9.4. Congestion in 1985

(1) Distribution of Arriving Time

It is assumed that the arriving time of ships calling at Sorong Port in 1985 will be distributed in Poisson's distribution pattern, as in 1979.

(2) Capacity of Anchorage Area

The anchorage area at Sorong Port is large enough that the limitation of anchorage capacity is not considered in the analysis.

(3) Distribution of Berthing Time

It is assumed that the distribution of berthing time of ships calling at Sorong Port in 1985 will be Poisson's distribution or Erlang's distribution (k = 2). However, the case of Regular distribution is taken into consideration for Erlang's distribution to see the sensitivity of these models.

(4) Cargo Volume by Kinds of Ships

The volume of cargoes by kind of ships is shown in Table 8.3.28. The detials of allocation of cargo volume by kinds of ships are described in Chapter 8.

(5) Loading and Unloading Factor

Loading factor is shown in Table 8.3.28. The factor seems small compared with the average value of all ships in Indonesia. It's because Sorong Port is located in the easternmost island in Indonesia, and it is close to the destination of the ship route.

(6) Number of Berthing Ships

The estimated number of ships calling at Sorong Port in 1985 is as shown in Table 8.3.28.

(7) Annual Operation Rate of Sorong Port

Information on wind direction, velocity and duration is indispensable for the estimation of waves in this port. However, no satisfactory observation records are available except for the records taken every three hours at the Yefman airport. Unfortunately these are also insufficient to be used for wave forecasting. The study team obtained observation data during the period of survey (one month) by an anemometer installed on the roof of the passenger terminal building at Sorong Port, but observation results of a longer period are necessary. Therefore, winds and waves at Sorong Port were estimated here under the following assumptions:

1) Judging from the topographical characteristics of Sorong Port, trouble-making waves are caused by:
   a. Prevailing winds from west or southwest during June to November.
   b. Prevailing winds from north-northwest, northwest or west-northwest during January to March.
2) Since the wind duration is unknown, it is assumed to be 3 hours.
3) The maximum wave height under which cargo handling is possible in the port is 0.7 m (significant wave height). The wind velocity at the wave height of 0.7 m or more is 7.5 m/s (14.6

knots) if it is determined by the SMB method, using the assumed fetch of 25 km in accordance with a. of assumption 1).

According to Table 6.2.1, the frequency of 11 knots or more, conservatively estimated is 8.2 percent (30 days/year). On the other hand, the frequency obtained by the same method in accordance with b. of assumption 1) is 2.8 percent (11 days/year).

Therefore, the annual operation rate of Sorong Port, as far as the wave height is concerned, is 89 percent (operating on 324 days/year). Taking other factors into consideration, 85 percent is adopted as the actual annual operation rate for Sorong Port.

(8) Necessary Equivalent Number of Berths

The necessary number of berths at Sorong Port in 1985 may be determined on the basis of the already obtained $\lambda = 610/(365 \times 0.85) = 1.966$ and $\mu = 16/23.8 = 0.672$ as follows:

1) If $\rho = 0.7$,

$$S = \frac{\lambda}{\rho\mu} = \frac{1.966}{0.7 \times 0.672} = 4.2 \text{ berths}$$

2) If ρ is 0.65, S = 4.5 berths
3) If $\rho = 0.6$, S = 4.9 berths

The above results are based on the asumption that the average berthing time in 1985 will remain at the same level as in 1979.

(9) Necessary Length of Berths

Berths in Sorong Port will be used by ships of all sizes. Construction of different berths for ships of different types and sizes are not considered for the following reasons:

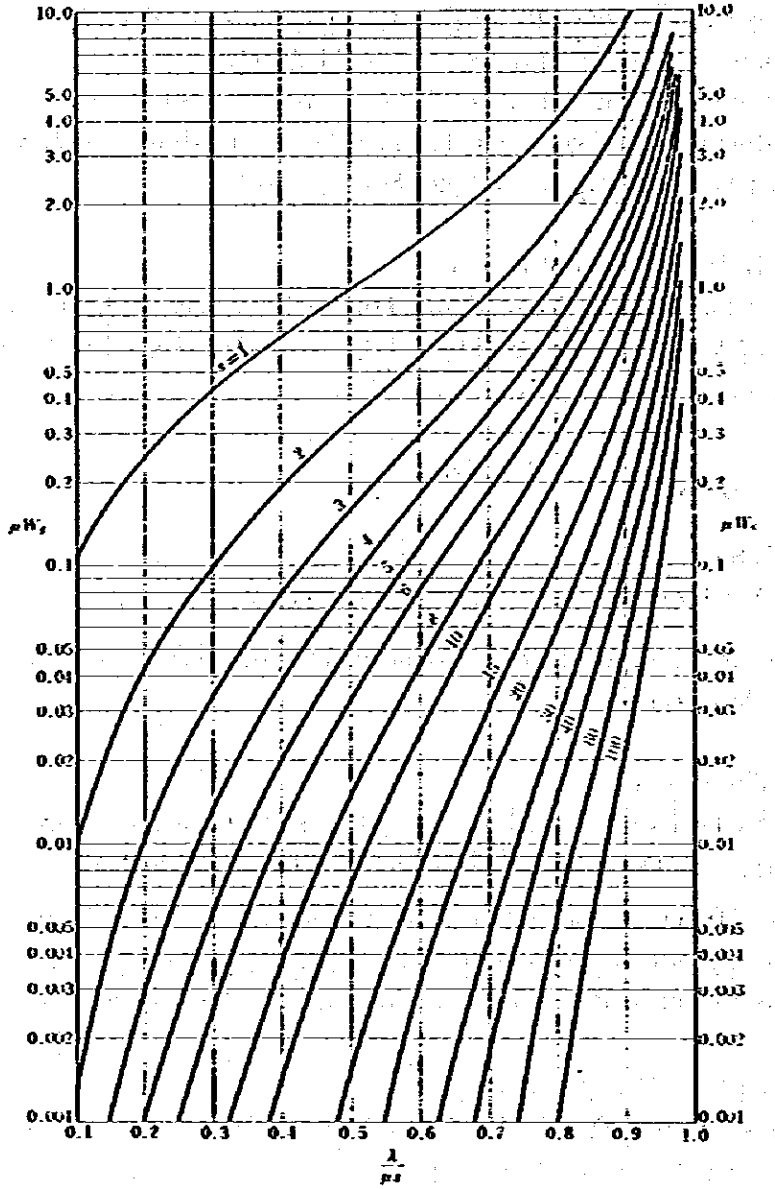
1) More than −10 m of water depth can be comfortably secured in front of wharves.
2) Cargo volume is not large enough to justify the exclusive use of wharves.
3) Continuous use of berths is more convenient, considering the presence of small local ships.
4) The anchorage is sufficiently large.

Ships berthing at Sorong Port in 1985 will be from Ocean Shipping, Nusantara (RLS and non-RLS) and Perintis. Small vessels such as Local ships and Rakyat, etc. are left out of the application of the queuing theory because they are considered a minor factor with only small waiting costs. These small ships will be berthed either when no large ships to which the queuing theory is applicable are berthed, or in the extra space of the berth when large vessels are berthed.

The conception of the number of equivalent berths is used to determine the necessary length of berths. The average berthed ship length La is:

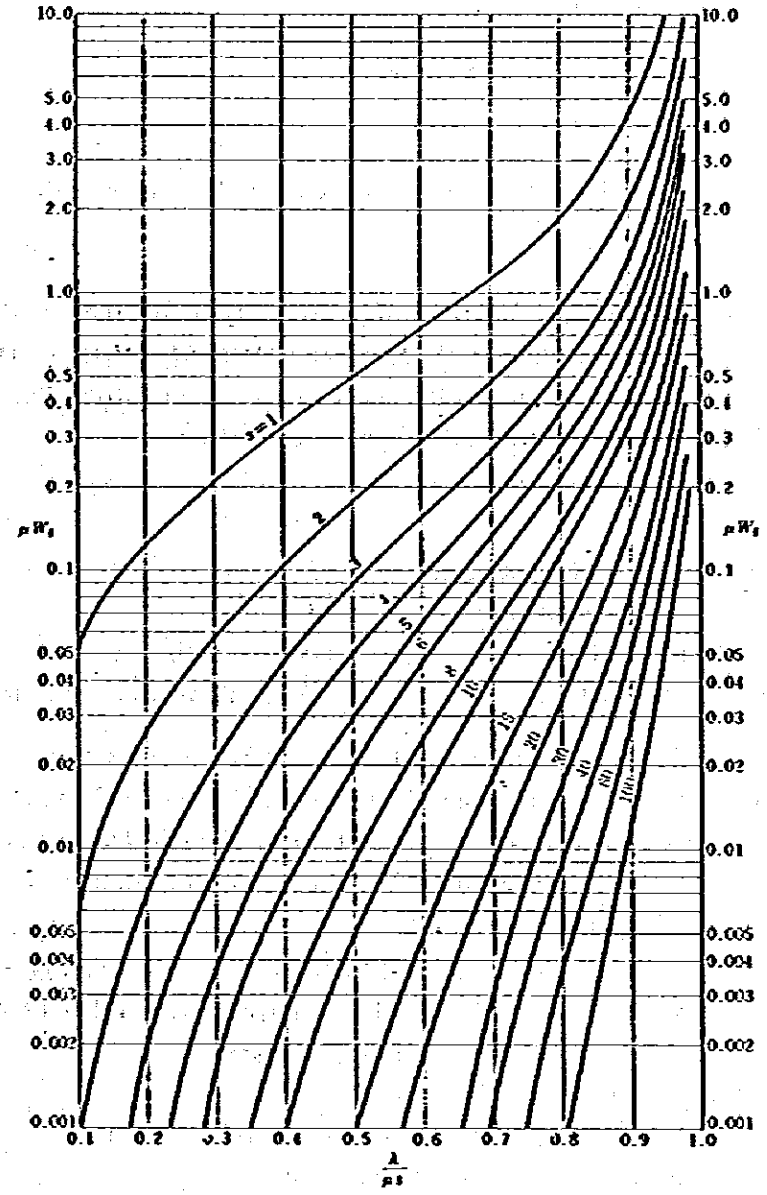
$$La = \frac{(133 + 20) \times 10 + (105 + 15) \times 355 + (61 + 10) \times 245}{610} = 100 \text{ (m)}$$

Fig. 9.4.1 (1) Relation Between ρ and μWq [M/M/S]



Source: H. Morimura & Y. Ohmae (1975), Applied Queuing Theory, Nikka Giren Publication (in Japanese)

Fig. 9.4.1 (2) Relation Between ρ and μWq [M/D/S]



Source: H. Morimura & Y. Ohmae (1975): Applied Queuing Theory, Nikka Gifen Publication, (in Japanese)

Therefore, if the number of equivalent berths is 4.2 to 4.9 (for berth occupancy ratio: 0.6 – 0.7) the necessary length of berths L_s is:

$L_s = 100 \times (4.2 - 4.9) = 420 - 490$ (m)

The length of berths to be newly constructed L_n is:

$L_n = (420 - 490) - 252 = 168 - 238$ (m)

This covers the berth length of 180 m obtained by the macroscopic analysis in Chapter 8.

(10) Congestion of the Port

Fig. 9.4.1. is the general outline of the results of analysis, by the queuing theory, of the relation between ρ and μWq, for models [M/M/S] and [M/D/S]. [M/(M or D)/S] in Fig. 9.4.1 shows that [distribution of arriving time is Poisson's distribution/(distribution of berthing time is Poisson's distribution or Regular distribution)/number of berths].

The summary of sections (1) to (9) is as follows:

Number of ship calls	:	610
Necessary number of equivalent berths	:	5
Equivalent number of berths in 1979	:	3
Distribution of arriving time	:	Poisson's distribution
Distribution of berthing time	:	Poisson's distribution or Regular distribution

Table 9.4.1. can be obtained from Fig. 9.4.1. by using λ, μ and S on the assumption that the available working time in 1985 is 16 hours, 6 hours longer than in 1979 and the average berthing time is 23.8 hours. The difference of the staying time of ships is 97.0 hours for the [M/M/S] model and 48.2 hours for the [M/D/S] model, if the equivalent number of berth in 1985 is 5 and it remains unchanged from 1979.

The average waiting time in 1978 is calculated by the same method as follows:

Number of ship calls	:	293 (number of large ships in Table 3.1.6. excludes tankers and special ships)
Working ratio of the Port	:	95%
Working time	:	10 hours (as same level in 1979)
Average berthing time	:	23.8 hours (ditto)
Equivalent number of berths	:	2.8 (Table 9.3.2.)

From these conditions each indexes are calculated as $\lambda = 293/365 \times 0.95 = 0.845$, $\mu = 10.0/23.8 = 0.420$ and $\rho = 0.845/0.420 \times 2.8 = 0.719$. Consequently, the average waiting time in 1978 is assumed as 1.62 days by the [M/M/S] model and 0.81 days by the [M/D/S] model.

Table 9.4.2 shows the state of berth in Sorong Port in terms of probability of state. According to this table, 5 percent represents the state of berths being unoccupied, 15 percent the state of one ship berthing, 20 percent the state of two ship berthing, 20 – 25 percent the state of three ships berthing, 17 percent the state of four ship berthing and less than 10 percent the state of five ships berthing. The probability of a ship waiting for vacancy is less than 10 percent.

$\rho = 0.588$ means that after the completion of the new wharf in 1985, the number of wharves is sufficient to meet the volume of cargo handled at Sorong Port.

Table 9.4.1. Average Staying Time (1985)

Model		S = 5 λ = 1.966, μ = 0.672 ρ = 0.588		S = 3 λ = 1.966, μ = 0.672 (ρ = 0.9*)		Difference in average staying time (hr)
[M/M/S]	Average number of staying ships : L	2.3		10.2		
	Average number of waiting ships : Lq	0.3		8.3		
	Average staying time : W	1.16 day	27.6 hr	5.2 day	124.6 hr	97.0
	Average waiting time : Wq	0.16 day	3.8 hr	4.2 day	100.8 hr	
[M/D/S]	Average number of staying ships : L	2.2		6.1		
	Average number of waiting ships : Lq	0.18		4.1		
	Average staying time : W	1.1 day	26.0 hr	3.1 day	74.2 hr	48.2
	Average waiting time : Wq	0.09 day	2.2 hr	2.1 day	50.4 hr	

Note: ρ=0.98 is theoretically obtained for S=3, λ=1.966 and μ=0.672, but ρ=0.9 is used taking the more realistic port situation into account.

Table 9.4.2. Probability of State of Berths in Sorong Port (1985)

S = 5 λ = 1.966 ρ = 0.588	[M/M/S]		[M/D/S]	
	Cumulative probability	Probability of state	Cumulative probability	Probability of state
State of berths being unoccupied	0.05	0.05	0.05	0.05
State of one ship berthing	0.20	0.15	0.20	0.15
State of two ships berthing	0.42	0.22	0.38	0.18
State of three ships berthing	0.62	0.20	0.63	0.25
State of four ships berthing	0.79	0.17	0.80	0.17
State of five ships berthing	0.86	0.07	0.903	0.103
State of one ship waiting	0.925	0.065	0.957	0.054
State of two ships waiting	0.957	0.05	0.982	0.025
State of three ships waiting	0.976	0.019	0.993	0.011

(11) Berth for small Vessels

The share of small vessels, such as Local ships and Rakyats, in the total number of vessels calling at Sorong Port is about 70 percent and the share of the cargo transported by small vessels is some 20 percent in 1979.

Though these small vessels were not included in the analysis of the waiting time and staying time as they are to berth in the space in between large vessels, it should be checked if wharves have enough space for them in 1985.

The total berthing days of large vessels with the length of more than 41 m is:

$$\frac{(23.8/24) \times 610}{5} = 121 \text{ days}$$

Since the average berthing time of large vessels is assumed 23.8 hours in 1985. However, as vessels usually berth during daytime from 6:00 to 18:00, the total days of berth occupancy will be 121 x (24/12) = 242 days.

Therefore, the total berthing days available for small vessels are:

$$365 \times 0.85 - 242 = 68 \text{ days}$$

The average cargo volume/ship for small vessels is 18.2 tons as shown in Table 9.4.3. and the average cargo handling time is about 3 hours assuming that the cargo handling efficiency is 5 ton/hour the average ship length is 18.6 m as shown in Fig. 9.3.1. and the cargo volume transported by small vessels in 1985 is 58,000 tons as shown in Table 8.3.23. Therefore, the total berthing days of small vessels is:

$$58{,}000/\{18.2/(3/24)\}/(430/18.6) = 17.2 \text{ days}$$
$$17.2 \times (24/12) = 35 \text{ days} < 68 \text{ days}$$

Therefore, the wharves at Sorong Port have enough length for small vessels as well as for large ones in 1985.

Table 9.4.3. Cargo Volume/Ship

	1974	1975	1976	1977	1978	1979 (1–8)
No. of ship call	283	656	367	537	611	373
Cargo volume (ton)	12,277	5,545	7,309	7,305	7,651	4,231
Cargo volume/Ship	43.4	8.5	19.9	13.6	12.5	11.3

Average cargo volume/Ship = 18.2 tons

(12) Limitation of the Queuing Theory

The model applied for the analysis of the congestion at Sorong Port does not always coincide with the actual phenomena (e.g., distribution of ship arrivals and seasonal fractuations). So some assumptions had to be made to supplement the lack of statistical data. The analysis being based on the hypothetical model, the result should be viewed with discretion.

The main assumptions for analysis are:

1) First in first serve (FI-FO)

2) Equivalent berth length
3) Distribution of arrival: Poisson's distribution
4) Distribution of berthing time: Poisson's or Regular distribution
5) Anchorage area is large enough
6) Berth occupancy ratio in 1979 = 0.8

The assumptions used for the calculation of the output data are:

1) Average berthing time in 1985 is 23.8 hours.
2) Available working time in 1985 is 16 hours.

9.5. Improvement of Cargo Handling Efficiency

The average cargo handling efficiency in 1985 is:

Cargo handling efficiency = 242,000/(610 x 23.8) = 16.7 t/hr since the number of berthed ships is 610 and the average berthing time is 23.8 hours. The loading and unloading factor of ships calling at Sorong Port from the main island of Java, etc. via various ports is low because Sorong is the distination of nearly all these ships. So, the assumed number of hatches is 1.

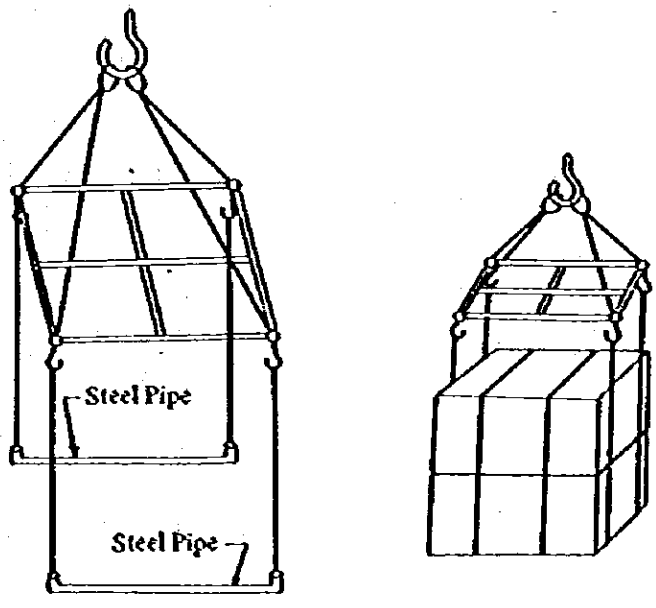
In the analyses in section 9.4 μ = 0.672 was used as the daily ships dealing capacity in 1985. This value can be achieved by increasing the working time from 10 hours in 1979 to 16 hours. Since μ can be expressed as daily available working time/berthing time, it is theoretically possible for μ to be increased in 1985 by either,

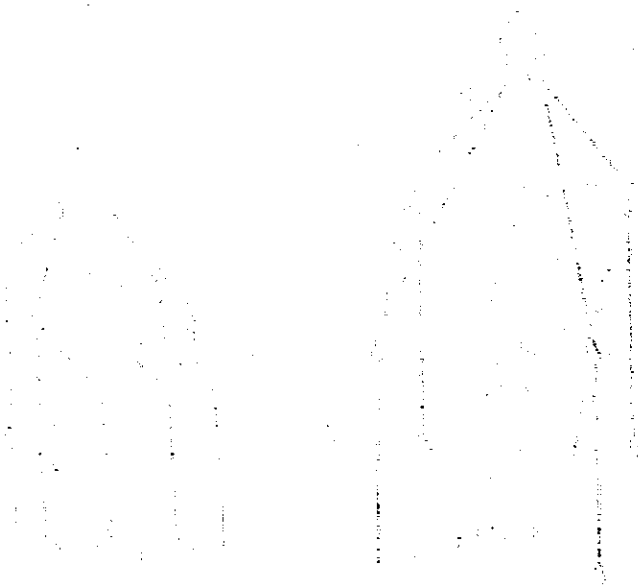
1) extending working time,
2) increase productivity of labour,
3) increasing mechanized cargo handling

and thereby reducing berthing time.

At the Port of Sorong, however, the major bottleneck of cargo handling exists in the low cargo handling efficiency with in the vessels. In order to solve the bottleneck, the introduction of pallet sling system shown in Fig. 9.5.1. is recommended as well as the extension of available working time by 6 hours.

Fig. 9.5.1. Pallet Sling System





Chapter 10.
PORT MASTER PLAN AND MEDIUM TERM PORT DEVELOPMENT PROGRAM

CHAPTER 10. PORT MASTER PLAN AND MEDIUM TERM PORT DEVELOPMENT PROGRAM

10.1. Scale of Port Development

10.1.1. Required Length of Berths

(1) Total Cargo Volume Handled at Public Wharves

As mentioned in 8.3., the volume of cargo handled at public wharves is estimated to increase from 84,000 tons in 1979 to 300,000 tons in 1985, and to 1,100,000 tons in 2000.

Table 10.1.1. Cargo Volume Handled at Public Wharves

($\times 10^3$ tons)

	1979	1985	2000
Total	84	300	1,100
Foreign Trade	35	30	140
Domestic Trade	49	270	960

Note: 1979 is based on STP of Sorong.

The cargoes can be classified by kinds of trade as in Table 10.1.2.

Table 10.1.2. Cargo Volume by Kinds of Trade

($\times 10^3$ tons)

	1979	1985	2000
Total	84	300	1,100
Foreign Trade	35	30	140
Inter-region	49	163	560
Feeder Service		107	400

Note: see Table 8.3.23.

(2) Required Length of Berths

The required length of berths is calculated by using throughput as in Table 10.1.3. With regard to the throughput of wharf, the target of 700 t/m is set for 1985 and the average of 900 t/m is set for 2000, with reference to Pelita III.

1985:

The length of berths required in 1985 is calculated to be 430 m.

However, since wharves with the length of 252m at depth ranging from –9 to –15m are already available a new wharf of 180m at depth evenly about –10m is to be constructed.

Existing wharves : depth –9 to –15m
length 252m

Wharf to be constructed	:	vessel size	15,000 DWT
		depth	-10.0m
		length	180m

2000:

The following are planned for 2000 to provide the required berth length calculated from the handling capacity.

