when the available depth is equal or greater than the average depth for the day. These depths may be expressed as follows:

$$a_6 = a_{min} + a_{seas} + t_6$$

$$a_{12} = a_{min} + a_{seas} + t_{10}$$

where; a_6 is the depth available for six hours of a given date.

t_6 is the tidal increment that exists for 6 hours of that date

a_{12}, t_{12} are the corresponding 12 hour figures

a_{min}, a_{seas} are as defined previously

2.1.1.5 Selection of Optimum Depth.

A dredging model will be used to determine the optimum relation of dredged channel depth to barge and ship size. The model will use as an input various sizes of vessels with varying draft and corresponding cost of transportation of all the important commodity flows. Usable draft, as a function of varying available draft throughout the year will be established for each flow. This draft will be used as the b ase line or lower bound. The cost of dredging to greater than the minimum available depth will then be computed.

By comparing dredging costs and fleet costs we may obtain an optimum channel depth. Total annual transportation costs for each flow under investigation are then calculated and plotted against draft for partial to full loading. Based on these data and on the relationship between full load draft and average usable draft, we calculate the relationship between full load draft and total transportation cost for each alternative minimum depth of channel. From such a relationship the size distribution of the fleet for each alternative of minimum depth will be selected. Then, dredging cost, fleet cost and the sum of these costs each as a function of minimum depth are combined and the minimum of the total cost obtained which indicatesthe best minimum depth of channel to be maintained.

This approach will be taken and transport costs derived for each barge or vessel with given draft and channel depth combination. Where a given vessel draft is less than the minimum channel depth by one or two feet depending on route, for all or part of the year, partial loading for all or part of the year will be assumed to ensure that no more than available minimum draft will be used in the transportation cost calculations.

This procedure will be repeated for each level of artificially increased channel depth, when dredging costs are added to the transport costs. The results of this study are shown in Appendix A.

2.1.1.6 Dredging Quantities.

The main consideration is dredging volume and costs. Dredging costs depend on three factors: a) volume of capital dredging; b) required volume of maintenance dredging, and c) physical possibility of performing the work. This last factor is important because in rivers with small river beds and small discharge dredging or deepening of the river bed alone cannot provide the required depth. Most of the basic information used in this study was obtained from reports published by NEDECO.

Experience shows that low (5% maintenance volume) is correct for artificial irrigation channels and where the velocity of the water-current is below the critical level, and where there is no seasonal variation of the water-level and water-discharge. In natural rivers, even in very stable rivers, and rivers subject to tidal flows, the required volume of maintenance dredging is, however, usually much greater than five per cent. This is particularly the case where a large sediment or silt flow concentration exists. The percentage of silt in suspension in the flow of the Musi River is reasonably high.

As a quantitative indication of river bed stability, the ratio of the critical water velocity of the river to the actual water velocity is often used. In calculating the critical velocity of the water-current many relationships may be used. A most common and effective measure

is:

$$V_{cr} = 1.3\left(\frac{0.01}{d^{1/6}} + 4.7\ d^{1/3}\right)\ a^{1/6}$$

Where d = average grain diameter (for almost all rivers $d_{50} \approx 0.0001$ wt); a = average water depth (for a = 5 feet - V = 0.4 ut/sec; for a = 15 feet - V = 0.4 ut/sec).

2.1.1.7 Multi-Purpose Use of Rivers

Complete water control includes the following components: irrigation; prevention of saline inundation and intrusion into streams of the coastal area; drainage and flood control; fisheries and water quality control; municipal and industrial supply; and, navigation. Up to the present, the projects undertaken have considered only two of these components, irrigation and navigation. However, even small modifications of the natural water regime affect all these components. With larger modifications it is necessary to examine all components in order to avoid serious mistakes and economic losses.

Three major inter-relationships between navigational condition and water consumption use are as follows:

1. The decrease in discharge during low water stage due to offtake for irrigation.
2. Reconstruction of a river owing to capital dredging for flood control or installation of barrages for water regulation.
3. The use for navigation of large irrigation and evacuation canals.

It is generally estimated that up to 60 per cent of the lower quartile flow may be pumped from rivers without adverse affects on navigation and other uses of surface water. This is true for large rivers in which

the cross section of the channel is a small part of the cross-section of the river as a whole, but in smaller rivers where the channel cross-section is 10 per cent or more of the river cross-section a 60 per cent reduction would prohibitively limit navigation. In order to estimate the limit of offtake which would still permit navigation the following condition is used:

$$\frac{Q}{V.M} > 10$$

where Q is discharge, V is water velocity and M is vessel midship section. If this constraint is satisfied, then the water offtake can be compensated with extra dredging. If this constraint is not met, then either smaller vessels must be used or navigation will be impossible.

For navigational use of irrigation or evacuation canals, the same condition must be satisfied and the slope of the banks must be safe with regard to vessel generated waves.

2.1.2 Deepening Musi River to Palembang - Dredging

The Musi River just prior to the start of recorded dredging in 1966 had a maximum depth over the Outer Bar of about 4.1 meters and the maximum depths over the remaining shallow bars in the river ranged from about 4.0 to 5.0 meters at mean low water.

The Outer Bar and the river bars have been gradually deepened by a process of maintenance dredging until early 1975 at which time the controlling depth of the primary river channel stood at about 5.3 meters. Reference Chart No. 160 - Sungai Musi.

During 1975 a capital dredging program performed by a private contractor dredged the Outer Bar to a depth of 7 meters and upriver in way of Payung Island to a depth of 6 meters, while RI dredges dredged the bars in the upper reaches of the Musi River below Palembang to 6 meters LLW.

The purpose in dredging the Outer Bar to 7 meters was to permit deeply laden ships with a 6 meter draft to navigate the Musi River outbound from Palembang on one high tide such that they would have 6 meters depth on the Outer Bar for several hours after the change of tide at high water.

Table VII - 2.1.2-1 is a tide table for the Musi River Outer Bar originated by Pertamina and distributed for limited use.

The readings in the Table VII - 2.1.2-1 are depths in decimeters above LLW for the Outer Bar for each hour of the day. The table reveals that for the month observed the maximum higher high tide was 2.8 meters and the minimum higher high tide was about 2.2 meters.

Assuming that the LLW dredged depth is 6 meters and that the minimum keel clearance is 0.5 meters, the usable depth at any HHW would be (6 + 2.2 - 0.5) = 7.7 meters = 25 feet.

Table VII - 2.1.2-2 is a table of supplementary tide and water level data which when used in conjunction with Table VII - 2.1.2-1 will give the height of water above LLW at any hour at any point on the river and during the rainy season as well. During the rainy season from December to April the Musi River rises about 1.1 meters at Palembang and levels out again at the Outer Bar.

In October 1975 the SS Indian Mail a large modern break bulk cargo ship called at the Port of Palembang and discharged a cargo of baled cotton and heavy lift machinery. The ship was 605 ft (184 M) long of 22,000 DWT and entered

Table 2.1.2-1 Tide Table

NOPEMBER 1975

h \ j	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	j / h
1	16	17	18	19	20	20	19	18	17	16	15	15	15	16	17	18	20	20	20	19	18	17	16	15	16	1
2	16	17	19	20	22	23	23	22	20	18	17	15	14	14	15	17	18	19	19	18	17	16	15	14	15	2
3	15	16	18	21	23	25	26	25	24	22	19	17	15	14	14	15	16	17	17	17	16	14	13	12	13	3
4	13	14	16	20	23	26	28	28	28	26	22	19	17	15	14	14	15	15	16	16	15	13	12	11	10	4
5	10	12	14	18	22	25	28	30	30	28	26	23	20	17	15	14	14	15	15	15	14	12	11	10	09	5
6	09	11	12	15	19	23	27	30	31	31	29	26	23	20	17	16	15	15	14	14	13	12	11	09	09	6
7	08	08	09	12	16	20	25	28	31	32	31	29	26	23	20	17	16	15	15	14	13	12	10	09	08	7
8	08	07	08	09	13	17	21	26	29	31	32	31	28	26	23	20	18	17	16	15	14	12	11	10	08	8
9	08	07	07	08	11	14	18	23	26	29	30	31	30	28	25	23	20	18	17	16	15	13	12	11	10	9
10	10	09	08	08	09	12	15	19	23	25	28	29	29	29	27	25	22	20	18	17	16	14	13	12	11	10
11	11	10	10	09	10	11	13	16	19	22	25	27	29	29	27	26	24	22	20	18	17	15	14	13	13	11
12	13	12	12	11	11	12	13	14	16	19	21	23	25	26	27	26	24	22	21	19	17	16	15	14	14	12
13	14	14	14	14	14	14	14	14	15	16	18	20	22	23	24	25	24	23	21	20	17	16	15	15	15	13
14	15	16	17	17	17	17	16	16	15	15	16	17	18	20	21	23	23	22	21	19	18	16	15	15	15	14
15	15	16	18	19	20	20	20	18	17	16	15	15	16	17	18	20	21	21	20	19	17	16	14	14	15	15
16	15	16	18	20	22	23	23	22	21	19	17	15	15	15	16	17	18	19	19	18	16	15	13	13	14	16
17	14	15	18	21	24	26	27	26	24	22	19	17	15	14	14	15	16	17	17	16	15	13	12	12	12	17
18	12	14	16	20	23	27	28	29	28	26	23	20	17	15	14	14	14	15	15	15	13	12	11	10	11	18
19	11	12	15	18	22	26	29	30	30	29	27	23	20	17	15	14	14	14	14	13	12	11	10	09	09	19
20	09	10	12	16	20	24	28	30	32	31	29	27	23	20	17	16	14	14	13	13	11	10	09	08	08	20
21	08	08	10	13	17	22	26	29	31	32	31	29	26	23	20	18	16	15	13	12	11	10	08	08	07	21
22	07	07	08	11	15	19	23	27	30	31	32	31	28	25	23	20	18	17	15	13	12	10	09	08	07	22
23	07	07	08	09	12	16	20	24	27	29	31	31	30	28	25	23	20	18	17	15	13	12	10	09	08	23
24	08	07	08	08	11	15	17	21	24	27	29	30	29	28	27	24	22	20	18	17	15	13	12	10	09	24
25	09	09	09	09	10	12	15	18	21	24	26	27	28	28	27	25	23	21	20	18	17	15	13	12	11	25
26	11	11	10	10	11	12	14	17	19	21	23	25	26	26	26	25	23	21	20	18	17	16	15	14	14	26
27	14	13	13	13	13	13	14	16	17	19	20	22	23	24	24	24	23	21	20	18	18	17	16	16	15	27
28	15	16	16	16	16	16	16	16	17	18	18	19	20	21	22	22	21	20	19	18	17	16	16	16	17	28
29	17	18	18	19	19	19	18	18	17	17	17	18	18	19	20	20	20	19	18	17	16	15	15	15	16	29
30	16	18	20	21	22	22	22	21	20	18	17	17	17	17	18	18	18	18	16	15	14	13	13	14	15	30
h / j	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	j / h

DESEMBER 1975

h \ j	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	j / h
1	15	17	19	22	24	25	25	24	22	21	18	17	16	16	16	16	16	16	15	13	12	11	11	11	13	1
2	13	15	18	22	25	27	28	27	25	23	21	19	17	16	16	16	15	15	14	13	11	10	09	09	10	2
3	10	13	16	20	24	28	29	30	29	27	24	21	19	17	16	15	15	14	13	12	11	09	08	07	08	3
4	08	10	13	17	22	27	30	31	32	30	28	25	22	19	17	16	15	14	13	12	11	09	07	06	06	4
5	06	07	10	14	19	24	28	31	32	32	31	28	25	21	18	17	16	15	14	13	11	10	08	06	05	5
6	05	06	08	11	15	21	26	29	32	33	32	30	27	24	21	18	17	16	15	13	12	11	09	07	06	6
7	06	05	06	08	12	17	22	26	29	31	32	31	29	26	23	21	18	17	16	15	13	12	10	09	07	7
8	07	06	06	08	10	14	18	22	26	29	30	31	30	28	25	22	20	18	17	15	14	13	12	11	09	8
9	09	08	07	08	09	12	14	19	23	27	29	29	29	28	26	23	21	19	18	16	15	14	13	12	12	9
10	12	11	10	10	10	11	13	16	19	22	24	26	27	27	26	24	22	20	18	17	16	15	15	14	14	10
11	14	13	13	12	12	13	13	15	17	19	21	23	24	25	25	24	22	20	18	17	16	15	15	15	15	11
12	15	16	16	16	15	15	15	15	16	17	18	20	21	22	23	22	21	20	18	17	16	15	15	15	16	12
13	16	17	18	19	19	18	18	17	17	17	17	18	19	19	20	20	20	19	17	16	15	14	14	15	16	13
14	16	18	20	21	22	22	21	20	19	18	17	17	17	17	18	18	18	17	16	15	13	13	13	13	15	14
15	15	17	20	22	23	25	25	24	22	20	19	17	16	16	16	16	16	16	15	13	12	11	11	12	13	15
16	13	16	19	22	25	27	28	27	26	24	21	19	17	16	15	15	15	15	14	13	12	11	10	09	10	11	16
17	11	13	17	21	25	28	29	30	29	27	25	22	19	17	15	14	14	13	12	11	10	09	09	08	09	17
18	09	11	14	18	23	27	30	31	31	30	28	25	22	19	17	15	14	13	12	11	10	08	07	06	07	18
19	07	08	12	16	20	25	28	31	32	32	30	28	25	22	18	17	15	14	13	11	10	08	07	07	06	19
20	06	07	09	13	17	22	26	29	31	32	32	30	27	24	21	18	17	15	13	12	11	09	07	06	06	20
21	06	06	07	10	14	18	23	27	30	31	32	31	29	27	23	21	18	17	15	13	12	10	08	07	06	21
22	06	06	06	08	12	16	20	24	27	29	32	30	29	27	25	22	20	18	17	15	14	12	11	09	08	22
23	08	07	07	08	10	13	17	21	24	26	28	29	28	27	25	23	21	19	18	17	15	14	13	12	11	23
24	11	10	09	09	10	12	15	18	21	23	25	27	27	26	24	23	21	20	18	17	16	16	15	14	13	24
25	13	12	12	11	11	12	14	17	19	21	23	24	24	24	23	22	20	19	18	17	17	17	16	16	16	25
26	16	15	15	14	14	14	15	16	17	19	20	21	22	22	22	21	19	18	17	16	16	16	17	17	17	26
27	17	18	18	18	17	17	16	17	17	18	19	19	20	20	20	19	18	16	15	15	15	15	16	17	18	27
28	18	19	20	21	21	20	19	19	19	18	18	18	18	18	17	16	15	14	13	13	13	14	15	17	28	
29	17	19	21	23	23	24	23	22	21	20	19	18	17	17	17	16	14	13	11	11	11	11	13	15	29	
30	15	18	21	24	26	27	26	25	23	22	20	19	17	16	16	15	13	12	11	09	09	09	10	13	30	
31	13	16	20	23	25	26	27	26	27	25	23	21	18	17	16	15	15	14	12	10	08	07	07	08	10	31
h / j	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	j / h

SUNGAI MUSI (Ambang Luar)

TABLE VII-2.1.2-2

SUPPLEMENTARY TIDE AND WATER LEVEL DATA

The tidal constants have been interpolated between the constants for the Pilot Light Vessel and those of Sungsang. The predictions are given for the Outer Bar. Upstreams HW and LW occur roughly 1 hour later for every 12 miles; consequently :

Location	Hours	
HW and LW bar west of Beruk (Pro) and east of Payung	¾	After the time of HW and LW on the Outer Bar.
HW and LW bar upstreams Kg. Upang ...	2¾	
HW and LW bar downstreams Kg. Perajen	3½	
HW and LW near Plaju	4	

During the wet season (December-April) the following corrections are to be applied :

Location	Deci-meters	
Outer Bar	0	To be added to the heights given in the tables.
Bar west of Beruk	2	
Bar upstreams from Kg. Upang	6	
Bar downstreams from Perajen	9	
Near Plaju	10	
Palembang	11	

the Musi River with a draft of about 20 feet (6 M). After discharging her cargo about 1000 tons, the Indian Mail sailed down river at a draft of 19 feet (5.8 M). The ship was equipped with a bow thruster, which was not used in transiting the river either way although it was held in readiness and was used for docking the ship.

The ship a relatively high powered ship 24,000 SHP and 22 knots speed had no problems at all in navigating the river at a speed of about 13 knots with slower speed at the turns and shallow areas. It was the general consensus of those involved that subject to draft limitations ships of 185 meters (607 ft) could navigate the Musi River with safety but should have tug assistance for docking and to assist large low powered ships without bow thrusters at the sharp turns in the river.

A report on the voyage of the SS Indian Mail to Palembang is included as Appendix-A.

In summary Palembang is suitable for an international ocean shipping port within the limitations of its draft which subject is discussed in the next section.

2.1.2.1 Dredging Operations

As stated oreviously all dredging prior to 1975 has been listed as maintenance dredging despite the fact that on several occasions the depth of water at the Outer Bar and other shallow areas in the river were gradually deepened about one meter. Figure VII-2.1.2-1 is a dredging plan of the Musi River navigational channel and is introduced at this time to indicate locations on the river which have been dredged and/or will require future dredging.

Table VII-2.1.2-3, sheet 1 to 10, is a listing of all maintenance dredging performed on the Musi River and Outer Bar by location of dredging and the year.

Table VII-2.1.2-4 is a summary of maintenance

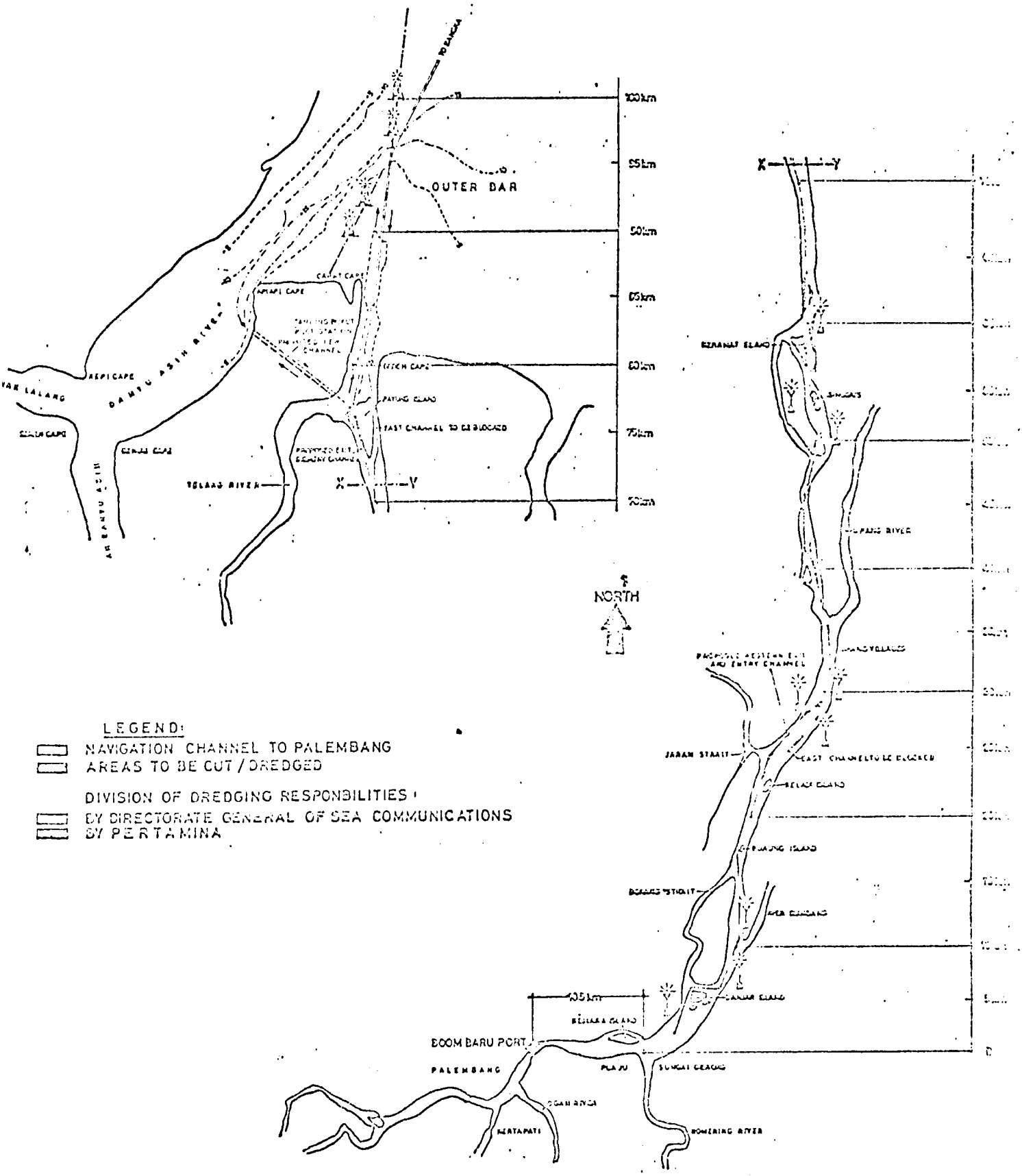


FIGURE: VII-2.1.2-1

MUSI RIVER CHANNEL OF NAVIGATION & FUTURE PLAN

SOURCE : TECHNICAL DIVISION / DREDGING AFFAIRS

PORT ADMINISTRATION OF PALEMBANG

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1975 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10	11
Item No.	Location	Type of soil at location	Normal (1) depth prior to initial capital dredging	Initial capital dredging quantities year 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost (2) 1000 M^3	Depth actual after annual maintenance	Depth siltation annual M	Chart depth no dredging M
1.	Ambang Luar (Outer Bar)	(3) Mud and sand	- 5.5	2,500 1975	- 7.0	- 5.3	124 450	- 5.5	0.2	4.1
2.	Pulau Payung Utara (North)	—	—	—	—	—	—	—	—	4.2
3.	Perajen	Sand (4)	- 5.1	160 1975	- 6.0	- 4.3	120 450	- 5.1	—	4.2
4.	Pulau Payung Barat (West)	Mud and sand	- 4.5	2,500 1975	- 6.0	—	—	—	—	4.3
5.	Pulau Payung Timur (East/(South)	Mud and sand	—	—	—	- 4.3	203 450	- 4.5	0.2	4.0
6.	Selat Jaran	Sand	- 5.1	160 1975	- 6.0	- 4.3	110 450	- 5.1	—	4.3
7.	Pulau Payung Selatan (South)									4.0
8.	Pulau Ayam	Sand	- 4.5	102 1975	- 6.0	—	—	—	—	4.0
9.	Pulau Banjar	Sand	- 4.5	204 1975	- 6.0	—	—	—	—	5.0
10.	TOTALS	—	—	5,625	- 6.0	—	557 450	—	0.2	

Notes : (1). All depths are in meters and all quantities are in cubic meters.
(2). The dredging costs are those used by the Dredging Division Palembang Port Administration and are in runiahs per cubic meter equals about US $ 1.10 per cubic meter or US $ 0.84 per cubic yard.
(3). Loam Sand = Zand Klei = Mud and sand
(4). Zand = Sand

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1974 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10
tem o.	Location	Type of soil at location	Normal depth prior to initial capital dredging	Initial capital dredging quantities year, 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost,	Depth actual after annual maintenance	Depth siltation annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	--	--	--	- 5.1	160,000 450	- 5.3	0.2
2.	Pulau Payung Utara (North)	Mud and sand	--	--	--	- 4.15	160,400 450	- 4.3	0.15
3.	Perajen								
4.	Pulau Payung Barat (West)								
5.	Pulau Payung Timur (East)/(South)								
6.	Selat Jaran								
7.	Pulau Payung Selatan (South)								
8.	Pulau Ayam								
9.	Pulau Banjar								
10.	TOTALS	--	--	--	--	- 5.1	320,400 450	- 5.3	0.2

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1973 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10
Item No.	Location	Type of soil at location	Normal depth prior to initial capital dredging	Initial capital dredging quantities year, 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost, 1000 M^3	Depth actual after annual maintenance	Depth siltation annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	--	--	--	- 4.0	416 400	- 5.1	0.3
2.	Pulau Payung Utara (North)	--	--	--	--	--	--	--	--
3.	Perajen	--	--	--	--	--	--	--	--
4.	Pulau Payung Barat (West)	--	--	--	--	--	--	--	--
5.	Pulau Payung Timur (East)/(South)	Mud and sand	--	--	--	- 4.8	460 400	- 5.1	0.3
6.	Selat Jaran	--	--	--	--	--	--	--	--
7.	Pulau Payung Selatan (South)	--	--	--	--	--	--	--	--
8.	Pulau Ayam	--	--	--	--	--	--	--	--
9.	Pulau Banjar	--	--	--	--	--	--	--	--
10.	TOTALS	--	--	--	--	- 4.8	876 400	- 5.1	0.3

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1972 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10
Item No.	Location	Type of soil at location	Normal depth prior to initial capital dredging	Initial capital dredging quantities year, 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost, 1000 M^3	Depth actual after annual maintenance	Depth siltation annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	—	—	—	- 4.5	444 400	- 4.8	0.3
2.	Pulau Payung Utara (North)	—	—	—	—	- 4.8	308 400	- 5.0	0.2
3.	Perajen	—	—	—	—	—	—	—	—
4.	Pulau Payung Barat (West)	—	—	—	—	—	—	—	—
5.	Pulau Payung Timur (East)/(South)	Mud and sand	—	—	—	- 4.7	163 400	- 4.8	0.1
6.	Solat Jaran	—	—	—	—	—	—	—	—
7.	Pulau Payung Selatan (South)	—	—	—	—	—	—	—	—
8.	Pulau Ayam	—	—	—	—	—	—	—	—
9.	Pulau Banjar	—	—	—	—	—	—	—	—
10.	TOTALS	—	—	—	—	- 4.6	515 400	- 4.8	0.2

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1971 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10
Item No.	Location	Type of soil at location	Normal depth prior to initial capital dredging	Initial capital dredging quantities year, 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost, 1000 M^3	Depth actual after annual maintenance	Depth siltation annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	—	—	—	- 4.5	747 350	- 4.7	0.2
2.	Pulau Payung Utara (North)	Mud and sand	—	—	—	- 4.5	129 350	- 4.7	0.2
3.	Perajen	-	—	—	—	—	—	—	—
4.	Pulau Payung Barat (West)	—	—	—	—	—	—	—	—
5.	Pulau Payung Timur (East)/(South)	—	—	—	—	—	—	—	—
6.	Selat Jaran	Sand	—	—	—	- 4.6	157 350	- 4.7	0.1
7.	Pulau Payung Selatan (South)	Mud and sand	—	—	—	- 4.5	246 350	- 4.7	0.2
8.	Pulau Ayam	—	—	—	—	—	—	—	—
9.	Pulau Banjar	—	—	—	—	—	—	—	—
10.	TOTALS	—	—	—	—	- 4.5	1279 350	- 4.7	0.2

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1970 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10
Item No.	Location	Type of soil at location	Normal depth prior to initial capital dredging	Initial capital dredging quantities year, 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost, 1000 M^3	Depth actual after annual maintenance	Depth siltation annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	—	—	—	- 4.3	588 350	- 4.5	0.2
2.	Pulau Payung Utara (North)	Mud and sand	—	—	—	- 4.3	242 350	- 4.5	0.2
3.	Perajen	—	—	—	—	—	—	—	—
4.	Pulau Payung Barat (West)	—	—	—	—	—	—	—	—
5.	Pulau Payung Timur (East)/(South)	—	—	—	—	—	—	—	—
6.	Selat Jaran	—	—	—	—	—	—	—	—
7.	Pulau Payung Selatan (South)	Mud and sand	—	—	—	- 4.4	143 350	- 4.5	0.1
8.	Pulau Ayam	—	—	—	—	—	—	—	—
9.	Pulau Banjar	—	—	—	—	—	—	—	—
10.	TOTALS	—	—	—	—	- 4.3	893 350	- 4.5	0.2

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

1 Year 1969 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10
Item No.	Location	Type of soil at location	Normal depth prior to initial capital dredging	Initial capital dredging quantities y ar, 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost, 1000 M^3	Depth actual after annual maintenance	Depth siltation annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	—	—	—	- 4.3	105 300	- 4.4	0.1
2.	Pulau Payung Utara (North)	Mud and sand	—	—	—	- 4.2	144 300	- 4.3	0.1
3.	Perajen	—	—	—	—	—	—	—	—
4.	Pulau Payung Barat (West)	—	—	—	—	—	—	—	—
5.	Pulau Payung Timur (East)/(South)	—	—	—	—	—	—	—	—
6.	Selat Jaran	—	—	—	—	—	—	—	—
7.	Pulau Payung Selatan (South)	Mud and sand	—	—	—	- 4.3	157 300	- 4.4	0.1
8.	Pulau Ayam	—	—	—	—	—	—	—	—
9.	Pulau Banjar	—	—	—	—	—	—	—	—
10.	TOTALS	—	—	—	—	- 4.3	406 300	- 4.4	0.1

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1968 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10
Item No.	Location	Type of soil at location	Normal depth prior to initial capital dredging	Initial capital dredging quantities year, 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost, 1000 M^3	Depth actual after annual maintenance	Depth siltation annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	—	--	--	- 4.2	310 300	- 4.3	0.1
2.	Pulau Payung Utara (North)	Mud and sand	—	--	—	- 4.2	225 300	- 4.3	0.1
3.	Perajen	—	—	--	--	--	--	--	--
4.	Pulau Payung Barat (West)	Mud and sand	—	--	--	- 4.3	250 300	- 4.4	0.1
5.	Pulau Payung Timur (East)/(South)	—	--	--	--	--	--	--	--
6.	Selat Jaran	Sand	—	--	--	- 4.3	513 300	- 4.6	0.3
7.	Pulau Payung Selatan (South)	--	--	--	--	--	--	--	--
8.	Pulau Ayam	—	—	--	--	--	--	--	--
9.	Pulau Banjar	--	--	--	--	--	--	--	--
10.	TOTALS	--	--	--	--	- 4.2	1704 300	- 4.3	0.1

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1967 - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10
Item No.	Location	Type of soil at location	Normal depth prior to initial capital dredging	Initial capital dredging quantities year, 1000 M^3	Depth after initial capital dredging	Depth prior to annual maintenance dredging	Maintenance dredging quantities yearly and cost, 1000 M^3	Depth actual after annual maintenance	Depth siltation annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	—	—	—	- 4.2	225 300	- 4.3	0.1
2.	Pulau Payung Utara (North)	—	—	—	—	—	—	—	—
3.	Perajen	—	—	—	—	- 4.2	62 300	- 4.3	0.1
4.	Pulau Payung Barat (West)	Mud and sand	—	—	—	- 4.2	101 300	- 4.3	0.1
5.	Pulau Payung Timur (East)/(South)	—	—	—	—	- 4.2	135 300	- 4.3	0.1
6.	Selat Jaran	Sand	—	—	—	- 4.2	184 300	- 4.3	0.1
7.	Pulau Payung Selatan (South)	—	—	—	—	—	—	—	—
8.	Pulau Ayam	—	—	—	—	—	—	—	—
9.	Pulau Banjar	—	—	—	—	—	—	—	—
10.	TOTALS	—	—	—	—	- 4.2	707 300	- 4.3	0.1

Table 2.1.2-3

Dredging Operations Vs Depth of Musi River

Year 1966 - Palembang to Outer Bar

1 tem o.	2 Location	3 Type of soil at location	4 Normal depth prior to initial capital dredging	5 Initial capital dredging quantities year, 1000 M^3	6 Depth after initial capital dredging	7 Depth prior to annual maintenance dredging	8 Maintenance dredging quantities yearly and cost, 1000 M^3	9 Depth actual after annual maintenance	10 Depth silta-tion annual M
1.	Ambang Luar (Outer Bar)	Mud and sand	—	—	—	- 4.1	176 300	- 4.2	0.1
2.	Pulau Payung Utara (North)	Mud and sand	—	—	—	- 4.1	79 300	- 4.2	0.1
3.	Perajen	Sand	—	—	—	- 4.1	87 300	- 4.2	0.1
4.	Pulau Payung Barat (West)	—	—	—	—	—	—	—	—
5.	Pulau Payung Timur (East)/(South)	—	—	—	—	—	—	—	—
6.	Selat Jaran	—	—	—	—	—	—	—	—
7.	Pulau Payung Selatan (South)	—	—	—	—	—	—	—	—
8.	Pulau Ayam	—	—	—	—	—	—	—	—
9.	Pulau Banjar	—	—	—	—	—	—	—	—
10.	TOTALS	—	—	—	—	- 4.1	342 300	- 4.2	0.1

Table 2.1.2-4

Summary Maintenance Dredging Operations
1966-1975 Musi River - Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10	11	12	13
Item No.	Location	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	Totals by area
		MAINTENANCE DREDGING IN 1000 M^3										
1.	Ambang Luar (Outer Bar)	176	225	310	105	508	747	444	416	160	125	3,216
2.	Pulau Payung Utara (North)	79	—	225	144	292	129	308	—	—	—	1,177
3.	Perajen	87	62	—	—	—	—	—	—	120	120	389
4.	Pulau Payung Barat (West)	—	101	250	—	—	—	—	—	—	—	351
5.	Pulau Payung Timur (East)	—	135	—	—	—	—	163	460	—	203	961
6.	Selat Jaran	—	184	513	—	—	157	—	—	—	—	854
7.	Pulau Payung Selatan (South)	—	—	—	157	143	245	—	—	—	—	545
8.	Pulau Ayam	—	—	—	—	—	—	—	—	—	—	—
9.	Pulau Panjar	—	—	—	—	—	—	—	—	—	—	—
10.	TOTALS BY YEAR	342	707	1298	406	893	1278	915	876	280	448	7,443
11.	Depth before and depth after dredging (Av)	- 4.1 - 4.2	- 4.2 - 4.3	- 4.2 - 4.3	- 4.3 - 4.4	- 4.3 - 4.5	- 4.5 - 4.7	- 4.6 - 4.8	- 4.8 - 5.1	- 5.1 - 5.3	- 5.3 - 5.5	—

dredging by year and location along with the surveyed or estimated depth prior to and after dredging.

2.1.2.2 Capital Dredging

Based on surveys of the Musi River made between 1968 and 1975, with all areas requiring dredging having been surveyed in 1975 by the Dredging Division of PPA, the following estimates of capital dredging required to dredge the Musi River to six meters and to eight meters were developed.

Summarized briefly approximately five million cubic meters of dredging was scheduled on the river this year in order to deepen it to usable six meters and it will require roughly about 25 million cubic meters of dredging to permit eight meter (26.2 feet) navigation on the river at LWS.

The capital dredging requirements are given by river location, depth of dredging, distance to dump in the river and distance to dump spoils, if they are carried to sea, in this case Bangka Strait, in Table VII-2.1.2-5. The dredging volumes required to deepen the Musi River are given in graph form vs depth of river in Figure VII-2.1.2-2. The dredging volumes were developed from Figure VII-2.1.2-3, Longitudinal Profile of the Talway of Musi River between Outer Bar and Palembang carried out by WRRC, Department of Civil Engineering-ITB for Foreign Technical Cooperation - Survey and General Planning Project Department of Communications, Directorate General of Sea Communications, Drawing Number - L.2.

Table VII-2.1.2-5

Capital Dredging Requirements - Deepening Musi River
Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10	11
Item No.	Location of dredging Musi River Reference chart No. - 160 Sungai Musi	Type of soil	Average depth of river date of survey M - LWS	Volume dredging required to depth 6 meters 1000 M^3	Volume dredging required to depth 8 meters 1000 M^3	Approximate distance to nearest spoils area for 6 meter dredging Miles	Approximate depth of spoils dumping area M - LWS	Approximate distance to nearest spoils area for 8 meter dredging Miles	Approximate depth of spoils dumping area M - LWS	Approximate distance to Bangka Strait dumping area Miles
1.	Ampera Bridge to Sungai Gerong	Sand	1968 10	—	—	—	—	—	—	± 79
2.	Sungai Gerong to Lat. 2° - 56'	Sand	1975 4.5 - 11	204	1050	2.0	11	2	11	± 77
3.	Lat. 2° - 56' to Lat. 2° - 52'	Sand	1975 4.5 - 12	280	1500	1.5	11	2	12	± 75
4.	Lat. 2° - 52' to Lat. 2° - 48'	Sand	1968 6 - 15	—	1050	—	—	2	15	± 70
5.	Lat. 2° - 48' to Lat. 2° - 44'	Sand	1975 4.3 - 10	270	2100	2.0	10	2	11	± 69
6.	Lat. 2° - 44' to Lat. 2° - 40'	Sand	1975 4.5 - 12	102	1500	0.5	12	0.5	12	± 63
7.	Lat. 2° - 40' to Lat. 2° - 36'	Sand	1968 6 - 17	—	1500	—	17	1.0	17	± 56
8.	Lat. 2° - 36' to Lat. 2° - 32	Sand	1968 10	—	—	—	—	—	—	± 49
9.	Lat. 2° - 32' to Lat. 2° - 28'	Sand	1968 12	—	—	—	—	—	—	± 42

Table VII-2.1.2-5

Capital Dredging Requirements - Deepening Musi River
Palembang to Outer Bar

1	2	3	4	5	6	7	8	9	10	11
Item No.	Location of dredging Musi River Reference chart No. - 160 Sungai Musi	Type of soil	Average depth of river date of survey M - LWS	Volume dredging required to depth 6 meters 1000 M^3	Volume dredging required to depth 8 meters 1000 M^3	Approximate distance to nearest spoils area for 6 meter dredging Miles	Approximate depth of spoils dumping area M - LWS	Approximate distance to nearest spoils area for 8 meter dredging Miles	Approximate depth of spoils dumping area M - LWS	Approximate distance to Bangka Strait dumping area Miles
10.	Lat. 2° - 28' to Lat. 2° - 24'	Sand	1975 4.5 - 10	350	1050	1.0	10	1.0	10	± 35
11.	Lat. 2° - 24' to Lat. 2° - 20' East Channel	Sand and mud	1975 4.5	1120	4200	3	13	3	13	± 29
12.	Lat. 2° - 24' to Lat. 2° - 20' West Channel	Sand and mud	1975 4.5	1120	4250	2	13	2	13	± 22
13.	Lat. 2° - 20' to Lat. 2° - 16'	Sand and mud	1975 4.5	1125	3500	12	15	12	15	± 12
14.	Lat. 2° - 16' to and through Outer Bar	Sand and mud	1975 5.5	750	3750	2	15	2	15	± 2
15.	Totals for Musi River Outer Bar to Ampera Bridge	Sand and mud	--	5321	25450	2.1 weighted average	12.7	3.4 weighted average	13.1	35 weighted average
16.	Kertapati terminal to turning basin to Ampera Bridge	Sand	13	—	—	—	—	—	—	—
17.	Totals for Musi River Outer Bar to Ampera Bridge	Sand and mud	—	5321	25450	2.1 weighted average	12.7 average	3.4 weighted average	13.1 average	35 weighted average

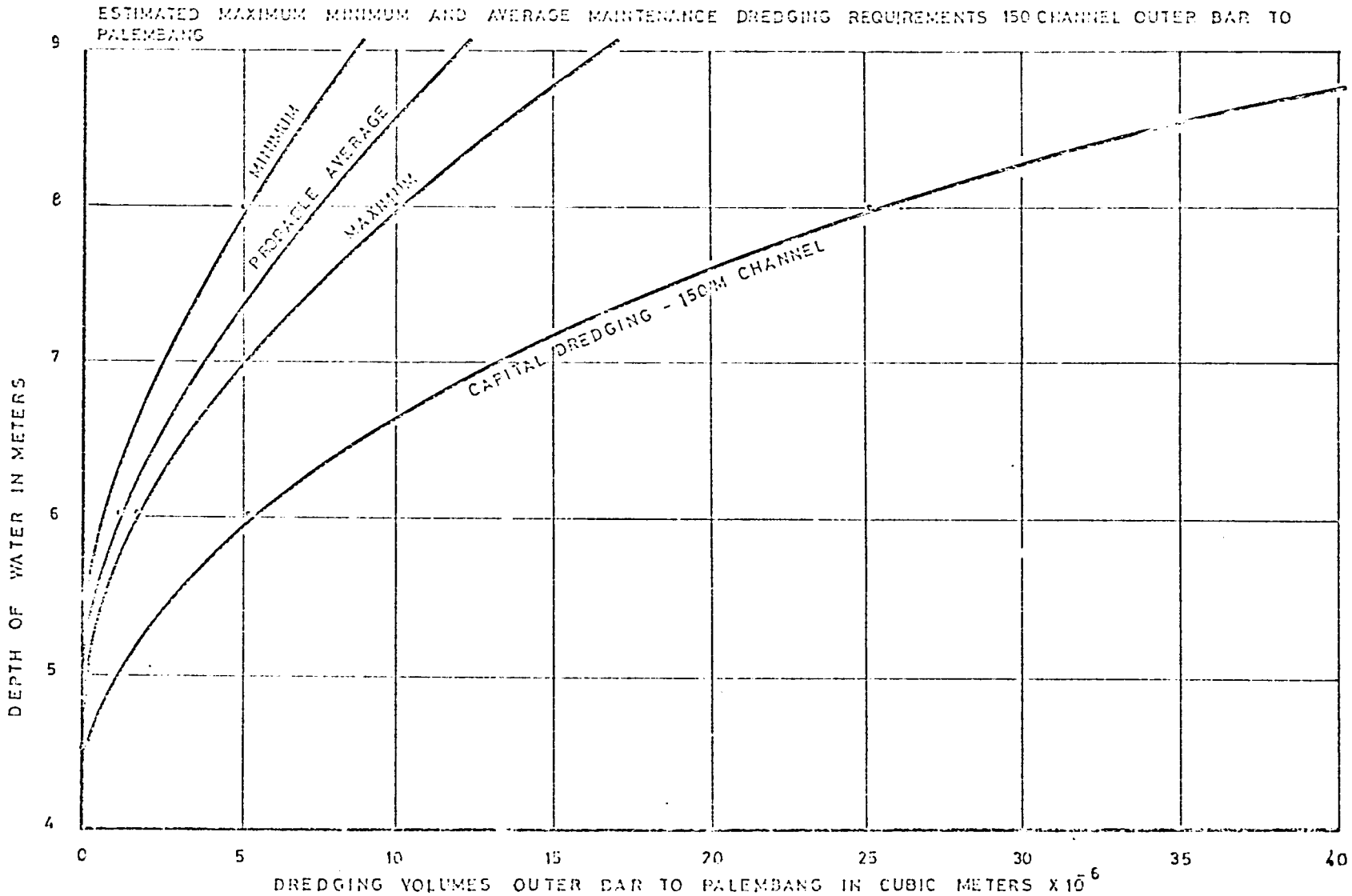


FIGURE VII-21.2-2

DREDGING REQUIREMENTS MUSI RIVER OUTERBAR TO PALEMBANG

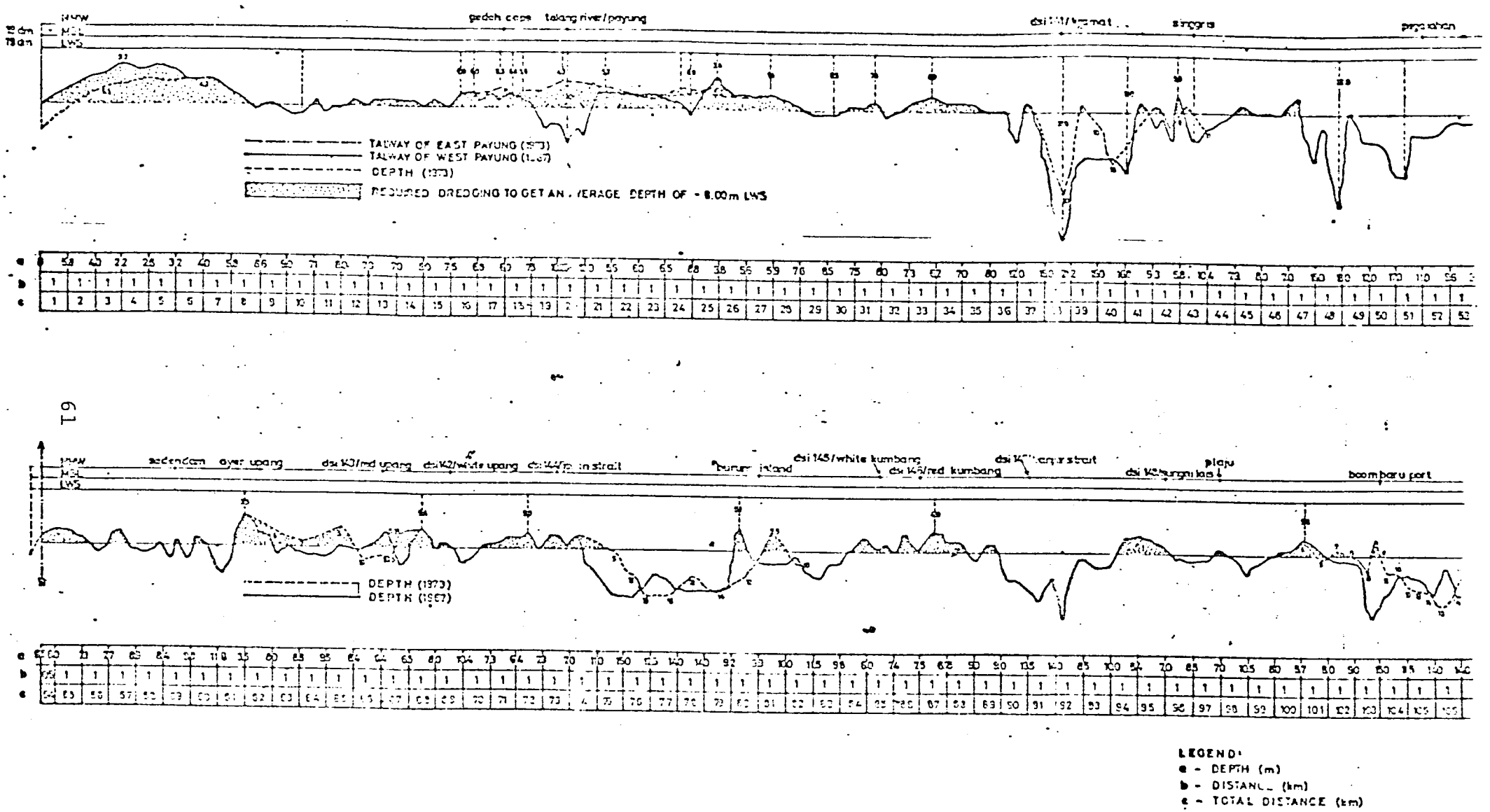


Figure VII-2.1.2-3

Longitudinal Profile of the Musi River Between Outer Bar and Palembang Port

Source: Foreign Technical Cooperation Survey - Directorate General of Sea Communications

2.1.2.3 Maintenance Dredging

In order to complete the picture on dredging information available, Table VII-2.1.2-6 is presented. Some of the information is repetitions and other information contained thereon is not shown elsewhere. Since maintenance dredging is difficult to assess particularly for new capital dredging projects, all of the available information is presented.

Maintenance dredging is frequently given as a percentage of the initial or capital dredging volumes and for the high sedimentation rivers in Southeast Asia has been known to range upwards of 20 percent to in some cases 50 percent for deeply dredged rivers. Based on the dredging volumes reported in the Musi River to date, Table VII-2.1.2-1, an analysis of the dredging operations was made in which the capital or channel deepening dredging was separated from the maintenance dredging. In order that a clearer picture of the maintenance dredging could be presented the maintenance dredging requirements which can be expected with increase in depth of the Musi River to Palembang have been estimated to approximate the curves set forth in Figure VII-2.1.2-4. The estimated capital and maintenance dredging volumes for deepening the Musi River are tabulated in Table VII-2.1.2-7. Additional maintenance dredging analysis is contained in the next two sections.

2.1.2.4 Maintenance Dredging - Ambang Luar - Outer Bar

Since Tables VII-2.1.2-1 present continuous information of the dredging of the Outer Bar, it was one of the sections selected for further analysis.

Using the Outer Bar profile from Figure VII-2.1.2-3, Table VII-2.1.2-8, a table of offsets was obtained which

Table VII-2.1.2-6

Dredging Information Port of Palembang

1966 to 1975

Item No.	Date from/ to	Location	Total Insitu Soil	Name of dredging ships	Type of dredging	Realization	Legend
1.	22-6-1966 to 13-7-1966	Outer Bar, P. Payung Utara, Perajen	340,000 M^3	Bali	Section Hopper Dredger	Deperla	
2.	8-8-1967 to 5-11-1967	P.Payung Barat, P. Payung Timur, Outer Bar, S.Jaran,Perajen	724,000 M^3	Bali	Section Hopper Dredger	Deperla	
3.	27-2-1968 to 13-12-1968	P.Utara, Outer Bar, Payung Selatan & Barat Selat Jaran	1,287,900 M^3	Aru	Section Hopper Dredger	Deperla	
4.	17-3-1969 to 23-5-1969	Outer Bar, P.Payung Utara, P.Payung Selatan	371,500 M^3	Bali	Section Hopper Dredger	Deperla	
5.	1-4-1970 to 29-12-1970	P.Payung Selatan, P. Payung Utara, Outer Bar	982,900 M^3	Bali	Section Hopper Dredger	Deperla	
6.	4-1-1971 to 31-12-1971	P.Payung Utara, Outer Bar, Selat Jaran	1,302,150 M^3	Bali/Aru	Section Hopper Dredger	Deperla	
7.	4-1-1972 to 31-12-1972	P.Payung Utara, Outer Bar, P.Payung Timur	815,250 M^3	Aru/Bali	Section Hopper Dredger	Deperla	
8.	1-1-1973 to 20-9-1973	P.Payung Timur, P. Payung Selatan, Outer Bar	818,250 M^3	Bali	Section Hopper Dredger	Deperla	
9.	19-9-1974 to 9-10-1974	Outer Bar	159,500 M^3	Aru	Section Hopper Dredger	Deperla	

Table VII-2.1.2-6

Dredging Information Port of Palembang

1966 to 1975

Item No.	Date from/ to	Location	Total Insitu Soil	Name of dredging ships	Type of dredging	Realization	Legend
10.	20-2-1975 to 19-4-1975	P.Payung Utara, P. Payung Selatan, Outer Bar	547.000 M^3	Aru/Lombok	Section Hopper Dredger	Deperla	
11.	Pelita 1975 to 1976	P.Payung Timur, P. Ayer, P.Banjar	750.000 M^3	Aru/Lombok	Section Hopper Dredger	Deperla	
12.	July 1975 to December 1975	Outer Bar, P.Payung Barat, P.Payung Selatan	±5,000,000 M^3	Poseidon	Section Hopper Dredger	Capital dredging Aid Holland	

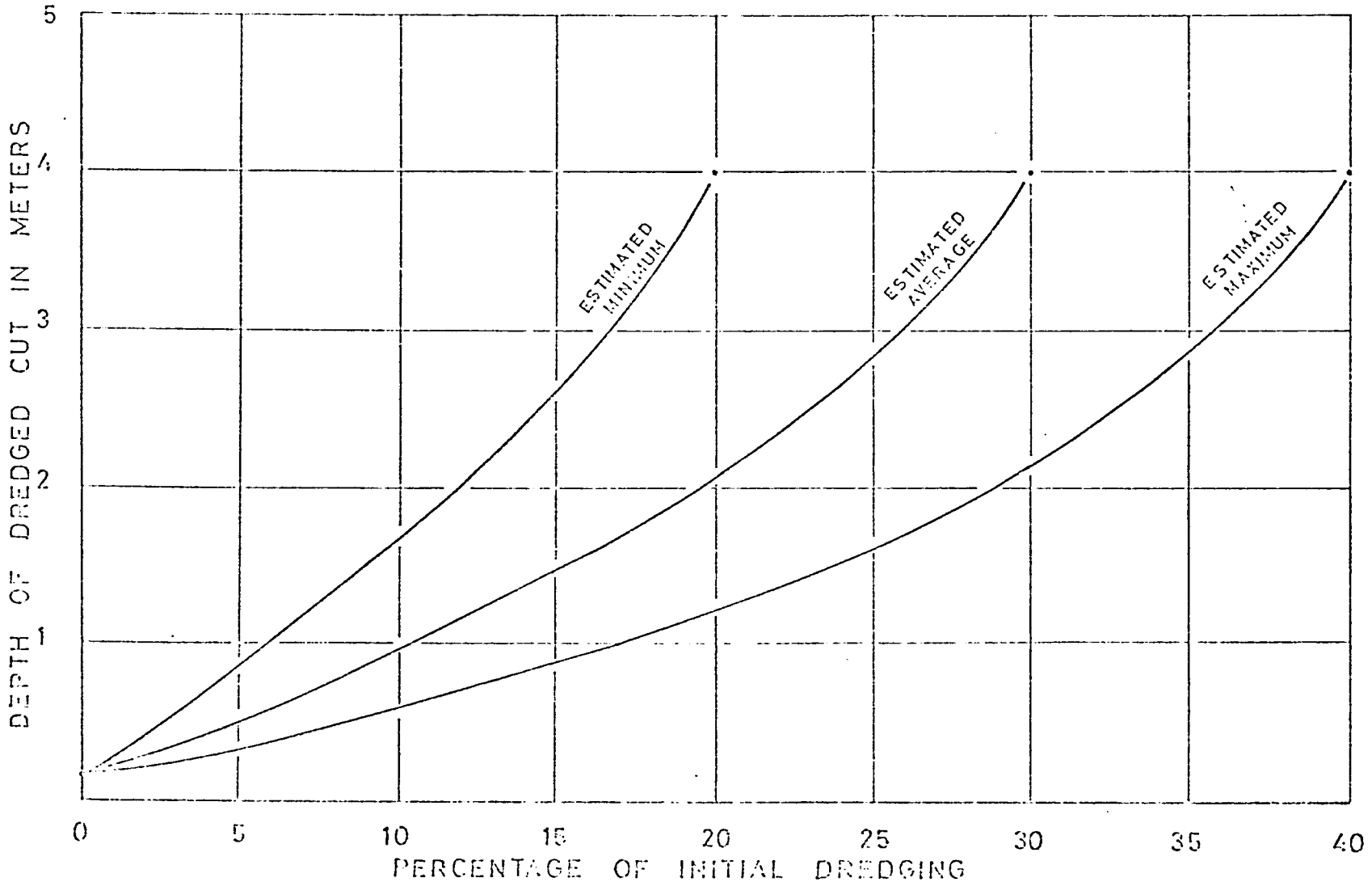


FIGURE VII-212-4

MAINTENANCE DREDGING AS A FUNCTION OF CAPITAL DREDGING MUSI RIVER SYSTEM

Table VII-2.1.2-7

Summary of Estimated Dredging Requirements - Deepening Musi River

Item No.	Location of dredging Musi River Reference Chart No.- 160 Sungai Musi	Capital dredging required 6 M - depth 1000 M^3	Maintenance dredging required 6 M - depth 1000 M^3	Capital dredging required 8 M - depth 1000 M^3	Maintenance dredging required 8 M - depth 1000 M^3	Basic Chart depth prior to initial dredging M	Comment
1.	Ampera Bridge to Sungai Gerong	--	--	--	--	11	
2.	Sungai Gerong to Lat. 2° - 56' (Pulau Banjar)	204	14	1050	273	5.0	
3.	Lat. 2° - 56' to Lat. 2° - 52' (Perajen)	280	53	1500	492	4.2	
4.	Lat. 2° - 52' to Lat. 2° - 48'	--	--	1050	205	6.0	
5.	Lat. 2° - 48' to Lat. 2° - 44' (Selat Jaran)	270	50	2100	609	4.3	
6.	Lat. 2° - 44' to Lat. 2° - 40' (Pulau Ayam)	102	21	1500	450	4.0	
7.	Lat. 2° - 40' to Lat. 2° - 36' (Pulau Ayam)	--	--	1500	450	4.0	
8.	Lat. 2° - 36' to Lat. 2° - 32'	--	--	--	--	8.0	
9.	Lat. 2° - 32' to Lat. 2° - 28'	--	--	--	--	8.0	

Table VII-2.1.2-7

Summary of Estimated Dredging Requirements - Deepening Musi River

Item No.	Location of dredging Musi River Reference Chart No.- 160 Sungai Musi	Capital dredging required 6 M - depth 1000 M3	Maintenance dredging required 6 M - depth 1000 M3	Capital dredging required 8 M - depth 1000 M3	Maintenance dredging required 8 M - depth 1000 M3	Basic Chart depth prior to initial dredging M	Comment
10.	Lat. 2° - 28' to Lat. 2° - 24' (Pulau Payung)	350	69	1050	310	4.2	
11.	Lat. 2° - 24' to Lat. 2° - 20' (South Payung) East Channel	1120	235	4200	1260	4.1	
12.	Lat. 2° - 24' to Lat. 2° - 20' (South Payung) West Channel	1120	213	4250	1239	4.3	
13.	Lat. 2° - 20' to Lat. 2° - 16'	1125	191	3500	1015	4.5	
14.	Lat. 2° - 16' to and through Outer Bar	750	122	3750	1088	4.5	
15.	Totals for Musi River Outer Bar to Ampera Bridge	5321	968	25450	7341	—	Maint.dredging = 18.2% capital dredging at 6 meters and 28.8% capital dredging at 8 meters.
16.	Kertapati terminal to turning basin to Ampera Bridge	—	—	—	—	11	
17.	Totals for Musi River Outer Bar to Ampera Bridge	5321	968	25450	7341	—	

Table VII-2.1.2-8

Offsets - Ambang Luar - Outer Bar

1	2	3	4	5	6	7
Item	Depth Mtr.	Length of Dredge Cut Mtr.	Average Volume To Be Dredged 100 M Channel 1000 M^3	Total Volume To Be Dredged To Depth 1000 M^3	Average Volume To Be Dredged 150 M Channel 1000 M^3	Total Volume To Be Dredged To Depth 1000 M^3
1	2	--	--	--	--	--
2	3	2550	110 138	138	160 200	200
3	4	3700	120 372	510	170 521	721
4	5	5400	130 592	1102	180 819	1540
5	6	6200	140 810	1912	190 1100	2640
6	7	7000	150 990	2902	200 1320	3960
7	8	7600	160 1160	4062	210 1533	5493

Source - Longitudinal Profile of the Talway of Musi River between Outer Bar and Palembang - carried out by WRRC - Dept. of Civil Engineering ITB - drawing number L-2 - Foreign Technical Cooperation - Survey and General Planning Project - Department of Communications - Directorate General of Sea Communications. See Figure VII

was in turn used to compute the dredging quantities for deepening the dredged cut in the bar which are contained in the table and plotted graphically in Figure VII-2.1.2-5.

The computation of maintenance dredging percentages and siltation depths are contained in Table VII-2.1.2-9. The dredging performed per year was obtained from Table VII-2.1.2-1; the capital dredging performed was estimated incrementally utilizing the dredged depth increases from Figure VII-2.1.2-5; the maintenance dredging volumes were then obtained and given as percentages of the total capital dredging associated with the depth involved and as a siltation depth to be dredged.

The analysis indicates that the average annual maintenance dredging for a period of eight years on the Outer Bar has been of the order of about 33 percent with a siltation depth of about 0.4 meters.

2.1.2.5 Maintenance Dredging - Payung Island

The shoal water in way of Payung Island were also selected for further analysis of their maintenance dredging requirements.

Using the same sources of information and the same procedures as outlined in the previous section; dredging offsets - Table VII-2.1.2-10, Dredging Volumes - Figure VII-2.1.2-6 and computations Table VII-2.1.2-11 were obtained.

A review of Table VII-2.1.2-11 reveals that the annual maintenance dredging for a period of ten years in the combined East and West Payung Island dredged channels amounted to about 359 percent of the theoretical capital dredging volumes and to a dredged siltation depth of about 1.24 meters.

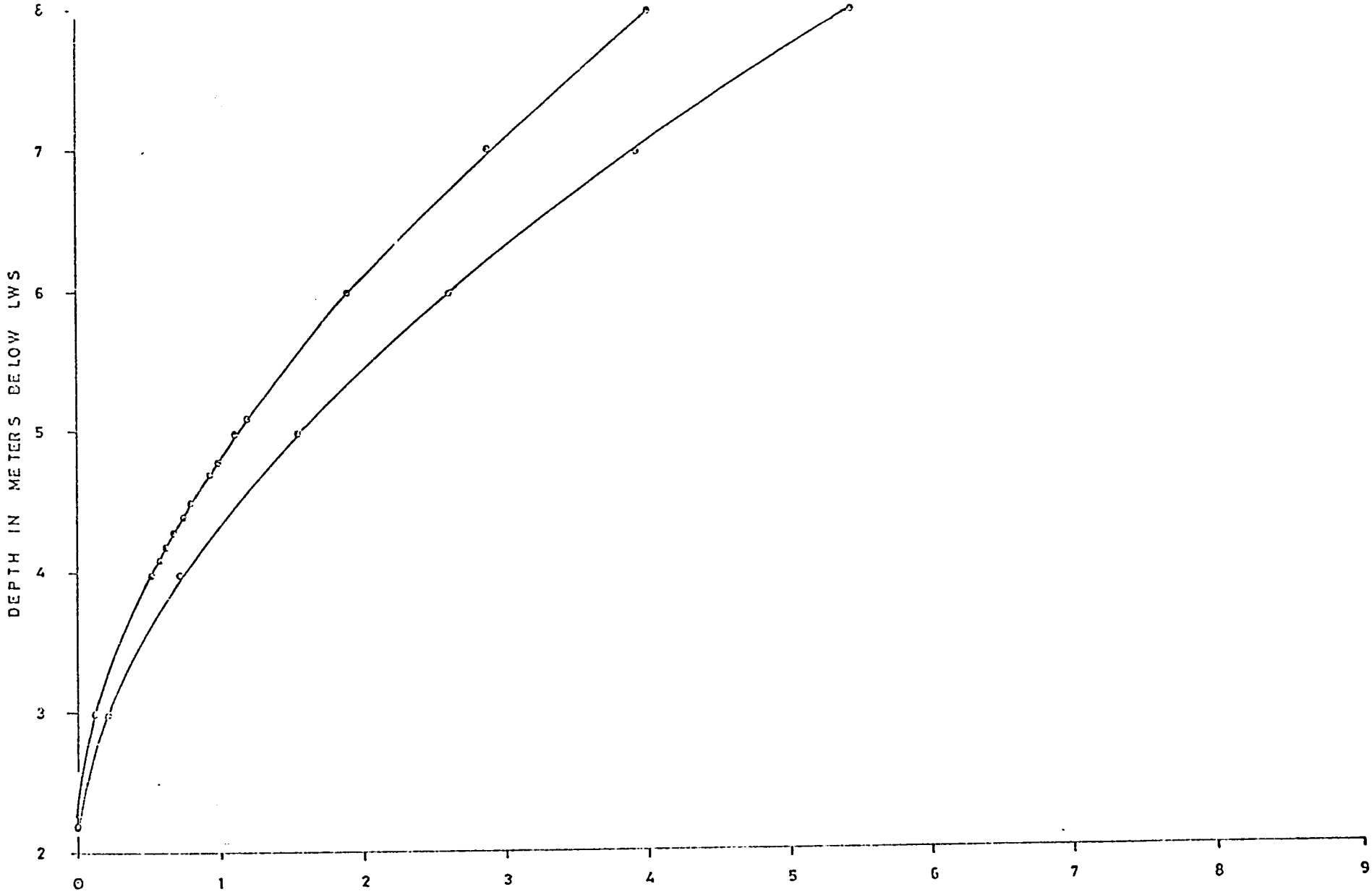


FIGURE VII – 2.1.2 – 5

DREDGING VOLUMES OUTER BAR IN $M^3 \times 10^{-6}$

Table VII-2.1.2-9

Computations - Maintenance Dredging

Ambang Luar - Outer Bar

1	2	3	4	5	6	7	8
Year	Dredging Performed 1000 M^3	Depth of Dredging Mtr.	Capital or Increased Depth Dredging 1000 M^3	Maintenance Dredging (2)-(4)=(5) 1000 m^3	Total Dredging To Previous Depth - Figure VII 1000 M^3	Percentage Maintenance Dredging (5)÷(6) = 7 Ratio	Depth of Siltation From Figure VII Mtr.
1966	176	4.1/4.2	57	119	570	0.21	0.2
1967	225	4.2/4.3	80	145	620	0.23	0.3
1968	310	4.2/4.3	--	310	620	0.50	0.5
1969	105	4.3/4.4	80	25	700	0.04	0.1
1970	508	4.3/4.5	100	408	800	0.51	0.6
1971	747	4.5/4.7	120	627	920	0.68	0.9
1972	444	4.5/4.8	180	264	1000	0.26	0.4
1973	416	4.0/5.1	200	216	1200	0.18	0.3
1974	160	5.1/5.3	130	30	1330	0.02	-
1975	124	5.3/5.5	170	(-) 46	1500	(-) 0.03	-
Totals 1966-1973	2931	4.1/5.1	817	2114	6430	2.61	3.3
Average Per Year	366	--	102	264	804	0.33	0.41

Table VII-2.1.2-10

Offsets - Payung Island

1	2	3	4		5	6	7		8	9		10	11
		West Channel				East Channel							
Item	Depth Mtr.	Length of dredge cut Mtr.	Average volume to be dredged 100 Mtr. channel 1000 M^3		Total volume to be dredged to depth 1000 M^3	Length of dredge cut Mtr.	Average volume to be dredged 100 Mtr. channel 1000 M^3		Total volume to be dredged to depth 1000 M^3	Average volume to be dredged 150 Mtr. channel 1000 M^3		Total volume to be dredged to depth 1000 M^3	Combined totals East and West channels to depth 1000 M^3
1	3	--	--		--	--	--		--	--		--	--
2	4	350 W	110	19	19	--	--		--	160	28	28	19
3	5	700 W	120	63	82	220	110	24	24	170	89	111	106
4	6	2000 W	130	175	257	760	120	91	119	180	242	359	376
5	7	9370 W	140	796	1093	12300	130	1600	1719	190	1054	1413	2812
6	8	10600 W	150	1497	2990	13100	140	1834	3553	200	1969	3382	6543

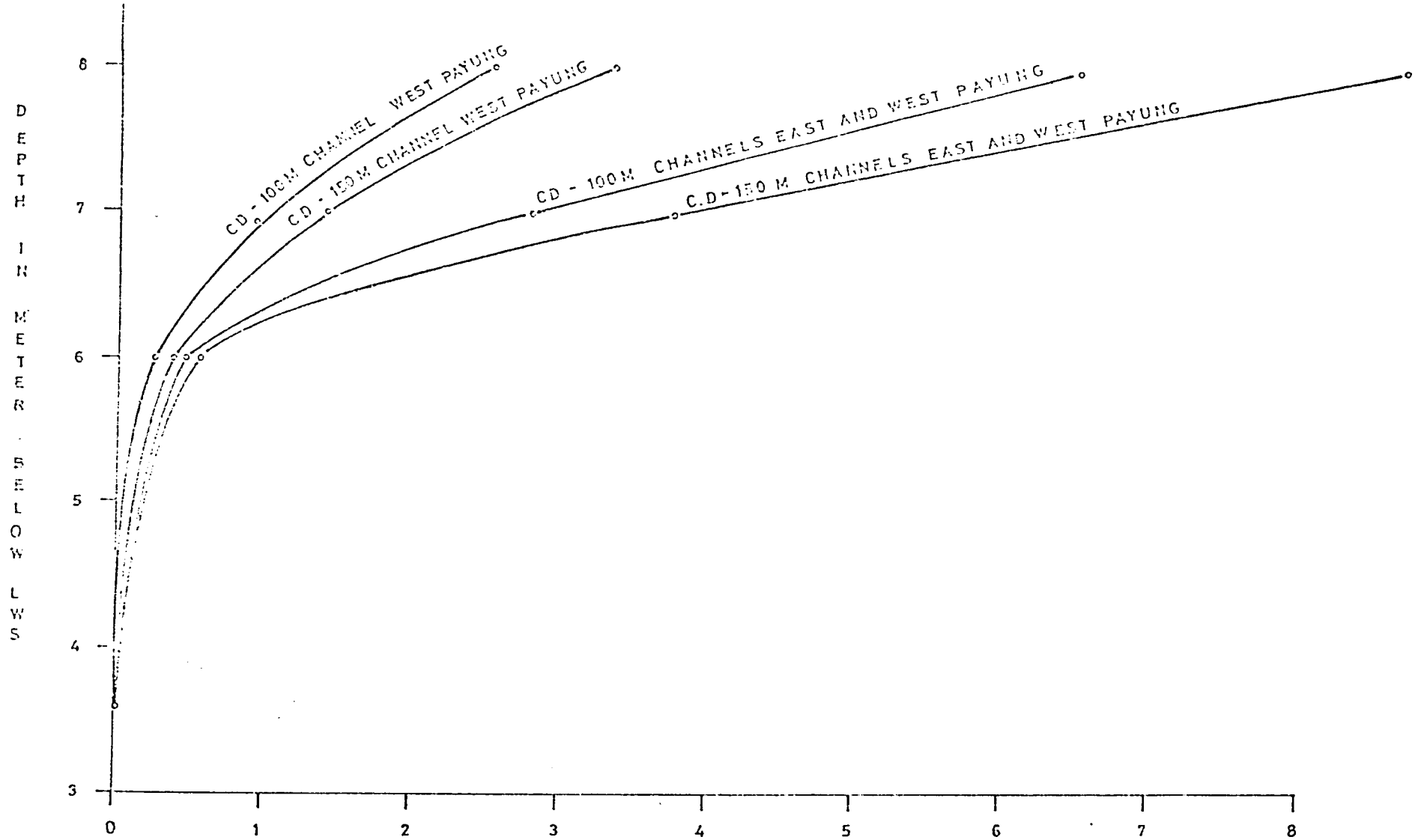


FIGURE: VII-2.1.2-6

DREDGING VOLUMES - TALWAYS OFF PAYUNG ISLAND IN MILLIONS OF CUBIC METERS

Table VII-2.1.2-11

Computations - Maintenance Dredging

Talways of Payung Island

1	2	3	4	5	6	7	8
Year	Dredging Performed 1000 M3	Depth of Dredging Mtr.	Capital or Increased Depth Dredging 1000 M3	Maintenance Dredging (2)-(4) =(5) 1000 M3	Total Dredging To Previous Depth - Figure VII- 1000 M3	Percentage Maintenance Dredging (5)÷(6) = 7 Ratio	Depth of Siltation From Figure VII- Mtr.
1966	79	4.1/4.2	20	59	20	2.95	0.3
1967	236	4.2/4.3	20	216	40	5.40	1.1
1968	475	4.3/4.4	20	455	60	7.58	1.3
1969	301	4.3/4.4	--	301	60	5.01	1.3
1970	385	4.4/4.5	20	365	100	3.65	1.4
1971	375	4.5/4.7	40	335	140	2.39	1.3
1972	471	4.7/5.0	60	411	200	2.06	1.6
1973	460	5.0/5.1	20	440	220	2.00	1.2
1974	160	5.0/5.1	--	160	220	0.73	1.0
1975	2500	4.5/6.0	250	2250	550	4.09	1.9
Totals 10 years	5442	--	450	4992	1630	35.86	12.4
Average Per Year	544	--	45	500	163	3.59	1.24

2.1.2.6 Alternate Musi River Dredging Volumes.

The previous dredging volumes were calculated by the PPS Team with excellent assistance and cooperation from the PPA Dredging Division. In parallel with the PPS on site team, an independent calculation of the Musi River dredging volumes was performed at the contractor Home Office. The following sections present the alternative dredging volumes.

Method of Determining Dredging Volumes.

Given the historical dredging volumes for the Musi River, Table VII-2.1.2-4, available survey charts and Chart 160-Sungai Musi, the river was divided into sections corresponding to the sections of the river as given in Table VII-2.1.2-4 which are indicated in the key Figure VII-2.1.2-7. The dredging volumes were then calculated for each section.

Volume of Material to be Dredged.

The various paths which were considered to arrive at the minimum amount of dredging required are given in Table VII-2.1.2-12. The paths are shown in the key Figure VII-2.1.2-7.

The dredging volumes by path for each meter increment of depth of river from five to 10 meters are shown summarized in Table VII-2.1.2-13 for 100 meter wide channels and in Table VII-2.1.2-14 for 150 meter channels.

Comparison Dredging Volumes.

A comparison of the capital dredging volumes estimated to be required by the separate analysis indicate that the estimates made in the E.G. Frankel, Inc. Home Office are about 20 percent less than those computed at Palembang. Recognizing that the river dredging may be somewhat less than thought required now PPS will use the higher local estimates to insure a fair comparison in trade off studies.

KEY

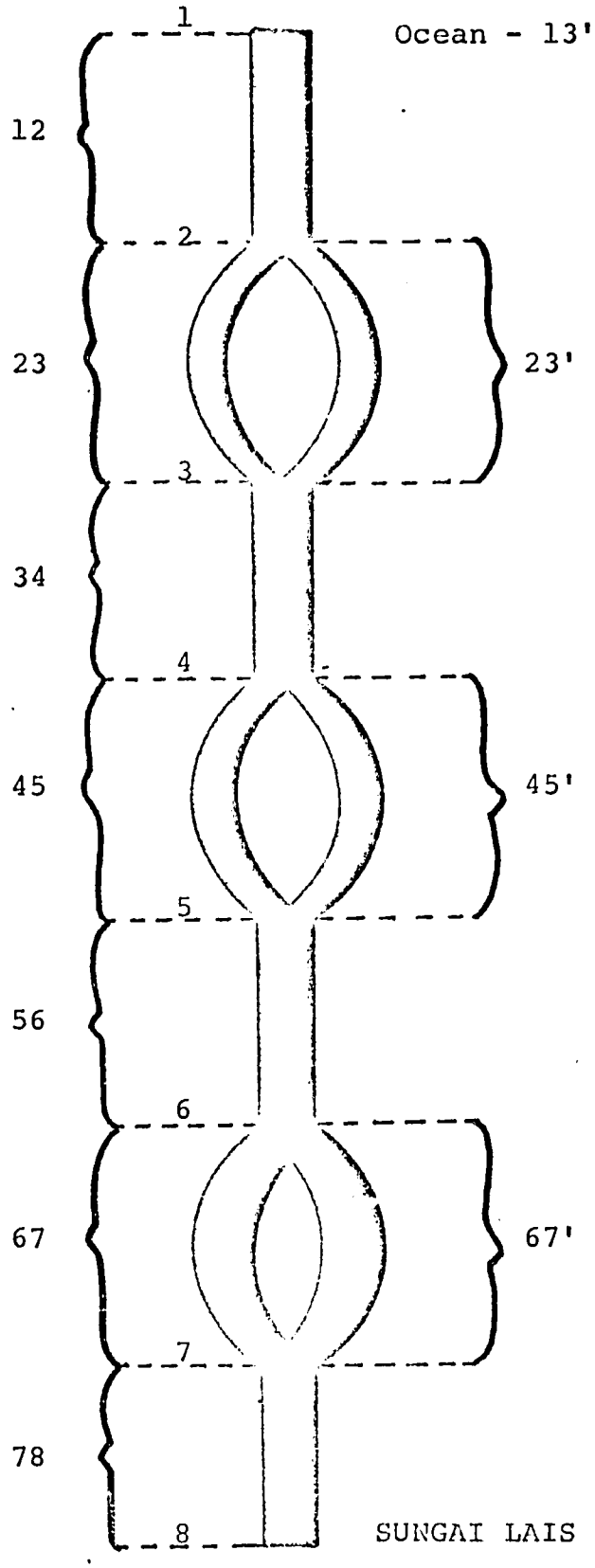


Figure VII-2.1.2-7

Channel Paths

TABLE VII-2.1.2-12

DEFINITION OF PATHS A-H

Path A:	12	23	34	45	56	67	78
Path B:	12	23'	34	45	56	67	78
Path C:	12	23	34	45'	56	67	78
Path D:	12	23'	34	45'	56	67	78
Path E:	12	23	34	45	56	67'	78
Path F:	12	23'	34	45	56	67'	78
Path G:	12	23	34	45'	56	67'	78
Path H:	12	23'	34	45'	56	67'	78

TABLE VII-2.1.2-13

VOLUME OF MATERIAL DREDGED FOR

DIFFERENT CHANNEL PATHS AND DEPTHS

Volume is in thousands of cubic meters. Channel is assumed to be one hundred meters wide.

Depth	Path A	Path B	Path C	Path D	Path E	Path F	Path G	Path H
5.0	361	166	361	166	289	94	289	94
6.0	1,407	1,348	1,382	1,322	1,321	1,261	1,296	1,236
7.0	4,976	5,052	4,959	5,036	5,806	4,882	4,789	4,865
8.0	10,613	10,694	10,549	10,630	10,121	10,203	10,057	10,138
9.0	20,059	20,191	19,900	20,031	20,129	20,260	19,969	20,101
10.0	30,979	31,682	30,909	31,611	30,820	31,522	30,749	31,452

Paths A-H are defined elsewhere.

TABLE VII-2.1.2-14

VOLUME OF MATERIAL DREDGED FOR DIFFERENT CHANNEL PATHS AND DEPTHS

Volume is in thousands of cubic meters. Channel is assumed to be one hundred fifty meters wide.

Depth	Path A	Path B	Path C	Path D	Path E	Path F	Path G	Path H
5.0	505	239	505	239	406	139	406	139
6.0	1,961	1,913	1,923	1,876	1,739	1,690	1,702	1,653
7.0	6,847	6,953	6,834	6,940	6,658	6,761	6,642	6,748
8.0	14,291	14,406	14,224	14,339	13,656	13,771	13,589	13,704
9.0	26,468	26,658	26,277	26,468	26,622	26,812	26,431	26,622
10.0	40,333	41,044	40,290	40,991	40,158	40,869	40,115	40,816

Paths A-H are defined elsewhere.

2.1.2.7 Maintenance Dredging Problems

Since it is obviously not possible to dredge 359 percent in maintenance dredging on a once a year dredging basis, there must be something wrong with either the statistics or in their application to the problem of determining the percentage of maintenance dredging actually performed.

Speaking of the dredging statistics other Study Teams have had difficulty in reconsiling the figures and one suggested as a possible solution that the dredged volume figures be discounted by 50 percent. If this were done, it would reduce the volume of maintenance dredging to 180 percent per year but would double the cost of the dredging performed. Discounting the dredged volume statistics, does not appear to be an acceptable answer because it will badly unballance the price structure of dredging.

There are several other possible answers to the maintenance dredging and its apparently high dredging percentages among which are the following.

1. The dredging may be deeper than the reported depth of the channel by a substantial margin. Since adequate pre-dredging and post-dredging surveys have not been the general practice, although the dredging division of PPA is gearing toward accomplishing the necessary surveys in the near future, the fact remains that dredging deeper by a meter or more could account for a substantial reduction in the dredging percentage.

2. Another very good possibility is that the maintenance dredging is not confined to the limits of the channel as originally specified but is in fact performing both capital and maintenance dredging on a much wider channel. This possibility is supported by several factors.

   a. Except in way of the Outer Bar, which incidently has a fairly reasonable percentage of maintenance dredging

the dredged channels are not well defined by navigational aids and the channels may be substantially wider than designed.

b. Ships navigating the channels do not seem to be constrained to as tight quarters as a fairly narrow channel would normally dictate.

c. The dredged channel may have been unofficially widened in early dredging to be more easily navigated by the pilots.

d. A review of the survey charts particularly for the Payung Island channels do not reveal a clearly defined channels but indicate rather broad irregular channels and there is a good possibility that substantial dredging may have been performed outside of the scheduled channels.

e. The possibility also exists that the length of river covered by the dredging statistics under the various Payung Island channel sectors was greater in length that than those parts of the river assumed to be associated with Payung Island is scaling the longitudinal profile of the river.

2.1.2.8 Dredging Musi River - Conclusions

a. That the primary cause for excessive percentages of maintenance dredging in the Musi River particularly in way of Payung Island is that a much wider channel is being dredged than specified or approved for dredging.

b. In the way of Payung Island, the following information applies to the East and West channels.

Channel	Dredging Volume 6 M 100 M channel 1000 M^3	Dredging Volume 6 M 150 M channel 1000 M^3	Dredging Volume 6 M 200 M channel 1000 M^3
East	359	496	656
West	257	355	471
Both channels	676	851	1117

i. Cost of one West 150 M channel Vs East & West 100 M channels = 355/676 or 0.53 which represents a potential savings of 47 percent in both capital and maintenance dredging costs.

ii. Cost of one West 200 M channel Vs East & West 100 M channels = 471/676 = 0.70 which represents a savings of 30 percent in both capital and maintenance dredging costs.

iii. Note : About the same ratios of dredging volumes hold for a dredging depth of eight meters for the East and West channels as exhibited above for six meter channels.

c. That the water flow rate, through one channel in lieu of two channels off Payung Island, would be improved and consequently should reduce the sediment deposit in the navigable channel.

d. A review of Figure VII-2.1.2-6 - Dredging Volumes - Talways off Payung Island reveals that the dredging volumes for a six meter channel appears to be quite reasonable at about 400,000 M^3 whereas the dredging volume for an eight meter channel in the area is about 3,400,000 M^3 or a cost 8.5 times as much as the six meter channel.

e. Again an inspection of Figure VII-2.1.2-3 reveals that while there appears to be sufficient dumping ground for spoils dredged in the river to a depth of six meters throughout the length of the river and for eight meter spoils upriver of Payung Island, the eight meter spoils in way of Payung Island could not be dumped in the river but would have to be carried to sea or otherwise disposed of inland reclamation projects.

f. That it is difficult if not impossible to determine the precise amounts of maintenance dredging involved in the Musi River system and that the maintenance dredging estimates given in Figure VII-2.1.2-2 for the river are reasonable estimates and are satisfactory for preliminary planning and cost estimating purposes.

2.1.2.9 Dredging Recommendations - Musi River;

1. That complete pre-dredging and post-dredging surveys be conducted for all dredging projects so that the Dredging Division at PPA and at the Harbors and Dredging Division of the Directorate of Sea Communications will know what dredging has been accomplished and will be in a better position to determine what the maintenance dredging requirements actually are.

2. The one and only dredged channel in way of Payung Island should be the West channel and it should be made wide enough to satisfy the requirements for the navigation of the required number of ships in both directions to and from Palembang. The East channel should be allowed to seek its normal level unless it is required for other purposes. In its natural state it apparently will handle ships with a draft of 4.2 meters at LWS.

3. Additional navigational aids should be installed in the navigable channels of the river to permit ships to navigate within the boundaries of the approved channels in order that excessive dredging may be reduced.

4. The dredging scheduled for the Musi River should be performed by dredges which have accurate positioning devices installed aboard such that the dredge master will know with precision where he is dredging. Estimates indicate that with accurate positioning of dredging, the amount of dredging required could be reduced by 50 percent. If the above estimate is true, as it appears to be, and we take as a base the required dredging; the excess dredging caused by poor positioning equipment amounts to about 100 percent. Rough calculations indicate that the cost of adequate electronic positioning devices on State owned dredges would pay for themselves in less than a three month period.

2.1.3 Increasing the Flow in the Musi River.

2.1.3.1 General.

The Musi and Upang River Deltas are really one large delta system with the Musi River being the predominant river in the system. The Upang River branches eastward off the Musi just below Kampung Upang about 45 kilometers downriver from Palembang and approximately 50 kilometers from Bangka Strait. See Figure VII-2.1.2-1.

The Upang and Musi River Delta is very flat and it becomes inundated during spring tides and large river discharge periods.

Considerable hydrometric information has been developed for the delta looking toward establishing the conditions for the solution of problems connected with navigation, river training, water supply, irrigation, drainage, coastal protection etc. Much of this data acquired is suitable for use in establishing boundary conditions for hydraulic model studies of the river system.

Hydrometric measurements consisting of two types of observations have been developed in surveys of the area.

1. Observations of the water motion which consists essentially of collecting data on the horizontal and vertical water movement, mainly current velocities and water levels.

2. Observations of the consequences of water movement which include bottom configuration, sediment transport and salinity measurements etc.

A recent tidal engineering study of the Upang-Musi Delta reported on river discharges as shown in Table VII-2.1.3-1. Table VII-2.1.3-2 contains additional data on the Musi and Upang River velocities and discharge quantities.

A preliminary review of the data in Tables VII-2.1.3-1 and 2 reveals that it might be possible to divert sufficient flow from the Upang River to increase the flow in the Musi River by about 20 to 25 percent. There is the further possibility that such an increase in the flow of the Musi would substantially reduce the maintenance dredging in the Musi River.

2.1.3.2 Increasing the Flow in the Musi River.

The dredging quantitites in the Musi River at a depth of six meters appear to be fairly reasonable and quantities which can be coped with in an economically viable dredging program. The validity of the above statement will be known in a few months when the present post dredging survey of the dredging in the Outer Bar and off Payung Island is completed and analyzed. However the amounts of dredging involved in taking the Musi River down to a depth of eight meters LWS suggests that perhaps means of reducing

TABLE VII-2.1.3-1

CHARACTERISTICS OF MUSI AND UPANG RIVERS

		MUSI		UPANG	
		neap tide	spring tide	neap tide	spring tide
$\hat{Q}_{ebb}$	(m^3/s)	3750	6750	1750	2100
$\hat{Q}_{flood}$	(m^3/s)	3350	5000	1875	2000
ebb volume	(m^3)	$65 \cdot 10^6$ 1)	$179 \cdot 10^6$	$45 \cdot 10^6$ 2)	$43 \cdot 10^6$
flood volume	(m^3)	$35 \cdot 10^6$ 1)	$121 \cdot 10^6$	$30 \cdot 10^6$ 2)	$69 \cdot 10^6$
Q_o	(m^3/s)	694	657	176	277
$k_1 - \emptyset_1$	(hr)	1	2,5	1	2,5

$\hat{Q}$ = maximum discharge

Q_o = upland discharge

$k_1 - \emptyset_1$ = phase difference horizontal and verical tide

1) 12 hours cycle

2) 24 hours cycle

Source : Technical Cooperation Project
Tidal Engineering
Institute of Technology - Bandung
Public Works
University of Technology - Delft
Nuffic Project THB/E/T6
Technical Report - 1974

TABLE VII-2.1.3-2

ESTUARY DATA AND NUMBERS MUSI AND UPANG RIVERS

Symbol		Dimension	MUSI (7408 29/30)	UPANG (7408 27/28)
V	= tidal prism	(m^3/tidal cycle)	$297 \cdot 10^6$	$110 \cdot 10^6$
P	= prism during flood	(m^3/tidal cycle)	$119 \cdot 10^6$	$42 \cdot 10^6$
Q_t	= runoff during one tidal cycle	(m^3/tidal cycle)	$58 \cdot 10^6$	$26 \cdot 10^6$
h	= water depth	(m)	8.3	6.2
$\hat{v}$	= max. current velocity during flood tide	(m/sec.)	1	0.9
F_o	= $(\hat{v} \cdot \sqrt{gh})^2$	(1)	0.11	0.11
E	= estuary number	(1)	0.020	0.021
e	= $\frac{Q_t}{V}$	(1)	0.19	0.24

Source : Investigations of Thatcher and Harleman as reported in
Technical Cooperation Project
Tidal Engineering
Institute of Technology of Bandung
Public Works
University of Technology - Delft
Nuffic Project THD/E/T5
Technical Report - 1974

the quantity of dredging in the river should be further investigated.

It is possible to decrease the amount of dredging in the Musi River by increasing the discharge flow in the river. Investigations along this line lead to the conclusion that the best solution to providing more flow in the Musi River would be to dam the Upang River as it branches from the Musi and to control the amount of water flowing into the Upang River.

It is realized that this is not a simple problem as the Upang River has many uses including navigation, drinking water, water for agriculture, drainage etc. However if the Upang River is dammed at its source and also dammed close to its mouth sufficient water could be discharged into the river to make it almost a large fresh water lake which would benefit agriculture in the area and would reduce the salt intrusion problem at the mouth of the Upang River as well as provide an increased flow in the Musi River which should help to reduce both the quantity of silt deposited and the cost of dredging involved.

The scope of the Palembang Port Study does not warrant a study in sufficient depth to fully evaluate a project such as the one described above which would undoubtedly require a substantial hydraulic model study as well as a major environmental impact study in order to fully evaluate the project.

2.1.4 Navigation and Other System Requirements

Aids to Navigation

The navigational aids on the Musi River have been reported by all interested parties to be generally satisfactory and when the current rebuilding and new building

program is completed the navigational aids should be satisfactory. There have been no delays of ships reported to be caused by a lack of aids to navigation on the Musi River.

Since it is cheaper to install and maintain a few additional aids to navigation in order to delineate more precisely the channel boundaries and to limit the amount of dredging to the specifically approved dredged channel widths than to perform excess channel width dredging, it is recommended that additional aids to navigation be installed.

Communications

Communications between ships, shipping agents, the Port Administration and the pilot station have been inadequate due in large part to inadequate maintenance of generating equipment at the pilot station which has resulted in one generator operation (two generators are inoperative) which has caused the pilot station to man their communication system for a very limited number of hours per day. The generators at the pilot station should all be quipped with mufflers so that they may operate in the day time without disturbing the sleeping pilots. The inoperative generators should be repaired as soon as possible and the communications schedule should be revised to provide better service.

Pilotage

Most of the delays to ships entering the Musi River have been attributed to one of two causes.

a. A shortage of pilots
b. Inoperative or inadequate pilot boats

The shortage of pilots is in the process of being eliminated as the result of a comprehensive pilot training program.

The number of pilot boats is inadequate and the existing boats are too slow to provide efficient pilot service. Additional pilot boats have been recommended and one or two have been approved for acquisition in the near future.

3.0 CHANNEL DEVELOPMENT

3.1 Alternative Channel Configurations and Associated Dredging Quantities

There are basically two routes by which ships of up to six or eight meters in depth could navigate to the present Port of Palembang. One is the route presently in use which crosses the Outer Bar of the Musi River and follows the main river channel about 110 kilometers (60 nautical miles) to Palembang. The second is an alternative route now under consideration which would start as the pilot vessel proceed into Banyuasin River, thence via a canal or channel across Sungsang Peninsula to the Musi River at Sungsang and then following the regular Musi River channel to Palembang. The distances from Palembang to the pilot vessel and to intermediate points via both routes are given in Table VII-3.1-1 and 3.1-1(a).

The channel to Palembang via the Outer Bar and the Musi River has been in use for many years at a bar depth of about 4.5 meters. The depth of this route is currently being dredged and will have an effective depth of six meters LWS by the end of 1975.

3.1.1 Channel Configurations

The Musi River and Outer Bar channels have until 1975 been 100 meter width channels. As a result of dredging authorized by Pelita II the depth of the channels were increased to six meters and the width of the channels was increased to 150 meters. In addition, in order to permit ships with maximum permissible draft to sail outbound on one tide, the depth of the Outer Bar channel was lowered to seven meters LWS thus providing six meters on the bar several hours after high water which in turn permits outbound ships to clear the bar on one tide from Palembang.

Table VII-3.1-1

Distance Table for Water Transportation

Between the Various Port Alternatives

FROM \ TO	ROUTE VIA	OUTER BAR	BANYUASIN	SUNGSANG	SUNGAI LAIS	PALEMBANG	KERTAPATI
Inland Water Transport System - Existing and/or Proposed							
OUTER BAR	OB	-	17	22	100	110	115
	B + M	-	17	29	107	117	122
BANYUASIN	OB	17	-	39	117	127	132
	B + M	17	-	12	90	100	105
SUNGSANG	OB	22	39	-	78	88	93
	B + M	29	12	-	78	88	93
SUNGAI LAIS	OB	100	117	78	-	10	15
	B + M	107	90	78	-	10	15
PALEMBANG	OB	110	127	88	10	-	5
	B + M	117	100	88	10	-	5
	Canal	107	90	124	10	-	5
BANGKA STRAIT OFFSHORE	OB	5	22	27	105	115	120
	B + M	5	22	34	112	123	128

Table VII-3.1-1

Distance Table for Water Transportation

Between the Various Port Alternatives

LAND TRANSPORT SYSTEM - EXISTING AND OR PROPOSED							
PALEMBANG	High-way	-	90	88	10	-	5
PALEMBANG	Rail-road	-	90	88	15	-	5

Not s : a). OB - Route from Musi to Banyuasin River via the Musi River Outer Bar.

b). B + M - Route from Musi to Banyuasin River via a Diversion Canal.

c). Canal - Proposed Inland Water Canal-Banyuasin Basin to Palembang.

d). All distances are in kilometers.

TABLE VII-3.1-1 (a)

DISTANCE TABLE FOR INLAND WATER TRANSPORTATION

SEBALIK CANAL ROUTE

FROM \ TO	Banyuasin	Sungsang Proposed Canal	Canal Sebalik Banyuasin River Entrance	Canal Sebalik Sebalik River Entrance	Selat Jaran River Junction	Musi River Junction	Sungai Lais	Palembang	Kertapati
Inland Water Transport System Existing and/or Proposed Improvements Barge Route via Sebalik Canal									
Banyuasin	-								
Sungsang Proposed Canal	4	-							
Canal Sebalik Banyuasin River Entrance	42	38	-						
Canal Sebalik Sebalik River Entrance	47	43	5	-					
Selat Jaran River Junction	67	63	25	20	-				
Musi River Junction	92	88	50	45	25	-			
Sungai Lais	117	113	75	70	50	25	-		
Palembang	127	123	85	80	60	35	10	-	
Kertapati	132	129	90	85	65	40	15	5	-

The present configuration of the Musi River Outer Bar channel and the configuration of the Musi River dredged portions of the channel are approximately as shown in Figure VII-3.1.1-1 along with the proposed configuration if the channel is deepened to eight meters.

3.1.2 Dredging Quantities

The dredging quantities for the Musi River system are given in Section VII-2.1.2, those for the Banyuasin River are in Section VII-3.3 and those for a Banyuasin-Musi River connecting channel across Sungsang Peninsula are in Section VII-3.2.

3.2 Feasibility of Canal Connecting The Musi and Banyuasin Rivers

From a technical view point it is feasible to dredge and maintain a ship channel across the Sungsang Peninsula as indicated in Figure VII-3.2-1. The real criteria for determining whether or not to dredge such a channel must rest with its economic viability.

Figure VII-3.2-2 is a cross section of the proposed canal one side of which depicts a typical eight meter channel and the other half a six meter channel.

The dredging volumes required to initially dredge and to maintain the channels are shown in Figure VII-3.2-3.

3.2.1 Palembang to Banyuasin via the Sebalik Canal

3.2.1.1 Survey of Sebalik Canal Route

Purpose of trip to evaluate the inland waterway route from Palembang to Banyuasin via:

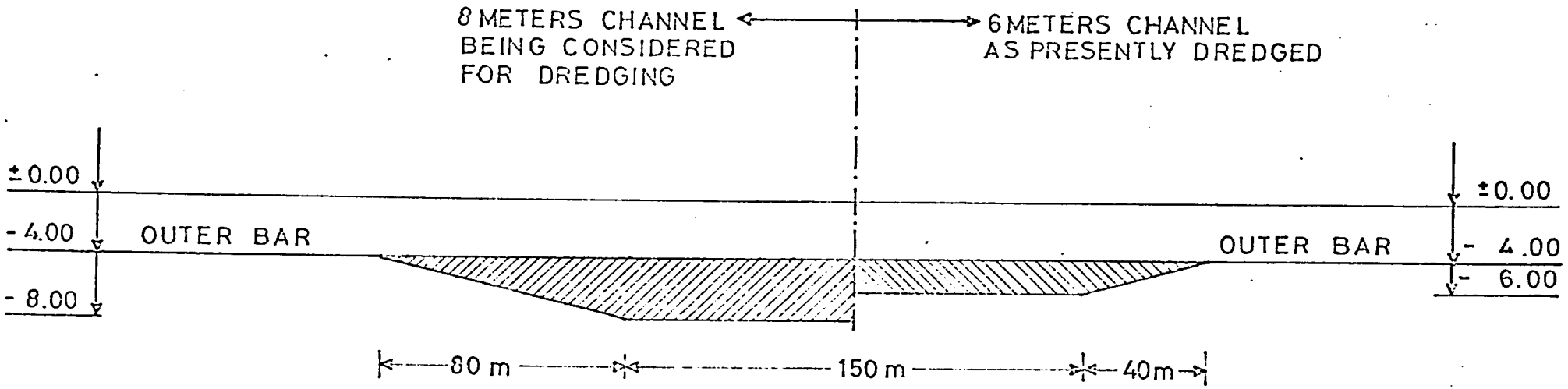


FIGURE VII - 3.1.1-1

CROSS SECTION DREDGED CHANNEL MUSI RIVER

(OUTER BAR)

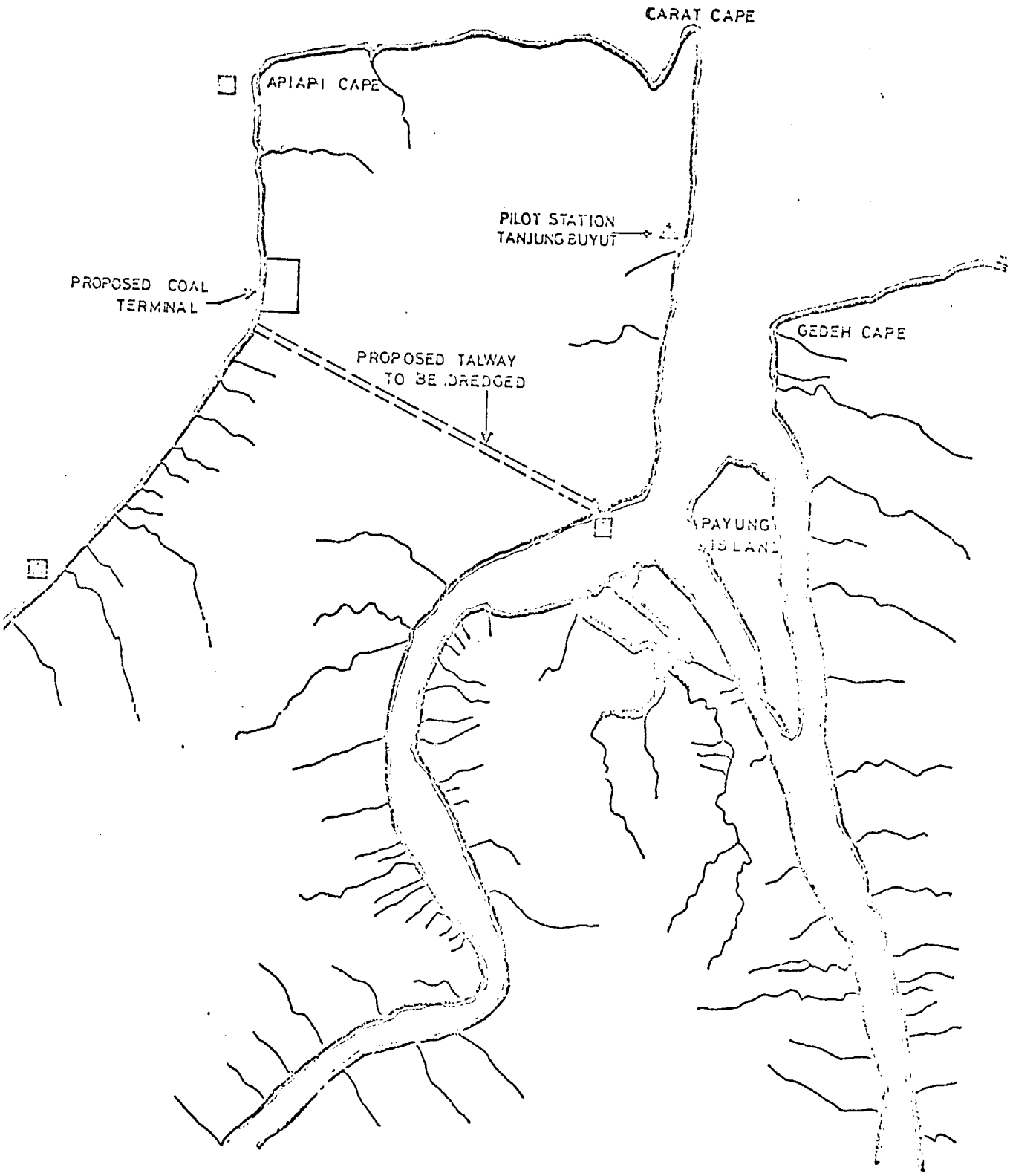
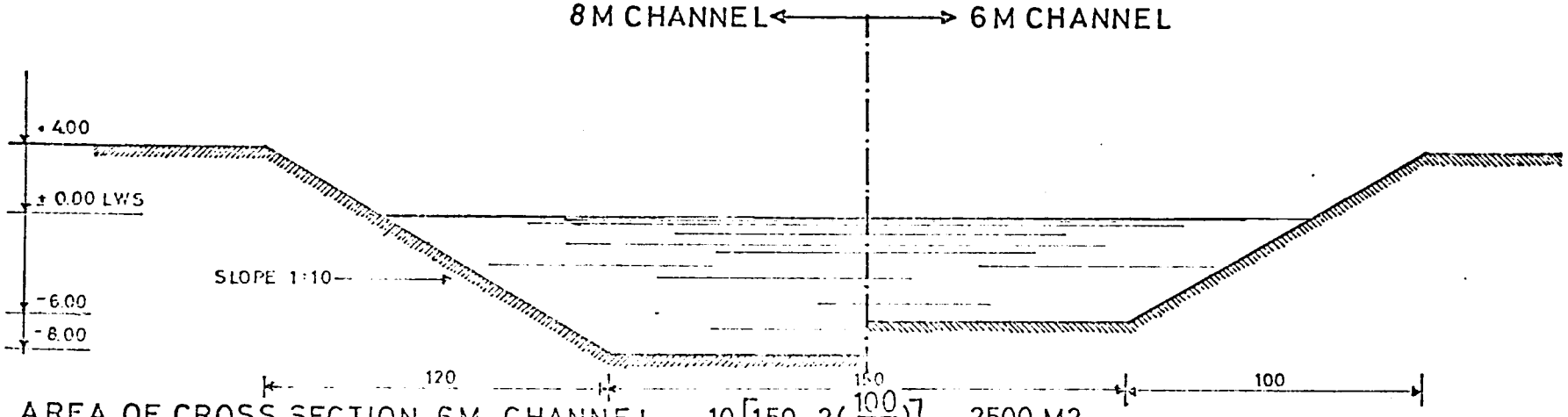


FIGURE : VII-3.2-1

BANYU ASIN - MUSI - SUNGSANG CANAL



AREA OF CROSS SECTION 6 M CHANNEL = $10\left[150+2\left(\frac{100}{2}\right)\right]$ = 2500 M2

8 M CHANNEL = $12\left[150+2\left(\frac{120}{2}\right)\right]$ = 3240 M2

EQUIVALENT LENGTH OF CHANNEL = 4.2 MILES = 7.7 KILOMETERS

DREDGING VOLUMES 6 M CHANNEL = 7700 x 2500 = 19.250.000 M3

8 M CHANNEL = 7700 x 3240 = 24.950.000 M3

FIGURE : VII-3.2-2

CROSS SECTION PROPOSED CHANNEL AT SUNGSANG PENINSULA

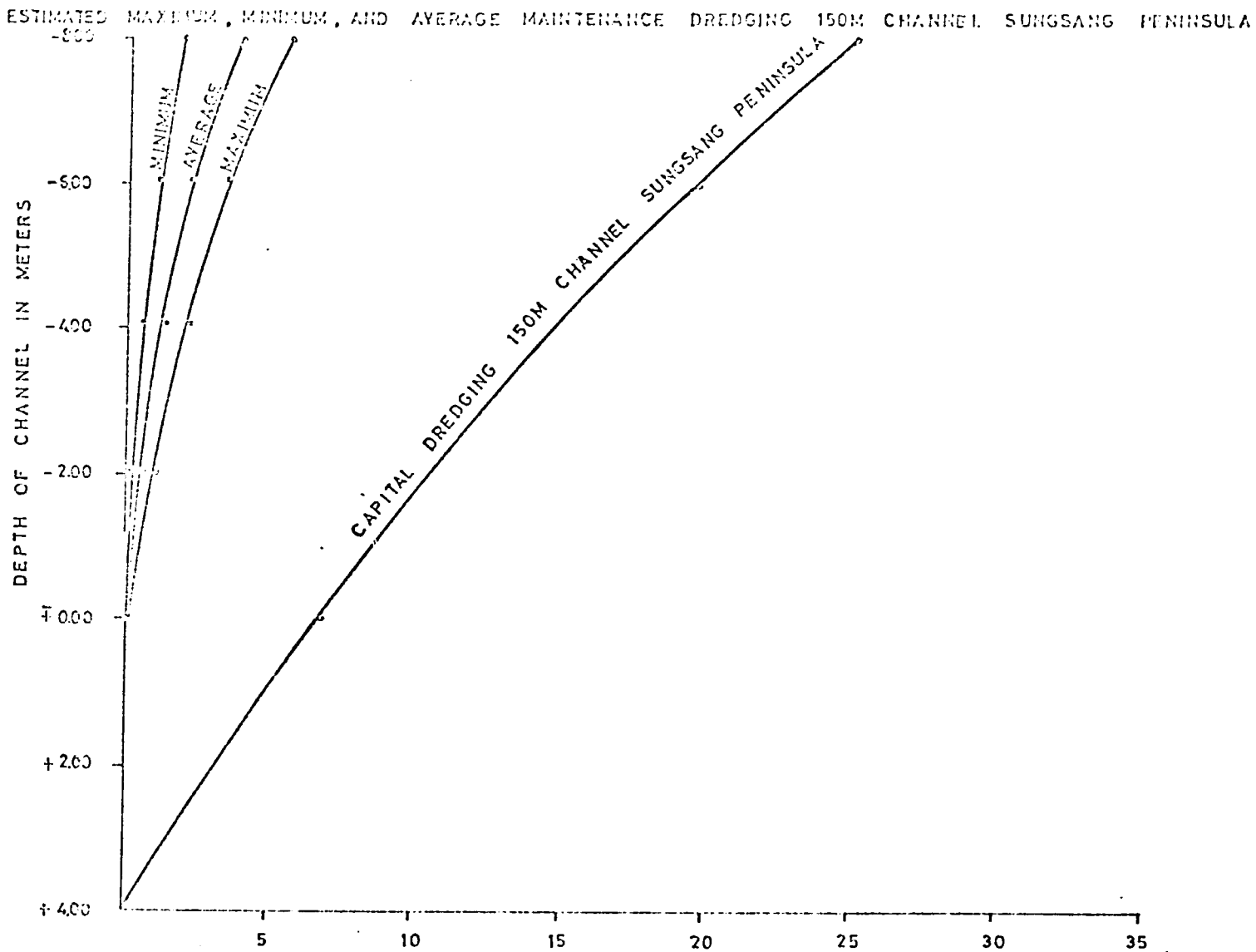


FIGURE VII - 3.2 - 3

DREDGING VOLUMES SUNGSANG PENINSULAR CHANNEL

Waterway	Distance KM.
a. The Musi River	35 KM
b. The Selat Jaran River	25 KM
c. The Sebalik River	20 KM
d. The Sebalik Canal	5 KM.
e. The Banyuasin River	42 KM
Total distance	127 KM

To determine its suitability as a primary inland waterway route for barges and other inland vessels should Banyuasin become an international seaport for the Province of South Sumatra and surrounding area.

The survey vessels left Palembang at 08:30 and arrived off the entrance of the Selat Jaran River where soundings were taken at regular intervals for the next 45 kilometers until the entrance to the Sebalik Canal was reached.

The Sebalik Canal is about 20 meters in width, its banks have tumbled down into the canal over a period of years and close to its banks the canal is considered to be foul ground with a number of obstructions such as toppled tree trunks and roots etc. The center of the canal is safe for navigation and the depths measured were in the center of the canal was quite satisfactory.

Upon entering the Banyuasin River from the Sebalik River a course of about 270° was maintained and a cross section of the Banyuasin River at the canal was obtained.

The principal data for the survey trip is contained in Table VII-3.2.1-1, the tide corrections were made from Table VII-3.2.1-2 and the route surveyed is shown on Figure VII-3.2.1-1.

3.2.1.2 Conclusions Sebalik Canal Route.

1. The distance between Palembang and Banyuasin via the

TABLE VII-3.2.1-1

SUMMARY DATA - TRIP PALEMBANG TO CANAL SEBALIK.

08:30 Departed Boom Baru

09:25 Arrived Entrance Selat Jaran River to Canal Sebalik.