Existing wharves	:	design vessel size	15,000 DWT
		depth	-10.0m
		length	180m
Extension	:	design vessel size	5,000 DWT
		depth	-7.5m (-9.0 to -15.0m)
		required length	135m
		existing length	120m
		extension	15m
Reconstruction (Wooden Wharf)	:	design vessel size	5,000 DWT
		depth	-7.5m
		length	135m
Wharves to be constructed	:	design vessel size	15,000 DWT
		depth	-10.0m
		length	740m (185m x 4 berths)
	:	design vessel size	5,000 DWT
		depth	-7.5m
		length	270m (135m x 2 berths)

(3) Width of Apron

The apron is planned to be 25m wide to realize efficient cargo handling.

Table 10.1.3. Required Berth Length by Route

Year	Route	Cargo Volume ($x10^3$ tons) (A)	Vessel Size (DWT)		Required Depth (m)	Handling Capacity (t/m) (B)	Berth Length (m)	
			Average	Maximum			A/B	Planned
1985	Foreign Trade	30						
	Inter-region	163						
	Feeder Service	107						
	Total	300	–	15,000	-10.0	700	430	432
2000	Foreign Trade	140	10,000	15,000	-10.0	900	160	185 (185x1)
	Inter-region	560	5,000	15,000	-10.0	900	630	740 (185x4)
	Feeder Service	400	1,000	5,000	-7.5	800	500	540 (135x4)
	Total	1,100	–	–	–	900	1,220 <1,290>	1,465

Notes:
1. Maximum vessel size is set based on past records and representative vessel sizes in Japan.
2. Handling capacity classified by route is based on Table 9.2.2, applying the throughput of large ports to large vessels, that of medium ports to medium vessels.
3. Berth length < > shows the total under each category and ( ) shows the applied standard berth length and the required number of berths.

10.1.2. Area Required for Transit Shed and Open Storage

(1) Cargo Volume Handled at Transit Shed and Open Storage

Cargoes can be divided into three groups depending on how they are handled after unloading: 1) cargoes stored in the transit shed to prevent damage due to rainfall and theft, 2) cargoes which may be kept safely at the open storage and 3) cargoes for immediate delivery without using these facilities. Refer to Table 10.1.4. for detail.

Table 10.1.4. Cargo Volume Handled at Transit Shed and Open Storage

(x10^3 tons)

	1985				2000			
	Total	Transit Shed	Open Storage	Direct	Total	Transit Shed	Open Storage	Direct
Foodstuffs								
Rice	27			27	89			89
Wheat	6	6			9	9		
Sugar	16	16			23	23		
Marine prod.	12			12	45			45
Live stock	2			2	2			2
Other crops	43	43			48	48		
Estate crops	46	46			178	178		
Sawn timber	1		1		241		241	
Machinery	18	9	9		46	23	23	
Vehicles	47		23	24	91		45	46
Chemical prod.								
Cement	25	25			68	68		
Fertilizer	46	26		20	96	48		48
Others	11	6	5		164	83	81	
Total	300	177	38	85	1,100	480	390	230

Items for immediate delivery:

Rice: government warehouses are to be used

Marine products: cold storage of private companies

Livestock: all for immediate delivery.

Vehicles and fertilizer: about 50 percent is to be delivered immediately.

Items projected for open storage:

Sawn timber: all for open storage

Machinery, vehicles and others: about 50 percent for open storage

(2) Area Required for Transit Shed

The area required for the transit shed is calculated by the following formula:

$$S = \frac{N}{R \cdot a \cdot w}$$

where:

S : area required for the shed (m^2)
N : annual cargo volume through the shed (ton/year)
R : rotation of cargo per year (20 – 25 times/year in Japan)
α : efficiency (= 0.5)
w : storage capacity (ton/m^2) (1.5 – 3.0 tons/m^2 in general)

consequently,

$$S_{1985} = \frac{177,000}{20 \times 0.5 \times 3.0} = 5,900\ m^2$$

$$S_{2000} = \frac{480,000}{2.5 \times 0.5 \times 2.5} = 15,360\ m^2$$

There is a transit shed of 97.5m x 20m in the back yard of the Concrete Wharf. The are of the existing shed is,

$$S_e = 97.5m \times 20m = 1,950\ m^2$$

Consequently, the area required for the new transit shed will be:

$$\Delta S_{1980-1985} = 3,950 \fallingdotseq 4,000\ m^2$$

$$\Delta S_{1985-2000} = 15,360 - (1,950 + 4,000) = 9,410 \fallingdotseq 9,400\ m^2$$

For cargo handling by vehicles, the cargo handling area will be constructed along the transit shed. The width of the area is planned to be 22m in view of the lengths of vehicles.

(3) Required Open Storage Area

The area required for the open storage may be obtained from the formula below.

$$S = \frac{N}{R \cdot \alpha \cdot w}$$

where,

S : area required for the open storage (m^2)
N : annual cargo volume through the open storage (ton/year)
R : rotation rate of the open storage
(20 – 25 times/year in Japan)
α : efficiency (= 0.5)
w : cargo volume handled per unit area (ton/m^2)
(1.5 – 3.0 tons/m^2 in general)

As for vehicles, however, separate open storage space is to be secured. The area is calculated on the assumption that parking space of 12.5m^2 (5.0m x 2.50m) is alloted per passenger car and 42.25m^2 (13.0m x 3.25m) per vehicle of other types. 60 percent of all vehicles is expected to be

passenger cars and 40 percent other types (Table 4.3.6). From these figures the area required for open storage may be estimated as below.

1985:

$$S_{1985} = \frac{(38{,}000 - 23{,}000)}{20 \times 0.5 \times 3.0} = 500\ m^2$$

$$Sy_{1985} = \frac{2{,}400 \times 0.6 \times 12.5 + 2{,}400 \times 0.4 \times 42.25}{25 \times 0.5} = 8{,}800\ m^2$$

The Port of Sorong is currently provided with open storage space of 5,225m², of which about 3,480m² may be used for open storage in 1985 as shown in Fig. 10.1.1.

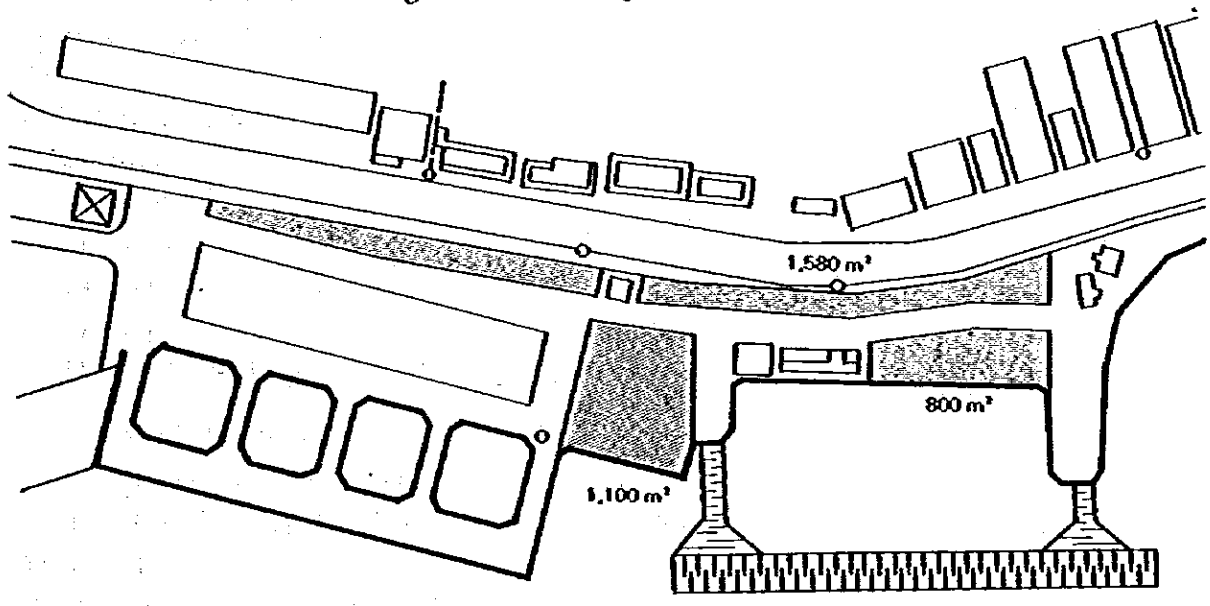
Accordingly, the additional area required for open storage in 1985 may be obtained as below.

$$\Delta S_{(1980-1985)} = 6{,}400 - 3{,}480 = 2{,}920 \fallingdotseq 2{,}900\ m^2$$

The existing open storage space along the road (the block of 1,580m² in Fig. 10.1.1.) will be turned to a green belt. Therefore, the additional area required in 2000 will be calculated as follows:

$$\Delta S_{(1985-2000)} = 19{,}800 - 6{,}400 + 1{,}580 = 14{,}980 \fallingdotseq 15{,}000\ m^2$$

Fig. 10.1.1. Existing Open Storage



(4) Passenger Terminal

The area required for the passenger terminal may be calculated from the formula below.

$$S = N \times \alpha \times a$$

where, S : area required for the passenger terminal (m^2)
N : number of annual passengers (people)
α : peak ratio (maximum number of passengers per day/N)
a : area required per passenger (m^2/person)

Accordingly, the area required for the passenger terminal in 2000 may be obtained as below.

$$S_{2000} = 30,400 \times 0.03 \times 1.2 = 1,101.6 \fallingdotseq 1,100\ m^2$$

10.2. Selection of the Site for Expansion

10.2.1. Characteristics of the Site

(1) Factors

As regards the site for the proposed expansion of Sorong Port, the area along the waterfront in Sorong Bay was selected, as shown in Fig. 10.2.1., based on the results of the preliminary survey and the first screening of the present survey.

In making the selection, the waterfront extending about 5km southeast from the island of Dofior was divided into 7 areas of 300m – 400m in radius, and characteristics of each area which might affect the expansion project were studied, so that comprehensive evaluation could be made. The factors to be considered here are listed below and Tables 10.2.1. (1) – (4) show the conditions of each area by various factors.

1) Present situation of the waterfront area and the future development plan
   a) distribution of flat land
   b) Present use of land
   c) urban planning
   d) distribution of housing (residential area)
   e) distance from the waterfront to the existing trunk road
   f) major landowners

2) Present use of the watersurface and the proposed plan
   a) main uses of the watersurface
   b) existing facilities
   c) plan for port facilities

3) Natural conditions
   a) rivers
   b) waves
   c) depth
   d) reefs
   e) soil
   f) littoral drift and sedimentation

4) Construction work

(2) Characteristics of Each Area

The characteristics of each area are described as follows:

1) Area 1

As can be seen from Fig. 10.2.1., there are hills close behind this area. Thus, with limited flat land and a large number of private houses, there is little room for the expansion of port facilities. There are no port facilities at present. Residential areas and greens are proposed under urban planning.

As this area is located on the outer side of Sorong Bay, it is likely to be subjected to the impact of waves during the season when northwest or west-northwest winds prevail. This may also be proven from the fact that the concrete revetment is constructed only to the north of this area.

Fig. 10.2.1. Prospective Site

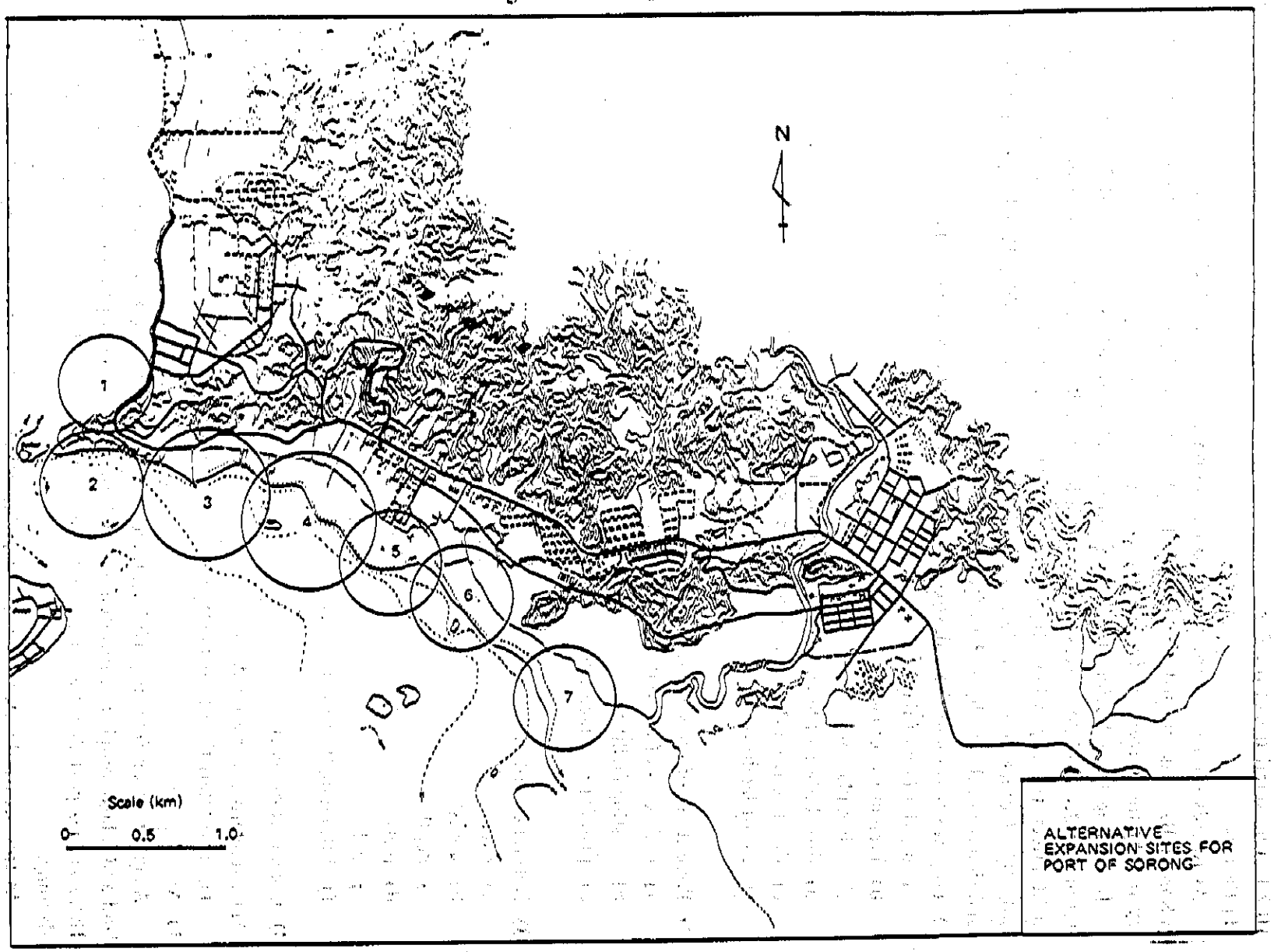


Table 10.2.1. (1) Present Situation and Plan of Waterfront Area

Items \ Site No.	1	2	3	4	5	6	7
1) Flat land area (refer to Fig. 10.2.1.)	small	small	large	large	large	larger	largest
2) Present land use (refer to Fig. 4.3.3)	recreation /residence	port (BPP)	government office/Pertamina/Usaha Mina	fishery	Pertamina's office, heliport/ W.I.F.I.	fishery workshop	no use
3) Town planning (refer to Fig. 4.3.2)	housing/ greenary	port area	port area	port area /warehouse	warehouse	port area (ferry/ fishing) recreation area	recreation area/ housing/sports center
4) Existing private houses	many	a few	a few	a few	no	a few	no
5) Distance from shore line to trunk road (refer to Fig. 4.3.4)	10 m	20 m	20 m	200 m	350 m	2~300 m	500 m
6) Land ownership (refer to 5.2.1)	private	BPP*	BPP (Pertamina & Usaha Mina)	Pertamina, Usaha Mina & Alfa Kurnia	Pertamina & W.I.F.I.	fishery company	

Note: * construction plan of port office

(2) Present Situation and Plan of Water Surface Area

Items \ Site No.	1	2	3	4	5	6	7
1) Water surface use	recreation	port	oil and fishery port	ship repair	fishery port/ cottage on the water	fishery port	no use
2) Existing facilities (refer to Fig. 5.2.2)	no	concrete wharf/ ferry jetty/ floating barge (Pertamina)	oil jetty (Pertamina) jetty (Usaha Mina)	slipway (Usaha Mina) jetty (Alfa Kurnia)	jetty (W.I.F.I.)	fishery's jetty	no
3) Planned facilities					jetty (now cancelled)	*	*

Note: * Between site 6 and 7, there is a construction plan of a jetty for bouy tender ship by the DGSC in 1980.

Table 10.2.1. (3) Natural Conditions

Items \ Site No.	1	2	3	4	5	6	7
1) Rivers (refer to Fig. 10.2.1)	no	no	no	no	Klademak Stream	no	Remu river
2) Wave (estimation)	a little	calm	calm	calm	calm	calm	calm
3) Sea depth (distance from shoreline to 10m deep) (refer to Fig. 6.3.4)	gentle (400 m)	very steep (80 m)	steep (150 m)	gentle (250 m)	gentle (300 m)	mild (200 m)	very gentle (800 m)
4) Reefs/shoal (refer to Fig. 6.3.4)	few	developed at Dofior	few	two shoal areas	few	a few reefs offshore	small islands to the south
5) Soil (refer to Fig. 6.3.5)	rock	sand/ gravel/rock	sand/ gravel	sand/ clay/gravel	sand/ gravel	sand/ gravel	sand/clay/ gravel
6) Depth of bearing stratum (refer to Fig. 6.3.5)	shallow (estimation)	0 to -4 m	-15 m	no up to -22 m	-11 m	-11 m	deep (estimation)
7) Littoral drift/sedimentation	no	no	no	no	little	little	prevalent

Table 10.2.1. (4) Construction Work

Items \ Site No.	1	2	3	4	5	6	7
1) Distance from seashore to quaywall	400 m	80 m	150 m	250 m	300 m	200 m	800 m
2) Area of stockyard for materials	small	small	small	small	small	large	largest
3) Bad effect of waves on construction work	much	little	little	little	little	little	little

Further, the distance from the shoreline to the depth of 10m is about 400m, requiring more extensive reclamation than in other areas for wharf construction.

2) Area 2

This area extends from the Nujew Point to the existing Concrete Wharf. It is the center of present port activities, with a floating barge of the Pertamina, Ferry Jetty in addition to the newly constructed Concrete Wharf and the trunk road runs just behind the area. The hinterland is mostly unoccupied except for some bars and amusement centers. Though the area is small, it is owned by BPP. The area is designated as a port area under urban planning.

With the Nujew Point blocking the waves, the waters are calm in this area. As shown in Fig. 10.2.1., the distance from the present shoreline to the depth of 10m is short with the slope of the seabed drastically steepening beyond the depth of about 5m. As regards the soil condition, the nearer to the island of Dofior, the closer the base rocks are to the surface as shown in Fig. 6.3.6. Since the distance to the depth of 10m is short, the area of reclamation and the size of revetment is small.

3) Area 3

The shoreline of this area is occupied by Pertamia and the Usaha Mina. The flat hinterland is larger than that of Area 2 because of the receding mountain skirts. According to the chief of the Sorong Port Administration, however, though the land shown in Fig. 5.2.1. (2) belongs to the Port of Sorong, it is on lease to the Pertamia and the Usaha Mina for a period of more than ten years. This area contains Oil Jetty of the Pertamia (including piping facilities), the cold storage of the Usaha Mina and the housing for port personnel.

This area is classified as a port area under urban planning. The area is featured by such natural conditions as 1) the depth of 10m is close to the shoreline, and 2) the seabed is expected to consist of sand and gravel, forming relatively trouble-free layers.

4) Area 4

Thought this area has fairly extensive flat hinterland, it is currently occupied by the Pertamina and the Alfa Kurnia Fisheries Company. The Alfa Kurnia has a wooden jetty in this area, which is used by shrimp boats engaged in offshore shrimp fishing. Because of the long distance from the shoreline to the depth of 10m, the scale of reclamation is expected to be fairly large. There are reefs in the waters in front of the area and the seabed foundation has a layer of cohesive soil, which are both unfavorable factors.

5) Area 5

The hinterland of the shoreline of this area is owned by the Pertamina, accommodating the headquarters of the Authority in Sorong. The W.I.F.I. Fisheries Company and its wooden jetty exclusively used by the company are also located in the area.

A small river flows into the sea on the eastern side of the area with a large concentration of stilt houses along the right bank. This area is classified as a warehouse area under the urban planning. Judging from the state of sedimentation, the discharge from the river is not so large. The terrain of the seabed is similar to that in Area 4.

6) Area 6

Though the flat hinterland is fairly extensive, the use of the land is not so extensive compared with other areas except Area 7. There is a wooden jetty extending into the sea, used exclusively by local fishermen, and a simple marine product processing plant at the base of the jetty. As regards private houses, there is only a small village.

In the urban planning, the port area is to be used by ferries and fishing boats and the rest of the area will be used for recreation. The distance from the shoreline to the depth of 10m is about 250m. Since there are reefs on the offshore side of this very spot, it will be necessary to remove them if the port area is to be secured by reclaiming as far as this point.

7) Area 7

This area is hardly developed and the flat land is the largest when compared with other areas. But it will be necessary to construct an access road to the port and water facilities. With the Remu River flowing on the eastern side of the area, the sediment runoff from the river is estimated to be fairly large compared with other areas judging from Fig. 6.3.4. Maintenance dredging after the construction of the wharf is, therefore, estimated to be costly.

10.2.2. Selection of the Site for Proposed Expansion

(1) Suitable Site for Port Development

Suitability of each area for port development was evaluated as below on the basis of the characteristics given in the Section 10.2.1.

Area 1 was found to be unsuitable for port development because of the bad natural conditions (particularly waves and the slope of the seabed) and the limited land area in the hinterland.

Area 7 is also unsuitable for a large-scale port development because 1) the cost of constructing an access road and water supply facilities will be larger than in other areas and 2) dredging may become necessary as the depth in front of the berth may decrease due to the sedimentation runoff from the Remu River after the construction of the berth.

As regards other five areas, there are no decisive factors of natural conditions, by which to choose one or the other. In the urban planning, Areas 2, 3, 4 and 6 are classified as prot areas while Area 5 is designated as a warehouse area.

Accordingly, the suitability of these areas for the development of a new public wharf should be evaluated by the convertability of the use of waters or hinterland. Since the Port of Sorong is expected to retain its present character of the major port for goods distribution, oil supply and fisheries into the year 2000, the present form of port utilization is not expected to undergo a major change. Therefore, the existing port facilities for oil supply and fisheries are assumed to remain the same, or become more productive in 2000 owing to possible improvements.

From this point of view, changes in the use of Areas 3, 4 and 5, where there are permanent port or hinterland facilities, will be extremely difficult. Even if it is possible, it is likely to take a long time for those concerned to reach an agreement and removal of facilities would certainly entail compensation.