Time	Sounding No.	Depth Measured	Depth LWS	Location and/or Comments
0929	1	6	4.2	River entrance South side
0933	2	4.5	2.7	River entrance North side Outside of channel
0935	3	6	4.2	Note - all depth measurements by lead line.
0937	4	8	6.2	
0939	5	12	10.2	
0940	6	13	11.2	
0943	7	11	9.2	
0946	8	9.5	7.7	
0951	9	11	9.2	
0957	10	11	9.2	
1002	11	10	8.2	40 KM mark.
1005	12	10	8.2	
1010	13	9	7.2	45 KM mark
1015	14	9	7.2	
1020	15	10	8.2	
1025	16	13	11.2	
1030	17	9.5	7.7	
1033	--	--	--	Off Gulanpao Kecil
1035	18	13	11.3	
1040	19	12.5	10.8	
1045	20	9	7.3	
1050	21	11	9.3	
1052	--	--	--	Entering Sebalik River
1055	22	10	8.3	
1100	23	10	8.3	
1105	24	10	8.3	

Time	Sounding No.	Depth Measured	Depth LWS	Location and/or Comments
1110	25	16	14.3	
1115	26	31	29.3	Off the point about 71 KM.
1120	27	12	10.3	Off 25 KM
1125	28	9	7.3	
1130	29	11	9.3	
1135	30	13	11.3	
1140	--	--	--	Spent 3 minutes fueling
1142	31	17	15.3	
1145	--	--	--	Off entrance to Canal Sebalik.
1146	32	3	1.3	100 meters from entrance
1147	33	3	1.3	canal appears to be about
1148	34	3	1.3	20 meters wide.
1149	35	2	0.3	
1150	36	3	1.3	
1151	37	3	1.3	
1152	38	3	1.3	
1153	39	2.5	0.8	
1154	40	2.5	0.8	
1155	41	2.5	0.8	
1156	42	2.0	0.3	
1157	43	2.0	0.3	
1158	44	2.0	0.3	
1159	45	2.25	0.5	
1200	46	2.0	0.3	
1201	47	2.0	0.3	
1202	48	2.0	0.3	
1203	49	2.25	0.5	
1204	50	2.50	0.8	
1205	51	2.25	0.5	
1206	52	2.25	0.5	
1207	53	2.25	0.5	
1208	54	2.25	0.5	

Time	Sounding No.	Depth Measured	Depth LWS	Location and/or Comments
1209	55	2.5	0.8	
1210	56	2.5	0.8	
1211	57	2.5	0.8	
1212	58	2.5	0.8	End of canal
1212.5	59	5.5	3.8	Headed directly across Banyu-
1213.3	60	5.0	3.3	asin on a westerly course of
1214	61	7.5	5.8	about 270°.
1215	--	--	--	Stopped one minute.
1216	62	9.75	8.1	
1217	63	9.30	7.6	
1218	64	7.0	5.3	
1219	65	7.0	5.3	
1220	66	8.0	6.3	
1221	67	8.0	6.3	
1222	68	7.0	5.3	
1223	69	6.5	4.8	
1224	70	6.0	4.3	
1225	71	4.5	2.8	About 100 meters from west bank of Banyuasin River.

Table VII-3.2.1-2

Tide Table

NOVEMBER 1975

j \ h	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	j \ h
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2	16	17	19	20	22	23	23	22	20	18	17	15	14	14	15	17	18	19	19	18	17	16	15	14	15	2
3	15	16	18	21	23	25	26	25	24	22	19	17	15	14	14	15	16	17	17	17	16	14	13	12	13	3
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22	07	07	08	11	15	19	23	27	30	31	32	31	28	26	23	20	18	17	15	13	12	10	09	08	07	22
23	07	07	08	09	12	16	20	24	27	29	31	31	30	28	25	23	20	18	17	15	13	12	10	08	08	23
24	08	07	08	08	11	15	17	21	24	27	29	30	29	28	27	24	22	20	18	17	15	13	12	10	09	24
25	09	09	08	09	10	12	15	18	21	24	26	27	28	28	27	25	23	21	20	18	17	15	13	12	11	25
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30	16	18	20	21	22	22	22	21	20	18	17	17	17	17	18	18	18	18	16	15	14	13	13	14	15	30
h \ j	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	j \ h

Table VII-3.2.1-2

Tide Table

DESEMBER 1975

h \ j	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	j / h
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2	13	15	18	22	25	27	28	27	26	23	21	19	17	16	16	16	15	15	14	13	11	10	09	09	10	2
3	10	13	16	20	24	28	29	30	29	27	24	21	19	17	16	15	15	14	13	12	11	09	08	07	08	3
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25	13	12	12	11	11	12	14	17	19	21	23	24	24	24	23	22	20	19	18	17	17	17	16	16	16	25
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30	15	18	21	24	26	27	26	25	23	22	20	19	18	17	16	16	15	14	12	11	09	09	09	10	13	30
31	13	16	20	23	26	28	29	28	27	25	23	21	18	17	16	15	15	14	12	10	08	07	07	08	10	31
h / j	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	j \ h

SUNGAI MUSI (Ambang Luar)

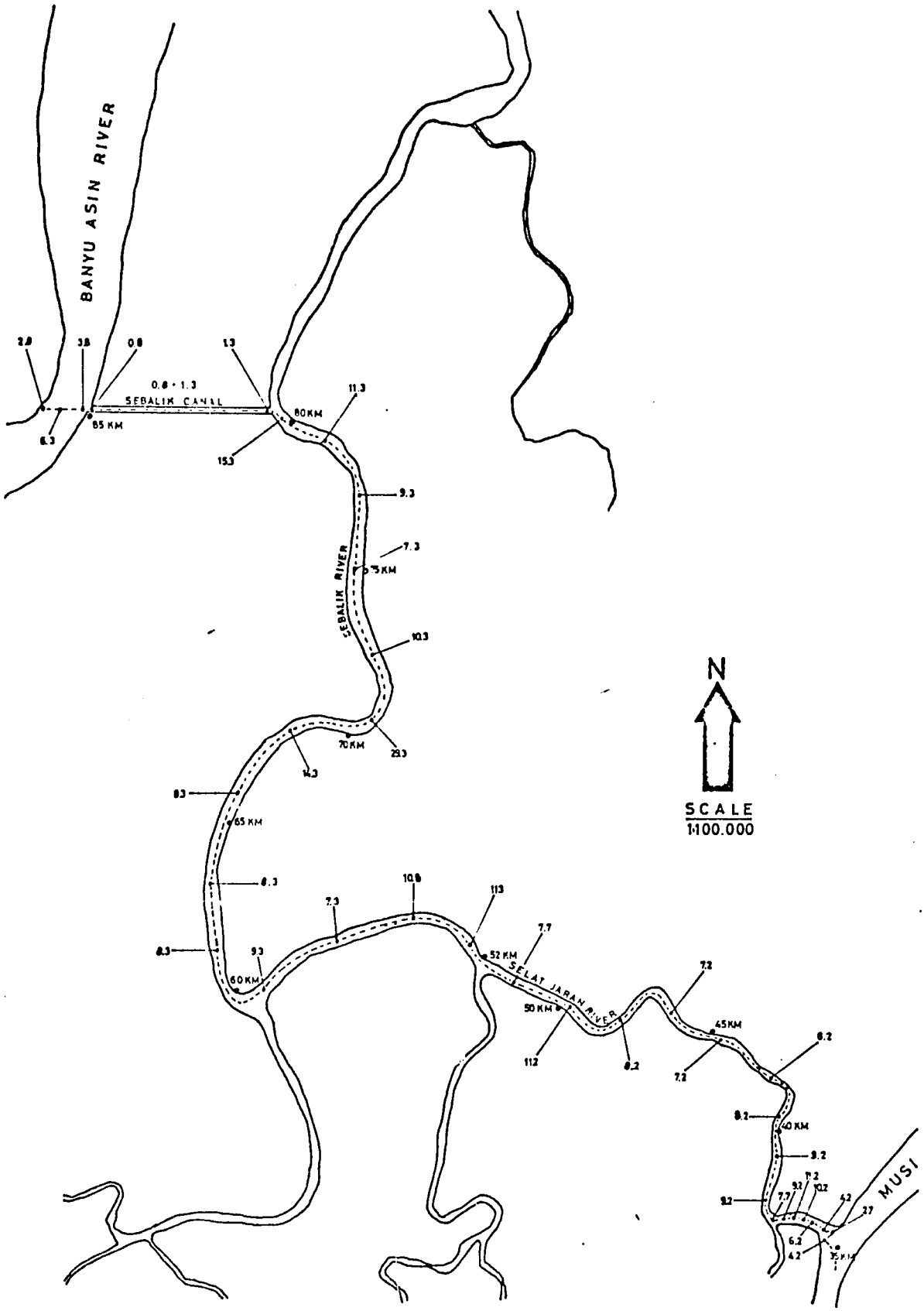


Figure VII-3.2.1-1

Inland Water Route from Musi to Banyuasin via Sebalik Canal

Source: E. G. F. Survey

Sebalik Canal is 127 KM which is the same distance as the Musi River - Outer Bar route between the two ports. The distance via a canal across Sungsang Peninsula from the same two ports would be 100 KM or 27 KM shorter.

2. The depth in the Musi, Selat Jaran, Sebalik and Banyuasin Rivers between Palembang and Banyuasin will support four meter draft shipping in their present condition without dredging.

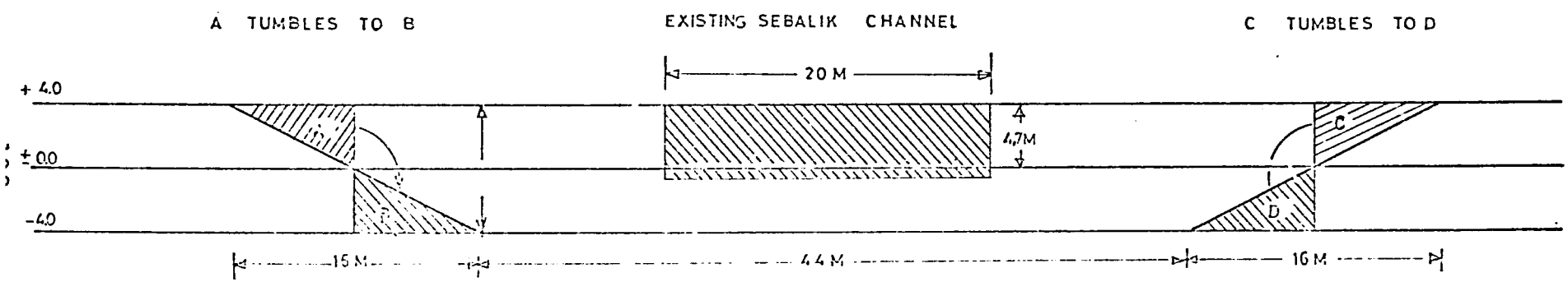
3. The Sebalik Canal has a controlling depth of about 0.5 meters at LWS, has about 2.5 to 3.0 meters depth at high water and 0.5 to 1.0 meter at low water. The average depth of the canal at LWS is approximately 0.7 meters.

4. The Sebalik Canal was originally dredged to about 20 meters in width, 4.0 meters deep and it is about 5.0 kilometers long. It is about 65 percent as long as a canal across the Sungsang Peninsula from Sungsang to Banyuasin would be and would cost considerably less to dredge to a suitable width and depth for inland water traffic than would a canal across Sungsang Peninsula.

5. The dredging volume required to make the Sebalik Canal 44 meters bottom width, four meters deep at LWS is approximately 1,930,000 M^3. See Figure VII-3.2.1-2.

6. The estimated capital cost of deepening and widening the present Sebalik Canal to the dimensions given above are 1,930,000 x 1.6 = US$ 3.1 million.

7. The annual maintenance dredging volumes for the Sebalik Canal are estimated to be about 10 percent of the underwater volume of the canal or about 100,000 cubic meters per year and the annual maintenance cost is estimated to be about US$ 150,000.



BOX CUT 60M OR 200FT PROPOSED SEBALIK CANAL

DREDGING VOLUME REQUIRED = 5000 [8 X 60 - 4,7 X 20] = 1,930,00 M^3

FIGURE VII – 3.2.1 – 2

CROSS SECTION EXISTING AND PROPOSED SEBALIK CANALS

3.3 Banyuasin Basin Approach Channel.

There are no recent surveys of the Banyuasin River entrance channel. Therefore, existing charts Selat Bangka Chart No.52 and Sungai Musi Chart No. 160, both Indonesian issue charts, were used to profile the channel entrance for a first estimate of the dredging volumes involved in deepening the channel from 11 meters to 15 meters. Figure VII - 3.3-1 is an approximate profile of the Banyuasin River entrance channel. Using the profile curve the dredging quantities required to be removed to deepen the channel were computed as indicated in Table VII-3.3-1 for channel dimensions as set forth in Figure VII-3.3-2.

The results of the computed volumes of capital dredging for the Banyuasin entrance channel are shown in graph form on Figure VII-3.3-3 along with estimated minimum and maximum maintenance dredging requirements for the dredged channel.

Summarizing, the computed dredging requirements reveal that approximately eight million cubic meters would have to be dredged to deepen the channel to 15 meters (49 feet) and that the maintenance dredging associated with a 15 meters channel is estimated to range from a minimum of about 1.6 million cubic meters to a maximum of approximately 3.2 million cubic meters per year.

3.4 Dredging Cost - Estimated

In estimating dredging costs it will be assumed that major capital dredging projects will be performed under contract by private enterprises and that maintenance dredging will be performed in house by RI Sea Communication dredges.

A summary of dredging costs is shown in Figure VII-3.4-1 and the sources are indicated by numbers which

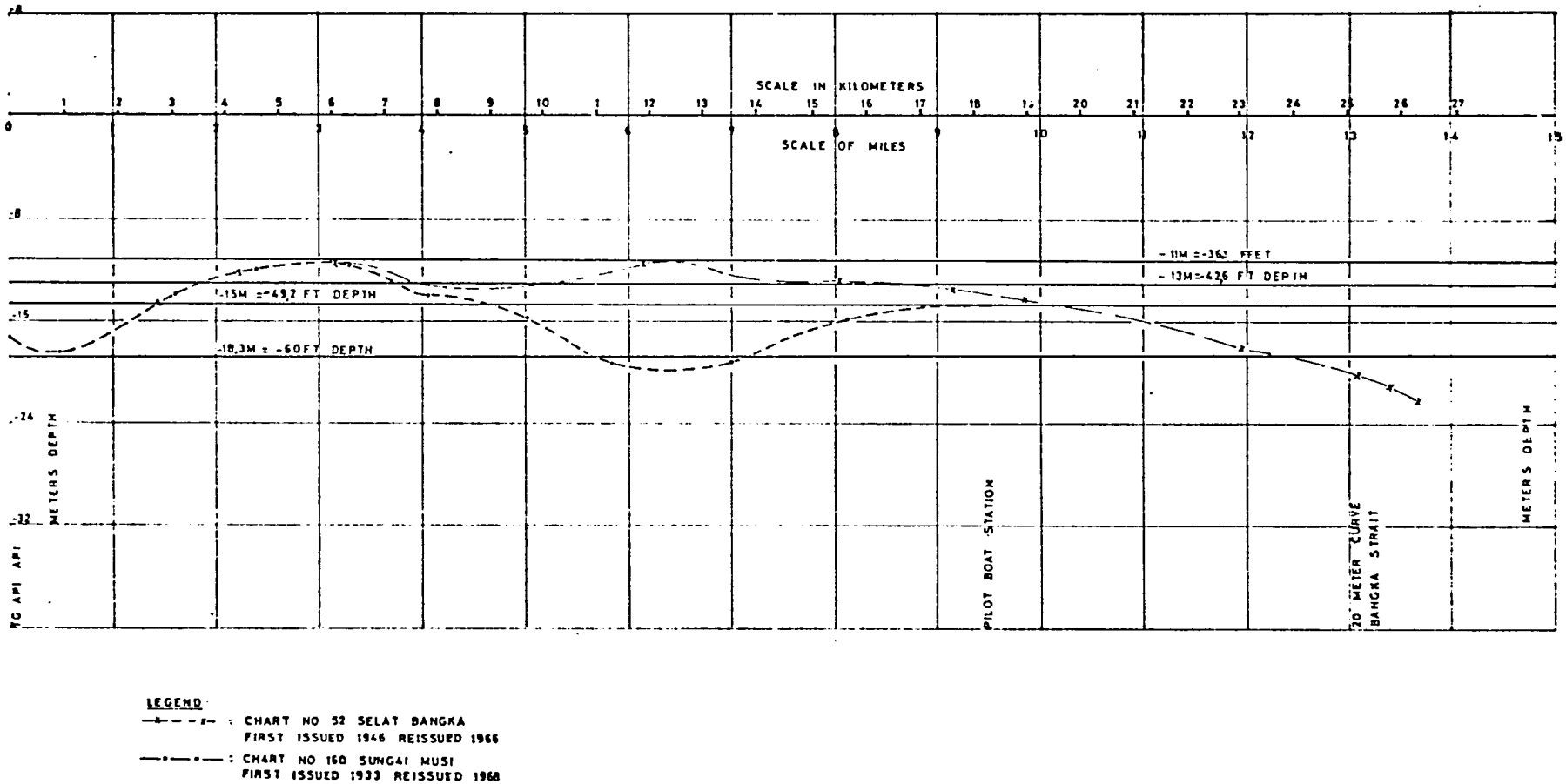


Figure VII-3.3-1

Profile Banyuasin River Entrance

Source: Indonesian Navigational Charts

Table VII-3.3-1

Capital Dredging Requirements - Deepening Banyuasin Entrance Channel

Tanjung Api Api to Pilot Station

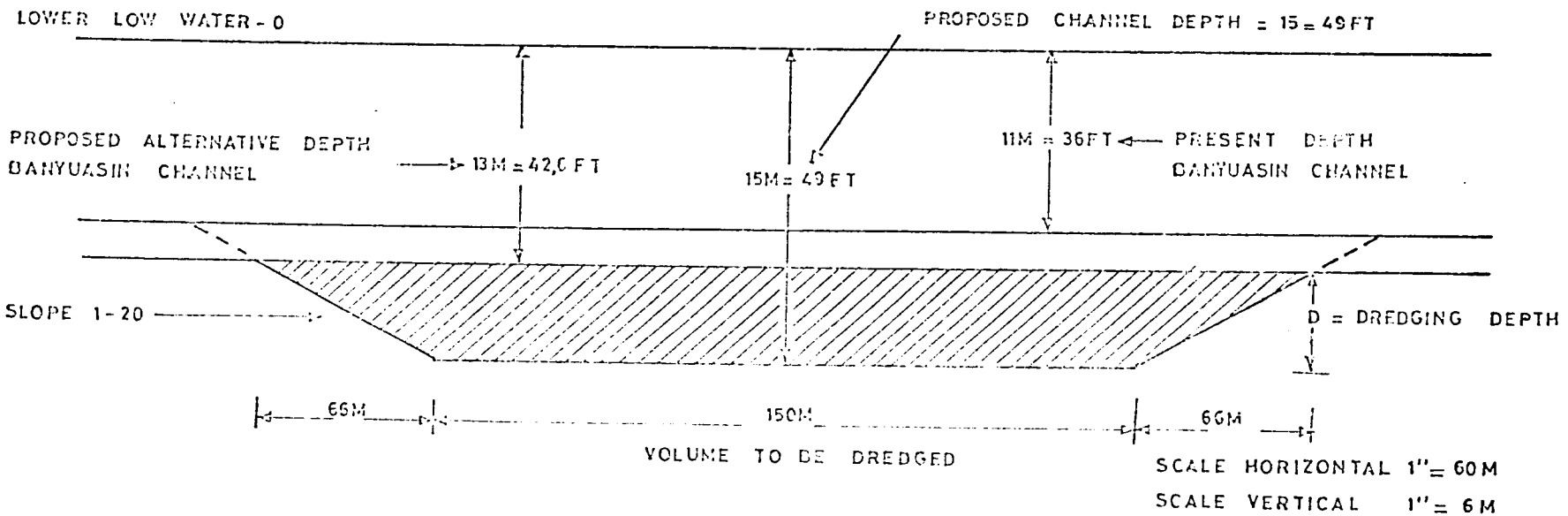
1	2	3	4	5	6	7	8	9	10
Item No.	Location of dredging Banyuasin Channel	Average existing depth water M	Dredging depth to 13 M - d M	Dredging depth to 15 M - d M	Dredging quantities to 13 M channel 150M-500 ft. 1000 M3	Dredging quantities to 13 M channel 180 M-600ft. 1000 M3	Dredging quantities to 15 M channel 150 M-500ft. 1000 M3	Dredging quantities to 15 M channel 180 M-600ft. 1000 M 3	Comment
1.	KM (0 - 1)	17.5	--	--	--	--	--	--	
2.	KM (1 - 2)	17.0	--	--	--	--	--	--	
3.	KM (2 - 3)	15.0	--	--	--	--	--	--	
4.	KM (3 - 4)	12.6	0.4	2.4	86.4	98.4	518.4	590.4	
5.	KM (4 - 5)	11.8	1.2	3.2	259.2	295.2	691.2	797.2	
6.	KM (5 - 6)	11.0	2.0	4.0	432.0	492.0	864.0	984.0	
7.	KM (6 - 7)	12.0	1.0	3.0	216.0	296.0	648.0	738.0	
8.	KM (7 - 8)	13.5	--	1.5	--	--	324.0	369.0	
9.	KM (8 - 9)	13.5	--	1.5	--	--	324.0	369.0	
10.	KM (9 - 10)	13.0	--	2.0	--	--	432.0	492.0	
11.	KM (10 - 11)	12.0	1.0	3.0	216.0	246.0	648.0	738.0	
12.	KM (11 - 12)	11.1	1.9	3.9	410.4	467.4	842.4	959.4	
13.	KM (12 - 13)	11.5	1.5	3.5	324.0	369.0	756.0	861.0	
14.	KM (13 - 14)	12.8	0.2	2.2	43.2	49.2	475.2	541.2	
15.	KM (14 - 15)	13.0	--	2.0	--	--	432.0	492.0	

Table VII-3.3-1

Capital Dredging Requirements - Deepening Banyuasin Entrance Channel

Tanjung Api Api to Pilot Station

1	2	3	4	5	6	7	8	9	10
Item No.	Location of dredging Banyuasin Channel	Average existing depth water M	Dredging depth to 13 M - d M	Dredging depth to 15 M - d M	Dredging quantities to 13 M channel 150M-500ft. 1000 M^3	Dredging quantities to 13 M channel 180M-600ft. 1000 M^3	Dredging quantities to 15 M channel 150M-500ft. 1000 M^3	Dredging quantities to 15 M channel 180M-600ft. 1000 M^3	Comment
16.	KM (15 - 16)	13.1	--	1.9	--	--	410.4	467.4	
17.	KM (16 - 17)	13.5	--	1.5	--	--	324.0	369.0	
18.	KM (17 - 18)	14.0	--	1.0	--	--	216.0	246.0	
19.	KM (18 - 19)	14.8	--	0.2	--	--	43.2	49.2	
20.	KM (19 - 20)	15.8	--	--	--	--	--	--	
21.	KM (20 - 21)	17.0	--	--	--	--	--	--	
22.	KM (21 - 22)	17.7	--	--	--	--	--	--	
23.	KM (22 - 23)	17.8	--	--	--	--	--	--	
24.	KM (23 - 24)	18.5	--	--	--	--	--	--	
25.	KM (24 - 25)	21.0	--	--	--	--	--	--	
26.	TOTAL QUANTITIES OF DREDGING			--	1,987.2	2,263.2	7,948.8	9,062.8	



VOLUME OF DREDGING ASSUMED TO BE (WIDTH X DEPTH X LENGTH)

FOR 150M CHANNEL (150 + 66) M X D X 1000 = 216 000 D = 216 D X 1000 M^3

FOR 180M CHANNEL (180 + 66) M X D X 1000 = 246 000 D = 246 D X 1.000 M^3

FIGURE VII - 3.3 - 2

PROPOSED CROSS SECTION OF BANYUASIN DREDGED CHANNEL

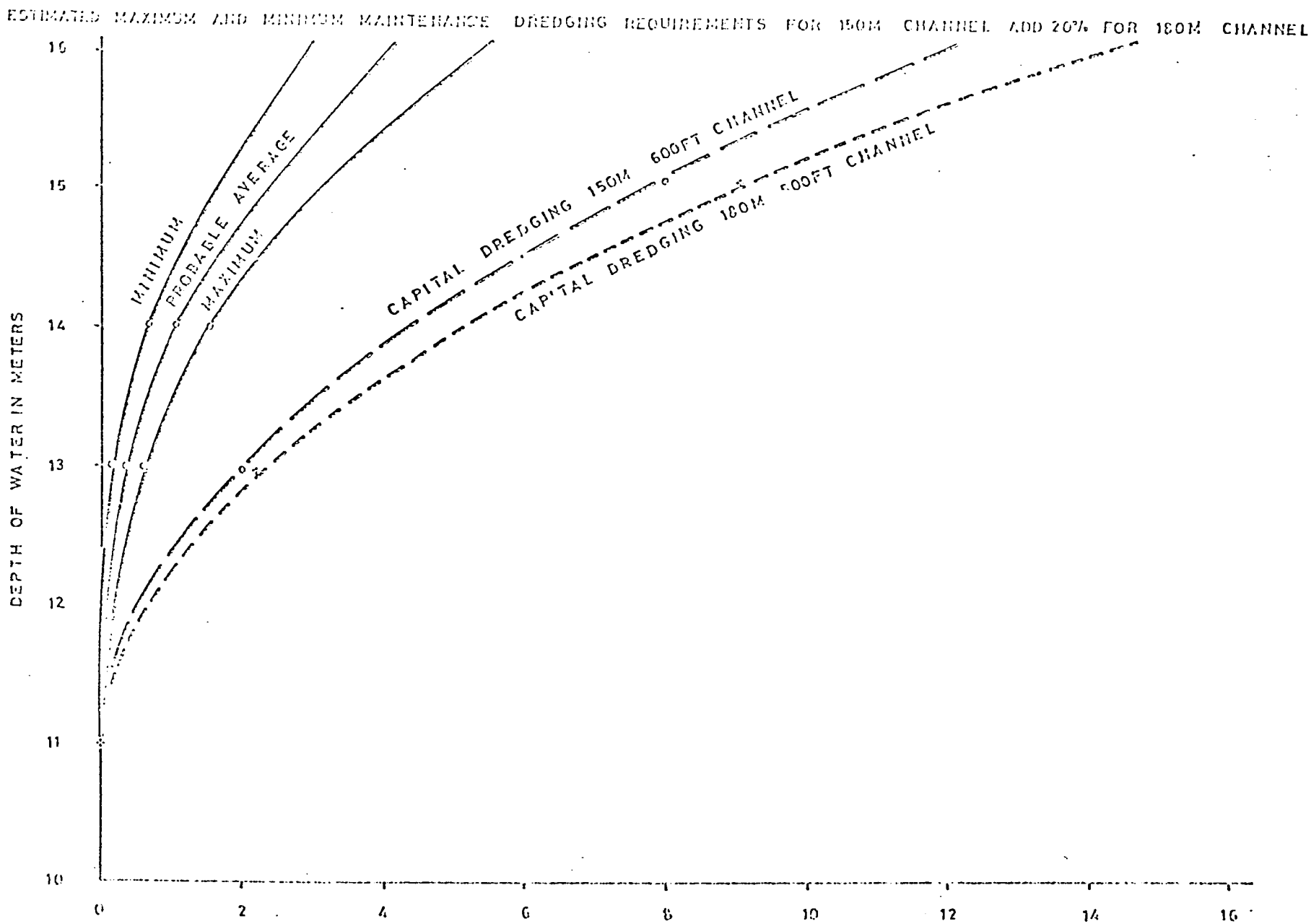


FIGURE: VII - 3.3 - 3

BAIYU ANH RIVER ENTRANCE CHANNEL DEPTH WATER VS DREDGING VOLUMES IN CUBIC METERS X 10^{-6}

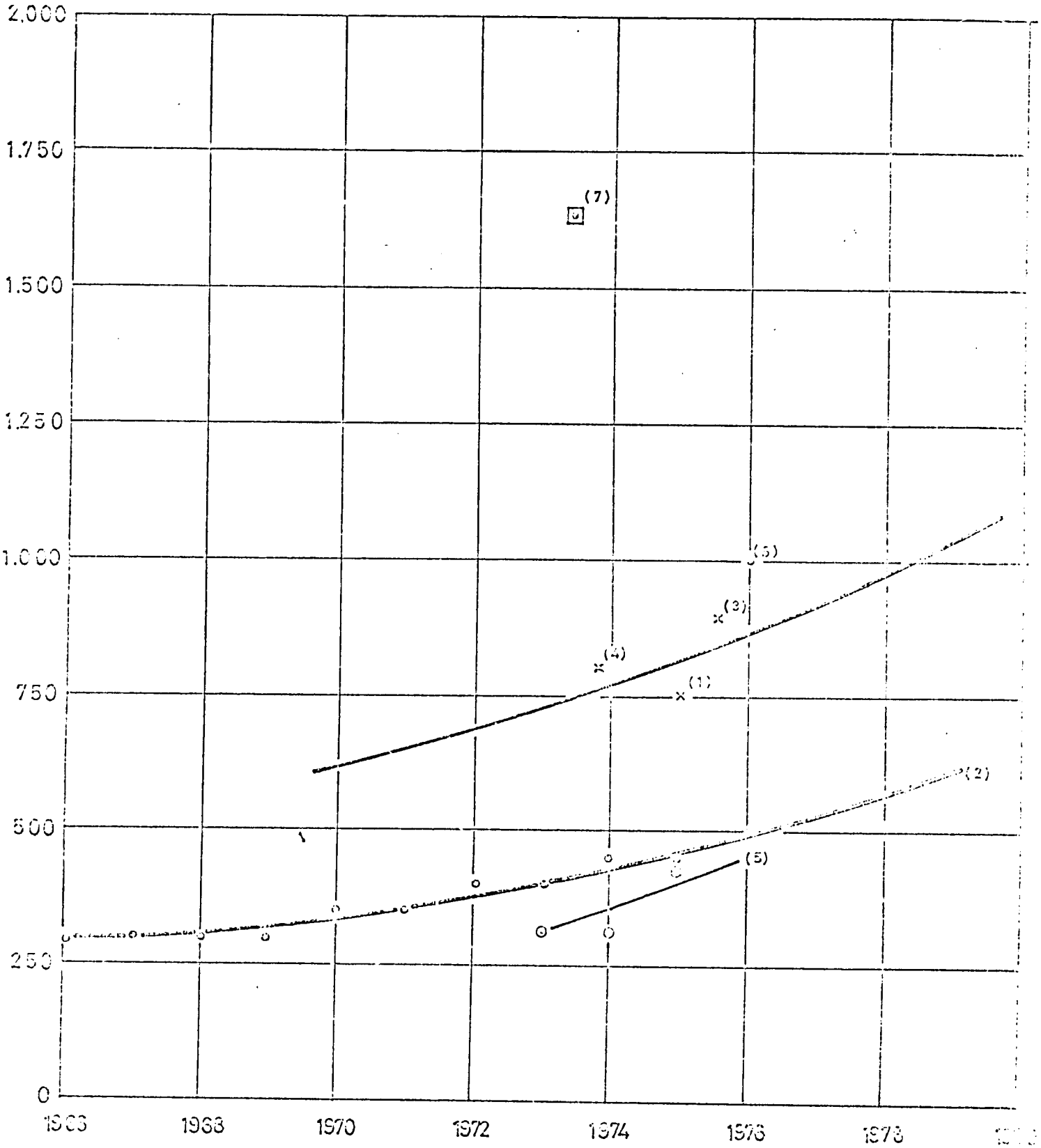


FIGURE VII-3.4-1

DREDGING COST-RUPIAHS/M3

correspond to the paragraph numbers in Section VII-3.4.1 where the sources and dates are identified.

Based on the cost data accumulated and extrapolating same to 1976 the most reasonable dredging costs appear to be the following.

Item No.	Location of dredging	Type of dredging	Depth of dredging	Cost per cubic meter Rupiahs	US$
1.	Musi River	Maintenance	6-8 mtrs	500	1.2
2.	Outer Bar	Capital	6-8 mtrs	500	1.2
3.	Sungsang Peninsular	Capital	6-8 mtrs	780	1.9
4.	Sungsang Peninsular	Maintenance	6-8 mtrs	570	1.4
5.	Banyuasin Entrance Channel	Capital	15 mtrs	1650	4.0
6.	Banyuasin Entrance Channel	Maintenance	15 mtrs	1250	3.0

3.4.1 Dredging Costs and Sources

1. Dredging Works at Barito River.

   Project to dredge river about 14,000 meter long and 200 meter wide to a depth of 6 meter LWS. The dredging volume was estimated to be six million M3. The cost of the dredging contract was approximately US$11 million which amounts to about US$1.83 per meter^3. Source - The Indonesian Times - 22 August 1975.

2. Dredging Program Musi River.

   The cost of maintenance dredging on the Musi River has varied in accordance with Figure VII-3.4-1 - Source - Palembang Port Administration - Dredging Operation Reports.

3. Dredging Division, Palembang Port Administration reports the cost of cutter head suction dredges with pipeline discharges is about 900 rupiahs per meter^3 in late 1975 and that the current price charged by Sea Communications Directorate of Harbor and Dredging for maintenance dredging by dredges such as the Aru and Lombok is 450 Rps/M^3.

4. Dredging Works Kahayan River.
Project to dredge river 18 kilometers long, 90 meters wide and seven meters deep. The dredging volume was estimated to be 6.4 million M^3. The cost of the dredging contract was about US$ 12.5 million which amounts to about US$ 1.95 per M^3.

5. Director General of Sea Communications at commissioning of the hopper dredge Lombok reported on maintenance dredging volumes and costs as follows :

Year	Volume in Million M3	Cost in Milliards	Cost per meter3 Rupiahs
1973	5.2	1.6	306
1974	7.6	2.3	302
1975	9.0	4.0	445

The results are plotted in Figure VII-3.4-1

6. Reconnaisance survey concerning Palembang Port, Musi River, and the estuary estimated the dredging cost per meter^3 to be US$ 2.50 for capital dredging in the Outer Bar channel.

7. Port Kelang, Malaysia Dredging Project.
Project to dredge many millions of cubic meters of mud and sand down to a depth of 45 feet (13.7 meters) and to transport the spoils a distance of about 11 miles. The dredging was performed by contract dredgers at a cost of about US $ 4.00 per M^3.

8. P.T. Nusantara Dredging Company - Palembang

Inquiries concerning estimated dredging costs for a new canal across the Sungsang Peninsula about four to six meter deep and 60 meters wide and for redredging the Sebalik Canal resulted in the following general quotations.

a. To dredge a canal across the Sungsang Peninsula

Item	Min.cost $	Max.cost $
i. Dredging per cubic meter	1.20	1.40
ii. Clearing of land per M^3	0.50	0.50
Total cost per cubic meter	1.70	1.90

b. Maintenance dredging with no land clearing requirements

Item	Min.cost, $	Max.cost, $
Dredging per cubic meter	1.20	1.40

3.5 Estimated Channel Development Requirements and Costs

The capital and maintenanc e dredging requirement volumes, the estimated cost per cubic meter for each type of dredging and the estimated total development costs for the various channel dredging projects considered are given in Table VII-3.5-1.

3.5.1 Musi River

It will be noted that the cost per cubic meter for dredging in the Musi River varies in accordance with the depth to which the river is to be dredged. The reason for this is the fact that for the deeper dredging in some instances it is necessary to transport the spoils a greater distance to find acceptable dumping grounds. For distances to the nearest spoils areas see Table VII-2.1.2-3.

TABLE VII-3.5-1

ESTIMATED CHANNEL DEVELOPMENT REQUIREMENTS AND COSTS.

BANYUASIN AND MUSI RIVER SYSTEMS.

Item	Channel Description	Channel dimensions			Capital dredging volumes 1000 M^3	Estimated capital dredging costs US$/$M^3$	Maintenance dredging volumes 1000 M^3	Estimated maintenance dredging costs US$/$M^3$	Estimated total capital dredging costs US$+1000	Estimated annual maintenance dredging costs US$+1000	Comments
		Depth Mtr	Width Mtr	Bank slope Ratio							
1	Musi River Outer Bar	6	150	1:10	2,500	1.20	330	1.20	3,000	400	
2	Musi River Outer Bar	7	150	1:10	3,780	1.20	1,100	1.20	4,540	1,310	
3	Musi River Outer Bar	8	150	1:10	7,250	1.20	2,100	1.20	8,700	2,520	
4	Musi River	6	150	1:10	3,130	1.20	640	1.20	3,760	770	
5	Musi River	7	150	1:10	9,460	1.44	2,720	1.44	13,620	3,920	
6	Musi River	8	150	1:10	18,200	1.44	5,240	1.44	26,200	7,550	
7	Banyuasin Basin Channel	13	150	1:10	2,000	4.00	550	3.00	8,000	1,650	Requires deep water equipment
8	Banyuasin Basin Channel	15	150	1:10	8,000	4.00	2,400	3.00	32,000	7,200	
9	Sungsang Peninsula Channel (ship)	6	150	1:10	19,250	1.90	1,930	1.40	36,575	2,700	
10	Sungsang Peninsula Channel (ship)	7	150	1:10	21,900	1.90	2,190	1.40	41,610	3,070	
11	Sungsang Peninsula Channel (ship)	8	150	1:10	24,950	1.90	2,500	1.40	47,400	3,500	
12	Sungsang Peninsula Channel (ship)	6	100	1:10	15,400	1.90	1,540	1.40	29,260	2,160	
13	Sungsang Peninsula Channel (ship)	6	100	1:2	9,240	1.90	920	1.40	17,600	1,290	

TABLE VII-3.5-1

ESTIMATED CHANNEL DEVELOPMENT REQUIREMENTS AND COSTS

BANYUASIN AND MUSI RIVER SYSTEMS.

Item	Channel Description	Channel dimensions			Capital dredging volumes 1000 M^3	Estimated capital dredging costs US$/$M^3$	Maintenance dredging volumes 1000 M^3	Estimated maintenance dredging costs US$/$M^3$	Estimated Total capital dredging costs US$+1000	Estimated annual maintenance dredging costs US$+1000	Comments
		Depth Mtr	Width Mtr	Bank slope Ratio							
14	Sungsang Peninsula Channel (barge)	4	60	1:2	4,681	1.90	470	1.40	8,900	660	
15	Sungsang Peninsula Channel (barge)	4	44	1:2	3,700	1.90	370	1.40	7,030	520	
16	Sungsang Peninsula Channel (barge)	4	30	1:2	2,830	1.90	280	1.40	5,380	390	
17	Sungsang Peninsula Channel (barge)	4	20	1:2	2,220	1.90	220	1.40	4,220	310	
18	Banyuasin to Palembang Canal (ship & barge) 100 M	6	100	1:2	100,000	1.80	5,000	1.40	180,000	7,000	

The following is a summary of costs for dredging the Musi River.

Depth of channel Meters	Dredging cost Outer Bar US $ 1000	Dredging cost Musi River except Outer Bar US $ 1000	Dredging cost Outer Bar to Palembang US $ 1000	Cost differential from present 6 mtr. channel US$ 1000
Capital Dredging				
6	3000	3760	6760	--
7	4540	13620	18160	11,400
8	8700	26200	34900	28,140
Maintenance Dredging				
6	400	770	1170	
7	1310	3220	4530	
8	2520	7550	10070	

The above capital dredging costs for the Musi River system from the Outer Bar to Palembang are plotted in graph form in Figure VII-3.5.1-1. Figure VII-3.5.1-1 indicates that RI, South-Sumatra and Palembang have an investment of about 6.8 million dollars in having increased the depth of the Musi River to six meters; it would require an additional investment of 11.4 million dollars to deepen the river to seven meters and an added investment of 28 million dollars to deepen the channel to eight meters. Figure VII-3.5.1-2 indicates that the annual maintenance cost for the Musi River will be about 1.2 million dollars at six meters, 4.5 million dollars at seven meters and 10 million dollars at eight meters.

A review of Figures VII-3.5.1-1 and 2 clearly indicate that the most practical and cost effective depth for the Musi River will be about six meters. Estimates of the dredging volumes and costs required to deepen the Musi River made by Pertamina have led to their conclusion that it is financially not viable to increase the depth of the Musi River beyond six meters.

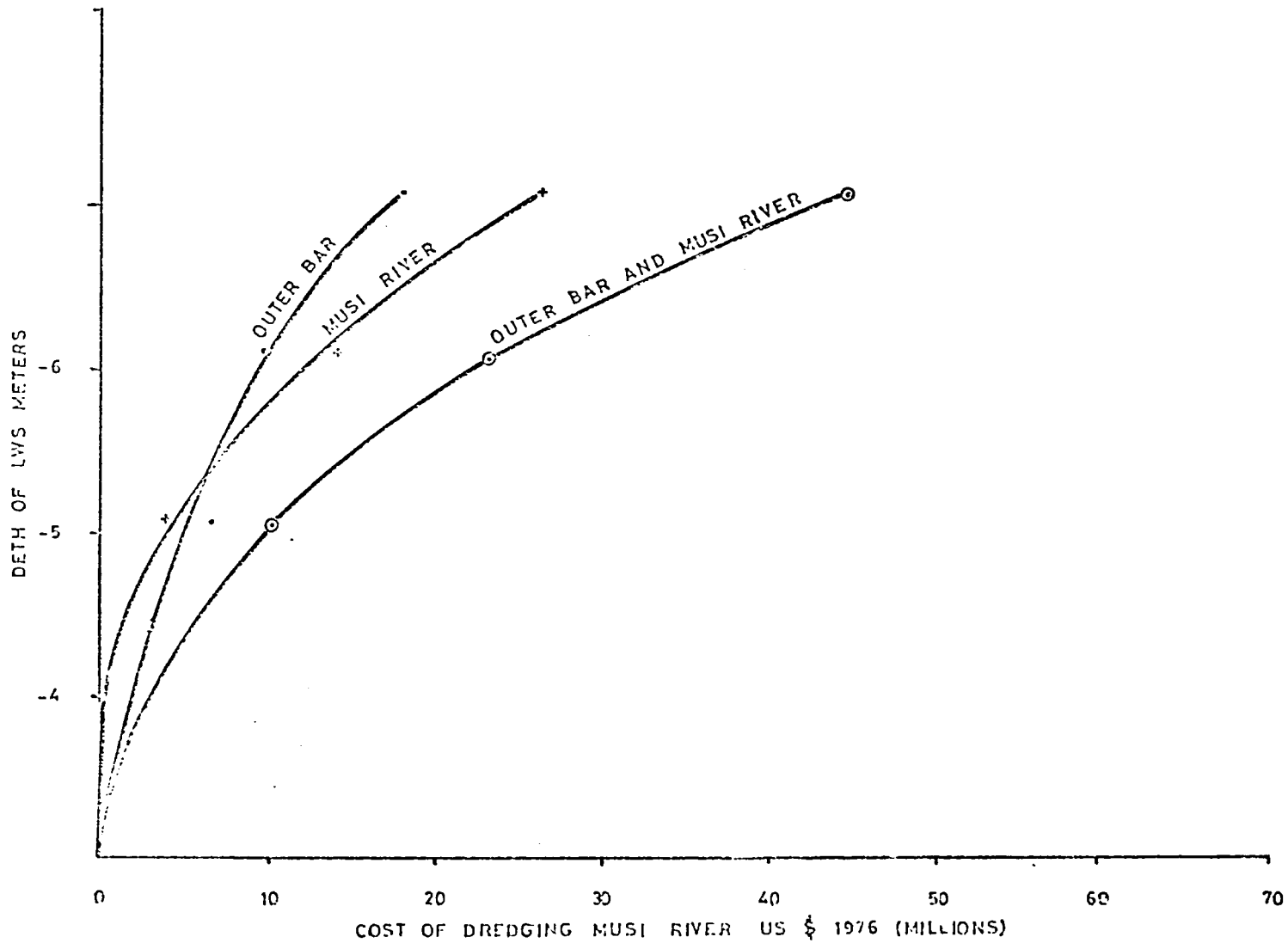


FIGURE VII - 3.51 - 1

CAPITAL DREDGING COST VS DEPTH MUSI RIVER

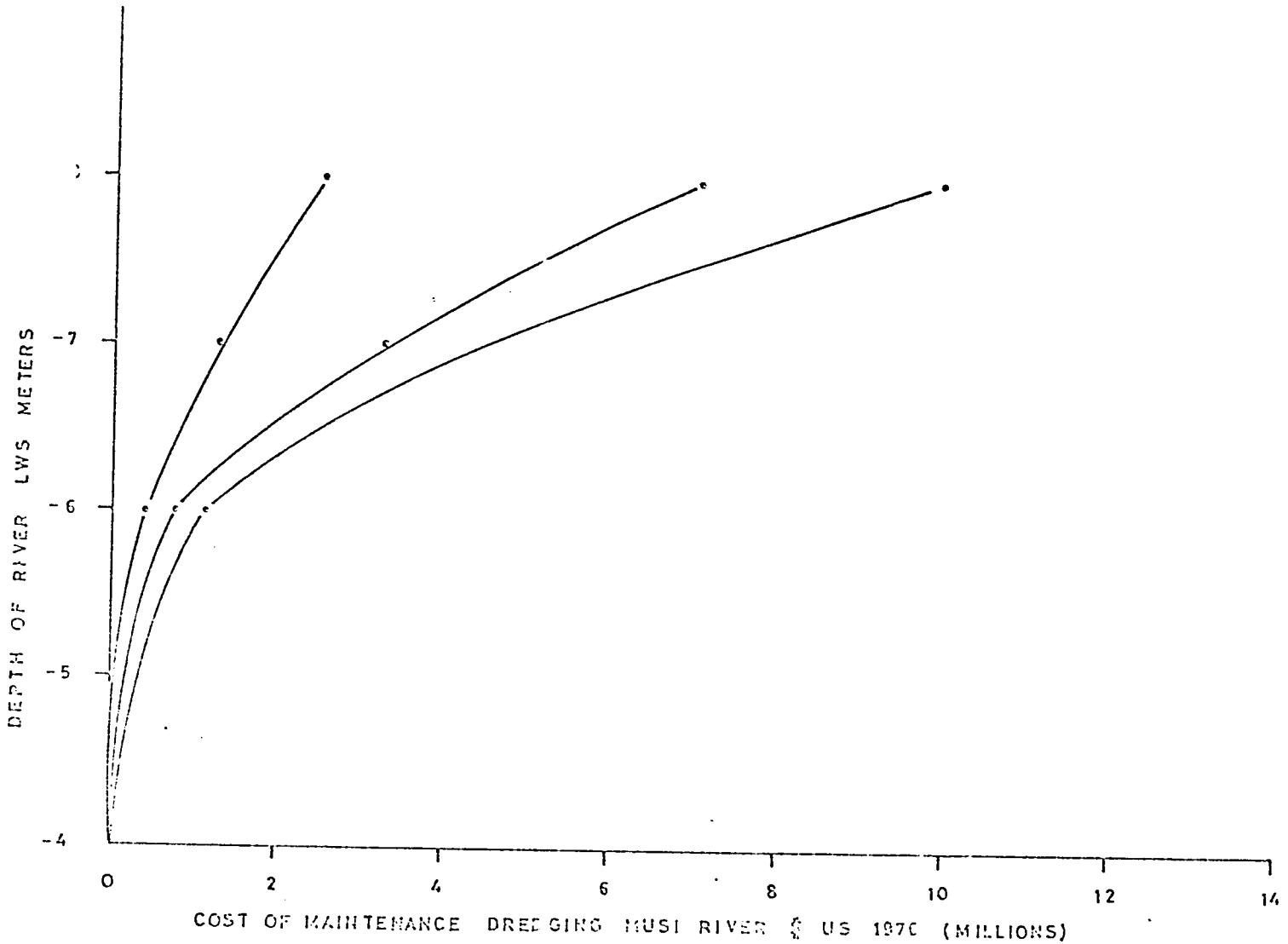


FIGURE VII - 3.5.1 - 2

MAINTENANCE DREDGING COST VS DEPTH MUSI RIVER

3.5.2 Banyuasin Basin Channel

There is a natural Banyuasin River channel of about 11 meters depth at LWS which leads to a 15 meter depth basin of Tanjung Api-Api. The channel profile and other data are given in Section-3.3. The estimated capital cost to dredge this channel to 15 meters depth at LWS is about 32 million dollars and the annual maintenance dredging cost will be around 7.2 million dollars. These figures clearly indicate that it will be very expensive to deepen the approach channel to Banyuasin and it is extremely doubtful that this cost could be recuperated in the operation of a port at Tanjung Api-Api. It is therefore recommended that port considerations on the Banyuasin River be limited to a 10 meter depth Port.

3.5.3 Sungsang Peninsula Canal

The establishment of a Port at Tanjung Api-Api, Banyuasin suggests that a ship canal or channel be cut across the Sungsang Peninsula to provide a 27 mile shorter route from the new port to Palembang. In addition the canal would provide a safe inside route for local river traffic to travel from Palembang to the Port of Banyuasin without having to go seven or eight miles out into Bangka Strait in order to cross over from one river entrance to the other.

Calculations of the dredging volumes involved and the costs of dredging various depths and configurations of canals across Sungsang Peninsula were made. Figure VII-3.5.3-1 shows the estimated capital and maintenance costs for a standard 150 meter wide, 1:10 bank slope, ship channel for various depths of water. Figure VII-3.5.3-1 reveals, as does Table VII-3.5-1, that the cost of dredging a six meter, 150 meter wide ship canal will be about 37 million dollars in capital dredging along with an annual maintenance dredging cost of about 2.7 million dollars.

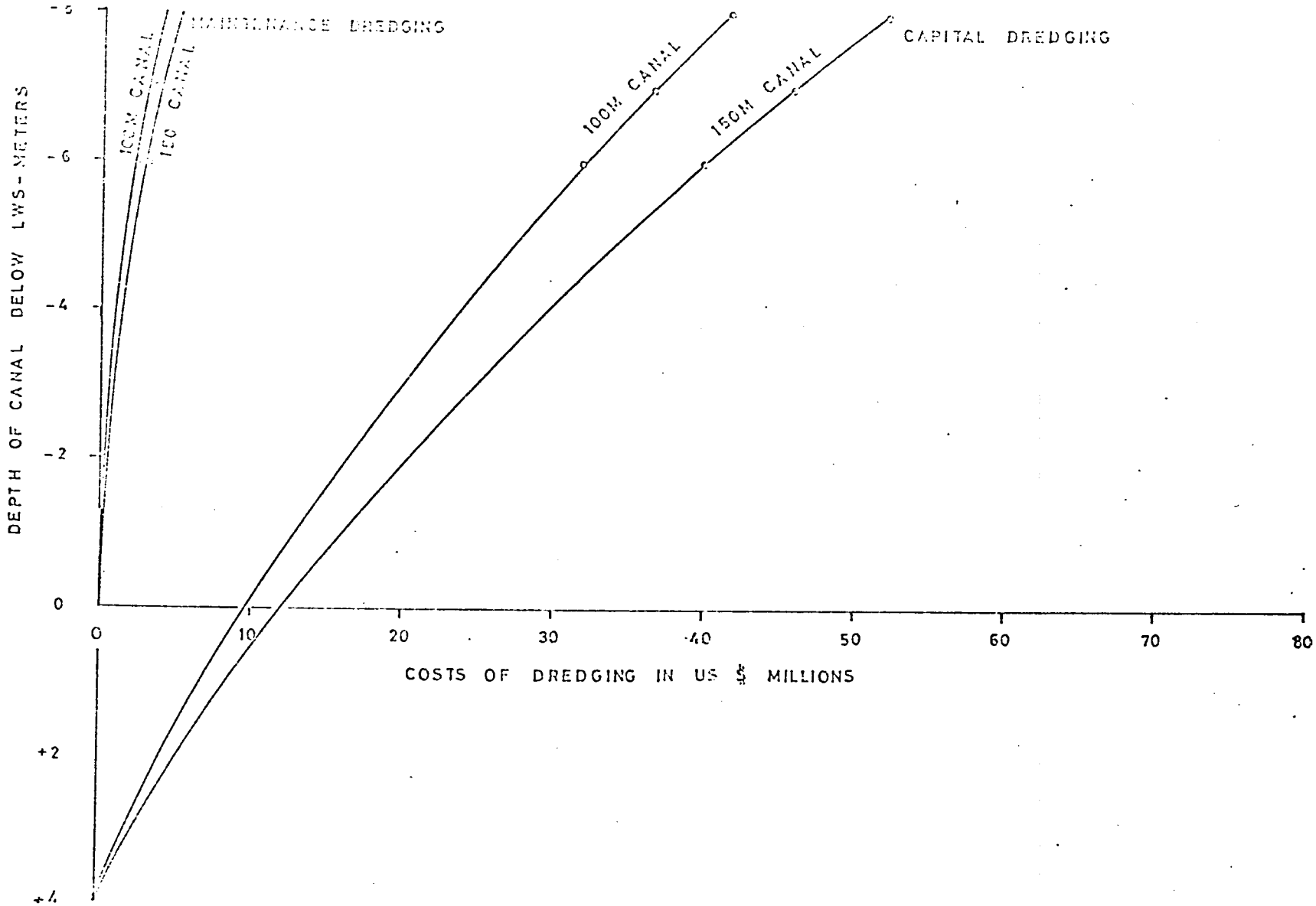


FIGURE VII - 3.5.3 - 1

DREDGING COSTS VS DEPTH OF CHANNEL SUNGSANG PENINSULAR CANAL

Whether a ship goes from the pilot vessel to Palembang via the Banyuasin River and Sungsang canal or via the Musi River Outer Bar to Palembang that portion of the Musi River from the Port of Sungsang to Palembang will be traveled on either route.

As a primary ship channel route to Palembang, the cost of the Sungsang Peninsula canal should be compared with the cost of maintaining the Musi River channel from the Outer Bar to Sungsang.

The following Table compares the cost of developing and maintaining a 150 meter wide, 6 meter deep ship channel from the pilot vessel to Sungsang via 1 - the Banyuasin River and 2 - The Musi River.

No.	Route	Capital dredging cost US $ millions	Maintenance dredging cost US $ millions
1.	Banyuasin River and Sungsang Canal to Sungsang	36.58	2.7
2.	Outer Bar and Musi River to Sungsang.	(6.25) Note this dredging has already been accomplished	0.4

From the above figures it is obvious that a Sungsang Peninsula canal cannot compete with the Outer Bar Musi River route to Sungsang and thence upriver to Palembang. The Sungsang canal route represents a capital investment of 37 million dollars over the Musi River Outer Bar route since the latter is in existance and it represents an annual maintenance cost of about 2.7 million more than the Musi River Outer Bar route.

While there may be some argument about the cost of dredging in the canal etc., spoils disposal will be a problem unless pumped up onto the banks of the canal by pipeline dredges, the fact remains that the Musi River Outer Bar route is much cheaper than the Banyuasin- Sungsang canal route. Even if we halve the canal dredging cost and double the Outer Bar maintenance dredging costs, the Banyuasin-Sungsang route will cost 20 million more in capital dredging costs and about 0.8 million more in maintenance dredging costs than the Outer Bar-Musi River route. Thus it appears that the Outer Bar-Musi River route to Palembang should be retained as the primary ship route and that the Sungsang Peninsula canal should receive further consideration only as an inland waterway barge and small vessel canal.

Figure VII-3.5.3-2 is a graph of the capital and maintenance costs of barge canals across Sungsang Peninsula. The capital cost fo a 60 meter wide, 4 meter deep canal is about 9.8 million dollars and its maintenance cost will be about 0.75 million dollars per year. The financial viability of such a canal will be discussed in a later section.

3.5.4 Banyuasin to Palembang Canal

A report published in 1939, entitled - An Ocean Port for Palembang, suggested that a ship and barge canal of about six meters depth running directly from the Banyuasin River to Palembang be dredged. The report indicated that the cost of such a canal had not been estimated.

Computations at 1976 estimated costs indicate that a 100 meter wide, six meter depth canal of about 90 kilometers in length would cost about 200 million dollars to dredge and would have an annual maintenance cost of around 80 million dollars. It is obvious that such a canal cannot compete w ith providing a six meter channel in the Musi Rivers natural waterway.