As regards Areas 2 and 6, though some facilities already exist, the ferry jetty and the Pertamina floating barge for unloading in Area 2 are temporary structures and the wooden jetty

in Area 6 is judged to have short service life.

In view of these findings, it is appropriate to consider that Areas 2 and 6 are suited for the port development in Sorong.

(2) Site for Medium Term Port Development Program

The length of the berth required for the Port of Sorong in 1985 is estimated to be 180m. In the present plan in which 1985 is the target year, the time allowance for the commencement of construction is small and so is the size of the new berth.

Accordingly, the search of the construction site was confined to areas where the proposed berth could be used integrally with existing facilities and where the necessary space for the construction of the new berth could be secured easily.

As already mentioned, the floating barge of the Pertamina and the ferry jetty run by BPP are located in Area 2. Therefore, it will be necessary to provide alternative facilities when constructing the new wharf. The function of the floating barge may be provided by the new wharf. The ferry jetty may be replaced by a new one. Since the space behind the new berth will not be sufficient for the construction of a transit shed and open storage, it will be necessary to reclaim some area.

(3) Site for Master Pla

In order to cope with the large quantity of cargo of the terminal port of Sorong 1,220m-long public berths will be necessary in 2000. Also required are the open storage space of about 20,000m^2 and the transit shed of about 16,000m^2. As area 2 id not large enough to accommodate such facilities, the master plan will be formulated for more spacious Area 6.

10.3. Proposed Master Plan

10.3.1. Utilization Plan of the Seafront

The port has a great possibility of becoming a terminal port in future owing to its geopolitically good location at the west end of Irian Jaya and the existence of calm, wide and deep sea area. The district also has a high potential to develop fishery and related industries on a large scale in future. On the other hand, the residents in the area will start to strongly demand recreation and natural beaches. It is necessary to frame a seafront utilization plan covering the port area, in order to coordinate these diverse demands and to promote the port improvement program smoothly.

Based on the results mensioned in 10.2., the following scheme is recommended. The seafront of the port area between the Nujew Point and the Remu River is suitable for the port activities. Recreation area is allocated to the west beach which faces the open sea. A fishery zone extends from the mouth of the Remu River toward southeast direction.

10.3.2. Forecast of Traffic Volume

(1) Basic Consideration

The equation below is the empirical formula now used for port master plan projects in Japan. By this formula, the traffic volume of the peak hour may be estimated, uisng the annual cargo volume to be handled by the port. In this formula, commuter traffic volume is not considered.

$$\text{Design traffic volume (vehicles/hour)} = z \times \frac{\alpha}{w} \times \frac{\beta}{12} \times \frac{\gamma}{\zeta} \times \frac{1+\delta}{\epsilon} \times \sigma$$

where,

- z : annual cargo volume (tons)
- w : average real loadage of a truck (tonnage/truck)
- α : share of modal split by trucks
- β : monthly variation (peak month/ordinary month)
- γ : daily fluctuation (peak day/ordinary day)
- δ : ratio of related vehicles (related vehicles/all trucks)
- ϵ : real load ratio (loaded trucks/all trucks)
- σ : hourly fluctuation (traffic volume of peak hour/traffic volume of peak day)
- ζ : average number of days operated per month

The study team observed the car traffic in the port area; but few vehicles were counted. Mainly from the results of interviews the characteristics of the car traffic in the port were concluded as follows:

a) Only several vehicles usually generate in connection with the port activities in a day. When a ship carrying rice (1 time in a month) berths, 4 trucks are observed to be used for cargo handling per hour (10:00 – 15:00).
b) The trucks are small, and the main types are pick up, wagon and small trucks.
c) The service area is limited within Kota Sorong at present because of the undeveloped road

network. This situation will not change in the year of 1985. However, the road is expected to extend beyond Klamono in 2000.

Considering future changes in these conditions and experiences in other ports, following figures are adopted:

	w	β	γ	ζ	δ	ε	σ	α
1985	1	1.2	1.5	25	0.5	0.5	0.16	1
2000	2	1.2	1.5	25	0.5	0.5	0.16	1

(2) Design Traffic Volume of the Port

The annual cargo volume to be handled in 1985 has been planned as 300,000 tons, 79,000 tons of which are to be transported from/to inland areas by trucks. Therefore, the design traffic volume may be calculated as below:

$$N'85 = 79{,}000 \times \frac{1}{1} \times \frac{1.2}{12} \times \frac{1.5}{25} \times \frac{1+0.5}{0.5} \times 0.16 = 227.52 \fallingdotseq 230 \text{ v/hr}$$

The annual cargo volume to be handled in the year 2000 has been planned as 1,100,000 tons, 48,000 tons of which are to be handled by trucks at the West Wharf and 112,000 tons may be at the East Wharf.

The design traffic volume may be calculated as below:

West Wharf:

$$N_{2000_w} = 50{,}000 \times \frac{1}{2} \times \frac{1.2}{12} \times \frac{1.5}{25} \times \frac{1+0.5}{0.5} \times 0.16 = 69.12 \fallingdotseq 70 \text{ v/hr}$$

East Wharf:

$$N_{2000_e} = 112{,}000 \times \frac{1}{2} \times \frac{1.2}{12} \times \frac{1.5}{25} \times \frac{1+0.5}{0.5} \times 0.16 = 161.28 \fallingdotseq 170 \text{ v/hr}$$

(3) Future Traffic in the Provincial Road Connected with the Port

The present traffic at the survey station is approximately 900 vehicles in a peak hour, as shown in the Section 4.3.(4). If the traffic increases along with the arithmetic means of GRDP and the population in Sorong, the traffic in a peak hour will be 1,500 vehicles in 1985 and 2,600 vehicles in 2000.

Table 10.3.1. Growth Rates of GRDP and Population

	1985/1978	2000/1978
GRDP	2.09	4.12
Population	1.20	1.72
(GRDP + Population)/2	1.65	2.92

The capacity of the provincial road is 1,800 pcu per hours.

For the year 1985:

The total traffic has been calculaged to be less than 1,730 (230 + 1,500).

Thus, the capacity of the road along the port is sufficient to accommodate this traffic.

For the year 2000:

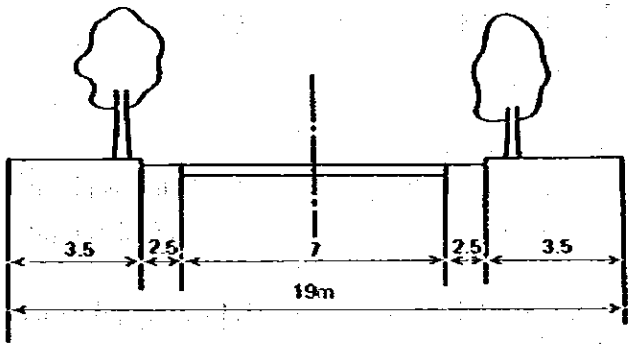
The traffic, excluding the traffic generated in the port, is already expected to exceed the capacity of the road in the western area of Klademak.

To meet this traffic demand it is necessary to improve and widen the provincial road. However, it is difficult to find extra open space along the road, especially in the Tg. Nujew area. Thus, improvement of the Kabupaten road, which connects Kampung Baru and Klademak area, passing through the inland hilly area, is recommended to be implemented before the year 2000.

If the same volume of traffic, 2,600 vehicles in a peak hour, is generated in the East Wharf, two provincial roads will easily divide the traffic between them. These roads will sufficiently meet additional demands from the port. The new provincial road will be the main road for the port in the eastern area.

Three two-lane access roads are sufficient to cope with the traffic of 170 vehicles. Fig. 10.3.1. shows a typical section of the access roads. Considering the traffic of heavy trucks in the future, a lane width of 3.5m has been proposed.

Fig. 10.3.1. Typical Section of the Access Road



10.3.3. Land Utilization of Port Area

In addition to the rear for cargoes and passengers, such as apron, transit shed, open storage and passenger terminal, the area for port management functions are required in the port area.

(1) Area for Port Management Facilities

The port area will be divided into two blocks in 2000: the East Wharf and the West Wharf.

The port management functions, such as port adminsitration office, custom, security office and so on will be newly developed in the East Wharf. The area for these functions, will be 10,000 m^2.

(2) Area for Warehouses

In the West Wharf, many warehouses have already been built. Therefore, no additional area for warehouses is planned.

In the East Wharf, a new area is planned for warehouses.

The area will be twice as large as the transit shed area since it will be used by the commercial sector as well.

(3) Parking Lot

The area required for the parking lot may be estimated on the basis of the number of vehicles generated by the port management. The traffic volume within the port in 2000, has been estimated 70 vehicles/hour in the West Wharf and 170 vehicles/hour in the East Wharf. The share of the vehicles generated by the port management is one-third od the total traffic volume.

Consequently,

$$S = N \times \delta \times h \times a \times (1 + r)$$

where,

- S : required area of the parking lot (m^2)
- N : traffic volume generated by the port (v/hr)
- δ : ratio of related vehicles ($= \frac{1}{3}$)
- h : average parking hour (= 4 hrs)
- a : required area per vehicle (12.5 m^2 for passenger car)
- r : related area ratio (=0.8; passage 0.5 and green belt etc. 0.3)

$S_W = 70 \times \frac{1}{3} \times 4 \times 12.5 \times (1 + 0.8) = 2,100\ m^2$

$S_E = 170 \times \frac{1}{3} \times 4 \times 12.5 \times (1 + 0.8) = 5,100\ m^2$

(4) Yard for Buoy Tender

For storing yard and work shop of buoys, yard of 7,400 m^2 is planned at the East Wharf.

(5) Basin for Small Crafts

For mooring of small crafts, such as tug boats, pilot boats and others, a basin for small crafts has been planned as in Table 10.3.2.

Table 10.3.2. Basin for Small Crafts

	Water Depth (m)	Vessel Size (G/T)	Area (m^2)
Basin for small crafts	3.5	150	11,000

Note: Design vessel size is assumed as follows;

Gross Tonnage	150 G/T
Overall Length	30 m
Draft	3.0 m

10.3.4. Layout of Master Plan for 2000

(1) Total Required Area

According to the results mentioned above, the land utilization in 2000 is summarized as in Table 10.3.3.

In this Table, figures in parenthsis are the results of calculation and mean the minimum required area for each facilities. Other figures show the result of layout. The layouted area is short of the required area in the West Wharf but on the other hand exceeds in the East Wharf. However, both totals are almost equal in the whole area (Layout: 42,300 + 284,000 = 326,300 m^2, Required: 72,000 + 250,000 = 322,000 m^2).

Table 10.3.3. Land Utilization of Port Area (2000)

(m^2)

		West Wharf	East Wharf	Remarks
Wharf Area	Apron	9,800 (11,300)	25,300 (25,300)	(berth length x 25 m)
	Transit Shed	6,000 (6,000)	12,000 (9,400)	
	Open Storage	6,100 (5,900)	62,500 (13,900)	includes tank yard and yard for container vans
	Passenger Terminal	1,100 (1,100)	1,100 (1,100)	
	Cargo Handling Area	2,500 (4,800)	7,500 (5,700)	length of transit shed x 1.10 x 22 m
Port Related Area	Port Management Offices	–	20,500 (10,000)	
	Warehouses	–	28,000 (18,800)	
	Parking Lot	2,100 (2,100)	14,500 (5,100)	
Others	Green Belt	3,200 (18,200)	22,300 (62,100)	(25% of total area)
	Buoy Tender Yard	–	7,400	
	Road	10,500 (21,600)	66,700 (75,000)	(30% of total area)
	Reserved Area and Others	1,000	16,200	
Total		42,300 (72,000)	284,000 (250,000)	

Note: 1. Figures in parenthesis are the results of calculation and mean the minimum required extent of each utilization.
2. The area of transit shed and open storage are alocated to West and East Wharf by using cargo handling capacity of each wharves.
3. As for passengers, it is so difficult to move from one wharves to another wharves in response to the ship, that the passenger terminals of 1,100 m^2 will be planned to construct in each wharves.

(2) Layout of the Master Plan

Layout of the Master Plan is presented in Fig. 10.3.2., and the details of land utilization is shown in Fig. 10.3.3. (1) and (2).

Tank yard for liquid bulk cargoes such as fuel oil and silos for non liquid bulk cargoes such as bulky wheat flour, grains and cement are located at the back of the transit shed in the East Wharf.

Regular calls of full container ships at the port are not supposed in the Master Plan. But it is sure that containers will become more popular even in the domestic trade. So a large lot of open storage is layouted in the East Wharf for stacking of containers.

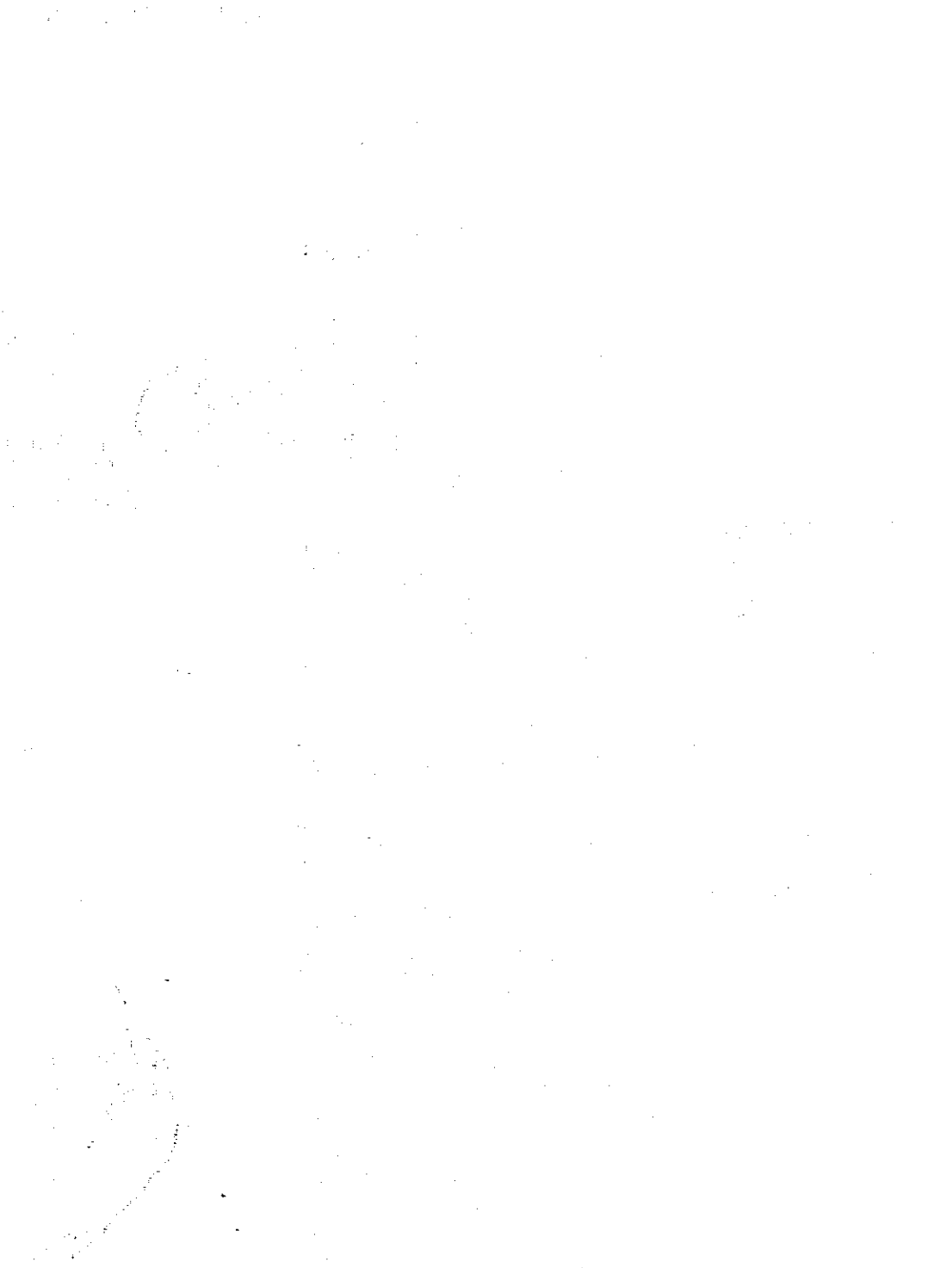
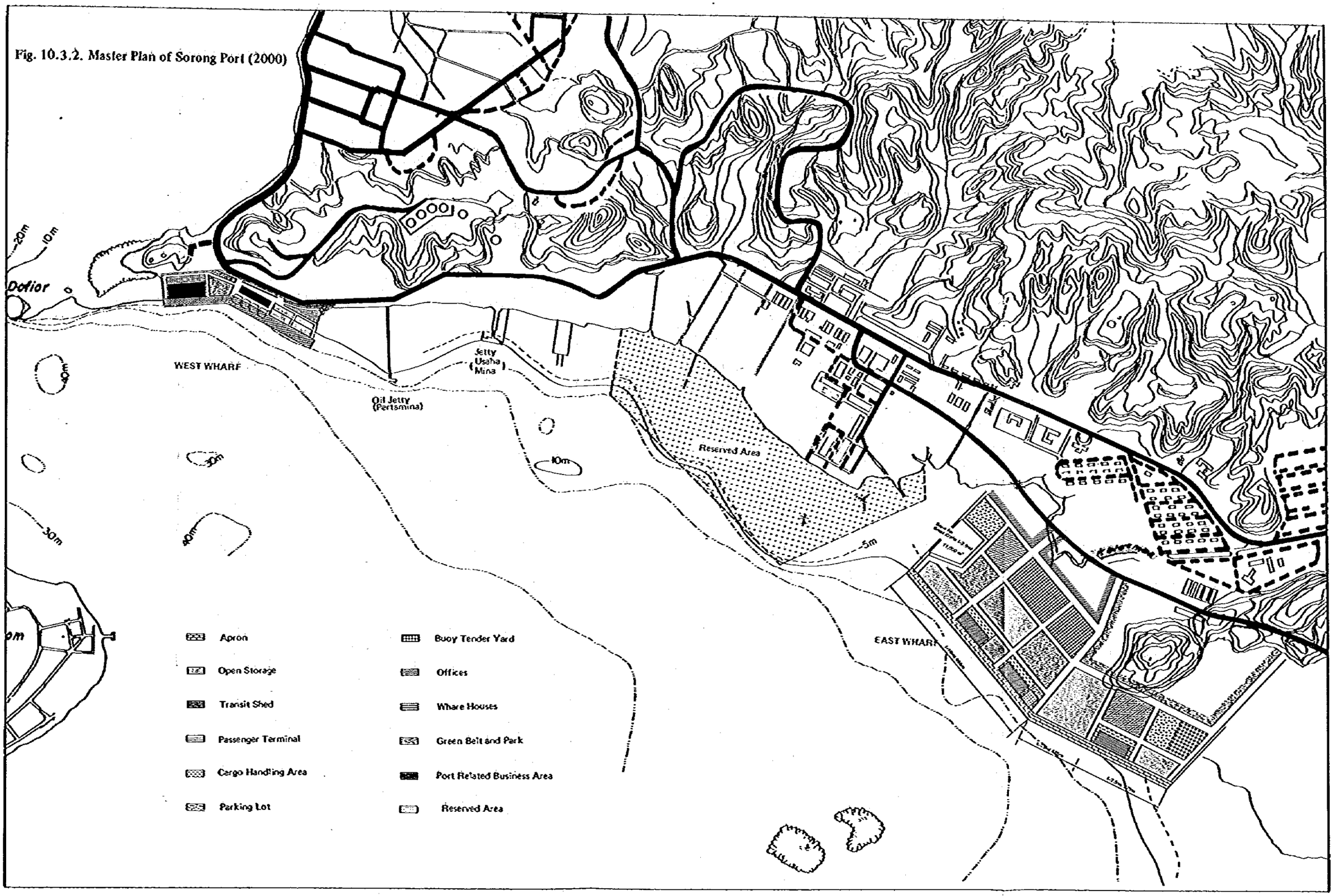


Fig. 10.3.2. Master Plan of Sorong Port (2000)



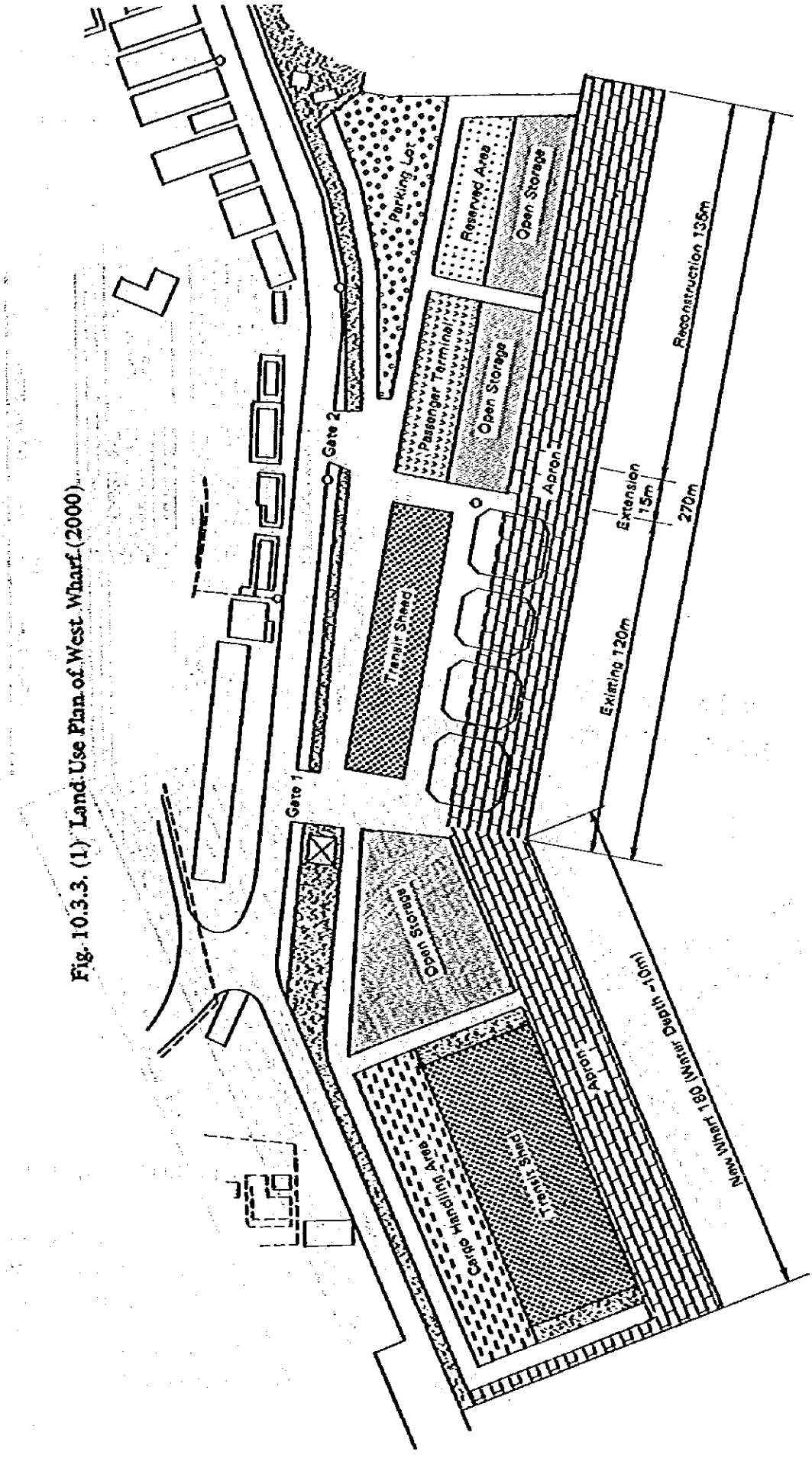
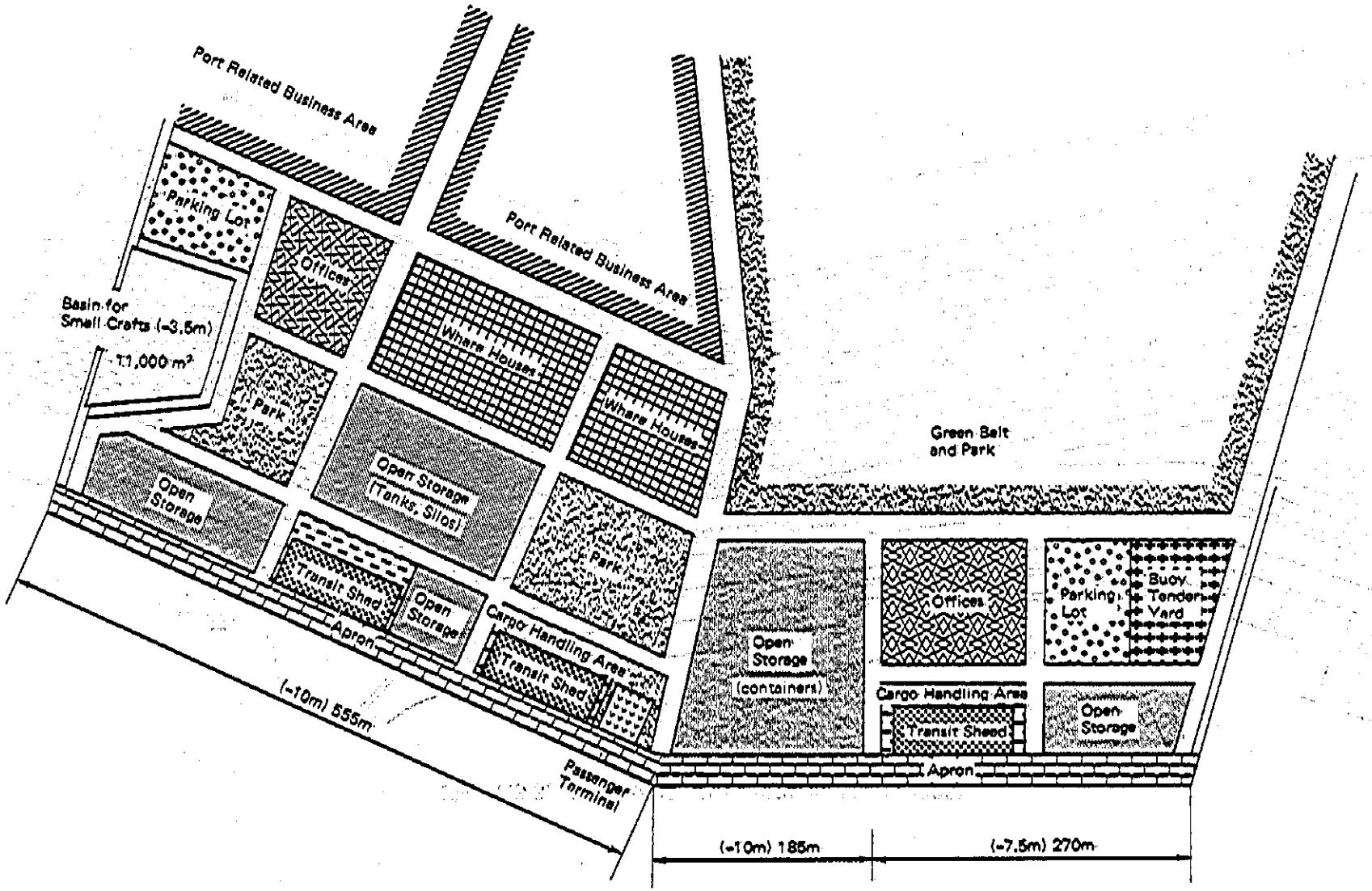


Fig. 10.3.3. (1) Land Use Plan of West Wharf (2000)

Fig. 10.3.3. (2) Land Use Plan of East Wharf (2000)



10.4. Medium Term Port Development Program for 1985

10.4.1. Lay Out of Port Facilities

(1) Wharf

Newly required wharf of −10m in depth and 180m in length is located next to the existing Concrete Wharf in order to realize the combined use of the new wharf and the existing one.

(2) Transit Shed and Open Storage

Newly required transit shed of 4,000m² is located at the back of the new wharf.

To enable the use of the standardized steel frame, the dimensions of the transit shed are assumed to be 40m in width and 100m in length.

Right behind the transit shed is planned a cargo handling area of 22m in width.

(3) Open Storage

Newly required open storage of 2,900m² is located at the back of the new wharf, the eastern side of the newly reclamated land.

(4) Road

Roads of 2-lanes (7m width) are planned in the wharf in order to realize smooth transport of cargoes.

Table 10.4.1. Land Utilization in the New Wharf

Items	Area (m²)	
Apron	4,620	(24.4%)
Open Storage	2,900	(15.3)
Transit Shed	4,000	(21.2)
Cargo Handling Area	2,460	(13.0)
Revetment	350	(1.9)
Road	2,340	(12.4)
Green Belt	2,230	(11.8)
Total	18,900	(100.0)

Note: Excludes the road connected the Ferry Jetty to the existing road.

10.4.2. Layout of Other Facilities

(1) Ferry Jetty

Since the existing ferry jetty is superannuated, a new jetty (pontoon type) is planed to be constructed on the west side of the new wharf.

Design maximum vessel size : 500G/T
Water depth : -4.5m

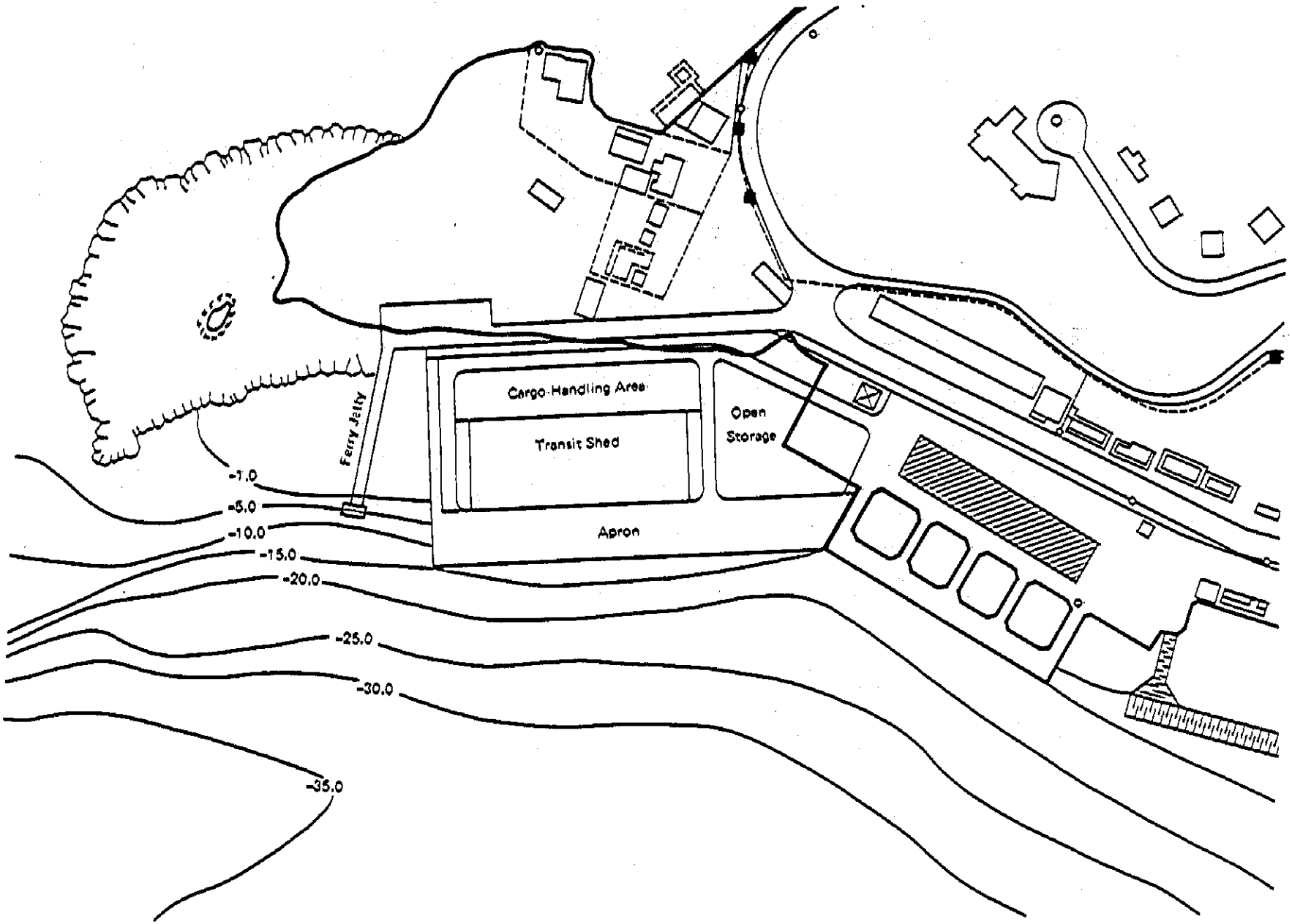
(2) Pontoon of Pertamina

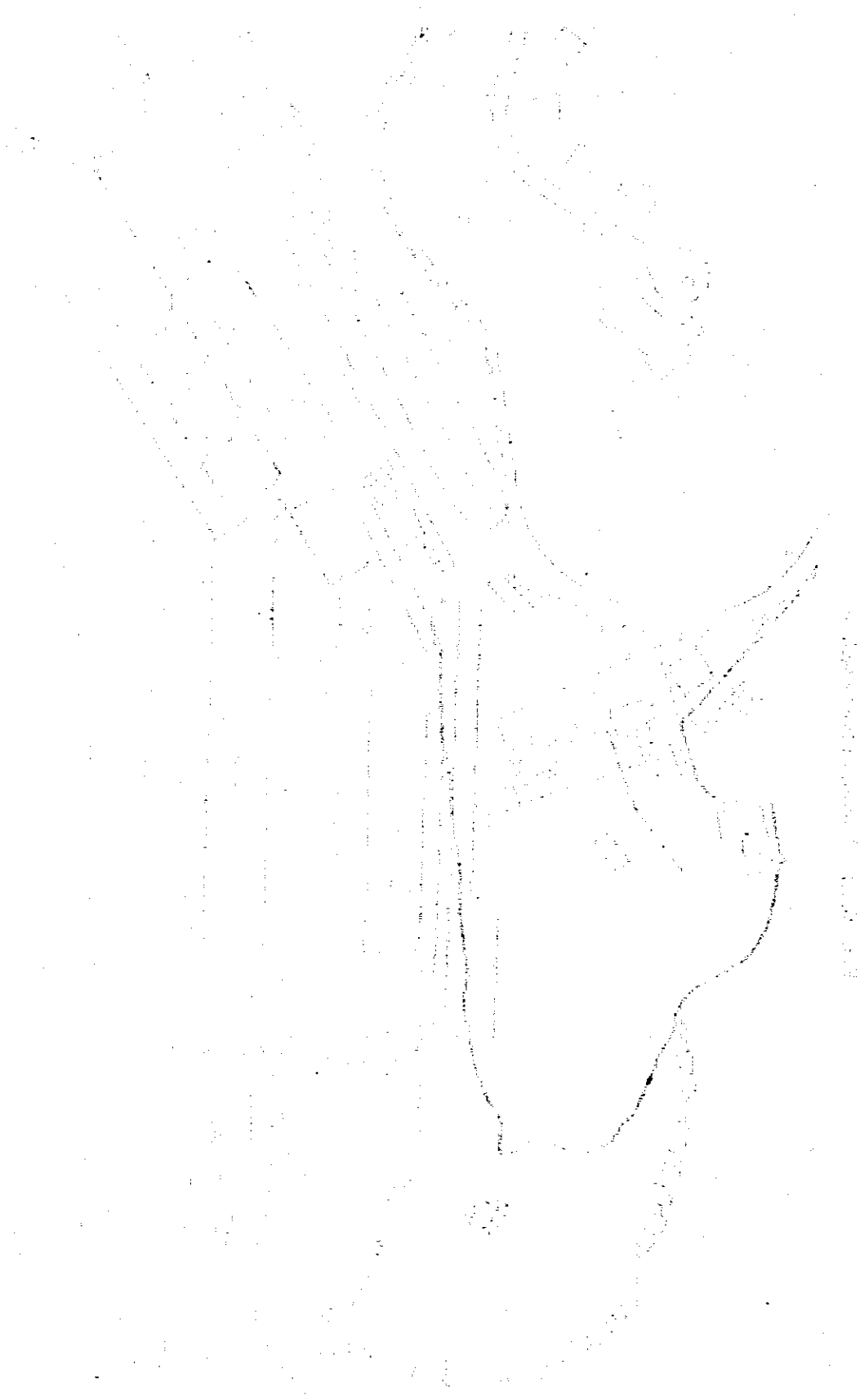
An alternative facility for the pontoon of Pertamina is not planned in this program. Cargoes for Pertamina such as pipes, drums and so on are assumed to be handled at the public wharves.

10.4.3. Layout of the Port Facilities

These facilities are arranged on the west side of the existing Concrete Wharf.
Layout of the port facilities is shown in Fig. 10.4.1.

Fig. 10.4.1 Layout of Port Facilities





Chapter 11.
DESIGN AND COST ESTIMATE

CHAPTER 11. DESIGN AND COST ESTIMATE

11.1. Conditions of Design and Cost Estimate

11.1.1. Desin Condition

The design conditions of the wharf which is the major structure of the port facilities in Medium Term Port Development Program, are as shown in Table 11.1.1.

Table 11.1.1. Design Conditions for Wharf in Medium Term Port Development Program

Items	Design Conditions for 15,000 DWT vessels
1. Object vessel	General Cargo vessel of 15,000 DWT vessels with 0.10–0.15 m/sec of approaching velocity
2. Tide level	HWL: +1.80 m
3. Top Elevation of Pier	+3.50 m
4. Water Depth in front of Pier	deeper than -10.0 m
5. Load to be supported	Uniform load: 3.0 t/m² (usual), 1.0 t/m² (earthquake) Live load: Forklift 6t, Truck Crane 15t
6. Condition of foundation	Bearing layer with N = 50 is at -10 to -20 m Seismic Coefficient Kh = 0.1
7. Allowed stress	Reinforced concrete σ = 80 kg/cm², Plain concrete = 53 kg/cm², steel = 1,400 kg/cm² Corrosion rate = 0.025 – 0.15 mm/year
8. Safety factors	Circular failure 1.3, Sliding 1.2, Overturning 1.2, Bearing of pile 2.5, Pulling of Pile 3.0
9. Durable years	50 years (20 years in cathodic protection and the rest in steel thickness if steel used).

Note: Tide level, HWL = +1.80m, is derived from "Tide Tables" published by Markas Besar Tni-Angkatan Laut, Jawatan Hidro-Oceanographi, Jakarta, 1980.

11.1.2. Construction and Cost Estimate Condition

The conditions of construction/cost estimate for the proposed port facilities are shown in Table 11.1.2.

Table 11.1.2. Conditions of Construction/Cost Estimate for Port Facilities

Items	Construction Conditions
1. Natural condition	Sea phenomena are not adverse.
2. Labor	Skilled labors will be provided from other places.
3. Equipment	Big working crafts are to be provided from Surabaya, Tg. Priok, Singapore or Japan (Pile Driver, Suction pump, floating crane)
4. Material	Timber, Sand and Stone from Sorong, other materials from other places.
5. Reclamation	Soil from hill by truck.
6. Schedule	Engineering service: 11 months Preparation of budget: 6 months
Items	**Conditions for Cost Estimate of Construction**
1. Exchange rate	1 US dollar = 625 Rupiah
2. Price base	is the expected 1980 base
3. Import duty	is not considered for imported material/equipment
4. Sales Tax	is considered for local currency portion
5. Contigency	is 15 percent for physical unknown factors and 15 percent for prices

The port of Sorong has various disadvantages for the port construction work, and they must be fully taken into account in considering the work method.

1) Capacity of construction

A contractor has to be introduced from outside since there is no contractor who is capable of carrying out the construction project in the area. The construction temporarily requires quite a few skilled laborers who must also be introduced from outside as it is impossible to recruit them from the area around the port.

2) Construction equipment

Large construction craft (such as pile driving barge, pump dredger and floating crane) are not available at the site. They must be brought in from Surabaya, Tg. Priok, Singapore or Japan. The cost of bringing them to the site constitutes a significant portion of the construction cost. Construction equipment (such as buldozers, power shovels and mobile cranes) may be introduced from Java island or other areas.

3) Construction materials

Construction materials that are available at the site and in the peripheral area are only timber, sand and stones. Other materials such as cement and steel that are used in great quantities have to be introduced from other areas.

4) Conditions of cost estimates

Other factors to be considered are as follows:

a) The exchange rate 1 US dollar = 625 Rp.

b) Customs duties for the imported construction materials and equipment and taxes are not included.

c) For the local currency, a sales tax of 5 percent is considered.

d) The price contingency is taken at 15 percent.

11.2. Design of Main Facilities

11.2.1. Comparative Design

For the 15,000 DWT vessels new wharf, four alternative plans (A, B, C and D) were prepared and compared.

Plan A : Open-type wharf with vertical piles-steel pile (Fig. 11.2.1.)
Plan B : Steel pipe type quaywall (Fig. 11.2.2.)
Plan C : Caisson type quaywall (Fig. 11.2.3.)
Plan D : Open-type wharf with battered piles-concrete pile (Fig. 11.2.4.)

As the result of comparison in terms of economy and workability, it is decided to employ alternative plan A (Open-type wharf with vertical piles – steel pile).

Table 11.2.1. Comparison Table

Item \ Type	Plan A Open-type wharf with vertical piles (steel pile)		Plan B Steel pipe type quaywall		Plan C Caisson type quaywall		Plan D Open-type wharf with vertical piles (concrete pile)	
Workability at sea	Very easy	◎	Very easy	◎	Not so easy	Δ	Easy	○
Construction Control	Very easy	◎	Very easy	◎	Not so easy	Δ	Easy	○
Amount of work	Small	◎	Small	◎	Much	Δ	Relatively small	○
Construction speed	Very fast	◎	Very fast	◎	Not so fast	Δ	Fast	○
Adaptability to change in ground	Good	◎	Adaptable	○	Adaptable	○	Not adaptable	×
Requirement of corrosion prevention	Required	Δ	Required	Δ	Not required	◎	Not Required	◎
Economy Construction cost ratio (steel pipe pile type=1.0)	1.0		1.13		1.17		1.18	

Note: 1. In the case of Plan A, B, it is practicable to penetrate a steel pipe pile or pipe type sheet pile for about 0.5m–1.0m into the bearing layer of N value at about 50, but in the case of Plan D it is difficult.
2. Construction cost for standard section.

(1) Alternative Plan A (Open-type wharf with vertical piles-steel pile)

1) Pile driving of steel pipe piles is made by a pile driving barge (a diesel pile hammer (D-40)). It is made at a rate of 4 piles/day.

2) A steel pipe pile is lighter in weight than a reinforced concrete pile and can be handled with ease at the time of pile driving. It has a great bending strength and has a large resistance for lateral force but, at the same time, has a great shortcoming of being easily corroded.

Therefore, a thorough corrosion prevention measure must be taken.

3) A pipe driving barge is brought from Surubaya.

(2) Alternative Plan B (Steel pipe type quaywall)

1) Pile driving of pipe-type sheet piles is made by a pile driving barge (a diesel-pile hammer (D-40)). It is made at a rate of 4 piles/day.

2) The anchorage is an inverted T-type of reinforced concrete mixed and placed in site.

3) Tie-wire rope, which is a steel cable for tie, is worked between pipe-type sheet piles and anchorages.

4) For the first 20 years of the total durability of 50 years, electrolytic protection is applied, for the remaining 30 years, a thickness of 1mm–3mm is provided as an allowance against corrosion.

5) A pile driving barge is brought from Surabaya.

(3) Alternative Plan C (Caisson type quaywall)

1) Concrete caissons (width 10.20m x height 12.10m x length 15.00m) are installed to build a gravity wharf. The weight of a caisson is about 1,000t.

2) As the construction site has no space for the production of concrete caissons, they are made on a floating dock.

If concrete caissons are produced one by one on a floating dock, the construction is delayed greatly and construction cost will run up. So two caissons are produced simultaneously. The number of days required for production of two caissons is 30 days on a floating dock and 24 days on the sea, in total 54 days.

3) For the installation of a floating dock, there are two plans: one is to bring a floating dock designed exclusively for production of concrete caissons from Japan, and the other is to transport one designed for shipbuilding from Surabaya.

(4) Alternative Plan D (Open-type wharf with battered piles-concrete pile)

It is impossible to drive reinforced concrete piles into the 30m base rock which lies on the west side of the designed pier.

Also, note the following.

1) Pile driving of reinforced concrete piles is done by a pile driving barge (a diesel pile hammer (D-40)).

2) A reinforced concrete pile is subject to damage if handled by careless at the time of pile suspension and pile driving.

3) Reinforced concrete piles are supplied with ease in the country.

4) The structure of the bulkhead is the same as that of Alternative Plan A.

5) A pile driving bargs is brought from Surabaya.