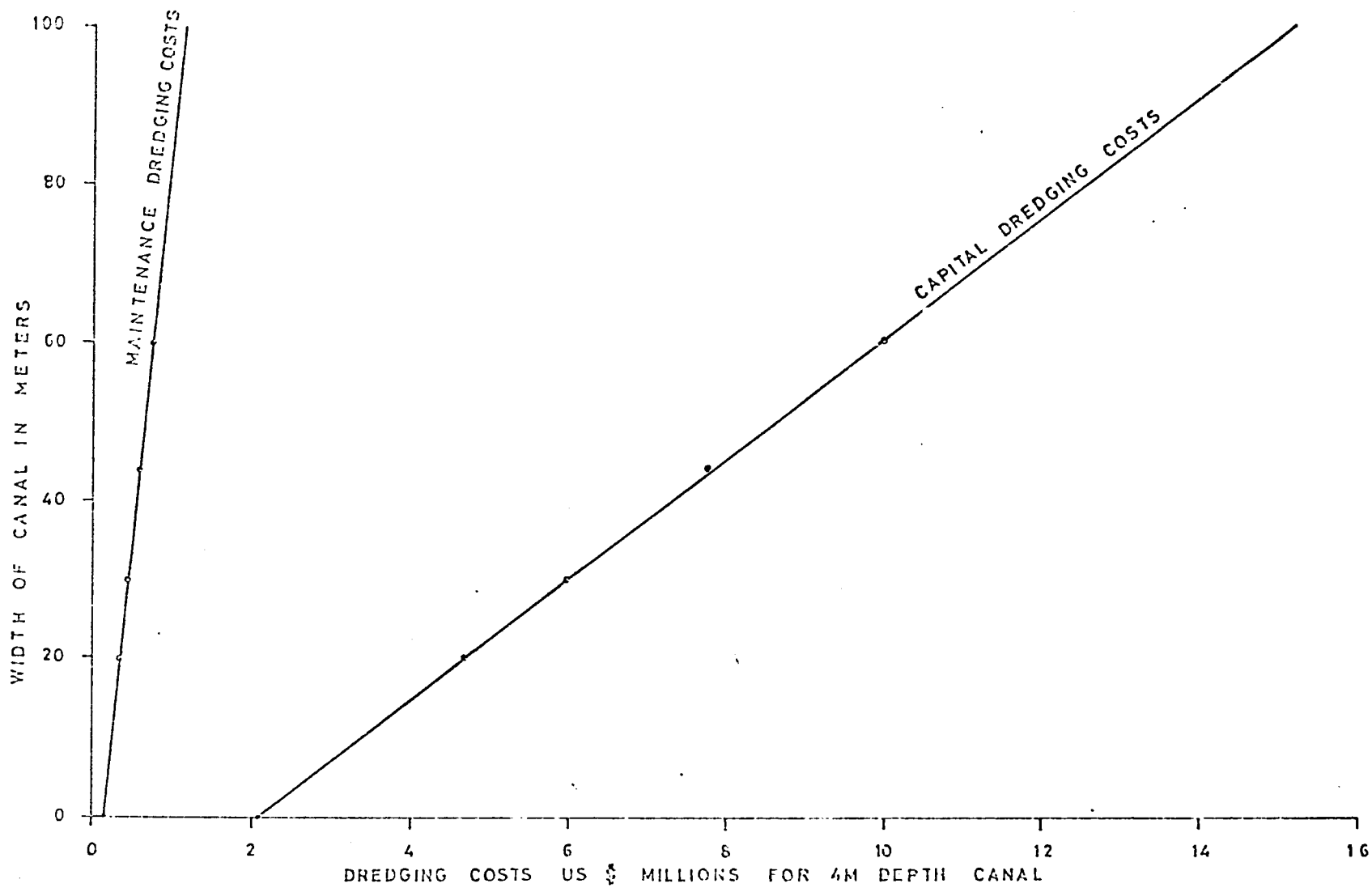


FIGURE VII - 3.53 - 2

CAPITAL AND MAINTENANCE DREDGING COSTS VS WIDTH OF CANAL SUNGSANG PENINSULAR

3.5.5 Sungai Lais - Port and Channel Proposal

3.5.5.1 Dredging Quantities - Phase I

The dredging quantities associated with dredging an approach channel and port basin at Sungai Lais were developed by using data contained in Figure VII-3.5.5-1 from a 1962 proposal for a second port on Musi River - Source BPP Palembang Technical Division. Phase I consists of that part of the project required to accommodate 1000 meters of 6 meter wharf.

Dredging quantities from Figure VII-3.5.5-1

Location	Width (M)	x	Length (M)	x	Depth (M)	Quantity 1000 M^3
Slip	150		400		10	600
Basin	400		600		10	2400
Slope						230
Channel	250		300		6	1350
			Total			4580

Dredging cost per M^3 for 1976 (includes land clearing)	US$	1.9
Capital dredging cost	"	8,710,000.-
Maintenance dredging volume (assume 10% submerged volume)		315,000 M^3
Maintenance dredging cost per M^3 must be transported to spoil area	US$	1.9
	"	600,000.- per year

An alternate and simplified layout for Sungai Lais is shown in Figure VII-3.5.5-2.

3.5.5.2 Land Reclamation Dredging

All of the Phase I capital dredging volumes will be used for land reclamation at the project and should be sufficient to provide fill for about 2,175,000 square meters or about 220 hectares.

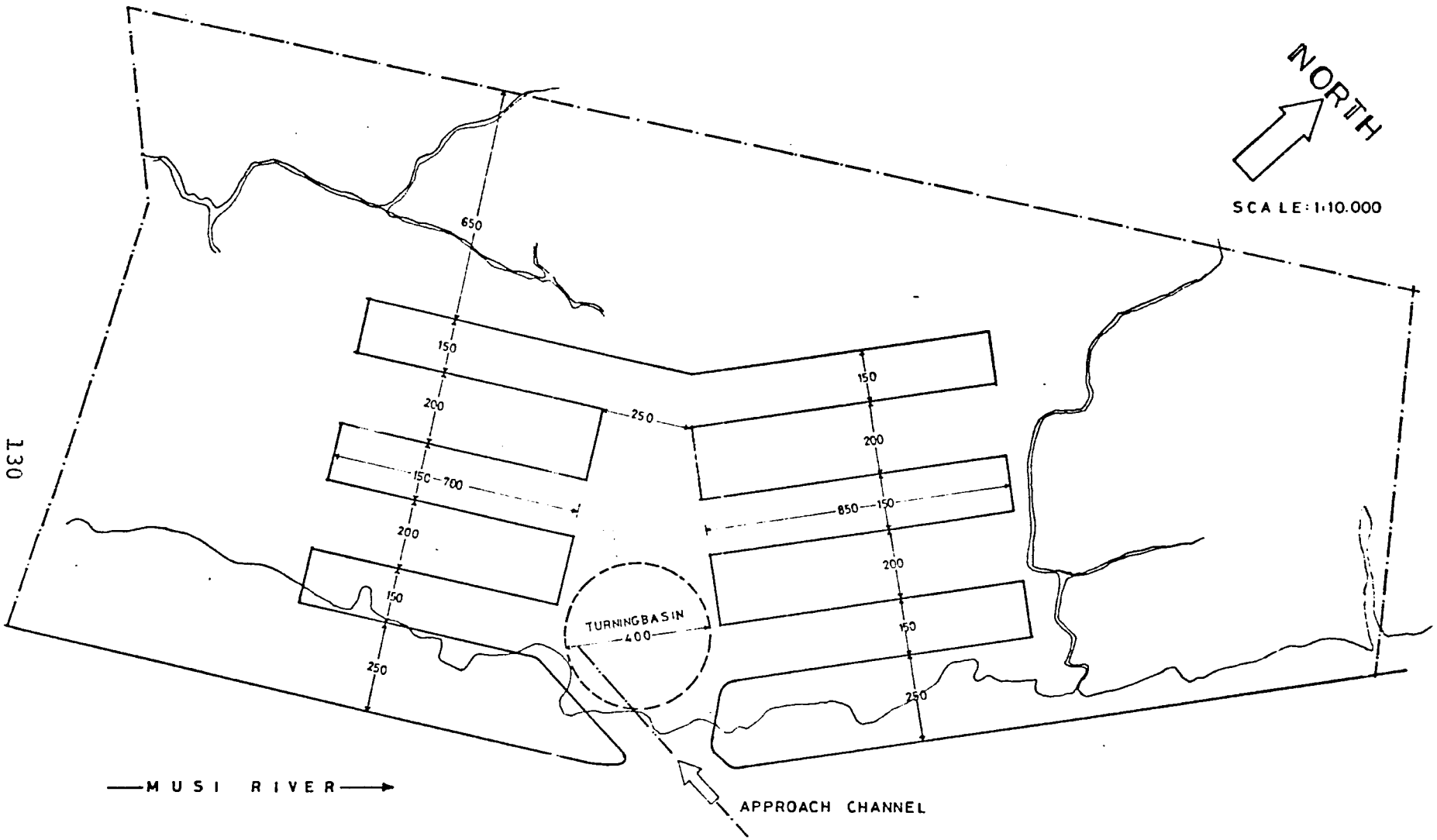


Figure VII-3.5.5-1

1962 Proposal for a Second Port on Musi River

Source: B. P. P. Palembang Technical Division

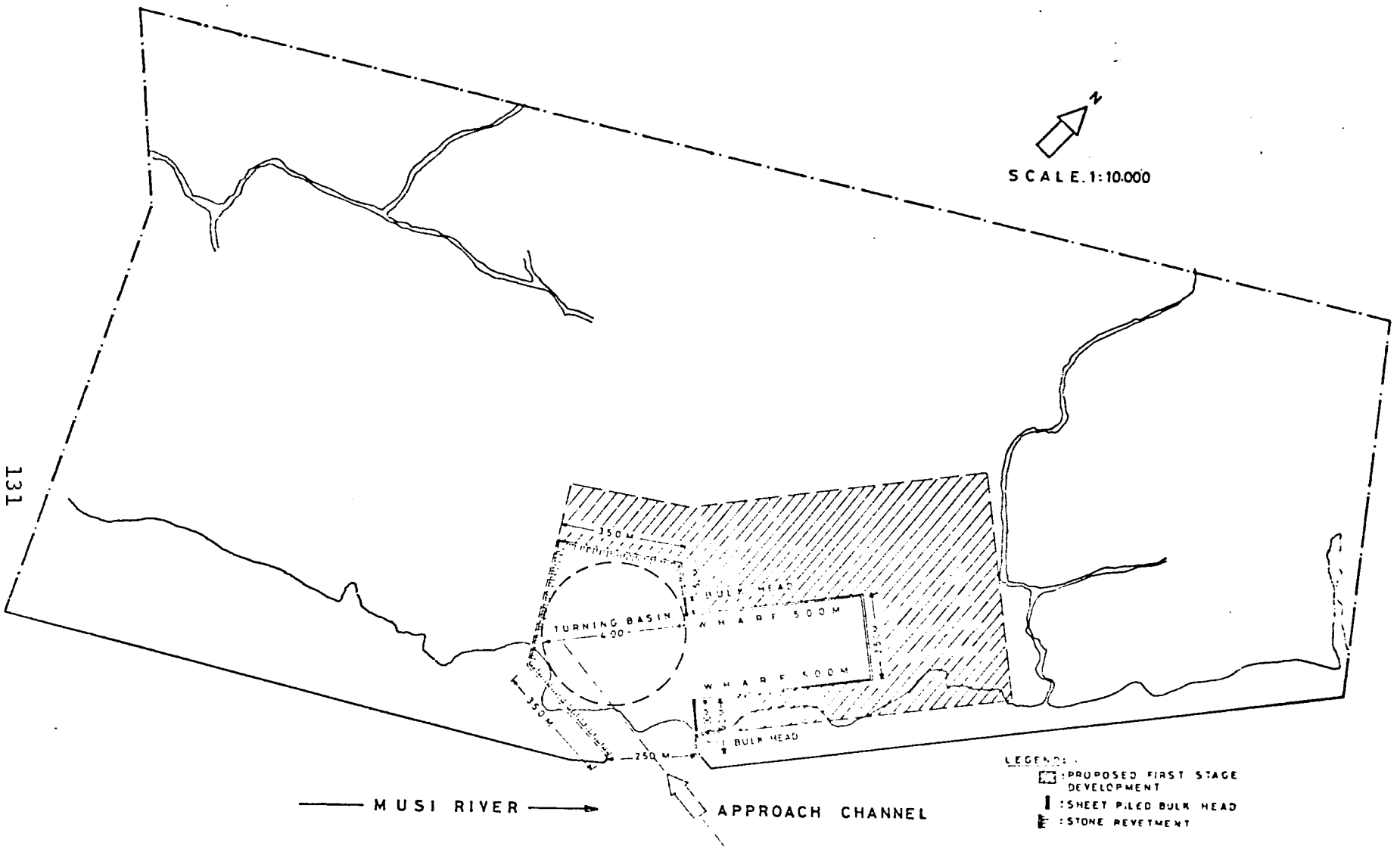


Figure VII-3.5.5-2

1962 Proposal for a Second Port on Musi River at Sungai Lais

Source: B. P. P. Palembang Technical Division

Sungai Lais Wharf and Bulkhead Costs.

Cost Item	US$ 1000	
Type I wharf 1000 M @ 8900	8,900	
Sheet pier bulkhead and stone revetment	1,000	
Total pier and bulkhead cost	9,900	end 1974 prices
	or 14,810	end 1976 prices including 151 physical contingencies.

Conclusion Sungai Lais.

The proposed plan for developing Sungai Lais as a satellite port for Palembang is a most ambitious and costly project. The total pier length for the project is about 11,750 meters which is approximately 10 times as much wharf space as Palembang will require for the next 10 years. Even if the project were divided into phases, the initial channel dredging and wharf construction would represent a tremendous initial capital investment which cannot be justified at this time. There is a possibility that the property could eventually be used as a marine industrial port development site but this usage is not foreseen in the next 20 years due to the many excellent marine industry sites now existing on the river below Palembang with six meters depth of water close to the river which will undoubtedly be used before Sungai Lais is developed. For comparison purposes the cost of developing Sungai Lais for Phase I is based on the minimum cost associated with a 1000 meter long - 6 meter deep wharf.

4.0 TECHNICAL ASSESSMENT OF DEVELOPING ALTERNATIVE LOCATIONS COMPATIBLE WITH THE REQUIREMENTS FOR AN INTERNATIONAL DEEP DRAFT PORT.

The following sections will review the various alternatives for a Palembang deep draft port and will compare the qualitative operational advantages of each scheme and will further consider the economic feasibility of those alternative considered to show any promise of becoming viable deep draft ports.

4.1 Comparison - Advantages and Disadvantages of Alternative Deep Draft Port Sites

In a search for better port facilities for the Province of South Sumatra various schemes have been devised and considered for improving and/or modernizing the Port of Palembang. The primary emphasis has been on providing deeper water so that more of the world merchant fleet can be accommodated in the port with a consequent reduction in freight rates in taking Indonesia's exports to market.

The schemes for increasing the size and/or capacity of the Port of Palembang are as follows :

Alternative (1) - Develop a new deep water port on the Banyuasin River at Tanjung Api-Api.

Alternative (2) - Develop a new deep water port on the lower Musi River at Sungsang.

Alternative (3) - Develop a new port at Sungai Lais on the Musi River downriver from Palembang across from Pertamina's Plaju Refinery.

Alternative (4) - Develop an offshore terminal in the Banyuasin River basin.

Alternative (5) - Develop an offshore terminal at Muntok a roadstead port on Bangka Island.

Alternative (6) - Expand the present Palembang Port facilities by increasing the size of the Port Administration upland area and deepening the Musi River approach to the port.

4.1.1. Alternative (1) - Develop a New Deep Draft Port on the Banyuasin River at Tanjung Api-Api Site 1 - Outer Bar, Site 2 - Inner Bar

Advantages - General

1) The primary advantage of this scheme is its accessibility to relatively deep water about 10-11 meters and its ability to handle ships up to about 40,000 DWT.

2) The port location is about 50 miles closer to the sea than Palembang thus decreasing a ships running time to and from the port by about 10 hours.

3) Ships at a draft up to 35 feet, 10-11 meters, may enter Banyuasin without waiting for a tide.

4) The land use in the area is minimal.

Disadvantages - General

1) The Tanjung Api-Api site is reported to have a very high accretion rate of approximately 50 meters per year or the land is unstable and still growing quite rapidly.

2) The island developing in the Banyuasin between Tanjung Api-Api and the west bank of the river (uncharted on the published navigational charts) is now quite large and threatens to choke off the ship manuevering area in the Banyuasin basin.

3) While the weather conditions at Tanjung Api-Api are generally favorable, the site is exposed and there

will at times be rough weather requiring the services of two large tugs to dock and undock ships.

4) The manuevering area in the Banyuasin basin off Tanjung Api-Api is rather limited for modern large ship operations.

5) The maximum size ships which can use the port would be about 40,000 DWTS operating at a draft of about 10-11 meters.

6) The maximum size ships which can use Bangka Straits are about 40,000 DWTS at a draft of 35 feet.

7) All cargo destined for Palembang and that city's exports will have to be transshipped by inland waterways adding about 127 kilometers to their inland waterways route.

8) A canal between the Banyuasin and Musi Rivers would be required to permit river barging between Palembang and Banyuasin without going out into Bangka Straits. If dredging of the Musi River outer bar is to be avoided the canal would require a depth of about six meters.

9) The amount of suitable waterfront land available at Tanjung Api-Api is rather limited for a new port and its required maritime supporting industry.

10) Any land requiring development for the port and its support will have to be reclaimed from existing mangrove swamps or reclaimed from present marine sites.

11) The cost of providing a connecting highway between Palembang and Banyuasin will be extremely high as most of the area between the connected points is underwater or semi-submerged lands.

12) The cost of providing a connecting railroad will again be very high.

13) The area now has no infrastructure and virtually no residents. A new kampung, town or city would have to be constructed at the site complete with all public offices, business facilities, industrial complexes, residential areas, recreational areas, highways, roads, utilities and schools as well as the port facilities.

14) Labor would have to be induced to live and work in the area.

15) Very little soil and hydraulic investigations have been undertaken in that area. A substantial investigation program must be undertaken prior to any design. All present cost estimates include therefore a 20% physical contingency.

Comments.

Site I - Outer Port. See Figure 2.3.1-2

The basic structural operational concept is to build a wharf as an offshore port off Tanjung Api-Api. The facilities would be constructed some 150 meters offshore along the -10 meter and -6 meter (at LLW) contour lines and connected to the shore by a number of bridges. The site selected will permit the establishing of a 10 meter (32 feet) port without dredging, and will permit the construction of some 800 meters of wharf - or 4-5 berths for ocean going vessels. It will of course be possible to increase the wharf's capacity for deeper draft ships through dredging. This site offers similarly the possibility to construct some 2,000 meters of wharf with an alongside depth of 6 meters at LLW.

Advantages and Disadvantages

Beyond the general advantages and disadvantages mentioned above - the main disadvantage of this type of

offshore port - is the limited operational areas available on the wharf structure self, and that any cargo intended for longer storage must be moved by truck to storage facilities on shore. This operation becomes more complex with the introduction of containerization - when most containers will have to be transported over long distances to or from the stacking yards on shore - as the limited wharf space will not permit stacking of many containers. In general operations become less efficient on offshore facilities requiring larger amount of equipment and manpower and are therefore more costly per ton handled. Furthermore long access bridges are vulnerable and are often damaged by coasters and fishing vessel at night; any accident on one of the bridges could close traffic there for many hours requiring diversion of traffic to the other bridges, thus congesting the traffic flow system.

Site II - Inner Harbor. See Figure 2.3.1-3.

Because of the aforesaid and the higher rate of accretion reported at Tanjung Api-Api - which could require substantial yearly dredging - we analyzed an alternative approach. Accordingly, a 10 meter deep port would be developed some 5 km further south. The basic structural operational concept at this site is to build the port facilities as a marginal wharf along the shore. The site selected would require dredging of a 3 km long approach channel from the deep water area at Tanjung Api-Api to the proposed wharf site, the dredging alongside the proposed wharf together with a turning circles for 10 meter and 6 meter drafts - a total of some 1.7 million m^3. The dredging is in the line of the deep water channel of the river and little maintenance dredging should be expected. Yet even with an assumed high yearly

maintenance dredging of 20% of the volume of capital dredging the operational advantages and savings to be achieved will no doubt offset the cost of maintenance dredging.

Advantages.

Further to the general advantages listed afore the following should be added :

1. The Inner Harbor site offers more protection from the sea than the Outer Harbor site.
2. The Inner Harbor site is reported to have more stable river conditions and therefore should not have the rapid accretion rate attributed to the Outer Harbor site.
3. The proposed construction is to reclaim the area from the wharf to the shore, thus creating a continuous port operational area thereby creating overall higher operational efficiency as compared to that achievable with the open fishpond system recommended for the Outer Harbor.

Disadvantages.

Further to the general disadvantages listed afore the following should be mentioned :

1) The overall manuevering space would be limited and deep draft vessels will have to make use of the turning circle, assisted by tug boats (which have to be procured in any case).

Conclusion on Site I - Outer Harbor - Site II - Inner Harbor

The overall development costs for the proposed port facilities at Banyuasin Tanjung Api-Api are practically same for both sites, and both sites permit the construction of similar wharf facilities - 800 meters of 10 meter draft and 2,000 meters of 6 meter draft. Site II, however, offers

considerable promise of being the overall "low cost" port. It is therefore proposed that the Inner Harbor be selected for further analysis.

4.1.2 Alternative (2) - Develop a New Deep Draft Port on the Lower Musi River at Sungsang.

Advantages.

1) The primary advantage of this scheme is its proximity to relatively deep water and its ability to handle ships of about 18,000 to 20,000 Dwts.

2) The location is about 50 miles closer to the sea than Palembang thus decreasing a ships running time to and from the port by about 10 hours.

3) Sungsang is a sheltered well protected port.

Disadvantages.

1) The primary disadvantage of this port site is the fact that, while it is close to relatively deep water, it is still inside the Musi River Outer Bar which in turn must be dredged to the port depth desired.

2) Any area selected for a port in Sungsang will displace a substantial number of residents, now living in the densely populated kampong on the waterfront.

3) The Sungsang River front is reported to be a heavy river action erosion area.

4) The deep water off Sungsang is now being filled in by spoils from dredges.

5) All cargo destined for Palembang and that cities exports will have to be transshipped in inland water transport another 80 kilometers.

6) The amount of land available at Sungsang is rather limited for a new port area and its required waterfront supporting industry.

7) The cost of providing a connecting highway between Palembang and Sungsang will be very high as most of the area between the connected points is semi-submerged lands.

8) The cost of providing a connecting railroad will again be very high.

9) The manuevering area off Sungsang in the Musi River is rather limited for modern large ship operations.

10) Most land required for the port and its supporting activities will have to be reclaimed from mangrove swamps.

Comments.

Sungsang in reality cannot be a deep water port. It can be approached from the sea by ships either entering the present Musi River Outer Bar channel or by transiting a Banyuasin-Musi River canal, if one were to be dredged. In either case the maximum feasible depth would probably be about six meters and the maximum possible depth would be about eight meters.

Sungsang could be used as a six meter port and would require about 50 percent of the dredging required to maintain a six meter channel from the Outer Bar to Palembang.

Since Sungsang has always had the same depth of channel restriction as Palembang and now has a six meter depth as does Palembang, it seems reasonable to assume that Sungsang will not be developed as a competitor of Palembang but may eventually develop as a satellite port of Palembang.

4.1.3 Alternative (3) - Develop a New Port at Sungai Lais on the Musi River Downriver from Palembang Across from Pertamina's Plaju and Sungai Gerong Plants.

See Figure VII-3.5.5-1

Advantages.

1) The only real advantage attributed to this site, which is close to Palembang, is that it is now unused and is available for use without displacing any residents or industry.

2) The land area is now owned by Sea Communications and is being held in reserve for port development purposes.

Disadvantages.

1) From a hydraulics standpoint this site has many disadvantages if to be considered for development of port facilities It lies directly across the Musi River from Pertamina's Plaju and Sungai Gerong refineries, which incidently are well situated on the deep water of an ebb tide reach of the Musi River. Pertamina's location is almost a self scouring section of the river while the opposite bank off Sungai Lais with slow moving currents and settling sediments is rather shallow and will require considerable capital dredging and a substantial amount of maintenance dredging to maintain a reasonable depth of water there.

2) While it is true that a port can be constructed at Sungai Lais with access to the Musi River, the fact remains that the cost of annual dredging of the channel leading to Sungai Lais could be prohibitive.

3) The configuration of the proposed layout creates as 250

meter entrance to a much wider basin of 400 + 500 = 900 meters. This will reduce the speed of the incoming tides thus depositing silt in the port basin, increasing the amount of maintenance dredging.

4) The land area is little more than a swamp area and will require reclamation in order to be useful port development land.

5) A complete road system would have to be constructed to the proposed site.

6) If the Port Administration were to operate Sungai Lais in addition to Boom Baru, it would be operating a split port, which has many disadvantages and added costs unless it handled separate commodities at each facility. Cargo for Boom Baru would be landed at Sungai Lais and vice versa and the port would have to transship considerable cargo at its expense, unless it operated under dual charges in the port which would lead to many unhappy and disgruntled shippers and freight forwarders and could result in the port losing instead of gaining cargo. Shippers are reluctant to ship cargo into a port where the cargo handling charges are not known.

Comments.

The Sungai Lais site has many disadvantages, particularly for deep draft port consideration. It would have the same draft as Palembang and it would cost the same for dredging as will Palembang.

In essence Sungai Lais is a poor substitute for Palembang. Further since there is considerable deep draft waterfront (5-6 meters) adjacent and downstream of Boom Baru which

can be used to expand the PPA facilities there is little need to consider developing alternative 3 - the development of a deep water port at Sungai Lais.

4.1.4 Alternative (4) - Develop an Offshore Terminal in the Banyuasin River Basin.

Advantages.

1) The port facility if it could be established would have relatively deep water, about 10-11 meters, with its access route through either entrance to Bangka Strait. The southeast section of Bangka Strait is limited to vessels of about 10-11 meters.

Disadvantages.

1) The primary disadvantage of this scheme is that the port area would be severely limited and would be connected to Tanjung Api-Api by a causeway.

2) The maximum size ships which could use the port would be about 40,000 DWT operating at a draft of about 10-11 meters or about the same size ships which can use Bangka Strait.

3) A canal between the Banyuasin and Musi Rivers would be required to permit river barging between Palembang and Banyuasin without going out into Bangka Straits.

4) The amount of land at Tanjung Api-Api for a back up and supporting area for an offshore terminal is rather limited and its reclamation development costs would be high.

5) The cost of providing highway and railroad service to Tanjung Api-Api will be very high.

6) The manuevering area in the Banyuasin Basin is rather

limited for large ship operations and would require a number of modern powerful tugs.

7) The rate of accretion in the Banyuasin Basin is reportedly quite high and may choke the proposed site by mangrove jungle buildup unless substantial maintenance dredging is performed.

Comments.

There is insufficient deep water in the Banyuasin Basin to establish an offshore terminal in the basin without a substantial amount of dredging being involved. Since Alternative 1 is basically the same proposal as Alternative 4, except that the former is a wharf connected to the shore with relatively short access bridges whereas the latter is an island structure with a single long access bridge and the former is being further developed the latter alternative will be dropped from further consideration.

4.1.5 Alternative (5) - Develop An Offshore Terminal At Muntok - A Roadstead Port

Advantages.

1) The primary advantage of this alternative is that it could be located in relatively deep water. The term relatively deep water is used because Bangka Strait is generally considered to be limited to ships with draft not exceeding about 10.7 meters (35 feet) although it is possbile to enter Bangka Strait from the northwest with ships with drafts up to 20 meters (66 feet).

Disadvantages.

1) Due to the high cost of structure either floating or fixed

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the size of the installation would have to be severely limited.

2) While an offshore terminal could be economical for the transshipment of high volumes of bulk cargo from deep draft ships to feeder barges and vice versa such an installation would not be considered feasible for general cargo except in very unusual circumstances.

3) Transshipping of high volumes of coal at an offshore terminal would not be feasible using barges and would probably require a submerged slurry pipeline in excess of 30 inches in diameter with its complicated terminal fittings to handle upwards of 20 million tons of coal per year.

4) The reliability of an offshore terminal, particularly a floating terminal cannot compare with that of a fixed shore attached port facility.

Comments.

Offshore terminals are usually devices of last resort in the development of port facilities and are generally only developed for high volumes of bulk, liquid cargoes or other specially handled cargoes when more conventional facilities cannot be located on sufficiently deep water.

Since the depth of water avialable in Bangka Straits is not deep enough to permit the operation of 100,000 to 160,000 DWT bulk cargo vessels and the fact that there is deep water in Lampung Province in the Panjang region almost equidistant from the Bukit Asam coal fields, as from Banyuasin, it is obvious that an offshore terminal, particularly a floating terminal, cannot compete with a regular terminal facility in the handling of Bukit Asam coal to deep draft ships.

A review of the cargoes which probably would be handled at a deep water Palembang port, do not include large volumes of either oil or coal. It is apparent that an offshore terminal would not be feasible and will not be further pursued at this time.

4.1.6 Alternative (6) - Expand the Present Palembang Port Facilities by Increasing the Size of the Port's Operational and Waterfront Areas and Deepening the Musi River Approach to the Port

Advantages

1) It utilizes the present infrastructure of the city and the port of Palembang.

2) Whether or not a satellite port is developed down river in the Banyuasin-Musi River delta area, Palembang will have to be maintained at about a minimum depth of six meters. Therefore, additional dredging will not be required to maintain the new port facilities at a six meter depth.

3) The cost of adding port facilities at Palembang will cost less than developing new facilities down river. This is aided by the fact that sufficient six meter depth sites are available down river adjacent to the present Boom Baru property to more than double its present wharf length and capacity.

4) Developing the Port of Palembang would help several of the principal port users namely Pertamina, Pusri and Kertapati who are now using the depth of the Musi River and would like to operate deeper vessels.

5) The present wharfs and warehouses at Boom Baru are quite modern and capable of being used as six meter wharfs for many years to come.

6) There is an adequate supply of labor available at Palembang and no housing is required for them as in the development of Banyuasin Tanjung Api-Api.

Disadvantages.

1) It will not be possible to make Palembang a truly deep water port although it should be feasible to maintain a depth of at least six meters to Palembang.

2) If a depth in excess of six meters is to be established, it will be necessary to lower the gas and oil pipelines, now between six and seven meters below LLW in the Musi River.

3) If the depth of the port is increased beyond six meters extensive capital and maintenance dredging will be required.

4) The maintenance dredging on the Musi River from the outer bar to Palembang will be about one million cubic meters per year.

Comments.

The Port of Palembang is the industrial and trading center of the Province of South Sumatra and has many industrial facilities including Pertamina, Pusri, Kertapati, the plywood factory and others which require a port depth of at six meters for efficient operations. There are also a number of excellent marine river front sites with six meters of water close by. This waterfront property will be developed as industrial sites in the near future and the demand for cargo handling facilities in the Palembang area will increase.

It is readily apparent, therefore, that increasing the capacity of the Port of Palembang via alternative 6 appears attractive, should receive complete analysis and is further considered in the following sections.

4.1.7 Alternative 7 - Banyuasin-Floating Wharf Facility.

Alternative 7 provides for the establishment of a floating wharf facility anchored in the Banyuasin Basin off Tanjung Api-Api in 11 to 15 meters of water. It is assumed that the floating facility will provide life support for the stevedores temporarily assigned to the facility. It is further assumed that a limited six meter depth pier facility will be required in the area to handle inter-island and local shipping.

Advantages.

1) The deep water port terminal would be semi-portable and could be moved to another site or sold if the project failed to develop as anticipated.

2) If the six meter port facility were to be built at Banyuasin it would provide a base for the building of an infrastructure and would greatly assist the development of the area.

3) The alternative could handle large ships of up to about 30 to 50,000 Dwts.

4) The port facility could be placed in operation in less time than required for any of the other alternatives with the possible exception of expanding Palembang.

5) The facility would be a seaport harbor and not a river port many miles from the sea. It would therefore speed the turn around of ships.

6) The facility would be able to house and provide services for most of the manpower.

Disadvantages.

1) The installation is basically a temporary solution to a problem and if successful the facilities will have to be replaced eventually by fixed facilities at an added cost.

2) A floating facility anchored in an open roadstead fairway will have some movement. The relative motion between a ship and a ship could be twice that encountered between a ship and a wharf, which may effect container but not bulk handling.

3) The port will have the same disadvantages as alternative (1) insofar as the movement of cargo between Banyuasin and Palembang.

Comments.

As indicated in Figure VII-2.3.2 there appears to be insufficient room in the Banyuasin basin to moor a floating wharf facility and to have room to manuever large ships to the facility.

4.1.8 Other Possible Port Sites.

4.1.8.1 Sungai Upang Delta.

Reports emanating from Water and Land Resources studies indicate that the delta of the Sungai Upang has been under consideration as a site for port expansion for the South Sumatra Delta area. A review of the available charts indicate the river entrance is very shallow, less than one meter depth, for a distance of about six nautical miles, 11 kilometers and that the river itself is quite shallow. While the river is undoubtedly a good inland waterway for small craft, the river entrance is not suitable for further study as a replacement possibility for any part of the Port of Palembang.

4.1.8.2 Perajen.

A study of the Musi River for alternative port sites

reveals that there are a number of locations along both banks of the Musi River below Palembang where there is adequate water close to the river bank and where port installations could be installed at a minimum cost, all cost including dredging considered. None of these sites would have communications except by water although there is a highway being pushed down the right bank of the Musi River to Perajen where there is a plywood plant located. The cost of land transportation down river from Palembang is now and will be for some time quite expensive.

Perajen offers no real advantage over Palembang other than that it is about 22 kilometers nearer the sea. While it has excellent marine industrial sites available its lack of infrastructure precludes its use as a general cargo port for the Palembang area at this time.

4.2 Development Factors.

4.2.1 Port Pair Depths.

In evaluating the planning factors for port facilities it is useful to examine the depths of the ports principal trading partners. The Indonesian Archipelago extends about 3,000 miles east and west and about 1,200 miles north and south. The distances between the interisland domestic ports are sufficiently large under normal conditions to justify the use of fairly large ships. However the use of large ships is a function of the amount of cargo to be shipped within a given time frame and the available depth of the trading ports.

This section discusses the data available on Indonesian ports and while the data may not be complete it is

suitable for general comparison purposes. Table VII-4.2.1-1 is a summary of Indonesian port data compiled primarily from Djakarta Lloyd sources. Table VII-4.2.1-2 is a listing of the Indonesian ports by Maritime District, class of port and depth of port.

An analysis of Table VII-4.2.1-2 indicates that as a six meter port Palembang has a depth equal to or greater than a majority of its Indonesian port pairs, particularly if the major oil exporting ports are eliminated.

Since Palembang is a major industrial center, has a port depth equal to or greater than most of its trading partners, has excellent marine sites for industrial expansion and given that the economy of South Sumatra will continue to develop, it may be concluded that there will always be a requirement for major port facilities at Palembang.

4.2.2 Traffic Capacity - Musi River

Concern has been voiced in some quarters about the capacity of the Musi River to absorb more traffic and as to whether or not the river could handle the shipping forecast for the next 15 to 20 years.

A large percentage of the inter-island fleet has an operating draft of just under six meters. When the controlling depth to the port was 4.5 meters all of these ships had to wait for high water in order to navigate the river. This caused considerable grouping of the ships trying to come up the river all at the same time. Now that the river has been dredged to six meters, most of the six meter draft vessels will be able to navigate the river at any stage of the tide and the fleeting of the ships waiting for high water should greatly diminish. This will mean that only those ships drawing well in excess of six meters will have to wait for

Table VII-4.2.1-1

Summary Indonesian Port Data

Item No.	Name of Port	Class of Port	Depth Port anchorage Mtr	Depth Port channel Mtr	Type Port Harbor Roadstead	Distance from sea Km.	Berths length & depth	Godowns per 1000 M^2	MHE No. units	Repair facilities	Port Status	Remarks
	FIRST MARITIME DISTRICT											
1	Belawan	1	7	CD	Harbor	12	2018 10	71.3	52	M.R.	GE + I	
2	Sabang	2	27 - 41	8	Harbor	-	460 8	N.D.	3	M.R.	Free Port	
3	Lhok Seumawe	3	10 - 20	-	Roadstead	-	22 3	0.4	0	0	G.E.	
4	Pangkalan Susu	3	N.D.	6	Roadstead M.B.	-	-	N.D.	4	DD +R. 750	C.O.	
5	Sibolga	3	6 - 14	-	Roadstead	-	130 1.2	0.6	1	0	G.E.	
	SECOND MARITIME DISTRICT											
1	Dumai	3	17.5 +	17.5	Harbor	-	3 piers 11-17.5	4.9	2	0	GE +CO	
2	Teluk Bayur/Padang	2	N.D.	N.D.	Harbor	-	426 6.5 - 8	7.7	7	DD + R 150	G.E.	
3	Sungai Pakning	3	26	-	Roadstead	-	2 piers 14.5	N.D.	0	0	C.O.	
4	Selat Panjang	3	N.D.	N.D.	Harbor	-	31 5	0	0	M.R.	G.E.	
5	Tanjung Uban	3	-	13	Harbor	-	4 OP + 600 10 - 13	N.D.	0	0	G.E. + OT	
6	Batam	1	12 - 14	14	Harbor	1	4 piers 1000-12	50	50	0		Under construction
	THIRD MARITIME DISTRICT											
1	Tanjung Priok	1	-	10	Harbor	-	5736 4 - 9	197	161 +	DD + R 10,000	GE + I	
2	Palembang	2	-	6.0	River		1386 5 - 8	5.0	21	DD + R 200	GE + I	

Table VII-4.2.1-1

Summary Indonesian Port Data

(contd)

Item No.	Name of Port	Class of Port	Depth Port anchorage Mtr	Depth Port channel Mtr	Type Port Harbor roadstead	Distance from sea Km.	Berths length & depth	Godowns per 1000 M^2	MHE No. units	Repair facilities	Port Status	Remarks
	THIRD MARITIME DISTRICT (Cont'd)											
3	Panjang	2	-	5.0	Harbor	-	417 3 - 6	8.4	6	O	G.E.	
4	Jambi	2	-	0.7 - 3	River	145	119 2	0.7	2	O	GE + I	See note 8
5	Ceribon	2	10 - 7	4	Harbor	-	309 2.8 - 4	0.8	11	M.R.	G.E.	
6	Pangkal Pinang	2	10	1.2	Roadstead	-	1.5	N.D.	6	O	G.E.	
7	Pontianak	2	11 - 12	0.2	River	-	270 0.2	5.6	3	M.R.	G.E.	
8	Cilacap	2	8.4	9	Harbor	-	418 7	7.3	5	M.R.	GE + I	
9	Muntok	3	10 - 22	-	Roadstead	-	ALO	N.D.	O	O	G.E.	
10	Sambas	3	N.D.	N.D.	Harbor	-	38	N.D.	O	O	G.E.	
11	Promankat	3	-	0.4	Roadstead	-	40 0.4	0.8	O	O	G.E.	
12	Tanjung Pandan	3	11-12(+)	-	Roadstead	-	ALO	N.D.	3	O	TOE	
13	Bengkulu	3	-	2	Roadstead	5.4	100 2	2.3	2	O	G.E.	
14	Tegal	3	-	3	Roadstead	-	465 2 - 3	2.4	2	DD + R 300	G.E.	
15	Singkawang	3	-	0.3	Roadstead	-	68 0.3	0.5	O	C	G.E.	
	FOURTH MARITIME DISTRICT											
1	Surabaya	1	12	7.5	Harbor	-	5450 8 - 10	N.D.	30 +	DD + R 4000	GE + I	
2	Banyuwangi	2	20 - 25	0.5 - 3	Roadstead	-	ALO 2.5	8.6	O	O	GE + I	

Table VII-4.2.1-1

Summary Indonesian Port Data

(contd)

Item No.	Name of Port	Class of Port	Depth Port anchorage Mtr	Depth Port channel Mtr	Type Port Harbor roadstead	Distance from sea Km.	Berths length & depth	Godowns per 1000 M^2	MHE No. units	Repair facilities	Port Status	Remarks
	FOURTH MARITIME DISTRICT (Cont'd)											
3	Kupang	2	15 - 20	30	Harbor	-	28.5 8.5	1.0	0	0	G.E.	
4	Semarang	2	M.B. 5.5	-	Roadstead	-	2964 2.5-5.5	6.5	11	DD + R 150	G.E.	
5	Ampenan/Lembar	3	8	8	Roadstead	3.2	ALO	0.53	0	0	G.E.	
6	Benoa	3	5.5	5.5	Harbor	-	120 5.5	2.2	0	0	G.E.	
7	Panarukan	3	20	-	Roadstead	-	ALO	N.D.	4	0	G.E.	
8	Probolinggo	3	12	1.6	Roadstead	2	ALO 1.2	N.D.	1	0	G.E.	
9	Meneng	-	12-15	-	Roadstead	-	50 12-15	1.0	0	0	N.D.	
	FIFTH MARITIME DISTRICT											
1	Bandjarmasin	2	Roadstead	2.5	Harbor	-	559 5 - 11	8.0	1	M.R.	G.E.	G.E.
2	Balikpapan	2	7.5	9.2	Harbor	-	6 piers 9 - 11	1.6	0	M.R.	G.E.	G.E.
3	Samarinda	2	-	3.3	River	60	228 0.3-1.5	3.4	N.D.	DD + R 175	G.E.	G.E.
4	Tarakan	2	-	3.1-10.3	Harbor	-	220 4.5-10	0.4	1	M.R.	G.E.	G.E.
	SIXTH MARITIME DISTRICT											
1	Ujung Pandang (Makasar)	2										

Table VII-4.2.1-1

Summary Indonesian Port Data

(cont'd)

Item No.	Name of Port	Class of Port	Depth Port anchorage Mtr	Depth Port channel Mtr	Type Port Harbor roadstead	Distance from sea Km.	Berths length & depth	Godowns per 1000 M²	MHE No. units	Repair facilities	Port Status	Remarks
	SIXTH MARITIME DISTRICT (Cont'd)											
2	Donggala	3	15	15	Roadstead	-	11	5.2	1	O	G.E.	
	SEVENTH MARITIME DISTRICT											
1	Manado / Bitung	3	9	9	Harbor	-	5.9 5 - 9	13.4	5	M.R.	G.E.	
	EIGHTH MARITIME DISTRICT											
1	Ambon	2	Very deep	Very deep	Roadstead	-	297 2 - 12	6.8	5	M.R.	G.E.	
2	Sorong	3	5o	30	Harbor	-	189 + 8 - 15	3.0	O	DD + R 600	G.E.	
	NINTH MARITIME DISTRICT											
1	Jayapura	3	13.8	9			3388 6 - 9	5.2	1	O	GI + F	

Table VII-4.2.1-1

Summary Indonesian Port Data

(contd)

IDENTIFICATION OF SYMBOLS USED AND OTHER COMMENTS - SUMMARY INDONESIAN PORT DATA

1. M.H.E. - Mechanical handling units which includes fixed, mobile, and floating cranes; conveyors and other mechanical lifting equipment such as forklifts.
2. Depths - All depths are assumed to be LWS unless otherwise indicated.
3. C.D. - Subject to constant dredging.
4. A.L.O. - Available lighters only.
5. M.R. - Minor repairs.
6. GE + I - General exports + imports.
7. C.O. - Crude oil loading station.
8. Jambi - A river port 200 M wide in rainy season and 50 M wide in dry season.
9. N.D. - No data available.
10. M.B. - Mooring buoy.
11. DD + R - Dry dock and repair facilities - capacity.
12. O.T. - Oil Transshipment.
13. O.P. - Oil Piers.
14. T.O.E. - Tin ore export (export and import Belitung only

Table VII-4.2.1-2

Ports by Maritime Districts

No. Port \ Dist. No.	1	2	3	4	5	6	7	8	9
	Name of port	Name of Port	Name of Port	Name of Port	Name of Port	Name of Port	Name of Port	Name of Port	Name of Port
	Class/depth	Class/depth	Class/depth	Class/depth	Class/depth	Class/depth	Class/depth	Class/depth	Class/depth
1	Belawan 1 / 7	Dumai 3 / 17	Tanjung Priok 1 / 10	Surabaya 1 / 7.5	Bandjarmasin 2 / - 2.5	(Makasar) TjungPandang 2 / - RS	Manado/ Bitung 3 / 9	Ambon 2 / - RS	Jayapura 3 / 9
2	Sabang 2 / 8	Padang 2 / 6	Palembang 2 / 6	Banyuwangi 2 / - 0.5	Balikpapan 2 / 9.2	Donggala 3 / - 1.5		Sorong 3 / 30	
3	Lhok Seumawe 3 / - RS	Sungai Pakning 3 / 14.5	Panjang 2 / 6	Kupang 2 / 15	Samarinda 2 / - 3.3				
4	Pangkalan Susu 3 / 6	Selat Panjang 3 / 5	Jambi 2 / - 0.7	Semarang 2 / - RS	Tarakan 2 / - 3.1				
5	Sibolga 3 / - RS	Tanjung Uban 3 / 13	Ceribon 2 / 4	Ampenan / Lombok 3 / 8					
6		Batam 1 / 17	Pangkal Pinang 2 / - 1.2	Benoa 3 / 5.5					
7			Pontianak 2 / - 0.2	Panarukan 3 / - RS					
8			Cilacap 2 / 9	Probolinggo 3 / - 1.6					
9			Muntok 3 / - RS	Meneng - / - RS					
10			Sambas 3 / - RS						
11			Promankat 3 / - 0.4						
12			Tanjung Pandan 3 / - RS						
13			Bengkulu 3 / - 2						
14			Tegal 3 / - 3						
15			Singkawang 3 / - 0.3						

- RS = ROADSTEAD PORT. - 1.2 = ROADSTEAD PORT WITH DEPTH LIGHTER CHANNEL.

the higher high water as some of the intermediate draft ships will be able to sail upstream on the lower high water. Given that about 50 percent of the ships which waited for high water, when the river depth was 4.5 meters, will be able to navigate the river at 6.0 meters without waiting for high water; the traffic capacity of the river could be doubled without a significant increase in the traffic density.

The present total volume of cargo moving on the Musi River is about 7.8 million tons in approximately 3,000 ship calls at the port. The volume of cargo will increase to about 11 million tons by 1985 and 14.2 million tons by 1995 and will be carried in not more than 4500 ships in 1985 and 5500 ships in 1995. The total volume of ships forecast for 1995 will therefore be about 5500 assuming the same size distribution as at present. If we assume that the average increase in tons carried per vessel will be about 10 percent the total of vessels calling at Palembang in 1995 would be about 5000 with less than 6000 ships per year by 2000. This should not cause significant traffic problems on the river although some traffic control may be required on parts of the river.

Capacity on Other River Systems.

The predicted traffic on the Musi River for the year 2000 will be less than 20 million tons. The Rhine River in Europe carries in excess of 300 million tons with a controling depth of about eight to nine meters. It is estimated that the Musi River could carry up to about 100 million tons of cargo if required without exceeding acceptable safety standards of navigation on the river.

4.2.3 Container Ship Services.

4.2.3.1 Primary Container Ship Services.

The major container ships serving Southeast Asia and scheduled into the Ports of Singapore, Port Kelang and Penang are listed in Table VII-4.2.3-1, along with their principal characteristics. The sources for the above data were the Straits Times and Lloyd's Register of Ships.

There are 46 full container ships listed as serving Southeast Asia. While the listing is undoubtedly not complete, it is representative of the types and sizes of container ships which will be serving Southeast Asia and the rest of the maritime world for some time to come.

Table VII-4.2.3-2 is a summary of the major characteristics of the full container ships serving the Straits area. It was designed to highlight the size, length and draft of the new large and fast third generation container ships. The table also contains a summary of container ship draft requirements It should be noted that all container ships can operate in 45-foot channels, 53 percent in 40-foot channels and 24 percent in 35-foot channels.

Since there are only a few of the major world ports with water depths of 45 feet, and with dim prospects for deeper ports in the future, except for off-shore installations, it is highly unlikely that the draft of container ships will exceed 43 feet in order that they may use 45-foot channels.

At the present time about the only Indonesian port having the necessary draft of approximately 14 meters (45 feet) and lying abreast of the main express container shipping routes from Europe to the Far East and from the United States west coast via Hongkong to the Straits in Southeast Asia is

Table VII-4.2.3-1

Major Containerships Serving Southeast Asia
Singapore, Port Kelang and Penang Area

Item No.	Ship's Name	Type*	DWT	Gross Tonnage	Length	Maximum Draft	Speed (Kts)	Power (SHP)
1	Liverpool Bay	CSS	47,777	59,889	950'	42'9"	26	81,132
2	Benavon	CSS	42,120	58,000	946'	42'9"	26.5	88,000
3	Tokio Express	CSS	35,700	58,450	895'8"	39'5"	26	81,132
4	City of Edinburgh	CSS	48,808	58,440	947'4"	42'8-3/4"	26.5	81,100
5	Bremen Express	CSS	42,224	57,535	941'8"	39'6"	26	81,100
6	Hamburg Express	CSS	42,124	58,938	943'7"	39'4-1/2"	26	81,132
7	Tokyo Bay	CSS	47,777	58,889	950'	42'9"	26	81,132
8	Kitano Maru	CSS	35,200	51,159	856'4"	39'4"	26.25	80,000
9	Osaka Bay	CSS	47,700	58,900	949'10"	42'9"	27.5	81,120
10	Cardigan Bay	CSS	47,770	59,860	949'11"	42'9"	27.5	81,120
11	Jutlandia	CSS	39,730	49,850	900'	37'	26	78,600
12	Nedlloyd Delft	CSS	42,900	57,500	911'8"	39'6"	27	81,100
13	Selandia	CSS	34,600	49,890	900'	37'	26	78,500
14	Nihon	CSS	34,447	50,805	902'11"	38'	26	78,500
15	Nedlloyd Dejima	CSS	42,900	57,500	941'8"	39'6"	27	81,100
16	Toyama	CSS	34,905	52,176	902'8"	36'3"	26.5	78,600
17	Korrigan	CSS	49,700	54,000	946'10"	42'7"	26.5	88,000
18.	Medelina	CSS	17,400	13,098	537'6"	30'4-3/4"	19	18,000
19.	Nipponica	CSS	24,200	25,860	682'10"	34'10"	23.5	38,000
20	Mediterranea	CSS	24,200	25,860	682'10"	34'10"	23.5	38,000
21.	President Johnson	CSS	14,244	13,265	563'8"	31'7-1/2"	20	19,250
22	President Madison	CSS	12,440	7,924	491'7"	29'4-7/8"	16.5	9,350
23	President Tyler	CSS	14,244	13,265	563'8"	31'7-1/2"	20	19,250
24	President Lincoln	CSS	14,244	13,265	563'8"	31'7-1/2"	20	19,250
25	Fairland	FCS	7,865	9,014	450'1"	25'1"	16	6,500
26	Beauregard	FCS	7,865	9,016	450'1"	25'1"	16	6,500
27	American Ming	CSS	22,224	18,764	700'6"	32'1-1/2"	21.5	27,300
28.	American Mist	CSS	22,224	18,764	700'6"	32'1-1/2"	21.5	27,300

Table VII-4.2.3-1
(cont'd)

Item No.	Ship's Name	Type*	DWT	Gross Tonnage	Length	Maximum Draft	Speed (Kts)	Power (SHP)
29	American Legion	CSS	22,225	18,764	700'6"	32'1-1/8"	21.5	27,300
30	American Astro	CSS	20,574	18,876	700'6"	32'1-1/2"	22	27,300
31	American Liberty	CSS	21,275	18,876	700'6"	32'1-1/8"	21.5	26,000
32	Melbourne Express	CSS	42,224	57,535	941'8"	39'6"	26.5	81,000
33	President Filmore	CSS	14,240	13,260	563'8"	31'7-1/2"	20	19,250
34	Moira	FCS	4,592	4,766	371'0"	23'8"	12.25	2,700
35	Kowloon Bay	CSS	47,777	58,889	950'	42'9"	26	81,132
36	American Main	CSS	22,224	18,704	700'6"	32'1-1/2"	22	27,300
37	American Archer	CSS	22,224	18,704	700'6"	32'1-1/2"	22	27,300
38	Medorfea	CSS	24,200	25,800	682'10"	34'10"	23.5	38,000
39	American Lancer	CSS	22,220	18,700	700'6"	32'1-1/2"	22	27,300
40	American Lynx	CSS	22,220	18,700	700'6"	32'1-1/2"	22	27,300
41	American Aquarius	CSS	22,220	18,700	700'6"	32'1-1/2"	22	27,300
42	Kamakura Maru	CSS	35,200	51,159	856'4"	39'4"	26	81,132
43	Gateway City	FCS	7,785	9,006	450'1"	25'1"	16	6,600
44	Asian Line	FSS	5,160	2,993	319'10"	21'4"	11.25	2,700
45	Yamatomi Maru	FSS	4,797	2,902	329' "	21'5"	14.5	5,000
46	Southern Union	FSS	4,797	2,902	329'	21'5"	14.5	5,000

*Legend - Ship Type
CSS - Containership Service
FCS - Feeder Container Service

TABLE VII-4.2.3-2

SUMMARY OF CHARACTERISTICS OF FULL CONTAINERSHIPS NOW SERVING SOUTHEAST ASIA

Item No.	Type of Containership	DWT Capacity (Average in Tons)	Length of Ship (Average in Feet)	Draft of Ship	Number of Ships in Class	Speed of Class (Kts)	Owners and Trade
1	Large Fast Third Generation Ships	47,300	940 +	Over 42'	3	26+	Japanese - Singapore Europe - Far East
2	Large Fast Third Generation Ships	40,000	900	39-40'	10	26+	German - Japanese Europe - Far East
3	Large Fas Third Generation Ships	37,000	900-910	36-38'	4	26+	Dutch Europe - Far East
4	Large Fast Modern	24,000	680-690	34-35'	3	23.5	Mediterraneau - Far East
5	Large Fast Modern	22,000	700-710	31-33'	13	20-22	American U.S.A. - Far East
6	Medium Second Generation	15,000	550	29-31'	2	16-20	M.I.S.C.
7	Feeder Ships	7,800	450	25'	3	16	American Straits - Hong Kong
8	Small Containership	5,000	329	21'5"	3	14.5	Japanese Straits - Japan

Summary of Vessel Draft Characteristics

Item No.	Item Grouping From Above	DWT Capacity (Average in Tons)	Length of Ship (Average in Feet)	Draft of Ship	Number of Ships in Class	Speed of Class (Kts)	Comment
9	1 + 2 + 3 + 4 + 5	33,800	825	Min. 30'	38	24.4	Items 6, 7 & 8 not true modern containerships
10	1 + 2	43,200	918	39' +	18	26.0	47.4% require 42-45' depth of water or a 45' channel
11	3 + 4	31,400	810	34-38'	7	22.7	18.4% require a 40' channel
12	5	22,000	705	31-33'	13	21.0	34.2% require a 35' channel

Batam which is under development as the primary container port of Indonesia.

It is the stated policy of the Republic of Indonesia that Batam will be the primary container port for Indonesia and that Tanjung Priok, Belawan and any container port in Banyuasin or Palembang would be a satellite or feeder container ports.- Source Mr. Seoperdjo, Commander Third Maritime District. The above statement of policy is in line with the established operating procedures of the world's major container shipping companies and consortiums.

4.2.3.2 Container Feeder Service.

Container feeder ship services are now in operation from Hongkong to ports in the Straits area, from Singapore to feeder ports and from Japan to the Straits in feeder type containerships. The size of typical container feeder ships is given in Table VII-4.2.3-3. These ships on average are between 100 and 140 meters in length, about 3000 to 5000 Dwt and have full load drafts of from 6.5 to 7.6 meters. Since containerships are generally volume loaded long before they are loaded to their maximum deadweight capacity, the average container feeder ship described above and in general use in Southeast Asia will have no difficulty operating to Palembang as a six meter port at almost any stage of the tide.

There is another class of container feeder ships operating out of Singapore. They resemble self propelled barges about 60 meters long, 15 meters wide, two to three meters draft, speed eight to ten knots and equipped with one crane centrally located on the forward deck where it is capable of handling about 26 to 30 20-foot containers

Table VII-4.2.3-3

Typical Container Feeder Ships

No.	Length (m)	Deadweight (Tons)	TEU	Draft (m)
1	108.2	3020	128	5.2
2	114.6	3410	142	5.6
3	122.2	3600	168	5.6
4	134.0	4180	172	5.8
5	140.8	4920	208	6.0

or about 14 40-foot containers. Such a feeder vessel could operate to Palembang at any stage of the tide and this type of vessel may eventually be operated in the RLS trade.

Another type of container feeder service which is popular in some parts of the world, particularly in the Carribbean Sea-West Indies Region is the roll on-roll off (Ro-Ro) service which generally features tug and barge combinations where containers on trailers are rolled onto the barge for transport and then rolled off the barge at its destination. The trailers are generally backed onto the barge with port tractors and removed by tractors from the receiving port.

Palembang and/or Banyuasin should be equipped to handled feeder container ships for both lift on-lift off (Lo-Lo) and Ro-Ro type services.

4.2.4 Timber and Log Carriage.

Timber and logs are increasingly carried in specialized ship or barges equipped with special timber or log loading/ unloading devices, storage and stowage facilities. These ships usually have oversized hatches, a large volumetric capacity. There are log carriers equipped with special gear for loading logs directly from log ponds on a continuous basis and at a rate of several hundred tons per hour.

Similarly large modern timber carriers are designed to handle large 5-10 ton bundles of sawn timber of up to 8 meters in length, and at rates of up to 40 tons or 70 m^3 per gang hour or hatch hour.

Several of these ships are now in use in Southeast Asia (West Malaysia, Serawak, Kalimantan etc) and the rapid increase in South Sumatran log and timber export will attract

this type of vessel in the near future. Port facilities to meet this demand are desirable.

4.2.5 Dry Bulk Shipping.

The large majority of shipments handled in Palembang excluding logs/timber and petroleum consists of dry cargo in bags and bales or liquid cargo in barrels. Many of this type of cargo should probably be handled in bulk on dense flow trade routes. The flow of bulkable cargo varies widely from a few hundred to well over 100,000 tons per year. While most of these flows are not sufficient to attract large bulk carriers, they are significant enough to justify their handling as pseudo bulk in :

a) special mini bulkers or bulk feeder ships
b) oceangoing barges
c) parcel bulk carriers or parcel tanker
d) LASH barges
e) small bulk carriers
f) bulk containers (liquid or dry)
g) slurry parcel tankers
h) other

Large savings in the handling can accrue by the effective use of an integrated bulk transport system, even if it implies multiple handling. Bulk transfer is usually rapid and cheap and therefore multiple handling is more acceptable in bulk commodity than in general cargo flow.

4.3 Technical Assessment of Developing Banyuasin as a Deep Water Port

There have been suggestions for the development of Banyuasin-Tanjung Api-Api as a deep water port for more than 50 years. While there have been requests or again suggestions for an engineering evaluation of the site as a deep water port it does not appear that such has been accomplished at least not to a depth warranting decision action.

There have been a number of studies in the Musi-Banyuasin Delta regions for farming, forestry, fishing, transmigration, environment control and others related to the area development.

It is the purpose of this section to look into the technical aspects of establishing a deep water port at Banyuasin-Tanjung Api-Api.

4.3.1 Banyuasin Port Basins

There is a deep water basin lying just west of Tanjung Api-Api in the Banyuasin River. The maximum depth of water in the basin is 20.2 meters (66.3 feet). The 15 meters (49.2 feet) depth contour curve delineates an irregular oblong basin, about 440 meters (0.25 miles) wide and 900 meters (0.50 miles) long lying about 200 meters from the Tanjung Api-Api shoreline. See Figure VII-4.3.1-1 and Table VII-4.3.1-1 for additional information.

The 10 meter (33 feet) contour curve shows an irregular oblong basin about 600 meters (0.34 miles) wide and 1400 meters (0.77 miles) long lying about 180 meters from the Tanjung Api-Api shoreline. See Figure VII-4.3.1-2 and Table VII-4.3.1-2 for additional information.

The 5 meter (16.4 feet) contour curve actually delineates two basins which for purposes of discussion are designated

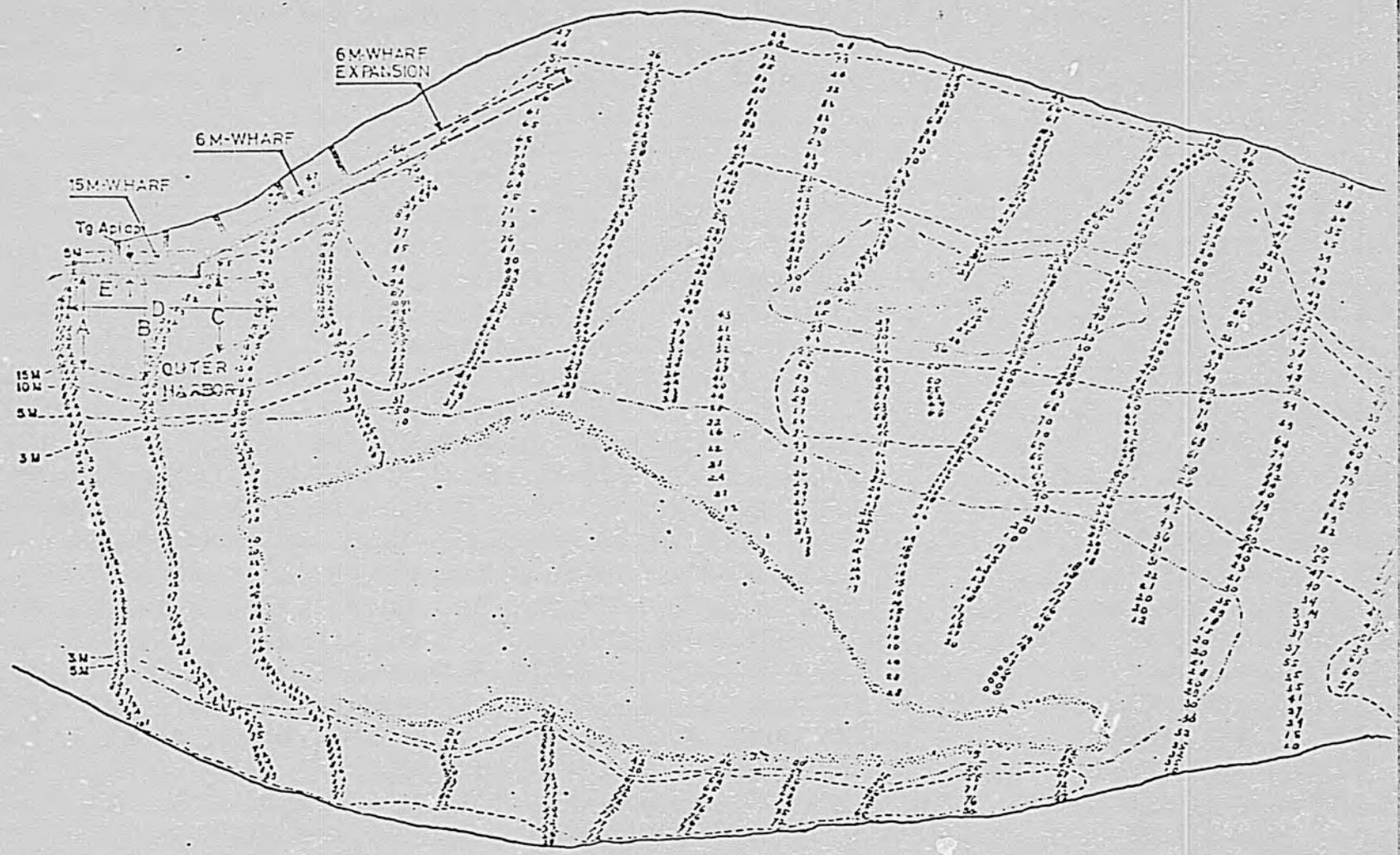


Figure VII-4.3.1-1
Banyuasin - Tanjung Api Api
15 M Basin

Table VII-4.3.1-1

Dimensions of Banyuasin
15 Meter Basin and Port

Banyuasin-Tanjung Api-Api - 15 Meter Basin.

Dimensions - See Figure VII-4.3.1-1

Letter	Meters	Feet	Miles
A	450	1500	0.26
B	500	1640	0.27
C	300	1180	0.20
D	900	2950	0.49
E	200	656	0.11

Banyuasin-Tanjung Api-Api - 15 Meter Port.

Port Facility Capabilities Outer Harbor - See Figure VII-4.3.1-1

Description of Item		Ocean Shipping	Interisland Shipping
Depth of wharf		15 M - 49 ft.	6 M - 20 ft.
Length of wharf		600 M - 2000 ft.	1000 M - 3280 ft.
Width of wharf		60 M - 200 ft.	60 M - 200 ft.
Access bridges	(1)	100 x 15 M	100 x 15 M
	(2)	140 x 15 M	100 x 15 M
	(3)	--	160 x 15 M
Total Dock or Wharf Area			
Square meters		40,200	69,400
Square feet		432,500	749,500
Future Expansion Possibilities		--	1000 M - 3280 ft.

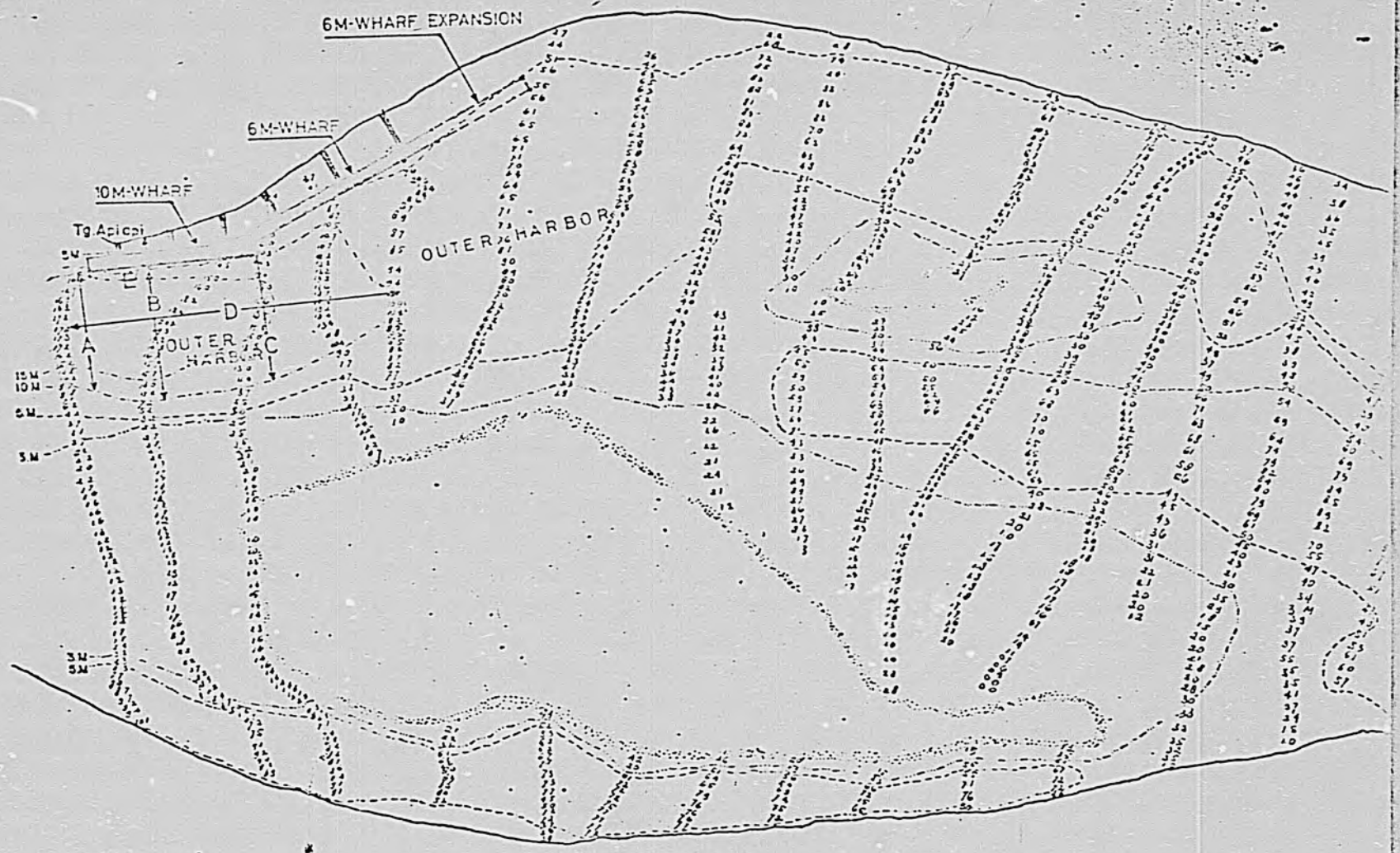


Figure VII-4.3.1-2

Banyuasin - Tanjung Api Api

Table VII-4.3.1-2

Dimensions of Banyuasin 10 Meter Basin and Port

Banyuasin - Tanjung Api-Api - 10 Meter Basin

Dimensions - See Figure VII-4.3.1-2

Letter	Meters	Feet	Miles
A	600	1970	0.33
B	650	2130	0.36
C	600	1970	0.33
D	1400	4590	0.77
E	180	590	0.10

Banyuasin - Tanjung Api-Api - 10 meter Port.

Port Facility Capabilities - Outer Harbor - See Figure VII-4.3.1-2

Description of Item		Ocean Shipping	Interisland Shipping
Depth at wharf		10 M - 33 ft.	6 M - 20 ft.
Length of wharf		800 M - 2620 ft.	1000 M - 3280 ft.
Width of wharf		60 M - 200 ft.	60 M - 200 ft.
Access bridges	(1)	60 x 15 M	140 x 15 M
	(2)	100 x 15 M	170 x 15 M
	(3)	160 x 15 M	190 x 15 M
Total Dock or Wharf Area			
Square meters		53,600	71,500
Square feet		578,900	772,200
Future Expansion Possibilities		--	500 M

outer harbor and inner harbor. The outer harbor 5 meter basin is about 900 meters (0.50 miles) wide and 2800 meters (1.5 miles) long. Away from the deep water areas the distance from the 5 meters basin to the shoreline in way of kind L (figure VII-4.3.1-3) is about 200 meters over mud flats which are building in the area. In order to have inter-island port facilities adjacent to any proposed deep water pier or wharf facilities substantial land fill operations would be required in way of the extensive and growing mud flats.

The inner harbor 5 meter (16.4 feet) contour curve is again almost rectangular and is about 625 meters (0.34 miles) wide and 2500 meters (1.37 miles) long, see Figure VII-4.3.1-3 and Table VII-4.3.1-3. The shoreline of the inner harbor up-river from Tanjung Api-Api in way of M + N Figure VII-4.3.1-3 is reported to be quite stable with a 5 meter depth about 60 meters offshore.

4.3.1.1 Summary of Basin-Port Capabilities.

The physical characteristics of the Banyuasin deep water basin are summarized in Table VII-4.3.1-4 along with the data pertaining to the size of ships which could use the existing port basins.

10 Meter Port

In brief there is sufficient depth of water in the Banyuasin River outer harbor basin and in the approach channel to the proposed port area to support an inline wharf 1400 meters (4600 feet) long with seven ocean shipping berths of 200 meters (660 feet) length. There is also room in the outer harbor with the 10 meter port configuration, Figure VII-4.3.1-2 for 1500 meters of wharf with a six meter depth. For all port configurations there will be approxi-

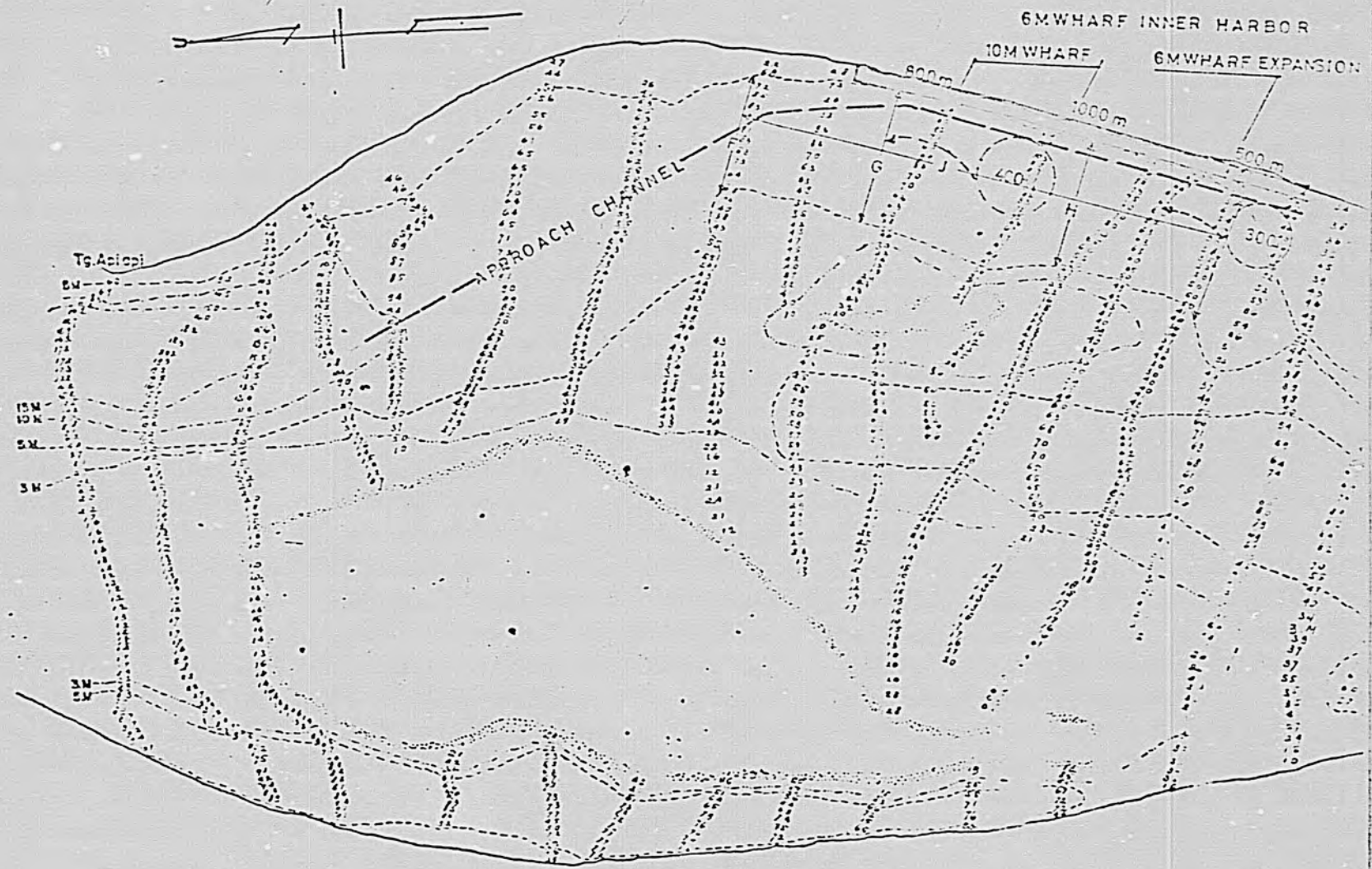


Figure VII-4.3.1-3
Banyuasin Api Api Cape Inner Harbor

Table VII-4.3.1-3

Dimensions of Banyuasin
10 Meter Basin and Port

Banyuasin - Tanjung Api-Api - 10 Meter Port.

Port Facility Capabilities - Inner Harbor - See Figure VII-4.3.1-3

Description of Item	Ocean Shipping	Interisland Shipping
Depth of wharf	10 M - 33 ft	6 M - 20 ft
Length of wharf	800 M - 2620 ft	1000 M - 3280 ft
Width of wharf	20 M - 66 ft	10 M - 33 ft
Access bridges	None	None
Total Dock or wharf area		
Square meters	16,000	10,000
Square feet	172,000	107,000
Future Expansion Possibilities	--	500 M - 1640 ft

TABLE VII-4.3.1-4

SUMMARY - BANYUASIN-TG. API-API - DEEP WATER BASINS PHYSICAL CHARACTERISTICS.

1 Item No.	2 Description of Basin Max. Depth of Ship M - Ft.	3 Length Meters Feet Miles	4 Width Meters Feet Miles	5 Area Sq.Mtrs. Acres	6 Maximum wharf length 15 mtrs Access bridges Max - M Min - M	7 Maximum wharf length 10 mtrs Access bridge Max - M Min - M	8 Maximum wharf length 6 mtrs. Access bridges Max - M Min - M	9 Max. size vessels Normal ships Recent shallow draft ships in DWT.	10 Length of vessel associated with DWT in Column N-9 M - Ft.
1.	Outer Harbor 15 Meter Basin 14 - 46	900 2950 0.49	440 1440 0.25	396000 56.4	600 160 100	-	2000 100 160	80,000 120,000	260 - 850 290 - 950
2.	Outer Harbor 10 meter basin 10 - 32	1400 4950 0.77	625 2050 0.34	875000 213.1	-	800 160 60	1500 190 140	23,000 43,000	150 - 500 200 - 660
3.	5 Meter Basin Outer Harbor	2800 9200 1.53	900 2960 0.49	2.52×10^6 614.0	-	-	See combinations above	4,000 7,000	90 - 300 110 - 360
4.	5 Meter Basin Inner Harbor	2500 8200 1.37	625 2050 0.34	1.56×10^6 380.1	-	800* -	1000 --	23,000 43,000	150 - 500 200 - 660

Source : Survey data Pelabuhan Palembang - Pengukuran Sungai Banyuasin pada bulan DUA 1970.
Vessel data - Trends in Ship Characteristics - E.G. Frankel, Inc., Penang Port Study. See Figure VII - 22.1 - 4, 5 and 6.

* requiring some 1.7 million m^3 of capital dredging.

mately 1500 meters (4900 feet) of excellent wharf space available for six meter wharfs in the inner harbor. As shown on Figure VII-4.3.1-3 a 10 meter hargor would require a 3 Km long dredged approach channel.

15 Meter Port.

While only local minor dredging is anticipated with a ten meter port extensive capital and maintenance dredging will be required to open a 15 meter channel into the 15 meter Banyuasin River Basin. The present minimum depth in the Banyuasin approach channel is 11 meters which is satisfactory for a 10 meter port but which will require dredging to an additional depth of four meters (13 feet) for a 15 meter channel.

Port Deeper Than 15 Meters.

The analysis of the Banyuasin River Basin reveals that while there is sufficient port basin area, based on present survey information, for a small 600 meter (1980 feet) wharf, two 300 meter (990 foot) berths, with a depth of 15 meters; there is insufficient port basin area in which to manuever a ship with greater draft than about 14 meters (46 feet). Therefore, the maximum ship draft limit of the 15 meter depth alternative port at Banyuasin is concluded to be 14 meters (46 feet) unless extensive basin as well as channel dredging is undertaken.

4.4 Port Development Costs.

4.4.1 Feeder Transport

There are a number of potential feeder transport methods to the proposed deep draft port sites. The major sites and corresponding feeder transport considered are as follows :

		Road	Rail	Barge	Pipe line	Cable way
Banyuasin	Fixed Port	x	x	x	x	x
"	Floating Terminal			x	x	x
"	Island Terminal	x	x	x	x	x
Sungsang	Fixed Port			x	x	
"	Island Port			x	x	
Sungai Lais	Fixed Port	x		x	x	
Palembang	Boom Baru Fixed Port	x		x	x	

While some of the routes, configurations and services of feeders have been studied before, (road to Tanjung Api-Api, Banyuasin), all the others were developed and evaluated by the consultants.

For each mode and site combination one or more routes and various levels of service capacity were assumed. The capital and operating costs were then determined based on the assumption that the service provided would be port particular. The only exception to that assumption were the road and rail connection to Banyuasin (Tanjung Api-Api) and the road to Sungai Lais. Here we assumed all or only part utilization for port purposes and derived several levels of costs chargeable to port related operations as port feeder costs.

As deep draft port capacity demand may well depend on feeder cost, various levels (total, or individual cargoes) of cargo flows by mode were assumed to determine the price elasticity of each feeder concept. The analysis assumed, that each feeder would serve only the feeder function, while in reality it may well combine feeder, distribution, collection and storage in one function. Therefore while feeders will generally reduce distribution, collection and storage costs we will assume that all the costs are borne by the feeder.

4.4.1.1 Road Transport Costs.

The main port feeder roads of interest are the proposed road to Banyuasin (Tanjung Api-Api), the road to Sungai Lais and roads to Boom Baru. The road to Banyuasin must as yet be constructed at a cost estimated at $ 86.7 million in 1975. This cost is for a 4 lane 79.6 km highway scarting at a point about 20 km from Palembang and 4 km from Talang Betung on the road to Teluk. The cost of this road could be reduced to $ 51.6 million (1975) if a 2 lane instead of a 4 lane highway is built. This also makes more sense as the projected traffic level to 1995 nor the connecting roads match the capacity of a 4 lane divided highway. On the other hand, there are serious questions on tha reliability of the road cost estimates, because of the very sketchy survey and particularly soil information available. It is therefore assumed that the Banyuasin road cost will be between $ 75 - $110 million for a 2 and 4 lane road respectively.

Considering Sungai Lais, the road Jalan Sungai Batang which links Palembang with the Sungai Batang ferry goes to within 2 km of the Sungai Lais port site. (A small bridge over Sungai Lais is required). The cost of this short road connection is estimated at $ 1.4 million. An additional $ 1.0 million would have to be spent to improve the existing Jalan Sungai Batang from the Pusri exit to the ferry.

If Boom Baru is expanded, then an extension to Jalan Mayor Memet Sastrawirya or other port circular road is required. The cost of this circular road is estimated to be $ 2.2 million including land acquisition costs.

Road transport costs are difficult to determine, particularly on as yet non-existing routes. A major problem on most routes is the very low load capacity of the existing

roads and bridges. Designed axle loads are low and there are no registered trucks in the province with an effective load capacity of more than 5 tons. In fact only 28 out of 5658 trucks have a 5 ton rated capacity and 62% or 3480 have a capacity of less than 2½ tons. It is also interesting to note that total road vehicle transport capacity in the province has not increase since 1969 (Table II-2.7-2). The average life of the existing truck fleet is nearly 10 years or equal to its assumed economic life, and the major operating cost element is therefore not depreciation but maintenance and repair.

Present trucking costs on long routes are Rp.25-40/ton km and Rp.43-60/ton km on short to medium routes. For difficult long distance hauls Rp.60/ton km is usually negotiated. Similarly for short routes which include port delivery or pick up Rp.30 per ton km generally applies. The existing road transport costs, excluding any road user charges are therefore :

	Rp/ton	$/ton
Center Palembang - Boom Baru	500	1.22
" " - Sungai Lais	960	2.34
" " - Banyuasin	5,880	14.34

If user charges are levied on truck transport to Banyuasin, designed to pay for the road investment (interest and capital repayment) over a 25 year period, including the cost of road maintenance, then the required user charge for use of the 79.6 km long new road is as follows (in 1975 dollars) :

Traffic in (000 tons)/year	User Charge $/ton	
	2 lane	4 lane
100	$ 46.00	$ 77.80
500	$ 9.20	$ 15.56
1000	$ 4.60	$ 7.78
2000	$ 2.30	$ 3.89

It is rather obvious that port traffic alone cannot afford to pay for the construction and maintenance of the road even if the port traffic captures the major share of Palembang shipments. Most cargoes originating at river locations are moving to Palembang downriver will continue to move to the port by barge independent of the port site. As a result road traffic forecasts do not exceed 1,000,000 tons/year even under the most optimistic assumptions.

4.4.1.2 Rail Transport Costs.

The railroad network terminal at Palembang is on the right side of the Musi River, at Kertapati, and there is no Musi River rail crossing. As a result, it will be difficult to introduce direct rail connection to any of the proposed port sites.

The construction of a rail bridge would have to be upriver of Kertapati where the opposite river bank is swamp. The construction costs of the railway crossing is estimated to be $ 5.8 - 8.9 million. The costs of a railway line (single line) to Banyuasin (Tanjung Api-Api) (106 km) or Sungai Lais (19 km) respectively is estimated at $ 60 million and $ 20 million including the Musi River crossing and $ 53 million and $ 13 million without the Musi River crossing. Rail freight charges on the existing amortized network are pre-

sently Rp.10.3 per ton km. As a result direct freight charges to Banyuasin would be Rp. 1092 ($ 2.66) per ton and Rp. 196 ($0.48) per ton to Sungai Lais. Rail connection to Boom Baru is deemed infeasible. As in the case of road transport the amortization of the line investment charged to port traffic would result in a tremendous increase in rail costs.

Traffic in (000 tons)/year	Line Amortization Costs 25 years $ 1/ton	
	Sungai Lais	Banyuasin
100	$ 18.04	$ 50.80
500	$ 3.61	$ 10.20
1000	$ 1.80	$ 5.80
2000	$ 0.90	$ 2.90

Fully burdened rail costs would therefore be $ 8.46/ton to Banyuasin under the optimistic assumption of 1 million tons of rail traffic per year. Similarly burdened costs to Sungai Lais by rail would be $ 2.28 under the same conditions.

4.4.1.3 Barge Transport Costs.

Barges traditionally serve as Palembang port feeder and for the lighterage of the major part of the port cargo exclusive of bulks. A large proportion of the cargo originates at or is destined to waterfront terminals. This applies particularly to agricultural commodities both outward or inward bound. Presently there are two types of barges in general use in Palembang, a 200 ton steel barge and a 50 ton wooden lighter. Their characteristics are presented in Table VII-4.4.1-1. There are 150 HP and 600 HP tugs avail-

TABLE VII - 4.4.1-1

Characteristics of Barges in Use at Palembang.

Type	Steel Barge	Wooden Lighter
Dwt	200	50
Length	31.5 m	15 m
Beam	6.0 m	2.8 - 3.0 m
Draft (loaded)	1.9 m	1.4 m
Rental cost/day	Rp. 90,000 = $ 220	Rp.15,000 = $ 36.4
Approx.construction cost	Rp. 35 million = $ 85,000	Rp.0.8-1.0 million= $ 1,941-$2,427

able. The first type is most universally used for barge towage and rents for Rp.25,000/day = $ 60/day. To get a general idea of the relative cost of using either of these two available lighter types via the Sebalik Canal to Banyuasin versus lighterage in the stream a proforma cargo lot of 3000 tons was transported to Banyuasin.

Suppose 3000 tons of rubber were to be loaded on liner for export on break bulk ship.

Loading time will be about 3000/700 = 4.29 days

All cargo must be delivered in a separate barge as time up and down river plus loading time at rubber factory will exceed 4 days.

Proforma

Wooden barges to Banyuasin

a) number required = 3000/45 = 67 barges

b) suppose barges for 1½ days loading are required to ensure no demurrage is paid for ship.

c) this means 23.4 = 24 barges must be on hand for arrival of vessel.

d) arrival of barges on the day prior to ship arrival is desired both to ensure prompt beginning of loading and security of cargo (i.e. if barges are left around too long, some will sink or be stolen etc.)

e) 4 barges are towed per trip by tug by existing canal :
distance trip = 100 km = 54 miles
sea time 1 way = 54/6 = 9 hours
therefore one trip per day is possible with tug

f) number of tugs required for first trip = 24/4 = 6 tugs

g) each subsequent day 15 full barges must be brought down and 15 empties returned - for this 4 tugs are required

i. Cost of tugs

Day 1	6 tugs to bring down 24 barges and return empty	$ 360.00
Day 2	4 tugs to bring down 16 barges and bring back 16 empties	$ 240.00
Day 3	4 tugs bring down 16 barges and bring back 16 empties	$ 240.00
Day 4	3 tugs bring down 12 barges and bring back 12 empties	$ 180.00
Day 5	6 tugs to bring back 24 empties	$ 360.00
	Total tug charges	$ 1380.00

ii. Cost of barges

a) barge loading and customs 1 day x 68 barges x 36	$ 2448.00
b) down and back 2 days x 68 barges x 36	$ 4896.00
c) waiting at site 5 days x 24 barges x 36	$ 4320.00
	$ 10800.00

Total estimated cost inefficiency factor 10%	=	$ 12180.00
Total expected cost	=	$ 13398.00
Cost per ton		$ 4.47

Proforma

Wooden Barges to stream

a) Number of barge trips 67

b) Number of barges on hand for ships arrival 1 days work. They can be there the same time the ship arrives. In practice this means barges must be at customs 9:00 o'clock

c) 2 barges towed by tug per trip from customs to stream.

Cost of tugboat		
1 tug x 5 days x 60	=	$ 300.00
Cost of barges		
Barge loading & customs 1 day x 68 barges x 36	=	$ 2,448.00
Waiting at ship 1½ days x 68 x 36	=	$ 3,672.00
Total estimated cost		$ 6,420.00
inefficiency factor 5%		
Total expected cost		$ 6,741.00
Cost per ton		$ 2.25

Incremental cost/ton for working at Banyuasin

incremental cost = $4.47 - $2.25 = $ 2.22/ton

Proforma.

Steel barges - Rental Equipment

a) 4 barges required waiting on arrival, again 1 day prior.

b) Single 200 ton barge 1½ days per trip.

T u g s	
4 tugs x 1½ x 60	$ 360.00
4 tugs x 1½ x 60	$ 360.00
4 tugs x 1½ x 60	$ 360.00
4 tugs x 1½ x 60	$ 360.00
4 tugs x 1½ x 60	$ 360.00
	$ 1,800.00
Barges	
16 barges load & customs 1 day	$ 3,520.00
16 barges down & back 16 x 1.5 x 220	$ 5,280.00
4.5 days x 4 barges waiting x 220	$ 3,960.00
	$ 12,760.00
Total estimated cost	$ 14,560.00
efficiency factor 1.1	
Total expected cost	$ 16,016.00
Total expected cost	$ 5.34/ton

(One reason for high cost is that existing barges with hatch covers. Flat top barges would be cheaper and almost better)

Incremental cost/ton for working at Banyuasin =
$ 5.34 - $ 2.25 = $ 3.09/ton

We next investigated the cost of barging cargo to Banyuasin using larger specially procured barges and tugs. To obtain the variation of investment and operating cost with throughput, these costs were calculated for flows of 500,000, 1,000,000 and 1,500,000 tons per year. The characteristics and costs of barges of 500-2500 ton capacity are presented in Table VII-4.4.1-2.

Considering tugboats to provide the required effective horsepower (EHP), characteristics of typical tugs are given in Table VII-4.4.1-3.

A 250 HP tug is too small for towing even a single 500 ton barge, while a 500 HP tug can tow barges of all the considered sizes. A 1000 HP tug on the other hand is powerful enough to tow two barges simultaneously (up to 2 x 2500 Dwt). Table VII-4.4.1-4 gives the number of tugs required.

Using 500 HP tugs (single tow) the total investment costs of the required tug-barge fleet for throughputs of 500,000, 1,000,000 and 1,500,000 tons per year are presented in Table VII-4.4.1-5.

Investment costs using 1000 HP tugs and double tows are shown in Table VII-4.4.1-6.

Considering the various alternatives, the minimum cost of barging cargo to Banyuasin was computed for the three alternate routes :

a) via the Outer Bar
b) via the existing but improved Sebalik Canal
c) via a new Sungsang Canal

The two canals are supposed to have 10.5-12.5 ft dredged depth BLW to accommodate the different sizes of barges.

TABLE VII-4.4.1-2

BARGE CHARACTERISTICS AND COSTS

DWT Barge	# trips for 500,000	# trips for 1000,000	# trips for 1500,000	Cubic # number	Length ft.	Beam ft.	Depth ft.	Draft ft.	Cost/ DWT	Cost	Drag in lbs. for 6 Kts.	EHP for 6 knots
500	1,000	2,000	3,000	287	130	22	10	8.4	240	120,000	14,000	214
1000	500	1,000	1,500	575	180	26	12	10.0	210	210,000	15,000	230
1500	333	666	1,000	862	205	28	15	12.6	190	285,000	15,500	237
2000	250	500	750	1150	225	31	16	13.9	180	360,000	16,000	245
2500	2 200	400	600	1437	230	38	16.5	13.9	160	400,000	16,500	253

$C_B = 0.85$

$C_{DWT} = 0.85$

Draft = DWT x 35/0.85 x 0.85 x L x B

TABLE VII-4.4.1-3

Tugboat Power and Capital Costs ($-1975)

SHP	EHP	Cost
250	150	242,000
500	300	424,757
650	390	485,466
1000	600	667,475

TABLE VII-4.4.1-4

Number of Tugs Required

(Tug trips/year = 200)

Dwt Barge	Number of Tugs in Single Tows			Number of Tugs in Double Tows		
	500,000 tons/year	1,000,000 tons/year	1,500,000 tons/year	500,000 tons/year	1,000,000 tons/year	1,500,000 tons/year
500	5	10	15	2.5	5	7.5
1000	2.5	5	7.5	1.25	2.5	3.75
1500	1.7	3.4	5.1	0.9	1.7	2.6
2000	1.25	2.5	3.75	0.6	1.25	1.8
2500	1	2	3	0.5	1	1.5

TABLE VII-4.4.1-5

INVESTMENT COSTS TUG BARGE SYSTEM

500 HP TUGS SINGLE TOW

($000)

Barge Out	# tugs	Unit cost tugs	Total cost tugs	#Barges	Unit cost barges	Total cost barges	Total invest-ment	Approximate capacity of system per year
Nominal Capacity system 500,000 tons								
500	5	424	2120	9	120	1080	3200	500,000
1000	3	424	1272	7	210	1470	2742	600,000
1500	2	424	848	6	285	1710	2558	600,000
2000	2	424	848	6	360	2160	3008	800,000
2500	1	424	424	5	400	2000	2424	500,000
Nominal capacity system 1,000,000								
500	10	424	4240	14	120	1680	5920	1,000,0
1000	5	424	2120	9	210	1890	4010	1,000,0
1500	4	424	1696	8	285	2280	3976	1,200,0
2000	3	424	1272	7	360	2520	3792	1,200,0
2500	2	424	848	6	400	2400	3248	1,000,0
Nominal Capacity system 1,500,000								
500	15	424	6360	19	120	2280	8640	1,500,0
1000	8	424	3392	12	210	2520	5912	1,600,0
1500	5	424	2120	9	285	2565	4685	1,600,0
2000	4	424	1696	8	360	2880	4576	1,600,0
2500	3	424	1272	7	400	2800	4072	1,500,0

TABLE VII-4.4.1-6

INVESTMENT COSTS TUG BARGE SYSTEM

1000HP TUGS DOUBLE TOWS

Barge Out	# tugs	Unit cost tugs	Total cost tugs	#Barges	Unit cost Barges	Total cost Barges	Total investment	Approximate capacity system
Nominal Capacity = 500,000 tons								
500	3	667	2001	10	120	1200	3201	600,000
1000	2	667	1334	8	210	1680	3014	800,000
1500	1	667	667	6	285	1710	2377	600,000
2000	1	667	667	6	360	2160	2827	800,000
2500	1	667	667	6	400	2400	2067	1,000,000
Nominal capacity = 1,000,000 tons								
500	5	667	3335	14	120	1680	5015	1,000,000
1000	3	667	2001	10	210	2100	4101	1,200,000
1500	2	667	1334	8	285	2280	3614	1,200,000
2000	2	667	667	8	360	2160	2827	1,600,000
2500	1	667	667	6	400	2400	3067	1,000,000
Nominal capacity = 1,500,000 tons								
500	8	667	5336	20	120	2400	7736	1,600,000
1000	4	667	2668	12	210	2520	5188	1,600,000
1500	3	667	2001	10	285	2850	4851	1,600,000
2000	2	667	1334	8	360	2880	4214	1,600,000
2500	2	667	1334	8	400	3200	4534	2,000,000

The results are plotted in Figure VII-4.4.1-1 for 500 HP tugs towing single 1000 Dwt barges and 1000 HP tugs towing a double tow of 1500 Dwt barges for all three routes.

Analysis were performed to determine the optimum tug-barge combination for various levels of cargo flow with available draft of either 10.5 ft, 12.5 ft or all draft limitations.

The resulting investment costs are given in Table VII-4.4.1-7 while the optimal unit costs are shown in Table VII-4.4.1-8. Therefore large transport cost variations (using full replacement of investment cost over economic life of the tugs and barges) varies from $0.86-$1.14 per ton if no investment is made into dredging of the Sebalik or Sungsang Canal.

The annual savings in transport costs accruing from the use of dredged Sebalik or Sungsang canals and the annual cost of maintaining the dredged canals including financial cost (25 year repayment and 10% interest) are presented in Table VII-4.4.1-9.

It is seen that a 10.5 ft or 3.1 m deep canal (either Sungsang or Sebalik) would not provide lower operating costs than the use of 120 ft barges using the Outer Bar route although it does provide a sheltered route.

Although annual savings in tug-barge operation of 12.0 ft barges occur when using the Sebalik or Sungsang canals dredged to 12.5 ft, these savings are more than eliminated by the combined capital and maintenance dredging costs. Traffic through the canal would have to exceed 3 million tons for the canal savings to equal canal costs.

Cost per ton with full canal costs absorption show that the lowest cost of canal route is the Sebalik using 10 ft deep 1000 ton barges.

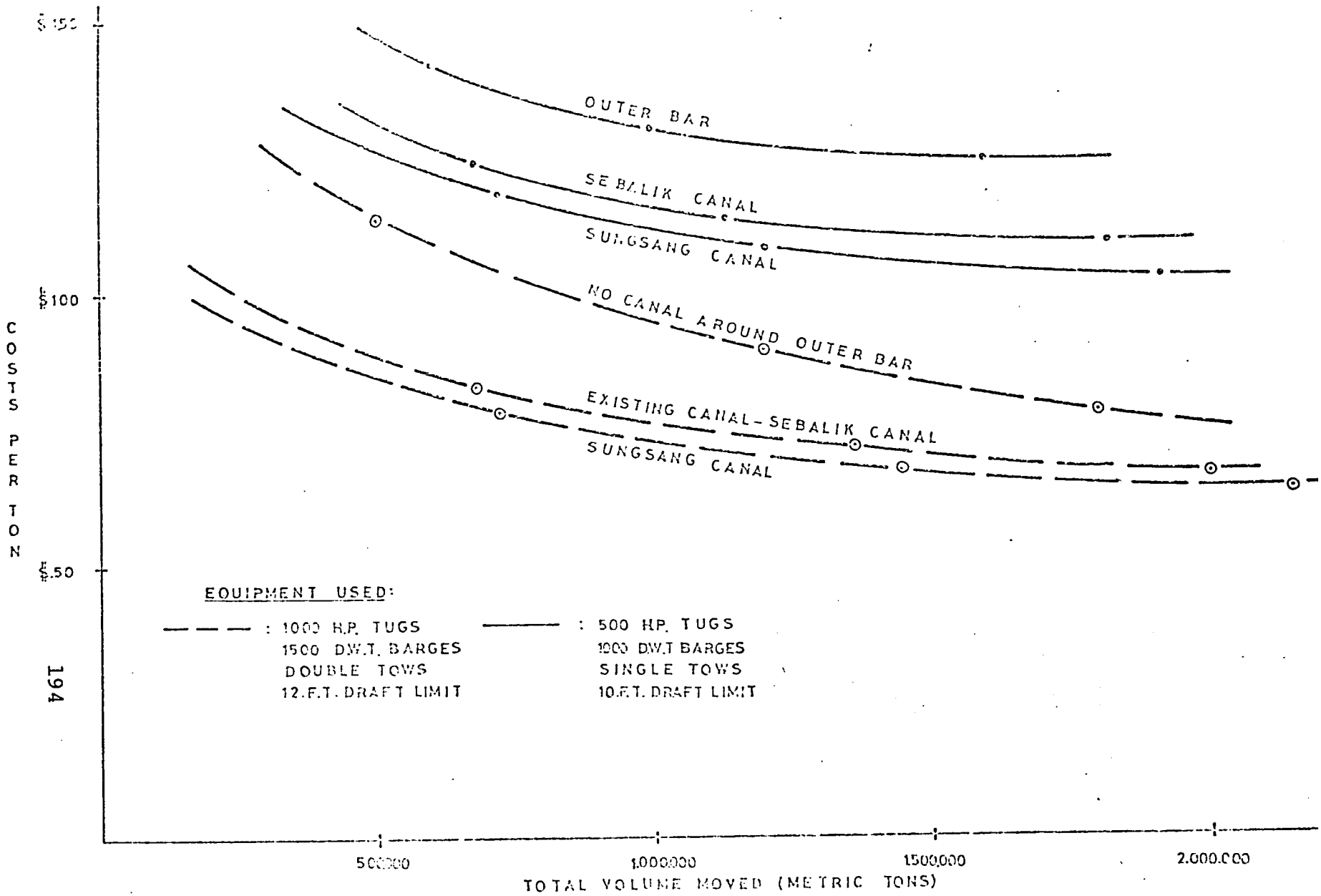


FIGURE VII-4.4.1-1

BULK BARGING SYSTEM OPERATING COSTS: PALEMBANG-BANYUASIN

TABLE VII-4.4.1-7

INVESTMENT COSTS - TUG BARGE FLEETS

Tons per Year	Least Cost Investment	Investment Cost
500,000	2 x 500 HP tugs, 5 x 1500 DWT barges	$ 2,092,000
1,000,000	1 x 1000 HP tugs,5 x 2000 DWT Barges	$ 2,467,000
1,500,000	2 x 1000 HP tugs,8 x 2000 DWT Barges	$ 4,214,000

TABLE VII-4.4.1-8

OPTIMAL UNIT COSTS IN $/TON

Route	Draft limitation, Ft.	Cargo flow in (000) T/Yr. 500	1000	1500
None (Outer Bar)	12.0	$ 1.14	$ 0.90	$ 0.86
	10.0	$ 1.48	$ 1.41	$ 1.26
Sebalik Canal	10.0	$ 1.32	$ 1.17	$ 1.11
	12.0	$ 0.90	$ 0.77	$ 0.72
Sungsang Canal	10.6	$ 1.26	$ 1.11	$ 1.05
	12.0	$ 0.85	$ 0.73	$ 0.68

TABLE VII-4.4.1-9

ANNUAL SAVINGS AND COSTS RESULTINGS FROM DREDGING SEBALIK AND SUNGSANG CANAL

(25 year amortization - 10% interest)

Canal	Draft Ft.	Cargo Volume 000 tons per year	Annual Savings $ (000)	Annual Cost of dredging ($ 000)			Cost per ton with full canal cost absorption
				Capital	Maintenance	Total	
Sebalik	10.0	500	--	70	40	110	1.54
	10.0	1000	--	70	40	110	1.38
	10.0	1500	--	70	40	110	1.19
	12.0	500	120	270	150	420	1.74
	12.0	1000	130	270	150	420	1.19
	12.0	1500	210	270	150	420	1.00
Sungsang	10.0	500	--	260	200	460	2.07
	10.0	1000	--	260	200	460	1.47
	10.0	1500	--	260	200	460	1.32
	12.0	500	145	460	390	850	2.55
	12.0	1000	170	460	390	850	1.58
	12.0	1500	270	40	39	850	1.24
Outer Bar	12.0	500	--	--	--	--	1.14
	12.0	1000	--	--	--	--	0.90
	12.0	1500	--	--	--	--	0.86

There are significant cost differences between the Sebalik and Sungsang canal. It is therefore recommended, that the Sebalik canal be dredged to provide a safe route for barges to Banyuasin.

The burdened costs of barging as a result vary from a low of $1.14 to a high of $1.74 per ton when 500,000 tons per year are shipped.

4.4.1.4 Pipeline Transport Costs.

As no local pipeline construction and operating costs were available, pipeline transport costs were derived from basic cost data. The main pipelines to Banyuasin of potential interest are :

1) Oil product pipeline from Pertamina refineries - petro-chemical plant
2) Coal slurry pipeline from Kertapati

1) The costs of a 12" oil product pipeline from Sungai Gerong to Banyuasin (59 km), including pumps, pipebridges, manifolds submarine river crossings, drainage channels, supports and others are estimated at $ 8.2 million installed. This pipeline could be used to pump through various products by batchpumping using dividing slugs. Pumping rates will vary from 180-300 tons per hour for an average annual rate of 1.2 million tons. In addition a product tank farm would be required. Tank capacities are estimated at 8 x 8000 tons. Tank farm costs including pumps, distribution system etc. are estimated at $4.12 million for total installed pipe-line system cost of $12.32 million.

Operating costs are about $300,000 year. Assuming a 25 year life and 10% interest total annual costs of such

a pipeline system would be

Annual financial costs	$ 1.132 million
Operating costs	$ 0.300 "
Total costs	$ 1.432 million
Costs/ton capacity	$ 1.19

If instead of a 12" pipeline a 16" pipeline with an annual throughput of 2.1 million tons is constructed, then cost/ton capacity is $0.89.

It therefore appears that unless at least 1.5 million tons are exported and/or landed oil products should be barged between Banyuasin and the refinery. It is similarly found that if crude input stock is landed from large distances which make the use of deep draft tankers and terminal attractive then a special crude pipeline should only be considered if this landed crude exceeds 2.0 million tons/year. Naphtha feed stock could obviously be handled by an oil product line if the line is designed for two directional flow.

2) Although coal slurry pipelines have been used successfully the cost of pulverization, mixing, pumping, river crossing, booster, dewatering and other investment items makes this type of installation prohibitively expensive. It is only justified when the economies of scale justify this approach. With a feeder distance Kertapati-Banyuasin of 96 km, we would have to move in excess of 4 million tons of coal for export per year to beat the cost of coal barging to Banyuasin.

4.4.1.5 Cableway Transport Costs.

The use of a cableway to transport dry bulk and dry unitized cargo (such as palletized or baled cargo) from an offshore barge terminal at Sungsang to Banyuasin over a

6.3 km distance was considered.

Using modern cableway practices with towed spacing of 300 meters, we require a total of 23 towers. At both ends marshalling-loading/unloading rails will be provided at both shore side storage (stockpiling) depots and at the offshore terminal end. Assuming a cableway installation cost 50% above a recent (U.S. Gypsum) system to account for additional construction costs due to swamps and inaccessibility, the installed cost of the cableway system with a capacity of 500 tons per hour or 1.0 million tons per year is estimated at $9.62 million with an operating cost (including maintenance) of $680,000 per year. Total annual costs (20 year life - 10%) is then equal to $1.64 million. Costs per ton would as a result be about $1.64 if one million to capacity is used.

To this cost must be added the cost of barging to and from Sungsang, transfer and stockpiling costs which amount to about $0.98/ton for a total cost of $2.62/ton.

On the other hand the system permits low cost loading/unloading of dry bulk cargo from ships and more effective distribution to stockpiles. The use of cableways as a result can be expected to reduce transfer and distribution costs by as much as $0.50/ton. Even so it is not competitive with barge transportation.

4.4.1.6 Summary of Transport Costs.

The feeder transport costs to the various ports sites by mode are summarized $/ton as follows for a throughput of 1,000,000 tons per year.

	Road*	Rail*	Barge	Pipe-line	Cable-way
Banyuasin Fixed Port	14.34	5.80	1.28	1.19	2.62
" Floating Terminal	-	-	1.28	1.29	2.62
" Island Terminal	14.34	5.80	1.28	1.19	2.62
Sungsang Fixed Port	-	-	0.98	0.80	-
" Island Port	-	-	0.98	0.80	-
Sungai Lais Fixed Port	2.34	1.80	-	-	-
Boom Baru Fixed Port	1.22	-	-	-	-

* Road or Rail line - no depreciation or interest.

4.4.2 Costs of Shallow Draft Shipping.

To determine the effect of maintaining various depth at future deep draft port facilities the costs of using special shallow draft vessels was studied.

The capital and operating costs for liquid and dry bulk carriers as well as ocean tug-barge combinations was determined for various deadweight capacity to loaded draft combinations.

The results of this study in terms of cost per ton of cargo carried over a typical 1500 mile (one way) trade route are presented in Figure VII-4.4.2-1.

The loaded speed of the tankers or bulk carriers was assumed at 15 knots, and that of the tug-barge combination at 12.5 knots.