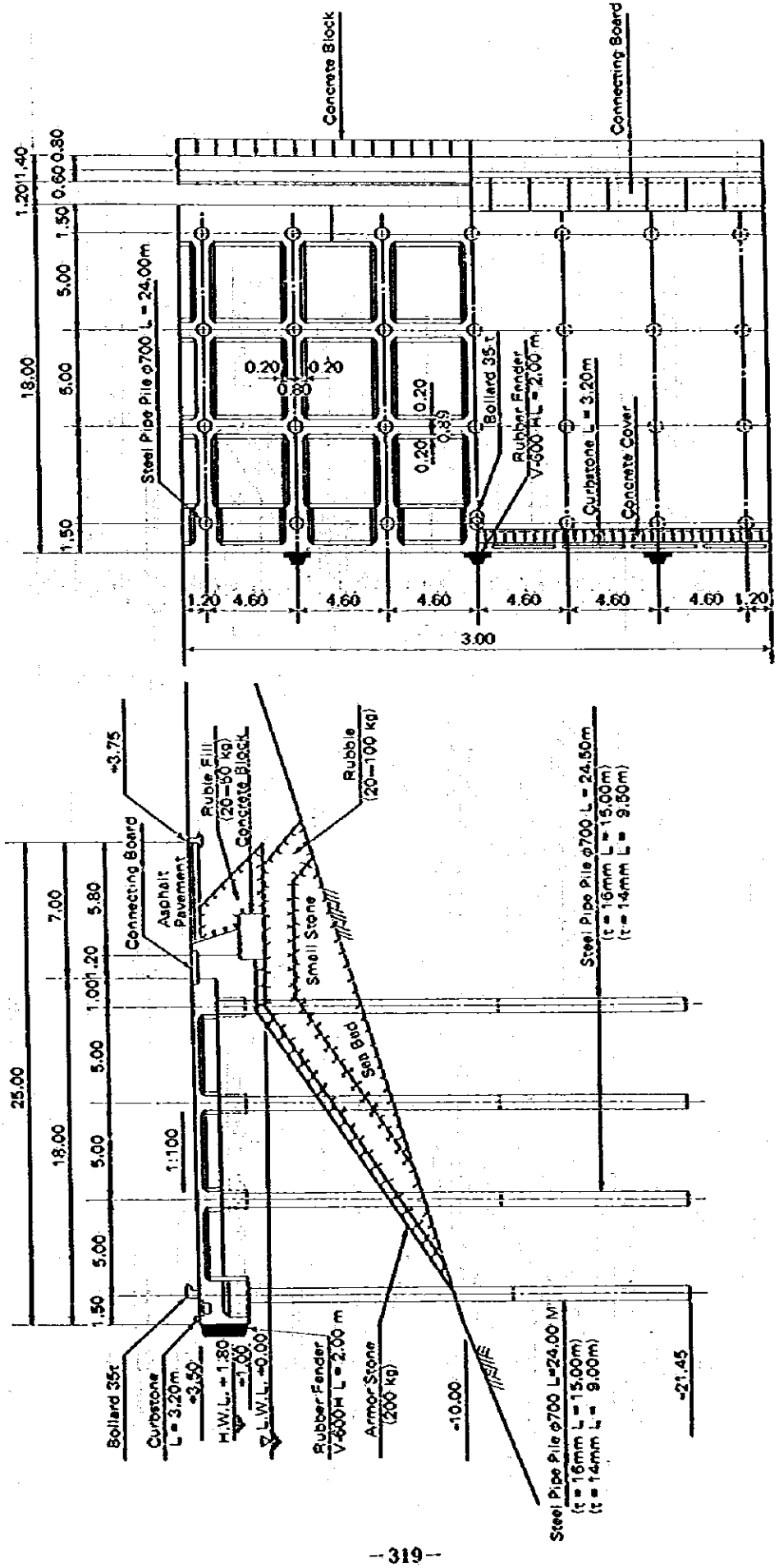
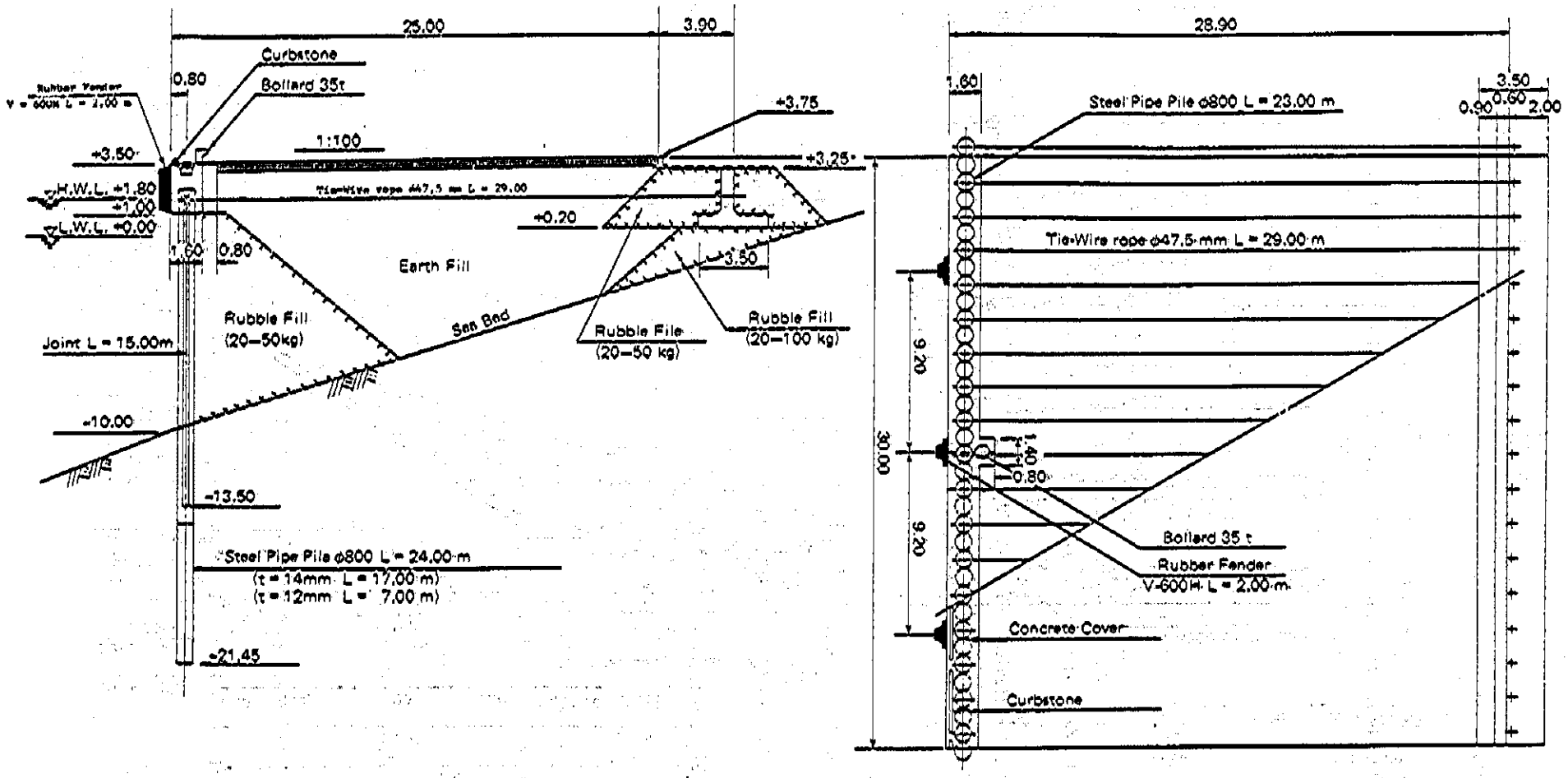


Fig. 11.2.1. Open-Type Wharf with Vertical Piles-Steel Pile (Plan-A)

Fig. 11.2.2. Steel Pipe Type Quaywall (Plan-B)



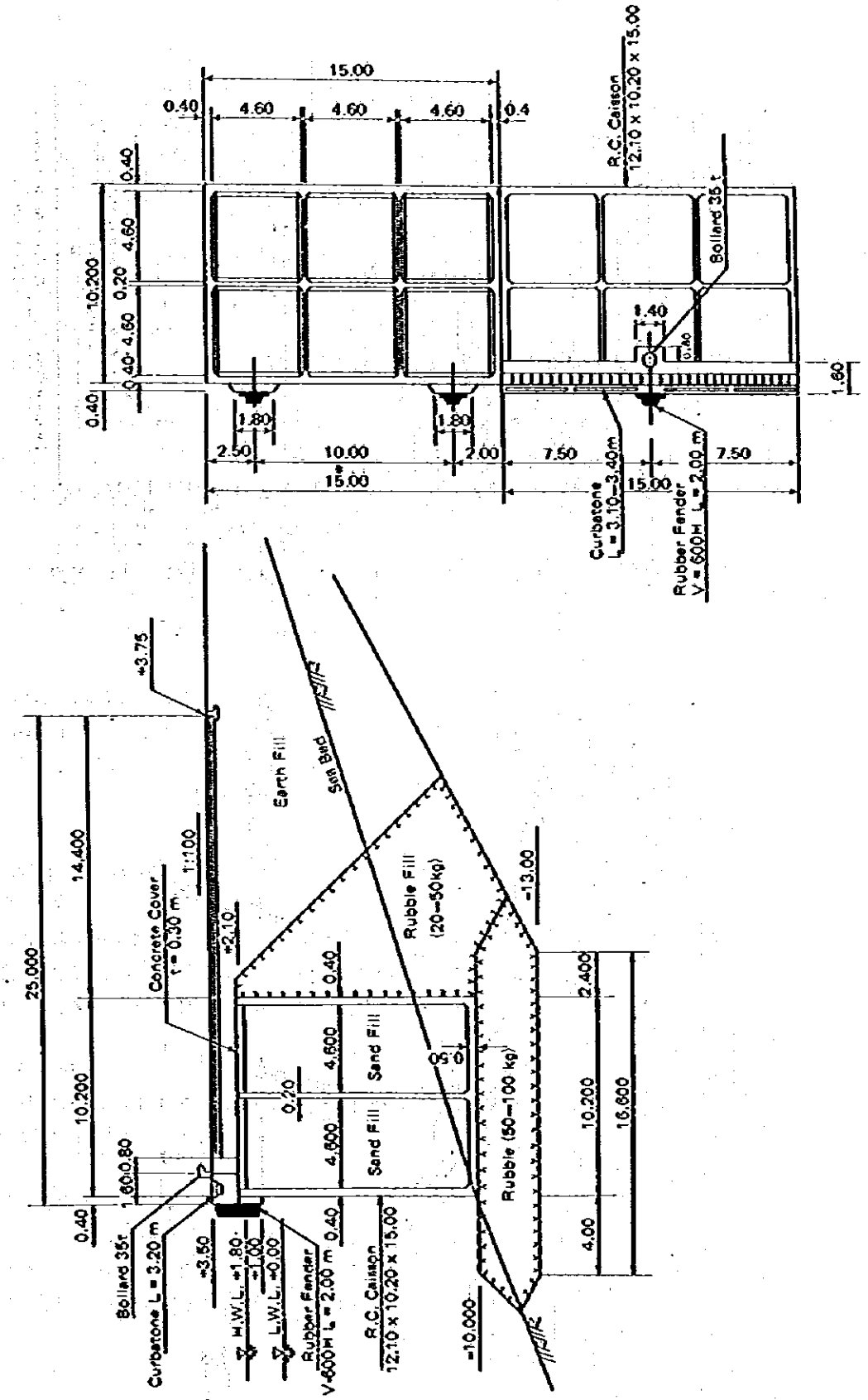


Fig. 11.2.3. Caisson Type Quaywall (Plan-C)

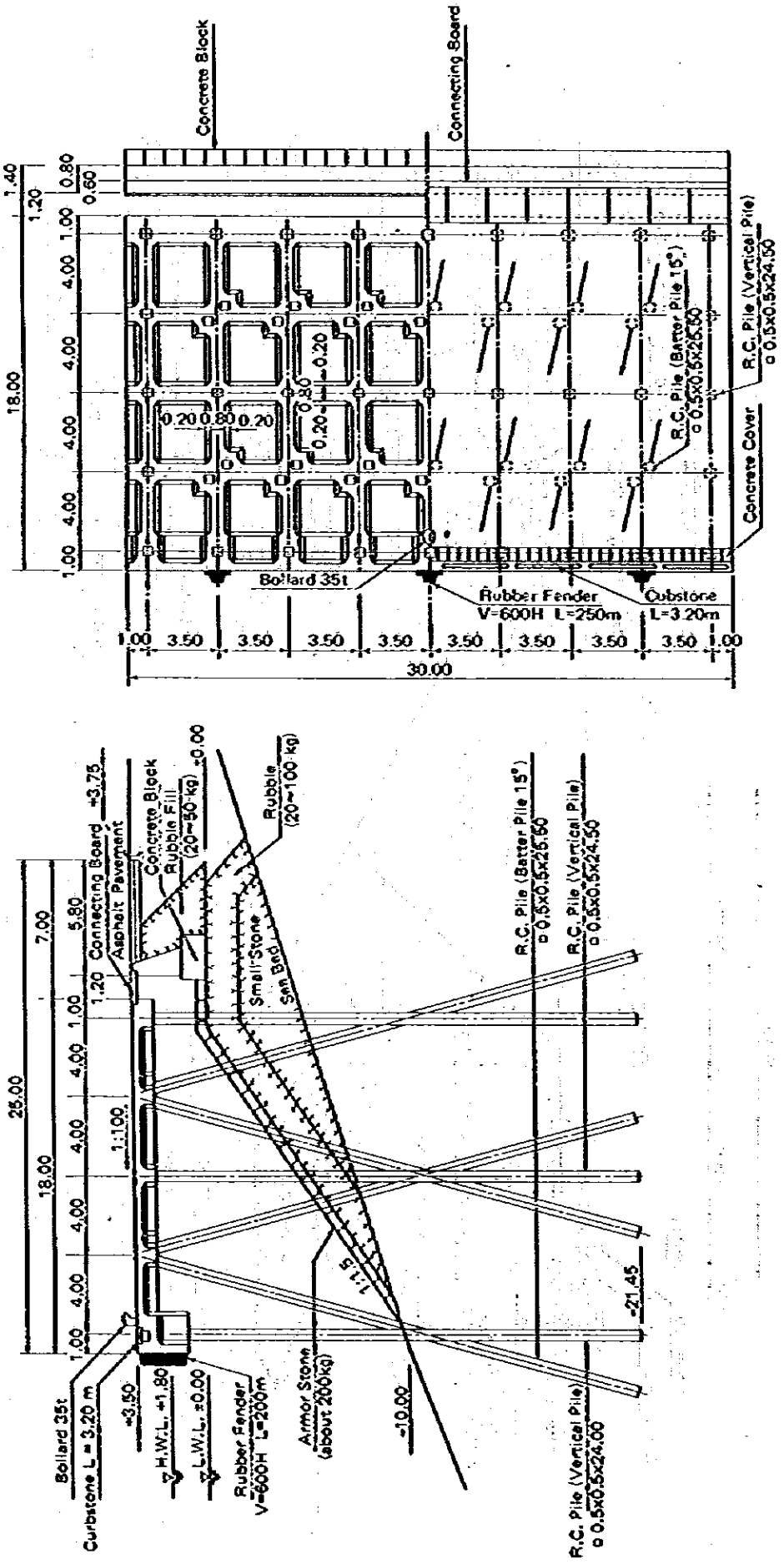


Fig. 11.2.4. Open-Type Wharf with Battered Piles-Concrete Pile (Plan-D)

11.2.2. New Wharf and Other Facilities

(1) New Wharf

As a result of the comparative study, the pier structure is decided, to be Alternative Plan A (open-type wharf with vertical piles-steel pile). A standard cross section and a plan of Alternative Plan A are shown in Figs. 11.2.1.

A Wharf comprises several blocks, one block being 30m length x 18m width. The steel piles are: 700mm in diameter, 14mm – 16mm in thickness and 24.0m -- 24.5m in pile length. The number of piles per block: 4 piles x 7 lines = 28 piles.

They have the electrolytic protection applied for the first 20 years and, for the remaining 30 years, have the thickness allowance of 1mm – 3mm against natural corrosion. The portion above +1.00m is equipped with 2.0m rubber fenders of V type, 600H, and one bollard of 35t type is installed per block. The thickness of the slab of concrete is 0.3m, and the concrete beam height is 1.2m.

The bulkhead has the mound made of small stones and rubbles at the bottom, a layer of concrete blocks and finally the layer of coping concrete. The wave height being 1.35, the weight of armor stone is set at about 200kg/piece. Stones are easily obtainable; they can be transported from the vicinity of the construction site.

The front slope grade of the mound is set at 1:1.5, and the back slope grade at 1:1.2.

The apron have the width of 25m, and the portion other than the concrete slab of the wharf is paved with asphalt. The apron has a drainage grade of 1 percent.

(2) Transition Part of Berth

Transition part of berth is located between the New Wharf and the Concrete Wharf. The construction methods are the same as these of the New Wharf.

(3) Ferry Jetty

The jetty is a rubble-mound revetment. Two pontoons are moored at the tip of this jetty for approaching ferries.

Dimensions of pontoons are:

length 10m x width 5.0m x depth 2.5m x 1 pontoon

length 5.0m x width 3.0m x depth 2.5m x 1 pontoon

(4) Revetment

The structure of the revetment is, the mound made of small stones and rubbles at the bottom, a layer of concrete blocks and a layer of coping concrete.

(5) Reclamation

The present ground height of the area to be reclaimed is from -10m to +2.8m. After reclamation, the ground height will be from +3.50m to +3.75m. The volume of soil for reclamation is 53,000m^3, and the area of reclamation is about 20,000m^2.

(6) Transit Shed

One transit shed (width 40m x length 100m = 4,000m^2) is to be constructed. It is made of steel frame in 2 spans, one span being 20m. The uniform load is 3t/m^2. The floor is made of

concrete. The roof is made of corrugated asbestos cement sheet.

(7) Plan of Port Facilities

The port facilities plan is shown in Fig. 11.2.5.

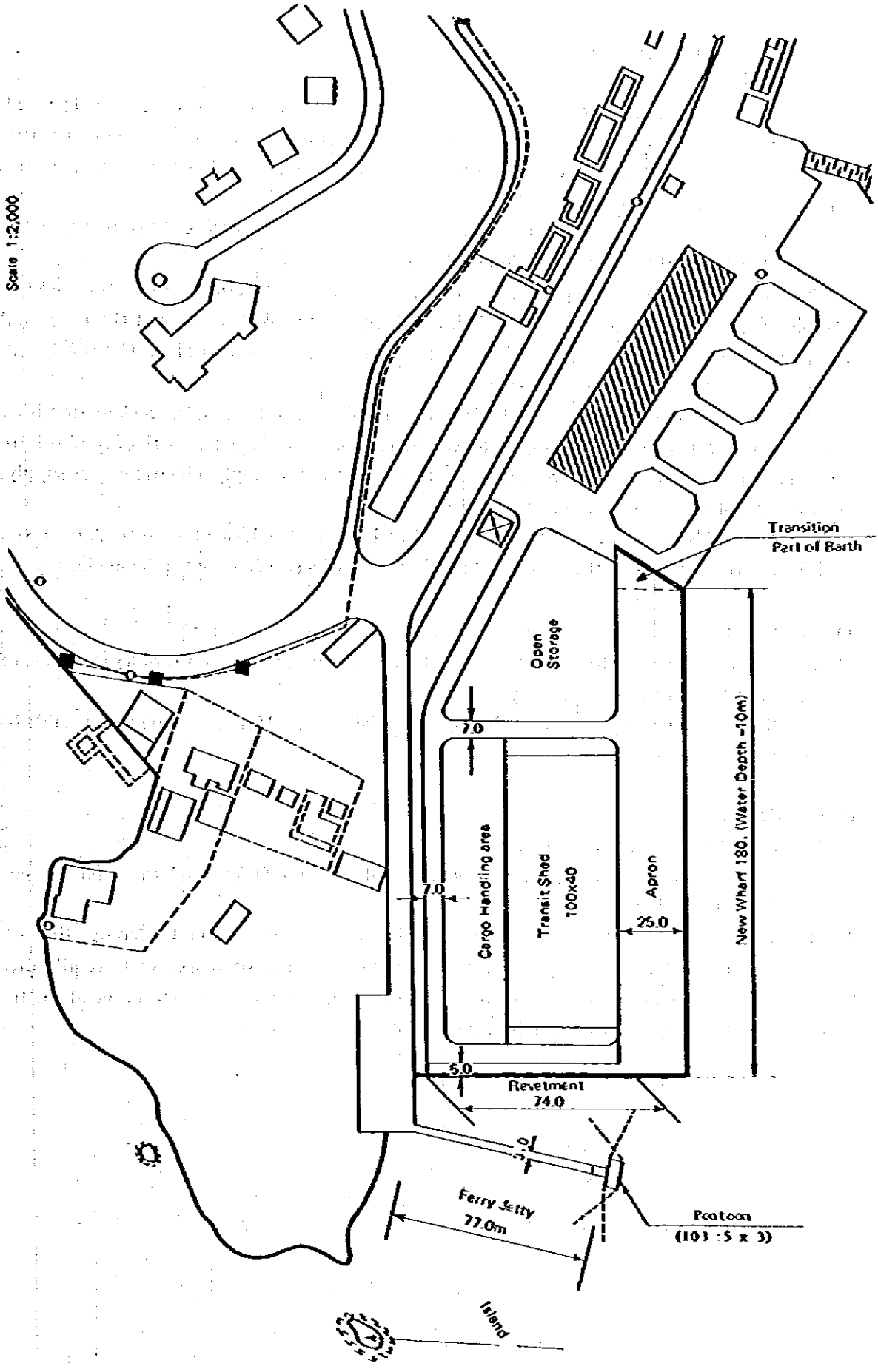


Fig. 11.2.5 Plan of Port Facilities

11.3. Construction Schedule

The construction schedule for Mediam Term Development Program is shown in Table 11.3.1. The construction period for this development program is 3 years from January 1982 to December 1984. From January 1985, effective use of all port facilities will be insured to cope with the cargo volume of 1985.

The soil investigation, the hydrographic survey and the engineering study will be started in January 1982, and the mobilization in October 1982.

The wharf being a steel pipe pile open type wharf, pile driving of the steel pipe piles must be completed prior to the construction of the bulkhead with small stones and the rubbles. After completion of the pile driving, the bulkhead of the wharf is constructed. The revetments are made concurrently with the pile driving.

After completion of the bulkhead of the wharf and the revetments, the reclamation is carried out using dump trucks. After completion of the reclamation, the earth work of road is initiated. After settlement of the reclaimed ground, the works of water supply, electric power supply, and road pavement are started from February 1984.

Navigation aids are to be installed at the end of 1983. In 1984, one transit shed, open storage, building, pavement around the transit shed and other works (gardens) are to be made.

11.3.1. New Wharf

1) The bulkhead of the wharf has the mound made of small stones and rubbles. Leveling of the rubble bed in the sea water is made by divers.

2) For the installation of concrete blocks, a mobile crane (25t) is mounted on a 200t barge, which is used as a floating crane.

11.3.2. Reclamation

1) Dump trucks are used for reclamation.

2) The distance of sand transportation is assumed to be 1,500m, and the removed sand is assumed to be 430 m^3/day.

3) It will be at least 2 to 4 months before the ground settles after the completion of the reclamation. Therefore, it is important to complete the series of works such as pile driving, revetment and reclamation as soon as possible, so that the suceeding construction of the transit shed and other facilities may be carried out on schedule.

Table 11.3.1. Construction Schedule for Medium Term Port Development Program

Item				1985						1982						1984						1985					
No.	Description	Unit	Quantity	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
1	New Wharf	m	180																								
2	Transition Part of Berth	m^2	144																								
3	Ferry Jetty	m	77																								
4	Revetment	m	74																								
5	Reclamation	m^3	53,000																								
6	Transit Shet	m^2	4,000																								
7	Building	m^2	30																								
8	Road	m^2	4,273																								
9	Pavement	m^2	6,614																								
10	Water Supply	sum	1																								
11	Electric Power Supply	sum	1																								
12	Navigation Aids	sum	1																								
13	Cargo Handling Equipment	sum	1																								
14	Service Vessels	sum	1																								
15	Others (Compensation)	sum	1																								
16	Mobilization/Demobilization	sum	1																								
17	Engineering Study	sum	1																								
18	Supervision	sum	1																								

11.4. Cost Estimate

The required quantities of materials can be calculated from the structure determined by comparative design and other facilities. The most economical construction method is to be employed among feasible methods. Based on the unit cost obtained through the field survey, the construction cost is estimated by summing up the cost of each stage of the work.

The construction cost of Medium Term Port Development Program is shown in Table 11.4.2.

The construction cost of Medium Term Port Development Program by each year (1982 – 1984) is shown in Table 11.4.2.

The construction cost of New Wharf (open-type wharf with vertical piles-steel pile) is shown in Table 11.4.3.(1), Table 11.4.3.(2).

Table 11.4.1. Construction Cost of Medium Term Port Development Program

Item No.	Description	Unit	Quantity	Unit Price (US$)			Amount ($\times 10^3$ US$)		
				Local Currency	Foreign Currency	Total Unit Price	Local Currency	Foreign Currency	Total Amount
1	New Wharf	m	180	6,640	11,111	17,751	1,195	2,000	3,195
2	Transition Part of Barth	m^2	144	541	921	1,462	77	133	210
3	Ferry Jetty	m	77	1,239	573	1,812	95	44	139
4	Revetment	m	74	1,274	546	1,820	94	40	134
5	Reclamation	m^3	53,000	13	8	21	689	424	1,113
6	Transit Shed	m^2	4,000	69	181	250	276	724	1,000
7	Building	m^2	30	328	86	414	10	2	12
8	Road	m^2	4,273	24	10	34	102	43	145
9	Pavement	m^2	6,614	17	11	28	112	73	185
10	Water Supply	sum	1				19	40	59
11	Electric Power Supply	sum	1				53	73	126
12	Navigation Aids	sum	1				2	35	37
13	Cargo Handling Equipment	sum	1				0	40	40
14	Service Vessels	sum	1				0	671	671
15	Others (Compensation)	sum	1				168	0	168
16	Mobilization/Demobilization	sum	1				103	67	170
17	Sales Tax (5%)						150	0	150
	Sub Total (A)						3,145	4,409	7,554
18	Engineering Study						229	344	573
19	Supervision						143	215	358
	Sub Total (B)						372	559	931
20	Physical Contingency (15%)						471	661	1,132
21	Price Contingency (15%)						598	844	1,442
	Sub Total (C)						1,069	1,505	2,574
	Total (A+B+C)						4,586	6,473	11,059
							(41.4%)	(58.6%)	(100%)

Table 11.4.2. Construction Cost of Medium Term Development Program by Each Year (1982 ~ 1984)

(x 10^3 US$)

Item No.	Description	Unit	Quantity	1982			1983			1984			Grand Total		
				Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
1	New Wharf	m	180	73	139	212	1,023	1,714	2,737	99	147	246	1,195	2,000	3,195
2	Transition Part of Berth	m^2	144				77	133	210				77	133	210
3	Ferry Jetty	m	77				95	44	139				95	44	139
4	Revetment	m	74				94	40	134				94	40	134
5	Reclamation	m^3	53,000				591	363	954	98	61	159	689	424	1,113
6	Transit Shed	m^2	4,000							276	724	1,000	276	724	1,000
7	Building	m^2	30							10	2	12	10	2	12
8	Road	m^2	4,273							102	43	145	102	43	145
9	Ravement	m^2	6,614							112	73	185	112	73	185
10	Water Supply	sum	1							19	40	59	19	40	59
11	Electric Power Supply	sum	1							53	73	126	53	73	126
12	Navigation Aids	sum	1				2	35	37				2	35	37
13	Cargo Handling Equipment	sum	1				0	20	20	0	20	20	0	40	40
14	Service Vessels	sum	1				0	577	577	0	94	94	0	671	671
15	Others (Compensation)	sum	1	34	0	34	134	0	134				168	0	168
16	Mobilization/Demobilization	sum	1	3	2	5	71	44	115	29	21	50	103	67	170
17	Sales Tax (5%)			5	0	5	102	0	102	43	0	43	150	0	150
	Sub Total (A)			115	141	256	2,189	2,970	5,159	841	1,298	2,139	3,145	4,409	7,554
18	Engineering Study	sum	1	229	344	573							229	344	573
19	Supervision	sum	1	11	17	28	66	99	169	66	99	165	143	215	358
	Sub Total (B)			240	361	601	66	99	165	66	99	165	372	559	931
20	Physical Contingency (15%)			47	67	114	299	406	705	125	188	313	471	661	1,132
21	Price Contingency (15%)			60	85	145	379	520	899	159	239	398	598	844	1,442
	Sub Total (C)			107	152	259	678	926	1,604	284	427	711	1,069	1,505	2,574
	Total (A+B+C)			462	654	1,116	2,933	3,995	6,928	1,191	1,824	3,015	4,586	6,473	11,059

Table 11.4.3. (1) Construction Cost of New Wharf
(Open-Type Wharf with Vertical Piles-Steel Pile)

(US$)

No.	Item	Size/Quality	Total
I	Direct Cost		
1.	Steel Pipe Pile Driving		866,494
2.	Concrete Placing		570,443
3.	Rubber Fender and Others		338,432
4.	Bulkhead		795,928
	Sub Total		2,571,297
II.	Indirect Cost	(I)x0.027	69,425
	Total (I+II)		2,640,722
III.	Miscellaneous Expenses at Work Site	(I+II)x0.10	264,072
IV.	Overhead	(I+II+III)x0.10	290,479
	Grand Total (I+II+III+IV)		3,195,273

3,195,273 US$/180m = 17,751 US$/m.

Table 11.4.3. (2) Construction Cost of New Wharf

(US$)

No.	Item	Size/Quality	Unit	Quantity	Unit price	Total
1	Steel Pipe Pile Driving					
1-1	Steel Pipe Pile	φ700	piece	112	3,994	447,328
	Steel Pipe Pile	"	"	38	4,691	178,258
	Steel Pipe Pile	"	"	38	3,334	126,692
1-2	Carriage of Pile	"	"	188	77	14,476
1-3	Pile Driving	"	"	112	477	53,424
	Pile Driving	"	"	18	477	8,586
	Pile Driving	"	"	20	639	12,780
	Pile Driving	"	"	18	444	7,992
	Pile Driving	"	"	20	502	10,040
1-4	Cutting of Pile Head	"	"	188	36.8	6,918
	Sub Total					866,494
2	Concrete Placing					
2-1	Support		m^2	3,240	9.8	31,752
2-2	Stage		"	1,404	2.5	3,510
2-3	Concrete	σ_{28} = 240kg/cm^2	m^3	2,658	81.1	215,563
2-4	Form		m^2	6,330	8.3	52,539
2-5	Reinforing Bar		t	345.6	635.5	219,628
2-6	Joint	t = 20mm	"	66	15.5	1,023
2-7	Connecting Board		piece	90	270.3	24,327
2-8	Concrete Cover		"	360	19.6	7,056
2-9	Corrosion Preventive Cover		"	146	67.3	9,815
2-10	Corner		m	180	29	5,220
	Sub Total					570,443
3	Rubber Fender and Others					
3-1	Rubber Fender	V-600H, L=2.0M	piece	18	13,286	239,148
3-2	Bollard	Type = 35t	"	6	1,647.8	9,886
3-3	Moring Ring	φ30	"	36	10	360
3-4	Electrolytic Protection	20 years	sum	1		89,038
	Sub Total					338,432
4	Balkhead					
4-1	Small Stone	under 20kg	m^3	8,130	20.2	164,226
4-2	Rubble	20~100kg	"	8,040	22.6	181,704
4-3	Armor Stone	200kg	"	2,282	24.2	55,224
4-4	Leveling of Rubble		m^2	1,740	36.2	62,988
4-5	Leveling of Rubble		"	1,910	12.1	23,111
4-6	Leveling of Armor Stone		"	3,900	18.1	70,590
4-7	Concrete Block		piece	180	308.5	55,530
	Concrete Block		"	60	334	20,040
4-8	Setting Block		"	180	118.3	21,294
	Setting Block		"	60	161	9,660
4-9	Coping Concrete	σ_{28} = 160kg/cm^2	m^3	448	95	42,560
4-10	Rubble Fill	20~50kg	"	1,818	20.2	36,723
4-11	Leveling of Rubble Fill		m^2	1,368	1.7	2,325
4-12	Mat	t = 3mm	"	1,062	20.8	22,089
4-13	Asphalt Pavement		"	936	26	24,336
4-14	Concrete Wall		m	180	19.6	3,528
	Sub Total					795,928

Chapter 12.

ECONOMIC ANALYSIS

CHAPTER 12. ECONOMIC ANALYSIS

12.1. Method of Analysis

The following are the basic principles used in analyzing the effects of developing Sorong Port:
(1) The project which this economic analysis covers is the Medium Term Development Program to be started in 1985, i.e., construction of the new 180 m wharf and its terminal facilities (including the construction of a shed on reclaimed land).
(2) The internal rate of return and the B/C ratio are computed and used to evaluate this project. The internal rate of return is obtained by the following Formula 12.1:

$$\sum_{i=o}^{n} \frac{Bi-Ci}{(1+IRR)^i} = 0 \qquad (12 \cdot 1)$$

Bi : Benefit in the "i" year
Ci : Cost in the "i" year
IRR : Rate of discount

The IRR that satisfies the above formula is the internal rate of return. The rate of discount, for computing the B/C ratio, is 12 percent, which Bappenas now employes for port projects.

12.2. Estimation of Benefits

The port of Sorong is developed for the purpose of increasing the capacity of its port facilities to accommodate the increased transportation demands resulting from the development of the regional economy. The development of the port will rationalize the transportation system centered around Sorong Port.

More important is the effect of the development of the port as a whole on regional development of the Sorong area and West Irian. The development of the port will greatly benefit the local industry and urban functions in the Sorong area.

This project is expected to bring the following benefits:
(1) Reduction of demurrage costs through resolving congestion at Sorong Port.
(2) Reduction of voyage costs by transfering the cargo transportation from RLS to Perintis in the service area of Sorong Port.
(3) Reduction of the cargo diversion cost for cargo storage through increasing the cargo storing capacity in the port by constructing a new shed in the reclamation land.
(4) Increase in the efficiency of cargo handling and decrease in damage to cargo through improving terminal facilities.
(5) Reduction of accidents of ships entering or leaving the port through introducing tugboats, service boats and navigation aids.
(6) Effects on regional development
a) Facilitation of the development of natural resources.
b) Improvement of urban functions

Of these benefits, only (1), (2) and (3) can be quantitatively analyzed and (4), (5) and (6) are difficult to quantify.

12.2.1. Reduction of demurrage costs through resolving congestion.

In computing the reduction of demurrage costs, port congestion (ship staying hours) is to be calculated for the case with no investment (the "without" case) and the case with investments (the "with" case).

The average staying hour of ships can be determined from Table 9.4.1. "Average Staying Time (1985)", Chapter 9 as follows:

Table 12.2.1. Reduction of Ship Staying Hour

(Hours)

	Average Stay in "with case" (1)	Average Stay in "without" case (2)	Reduction in Average Stay (2) – (1)
Maximum	27.6	124.6	97.0
Minimum	26.0	74.2	48.2
Mean	26.8	99.4	72.6

It can be seen that an extra 99.4 hours (mean value employed) is required per ship it no investments are made. This length of time can be improved to be 72.6 hours by the investments. The average ship size here is 2,000 DWT and the daily cost per ship due to a stay is $1,071 (source: Economic Study for Sea Transportation in Irian Jaya).

Therefore, the reduction of demurrage costs by easing of the congestion is as follows:

$1071.0\$ \times 72.6\ h \div 24\ h \times 610\ \text{vessels} = 1{,}976 \times 10^3\ \$/Yr$

Benefit: $1{,}976 \times 10^3$ US$/Yr

12.2.2. Reduction of voyage costs

After completion of the new wharf, the cargo transportation can be transferred from RLS to Perintis. The difference in voyage costs between RLS and Perintis represents the benefit brought about by the reduction of voyage cost.

The volume of cargo handled in Sorong Port and its service area is shown in Table 8.3.27., Chapter 8. The volume of cargo transported by Perintis within the bounds of the service area is shown in the following table:

Table 12.2.2. Transportation Cargo Volume within Service Area

($\times 10^3$ tons)

Cargo Volume by Perintis in 1985	Objective Cargo Volume in 1985
107	94

Note: Objective cargo volume to calculate the benefit is improved by the estimated cargo composition rate with 88 percent for RLS. (Source: Table 8.3.27)
(RLS: 71% Perintis 9%)

The average distance between Sorong Port and other ports in its service area is calculated based upon the proportionate allocation of inhabitants in the service area as follows:

Table 12.2.3. Average Distance from Sorong to Other Ports

(Miles)

	Population ($\times 10^3$ people)		Actual Distance	Average Distance
Sorong ~ Nabire	218.2	(41%)	370	150.9
Sorong ~ Serui	63.3	(12%)	300	35.5
Sorong ~ Biak	86.0	(16%)	340	54.7
Sorong ~ Manokuari	104.1	(19%)	230	45.0
Sorong ~ Fak-Fak	63.3	(12%)	170	20.1
Total (Average)	534.9	(100%)	1,410	306

The required number of ships by type is shown below:

Table 12.2.4. Comparison of Required Number of Service Trips by Type

	Cargo Volume between Sorong and Other Ports	Required Number of Service Trips	Voyage days per Vessel	Voyage Cost ($\times 10^3$ $)
Perintis (With Case)	94	359	1.3	279
RLS (Without Case)	94	359	1.1	392
Balance	–	–	0.2	113

Note: Voyage speed (Source: Economic Study for Sea Transportation in Irian Jaya)
RLS 12 Knots/hour
Perintis 10 Knots/hour
Voyage cost (Source: Economic Study for Sea Transportation in Irian Jaya)
RLS 992 $/day
Perintis 598 $/day

Therefore, the total reduction of voyage costs realized by Perintis is as follows:

$392 \times 10^3\ \$ - 279 \times 10^3\ \$ = 113\ \$ \times 10^3$/year

Benefit: 113×10^3 US$/Yr

12.2.3. Reduction of Cargo Diversion Costs

If reclamation is not carried out, and no new shed is constructed behind the new wharf, new warehouses must be constructed at some convenient place near Sorong Port. There is no open storage space available either, except for the existing warehouse district.

This means a decline of efficiency in cargo handling. But, here, only the reduction of the

cargo diversion cost will be computed and used as a benefit. The occurrence of cargo diversion is shown in the following table and the share of the cargo stored in the existing sheds is 32.8 percent (4,000 m^2 ÷ [4,000 m^2 + 1,950 m^2] = 0.672)

Table 12.2.5. Estimated Volume of Diversion Cargo in 1985

($\times 10^3$ Ton)

Total Cargo to be stored at Sheds	Diversion Cargo
177	119

Source: Table 10.1.4

Supposing that these cargoes are transported by 5-ton trucks, the required number of trucks is computed in the following. In this case, the loading factor of a truck is assumed to be 80 percent and the operating time per truck per day is assumed to be 8 hours.

The number of trips per truck is as follows:

8 h ÷ 1.33 h*=6.015 round/day

*1.33 h = loading 0.66 h + unloading 0.34 h + transportation 0.33 h

Therefore, the required number of trucks is as follows:

6.015 x 4 ton = 24.06 ton

119 x 10^3 ÷ 24.06 = 4,946 unit

The diverting cost by trucks is as follows:

4,946 units x 52.7 $/unit = 260,650 $/year

Benefit: 261,000 $/Yr

12.2.4. Reduction of Damage to Cargoes

As stated in the preceding section, damage to cargoes can be reduced since cargo handling becomes smoother with the improvement of shed and open storage yard.

12.2.5. Decrease of Accidents in Port

The introduction of tugboats in particular can improve the towing service which presently depends only on Pertamina tugboats. This will result in a timely and effective control of ships entering and leaving the port.

It is considered that the smooth control of ship entry and departure by the towing service and by the introduction of navigation aids will reduce the possibility of port accidents.

12.2.6. Effects on Regional Development

It can be said that this project will have the following effects on the local community:

(1) Facilitation of the development of natural resources.

The natural resources in the interior areas of the West Irian and Sorong areas have not yet been explored, and nothing is known of their characteristics and the amount of reserves. Judging from the vast area, the resources cannot be scarce. The problem is the inadequacy of roads leading to the interior, the lack of facilities necessary to procure and transport the equipment and materials required for the improvement of infrastructure, and the shortage of funds to finance construction.

The expansion and improvement of Sorong Port will not only help to upgrade its urban facilities but could have an immense impact on the development of natural resources in the interior. When the port is fully developed as the terminal and equipment and materials can be brought in Sorong City will become an efficient base for the future development of the interior.

At the same time, the expansion and improvement of this port will accelerate the further development of the Sorong hinterland by enabling the smooth shipment of equipment, materials and personnel necessary for the development of agriculture, fishery and forestry.

(2) Improvement of urban functions

When Sorong Port is expanded and improved, the number of personnel will increase to sustain increased port activities. The following is the number of staff who will be necessary in 1985:

BPP personnel	120	(70)
Dock workers	700	(425)
Workers engaged in cargo transportation in the hinterland	520	(320)
Employees in related activities (customs office, etc.)	330	(200)
Total	1,670	(1,015)

Note: Figures in ( ) shows the employees in 1980.

Assuming that each person has a family of four members, the total population will be 6,680. Thus Sorong City will develop as a market with the expansion and improvement of the port. Further, the improvement of the port will make daily necessities available at cheap prices. Thus the city will further grow as an urban community.

12.3. Estimation of Costs

12.3.1. Estimation of Construction Cost

From Table 11.4.2, Chapter 11, the project cost, which constitutes the object of this economic analysis, is shown in the following table:

Table 12.3.1. Project Cost Used in Economic Analysis

($\times 10^3$ US$)

Year	Construction Cost
1982	980
1983	6,005
1984	2,600
Total	9,585

Note: The sales tax is excluded.

12.3.2. Estimation of Operating Costs

The operating costs which correspond to the new facility are divided into the following categories:

(1) Personnel cost
(2) General administration cost
(3) Operation cost
(4) Maintenance of equipment and facility

(1) Personnel cost

Personnel cost entailed by new facilities is obtained by alloting the total personnel cost in 1985 to the new facilities' cost as follows:

Total personnel cost in 1985: 92,000 $/Y = 120 x 770 $/Yr

Personnel cost for new facilities in 1985: $38{,}000\ \$/Yr = 92{,}000\ \$ \times \frac{180m}{432m}$

(2) General administration cost

Applying the same method as the above, the cost is obtained as follows:

Total administration cost in 1985: 21,000 $/Yr = 120 x 176 $/Y

Administration cost for new facilities: $9{,}000\ \$/Yr = 21{,}000\ \$ \times \frac{180}{432}$

(3) Operation cost

The operation cost as shown in Table 12.3.2. is obtained by cumulative computation for fuel, power and water necessary for new facilities.

Table 12.3.2. Fuel, Power and Water Cost

(Million Rp.)

(1) Tugboat 800 HP x 1	220 Kℓ x 50 Rp/ℓ	11
(2) Pilotboat	41 Kℓ x 50 Rp/ℓ = 2	2.0
(3) Folklifts (2 units)	5 Kℓ x 50 Rp/ℓ x 2 units = 0.5	1.0
(4) Mobile crane (1 unit)	2 Kℓ x 50 Rp/ℓ x 1 unit = 0.1	0.1
(5) Water for vessels	74×10^3 x 150 Rp/Ton = 11.1	11.1
(6) Power Cost		3.7
	26,000 KWH x 46 Rp/KW = 1.2	
	55,000 KWH x 46 Rp/KW = 2.5	
Total		29

Note: The cost for new facility 44,000 $/year.

(4) Maintenance cost

The maintenance cost as shown in Table 12.3.3. is obtained by cumulative computation.

Table 12.3.3. Maintenance Cost for New Facilities

(Million Rp./year)

Facilities	Main-tenance Cost	Con-struction Cost	Percentage of Const. Cost (%)	Content of Maintenance	Commence-ment of Use
New Wharf	16.5	3,315	0.5	Fender, Curbstone	1985
Ferry Jetty	0.6	134	0.5	Repairing	1983
Transit Shed	9.6	963	1.0	Repairing of painting, roofing	1985
Building	0.1	10	1.2	Repairing	1985
Road	1.4	141	1.0	Asphalt Pavement & Marking	1985
Open Storage	0.2	25	1.0	"	1985
Water Supply	2.8	57	5.0	Repairing & Spair Parts	1985
Electric Power Supply	6.0	121	5.0	"	1985
Navigation Sids	0.2	36	0.5	Replacement of Battery	1984
Sub Total	(37.4)	(4,802)			
Tuor boat (1 unit)	46	465	10.0	Repairing & Spair Parts	1985
Pilot boat (1 unit)	7	79	10.0	"	1985
Folklifts (2 units)	2.4	31	8.0	"	1984 (1 unit) 1985 (1 unit)
Sub Total	(55.4)	(575)			
Grand Total	92.8	5,377			

12.4. Evaluation

The B/C ratio in Table 12.4.1. is 1.45, which indicates that this project is feasible.

As stated in Chapter 12.1. the discount rate used in computing the B/C ratio is 12 percent, which is employed by BAPPENAS for its port projects.

As can be seen in Table 12.4.3, the IRR is 18.6 percent and this also means that the project is feasible.

For the calculation of IRR, the mean value of the ship staying hour in port is employed.

If the lowest value of 48.2 hours is applied for the calculation, the IRR of 12.6 percent (B/C ratio 1.04 in Table 12.4.2.) is obtained as shown in Table 12.4.4. and also this value means the project is feasible.

It must be remembered, however, that the benefits, on which the above figures are based, do not include the indirect effects of the project on regional development, because they cannot be computed.

The greatest significance of this project is in regional development which profoundly affects the development of natural resources and urban development in West Irian around the Sorong area. What is more, nature in the interiors still remains intact and, as far as can be judged from the present activities around Sorong, the development of this port is likely to have a great impact on the future development of the Sorong area.

Finally, it can be concluded that this project is highly feasible if it is evaluated in terms of its IRR of 18.6 percent, and the above-mentioned effects on regional development.