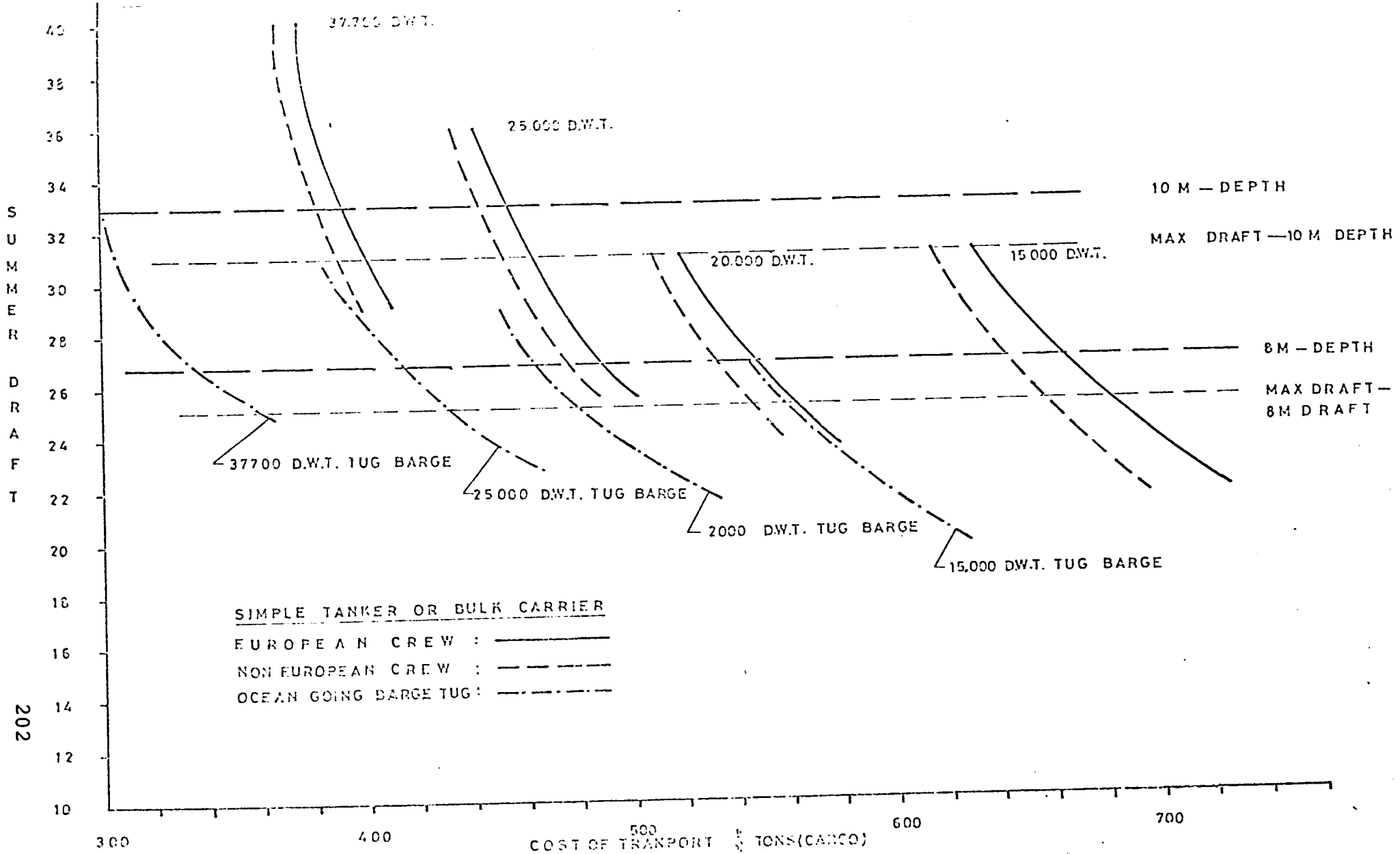


FIGURE VII-4.4.1-2

COST PER TON VERSUS SUMMER DRAFT

SHALLOW DRAFT VESSEL STUDY (8000MILE ROUTE)

It is noted that a 37,500 Dwt tanker or bulk carrier with a normal draft of 38' could be designed as a shallow draft vessel with a loaded draft of 30'. The resulting penalty would be a 12% cost per ton increase on a 1000 mile route, going down to an 8% cost per ton increase on a 1500 mile run. It is also important to note that while specially designed shallow draft ships have appreciably higher costs than regular draft vessels of the same deadweight, they generally have a lower cost than regular draft vessels of smaller deadweight but the same draft.

Another important fact is that modern oceangoing bulk barges (liquid or dry) push towed by tugs operate at a much lower draft and cost than equivalent deadweight tankers and bulk carriers.

For example total costs per ton of a shallow draft 37,700 Dwt tug barge over a 1500 mile route would be only about one half of that of a conventional 15,000 Dwt tanker serving the same route.

To analyze the effect of using shallow draft vessels in lieu of the development of a deep draft terminal we calculated the additional cost of using shallow draft vessels within the current 6 m Musi River depth limitation which permits vessels of up to 7.5 m to come in with the tide.

Using the minimum and maximum quantities of cargo projected for the deep draft port terminal in 1990 for example (Table VII-5.1-2) we obtain the following additional cost.

For each of the projected cargo flows (minimum or maximum) we next computed the average route distance and resulting costs (or freight charges) given these cargoes where handled on the average by a ship of 80% of the Dwt of the maximum

size of ship of regular dimensions admittable under the available draft at the deep draft port terminal.

Assuming the minimum expected cargo flow through the deep draft port of 1,299,000 tons in 1990 shipped over an average distance of 1430 miles total expected freight cost (1975 dollars) is for the deep draft port :

$ 4,290,000/year - 15 m draft limit

$ 7,410,000/year - 10 m " "

and by use of shallow draft vessels using facilities in the Musi River :

$ 8,455,200/year - 8 m draft limit

If we assume the upper limit or maximum cargo flow through a deep draft port facility we obtain a cargo volume of 3,270,000 tons and 2,365,000 m^3 shipped over an average distance of 1921 miles. Total expected freight cost (1975 dollars) is then for deep draft port use :

$ 19,790,000/year at 15 m darft limit

$ 29,982,000/year at 10 m draft limit

and by use of shallow draft vessels using facilities in the Musi River :

$ 33,120,000/year at 8 m draft.

If regular draft vessels are used in the Musi River with an 8 m draft limitation, then the cost of moving the minimum expected cargo (1.299 million tons) is $ 10.27 million and when moving the maximum expected deep draft port cargo $ 40.08 million.

The conclusions are that :

a) If no deep draft port is developed then shallow draft vessels or tug-barge combinations should be used to carry cargo that would preferably move on deep draft vessels. The minimum savings over the use of regular type vessels would

be $ 1.82 million per year. On the other hand if the maximum amount of cargo is moved in special shallow draft vessel cost saving may be as high as $ 6.96 million per year.

b) The savings in shipping (freight) costs via a deep draft terminal (10 or 15 meters) and using special shallow draft vessels utilizing Musi River facilities in 1990 :

Savings in Freight Costs	Minimum Cargo Projection	Maximum Cargo Projection
15 m deep draft port and shallow draft vessels (8m)	$ 4.16 million	$ 13.33 million
15 m deep draft port and regular vessels (8 m)	$ 5.98 million	$ 20.29 million
10 m deep draft port and shallow draft vessels (8m)	$ 1.05 million	$ 3.14 million
10 m deep draft port and regular draft vessel (8 m)	$ 2.86 million	$ 10.10 million

In other words while use of shallow draft vessels would greatly reduce the freight costs compared with the use of equal draft regular vessels, there is still an appreciable freight cost difference between the use of shallow draft vessels in the Musi River and regular vessels using a new deep draft terminal. These freight cost differences (1990) are between $4.16-$13.33 million/year for a 15 m port and between $1.05-$3.14 million/year for a 10 m deep draft port. The use of shallow draft ocean tug-barge combination would reduce this freight cost differential by about 30%. It is assumed that barge would only be used on the interisland and close by foreign (up to 1500 miles) routes.

4.4.3 Wharf Requirements and Construction Costs

4.4.3.1 Ship Arrivals

Prediction of Ship Calls at Palembang

Based on the data available at this time the number cf ship calls to the Port have been determined based on the average cargo lifts per ship calling at Palembang as given in Table VII-4.4.3-1.

The number of annual ship calls in the year 1984 can be estimated to be about as follows assuming the ratio of general cargo carried by interinsular shipping and that carried by local shipping is two to one.

a. General Cargo

$$= \frac{1}{2}\left(\frac{832,000}{1200} + \frac{2}{3} \times \frac{1044,000}{950} + \frac{1}{3} \times \frac{1044,000}{250}\right) = 1410$$

shipcalls

b. Special Cargo

Petroleum and Products $= \frac{1}{2}\left(\frac{8500,000}{7000} + \frac{8500,000}{5000}\right) = 1456$

Fertilizer $= \frac{1}{2}\left(\frac{250,000}{950}\right) + \frac{1,380,000}{7000} = 329$

Coal $= \frac{400,000}{4000} = 100$

Cement/Polypropylene/Tapioca =

$$\frac{1}{2}\left(\frac{150,000 + 20,000 + 50,000}{950}\right) = 116$$

Wood $= \frac{900,000}{2400} = 375$

Total ships calls to Palembang Area = 3786 /year

Ship movements in the Musi River Channel = 7576 / year

Table VII-4.4.3-1

Length of Ship Vs Cargo Handled for Berthing Analysis

Item No.	Type of Shipping	Average cargo per ship Reconnaissance survey concerning Palembang Port, Musi River and the Estuary of Banyuasin, June 1974	Average cargo per ship Palembang Port Study E.G. Frankel, Inc., November 1974	Comment
		Average length of ship Meters - feet		
	A. GENERAL CARGO			
1.	Ocean going shipping	1200 150 - 500	1200 150 - 500	With the increase in depth of the Musi River from 4.5 to 6.0 M the size of cargo per ship may increase. However, this will take time.
2.	Inter-insular shipping	950 60 - 200	950 60 - 200	Inter-insular shipping of general cargo is not seriously hampered with a river depth of six meters
3.	Local shipping	120 30 - 100	250 40 - 130	
	B. SPECIAL CARGO			
1.	Fertilizer (bagged) 1974 - 100,000 tons 1978 - 240,000 tons	950 60 - 200	950 60 - 200	

Table VII-4.4.3-1

Length of Ship Vs Cargo Handled for Berthing Analysis

(contd)

Item No.	Type of Shipping	Average cargo per ship Reconnaissance survey concerning Palembang Port, Musi River and the Estuary of Banyuasin, June 1974	Average cargo per ship Palembang Port Study E.G. Frankel, Inc., November 1974	Comment
		Average length of ship Meters - feet		
2.	Fertilizer (bulk) 1974-380,000 tons 1978- 1,380,000 tons	950 60 - 200	5000 120 - 400	Pusri has under contract and is building special small shallow draft bulk carriers which will eventually raise the cargo per ship to about 7000 tons.
3.	Crude oil tanker a. small tanker loaded b. medium tanker partial load	7000 5000 120-140/400-460	7000 5000 120-140/400-460	It is possible to build special shallow draft tankers for six meter draft service.
4.	Wood	1230 M^3	2400 150 - 500	The size of bulk wood carriers is increasing to 6000 to 8000 Dwt.

Table VII-4.4.3-1

Length of Ship Vs Cargo Handled for Berthing Analysis

(contd)

Item No.	Type of Shipping	Average cargo per ship Reconnaissance survey concerning Palembang Port, Musi River and the Estuary of Banyuasin, June 1974	Average cargo per ship Palembang Port Study E.G. Frankel, Inc., November 1974	Comment
		Average length of ship Meters - feet		
5.	Coal	4000 100 - 330	5000 120 - 400	The coal industry will start moving coal out of Palembang in 4000 ton ships but hopes to increase the ship size to 6000 to 8000 tons. If the coal industry cannot use the larger size bulk carriers there will not be much coal shipped out of Palembang except inter-island by barge. This will require that the Ampera Bridge be operable.
6.	Cement/Polypropylene/Tapioca etc.	550 50 - 165	550 50 - 165	

4.4.3.2 Wharf Requirements

The wharf or pier requirements fall into two general categories private facilities and public sector facilities - i.e. Palembang Port Administration Facilities - Boom Baru or at Banyuasin.

In this preliminary development of wharf requirements, it is assumed that the private facility requirements will be available when required unless there are extenuating circumstances in which case they will be mentioned.

This section will deal with the public sector wharf requirements.

4.4.3.3 Number of ships Requiring Docking

Based on the cargo forecast for 1984 the number of ships requiring public sector wharfage are determined as follows.

Assumptions

a. That for general cargo any given ship arriving at Palembang will in addition pickup a cargo there as well.

b. That all import cargo will be handled at the public facility.

c. That 60 percent of the inter-island cargo will be handled at the public facility.

d. The ratio of interinsular shipping to local shipping is two to one.

e. That three hatches are worked on an ocean ship, two hatches on an interinsular ship and one hatch on a local shipping vessel.

f. That the average cargo worked per hatch per hour is ten tons.

g. That the port works two shifts with seven hours effective work per shifts.

h. That the port works six days a week and two shifts per working day or 12 shifts per week.

i. That the average distance between ships at the wharf will be approximately 10 percent of the length of the ship.

Table VII-4.4.3-2 shows the public sector wharf requirements for the Palembang area and further illustrate how the results were obtained using the assumptions outlined above. The computations show that in 1984 the public sector wharf requirements for Palembang using an 80% wharf utilization factor will be about 1500 meters of wharf.

4.4.3.4 Wharf Construction

There are four basic types of wharf construction which have application in the Palembang/Banyuasin area, and were analyzed by the Consultants.

Type I - See Figure VII-4.4.3-1 and VII-4.4.3-2

This type of wharf construction is generally accepted for soil conditions similar to those encountered in this region and for alongside water depths in the 6-8 M range, and where the deep water is close to shore. The main wharf structure designed for a distributed life load of three tons/ M^2 composes of a ten meter wide concrete deck supported by concrete piles. The steel sheet pile bulkhead (cut-off wall) penetrates some 2-4 M into the river bed. The unsuitable top layer of the river bed soil is removed and replaced by sand or stone. The area behind the bulkhead connecting the wharf to the shore is filled with selected fill material - thus increasing the overall soil stability. (The Boom Baru Wharf now being rehabilitated is of similar design.) Type Ia and that of Sungsang is principally similar to that at Palembang but adapted to the salt water conditions there, i.e. Type Ia.

TABLE VII-4.4.3-2

PUBLIC SECTOR WHARF (BOOM BARU) REQUIREMENTS - 1984.

Item No.	Type of shipping to be accommodated	Average length per ship Mtr.	Average cargo handled per call tons	Cargo handled in port per category tons	Number of ships berthing to handle cargo 5+4 = x	Number of days to unload each ship	Number of pier days x 1000 M	Number of wharf meters required per 313 day working year
1	Ocean Shipping Imports	150	1200	426,000	355	$\frac{1200}{30x14} = 2.9$ say 3 days	$\frac{1.1x3x50x355}{1000} =$ 176	
2	Inter-insular shipping Imports and Exports	60	950	418,600	441	$\frac{950}{20x14} = 3.4$ say 4 days	$\frac{1.1x4x60x441}{1000} =$ 117	
3	Local Shipping Imports and Exports	40	250	206,800	828	$\frac{250}{10x14} = 1.8$ say 2 days	$\frac{1.1x2x40x828}{1000} =$ 73	
4	Totals or 100% Pier Utilization				1624		365	1166 or 1200
5	Total Requirement Assuming 80% Pier Utilization						456	1457 or 1500
6	Total Requirement Assuming 60% Pier Utilization						608	1942 or 2000

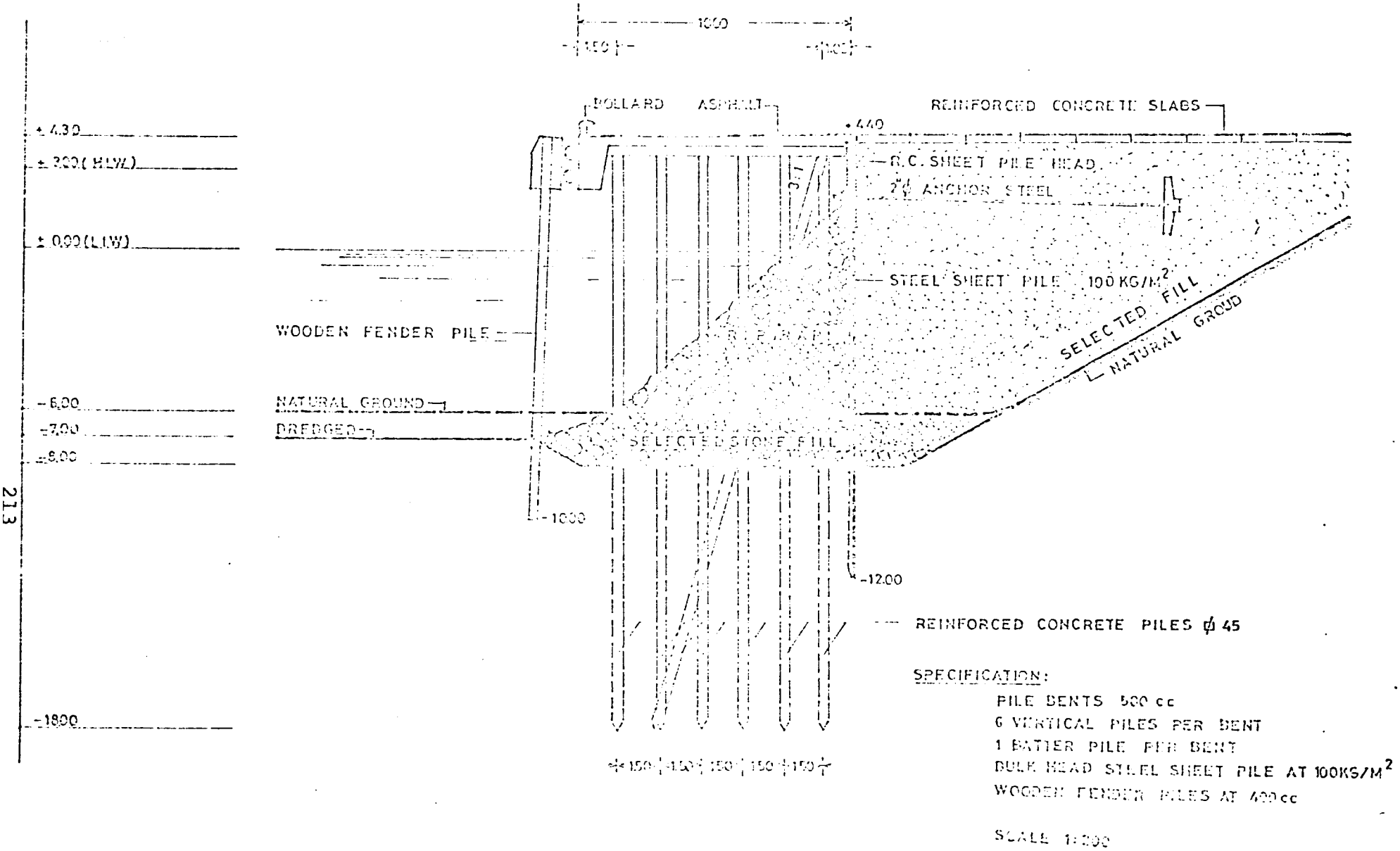


Figure VII-4.4.3-1

Boom Baru Wharf for Interinsular Shipping

Type Ia

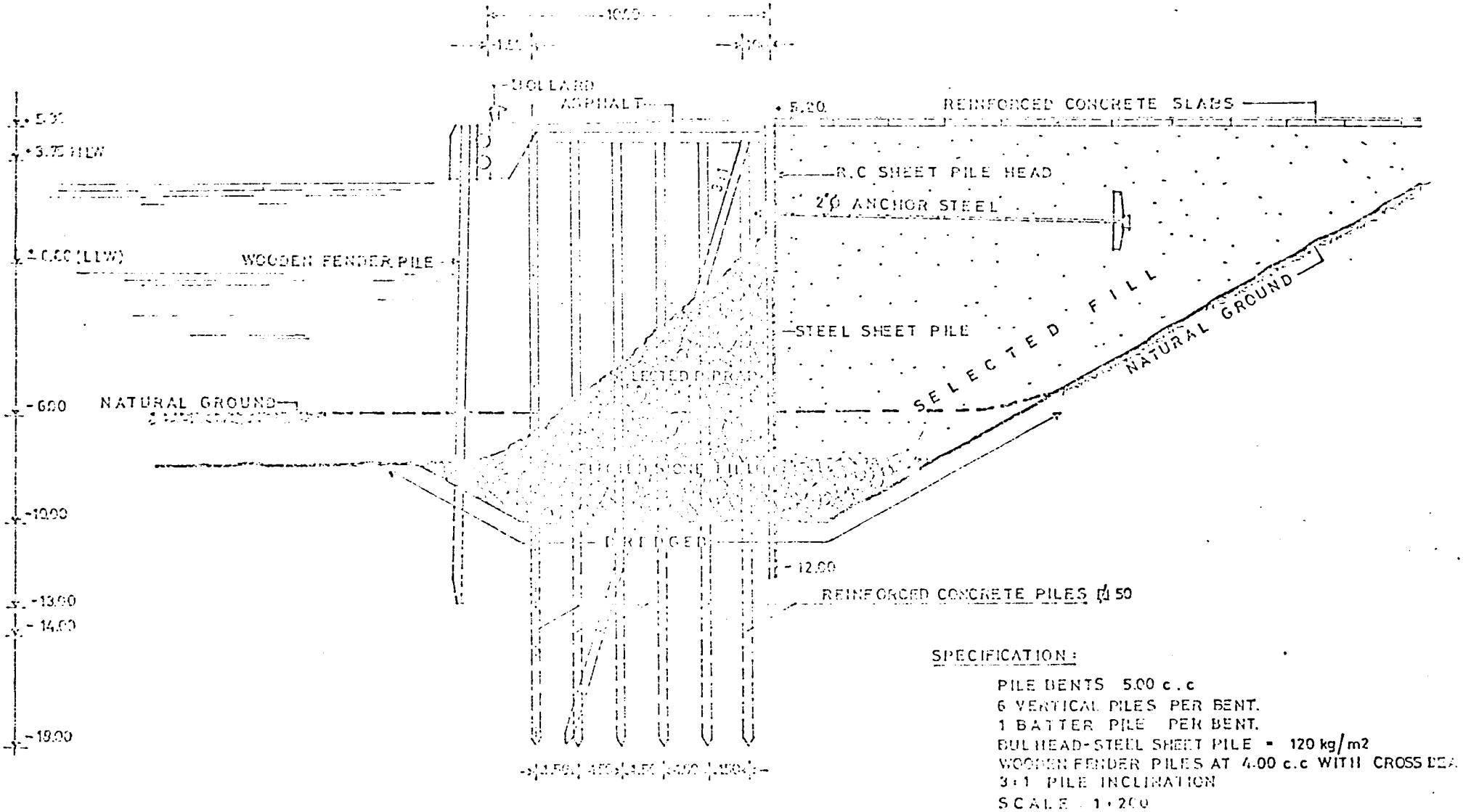


Figure VII-4.4.3-2

Banyuasin Wharf for Interinsular Shipping
Type Ib

Type II - See Figures VII-4.4.3-3 and VII-4.4.3-4

This type of wharf construction is generally accepted for soil condition similar to those found in this region and for alongside water depths in the 8-10-12 M range, and where the deep water is not too far from shore. The main wharf structure, designed by heavy structure for a distributed life load of five tons/M^2, comprises of a twenty meter wide concrete deck supported by concrete piles. Similar to Type I, the fill behind the bulkhead is selected fill material which will increase the overall soil stability. Type IIa is the proposed general conceptual design for Palembang and Type IIb for Banyuasin. The design concept at Sungsang is principally similar to that of Palembang but adapted to the salt water conditions there, i.e. Type IIa.

The proposed design is suitable for intensive container handling operations. The deck is designed to support container gantry cranes of standard 50 feet rail-span design with a lifting capacity of 40 tons at full out-reach and 60,000 lbs/wheel load. Though initially intended to be used in Palembang with an alongside depth of 8.5 M at LLW only, the structure is, however, designed to permit in the future the increasing of the alongside depth to 10.5 M at LLW, similar to Banyuasin.

Type III - See Figure VII-4.4.3-5

This is the "Island Wharf" type of construction generally accepted for soil conditions similar to those of Banyuasin, for alongside water depths in the 6-8 M range, and where the deep water is far from shore. The proposed conceptual design is for the 6 M outer harbor at Banyuasin. The main wharf is a light structure, designed for a distributed life load of three tons/M^2 is comprised of a 60 meter wide deck without bulkhead and fill. The island-wharf is connected to the shore and the Port's storage

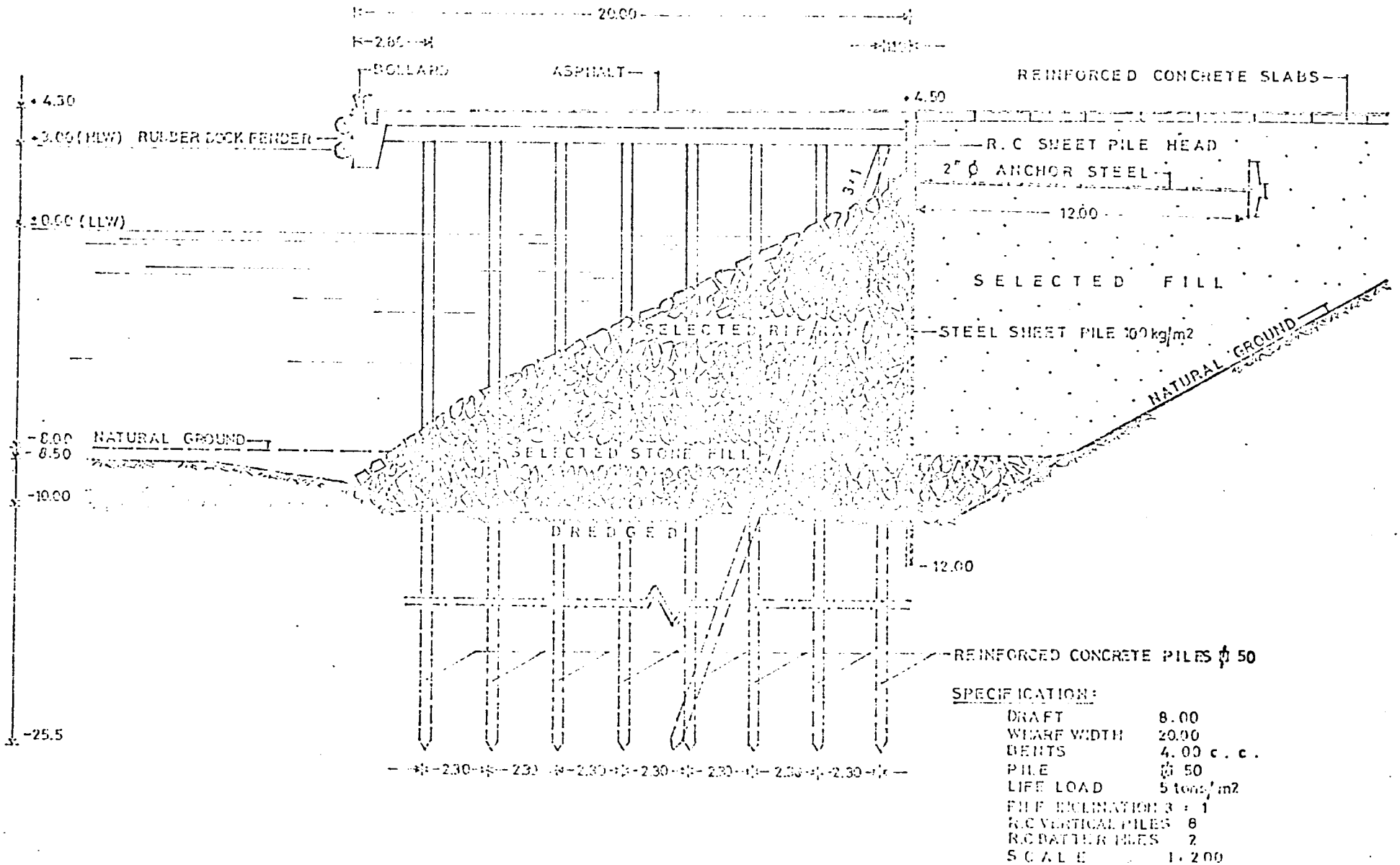


Figure VII-4.4.3-3

Boom Baru New Main Wharf for Oceangoing Vessels
Type IIa

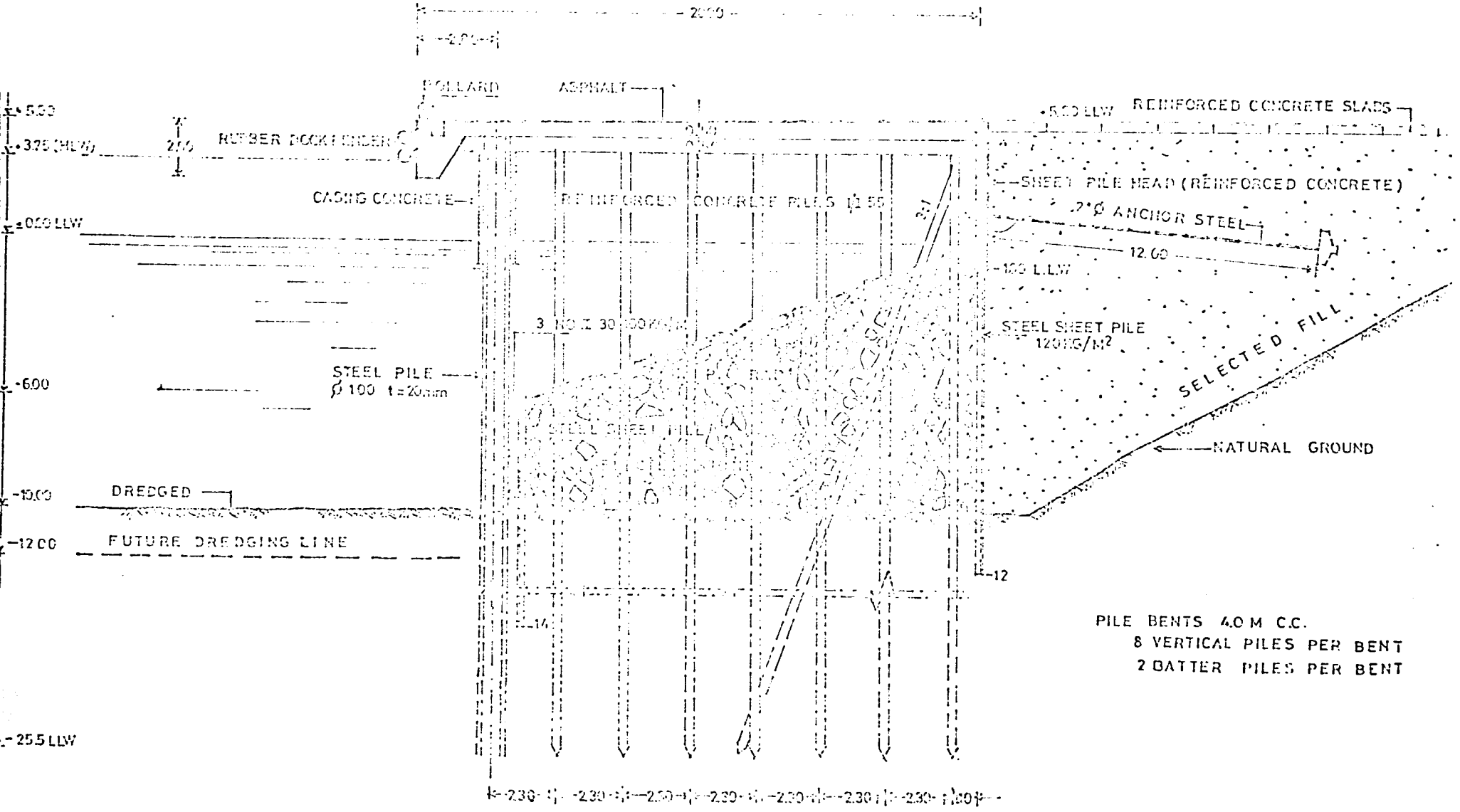
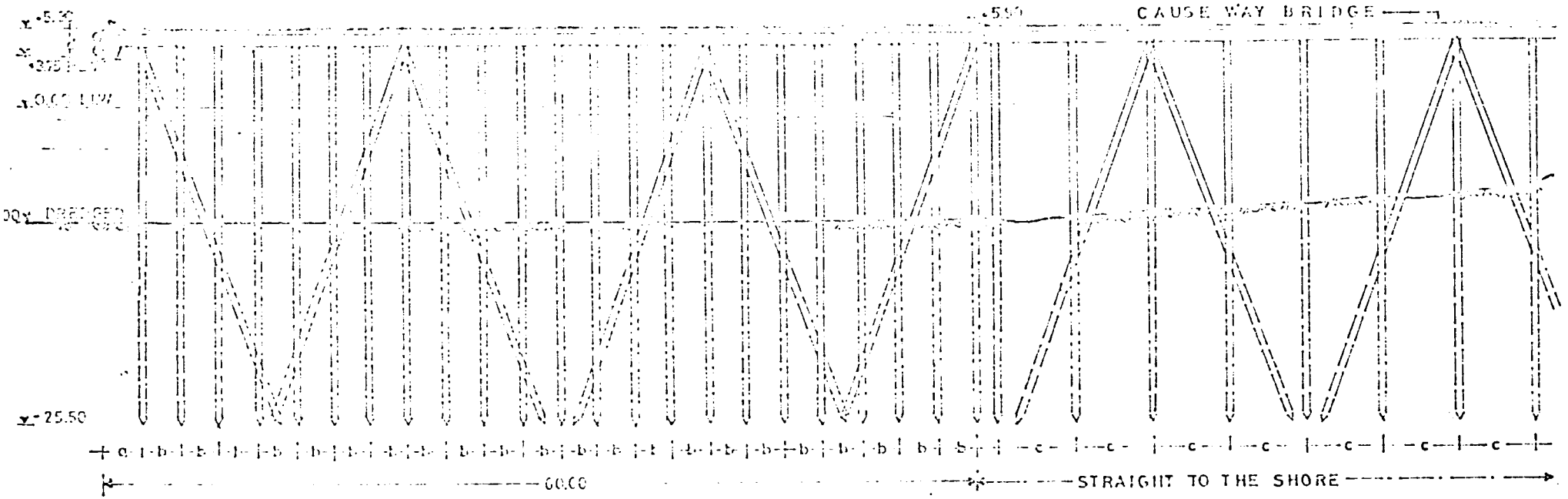


Figure VII-4.4.3-4

Banyuasin Main Wharf for Oceangoing Vessels

Type IIb



SPECIFICATION :

VERTICAL PILES	: 23/BENT
BATTER PILES	: 6/BENT
LIVE LOAD	: 3 T/M 2
BENTS	: 5.00 c . c
< ⊕ >	: EVERY 3rd BENT

DIMENSION :

PILES	: ⌀ 45
PILES LENGTH	: 30.00
PILE INCLINATION	: 3 : 1
a	: 2.60
b	: 2.45
c	: 5.00
d	: 2.00
SCALE	: 1 : 400

Figure VII-4.4.3-5

Banyuasin Offshore Island Wharf for Interinsular Vessels

Type III

facilities there by at least two causeway bridges. Some Gudangs are usually built on this island wharf, but have obviously limited storage areas. This type of construction does not permit efficient cargo handling operations as most cargoes unless directly delivered, have to be double handled and transported to the larger storage areas on shore.

Type IV - See Figure VII-4.4.3-6

This is an "Island Wharf" similar to Type III, but designed as "heavy structure" for a distributed life load of 5.0 tons/M^2 permitting container handling operations similar to those described for Type II and for alongside depth in the 8-10-12 M range. The proposed conceptual design is for the ten M outer harbor at Banyuasin.

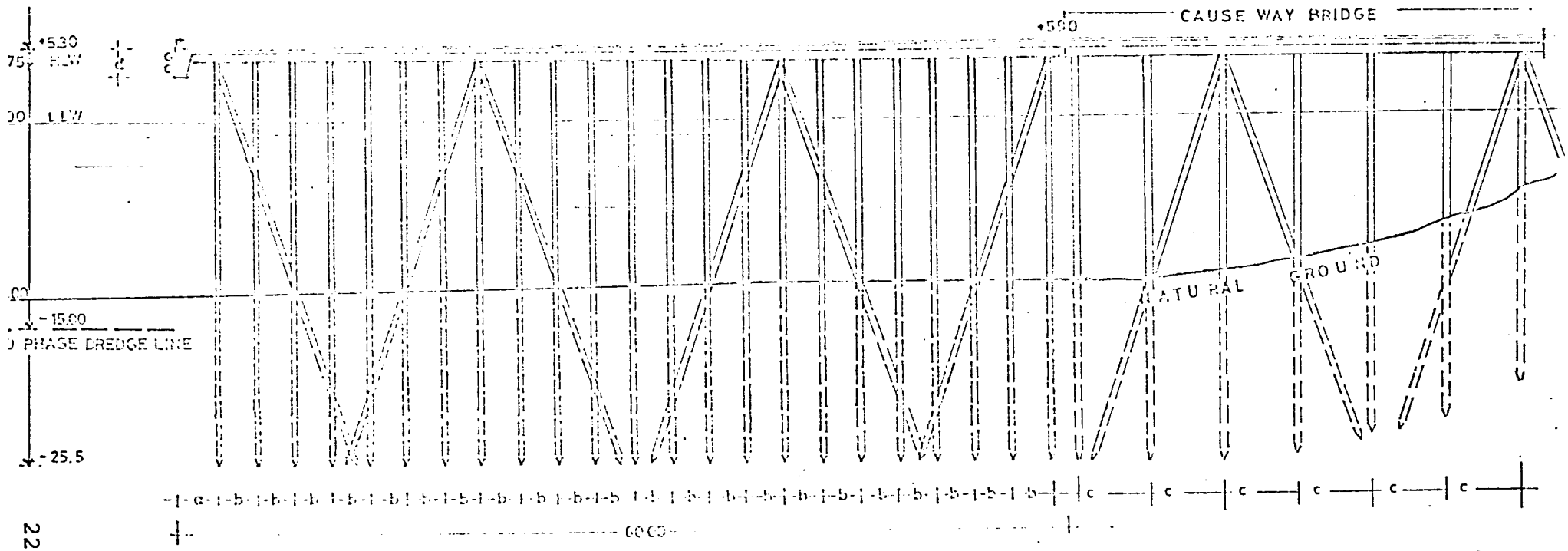
Causeway Bridge - See Figure VII-4.4.3-7

The causeway is a piled structure, 15 M wide, connecting the "Island Wharves" to the port's storage areas and facilities on the shore. The bridge is designed for heavy loads. Each of the island wharves (6 M and 10 M) should have at least two connections to the shore in order to permit efficient and smooth traffic flows from and to the island wharf.

Floating Port Facilities - See Figure VII-4.4.3-8

General

An alternative to fixed terminal facilities is the provision of floating port facilities rigidly anchored or moored in an easily approachable location. There are numerous applications of this approach consisting of the use of a converted tanker or bulk carrier, specially designed stable (catamaran) terminal platform, or terminal barge. (The Consultant has been in charge of a large number of floating or floatable terminal designs for the "Instant



SPECIFICATION

VERTICAL PILES	-	23/BENT	DIMENSION:		
BATTER PILES	-	6/BENT	a	-	2.80
PILES	-	1150	b	-	2.55
LIFE LOAD	-	54/m2	c	-	500
BENTS	-	4.00 c.c	d	-	2.00
PILE INCLINATION	-	3:1	←□→		6 BATTER PILES
PILES LENGTH	-	30.00			EVERY 4 TH BENT
SCALE	-	1:500			

Figure VII-4.4.3-6

Banyuasin Offshore Island Wharf for Oceangoing Vessels

Type IV

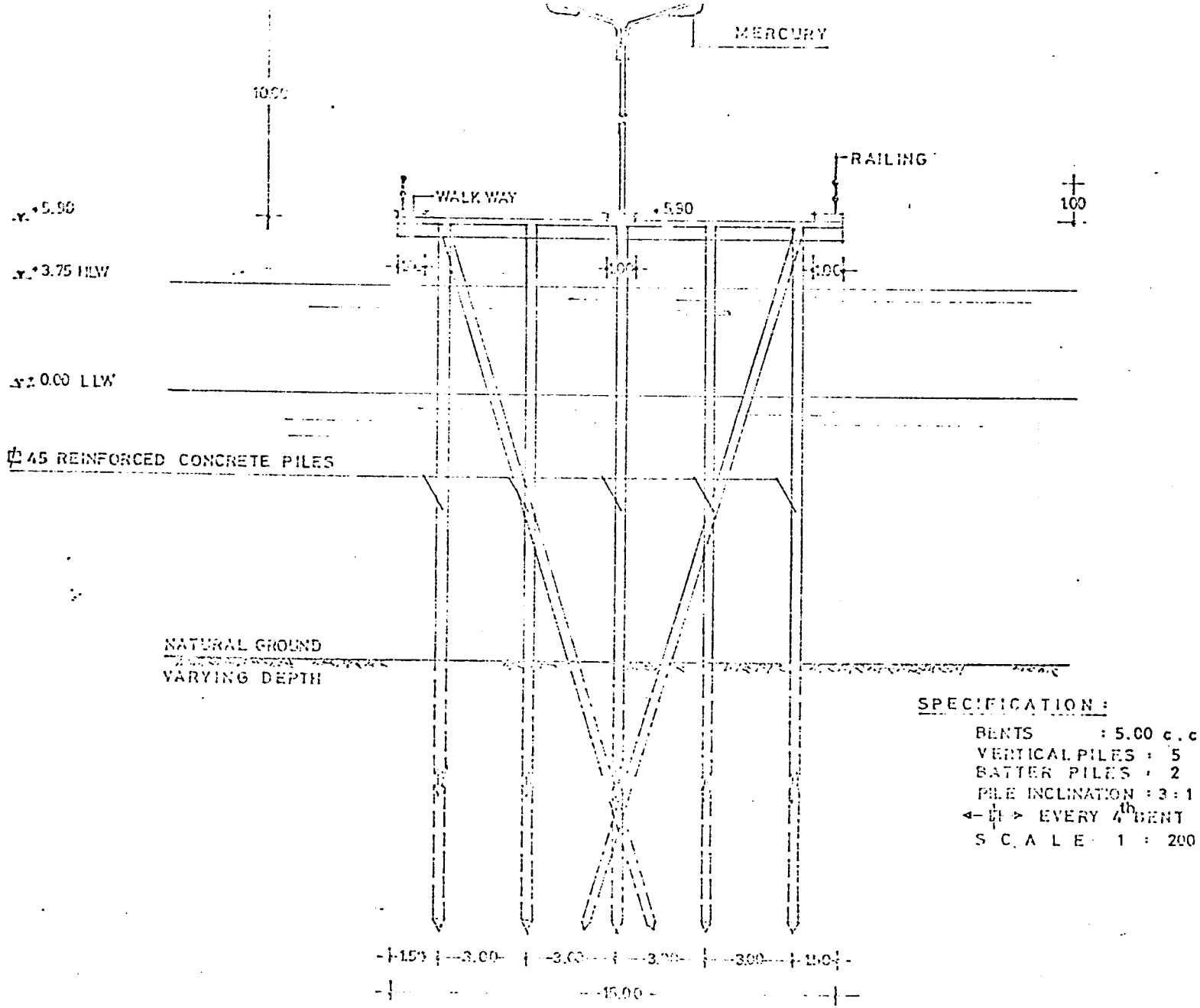


Figure VII-4.4.3-7

Banyuasin Causeway Bridge to Offshore Island Wharf
Cross Section

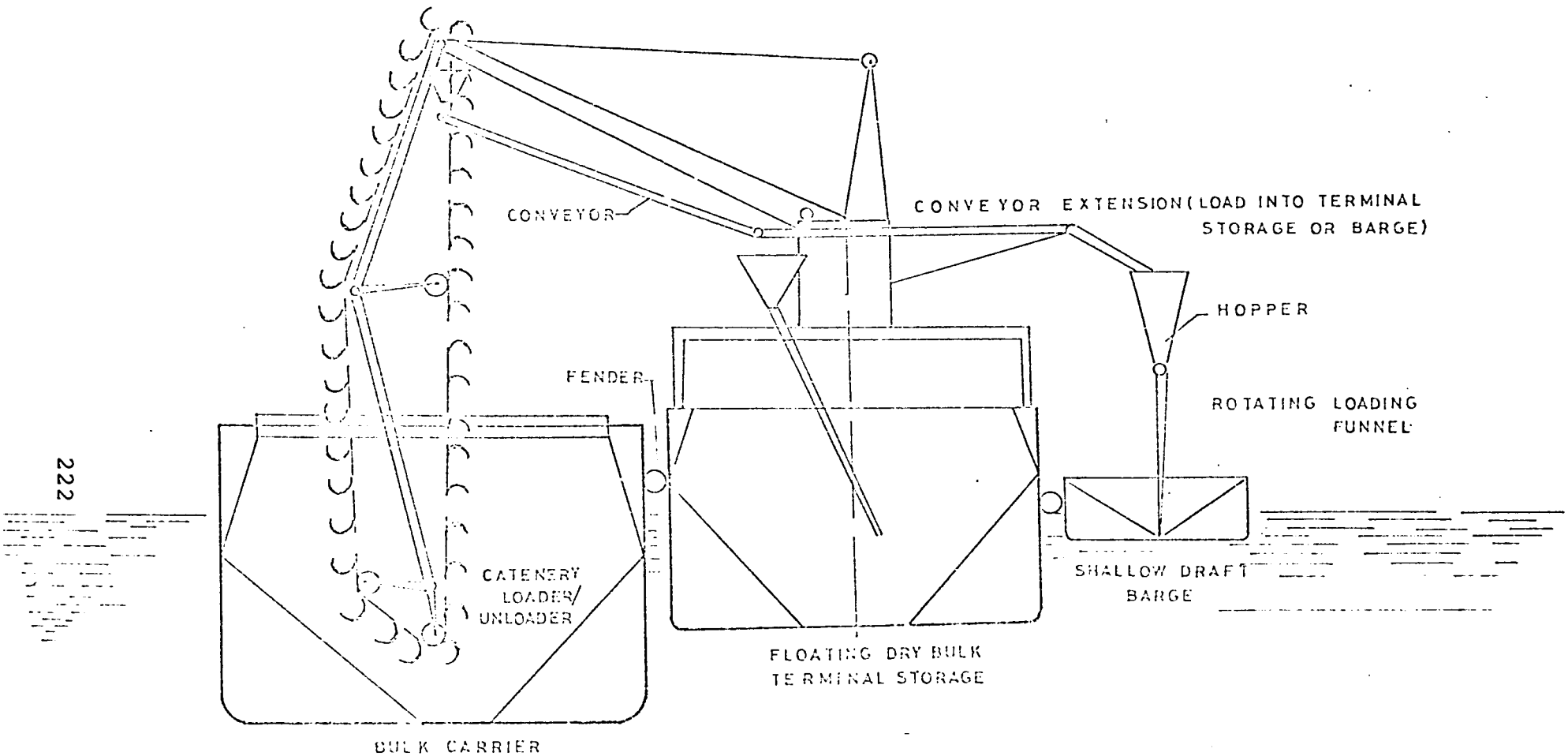


Figure VII-4.4.3-8
Floating Dry Bulk Terminal

Port Project" of the United States Department of Defense.)

Some applications also use self elevating barge of platform type structures such as De Long piers or jack-ups. The proposed floating terminal will consist of a converted (about ten years old) tanker/bulk carrier or a specially built terminal platform or ocean barge. The floating terminal will be permanently moored to a pair of piled anchor buoys in line with the predominent tidal direction.

The floating terminal will be able to dock vessels on both sides or berth a vessel on one side and barges or lighters on the other side. Efficient and safe fendering and mooring equipment will be installed.

The floating terminal will be equipped with a pair (2) of rail mounted, gantry supported catenery/ conveyor type loaders/unloader for dry bulk cargo transfer between ship and terminal, ship and barge or barge and terminal. Total installed dry bulk cargo transfer rate will be 600 - 1000 tons per hour depending on terminal selected. The terminal will have dry bulk storage capacity sufficient to prestore or receive 1-2 normal full ship loads. While primarily designed for dry bulk cargo transfer, the floating terminal will also be equipped for liquid bulk transfer. At a later date, a submarine pipeline to the head buoy may be installed and tied to the ship via a tressle between the head buoy and the ship.

While not designed for general or containerized cargo initially, the floating terminal could be equipped with a container crane or gantry as a floating container terminal. Deck storage of several hundred containers

would provide the buffer, with feeder containers supplied by container carrying barges or other special container feeder vessels.

A list of basic floating terminal alternatives is presented in Table VII-4.4.3-3. The capital costs of each of the floating terminal alternatives includes:

a. vessel acquisition or construction
b. vessel outfitting or conversion
c. installation of dry and liquid bulk transfer or transfer equipment
d. installation of mooring, berthing and anchoring equipment
e. installation of piled anchor buoys
f. installation and/or conversion of power and operations support plant and machinery

The above does not include the cost of general cargo or container handling equipment.

Similarly operating costs include:

a. ship or terminal maintenance
b. cost of terminal crew, including equipment operators, but excluding stevedores
c. fuel and supplies

Each of the alternative floating terminal configurations have different operating advantages. From the point of view of relative cost/effectiveness the average capital cost of $11.50 million is used at this stage. Adding a 20% contingency and a 15% escalation to bring costs to 1977 we obtain the following alternatives:

Converted Bulk Carrier

The floating dry bulk terminal will be a second hand 10-15 year old dry bulk carrier of 25-50,000

Table VII-4.4.3-3

Floating Terminal Alternatives for Banyuasin-Tg. Api-Api Deep Draft Port

Alt.No.	Alternative (age years)	Cargo handling rate tph dry, wet	Types of of cargo transfer	Dimensions L, B, D, m	Storage capacity tons Dry/ (liquid)	Cost: Capital fully converted $ 000 1975	Cost: Maintenance and Operation $000/year
1.	Bulk carrier 25000 tons (10)	600 --	Dry bulk -- liquid (direct only)	174.0 m 23.6 m 10.2 m	25,000 (5000)	9,200	660
2.	Bulk carrier 50000 tons (10)	1000	Dry bulk -- liquid (direct only)	212.0 m 30.6 m 12.4 m	50,000 (8000)	12,600	880
3.	Tanker 25000 tons (10)	600 (600)	Dry and liquid bulk	172.0 m 23.9 m 10.3 m	25,000 (25000)	8,600	660
4.	Tanker 50000 tons (10)	1000 (1500)	Dry and liquid bulk	210.0 m 30.4 m 12.7 m	50,000 (50000)	11,420	880
5.	Floating Catamaran platform	800 (1000)	Dry and liquid bulk	180.0 m 50.0 m 12.8 m	10,000 (10000)	16,200	500
6.	Ocean barge 30000 tons (0)	600 (800)	Dry and liquid bulk	162.0 m 27.0 m 8.6 m	30,000 (30000)	9,800	500
7.	Ocean barge 50000 tons (0)	1000 (1500)	Dry and liquid bulk	198.0 m 33.0 m 11.0 m	50,000 (50000)	12,800	600
	Average Cost					11,500	

tons capacity on which one or more catenery loaders/ unloaders are mounted on a mobile portal/gantry. This floating transfer terminal can be anchored (or docked in an array of multi-buoys) at the proposed terminal location shown on Figure VII-4.4.3-9. It is designed to unload arriving bulk carriers of any size and will operate at any location consistent with the bulk carrier draft and cargo destination or handling requirements. Small bulk carriers will discharge all their cargo into the floating bulk terminal, while any excess which cannot be accommodated in the floating terminal will be directly transferred into one of the 500-1500 ton shallow draft dry bulk barges. In this manner ships of up to 50,000 tons or larger capacity should be able to call and discharge without delay. Cargo will be transferred from the floating terminal, after the dry bulk carrier's departure, into the dry bulk barges which in turn are towed to the shallow draft barge terminal for unloading. The barges will be designed for 3-4 M draft and could, therefore, be served at a variety of locations in the Musi River and its tributaries. This system introduces substantial investment cost savings and flexibility. On the other hand, the double handling of the dry bulk cargo will show significant increases in operating costs. The important advantages of this system can be summarized as follows:

a. Any size of dry bulk carrier can be loaded/unloaded.
b. Dry bulk cargo can be loaded/unloaded at a number of terminals with potential savings in feeder costs.
c. The major investment components of the system such as the floating dry bulk terminal

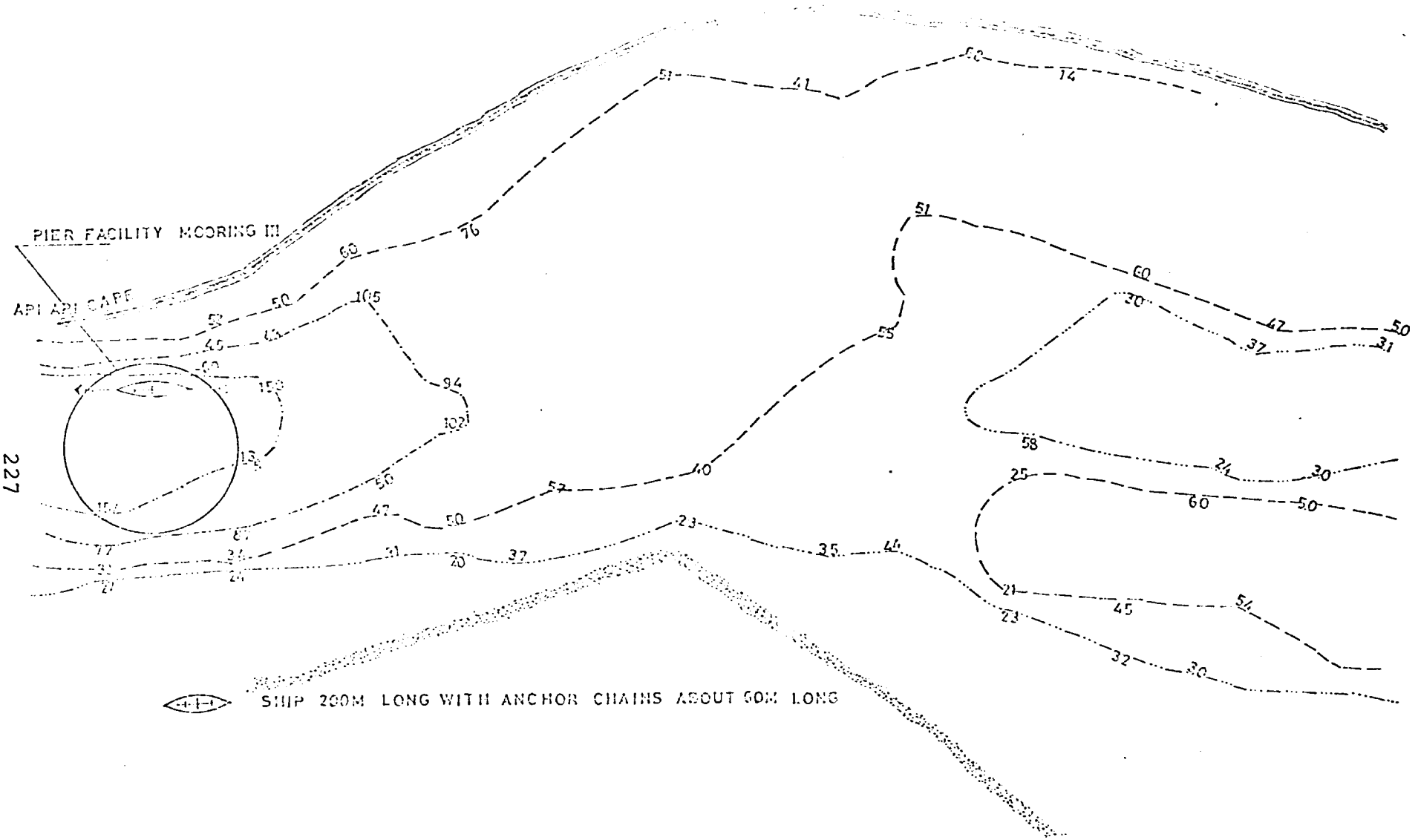


Figure VII-4.4.3-9

Banyuasin Basin Anchoring Positions Floating Port Facilities

and barges can be redeployed or sold at any time, if for any reason their need expires. Therefore, the risk of an underutilized "white elephant" type facility is eliminated.