Table 12.4.1. Cost Benefit Table (Discount Ratio = 12.0%)

(1,000 US$)

Year		Discounted Value (Discount Ratio = 12.0%)	
		Cost	Benefit
1	1982	980.00	
2	1983	5,361.86	
3	1984	2,072.72	
4	1985	170.12	1,672.73
5	1986	151.88	1,493.43
6	1987	135.61	1,333.39
7	1988	121.08	1,190.51
8	1989	108.10	1,062.91
9	1990	96.53	949.17
10	1991	86.18	847.41
11	1992	76.96	756.70
12	1993	68.71	675.63
13	1994	61.35	603.25
14	1995	54.78	538.62
15	1996	48.90	480.81
16	1997	43.67	429.35
17	1998	38.98	383.29
18	1999	34.80	342.16
19	2000	31.07	305.50
20	2001	27.75	272.84
21	2002	24.78	243.70
22	2003	22.13	217.61
23	2004	19.74	194.11
24	2005	17.64	173.43
25	2006	15.75	154.87
Total		9,871.09	14,321.42

$$\text{BC Ratio} = \frac{14321}{9871} = 1.45$$

Table 12.4.2. Cost Benefit Table (Discount Ratio = 12.0%)

(1,000 US$)

Year		Discounted Value (Disbount Ratio = 12.0%)	
		Cost	Benefit
1	1982	980	
2	1983	5,361.86	
3	1984	2,072.72	
4	1985	170.12	1,200.09
5	1986	151.88	1,071.45
6	1987	135.61	956.64
7	1988	121.08	854.13
8	1989	108.10	762.58
9	1990	96.53	680.98
10	1991	86.18	607.97
11	1991	76.96	542.89
12	1993	68.71	484.73
13	1994	61.35	432.80
14	1995	54.78	386.43
15	1996	48.90	344.96
16	1997	38.98	274.99
18	1999	34.80	254.48
19	2000	31.07	219.18
20	2001	27.75	195.75
21	2002	24.78	174.84
22	2003	22.13	156.12
23	2004	19.74	139.27
24	2005	17.64	124.43
25	2006	15.75	111.11
Total		9,871.09	10,283.85

$$\text{BC Ratio} = \frac{10,284}{9,871} \fallingdotseq 1.04$$

Table 12.4.3. IRR Calculation Table (IRR = 18.6%)

Year		Cost (x 10^3 US$)			Benefit (x 10^3 US$)				Discounted Value (Bi-Ci)
		Project Cost	Total Operation Cost	Total	Reduction of Ship Staying	Reduction of Vessel Voyage	Reduction of Cargo Diversion	Total	
1	1982	980		980					▲ 980
2	1983	6,005		6,005					▲5063
3	1984	2,600		2,600					▲1848
4	1985		239	239	1,976	113	261	2,350	1265
5	1986		239	239	1,976	113	261	2,350	1067
6	1987		239	239	1,976	113	261	2,350	900
7	1988		239	239	1,976	113	261	2,350	759
8	1989		239	239	1,976	113	261	2,350	640
9	1990		239	239	1,976	113	261	2,350	539
10	1991		239	239	1,976	113	261	2,350	455
11	1992		239	239	1,976	113	261	2,350	383
12	1993		239	239	1,976	113	261	2,350	323
13	1994		239	239	1,976	113	261	2,350	273
14	1995		239	239	1,976	113	261	2,350	230
15	1996		239	239	1,976	113	261	2,350	194
16	1997		239	239	1,976	113	261	2,350	163
17	1998		239	239	1,976	113	261	2,350	138
18	1999		239	239	1,976	113	261	2,350	116
19	2000		239	239	1,976	113	261	2,350	98
20	2001		239	239	1,976	113	261	2,350	83
21	2002		239	239	1,976	113	261	2,350	70
22	2003		239	239	1,976	113	261	2,350	59
23	2004		239	239	1,976	113	261	2,350	50
24	2005		239	239	1,976	113	261	2,350	42
25	2006		239	239	1,976	113	261	2,350	35
Total		9,585	5,258	14,843	43,472	2,486	5,742	51,700	▲9

Table 12.4.4. IRR Calculation Table (IRR = 12.6%)

Year		Cost (x 10^3 US$)			Benefit (x 10^3 US$)				Discounted Value (Bi-Ci)
		Project cost	Total operation cost	Total	Reduction of Ship Staying	Reduction of Vessel Voyage	Deduction of Cargo Diversion	Total	
1	1982	980		980					▲980
2	1983	6,005		6,005					▲5,333
3	1984	2,600		2,600					▲2,051
4	1985		239	239	1,312	113	261	1,686	1,014
5	1986		239	239	1,312	113	261	1,686	900
6	1987		239	239	1,312	113	261	1,686	799
7	1988		239	239	1,312	113	261	1,686	710
8	1989		239	239	1,312	113	261	1,686	631
9	1990		239	239	1,312	113	261	1,686	560
10	1991		239	239	1,312	113	261	1,686	497
11	1992		239	239	1,312	113	261	1,686	442
12	1993		239	239	1,312	113	261	1,686	392
13	1994		239	239	1,312	113	261	1,686	348
14	1995		239	239	1,312	113	261	1,686	309
15	1996		239	239	1,312	113	261	1,686	275
16	1997		239	239	1,312	113	261	1,686	244
17	1998		239	239	1,312	113	261	1,686	217
18	1999		239	239	1,312	113	261	1,686	192
19	2000		239	239	1,312	113	261	1,686	171
20	2001		239	239	1,312	113	261	1,686	152
21	2002		239	239	1,312	113	261	1,686	135
22	2003		239	239	1,312	113	261	1,686	120
23	2004		239	239	1,312	113	261	1,686	106
24	2005		239	239	1,312	113	261	1,686	94
25	2006		239	239	1,312	113	261	1,686	84
Total		9,585	5,258	14,843	28,864	2,486	5,742	37,092	28

Chapter 13.
FINANCIAL ANALYSIS

CHAPTER 13. FINANCIAL ANALYSIS

13.1. Method of Analysis

The investment effects of this project are analyzed and evaluated by the following two methods:

(1) Analysis and evaluation of project by the DCF method.

(2) Analysis and evaluation of project by financial statements.

The purpose of the financial analysis is to ascertain the impact of investments of the present project on the condition of financial control of port operating bodies or to analyse whether financial healthiness may be ensured.

In other words, based on the premise that the financial control is carried out by business accounting under the self-supporting accounting system, it is to analyse the effect of investments in the project, i.e., payability situation, ascertainment of financing situation and present problems and measures to be taken.

Needless to say, the ascertainment of financial healthiness is possible only when the management is throughly aware of the entire financial affairs. Therefore, the analysis covers the entire financial operations.

13.1.1. Financial Rate of Return (FRR)

In evaluating the project by the DCF method, the FRR (financial rate of return) is determined by Formula 12.1 in Chapter 12, using the earning increase after the completion of the project as the Benefit and the project construction cost as the Cost.

As stated in the foregoing paragraphs all aspects of the operation of the Port of Sorong will be analysed. The profitability of the project will be judged independently in the analysis. Thus, profit before depreciation and interest payment for the entire port must be calculated for every year. The estimated amount of profit before depreciation and interest payment for the Port of Sorong is regarded as the benefit.

The profit before depreciation and before interest payment of each year after 1985 when investment effects begin to appear, is the operating profit, i.e., the benefit.

By using the above method, the financial rate of return (FRR) is calculated on the independent profit system of the Port of Sorong.

13.1.2. Financial Statements

In conducting the analysis, Financial Statements (Income Statement, Source & Application of Funds, etc.) will be prepared to ascertain the soundness of financial affairs.

Financial analysis of the Port of Sorong will be based on the following premises:

(1) The self-supporting accounting system based on the cost method is adopted.

(2) Investment funds for development are borrowed from abroad with the conditions of loan below.

Table 13.1.1. Loan Condition of Long Term Loan

Rate of interest	3% per annum.
Term of gracement for principle	10 years.
Term of repayment of principle	30 years.
Term of loan	40 years.

(3) Depreciation is based on the straight line method and life cycle based on the standard set by the Indonesian Government.

Table 13.1.2. Depreciation Rate and Life Cycle by Facility

Item	Depreciation Rate	Life Cycle (years)
Quay	0.02	50
Open Storage	0.02	50
Warehouse	0.03	33
Road	0.01	100
Office Building	0.03	33
Water Supply	0.04	25
Power Supply	0.03	33
Navigation Aids	0.04	25
Cargo Handling Equipment	0.05	20
Vessel	0.05	20

Source: Directorate General of Sea Communications.

(4) Surplus and National Development Fund

After depreciation and payment of interest, 45 percent of Net Profit will be deducted as tax and 30.3 percent is paid to the National Development Fund – (Net profit 100 percent – Tax 45 percent) x 55 percent. The surplus is retained as the internal reserve.

In this analysis, 41 percent of the total investment is assumed to be met by National Development Fund without interest. The reason for setting the figure at 41 percent is that the domestic currency portion accounts for 41 percent of the construction costs under the project.

13.2. Estimation of Revenues

On the basis of actual business results contained in 1979 Sorong Port Financial Report (Table 5.1.3.), computation is made based on the current tariff standards.

(1) Port due : Based on the business result of 1979, the unit charge per cargo ton is established to be multiplied by the weight of total cargo volume handled at Sorong Port for each fiscal year.

(2) Mooring charge : The unit charge per cargo ton is established as above to be multiplied by the weight of cargo handled at the public wharf for each fiscal year.

(3) Towage : The revenue from Pertamina's tugboats is calculated by the increased rate of total cargo volume based on the business result of 1979.
The calculation of the revenue from the newly introduced tugboat is made by cumulative computation based on the current tariff and its working hours.

(4) Pilotage : The unit charge per cargo ton is established to be multiplied by the weight of total cargo at Sorong Port for each fiscal year.

(5) Facilities charge : Based on the business result of 1979, the unit charge per cargo ton is established to be multiplied by the cargo volume using the public facilities for each fiscal year.
This unit charge includes Open Storage, Warehouse Storage, Direct Transport and Equipment Rental charges.

(6) Water supply : The necessary amount of supply is estimated from the number of vessels by type and size to be multiplied by the tariff.

(7) Others : Based on the business result of 1979, the revenues are calculated by the increased rate of cargo volume handled at the public wharves.

Table 13.2.1. Total Revenues of the Port of Sorong in 1985

(Million Rp.)

Revenue Items	Unit Charge	Revenue in 1985	Remarks
Port Due	7.4 Rp./Cargo Ton	35	$7.4 \times 4675.9 \times 10^3$ tons
Mooring Charge	539 Rp./Cargo Ton	162	$539 \times 300 \times 10^3$ tons
Towage	—	92	$2.1 \times 10^6 \times \frac{4676}{2950} = 3.3$ 800 HP: (12.450 Rp.x 365) + (34,445 Rp.x 2,433 h) = 88×10^6 Rp. 3.3 + 88.3 = 92
Pilotage	26.1 Rp./Cargo Ton	122	$26.1 \times 4675.9 \times 10^3$ tons
Open Storage	11.3 Rp./Cargo Ton	3	$11.3 \times 300 \times 10^3$ tons
Warehouse Storage	109 Rp./Cargo Ton	33	$109 \times 300 \times 10^3$ tons
Direct Transportation	39.4 Rp./Cargo Ton	12	$39.4 \times 300 \times 10^3$ tons
Equipment Rental	16.9 Rp./Cargo Ton	5	$16.9 \times 300 \times 10^3$ tons
Water Supply	300 Rp./Ton	22	$300 \times 74 \times 10^3$ tons
Others	—	16	$4.4 \times 10^6 \times \frac{300}{83.8}$
Total		502	

13.3. Estimation of Costs

13.3.1. Construction Cost

The construction cost of this project is 6,912 million Rp. as shown in Table 11.4.1, Chapter 11. The construction cost under analysis includes a 15 percent physical contingency and a 15 percent price contingency.

13.3.2. Operating Expenses

The operating expenses are estimated for each of the following six categories:

(1) Personnel cost
(2) General administration cost
(3) Operation cost
(4) Maintenance cost
(5) Depreciation cost
(6) Interest

13.3.3. Personnel Cost and General Administration Cost

(1) These costs are cumulatively computed for every fiscal year by estimating the personnel increase corresponding to the new facilities. In this case, the per-capita personnel cost and administration cost are set on the basis of the 1979 results as follows:

Personnel cost	:	483×10^3 Rp/year/capita
General administration cost	:	110×10^3 Rp/year/capita

(2) Estimation of Personnel Number

(i) Administrative Department – Administrative and general affairs branch handling personnel affairs, finances, the purchase of materials, information and regulation.
(ii) Staff Department – Staff branch handling technology, maintenance and transportation.
(iii) Operational Department – Terminal operation, storage facility operation, land transportation, ship mooring control, fire and safety control, etc.

Generally, the port organization can be divided into these three parts.

The administrators of this port will be required to effectively deal with situations in the following four areas in and after 1985.

(1) Increase of personnel in the operational department with emphasis on the assurance of profit and the expansion of service activities (increase of pilots, boat crews and equipment maintenance personnel mainly).

(2) Complete provision of materials and equipment and recruitment of personnel necessary for the above purposes.

(3) Increase of efficiency in the cargo handling work of the UKA (port workers union) is necessary to cope with the increase in the volume of cargoes. Hence, it is required to set up a guidance and supervisory system for cargo handling, to increase personnel and to provide

necessary materials and equipment.

(4) Increase of financial personnel and the clear definition of administrative assignment. (Execution of cost control according to the port charge system, strengthening of budget control, and strengthening of account control according to the increase of bill collection and processing resulting from the increase of port revenues.)

The number of personnel necessary for Sorong Port in 1985 to meet the above four requirements is shown in Table 13.3.1.

Table 13.3.1. Port of Sorong Personnel Staff in 1985

Present Organization	Present Employees	Operation Items	Number of Personnels in 1985	Remark
Chief of Port	1		1	
		Administrative Dept.	34	
		• Chief	2	
		• General	7	
		• Personnel	3	
		• Public Relation	1	
		• Statistic	1	
		• Law	1	
		• Purchasing	1	
Administration	19	• Finance	18	
Service Work	20			
		Staff Dept.	21	
		• Chief	2	
		• Engineering	8	
		• Maintenance	8	Warehouse, equipment, mechanic, Warf, housing, office
Technical Work	9	• Traffic management	3	
		Operating Dept.	64	
		• Chief	2	
		• Terminal & Warf	8	
		• Land transportation	7	
		• Domestic warehouse	5	
Pilot Work	18	• Pilot & Tug	29	
		• Water supply	3	
		• Fire and security	4	
		• Communication	6	
Total	67		120	

Table 13.3.2. Personnel and Administration Cost in 1985

(Million Rp.)

	Number	Cost
Personnel Cost	120	58
General Administration Cost	120	13
Total	120	71

13.3.4. Operation Cost

The 1979 basis is used for the existing facilities, and for the operation cost for the new facilities, the figures in Table 12.3.2. are adopted.

Table 13.3.3. Operation Cost in 1985

(Million Rp.)

Existing Facilities	8
New Facilities	29
Total	37

13.3.5. Maintenance Cost

Similarly, this cost is also computed in two categories of existing and new facilities. The 1979 basis is used for the existing facilities and the figures in Table 12.3.3. are used for the new facilities.

Table 13.3.4. Maintenance Cost in 1985

(Million Rp.)

Existing Facilities	35
New Facilities	93
Total	128

13.3.6. Fixed Assets and Depreciation Cost

(1) Fixed Assets

At Sorong Port there is no financial control resembling that of a private company's management based upon the principle of business accounting. For its existing facilities, therefore, assets involved must be revaluated and computed separately from the assets to be newly acquired by this project. Table 13.3.5. is the evaluation of the assets of the existing facilities, taking the year of their acquisition into consideration.

The assets to be newly acquired by this project are shown in Table 13.3.6.

Table 13.3.5. Fixed Assets of Existing Facility

(Million Rp.)

Facilities	Quantity	Purchased Year	Book Value at Purchased Year	Revaluated Book Value at 1980	Yearly Depreciation
Concrete Wharf	120m x 12m x 15m	1978	1,009	1,009	20.18
Wooden Wharf	132m x 12m x 11m	–	–	105	10.5
Ferry Jetty	15 m x 3 m x 3 m	–	–	(7)	–
Transit Shed (A)	97.5 m x 20 m	1978	243	243	7.36
Open Storage (A)	3,750 m^2	1977	163	163	3.26
Open Storage (B)	1,475 m^2	1977	64	64	1.28
Water & Oil Supply Facility	1 unit	1977	31	31	1.24
Mobile Crane	3T x 1	–	–	11	0.92
Forklift	5T x 1	–	–	7	0.58
Pilot Boat	125 PK x 2	–	–	32	2.67
Official Houses	70 m^2 x 3, 36 m^2 x 2	1977	39	39	1.18
Land		–	–	600	–
Land for Doom	1,450 m^2	–	–	8	–
Others	Generator, Materials etc.	1978	327	327	13.08
Total				2,031	62.25

Table 13.3.6. Fixed Assets of New Construction Facility

(Million Rp.)

Facilities	Book Value at the beginning of 1985	Yearly Depreciation	Beginning Year of Depreciation
New Wharf	3,315	66.30	1985
Ferry Jetty	134	2.68	1983
Open Storage	25	0.50	1985
Transit Shed	963	29.18	1985
Building	10	0.30	1985
Road	141	1.41	1985
Water Supply	57	2.28	1985
Electric Power Supply	121	3.67	1985
Navigation Aids	36	1.44	1984
Tug Boat	465	23.25	1985
Pilot Boat	79	3.95	1985
Forklift	31	1.55	1984 (1 unit) 1985 (1 unit)
Land	1,535	–	1985
Total	6,912	136.51	

(2) Depreciation

The depreciation is to be calculated by the straight line method in accordance with the depreciation rate listed in Table 13.1.2. The land is not an asset to be depreciated. The result of calculation is shown in Table 13.3.7. and this table covers both existing and new facilities.

Table 13.3.7. Fixed Assets Schedule

(Million Rp.)

Year	Balance Beginning	Investment (I)			Depreciation (D)	Balance at End	Accumulated (Book Value)	Accumulated Depreciation	Progress
		New	Replace	Total					
1980	1,934				62	1,872	2,031	159	
1981	1,872				62	1,810	2,031	221	
1982	1,810				62	1,748	2,031	283	
1983	1,748	134		134	65	1,817	2,165	348	564
1984	1,817	51		51	67	1,801	2,216	415	4,843
1985	1,801	6,727		6,727	198	8,330	8,943	613	
1986	8,330				198	8,132	8,943	811	
1987	8,132				198	7,934	8,943	1,009	
1988	7,934				198	7,736	8,943	1,207	
1989	7,736				198	7,538	8,943	1,405	
1990	7,538		105	105	198	7,445	8,943	1,498	
1991	7,445				198	7,247	8,943	1,696	
1992	7,247		50	50	198	7,099	8,943	1,844	
1993	7,099				198	6,901	8,943	2,042	
1994	6,901				198	6,703	8,943	2,240	
1995	6,703				198	6,505	8,943	2,438	
1996	6,505				198	6,307	8,943	2,636	
1997	6,307				198	6,109	8,943	2,834	
1998	6,109				198	5,911	8,943	3,032	
1999	5,911				198	5,713	8,943	3,230	
2000	5,713		105	105	198	5,620	8,943	3,323	
2001	5,620				198	5,422	8,943	3,521	
2002	5,422		50	50	198	5,274	8,943	3,669	
2003	5,274				198	5,076	8,943	3,867	
2004	5,076				198	4,878	8,943	4,065	
2005	4,878		544	544	198	5,224	8,943	3,719	

13.3.7. Long Term Loans and Interest

59 percent of the project cost is covered by the foreign long term loan and 41 percent National Development Fund.

The result of calculation employed by the loan condition in Table 13.1.1. is shown in Table 13.3.8.

Table 13.3.8. Long Term Loan Schedule

(Million Rp.)

Year	Project Cost			Loan Repayment Ammount	Loan Balance at End	Interest on Loan
	National Development Fund	Long Term Loan	Total			
1982	289	409	698		409	12
1983	1,833	2,497	4,330		2,906	87
1984	744	1,140	1,884		4,046	121
1985					4,046	121
1986					4,046	121
1987					4,046	121
1988					4,046	121
1989					4,046	121
1990					4,046	121
1991					4,046	121
1992				14	4,032	121
1993				97	3,935	118
1994				135	3,800	114
1995				135	3,665	110
1996				135	3,530	106
1997				135	3,395	102
1998				135	3,260	98
1999				135	3,125	94
2000				135	2,990	90
2001				135	2,855	86
2002				135	2,720	82
2003				135	2,585	78
2004				135	2,450	74
2005				135	2,315	69
2006				135	2,180	65

13.4. Income Statement and Source and Application of Funds

In Table 13.4.1. and Table 13.4.2. prepared by the method mentioned in the previous section are shown the financial position after the completion of this project.

"Income Statement" shows the financial situation to mainly ascertain the income position of the Port of Sorong.

"Source & Application of Funds" shows the cash flow after the completion of the project to mainly ascertain the long term debt or the repayment position of borrowings. Both financial statements show the financial position on the assumption that 41 percent of the project cost is raised from the National Development Fund (Case 2 with 3.2 percent FRR).

Table 13.4.1. Income Statement of Sorong Port

(Million Rp.)

	1980	1981	1982	1983	1984	1985	1986 ~ 1990	1991 ~ 1995	1996 ~ 2000	2001 ~ 2005
Operating revenues	185	204	225	249	280	502	2,510	2,510	2,510	2,510
Operating expenses	83	85	88	92	97	236	1,180	1,180	1,180	1,180
Operating profit	102	119	137	157	183	266	1,330	1,330	1,330	1,330
Depreciation	62	62	62	65	67	198	990	990	990	990
Interest on Loan	–	–	12	87	121	121	605	584	490	389
Gross profit	40	57	63	5	▲ 5	▲ 53	▲ 265	▲ 244	▲ 150	▲ 49
Tax (45%)	18	26	28	2	–	–	–	–	–	–
National development fund reserve (30.3%)	12	17	19	2	–	–	–	–	–	–
Net profit	10	14	16	1	▲ 5	▲53	▲ 265	▲ 244	▲ 150	▲ 49
Operating Ratio (%)	45	42	39	37	35	47	47	47	47	47

Table 13.4.2. Source and Application of Funds of Sorong Port

(Million Rp.)

	1980	1981	1982	1983	1984	1985	1986 ~ 1990	1991 ~ 1995	1996 ~ 2000	2001 ~ 2005
(A) Source of Funds										
Operating profit before interest and depreciation	102	119	137	157	183	266	1,330	1,330	1,330	1,330
Depreciation	62	62	62	65	67	198	990	990	990	990
Long Term Loan			409	2,497	1,140					
National Development Fund			289	1,833	744					
Total	164	181	897	4,552	2,134	464	2,320	2,320	2,320	2,320
(B) Application of Funds										
Addition to Fixed Assets			698	4,330	1,884		105	50	105	594
Interest			12	87	121	121	605	584	490	389
Principal								381	675	675
Others	30	43	47	4	5	53	265	244	150	49
Total	30	43	757	4,421	2,010	174	975	1,259	1,420	1,707
(C) Decrease/Increase of Net Current Assets	134	138	140	131	124	290	1,345	1,061	900	613
Debt Service Coverage	–	–	–	255	207	383	383	240	199	1,064
Return on Net Fixed Assets	5	7	8	9	10	3	3	4	4	5

13.5. Evaluation

13.5.1. Evaluation by FRR

The FRR calculated for each case are shown below:

Case 1	Where the total construction cost is financed by foreign loans, maintaining the current level of port tariffs.	FRR=Nil
Case 2	Where 41% of the construction cost is subsidized by the non-interest National Development Funds, maintaining the current level of port tariffs.	FRR=3.2%
Case 3	Where the total construction cost is financed by foreign loans, increasing the current level of port tariffs by 10%.	FRR=0.0%
Case 4	Where 41% of the construction cost is subsidized by non-interest National Development Funds, increasing the current level of port tariffs by 10%.	FRR=4.8%
Case 5	Where the total construction cost is financed by foreign loans, increasing the current level of port tariffs by 40%.	FRR=3.3%
Case 6	Where 41% of the construction cost is subsidized by the non-interest National Development Fund, increasing the current level of port tariffs by 40%.	FRR=9%

In the case where the total construction cost is financed by foreign loans (Case 5), a 3.3 percent FRR is obtained by increasing the current level of port tariffs by 40 percent.

However, when 41 percent of the construction cost is raised from National Development Fund (considered as subsidies), the FRR is 3.2 percent under the current level of port tariffs.

In this case, the interest rate on foreign loans is assumed to be 3.0 percent, so a return on investment is secured.

13.5.2. Evaluation by Financial Statements

In the aforementioned case of a 3.2 percent FRR (Case 2), Table 13.4.1. Income Statement shows the loss of about 50 million R_p. every year.

However, there is little problem in the payment of interest and principal on the long term loan, judging from the financial statement for this case shown in Table 13.4.2. Source & Application of Funds.

Therefore, in the case where 41 percent of the project cost is raised from the National Development Fund for new investments, there is no obstacle in paying the principal and interest on foreign loans without increasing the current level of port tariffs.

13.5.3. Conclusion

In the case where 41 percent of the construction cost is covered by the National Development Fund, the FRR will be 3.2 percent and there will be no particular obstacle in paying foreign loans which is equivalent to 59 percent of the project cost. But, the loss of about 50 million R_p. for each term is not desirable from the standpoint of business financing.

In conclusion, this investment is considered reasonable considering the fact that the investment in social infrastructure is expected to have a great impact on the regional development, and that enough benefits can be expected according to our economic analysis.

Table 13.5.1. FRR Calculation Table: Case 2 FRR = 3.2%

(Million Rp.)

Year		Balance			Discounted Value (B – C)
		Project Cost (C)	Operating Profit (B)	(B – C)	
1	1982	409		▲ 409	▲ 409
2	1983	2,497		▲2,497	▲2,420
3	1984	1,140		▲1,140	▲1,070
4	1985		266	226	242
5	1986		266	226	235
6	1987		266	266	227
7	1988		266	266	220
8	1989		266	266	213
9	1990		266	266	207
10	1991		266	266	200
11	1992		266	266	194
12	1993		266	266	188
13	1994		266	266	182
14	1995		266	266	177
15	1996		266	266	171
16	1997		266	266	166
17	1998		266	266	161
18	1999		266	266	156
19	2000		266	266	151
20	2001		266	266	146
21	2002		266	266	142
22	2003		266	266	137
23	2004		266	266	133
24	2005		266	266	129
25	2006		266		125
Total		4,046	5,852	1,806	▲ 3

Table 13.5.2. FRR Calculation Table: Case 3 FRR = 0.0%

(Million Rp.)

Year		Balance			Discounted Value (B - C)
		Project Cost (C)	Operating Profit (B)	(B - C)	
1	1982	698		▲ 698	▲ 698
2	1983	4,330		▲4,330	▲4,330
3	1984	1,884		▲1,884	▲1,884
4	1985		315	315	315
5	1986		315	315	315
6	1987		315	315	315
7	1988		315	315	315
8	1989		315	315	315
9	1990		315	315	315
10	1991		315	315	315
11	1992		315	315	315
12	1993		315	315	315
13	1994		315	315	315
14	1995		315	315	315
15	1996		315	315	315
16	1997		315	315	315
17	1998		315	315	315
18	1999		315	315	315
19	2000		315	315	315
20	2001		315	315	315
21	2002		315	315	315
22	2003		315	315	315
23	2004		315	315	315
24	2005		315	315	315
25	2006		315	315	315
Total		6,912	6,930	18	18

Table 13.5.3. FRR Calculation Table: Case 4 FRR = 4.8%

(Million Rp.)

Year		Balance			Discounted Value (B - C)
		Project Cost (C)	Operating Profit (B)	(B - C)	
1	1982	409		▲ 409	▲ 409
2	1983	2,497		▲2,497	▲2,383
3	1984	1,140		▲1,140	▲1,038
4	1985		315	315	274
5	1986		315	315	261
6	1987		315	315	249
7	1988		315	315	238
8	1989		315	315	227
9	1990		315	315	216
10	1991		315	315	207
11	1992		315	315	197
12	1993		315	315	188
13	1994		315	315	179
14	1995		315	315	171
15	1996		315	315	163
16	1997		315	315	156
17	1998		315	315	149
18	1999		315	315	142
19	2000		315	315	135
20	2001		315	315	129
21	2002		315	315	123
22	2003		315	315	118
23	2004		315	315	112
24	2005		315	315	107
25	2006		315	315	102
Total		4,046	6,930	2,884	13

Table 13.5.4. FRR Calculation Table: Case 5 FRR = 3.3%

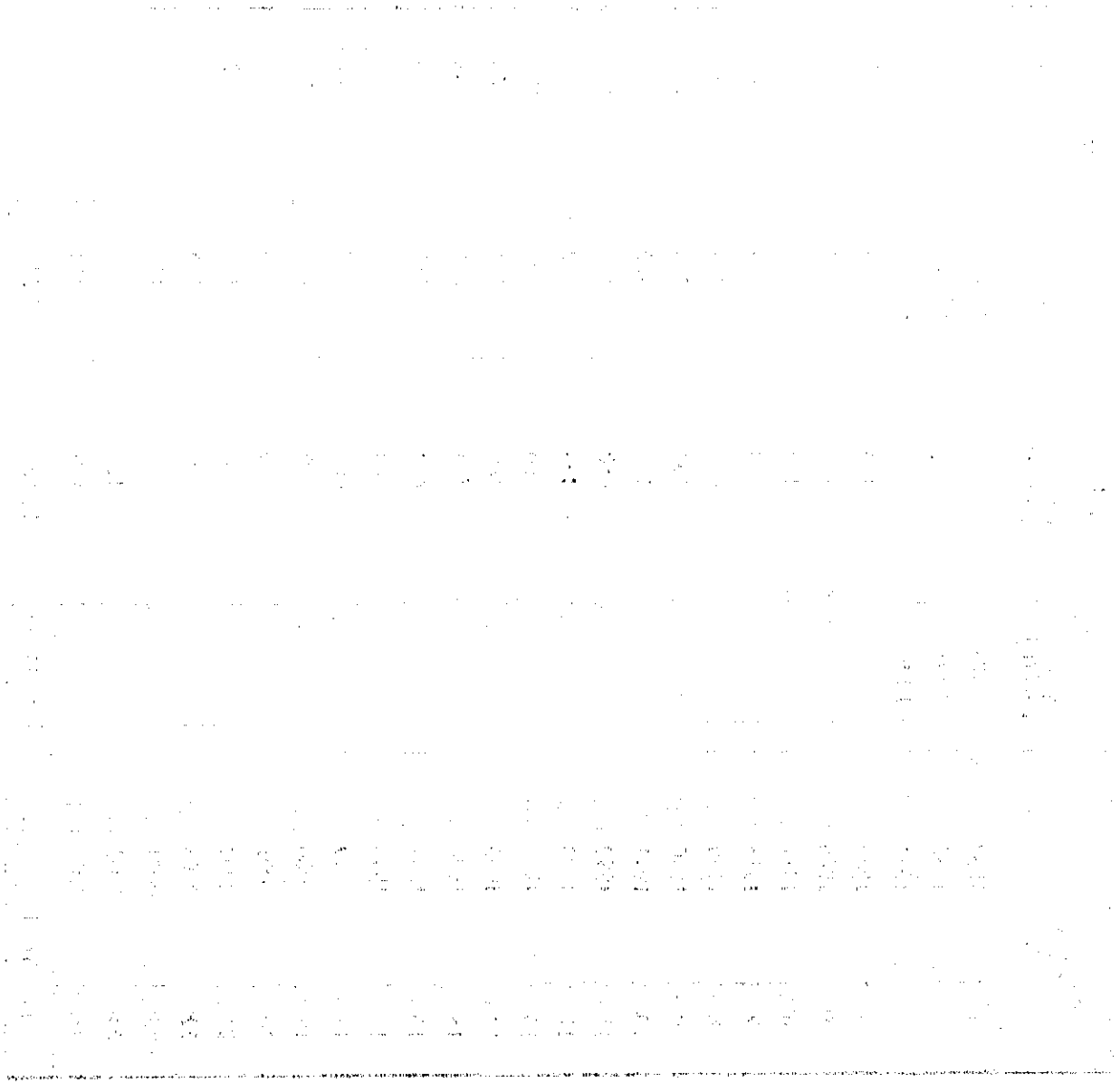
(Million Rp.)

Year		Balance			Discounted Value (B – C)
		Project Cost (C)	Operating Profit (B)	(B – C)	
1	1982	698		▲ 698	▲ 698
2	1983	4,330		▲4,330	▲4,192
3	1984	1,884		▲1,884	▲1,766
4	1985		460	460	417
5	1986		460	460	404
6	1987		460	460	391
7	1988		460	460	379
8	1989		460	460	366
9	1990		460	460	355
10	1991		460	460	343
11	1992		460	460	332
12	1993		460	460	312
13	1994		460	460	302
14	1995		460	460	292
15	1996		460	460	292
16	1997		460	460	283
17	1998		460	460	274
18	1999		460	460	265
19	2000		460	460	256
20	2001		460	460	248
21	2002		460	460	240
22	2003		460	460	232
23	2004		460	460	225
24	2005		460	460	218
25	2006		460	460	211
Total		6,912	10,120	3,208	11

Table 13.5.5. FRR Calculation Table: Case 6 FRR = 9%

(Million Rp.)

Year		Balance			Discounted Value (B – C)
		Project Cost (C)	Operating Profit (B)	(B – C)	
1	1982	409		▲ 409	▲ 409
2	1983	2,497		▲2,497	▲2,291
3	1984	1,140		▲1,140	▲ 960
4	1985		460	460	355
5	1986		460	460	326
6	1987		460	460	299
7	1988		460	460	274
8	1989		460	460	252
9	1990		460	460	231
10	1991		460	460	212
11	1992		460	460	194
12	1993		460	460	178
13	1994		460	460	164
14	1995		460	460	150
15	1996		460	460	138
16	1997		460	460	126
17	1998		460	460	116
18	1999		460	460	106
19	2000		460	460	98
20	2001		460	460	89
21	2002		460	460	82
22	2003		460	460	75
23	2004		460	460	69
24	2005		460	460	63
25	2006		460	460	58
Total		4,046	10,120	6,074	▲ 5



APPENDIX

TERMS OF REFERENCE
OF
MASTER PLAN AND PREDESIGN
FOR
THE PORT OF SORONG

June, 1979

Directorate General of Sea Communications
Department of Transport, Communications and Tourism
The Republic of Indonesia

I. BACKGROUND AND SUPPORTING INFORMATION

1. NECESSITY OF THE PROJECT

The region of Irian Jaya is abundant in natural resources such as oil, mining and agricultural products.

The region, however, which came back under jurisdiction of Indonesia, eighteen years ago, is sparsely populated and is in minor economic activity partly because of rather cold investment for its infrastructure.

Breaking out this situation, Sorong is coming before the flushlights as a "pioneer" for development of the "eastern frontier".

Looking out the future economical activity in this area, a preceded investment for infrastructure would be indispensable, especially for a deep sea port.

The port of Sorong thus selected as the "nuclear port" of Irian Jaya, where shipping requirement is rising.

2. INSTITUTIONAL FRAMEWORK

The masterplan and predesign of the port of Sorong is a project of the Directorate General of Sea Communications (DGSC). The functional responsibility is held on the Directorate of Ports and Dredging which carries out the project joined with the Planning Bureau, Research and Development Institution of Sea Communications, and the Port Administration of Sorong.

3. GOVERNMENT FOLLOW-UP

With the improvement of the port facilities, the Government of Indonesia will ensure effective and reliable shipping services as well as the influence to the growth of the regional economy and increase the transport demand.

The project is expected to consist of basic investment program and will serve as a guide to attract private investment and will be feasible for implementation.

II. OBJECTIVES

The principal purpose of the study is to provide the Government of Indonesia with a recommendation for the future development plan of the port of Sorong as a main port in Irian Jaya.

The objectives of the study on the development project of Sorong Port area as in:

1. To prepare a comprehensive masterplan for development of the port of Sorong, based on the forecast of development of its influence area, its social and economic aspect, and the correlation to other main port.
2. To prepare a short term plan for the port of Sorong and its financial and economic analysis.

III. PLAN OPERATION

III-1 Scope of Works

1. To review relevant existing studies and reports.
2. To study natural, social and economic situations of the port and its influence area.
3. To forecast the future traffic volume by land & marine transport.
4. To prepare a comprehensive masterplan of the port.
   * to study existing capacity of the port.
   * to study industries and man power relating to the port.
   * to study economic structure in adjacent area.
   * to select a site and to make layout of the port based on both natural and economic conditions.
   * to study access road and waterway of the port.
   * to study administration and operation of the port.
   * to study relevancy with other projects in adjacent area.
   * to study environmental assessment.
5. To prepare a short term plan of the port.
   * to study the port traffic.
   * to make an arrangement plan of the port facilities.
   * to make an arrangement plan of the cargo handling equipment and storage facilities.
   * to study the dredging requirement and reclamation.
   * to study the utilities.
   * to make a preliminary design of port facilities.
   * to make rough cost estimates and implementation program.
   * to study economic and financial analysis.
   * to make an improvement plan for the existing port facilities if necessary.
   * the study shall include some alternative plans.
6. To make preliminary engineering services for soil and hydraulic problems if necessary.
7. To recommend to the Government of Indonesia with some proper idea for regional development in connection with the port development.
8. To provide transfer of knowledge in the different fields relevant to this project.
9. To indicate the methodology of the study.

III-2 Principle of Planning

1. To meet traffic volume forecast by land and marine transportation.
2. To take into consideration the regional development plan.
3. To include proper idea as a part of regional development.
4. To consider the relationship with the ports in the influence area.
5. To sinchronize the port planning with urban plan of Sorong city and road network.
6. To consider environmental assessment.
7. To make recommendations for a sound financing policy of the port in the future.
8. To consider the relationship with other project in adjacent area.

III-3 Report

The following reports shall be submitted to the Government of Indonesia:

1. Inception report

   This report shall include program of a study and survey schedule for the port of Sorong.

2. Interim report

   This report shall include the following:

   a. The comprehensive masterplan shall indicate a direction of the plan of Sorong Port as a main port for oceangoing vessels.

   b. The short term plan shall include rough cost estimate in due consideration of alternative plan.

   This report shall be submitted and explained to the Government of Indonesia within three months after the completion of field survey.

   The Government of Indonesia will provide its comments within one month after the receipt of interim report.

3. Draft final report

   This report shall be prepared as a draft of final report with the short term plan and the masterplan for Sorong port. This report shall be submitted to the Government of Indonesia within three months after receipt of comments on the interim report.

   The Government of Indonesia will provide its comments within one month after receipt of the draft final report.

4. Final report

   The final report shall be submitted to the Government of Indonesia within about three months after receipt of final comments on draft final report.

5. A summary of the each report except Interim report shall be provided.

6. The report shall be made in English and distributed as follows:

   * Inception Report : 30 copies
   * Interim Report : 30 copies
   * Draft Final Report : 30 copies
   * Final Report : 60 copies

   Note: The above schedule is subject to the preparation of required information, data and comments in time by the Government of Indonesia.

IV. UNDERTAKING OF THE GOVERNMENT OF INDONESIA

1. To provide the study team with available data and information necessary for the study.
2. To exempt the study team from taxes and duties on the materials, equipment and personal effects brought into Indonesia by the team, according to the Government of Indonesia regulations.
3. To assign the official counterparts during the survey.
4. To make arrangement for visiting the authorities concerned.
5. To provide the study team with transportation facilities such as mobile car and boat for the

field survey, and to arrange suitable accommodation facilities in the vicinity of the study areas.

V. UNDERTAKING OF THE GOVERNMENT OF DONOR COUNTRY

The survey team of Donor country will transfer its technical knowledge concerning the project studies to the Indonesian counterparts during the field survey and processing data in Japan.

SCOPE OF WORK THE STUDY ON THE DEVELOPMENT PROJECT OF THE PORT OF SORONG, THE REPUBLIC OF INDONESIA

This Scope of Work is agreed by the following two authorities concerned:

Directorate General of Sea Communications, Department of Communications the Government of the Republic of Indonesia.

Japan International Cooperation Agency, the Official Agency responsible for the implementation of technical cooperation programmes of the Government of Japan.

To confirm the aforementioned, the Scope of Work is herewith attached and signed by the responsible personnels of the said authorities concerned.

Date: March 1, 1980
Issued at: Jakarta

For Department of Communications, the Government of the Republic of Indonesia.

J. E. HABIBIE
Secretary of the Directorate General of Sea Communications

Department of Communications
The Republic of Indonesia

For Japan International Cooperation Agency, the Government of Japan.

Kazuo Kudo
Leader
Japanese Preliminary Survey Team
Director
Hydraulic Engineering Division
Port & Harbour Research Institute
Ministry of Transport
Japan

SCOPE OF WORK
FOR
THE STUDY ON THE DEVELOPMENT PROJECT
OF
THE PORT OF SORONG,
THE REPUBLIC OF INDONESIA

February, 1980

Japan International Cooperation Agency

I. INTRODUCTION

In response to the agreement reached between the Government of the Republic of Indonesia and the Government of Japan concerning the implementation of the Study on the Development Project of the Port of Sorong, Japan International Cooperation Agency (hereinafter referred to as JICA), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, will carry out the Study.

The present document sets for the Scope of Work in regard to the abovementioned Study, which is to be carried out in cooperation with the Government of the Republic of Indonesia and its authorities.

II. OBJECTIVES

The Study intends to formulate a master plan for the Port of Sorong to support the significant growth of the regional economy, mainly in its area of influence, covering Irian Jaya and parts of Maluku islands, and to cover the increasing demand of sea traffic through the Port until about 2000.

It also includes a short term plan for the Port for the period ending 1985 with a feasibility study.

III. OUTLINE OF THE STUDY

In order to achieve the objectives, the Study consists of two phases.

Phase I

The Study in phase I will cover a master plan for the Port of Sorong and its vicinity.

The Inception Report on a program of the Study and the schedule for the field Surveys will be submitted by the Study Team to the Government of the Republic of Indonesia at the first meeting. After discussion between the Government and the Team on it, the Team will carry out the Surveys, which include the following items:

a) Review and analyse all the available pertinent reports and data, furnished by the Government of the Republic of Indonesia.
b) Carry out necessary field investigations for the Port of Sorong and its vicinity, including the present status of facilities, and operations.
c) Assess the existing capacity of the port and define the urgent needs for improvement.
d) Comment on possible improvement for port operation, including other related subjects such as customs, cargo forwarders etc. if any.
e) Prepare a traffic projection of the Port for the first ten years and outline of the following ten years.
f) Analyse and forecast shipping characteristics, such as type and size of calling vessels, type of services, lot size, etc.
g) Review present status of town planning from the view point of port development, and comment on, if any, necessary adjustments to the appropriate authorities.

h) Investigate and assess the present status of power, water, communication, repair facilities, ship chandling, labour size, etc. which are considered essential for the orderly development of the port.

i) Assess the availability and costs of materials, the construction equipment, and the skilled and unskilled labour, for the different construction plans.

j) Examine and assess the functions and relations of the Port of Sorong to all other major ports in Irian Jaya and other islands near the Port, and provide a realistic scenario for the possible course of balanced development of these ports.

Based on the above Studies, conditions and assumptions on which the master plan and feasibility study can be worked out will be summarized in the form of Provisional Report. The Report will be reviewed by the concerned government authorities, and a consensus shall be formulated before the start of the next step.

The report shall include proposals for technical investigations, such as boring and soil test, wave and current observations, which will require long survey period and are to be carried out by the Government of the Republic of Indonesia.

Based on the results of discussion on the Provisional Report, a master plan for the Port of Sorong as a guide for the orderly development of the port will be submitted in the form of the Interim Report, of which major roles will be as follows:

a) Define the long term space requirement for the port activities, including port related industries, and work out the best space allocation with respect to the overall township development.

b) Choose a basic arrangement of the facilities, and plan the frame work of the port, such as alignment of channels, basins, pier-head lines, and main access to the port area.

c) Establish and maintain a smooth interface between the development of township and the port, including access to the port, and arrangement of utility supply.

Phase II

The Study in Phase II will consist of a short term port development program, and a feasibility study, which cover the following items:

a) Define the short term development, based on the traffic projection and urgent needs of repair for the existing port facilities, indentified in the course of the above studies, if any.

b) Carry out preliminary design of port facilities for the short term and make realistic cost estimate, including necessary port equipment, such as cargo-handling equipment, harbour crafts, utility supply in port area, navigation aids, etc. The cost estimate should be prepared in such a manner that clearly separates foreign components, domestic components, and taxes and duties, if any.

c) Identify and assess all the economic benefits associated with proposed short term port development. Effort should be taken to quantity economic benefits as much as possible. Then carry out benefit/cost analysis.

d) Review and assess existing tariff structure and rates, and propose changes, if necessary.

e) Review and assess the present status of the financial position of the port, and make necessary advices for improvement, if any.

f) Carry out financial analysis of the port and prepare financial tables such as profit/loss statement, fund flow statement, and balance sheet, then calculate financial indicators, such as

IFRR, return on fixed assets, and debt/service ratio.

g) Work out outline of construction method and time schedule of the proposed first phase development.

IV. TIME SCHEDULE

The Study is to be completed within twelve months after the commencement of field surveys, which will start in the early next fiscal year of 1980. The duration of field surveys in the Republic of Indonesia will be about three months.

V. REPORTS

JICA will prepare and submit to the Government of the Republic of Indonesia the following reports in English during the course of the Study.

1) Inception Report (30 copies)
2) Provisional Report (30 copies)
3) Interim Report (30 copies)
4) Draft Final Report (30 copies)
5) Final Report (60 copies)

VI. THE GOVERNMENTS' UNDERTAKINGS

The Government of the Republic of Indonesia shall undertake the following items:

1) To provide the Study Team with necessary and available informations and data.
2) To arrange the appointments for visiting the appropriate authorities, and entering the necessary study areas.
3) To assign counter part officials to the Study Team during the study period.
4) To provide the Study Team with facilities, such as automobiles, boats, suitable offices with copying equipment and secretarial services and to arrange suitable accommodations in the vicinity of the study area.
5) To exempt the Study Team from taxes and duties for the equipment, materials and personal effects to be brought into the Republic of Indonesia according to the Government's regulations.
6) To exempt the Study Team's members from the Republic of Indonesia income tax and charges of any kind imposed on or in connection with the living allowance remitted from abroad.
7) To perform technical investigation for natural conditions in the project site.

The study will be carried out in such a manner that through this study the team will ensure technological transfer to Indonesian counterparts as much as possible.