The estimated (end 1975) investment costs of the major components of this alternative are:

Dry Bulk Carrier/25,000 DWT (10 years)	$ 7.5 million
Conversion and Installation of 2 Catenery Loaders/Unloaders each 600 ton/hr capacity	3.5 million
Fendering, anchor and other equipment	0.5 million
Total Floating Equipment	$11.5 million
(Optional Landside Facilities)	
Barge Berth at Banyuasin	$ 1.0 million
Barge Loading/Unloading Equipment	1.2 million
Conveyor	1.0 million
Storage Area, etc.	4.0 million
Total Fixed Facilities	$ 7.2 million

	Excl. Landside	Incl. Landside
Grand Total (end 1975 cost)	$11.5	$18.7 million
20% Contingency	2.3	3.7 million
Sub Total	$13.8	$22.4 million
15% Cost Escalation - 1976	2.07	3.4 million
Total Cost end 1976	$15.9	$25.8 million

Operating Costs for 1 million tons/year

Maintenance of Vessel + Installation	$350,000
Crew and Operators - 50 at $2,000/year	100,000
Fuel and Supplies	200,000
	$650,000

The investment costs in fixed facilities could be appreciably reduced by either the initial use of existing shallow water depths in the Musi River, or

by a more limited development of the bulk storage area and new barge wharf complex.

Operating costs will depend on factors such as the use of the floating terminal (extent of use, if any, or self propulsion), the use of BPP tugboats for barge movements, etc.

Wharf Construction Costs

At the present time, there is under construction at Palembang Boom Baru, a new wharf of the ten meter wide concrete pile and slab with sheet steel pile bulkhead and land fill, etc., somewhat similar to Type Ia.

The contract price for a 164.5 meter length of the above described wharf construction was 440 million rupiahs or about US$1 million. If we assume that engineering, inspections and miscellaneous items will cost about 15 percent, the overall cost per meter of Type I wharf construction is about US$6,520 or say US$6,500 per meter of wharf.

Applying an inflation factor of about 15 percent to represent 1976 prices, the construction cost amounts to about US$7,500 per meter.

The Consultants analyzed and priced the various wharf types, applying modern internationally accepted design standards and using unit prices based on the available end 1975 construction costs. Depending on the expected time of construction, a cost escalation factor has to be applied. While the factor of physical contingency to be applied will depend upon the amount of soil and hydrological investigations, that will be undertaken prior to final evaluation and design. We have tentatively assumed these to be 10% at Palembang, 15% at Sungsang and Sungai Lais and 20% at Banyuasin.

Following in Table VII-4.4.3-4 is a summary of the comparative construction cost per meter wharf at various locations showing the basic cost as per end 1975 prices, the physical contingencies 10-15-20% and 15% cost escalations in 1976 and 1977. In Table VII-4.4.3-5 and VII-4.4.3-6 we have shown the comparative costs of construction of 1, 2, and 3 berths including all facilities at Banyuasin and Palembang. All prices taken are basic prices of end 1975.

On Table VII-4.4.3-7 we have, for comparison, evaluated the construction costs of 1000 wharves at various port sites. A more detailed cost estimate will be presented in the full report. The cost of floating equipment is given in Table VII-4.4.3-8 and operating costs are presented in VII-4.4.3-9, 4.4.3-10, 4.4.3-11 and 4.4.3-12.

4.4.3.5 Berth Capacity

4.4.3.5.1 Estimated Berth Capacity

The estimated berth capacity as given in the Reconnaissance Survey Water Resources Research Center Department of Civil Engineering, ITB, June 1974.

1. The report quoting a paper - Target and Content of Pelita II page 12 of the Port Administrator of Palembang, states that Boom Baru will have a maximum handling capacity of about 581,262 tons per year.
2. The Reconnaissance Report, page 41, in computing the length of pier facility required in the future assumed a productivity of 1000 tons per meter length of wharf per year.

These, we assume, are general averages as berth capacity must be evaluated by factor such as:

- Number of days worked annually
- Number of shifts

Table VII-4.4.3-4

Comparative Construction Cost of Wharves/M Length

Description	Marginal wharf – 10 M wide deck				Marginal wharf – 20 M wide deck			Island wharf 60 M wide deck		Bridge 15 M wide
Alongside depth at LLW	6 Meter				8 Meter		10 Meter	6 meter	10 meter	
Location	Palembang	Banyuasin	Sungai Lais	Sungsang	Sungsang	Palembang	Banyuasin	Banyuasin	Banyuasin	Banyuasin
Type	I a	I b	I a	I a*	II a	II a	II b	III	IV	Bridge
Basic cost/M 1975, US $	8,750	9,500	8,900	9,000	16,900	15,900	21,700	11,650	27,600	2,700
Physical contingencies										
10 %	875					1,590				
15 %			1,340	1,350	2,500					
20 %		1,900					4,340	2,330	5,520	540
SUB-TOTAL	9,625	11,400	10,240	10,350	19,400	17,490	26,040	13,980	33,120	3,240
Cost escalation, 15% – 1976	1,435	1,730	1,520	1,550	2,900	2,610	3,940	2,100	4,970	480
SUB-TOTAL	11,060	13,130	11,760	11,900	22,300	20,100	29,980	16,080	38,090	3,720
Cost escalation, 15% – 1977	1,640	1,970	1,740	1,800	3,300	3,000	4,520	2,420	5,710	580
Cost/M US $ end 1977	12,700	15,100	13,500	13,700	25,600	23,100	34,500	18,500	43,800	4,300
Bridge: 0.6 M/M wharf	—	—	—	—	—	—	—	2,600	2,600	
Total Cost/M US $ end 1977	12,700	15,100	13,500	13,700	25,600	23,100	34,500	21,100	46,400	4,300

Notes : (1). The main cost differences between Types Ia and Ib and IIa and IIb stem from the more difficult and unknown soil conditions at Banyuasin, as well as the salt water conditions there.

(2). Similarly, the physical contingencies at Banyuasin were taken at 20% as against 10% at Palembang.

(3). Soil conditions at Sungsang though unknown are apparently somewhat better than those at Banyuasin.

* Similar to Types Ia and IIa – but adapted to salt water conditions.

Types : Ia – See Figure VII-4.4.3.4-1
Ib – See Figure VII-4.4.3.4-2
IIa – See Figure VII-4.4.3.4-3
IIb – See Figure VII-4.4.3.4-4
III – See Figure VII-4.4.3.4-5
IV – See Figure VII-4.4.3.4-6
Bridge – See Figure VII-4.4.3.4-7

Table VII-4.4.3-5

Comparative Construction Costs of Port Facilities

LOCATION		PALEMBANG - BOOM BARU WHARVES					
DESCRIPTION		MARGINAL WHARF - 10 M WIDE DECK			MARGINAL WHARF - 20 M WIDE DECK		
Alongside Depth at LLW		6 Meter			8 Meter		
Cost per M. Wharf US $		8,750			15,900		
No. of Berths		1	2	3	1	2	3
Length of Wharf M		130	260	390	180	360	540
Item No.	Description of Cost Items						
1.	Type of Facilities						
2.	Dredging	-	-	-			
3.	Nav. Aids	-	-	-	-	-	-
4.	Land Reclam.	300	520	800	400	720	1,080
5.	Wharf Constr.	1,140	2,280	3,420	2,860	5,720	8,580
6.	Warehouses	800	1,600	2,400	1,000	2,000	3,000
7.	Open Storage	100	160	240	100	160	240
8.	Floating Equip.	150	900	900	150	1,200	1,200
9.	Mech.Hand.Equip.	200	300	400	200	1,100	1,300
10.	Workshops	20	30	30	20	30	30
11.	Communications	-	-	-	-	-	-
12.	Admn. Building	10	20	30	10	30	30
13.	Housing	-	-	-	-	-	-
14.	Electricity	-	-	-	-	-	-
15.	Water Plant	-	-	-	-	-	-
16.	Streets + Roads	-	-	1,000	-	1,000	1,500
	COST US $	2,720	5,710	9,220	4,740	11,960	16,960
	10% Phys.Cont.	280	570	920	470	1,960	1,700
	SUB-TOTAL	3,000	6,280	10,140	5,210	13,920	18,660
	Cost.Esc.15%/1976	450	940	1,520	790	2,080	2,800
	SUB-TOTAL	3,450	7,220	11,660	6,000	16,000	21,460
	Cost.Esc.15%/1977	550	1,080	1,740	900	2,400	3,240
	COST - END 1977	4,000	8,300	13,400	6,900	18,400	24,700
17.*	Highway Pal.to Port site	-	-	-	-	-	-
18.*	Highway Pal. to Banyuasin	-	-	-	-	-	-
19.*	Sungsang Canal	-	-	-	-	-	-
20.*	Sebalik Canal	-	-	-	-	-	-

* OPTIONAL

Table VII-4.4.3-6

Comparative Construction Costs of Port Facilities

LOCATION		BANYUASIN OUTER HARBOR									BANYUASIN INNER HARBOR					
DESCRIPTION		OFFSHORE - ISLAND - WHARVES - 60 M WIDE DECK									MARGINAL WHARF - 10 M WIDE DECK			MARGINAL WHARF - 20 M WIDE DECK		
Alongside Depth at LLW		6 Meter			10 Meter			15 Meter			6 Meter			10 Meter		
Cost per Meter Wharf US $		13,300			29,200			38,000			9,500			21,700		
No. of Berths		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Length of Wharf M		130	260	390	180	360	540	250	500	750	130	260	390	180	360	540
Item No.	Description of Cost Items															
1.	Type of Facilities															
2.	Dredging	-	-	-	-	-	-	8,000	8,000	8,000	-	-	-	3,400	3,400	3,400
3.	Aids to Navigation	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
4.	Land Reclam./or Acquis. *)	600	800	1,200	600	1,100	1,600	1,000	1,600	2,400	600	800	1,200	600	1,100	1,600
5.	Pier Facilities	1,700	3,400	5,100	5,200	10,400	15,600	9,500	19,000	28,500	1,200	2,400	3,600	3,900	7,800	11,700
6.	Warehouses	800	1,600	2,400	1,000	2,000	3,000	1,200	2,400	3,600	800	1,600	2,400	1,000	2,000	3,000
7.	Storage Areas	100	160	240	100	160	240	120	200	300	100	160	240	100	160	240
8.	Floating Equipment	1,720	1,850	2,010	2,120	2,250	2,410	2,520	2,650	2,810	1,720	1,850	2,010	2,120	2,250	2,410
9.	Mech.Handling Equip.Mobile	200	300	400	200	1,100	1,300	300	1,200	1,500	200	300	400	200	1,100	1,300
10.	Maint. and Repair Workshops	30	40	50	40	50	60	80	100	120	30	40	50	40	50	60
11.	Communications	25	25	25	25	25	25	35	35	35	25	25	25	25	25	25
12.	Administration Buildings	50	100	150	150	200	250	180	220	280	50	100	150	150	200	250
13.	Housing	4,000	6,000	9,000	4,500	7,000	10,400	4,500	7,000	10,400	4,000	6,000	9,000	4,500	7,000	10,400
14.	Electricity	400	600	800	600	800	1,000	700	900	1,100	400	600	800	600	800	1,000
15.	Water Plant	200	250	250	200	250	250	250	300	300	200	250	250	200	250	250
16.	Streets and Roadways	800	1,200	1,800	1,000	1,750	2,500	1,000	1,750	2,500	800	1,200	1,600	800	1,200	1,600
	Cost US $	11,225	16,825	23,925	16,235	27,585	39,135	29,885	45,855	62,345	10,625	15,825	22,425	19,135	27,835	37,935
	20% Physical Contingencies	2,245	3,365	4,785	3,250	5,515	7,825	5,975	9,170	12,470	2,125	3,165	4,485	3,825	5,565	7,585
	SUB-TOTAL	12,470	20,190	28,710	19,485	33,100	46,960	35,860	55,025	74,815	12,750	18,990	26,910	21,760	33,400	45,520
	Cost Escalation 15% - 1976	1,870	3,030	4,300	2,925	4,965	7,040	5,380	11,000	11,220	1,910	2,845	4,035	3,265	5,010	6,830
	SUB-TOTAL	14,340	23,220	33,010	22,410	38,065	54,000	41,240	66,025	86,035	14,660	21,835	30,945	25,020	38,410	52,350
	Cost Escalation 15% - 1977	2,150	3,480	4,950	3,360	5,705	8,100	6,180	9,905	12,905	2,200	3,275	4,645	3,750	5,760	7,850
	COST US $ - END 1977	16,490	26,700	37,960	25,770	43,770	62,100	47,420	75,930	98,940	16,860	25,110	35,590	28,770	44,170	60,200
17.*	Highway Palem. to Portsite	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
18.*	Railway Palem.to Banyuasin	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
19.*	Sungsang Penins.Canal 44M - 4 M	7,700	7,700	7,700	7,700	7,700	7,700	7,700	7,700	7,700	7,700	7,700	7,700	7,700	7,700	7,700
20.*	Sebalik Canal 44 x 4 M	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100

* OPTIONAL

Table VII-4.4.3-7

Preliminary Cost Analysis - Alternative Port Development Sites

For 1000 Meters of Port Facilities - Capital Costs in US$1000

Item No.	Various Alternative Descriptions / Description of Cost Items	All expansion at Banyuasin Ocean Shipping at 10 M interisland Shipping at 6 M. 500 M x 10 M + 500 M x 6 M		Sungsang 60 % of increase and Palembang 40 % of increase 8 Mtr.Port	All expansion at Sungai Iais as a six Meter Port Light Structure	All expansion at Palembang as a six meter port Light Structure	All expansion at Palembang Heavy construction Alt.I-Permitting vessel of 6M draft at LLW. Alt.II- D70 but at HHW only		Palembang 40% of increase and Banyuasin 60% of increase Banyuasin 10 M	Palembang 50% of increase and Banyuasin 50% of increase as a floating port
		Outer Harbor	Inner Harbor				I-8 M Port	II-6 M Port		
							Heavy Structure			
1.	Type of Facilities	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed Palembang Floating Banyuasin
2.	Dredging	None	3,400	5,700	8,710	None	28,140	None	None	None
3.	Aids to Navigation	500	500	100	40	None	1,000	None	[illegible]	[illegible]
4.	Land Reclamation/ or acquisitions *)	480,000 M^2 3,240	480,000 M^2 3,240	330,000 M^2 3,680	Land fill fallout from dredging None	100,000 M^2 2,000	100,000 M^2 2,000	100,000 M^2 2,000	330,000 M^2 2,730	290,000 M^2 2,610
5.	Pier Facilities	33,805	30,150	Sungsang 300M x 6M 300M x 6M Palembang 400M x 6M 16,825	1000M x 6M 14,810	1000M x 6M 12,730	1000 Meter 23,130	23,130	Banyuasin 300M x 10M 300M x 6M Palembang 400M x 6M 24,705	Banyuasin 200M Floating 300M x 6M Palembang 500M x 6M 24,885
6.	Warehouses	5,775	6,000	6,350	1000M of wharf 6,350	6,350	6,350	6,350	6,000	4,450
7.	Storage areas,48,000 M^2	480	480	480	480	480	480	480	480	33,500 M^2 335
8.	Floating Equipment	5,820	5,820	6,850	2,400	1,030	2,630	1,830	6,250	6,250
9.	Mechanical Handling Equipment Mobile	1,875	1,875	2,740	1,875	1,875	1,875	1,875	2740	1,590
10.	Maintenance and Repair Workshops	100	100	100	100	50	50	50	50	50

*) Assumed that a 100 M wide operation area could be acquired at Palembang.

Table VII-4.4.3-7

Preliminary Cost Analysis - Alternative Port Development Sites For 1000 Meters of Port Facilities - Capital Costs in US$1000 (contd)

Item No.	Various Alternative Descriptions / Description of Cost Items	All Expansion at Banyuasin Ocean Shipping at 10 M interisland Shipping at 6 M. 500 M x 10 M + 500 M x 6 M		Sungsang 60% of increase and Palembang 40% of increase 8 Mtr. Port	All Expansion at Sungai Lais as a six Meter Port light Structure	All expansion at Palembang as a six meter port Light Structure	All expansion at Palembang Heavy construction Alt.I-Permitting vessel of 8 M draft at LLW. Alt.II- DTO but a HHW only		Palembang 40% of increase and Banyuasin 60% of increase Banyuasin 10 M	Palembang 50% of increase and Banyuasin 50% of increase as a floating port
		Outer Harbor	Inner Harbor				I- 8 M Port	II-6M Port		
							Heavy Structure			
11.	Communications	25	25	25	—	—	None	None	25	25
12.	Administration Buildings	4,000 M^2 460	4,000 M^2 460	3,000 M^2 345	4,000 M^2 460	500 M^2 60	500 M^2 60	500 M^2 60	3,000 M^2 345	1,500 M^2 175
13.	Housing	20,780	20,780	15,875	None	None	None	None	16,210	13,510
14.	Electricity	1,500	1,500	900	—	—	None	None	900	900
15.	Water Plant	250	250	250	—	—	None	None	250	250
16.	Streets and Roadways	3,330	3,330	4,980	3,330	3,330	3,330	3,330	4,980	4,980
17.	Highway Palembang* to Port Site	100,000*	100,000*	100,000*	1,650	None	None	None	100,000*	100,000*
18.	Railway Palembang* to Banyuasin	75,000*	75,000*	75,000*	None	None	None	None	75,000*	75,000*
19.	Sungsang Peninsular* Canal 44 M - 4 M	7,700	7,700	None	None	None	None	None	7,700*	7,700*
20.	Sebalik Canal 44 x 4 M	3,100	3,100	None	None	None	None	None	3,100	3,100
21.	Sub-total Required	81,040	81,010	65,200	40,205	27,905	69,045	39,105	69,915	63,610
22.	Sub-total Optional	182,700*	182,700	175,000	—	—	—	—	182,700	182,700
23.	TOTAL	263,740	263,710	240,200	40,205	27,905	69,045	39,105	252,015	246,310

Table VII-4.4.3-8

Banyuasin
Floating Equipment for 3-4 Berths

Item No.	Berth Draft, M / No. Berth	Cost ($ 000) 6			8			10			15		
		1	2	3	1	2	3	1	2	3	1	2	3
1.	Tugs large	1,200	1,200	1,200	1,200	1,200	1,200	1,600	1,600	1,600	2,000	2,000	2,000
2.	Mooring and small tugs	300	300	300	300	300	300	300	300	300	300	300	300
3.	Security boats	100	100	200	100	100	200	100	100	200	100	100	200
4.	Floating crane	-	130	130	-	130	130	-	130	130	-	130	130
5.	Crew boats	120	120	180	120	120	180	120	120	180	120	120	180
6.	Sub-total	1,720	1,850	2,010	1,720	1,850	2,010	2,120	2,250	2,410	2,520	2,650	2,810
7.	Maint. 5 %	86	92	105	86	92	105	106	112	121	126	133	145
8.	TOTAL	1,806	1,942	2,115	1,806	1,942	2,115	2,226	2,362	2,531	2,646	2,783	2,955

Table VII-4.4.3-9

Preliminary Cost Analysis - Alternative Port Development Sites

For 1000 Meters of Port Facilities - Maintenance Costs in US $1000

Item No.	Various Alternative Descriptions / Description of Cost Items	All expansion at Banyuasin Ocean Shipping at 10 M interisland Shipping at 6 M. 500 M x 10 M + 500 M x 6 M		Sungsang 60 % of increase and Palembang 40% of increase 8 Mtr.Port	All expansion at Sungai Lain as a six Meter Port Light Structure	All expansion at Palembang as a six meter port Light Structure	All expansion at Palembang Heavy construction Alt.I-Permitting vessel of 8M draft at LLW. Alt.II- DTO but at EHW only		Palembang 40% of increase and Banyuasin 60% of increase Banyuasin 10 M	Palembang 50% of increase and Banyuasin 50% of increase as a floating port
		Outer Harbor	Inner Harbor				I-8 M Port	II-6 M Port		
							Heavy Structure			
1.	Type of Facilities	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed Palembang Floating Banyuasin
2.	Dredging	1170	1850	3290	1770	1170	1070	1170	1170	1170
3.	Aids to Navigation	50	50	10	4	--	10	--	50	50
4.	Land Reclamation/ or acquisitions *)	--	--	--	--	--	--	--	--	--
5.	Pier Facilities	500	450	300	260	220	360	360	400	400
6.	Warehouses	60	60	62	62	62	62	62	60	45
7.	Storage areas,48,000 M^2	10	10	10	10	10	10	10	10	7
8.	Floating Equipment	300	300	340	120	90	140	90	310	310
9.	Mechanical Handling Equipment Mobile	200	200	270	200	200	200	200	270	160
10.	Maintenance and Repair Workshops	5	5	5	5	3	3	3	5	3

*) Assumed that a 100 M wide oper

Table VII-4.4.3-9

Preliminary Cost Analysis - Alternative Port Development Sites

For 1000 Meters of Port Facilities - Maintenance Costs in US $1000

(contd)

Item No.	Various Alternative Descriptions / Description of Cost Items	All Expansion at Banyuasin Ocean Shipping at 10 M interisland Shipping at 6 M. 500 M x 10 M + 500 M x 6 M		Sungsang 60 % of increase and Palembang 40% of increase 8 Mtr. Port	All Expansion at Sungai Lais as a six Meter Port light Structure	All expansion at Palembang as a six meter port Light Structure	All expansion at Palembang Heavy construction Alt.I-Permitting vessel of 8 M draft at LLW. Alt.II- DTO but a HHW only		Palembang 40% of increase and Banyuasin 60% of increase Banyuasin 10 M	Palembang 50% of increase and Banyuasin 50% of increase as a floating port
		Outer Harbor	Inner Harbor				I- 8 M Port	II-6M Port		
							Heavy Structure			
11.	Communications	3	3	3	--	--	--	--	3	3
12.	Administration Buildings	10	10	8	10	2	2	2	7	4
13.	Housing	208	208	160	--	--	--	--	162	135
14.	Electricity	75	75	50	--	--	--	--	50	50
15.	Water Plant	15	15	15	--	--	--	--	15	15
16.	Streets and Roadways	33	33	50	33	33	33	33	50	50
17.	Airhway Palembang* to Port Site	2000*	2000*	2000*	17	--	--	--	2000*	2000*
18.	Railway Palembang* to Banyuasin	2250*	2250*	2250*	--	--	--	--	2250*	2250*
19.	Sungsang Peninsular* Canal 44 M - 4 M	590*	590*	590*	--	--	--	--	590*	590*
20.	Sebalik Canal 44 x 4 M	150	150	--	--	--	--	--	150	150
21.	Sub-total Required	2789	3419	4300	2491	1790	10890	1930	2552	2552
22.	Sub-total Optional	4840	4840	4840	--	--	--	--	4840	4840
23.	TOTAL	7629	8259	9140	2491	1790	10890	1930	7392	7392

Table VII-4.4.3-10

Preliminary Cost Analysis - Alternative Port Development Sites For 1000 Meters of Port Facilities - Capital Costs in US $1000

Mechanical Handling Equipment

I	Various Alternative Descriptions / Description of Cost Items	All expansion at Banyuasin Ocean Shipping at 10 M interisland Shipping at 6 M. 500 M x 10 M + 500 M x 6 M		Sungsang 60 % of increase and Palembang 40% of increase 8 Mtr.Port	All expansion at Sungai Lais as a six meter Port Light Structure	All expansion at Palembang as a six meter port Light Structure	All expansion at Palembang Heavy construction Alt.I-Permitting vessel of 6M draft at LLW. Alt.II- DTO but at HHW only		Palembang 40% of increase and Banyuasin 60% of increase Banyuasin 10 M	Palembang 50% of increase and Banyuasin 50% of increase as a floating port
		Outer Harbor	Inner Harbor				I-8 M Port	II-6 M Port		
							Heavy Structure			
1	Fork Life Equipment 20t Spare Flats	40 Flt 500	400 Flt 500	4 Flt 500	40 Flt 500	40 Flt 500	40 Flt 500	40 Flt 500	40 Flt 500	25 Flt 313
2	Cranes small quick acting 3T	4 200	8 200	8 200	8 200	8 200	8 200	8 200	8 200	4 100
3	Cranes medium 35T	100	100	100	100	100	100	100	100	100
4	Cranes medium 15T	75	75	75	75	75	75	75	75	75
5	Container Crane	800	800	1600	800	800	800	800	1600	800
6	Tractor Trailers	100	100	100	100	100	100	100	100	100
7	Portable Unloaders	100	100	160	100	100	100	100	160	100
	Subtotal	1875	1875	2740	1875	1875	1875	1875	2740	1590
	Maintenance	200	200	270	200	200	200	200	270	160

Table VII-4.4.3-11

Preliminary Cost Analysis - Alternative Port Development Sites For 1000 Meters of Port Facilities - Capital Costs in US $1000

Floating Equipment

1	Various Alternative Descriptions / Description of Cost Items	All expansion at Banyuasin Ocean Shipping at 10 M interisland Shipping at 6 M. 500 M x 10 M + 500 M x 6 M		Sungsang 60 % of increase and Palembang 40% of increase 8 Mtr.Port	All expansion at Sungai Lais as a six meter Port Light Structure	All expansion at Palembang as a six meter port Light Structure	All expansion at Palembang Heavy construction Alt.I-Permitting vessel of 8M draft at LLW. Alt.II- DTO but at HHW only		Palembang 40% of increase and Banyuasin 60% of increase Banyuasin 10 M	Palembang 50% of increase and Banyuasin 50% of increase as a floating port
		Outer Harbor	Inner Harbor				I-8 M Port	II-6 M Port		
							Heavy Structure			
1	Tugs large	2@1200HP 2000	2@1200HP 2000	2@1200HP 1@ 800HP 2600	2@ 800HP 1200	2@ 800HP 1200	2@1200HP 2000	2@ 800HP 1200	2@1200HP 1@ 800HP 2600	2@1200HP 1@ 800HP 2600
2	Combination small tug and mooring boat	3@ 480HP 450	3@ 480HP 450	4@ 480HP 600	3@ 480HP 450	2@ 480HP 300	2@ 480HP 300	2@ 240HP 300	4@ 480HP 600	4@ 480HP 600
3	Lighters	20@ 300T 2000	20@ 300T 2000	20@ 300T 2000	--	--	--	--	20@ 300T 2000	20@ 300T 2000
4	Security Boats	3@ 240HP 300	3@ 240HP 300	4@ 240HP 400	2@ 240HP 200	2@ 240HP 200	2@ 240HP 200	2@ 240HP 200	4@ 240HP 400	4@ 240HP 400
5	Floating Cranes*	2 250	2 250	2 250	1 130	1 130	1 130	1 130	2 250	2 250
6	Stake Boats for Mooring Barges-Manned	2 100	2 100	2 110	--	--	--	--	2 100	2 100
7	Water Barge 500T	120	120	120	120	--	--	--	120	120
8	Crew Boats 60 Pass/20Kts	3 180	3 180	3 180	--	--	--	--	-- 180	3 180
	Subtotal	5400	5400	6250	2100	1830	2630	1830	6250	6250
	Maintenance 5%	300	300	340	120	90	140	90	310	310

Table VII-4.4.3-12

Preliminary Cost Analysis - Alternative Port Development Sites

For 1000 Meters of Port Facilities - Operating Costs in US $1000

Economic Life & Cost Amm	Item Nos. from Main Table	Description of Cost Items / Various Alternative Descriptions	All Expansion at Banyuasin Ocean Shipping at 10 M interisland shipping at 6 M 500 M x 10 M + 500 M x 6 M				Sungsang 60 % of increase and Palembang 40% of increase 8 M port		All Expansion at Sungai Lais as a six meter port Light Structure		All expansion at Palembang as a six meter port Light Structure		All Expansion at Palembang Heavy construction Alt.I-Permitting vessel of 8M draft at LLW. Alt.II-DTO but at HHW only.				Palembang 40% of increase and Banyuasin 60% of increase Banyuasin 10 M		Palembang 50% of increase and Banyuasin 50% of increase as a floating port	
			Outer Harbor		Inner Harbor								I-8 M Port Heavy		II-6 M Port Structure					
			1)	2)	1)	2)	1)	2)	1)	2)	1)	2)	1)	2)	1)	2)	1)	2)	1)	2)
25	2	Dredging	1.170	60	1.850	415	3.290	705	1.770	915	1.170	160	10.070	3.175	1.170	60	1.170	60	1.170	60
5	3 + 11	Navigational Aids & Communication	60	190	60	190	11	45	5	15	-	-	10	360	-	-	53	190	53	190
25	5	Pier Facilities	500	4.565	450	4.070	300	2.270	260	2.000	220	1.720	360	3.120	360	3.120	400	3.335	400	3.360
20	6 + 7 + 12	Warehousing, Storage & Admin Bldg	80	975	80	1.005	80	1.040	82	1.040	74	1.000	74	1.000	74	1.000	77	990	56	720
10	8	Floating Equipment	300	1.435	300	1.455	340	1.715	120	600	90	260	140	660	90	460	310	1.560	310	1.560
5	9	Mechanical Handling Equipment	200	705	200	705	270	1.030	200	705	200	705	200	705	200	705	270	1.030	160	600
10	10	Workshops	5	30	5	30	5	30	5	30	3	30	3	30	3	30	5	30	3	30
20	14 + 15	Electricity & Water Plan	45	280	25	280	24	180	-	-	-	-	-	-	-	-	33	180	33	180
25	4 + 13 + 16	Land, Housing & Streets	225	2.735	225	2.735	210	2.455	33	335	33	535	33	535	33	535	212	2.330	185	2.110
			2.585	10.995	3.195	10.885	4.530	9.470	2.475	5.640	1.790	4.310	10.890	9.585	1.930	5.910	2.530	9.765	2.370	8.810

* Admin. Expense of 2% have been included in operations cost

**Interest 10% on Undisbursed Balance

1) Maintenance

2) Operation + Administration + Financial

- Gross Number of hours worked/day
- Net Number of hours worked/day
- Hours lost due to ship operation
- Hours lost due to rain, etc.
- Actual net hours worked/day
- Berth Occupancy
- Number of hatches worked
- Average tons loaded per vessel
- Outputs tons per net gang hatch hour
- Type of cargo
- Percentage overside
- Percentage direct delivery
- Percentage to wharf/storage

The Consultants used this approach in their evaluation of berth capacities and port throughput.

4.4.3.6 Warehouses

The cost of a standard warehouse with concrete bed foundation, but no piling foundations, ranges from about 60,000 to 80,000 rupiahs or about US$150 to US$200 per square meter or about US$15 to US$20 per square foot. Pilings per meter length driven are approximately Rp. 6000 or US$15. There are no pilings under the warehouses at Boom Baru, Palembang.

The cost per square meter of warehouse used by the Reconnaissance Survey was US$150. Adding 15 percent for escalation, the 1976 cost will be about US$165 per square meter.

At 5000 meter^2 per 130 meter berth, the average warehouse capacity per meter length of wharf is 38.5 meter^2 which represents a cost of 38.5 x 165 = $6350 for warehouse construction per meter of wharf length.

4.4.3.7 Land Reclamation and Costs

The cost of land reclamation in the Palembang area ranges from abour Rps. 800 to 1000 or US$ from 2.00 to 2.50 per square meter by dredge fill and from Rp. 1200 to 1500 or US$3.00 to 3.75 per square meter when land fill is supplied by truck.

Land reclamation in the area requires about two cubic meters of land fill per square meter of reclaimed land and the rate of compaction is about 20 percent. It is assumed that land fill in the Banyuasin area will require three to four cubic meters of fill per square meter of area. We have assumed reclamation cost of Rp. 2750 or US$6.7/$M^2$ and at Sungsang where reclamation is partly on land which has to be acquired, we have assumed an average cost of Rp. 4100 or US$10/$M^2$. There is no reclamation cost at Sungai Lais as the reclamation will be as fall out from the dredging.

4.4.3.7.1 Land Acquisition

In order to extend the existing Boom Baru wharf facilities eastwards, beyond the present boundaries, the port may have to acquire land. We have assumed that the BPP will be able to acquire not more than a 100 M wide strip of land. Some of the land is built up with small dwelling units mainly of wooden construction and other areas are free, used for landing of gravel and sand. Some parts in the anchorage of the sailing vessel are under port jurisdiction. The cost of acquisition of empty land was given at Rp. 5000/M^2 and that of built up as 10-12000 Rp/M^2. We have assumed an average of Rp. 8200 or US$20/$M^2$ including reclamation whenever required. At Sungsang we assumed that some land acquisition will have to be made and have assumed an average

cost of Rp. 4100 or US$10/$M^2$ including reclamation. At Banyuasin and at Sungai Lais we have assumed that the land there is freely available and that no acquisition is required.

4.4.3.8 Land Requirements

The following land requirements are assumed to be needed in order to construct and operate port facilities at the various ports under construction and according to the various comparatively alternatives shown on Table VII-4.6.1-1.

Columns	Locations	% of facilities there	M^2 per 1000M^2 wharf Sub-total	Total
See Table VII-4.6.1-1				
1	Banyuasin	100	480,000	480,000
2	Banyuasin	100	480,000	480,000
3	Sungsang	60	290,000	
	Palembang	40	40,000	330,000
4	Sungai Lais	100	480,000	480,000
5	Palembang	100	100,000	100,000
6	Palembang	100	100,000	100,000
7	Palembang	100	100,000	100,000
8	Palembang	40	40,000	
	Banyuasin	60	290,000	330,000
9	Palembang	50	40,000	
	Banyuasin	50	240,000	290,000

Note: The areas are based upon 480 M^2 per meter wharf or some 20 acres of land area per deep water berth - a good average size by international standards.

At Palembang, however, because of the dense populated areas east of Boom Baru, we assumed that the port would be able to acquire a 100 M wide operational area, i.e., some 4 1/2 acres/berth. This would be less than at the other locations but would be adequate provided that operations and hence use of operational areas is efficient.

4.4.3.9 Housing Requirements and Costs

For planning purposes for housing projects, the following criteria were used:

1. The cost of the land is treated separately from that of home construction and outfitting. The maximum allowances for land for housing varies in accordance with the following table:

Class of Housing	Max. Rupiah per M^2
I	4000
II	3000
III	1000/1500
IV	500/ 750

The above costs would be applicable in the Palembang area and the average cost, if assumed, to be about 2500 Rupiah per M^2. The cost of land in a large tract purchase at Banyuasin would be a minimum of 50 Rp/M^2 and a maximum of 100 Rp/M^2. An average cost of 75 Rp/M^2 had been assumed.

2. The usual industrial housing development standard is 100 housing units per 2.5 hectares of each unit averages about 250 M^2 overall.

3. Houses in housing projects are estimated to cost as follows:

Average staff houses	1,500,000 Rps.
Average labor pool house	1,000,000 Rps.

4. The total cost of a housing development exclusive of land purchase but including development of streets and external public utility facilities is estimated as follows:

House	56.6%
Street Improvement	16.4%
Public Utilities	20.0%
Miscellaneous	7.0%
Total Cost of Development	100.0%

Total Cost of development vs housing cost

= 100/56.6

= 176%

5. The Port of Palembang now has about the following personnel complement which will handle about 500 meters of wharf length.

Officers	141
Staff	185
Port Personnel	326
Stevedores (Labor Pool)	800 - 1200
Total Personnel	1126 - 1526

Assume for planning purposes a port personnel requirement of 300 and a labor pool requirement of about 1000 per 500 meters of wharf or two stevedores per meter of wharf.

The cost of housing per 1300 personnel to man 500 meters of wharf are as shown in the following Table VII-4.4.3-13.

4.4.3.10 Electrical Requirements and Costs

The following electrical requirements are assumed for a 1000 meter wharf development:

	Estimated Electrical Demand	Kilowatt
1.	Housing Project - 500 watts per house x 2600 houses per 1000 meter of wharf	1300
2.	Public Street Lighting 10 Km @ 1 unit per 50 meters = 200 x 500	100
3.	Water Works	300
4.	Port Facility	300
5.	Total Connected Load (TCL)	2000
6.	Demand Load Factor - Assume 50% of TCL	1000
7.	Assume a 50% Factor for Expansion	500
8.	Total Capacity to be Installed	1500
	Estimated cost generating equipment plus distribution system	US$1,500,000
9.	Maintenance 5%	US$ 75,000

Personnel Requirements

The personnel complement of Palembang Port Administration Boom Baru facilities is approximately as follows:

Officers	141
Staff	185
Stevedores on the worklists	1200
Stevedores normally working	800

Total personnel working Boom Baru range from a minimum of about 1126 to a maximum of about 1526.

Table VII-4.4.3-13

Housing Costs

Item No.	Item Description	Cost Palembang 1000 US$	Cost Banyuasin 1000 US$
1	Land Area	325,000 M^2	575,000 M^2
2	Land Reclamation	1,463	3,881
3	Land Cost	1,982	105
4	Houses	3,625	3,625
5	Street Improvement	1,050	1,050
6	Public Utilities	1,280	1,280
7	Miscellaneous	450	450
8	Total Housing Cost Per 500 M of Wharf or 1300 personnel	9,850	10,391
9	Housing Cost per Meter of Wharf	19.70	20.78
10	Housing Cost per Unit Personnel	7.58	7.99

Note: As shown on Table VII-4.6.1-1 the assumed different cost for the infrastructure (lines 13-16) for the various alternative port locations. The difference of costs stems from the following assumptions

i. Palembang - All port labor and staff will come from the town of Palembang which has all town infrastructure and that no special housing will have to be constructed as a prerequisite to operate additional port facilities there. Still we would acquire in the future a new road leading to the port in order to avoid the congested down town near port areas.

ii. Sungai Lais - Similar conditions as for Palembang.

iii. Banyuasin - All port labor and staff will come

Table VII-4.4.3-13

Housing Costs

(contd)

from outside areas and that all infrastructure for a town will have to be built up.

iv. Sungsang - Some of the port labor may come from there, but that all staff will come form outside areas and that only 40% of the areas infrastructure could be utilized for the port's requirements and that 60% will have to be built up.

Since the management studies of personnel complement have not been completed, for preliminary cost comparison purposes, the following complement of personnel will be assumed to be required to man a terminal with a wharf length of about 500 meters.

Officers	140
Staff	180
Stevedores	980
Assumed Total	1300 men

4.5 Development Plans

4.5.1 Coal

General

Palembang has been a coal port for many years. The Bukit Asam coal mines are located about 173 kilometers to the south and west of the port and the coal arrives by rail at the Kertapati terminal about five miles upriver from the primary port facilities at Boom Baru.

Some years ago about 800,000 tons of coal per year were mined in the area but lately the production has dropped to less than 100,000 tons due to the booming oil market. As a result of the drop off in the coal trade the coal handling facilities have received scant maintenance and much of the equipment should now be rehabilitated although much of the equipment should be surveyed and disposed of as scrap metal.

The operation and condition of the Kertapati coal terminal is described in Volume V-2.4

Development Plans.

There are two coal development projects which have

progressed beyond the contract signing stage and are in the process of being implemented. The two projects are outlined as follows Project No. 1 is a long term project while Project No. 2 is a short term project.

Project No. 1 - Coal for Export.

P.T. Shell International and the Republic of Indonesia have signed a contract under which the Shell Company will mine coal in the Province of South Sumatra under a production sharing agreement with the state owned P.N. Batubara Mining Company. Under the contract Shell Mijnbouw plans to invest US$ 1.2 billion of which 900 million will be spent on production and 300 million on marketing and transport facilities.

Production projection range from 25 to 30 million tons per year for export. The contract which is valid for 30 years will cover a 71,480 square kilometer area in South Sumatra.

To market 25 million tons of coal per year will require that a substantial quantity of the coal will have to be transported to the European market. If the coal is to compete with other coal sources, it will have to be transported in large economical bulk coal carriers having a minimum size of about 100,000 to 120,000 DWT ships with an eventual maximum size ranging from about 200,000 to 250,000 DWT. Ships of the size Shell plans to use in the transport of this coal to market will have depths in excess of about 55 feet and ships of this draft cannot operate into the proposed port of Banyuasin or in Bangka Straits.

Furthermore since there is good deep water available on Semangka Bay in the vicinity of Panjang, plus the fact that

there is an existing railroad from the coalfield area to the Port of Panjang, Shell plans to transport the 25 million tons of coal produced annually to deep water for overseas shipment via a port to be developed on deep water at Semangka Bay.

It is the concensus of the Palembang Port Study Team that the coal in question cannot be shipped to the overseas market in large bulk coal carriers from either the Palembang or Banyuasin Port areas.

Project No. 2 - Coal for Domestic Consumption.

While the coal for export will come primarily from new mines, the present plans are for P.N. Batubara to refurbish and modernize the existing Bukit Asam mines and to increase their production to about two million tons of coal per year. This coal would be primarily for local South Sumatra consumption with some of the coal being shipped to West Java for use in power plants.

In order to use two million tons of coal in the Indonesian market it will be necessary to convert some of the presently oil fired power stations to coal fired power plants. This will take time and in the interim it is planned to export up to about 500,000 tons of coal per year into the Southeast or East Asia coal market. This coal will be shipped by rail to Palembang and thence onto small bulk carriers which will load at the Kertapati coal terminal in Palembang.

Project No. 1 - Rehabilitation and Expansion of Bukit Asam Mines.

1. Shell is exploring a large area in Sumatra for coal

and is also assisting P.N. Batubara as technical advisers in the rehabilitation of their existing mines and in the transportation and marketing of coal.

2. Shell is encouraging P.N. Batubara to produce 2,000,000 tons of coal per year from their existing mines and they are interested in moving a substantial part of this coal through Kertapati which will require the operation of the Palembang Ampera Bridge in order to handle economical ship sizes.

3. Shell has been on scene here about one and one half years and state that much of the 2 million tons of coal will be for Sumatra consumption, cement plant, new power station supplying Palembang etc. and about 500,000 tons/year may be shipped to Java or other domestic users.

4. It will take some time to build up to 2,000,000 tons/year, however the mines have increased their production somewhat and are beginning to move coal through Kertapati. Production next year will be about 200,000 tons, about 100,000 tons for local use and 100,000 tons surplus for export to Southeast Asia.

5. Since oil is more easily transported Shell (and the Indonesian Government) feel that Indonesia, particularly Sumatra and Java should convert to the burning of coal and that the oil saved in the process should be exported to increase the country's foreign exchange position.

6. Shell will help export the initial 100,000 tons surplus to Southeast Asia, perhaps as far as Taiwan, until some of the Indonesian power and industrial plants convert to coal. Shell further estimates that the surplus coal available for export may rise to about 500,000 tons by 1979-1980 and that

for the next five years the coal will have to move to market via Kertapati. After 1980 this coal may move to market via the deep water port which will be developed for Project No.2.

Production has already increased at the Taba mines and Shell, RI and the World Bank are interested in promoting this coal production.

Project No. 2 - Development of New Coal Fields for Exporting - 25 Million Tons/Year.

1. Shell is involved in a separate major project that of exploring for the necessary mines, developing the mines, developing a transport system and port facilities at a deep water port for the mining, transport and marketing of about 25 million tons of coal per year.

2. Shell has been involved in a study of the above project for about 1½ years, in Indonesia, and their basis for signing a further agreement, which they signed a production-sharing agreement with the R.I. on October 15, are as given below.

Note : The agreement provides for a feasibility study which will determine the location (two or three mining areas), the quality of coal which can be mined and the marketability of the coal. The study will take about 12 months following which Shell and the R.I. will decide whether to go ahead with the actual development of the mines along with the requisite transport, port, shipping and marketing systems. The agreement also calls for Shell to provide R.I. with technical advice on the Bukit Asam mine, Project No. 1, to P.N. Batubara.

3. They have investigated the possibility of moving the coal to a deep water port both in an easterly and southerly

direction and have tentatively decided upon looking further into a deep water port on either Lampung or Semangka Bay. However, since one port is cheaper to build than two ports only one port will be built.

4. Project No. 2 plans to utilize and perhaps expand the existing railroad from the coal fields to Panjang.

5. The port will operate on a 24 hour basis and Shell originally wanted to carry coal in 200,000 Dwt. bulk carriers. However it appears that the eventual consumers of the coal, including Europe, do not have port facilities for ships much over 100,000 Dwt. with drafts of about 16-17 meters. Shell will, however, eventually want to use ships in the range of 150,000 Dwt. in the program.

6. With regard establishing a major coal port at Banyuasin Shell replies that they have looked at Bangka Straits and Banyuasin and estimated the largest ship they could use in this area would be about 70,000 Dwt. Having looked at both coasts they selected the south coast where 150,000 Dwt. ships are feasible through Sunda Straits and the aforementioned bays.

7. Early in 1977 they will be in a position to say how the coal production will develop. They will have to acquire a market and this will take time. The build up will undoubtedly be gradual with say 5,000,000 tons/year for the first two years of operation. If they were going to move large quantities of coal early in the program a pipeline would have advantages over a railroad system. However, pipelines are inefficient at partial loads and a trade off study has been made between the pipeline and a railway transport system which indicates the railway system is advantageous in the early building years of the project but that a slurry pipeline will eventually be required to handle the anticipated full mine production.

Findings.

The railroad distance from Baturaja to Palembang is 173 kilometers and the distance from Palembang to Banyuasin is about 90 kilometers. The railway distance from Baturaja to Banyuasin would therefore be approximately 263 kilometers. The railway distance from Baturaja to Panjang is 227 kilometers. Thus while Palembang has the advantage of a shorter rail distance to its port by about 54 Km when compared to the rail distance to the port of Panjang, Banyuasin would have a longer rail route to Baturaja by about 36 Km. Further since a railway line exists from the proposed mining area to Panjang it will be cheaper to expand the present railway over known terrain than to lay a longer new railway line in a partially surveyed jungle swamp where many construction problems may develop.

The controlling depth in Bangka Straits and into Banyuasin is about 35 feet (11 meters) which will not permit the operation of ships with a Dwt of more than about 70,000 tons. Since it will not be possible to operate very large deep draft ships into Banyuasin Shell will not be interested in developing Banyuasin as the major coal port for the handling of about 25 million tons of coal per year.

Conclusions.

1. That under no circumstances will Shell or the Republic of Indonesia consider the development of Banyuasin as a major coal port for the mines of Southern Sumatra.

2. That basically the same reasoning applies to any future consideration of Banyuasin or Bangka Straits as a deep draft oil port for South Sumatra. The new oil fields in South Sumatra appear to be generally south and east of the present oil fields and closer to the deep water in the Panjang area.

4.5.2 Petroleum and Petrochemicals

Palembang has two petroleum refineries, Plaju and Sungai Gerong. Both refineries receive crude from and deliver petroleum products to ships berthed at their private piers. The tonnages handled have declined over the last fifteen years, so that at present the refineries are operating at 60% of capacity. In addition the average size of ships calling at the refinery has decreased. Because the plant is twenty years old and maintenance costs are increasing along with the cost of handling petroleum in small tankers, plans are presently under consideration for converting one of the refineries to production of petrochemicals. The exact nature of these plans are not yet decided and any decision regarding such plans have been delayed by Pertamina's present liquidity problems. One source at Pertamina predicted that the conversion would result in a change of product mix, but not in tonnage handled. He also estimated that the number of ship calls at Oertamina would increase due to the use of smaller product vessels for distribution of petrochemicals. The PPS team predicted that the conversion will be completed in 1985, but that the total output of the refineries will be reduced by 10%. In addition the number of vessel calls should remain constant or be reduced, since the calls by smaller sized product vessels will be counterbalanced by the use of larger size tankers. Both projections indicate that the shipping demand for the Pertamina refineries will not change significantly over the next decade.

4.5.3 Fertilizer

Palembang has been shipping urea from the Pusri

wharf since 1964. The present capacity of the plant is 480,000 ton/year of urea. Pusri III now under construction is due to be completed at the end of 1976 adding an additional capacity of 570,000 tons. Presently soil investigation are being conducted for a Pusri IV expansion which would add another 570,000 tons/year capacity by 1979/80. Thus the total capacity in 1980 should be 1.6 million tons of urea. Plans are also being considered for converting Pusri I to a diammonium phosphate plant producing about 160,000 tons per year; however, no date has been fixed for this project.

The present shipment of bulk urea is being handled by four chartered ships, three of which were formerly used for carrying coal. These vessels are due to be replaced by three 7000 DWT bulk carriers to be delivered starting at the end of 1976. The last ship is scheduled to arrive in mid 1977. Plans are also being considered for purchasing one or two additional vessels so as to have adequate shipping capacity for handling the output of Pusri I-IV as well as the distribution of TSP. These vessels were designed with a six meter draft so as to allow unhindered movement in and out of Palembang. Plans are also being considered for providing pilots on board the vessels so as to allow complete autonomy in operation.

In order to accommodate the expansion of capacity and the new vessels, the bulk loader at the Pusri wharf is being replaced with a quadrant beam loader capable of handling 750 tons/hour.

At the end of 1978 the estimated number of vessel calls for bulk shipments is 4.2 per week, thereby allowing 28 hours per ship call for a 70% berth occupancy. In addition, there will be ship calls at the second Pusri berth for handling bagged urea, bagged imports, spare

parts and equipment. The PPS study team estimated that fertilizer imports would amount to 187,000 tons in 1985.

The development plans for Pusri are well co-ordinated to provide adequate shipping capacity through its own wharf and to minimize the delay of its vessels when calling at Palembang.

4.5.4 Plywood and Wood Products

Palembang has a large modern plywood plant which has been in operation since 1974. Output is approximately 180 m^3/day but construction is underway to double the capacity of the plant. Additional plans are formulated for tripling the present capacity by 1980. Also a request has been filed with the government for construction of a second large plywood factory in South Sumatra.

The present shipment of plywood is about 2,200 m^3 per month primarily shipped to Jakarta on small ships which load directly from the factory. The expansion of the plant's capacity can be easily handled through the existing wharf which at present handles about three ships per month.

The Sumatra Regional Planning Study identified two potential projects related to wood manufacture which could be located in South Sumatra. The first is a large scale pulp and paper mill and the second is a plant for producing hardwood chips. The former would have a capacity of about 800 tons/day of pulp, the latter more than 100,000 m^3 per year. The same study estimated that these projects would be realized by 1985.

Plywood and timber products are directed toward the domestic market. The PPS team estimates that demand will

grow at a rate of 12% annually but that local consumption will absorb an increasing proportion of the output. The estimated flow of timber products through the Port of Palembang is estimated to reach 150,000 tons in 1980 and increase at a rate of 11-12% thereafter. The majority of this will probably be handled via factory wharves. Thus by 1985 an estimated 245,000 tons of timber products will be handled at private wharves.

4.5.5 Sawn Timber.

Presently sawn timber is produced at a number of small factories which lightered their output to ships at anchor. In this way about 34,000 tons were shipped out of Palembang in 1974. The saw mills are primarily small primitive mills though a few are medium sized mechanized mills.

The PPS team projects a major growth in the shipment of sawn timber both export and domestic. For export the volume of sawn timber is expected to account for about 15% of the timber shipments in 1990 and 25% in the year 2000. This amounts to 355,000 m^3 in 1990. An additional 460,000 m^3 is projected for domestic shipments in that year, for a total of more than 800,000 m^3. This large volume will require the introduction of large scale mechanized saw mills equipped with their own wharf facilities. Loading would continue to be to lighters or possibly direct to ships where adequate depth is available adjoining the saw mill.

4.5.6 Cement.

Presently the Port of Palembang unloads about 75,000 tons of imported and domestic cement. Plans are now under-

way to construct a 5-600,000 ton capacity clinker plant at Baturaja and to transport half of the output by rail to Palembang where it will be ground and bagged for local and interisland distribution. The plant and grinding mill are scheduled to be in operation in 1979. An expansion of the Baturaja facility to 1-1.2 million ton capacity is projected for 1982/83. This program would most likely be supported by an expansion of the Palembang grinding mill to handle 5-600,000 tons/year. The hinterland for Palembang cement will be limited by the existence of similar facilities at Panjang, Medan and Padang. The proposed market area includes only South Sumatra, including Bangka, Belitung and Jambi. Any excess production would be sent to Jakarta.

The grinding mill in Palembang is planned to be located next to the TABA facility at Kertapati. This location allows for direct receipt of clinker from the railroad and direct delivery of the product to road, rail and water transport. In addition inputs for the Baturaja plant, primarily iron sand and refractories, and the Palembang plant, primarily gypsum and Kraft paper, will be handled via the Palembang facility.

The PPS team estimates an annual growth in regional demand of 15%. Of this demand half is expected to be supplied by local waterborne shipments. The surplus production projected to range from 78,000 to 155,000 and back down to 22,000 in the period from 1980-1995 would presumably be sent to Jakarta via domestic shipping. All vessels calling at the Palembang plant would be constrained in size by raised height of the Ampera Bridge and limitation of river depth above the bridge. For inputs and for large shipments of output it may be necessary to transfer cargo via lighter from the Palembang plant to vessels at anchor. In all

cases a wharf will be required at the Palembang plant. This wharf will have to be sized for handling an estimated 522,000 tons in 1990, 75,000 in, 304,000 local out and 143,000 interisland out. No plans are available at present for this facility.

4.5.7 Rice

South Sumatra is a deficit area in terms of rice production. Over 70,000 tons were brought in through Palembang in 1974. The two primary sources of expansion in supply are the Pertamina Rice Estate project and the extension of rice cultivation in the Banyuasin region.

The Rice Estate project proposes to eventually put in cultivation 20,000 hectares using a highly mechanized form of agriculture. At present only some hectares have been placed under cultivation and the total project is not expected to be completed until the early 1980's. The projected yield per hectare is about 8 tons, thus the total output of the project should be approximately 160,000 tons per year. Assuming a comparable amount of land can be cultivated in the Banyuasin area where present yields are not more than .8 tons/hectare then a total output of 176,000 tons/year by 1985 might be anticipated. However this only amounts to a 36% increase over the present production plus imports of South Sumatra, while the demand is expected to grow at about 3% per year. For this reason the PPS team has projected an increase in inward shipments of rice and the developments at the Rice Estate or in Banyuasin will not require an increase in port facilities.

4.5.8 Rubber

Rubber is produced primarily by small holders. Large

estates contributed less than 2% of the output in 1974. However, the marketing and milling of rubber is centered in Palembang. Most of the mills are located along the Musi River and the output is lightered to ships at anchor in the Musi. The supply of rubber is somewhat elastic and small holders generally alter their planting in response to a change in prices. The rise in the cost of synthetic rubbers, the more active marketing in socialist countries and the anticipated recovery in demand in Western Europe and the USA all point to a continuing growth in demand. The formation of a common rubber market by Malaysia, Thailand and Indonesia should help to stabilize rubber prices and encourage the growth in supply from the small holders. The PPS team estimates a long term growth of 6% per annum.

The rate of growth of rubber exports will probably result in a proliferation of rubber mills rather than the introduction of a large scale units. If this is the case the the output will continue to be lightered to vessels in the river and there would be no additional demand for wharf space within the port.

5.0 EVALUATION OF ALTERNATIVES

5.1 Future Traffic Demand.

Projections of the form in which commodities will be shipped in 1990-2000 are based on four factors, the present form of shipment, other possible forms, the total volume to be shipped, and the potential origin/destination. The information is summarized in Table VII-5.1-1 for the various commodities included in the economic forecast.

In order to estimate the amount of cargo which would be handled in deep draft port two assumptions were made. The first was that the minimum volume of cargo through a deep draft port would include all exports except logs which would be handled in the river, crude and oil products which would be handled through Pertamina's wharf and general cargo. The second was that the maximum volume of cargo would include logs, 70% of the genral cargo but none of the crude and oil products. It would also include imports of fertilizer for transshipment, rice, sugar, cotton, wheat and flour, naphtha and 70% of general cargo. The resulting tonnages are given in Table VII-5.1-2.

It is also likely that a deep draft port would be used for transshipment of domestic cargoes to and from Palembang. Aside from transshipment fertilizer, which would be distributed through a deep draft facility, some of the crude and oil products might be handled in large tankers for transfer at a deep draft facility to/from refinery lighters. If half of the petroleum shipments were handled this way, then an additional 2.5 million tons of liquid bulk would be handled through the deep draft port in 1990 and 1.6 million tons in 2000.

TABLE VII-5.1-1

FORM OF FUTURE COMMODITY MOVEMENTS

(000 Tons)

COMMODITY	Present Form	Possible Form	Projection 1990-2000	Origin/ Destination
Domestic Inward				
Salt	Bagged	Bulk-Cont.	27 - 34	Interisland
Coconut oil	Drum	Bulk	36 - 54	Local
Rubber	Bales	Container	8 - 13	Local
Coffee	Bags	Container	3 - 5	Local
Petrochemical Inputs (Chlorine)	-	Bulk, drum	70 - 190	Interisland
Rice	Bag	Bulk, cont.	42 - 47	Interisland
Sugar	Bag	Bulk, cont.	96 - 106	Interisland
Wheat & Flour	Bag	Bulk, cont.	27 - 35	Java
Crude	Bulk	Bulk	1610-1080	Interisland & Local
G.C.	Various	Container	376-795	Interisland
Total Domestic Inward			2295-2359	
Domestic Outward				
Fertilizer Pusri	Bulk, Bag	Container	1545-2145	
Tranship	Bag	Container	309-708	
Cement	-	Bag, Bulk, Cont.	447-787	
Petrochemical				
Base material	-	Bagged, baled	340-630	
Products	-	Container	110-420	
Oil Products	Drum, Bulk	-	3380-2140	
Sawn Timber	Bundle	Container	460-1325	
Timber Products	Sheets	Container	333-743	
Coal	Bag, Bulk	-	970-820	
General Cargo	Various	Container	98-208	
Total Domestic Outward			7992-7567	
GRAND TOTAL DOMESTIC			10287-9926	

TABLE VII-5.1-1

(Continued)

COMMODITY	Present Form	Other Possible Forms	Projected Volume 1990-2000	Potential Origin/ Destination
Imports				
Fertilizer	Bagged	Bulk, cont.	309 - 708	
Rice	Bagged	Bulk, cont.	128 - 142	Thailand
Sugar	Bag	Bulk, cont.	24 - 26	India
Wheat & Flour	Bag	Bulk, cont.	3 - 4	U.S.A.
Cotton	Bale	Container	9 - 12	U.S. Egypt
Cement Manufacture Inputs (gypsum)	-	Bulk	75 - 224	
Naptha	-	Bulk	670-1840	
Oil Products	Drum	Bulk	268-578	Nearby
General Cargo	Various	Containers	313-664	Various
IMPORTS TOTAL			1797-4198	
Exports				
Rubber	Bale, crate	Container	378-616	Europe, U.S.
Coffee	Bag	Container	67-82	Various
Oil Products & Crude	Bulk & drum			
Logs	Loose		2010-3176	Asia
Sawn Timber	Bundle		355-1058	Asia, Europe
General Cargo	Various	Container	23-42	Various
EXPORTS TOTAL			1023-2098 2010+-3176+	
GRAND TOTAL			2820-6296 2010+-3176+	

+ Logs measured in cubic meters (000)

TABLE VII-5.1-2

DEEP WATER PORT CARGO PROJECTIONS

(000's tons)

COMMODITY	MINIMUM		MAXIMUM		FORM
	1990	2000	1990	2000	
Exports					
Rubber	378	616	378	616	Container
Coffee	67	74	67	82	Container
Logs	-	-	2010 +	3176 +	Loose
Sawn Timber	355	1058	355 +	1058 +	Container
General Cargo	-	-	16	29	Container
Sub-Total	800	1748	461 2365+	727 4234 +	
Imports					
Fertilizer	309	708	309	708	Container
Rice	80	120	128	142	Bulk
Sugar	-	-	24	27	Container
Wheat & Flour	-	-	3	4	Container
Cotton	-	-	9	12	Container
Naptha	-	-	670	1840	Bulk
General Cargo	110	233	219	465	
Sub-Total	499	1061	1362	3198	
Total Foreign	1299	2809	1823 2365+	3925 4234+	
Domestic Inward					
General Cargo	-	-	250	540	
Domestic Outward					
Fertilizer	-	-	700	1400	
Cement	-	-	447	787	
General Cargo	-	-	50	104	
Total Domestic	-	-	1447	2831	
GRAND TOTAL	1299	2809	3270 2365 +	6756 4236+	

It is noted that there are large differences between the minimum and maximum expected cargo to be handled through the deep water port. For example while we are confident of a demanded throughput of 1,299,000 tons by 1990, the actual throughput could be more than three times as much. Approximately the same ratio is noted between minimum and maximum demand for the year 2000. Projected demand obviously depends on many internal and external factors, such as quality and level of service, costs, infrastructure, term of trade and more. Most of these are adaptive factors. As costs per unit cargo decrease, the amount of cargo will usually increase which in turn generally improves the quality of service which in turn increases cargo flow and thereby reduces costs. In reality there are also other factors influencing these trends such as existing investments in capital assets such as ships, piers and cargo handling equipment or tradition.

5.2 Pier Development.

1) Traffic Forecasts.

The traffic forecast for 1990 as shown in Table VII-5.1-2 presents the foreign trade traffic originating or destined to the region of Palembang. This traffic does not include the local and interinsular (Nusantara) traffic of Palembang - which will continue to be handled at the Boom Baru and other facilities of the Port of Palembang. The resultant recommendations for short term improvements as shown in Volume VI are aimed at accommodating the increasing local traffic of Palembang up to 1985/88.

From the cargo handling port operational point of view we have separated the traffic in two major groups

i) Break bulk cargo including
   a) bagged cargo - long runs
   b) packaged timber - long runs
   c) rubber
   d) general cargo
   e) container

ii) Bulk cargo
   a) dry bulk
   b) liquid bulk

2) Locations

While the break bulk cargo can be handled both at Palembang and in the Banyuasin Tanjung Api-Api area the handling of bulk cargo at Palembang should be excluded from consideration because of the Musi River's channel and its Outer Bar limitations which are especially detrimental for large scale interocean bulk trade activities. The sufficient improvement of the channel requiring deepening and removal of some bends is an extremely costly proposition given the hydrological properties of the river. Some 25 million cubic meters of capital dredging costing some US$ 28.5 million and some 8-10 million cubic meters of annual maintenance dredging costing some US$ 8-10 million would be required to make Palembang accessible to ships with an eight meter draft at all stages of the tide. It is clear that such an expenditure would hardly render itself economically - and a solution - avoiding the dredging of the channel should be investigated.

3) Port Capacity.

The main factors affecting the capacity of a break bulk cargo port are :

i) number of berths
ii) the berth occupancy
iii) the tonnage of cargo handled per ship
iv) the productivity while vessels are at berth which in turn involves : workable hours, the number of hatches worked, the proportion of effective working time and the labor output : depending again upon the type of cargo and the available cargo handling equipment
v) the availability of open and closed storage areas
vi) the achievable rates of bringing in exports and clearing imports, involving in turn the rate of direct and indirect delivery.

The rate of ship arrivals in a port changes over time and ships' arrival is generally random causing at times to queueing of vessels awaiting berth space, while at time leaving empty berths awaiting the arrival of ships. There is however some figure of port capacity which maximizes the total net benefits, that is net benefits to both ship owners and the port when taken as a whole. If any port administration were to insists on 100 percent utilization of its capacity it would minimize its cost per ship - but ship owners would incur costs while waiting for berths. On the other hand, if enough berths were constructed and maintained, the ship owner's waiting time and costs would be reduced to zero; but the port would bear the high costs of constructing and maintaining the berths.

The basic problem is one of trade offs - more berths = higher costs to the port but lower costs for ship owners; fewer berths = lower costs for the port but higher cost to ship owners. Higher port costs would require the port to increase its charges against the cargo - which would eventually be passed on to and will have to be borne by the con-

sumer. This is generally defined as financial costs. Higher shipping cost mainly in foreign currency - even if a substantial part of the forecast traffic will be carried by Indonesian flag vessels - will have to be borne by the nation's economic resources. Shipping costs are therefore generally defined as economic costs. The optimum number of berths will be somewhere between that number required to avoid any waiting by ships (upper limit) and the number which will be fully utilized year-round (lower limit) resulting in a berth occupancy rates. This subject will be further elaborated in the Full Report.

4. Required Facilities

(I) Break Bulk Cargo - See Tables VII-5.2-1 and VII5.2-2

Based on the aforesaid the consultants have analyzed the facilities-requirements to handle the traffic forecast by 1980. The assumed cargo handling outputs are some 50-80% above those presently achieved. With the setting up of training centre and introduction of training schemes for port labor and staff - the introduction of palletization and the procurement of cargo handling equipment (see Volume VI - Short Term Improvements) - the port administration should have no difficulties to reach these outputs by 1990.

Following is the summary of the main requirements:

Traffic	Palembang*		Banyuasin	
	Berth days	Berth	Berth days	Berth
Break Bulk Cargo				
Low	876 =	3.6 say 3-4	847 =	3.5 say 3-4
High	1,126 =	4.3 say 4	1,097 =	4.2 say 4

TABLE VII-5.2-1

CARGO FACILITY REQUIREMENT - BOOM BARU

Location	PALEMBANG - BOOM BARU							
Description of facilities	MARGINAL WHARF							
Alongside depth, M	6 Meter				8 Meter			
Number berths	1	2	3	4	1	2	3	4
Length M total	130	360	390	520	180	360	540	720
Days worked/yr.- accum.	350	700	1,050	1,400	350	700	1,050	1,400
Shifts worked/day - accum.	3	6	9	12	3	6	9	12
Gross Nos.hours worked/day-accum.	24	48	72	96	24	48	72	96
Net Nos.hours worked/day-accum.	18	36	54	72	18	36	54	72
Hours lost due to operations-accum.	1.8	3.6	5.4	7.2	1.8	3.6	5.4	7.2
Hours lost due to rain - accum.	1.8	3.6	5.4	7.2	1.8	3.6	5.4	7.2
Actual net Nos.hours worked/day-accum.	14.4	28.8	43.2	57.6	14.4	28.8	43.2	57.6
Berth occupancy rate %	60	65	70	75	60	65	70	75
Berth days - Operating	210	455	735	1050	210	455	735	1,050

TABLE VII-5.2-1 (Con't)

CARGO FACILITY REQUIREMENTS - BOOM BARU

Cargo - Imports/exports (000 Units)			Average cargo carried per vessel	Output tons/gang hatch/hour	Nos. hatches worked	Hours per vessel required	Days per vessel		Days required for total cargo		Nos. vessel		Nos. Berth	
Type : 1990- Forecasts	Low	High					Part.	½ day rounded	Low	High	Low	High	Low	High
Bagged - Long runs - T	150	200	4000	30	3.5	38.1	2.6	3.0	113	150	38	50		
Timber - Packaged - M^3	350	360	4000	25	3.5	45.7	3.2	3.5	307	315	88	90		
Rubber - T	370	380	4000	30	3.5	38.1	2.6	3.0	279	285	93	95		
General cargo - T	40	90	850	15	2.5	22.7	1.6	2.0	94	212	47	106		
Containers - 20'Equiv.TEU	10	20	120	Lifts 15	1 crane	8.0	0.6	1.0	83	166	83	166		
SUB-TOTAL									876	1128	349	507	3 - 4	4 +
Bulk - Dry	310	1420	15000	250/ 750		60/ 20	4.2/ 1.4	4.5/ 1.5	95/ 32	428/ 142	21	95		
Bulk - Liquid	-	670	14000	500		28	2.0	2.0	-	96	-	48		
SUB-TOTAL									95/ 32	524/ 238	21	143	1	1

TABLE VII-5.2-2

CARGO FACILITY REQUIREMENTS - BANYUASIN

Location	BANYUASIN							
Description of facilities	* OUTER HARBOR - OFFSHORE ISLAND WHARF AND INNER HARBOR - MARGINAL WHARF				OUTER HARBOR-OFFSHORE ISLAND WHARF			
Alongside depth, M	10 Meter				15 Meter			
Number berths	1	2	3	4	1	2	3	4
Length M total	180	360	540	720	250	500	750	1,000
Days worked/yr.- accum.	350	700	1,050	1,400	350	700	1,050	1,400
Shifts worked/day - accum.	3	6	9	12	3	6	9	12
Gross Nos.hours worked/day-accum.	24	48	72	96	24	48	72	96
Net Nos.hours worked/day-accum.	18	36	54	72	18	36	54	72
Hours lost due to operations-accum	1.8	3.6	5.4	7.2	1.8	3.6	5.4	7.2
Hours lost due to rain - accum.	1.8	3.6	5.4	7.2	1.8	3.6	5.4	7.2
Actual net Nos.hours worked/day-accum.	14.4	28.8	43.2	57.6	14.4	28.8	43.2	57.6
Berth occupancy rate %	50	60	65	70	50	60	65	70
Berth days - Operating	175	420	683	980	175	420	683	980

TABLE VII-5.2-2 (Con't)

CARGO HANDLING REQUIREMENTS - BANYUASIN

Cargo - Imports/exports (000 Units)			Average cargo carried per vessel	Output tons/ gang hatch/ hour	Nos. hatches worked	Hours per vessel re-quired	Days per vessel		Days required for total cargo		Nos. vessel		Nos. Berth	
Type : 1990- Forecasts	Low	High					Part.	½ day rounded	Low	High	Low	High	Low	High
Bagged - Long runs - T	150	200	8500	30	3.5	81.0	5.4	6.0	106	141	18	24		
Timber - Packaged - M^3	350	360	8000	25	3.5	9.4	6.4	6.5	285	293	44	45		
Rubber - T	370	380	4000	30	3.5	38.1	2.6	3.0	279	285	93	95		
General cargo - T	40	90	850	15	2.5	22.7	1.6	2.0	94	212	47	106		
Containers - 20'Equiv.TEU	10	20	120	Lifts 15	1 crane	8.0	0.6	1.0	83	166	83	166		
SUB-TOTAL							-		847	1097	285	436	3 - 4	4 +
Bulk - Dry	310	1420	15000	250/ 750		60/20	4.2/ 1.4	4.5/ 1.5	95/ 32	428/ 142	21	95		
Bulk - Liquid	-	670	14000	500		28	2.0	2.0	..	96	-	48		
SUB-TOTAL									95/ 32	524/ 238	21	143	1	1

Note : * The 10 M offshore island wharf can be dredged to 13 M at LLW so as to handle vessels of 12 M draft, which will be able to enter and leave the port area under tidal restrictions (tidal differences : 3.75 M on springs, 2.50 M on neaps).

Bulk Cargo

Low	--	95 =	0.6 say 1
High	--	238 =	1.3 say 1

* The higher number of berth-days required at Palembang for the same amount of cargo stems from the lower average amount of cargo carried by vessels to and from Palembang due to draft restriction.

As seen from the above the facility requirements for break bulk cargo are similar for both Palemang and Banyuasin. The choice of location will depend therefore upon other factors such as :

i) overall port facilities construction cost
ii) overall port related township infrastructure cost
iii) overall cargo handling cost
iv) land or barge transportation cost between Palembang and Banyuasin as against shipping costs or savings

These points and the consultant's conclusion and recommendation will be further analyzed in the final report.

(II) Bulk Cargo

The location of suitable facilities presents less options. If to provide facilities able to handle bulk carriers of such dimensions so as to achieve reduced freight costs for Indonesia's exports and imports - deep draft facilities must be constructed. Deep draft facilities will stimulate the country's exports and increase their competitiveness. Construction costs of the facilities, the overall cargo handling costs as well as inland transportation costs

must be low to keep the overall commodity costs as low as possible, not offsetting the saving gained through lower ocean freight rates. These facilities stem therefore best to be placed at Banyuasin.

Further elaborations on the Bulk Cargo Exports Imports see in chapter .

5. Facilities

Break Bulk Cargo

The technical aspects of the construction of facilities to handle break bulk cargo were shortly reviewed in Chapter VII-4.4.3.4 and will be further elaborated upon in Volume VIII-Engineering.

Bulk Cargo

The consultants evaluated various alternatives for a Bulk Cargo Handling Terminal in order to achieve an economic yet effective solution. The four basic alternatives are here shortly described - while more detailed data will be given in Volume VIII - Engineering.

a) Floating Terminal (Figure VII-4.4.3-8)

A floating terminal consisting of a converted bulk carrier or specially constructed floating platform is moored to a pair of mooring buoys anchored in line with the predominant tidal currents. The floating terminal is equipped to berth oceangoing bulk carriers on the ocean side and barges or coastal vessels on the land side. Pneumatic fenders and constant tension devices are used to facilitate berthing and to absorb berthing energy. The terminal will be equipped with catenery loader/unloaders, transfer conveyors and vacuators. It will be capable of loading and unloading bulk carriers to or from the terminal storage, alongside barge/coasters

or both. The terminal will have a storage capacity of about 30-40,000 tons and generate all required services such as electric power, fresh water, compressed air. It will also provide storage for ship supplies such as fuel and water. Accommodations for the terminal crew (estimated at 85 men) will be available in the terminal superstructure.

b) An Offshore Dolphin Berth (see Figure VII-5.2-1)

The berth consists of an open reinforced concrete structure on which the bulk loader/unloader will travel and will support the loading/unloading conveying system. The structure is 150 m long and some 20-25 m wide. The vessel's berthing energy is absorbed by a group of fender dolphins designed to handle 50,000-80,000 Dwt bulk carriers approaching the wharf at a speed of 0.15 m/sec. and an angle of 8°. Tugboats will assist the berthing and unberthing of vessels. This fendering system permits a relative light concrete support structure, as this is not subjected to the berthing impact of vessels.

The piles of the breasting and mooring dolphins are of high tensile steel, specially treated or cathodically protected against corrosion. Catwalks will connect the fender dolphins to the structure, while the mooring dolphins will be easily accessible from a launch.

The berth is connected to the shore by a steel bridge structure carrying the conveying system and pipelines and serving as walk way.

The bulk terminal is of multipurpose design able to load and unload bulk as well as liquid.

The shore facilities comprise of an open storage area for 50,000 m^3 with stacking and reclaiming facilities, as well as a small covered storage area for 10,000 m^3. A generator

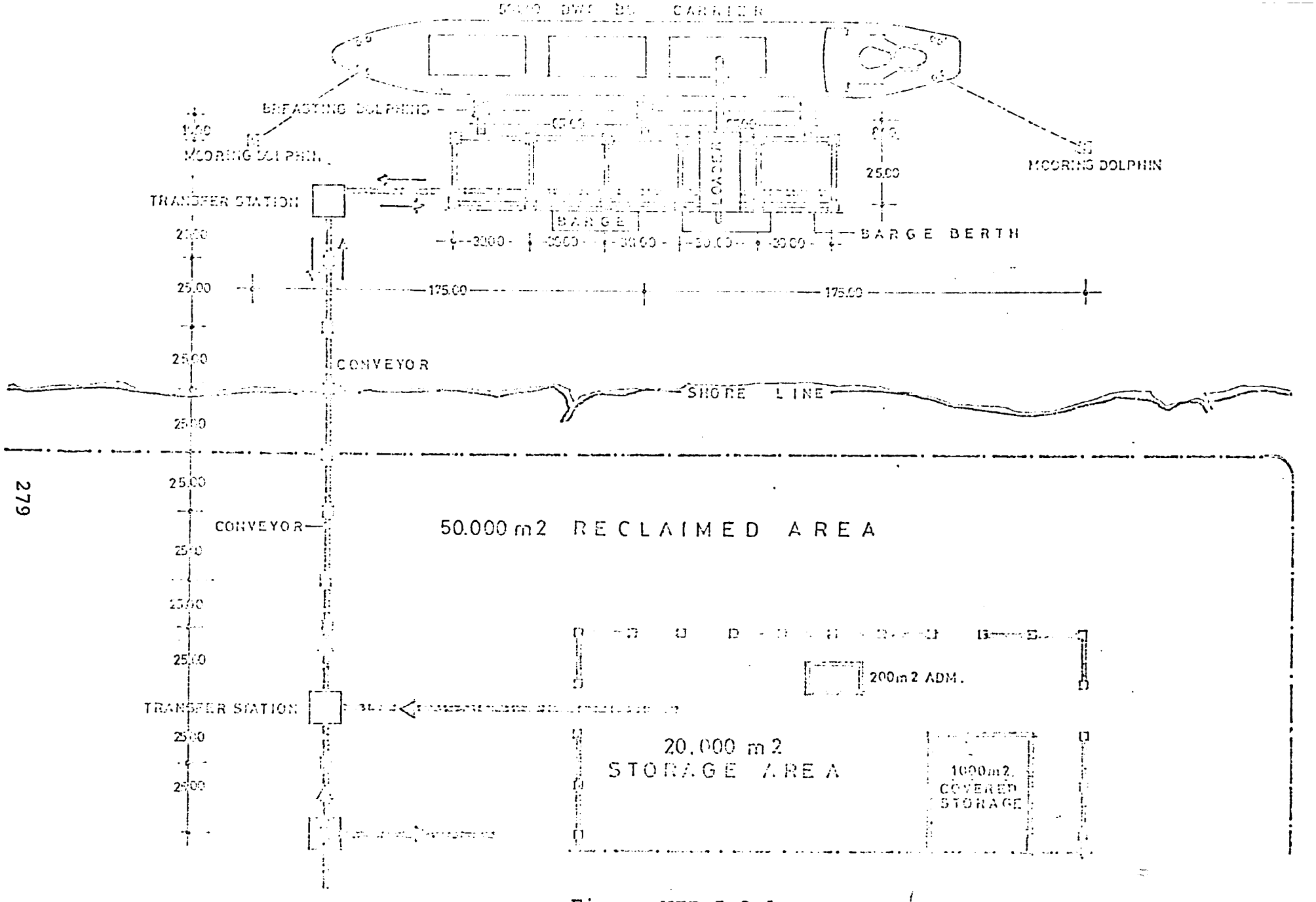


Figure VII-5.2-1

Banyuasin Specialized Bulk Terminal at Tg. Api Api

Scale 1 : 2000

station will supply the required power. Living quarters for some 100 labors and 20 staff will have to be created.

The inshore side of the berth will serve as barge berth. Bulk carrying barges will be loaded by the loader directly from vessels and/or from the buffer storage on shore, similarly barges will unload directly onto vessels or into the buffer storage.

c) Offshore Wharf - see Figure VII-5.2-2

The wharf is designed to serve as bulk terminal and simultaneously as wharf. All bulk handling and shore facilities are similar to (b) above. When not in use for bulk handling, the wharf could handle break-bulk unitized cargo; using either ships gear, mobile cranes or a specially designed loader. The berthing energy of the approaching vessel is absorbed either by the wharf structure or by breasting dolphins. Two 10 m wide cause way bridges connect the wharf to the shore and the storage area there.

(d) Gravity Prefabricated Island See Figure VII-5.2-3 and Figure VII-5.2-4

The proposed terminal consists of a prefabricated gravity type island, made of reinforced concrete or steel. The structure is constructed on shore and then floated to location and sunk in place. Depending upon soil condition the structure will settle after gravity loading somewhat in the sea bed material. In case of silty bed material the structure could be supported by piles driven from the structure after its placing on the sea bed. The piles will be capped prior to gravity filling. The load will be carried by the piles, thus preventing excessive settling of the structure. The analyzed structure is 107 m long x 32 m wide and 21 m high has 30,000 Dwt when floating and of 45,000-50,000 ton capacity after

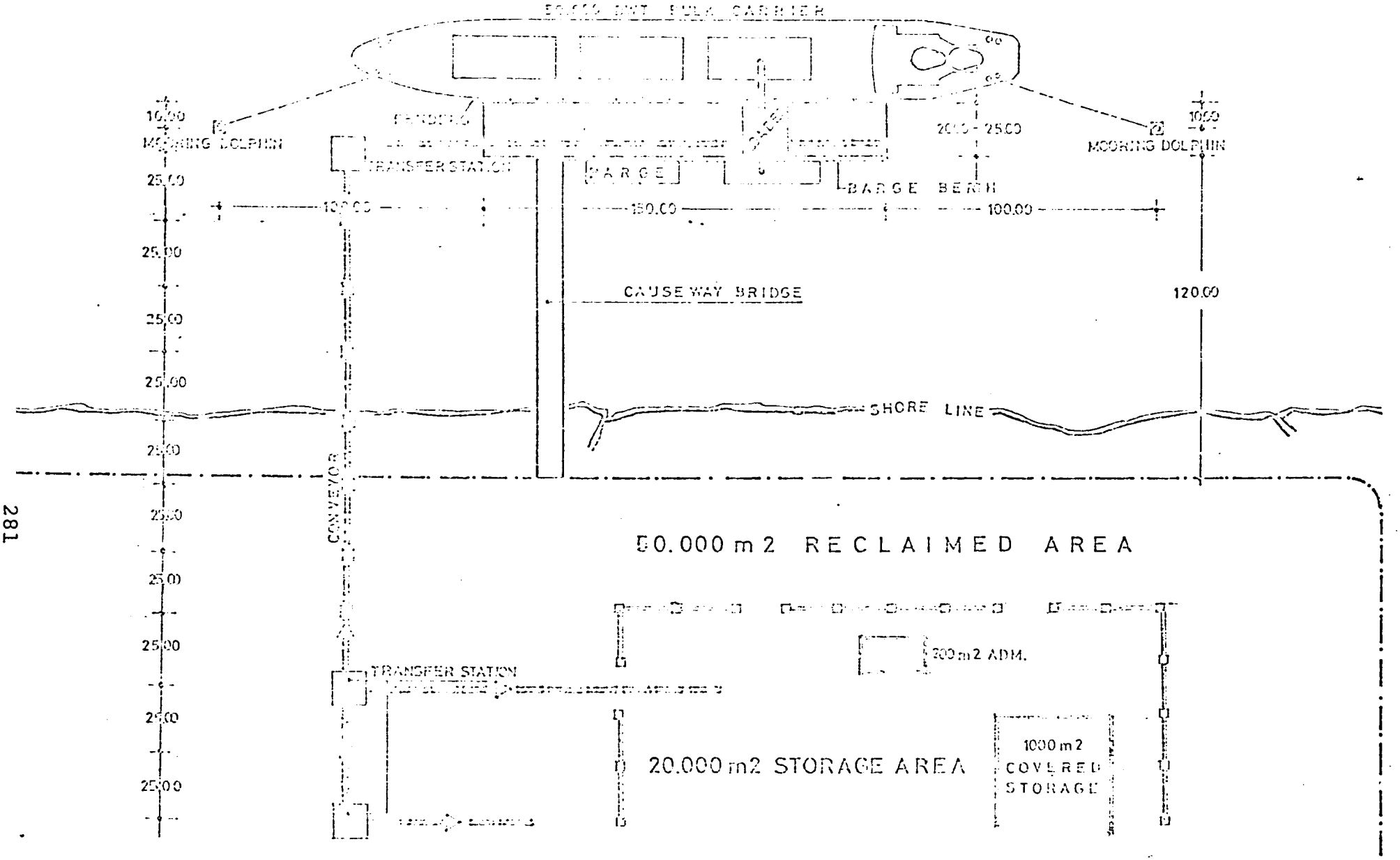
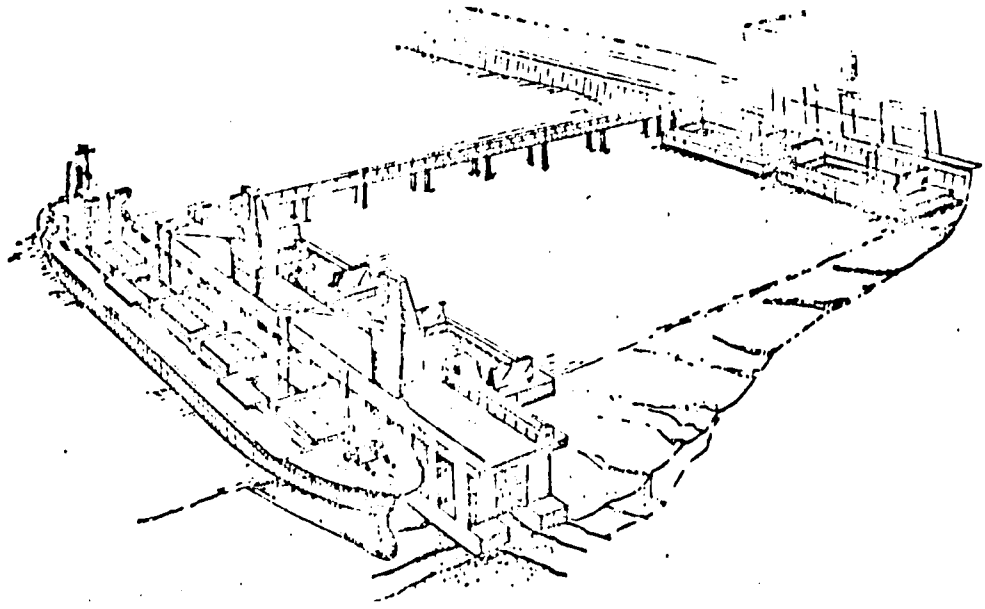
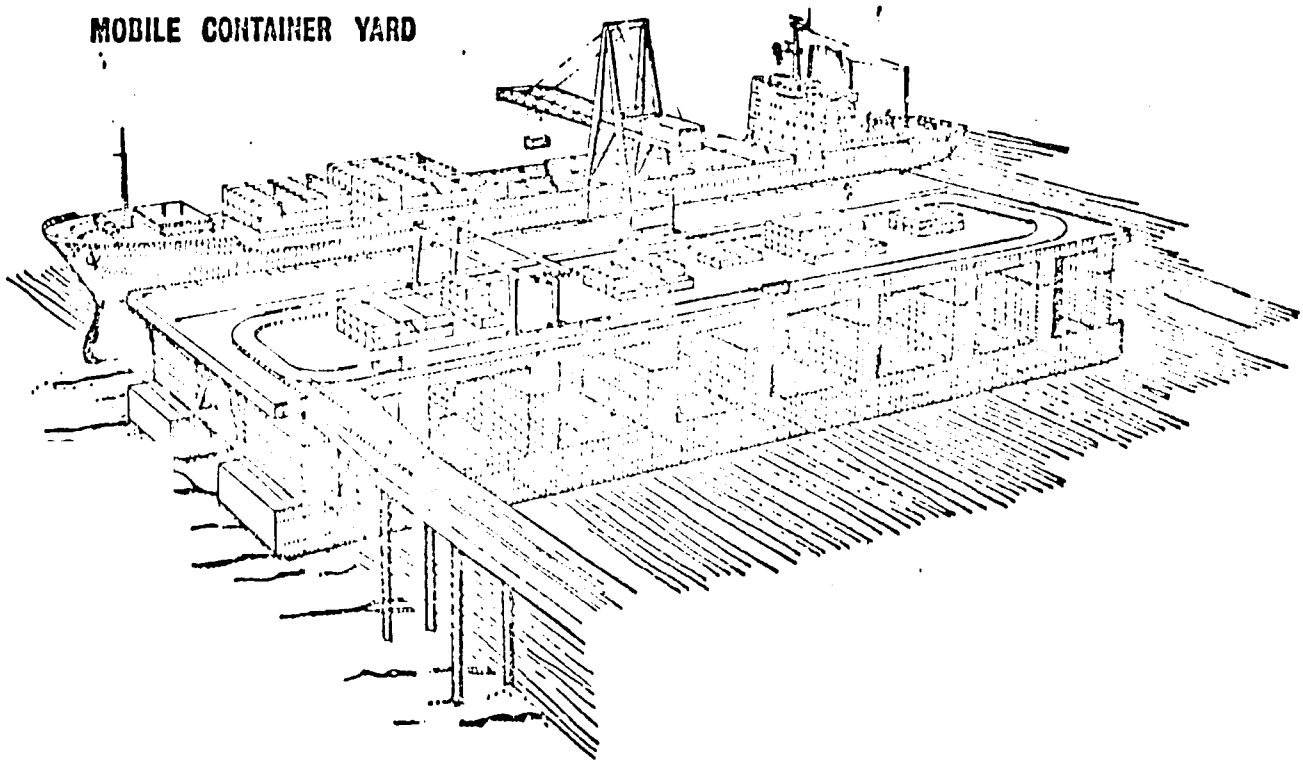


Figure VII-5.2-2

Banyuasin Specialized Bulk and Unitized Cargo Wharf

Scale 1 : 2000





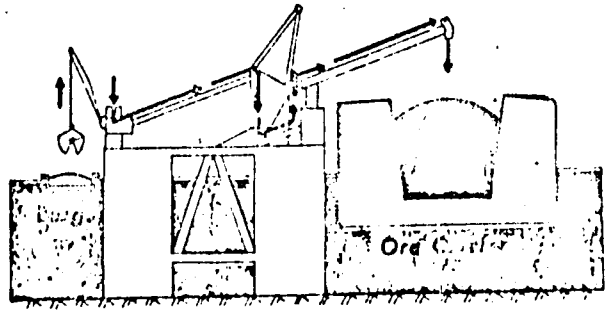


Figure VII-5.2-3

Gravity Prefabricated Island Terminal

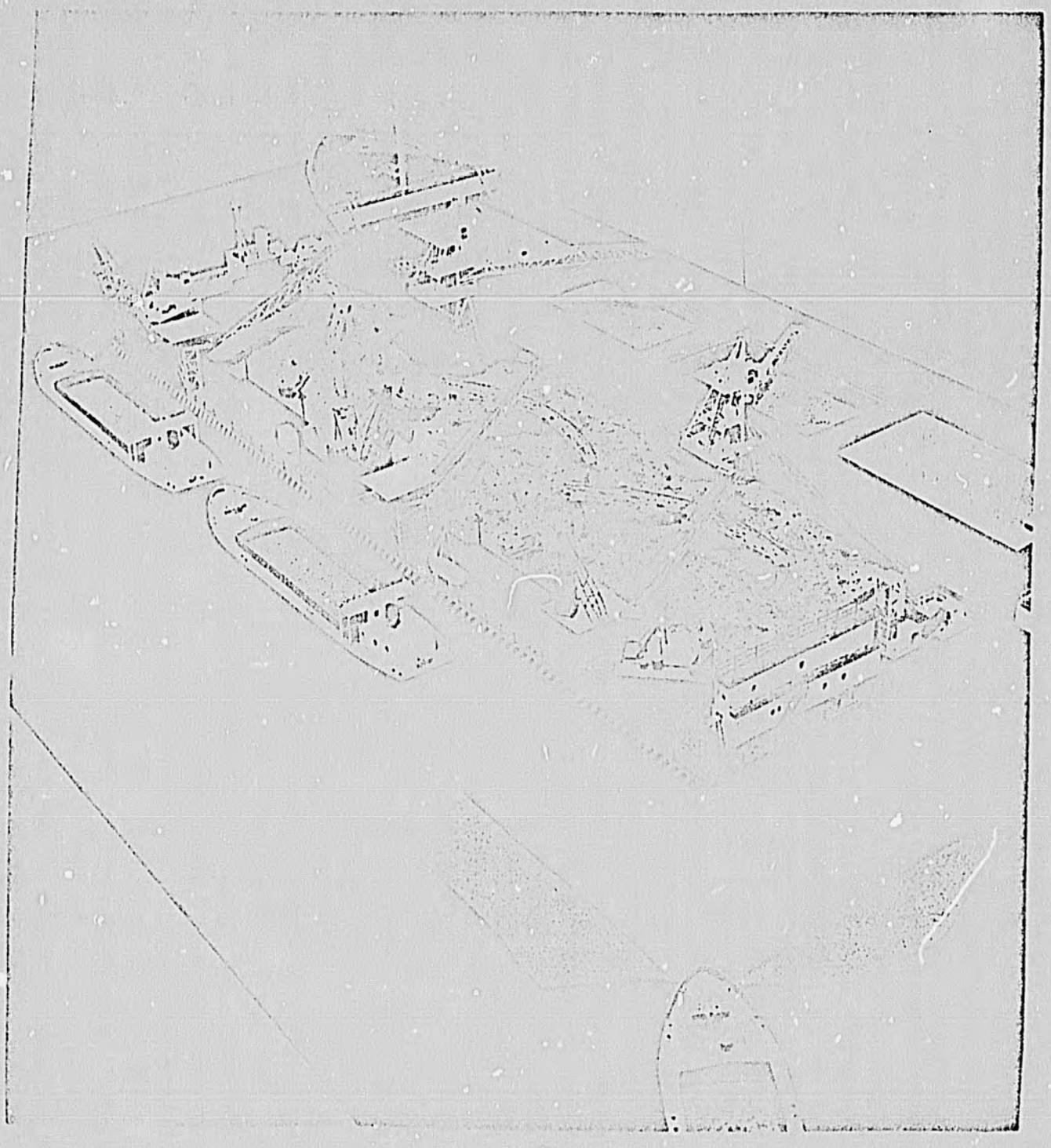


Figure VII-5.2-4
Gravity Bulk Terminal

sinking in place. The gravity island serves as storage and loading platform.

Such gravity island will serve as self supporting unit not requiring any shore facilities. These could be added in future with the growth of traffic.

Comparative Costs - Bulk Cargo Terminal - Alongside Depths 10 m and 15 m at LLW.

Type	Floating terminal cost US$ (000)*	Dolphin berth cost US$ (000)***	Offshore wharf cost US$ (000)***	Gravity Island cost US$ (000)*
Draft - 10 m	15,000	17,100	19,200	17,600
Draft - 15 m	16,000	25,300**	27,700**	19,800**

* Self-supporting units - without shore based storage

** Includes US$ 8,000,000 for dredging channel to -13 m at LLW which will enable to handle vessels with drafts of 15 m but under tidal restrictions (Banyuasin Tidal Differences : 3.75 m on spring and 2.50 m on neaps)

*** Include shore based storage : 50,000 tons open storage, 10,000 tons covered storage and storage facilities and equipment cost US$ 6-8 million.

The evaluation of the various alternatives shows that Bulk Cargo Terminals of various types could be successfully developed at Banyuasin. Each type has of course its advantages and disadvantages. Though there are cost differences of up to 65% between the alternatives,the various alternatives eachpresent a different ype of facility and a different operational approach. The analysis should be based on operation costs, future expansion possibilities etc.

Total Annual Costs for the various alternatives listed in Table VII-5.3-1 are therefore

Annual Costs of Banyuasin Throughput

($ and tons in 000)

Alt.No.	500 tons	1,000 tons	1,299 tons	1,447 tons
1	$ 12,350	$ 12,920	$ 13,244	$ 13,356
2	$ 15,610	$ 16,240	$ 16,564	$ 16,676
3	$ 12,440	$ 13,010	$ 13,334	$ 13,446
4	$ 5,867	$ 6,437	$ 6,761	$ 6,873
5	$ 4,350	$ 4,920	$ 5,244	$ 5,356
6	$ 4,600	$ 5,170	$ 5,494	$ 5,606
7	$ 4,505	$ 5,075	$ 5,399	$ 5,511
8	$ 6,835	$ 7,405	$ 7,729	$ 7,841
9	$ 4,828	$ 5,398	$ 5,722	$ 5,834
10	$ 7,143	$ 7,713	$ 8,037	$ 8,149
11	$ 4,180	$ 4,750	$ 5,074	$ 5,186
12	$ 6,798	$ 7,368	$ 7,692	$ 7,804

If we consider the minimum and maximum expected throughput (Table VII-5.1-2) for 1990, then, in 1975 dollars, the cost per ton (full burdened) is as follows for the various major cargo types.

Alt.No.	Minimum Cargo			Maximum Cargo		
	General $/ton	Dry Bulk $/ton	Logs Timber $/ton	General $/ton	Dry Bulk $/ton	Logs Timber $/ton
1	$ 14.66	$ 4.27	$ 7.57	$ 6.06	$ 1.16	$ 1.82
2	$ 16.94	$ 5.34	$ 9.33	$ 8.02	$ 1.29	$ 2.03
3	$ 14.74	$ 4.30	$ 7.55	$ 7.38	$ 1.14	$ 1.83
4	$ 7.45	$ 2.18	$ 3.80	$ 4.09	$ 2.01	$ 3.80
5	$ -	$ 5.90	$ 8.86	$ -	$ 1.20	$ 1.98
6	$ -	$ 5.95	$ 8.92	$ -	$ 1.20	$ 1.99

7	$ -	$ 5.92	$ 8.89	$ -	$ 1.20	$ 1.98
8	$ -	$ 8.62	$ 13.06	$ -	$ 1.36	$ 2.28
9	$ 16.84	$ 4.28	$ 7.40	$ 8.26	$ 1.12	$ 1.80
10	$ 23.63	$ 5.99	$ 10.36	$ 10.99	$ 1.36	$ 2.06
11	$ -	$ 5.73	$ 8.69	$ -	$ 1.14	$ 1.92
12	$ -	$ 8.58	$ 13.00	$ -	$ 1.36	$ 2.28

5.3 Projected Deep Draft Port Costs.

The costs of the various proposed facilities are summarized in Table VII-5.3-1. Total recurrent costs which include amortization, interest, and port operating costs vary from a low of $ 3.58 million per year for an offshore bulk terminal with limited unitized cargo handling capacity to over $ 15.00 million per year for a full 3 x 250 m wharf port development at Banyuasin in 15 m of water. All the fixed port facilities at Banyuasin and Boom Baru are designed for a general cargo capacity of 1 million tons per year, and container handling capacity of 20,000 TEU/year or about 200,000 tons/year. The fixed Banyuasin port alternatives also include dry bulk handling capability of 1 million tons per year, while all the floating and other offshore bulk terminal alternatives at Banyuasin are designed to handle 1.4 million tons of dry bulk per year.

The other cost applicable to the port alternatives are feeder costs, all of which have been computed in Section VII-4.4.1 as costs over and above feeder costs to Boom Baru as a result no feeder costs are assumed in the Boom Baru expansion. For the analysis of the Banyuasin alternatives we assume barging through a 10 ft Sebalik canal in 1000 ton barges though obviously Outer Bar barging may be used if large bulk shipment commence. For the purposes of establishing port costs we therefore take

Table VII-5.3-1

Summary Port Costs

Alternative No.	Item Description	Draft	Investment cost ($ 000)		Operating cost ($000)/yr.	Financial costs ($000)/yr.	Total recurrent costs ($000)/yr	Capacity of Facility		
			Fixed Facilities	Equipment				Break bulk cargo	Unitized cargo cont. TEU	Dry bulk
	Barramain Delta Alternatives									
1.	Offshore inland wharf 4 berths 180 M	10 - 12	64,600	19,700	3,000	8,750	11,750	1,000,000	20,000	1,000,000
2.	Offshore island wharf 3 berths *250	15*	80,000	19,900	3,900	10,170	15,070	1,000,000	20,000	1,000,000
3.	Marginal wharf 4 berth 180 M	10 - 12	62,000	19,700	3,300	8,540	11,840	1,000,000	20,000	1,000,000
	Palembang Alternatives									
4.	Marginal wharf 4 berth x 180 M	8*	23,800	3,500	2,600	2,667	5,267	1,000,000	20,000	—
	Barramain Offshore Alternatives									
5.	Floating	10 - 12	15,000	—	1,500	2,250	3,750	—	—	1,400,000
6.	Floating	15	16,000	—	1,600	2,400	4,000	—	—	1,400,000
7.	Dolphin	10 - 12	2,800	14,300	1,500	2,405	3,905	—	—	1,400,000
8.	Dolphin	15	11,000	14,300	3,100	3,135	6,235	—	—	1,400,000
9.	Island Wharf	10 - 12	4,200	15,000	1,600	2,628	4,228	100,000	5,000	1,400,000
10.	Island Wharf	15	12,700	15,000	3,200	3,343	6,543	100,000	5,000	1,400,000
11.	Gravity island	10	6,000	11,600	1,300	2,280	3,580	—	—	1,400,000
12.	Gravity island	15	16,200	11,600	3,000	3,198	6,198	—	—	1,400,000

* With tidal restrictions

the fully burdened cost of feeder to Banyuasin (fixed, off-shore etc.) as

$ 1.32/ton	500,000 tons/year
$ 1.17/ton	1,000,000 tons/year
$ 1.11/ton	1,500,000 tons/year

5.4 Projected Deep Draft Port Benefits.

There are various ways to determine the benefits of a deep draft port. Quantitative benefits can be determined by evaluating the differences in freight, cargo transfer, feeder and other costs which are expected to be incurred with or without a deep draft port. This has been done for the deep draft port alternatives.

To determine the freight differences we have taken the lower and upper limit of the cargo flow projections for 1990 and computed the applicable freight charges under conditions where the cargo is moved either through expanded facilities in the Musi River (Boom Baru and lighterage) versus moving appropriate exports and imports via a deep draft port at Banyuasin. Although some local and inter-island traffic is expected to be handled via a deep draft port, we did not include these benefits. Origin and destinations of major cargo flows were determined and freight rates for the particular routes and methods of handling (break bulk, container, parcel, bulk etc.) were obtained. We then computed the resulting freight costs of exports and imports if :

a) handled all out expanded Musi River facilities
b) if the minimum or maximum of projected imports and exports are handled at a full deep draft port at Banyuasin
c) only bulk cargo and a limited amount of unitized general

cargo is handled over an offshore bulk handling terminal.

These results are shown in Tables VII-5.4-1 to VII - 5.4-3.

The freight charges used are generally liner (conference) rates and unitized (containerized) rates. Only very little bulk movement was assumed to maintain the analysis as conservative as possible. For rubber and coffee for example we essentially only removed the surcharge, which is imposed by the conference to make up losses due to Musi River approach distance, draft limitations and the fact that it is a lighterage port. As a result, only small differences in bulkable cargo freight rates between Musi River expansion and deep draft port handling were assumed. In fact the large quantities of log, timber and rubber exports as well as some imports will justify handling by bulk carrier, parcel bulker or parcel tanker at about 30-40% of the cost of the present freight rates.

The shipping costs using expanded Musi River facilities are estimated to be $ 174.99 million (with 1990 cargo flows) versus an estimated cost with cargo flowing through the Banyuasin port facility of $ 157.94 million and $ 150.93 million respectively with minimum and maximum cargo flows through the deep draft port facilities.

5.5 Cost - Benefit Analysis and Evaluation of Alternatives

The benefits in terms of reduced shipping costs were presented in Tables VII-5.4-1 to Tables VII-5.4-3. Considering now the reduction in shipping cost or benefits derived from particular facilities we obtain

TABLE VII-5.4-1

ESTIMATED SHIPPING COSTS PALEMBANG TRADE

1990 - NO PORT AT BANYUASIN

FREIGHT STRUCTURE UNCHANGED

	EUROPE			U.S.A.			A S I A		
	Volume tons (000)	Freight rate $/ton	Total cost $(000)	Volume tons (000)	Freight rate $/ton	Total cost $(000)	Volume tons (000)	Freight rate $/ton	Total cost $(000)
EXPORTS									
Rubber	151	115	17,365	226	104	23,504	-	-	-
Coffee	40	140	5,600	27	127	3,429	-	-	-
Logs	-	-	-	-	-	-	703	50	34,447
Sawn Timber	-	-	-	-	-	-	355	40	14,200
General Cargo	4	233	932	5	238	1,190	4	95	380
IMPORTS									
Fertilizer	100	80	8,000	100	80	8,000	100	55	3,500
Rice	-	-	-	64	80	5,120	64	55	3,520
Sugar	-	-	-	-	-	-	24	55	1,320
Wheat	-	-	-	3	75	225	-	-	-
Cotton	-	-	-	3	127	381	-	-	-
Naphtha	-	-	-	-	-	-	670	N.A.	N.A.
General Cargo	60	233	13,980	100	238	23,800	60	95	5,700
Total			45,877			65,649			63,067

TOTAL SHIPPING COST $ 174,593,000

Comments.

Rubber	Freight rate given by Java-New York & Europe Indonesia Rate Agreements as of November 1975.
Coffee	Same as above.
Logs	Estimated cost using current cargo handling method.
Sawn timber	Freight rate by Java-New York & Indonesia-Europe Rage Agreements.
Gen.cargo	Indonesia Japan Rate estimated as tariff not available at time of writing
Fertilizer	Estimated cost of bulk shipment bagging within ship.
Rice	Estimated cost of bulk shipment bagging within ship.
Sugar	Estimated cost of bulk shipment bagging within ship.
Wheat	Estimated cost of bulk shipment bagging within ship.
Cotton	Freight rate by Java New York Rate Agreement as of Nov.1975.
Naphtha	No data available.
Gen.cargo	Freight rate by Java-New York & Indonesia-Europe Rate Agreements Indonesia Japan rate estimated as tariff not available at time of writing.

TABLE VII-5.4-2

ESTIMATED SHIPPING COSTS PALEMBANG TRADE

1990 - MINIMUM EXPECTED USE OF PORT AT BANYUASIN

	EUROPE			U.S.A.			A S I A		
	Volume tons (000)	Freight rate $/ton	Total cost $(000)	Volume tons (000)	Freight rate $/ton	Total cost $(000)	Volume tons (000)	Freight rate $/ton	Total cost $(000)
EXPORTS									
Rubber	151	85	12,835	226	90	20,340	-	-	-
Coffee	40	115	4,600	27	100	2,700	-	-	-
Logs	-	-	-	-	-	-	703	50	35,150
Sawn Timber	-	-	-	-	-	-	355	36	12,780
General Cargo	4	180	720	5	180	900	4	90	360
IMPORTS									
Fertilizer	100	80	8,000	100	80	8,000	100	55	5,500
Rice	-	-	-	40	70	2,800	40	50	2,000 *
				24	80	1,920	24	55	1,320 **
Sugar	-	-	-	-	-	-	24	55	1,320
Wheat	-	-	-	3	75	225	-	-	-
Cotton	-	-	-	3	127	381	-	-	-
Naphtha	-	-	-	-	-	-	670	N.A.	N.A.
General Cargo	30	180	5,400	50	180	9,000	30	90	2,700 +
	30	233	6,990	50	238	11,900	30	95	2,850 ++
Total			38,545			58,166			61,227

TOTAL SHIPPING COST $ 157,938,000

Comments.

Rubber	Current conference freight rate minus existing Palembang surcharge minus 10% reduction for container.
Coffee	Same as above.
Logs	Estimated cost using current cargo handling methods.
Sawn timber	Estimated cost with $4.00 per ton reduction for bundling and grading facility. Reduction due quicker cargo handling and increase stowage factor.
Gen.cargo	Current conference freight rate minus Palembang surcharge minus 10% reduction for containers.
Fertilizer	Estimated cost using bulk shipment bagging within ship.
Rice	* Estimated cost for portion unloaded using bulk equipment.
	** Estimated cost for portion unloaded with bagging in ship.
Sugar	Estimated cost for unloading with bagging in ship.
Wheat	Estimated cost for bulk shipment with bagging in ship.
Cotton	Current conference freight rate.
Naphtha	---
Gen.cargo	+ Estimated cost at reduced conference rates.
	++ Estimated portion handled through Boom Baru at old rates.

TABLE VII-5.4-3

ESTIMATED SHIPPING COSTS PALEMBANG TRADE

1990 - MAXIMUM EXPECTED USE OF PORT AT BANYUASIN

	EUROPE			U.S.A.			A S I A		
	Volume tons (000)	Freight rate $/ton	Total cost $(000)	Volume tons (000)	Freight rate $/ton	Total cost $(000)	Volume tons (000)	Freight rate $/ton	Total cost $(000)
EXPORTS									
Rubber	151	85	12,835	226	90	20,340	-	-	-
Coffee	40	115	4,600	27	100	2,700	-	-	-
Logs	-	-	-	-	-	-	703	50	35,150
Sawn Timber	-	-	-	-	-	-	355	36	12,780
General Cargo	4	180	720	8	180	1,440	4	90	360
IMPORTS									
Fertilizer	100	65	6,500	100	70	7,000	100	40	4,000
Rice	-	-	-	64	70	4,480	64	40	2,560
Sugar	-	-	-	-	-	-	24	40	960
Wheat	-	-	-	3	65	195	-	-	-
Cotton	-	-	-	3	105	315	-	-	-
Naphtha	-	-	-	-	-	-	670	N.A.	N.A.
General Cargo	60	180	10,800	100	180	17,500	60	95	5,700
Total			35,455			53,970			61,510

TOTAL SHIPPING COST $ 150,935,000

Comments.

Rubber	Current conference freight rate minus existing Palembang surcharge with 10% rate reduction for containers.
Coffee	Same as above.
Logs	Estimated cost using current cargo handling method.
Sawn timber	Estimated cost $4.00 per ton reduction cost for use of bundling and yarding facility, reduction due quicker cargo handling and increase stowage factor.
Gen.cargo	Current conference freight minus Palembang surcharge with 10% reduction for containers. Reduction in rate to Japan 5% of estimated rate. Probable reduction much larger, but due unavailability of tariff a very conservative estimate was used.
Fertilizer	Estimated cost using bulk unloading equipment.
Rice	Estimated cost using bulk unloading equipment.
Sugar	Estimated cost using bulk unloading equipment.
Wheat	Estimated cost using bulk unloading equipment.
Cotton	Current conference rate Java New York minus Palembang surcharge with 10% reduction for containers.
Naphtha	No data available.
Gen.cargo	Current conference freight rate minus existing Palembang surcharge with 10% reduction for containers.

Alt. No.	Benefits/year		Cos. 'year		Benefit/Cost	
	Minimum $ (000)	Maximum $ (000)	Minimum $ (000)	Maximum $ (000)	Minimum	Maximum
1	17,050	24,060	13,244	13,356	1.28	1.80
2	17,050	24,060	16,564	16,676	1.03	1.44
3	17,050	24,060	13,334	13,446	1.28	1.79
4	-	-	6,761	6,873	-	-
5	3,800	11,200	5,244	5,356	0.72	2.11
6	3,800	11,200	5,494	5,606	0.71	2.00
7	3,800	11,200	5,399	5,511	0.72	2.03
8	3,800	11,200	7,729	7,841	0.49	1.43
9	4,960	13,200	5,722	5,834	0.87	2.26
10	4,960	13,200	8,037	8,149	0.62	1.63
11	3,800	11,200	5,074	5,186	0.75	2.16
12	3,800	11,200	7,692	7,804	0.49	1.43

These benefit/cost ratios are simple, the ratio of savings in shipping costs in using various deep draft facilities versus the expanded Musi port divided by annual cost. In reality the denominator should be the difference in annual costs between the deep draft and Musi port facilities. This approach is possible with the first four facilities, because they handle the same mix of cargoes, but could not be done for the deep draft facilities at Banyuasin primarily designed to handle bulk cargo, because there is no comparative cost figure for the port expansion in the Musi River. If we compute the Benefit/Cost Differential ratio then the three first deep draft alternatives all have minimum ratios of 2.0 and maximum ratios of 3.7.

It appears that a deep draft port development at Banyuasin before 1985 is not only justified but will also result

in significant benefits.

It is difficult to determine if it is more attractive to commence with a limited offshore terminal development, or the construction of a 3-4 berth port. This decision depends largely on the potential for handling bulkable cargoes in bulk.

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