different types of vessel calling (ocean-going vessels, coastal vessels, fishery boats and others). This means that the port area should be divided, in principle, into several specified parts such as for ocean-going vessels, coastal cargo vessels, fishery boats and others.

4.2.3 Background of the Port Development

The proposed Master Plan is formulated considering two major goals of the port development illustrated in section 4.1. In particular, it is very important to incorporate the idea of supporting regional and national prosperity into the Plan. In this sense, the Master Plan should be prepared to keep as much flexibility in its component as possible, so that the possible contingency of the hinterland conditions can be incorporated.

At the same time, to implement the proposed project, both public authorities and private companies have to make great efforts, in mobilizing necessary investment funds.

4.3 Alternative Sites for the Port Development

In order to determine the site for the port development, it is necessary to examine various aspects regarding natural conditions, socio-economic conditions and actual situation of land and water area around the port from a long term point of view.

In Chapter 3 (Present Situation of the port of Antsiranana), the results of the visual observation around the port site within the radius of 3km were shown. Taking this into account, in this Study, the area in the vicinity of Anse Melville (Site A) and the area around the present port (Site B) are selected as possible alternatives on the basis of comprehensive consideration of the outcome of the site surveys and discussions with relevant parties and organizations (Figure 4-3-1).

Site A has a vast and shallow area to be developed, which is well protected from wave. This site can be developed more or less freely. However, it is too shallow for large vessels to call. In order to construct port facilities having a large quay, it would be necessary to dredge the basins and the channels to a considerable extent, which would constitute a great amount of investment. Moreover, this site is inconvenient in terms of short/medium term development because of inadequate accessibility to the town of Diego Suarez and to relevant authorities and organizations of the port. It should be understood as the area to be developed in the long term over the year 2010.

Site B is the most suitable place for the port development from various points of view. It has a deep water area northwards and in front of the existing quay, while the

southward area is shallow and extremely calm. In addition, at Site B, there would be no problems in terms of accessibility and communication to the existing port services. However, the space is restricted by the sea and plateau. Therefore, reclaimed land would be necessary to extend the port area. If the reclamation is carried out in deep sea area, the construction cost would become higher.

Considering various aspects including the construction cost, it is thought that the Site B should be adopted for the development site in the Master Plan.

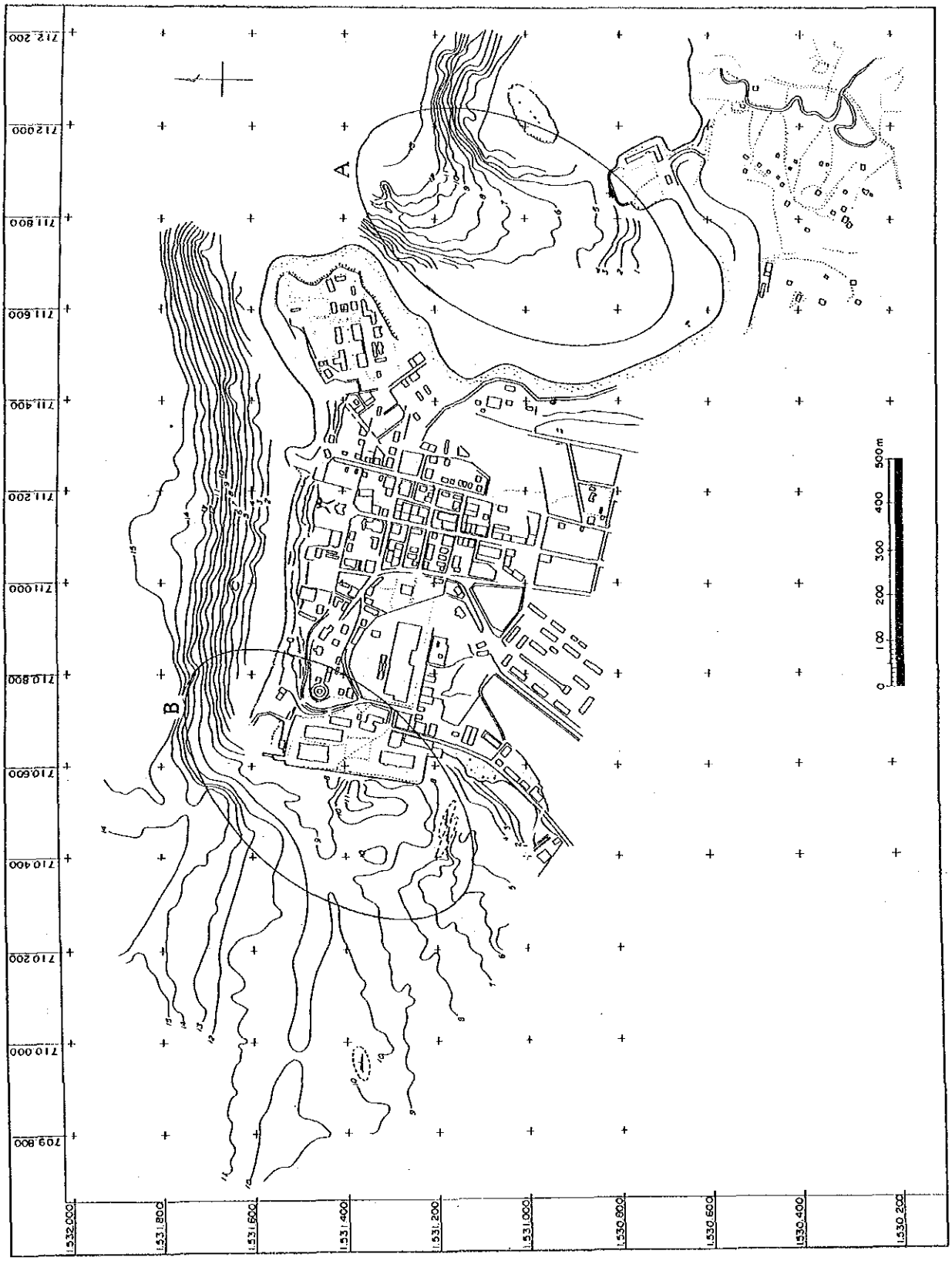


Figure 4-3-1 Alternative Sites for the Port Development

4.4 Demand Forecast

4.4.1 Future Socioeconomic Framework

(1) Population

1) Madagascar

According to the Madagascan government's estimation, the population of Madagascar in 1999 will be approximately 14.2 million with an average increase rate from 1992 to 1999 of about 2.7 % (Table 4-4-1). The estimated population of Madagascar in 2025 is about 26 million and the average increase rate from 1999 to 2025 is about 2.4 %, based on the World Bank's "World Development Report 1992".

Therefore these forecasts have been adopted as the future population framework, because there is no reliable forecast data except that of the World Bank. The results of forecast are shown in Table 4-4-2 and Figure 4-4-1.

Table 4-4-1 Estimated Population
according to the Madagascan Government

YEAR	Population
1985	9,855,000
1990	11,197,200
1992	11,796,900
1993	12,108,700
1994	12,428,700
1995	12,760,700
1996	13,101,600
1997	13,451,600
1998	13,811,000
1999	14,180,000

Source: "Madagascar in figures 1992"
;Banque des Donnes de l'Etat

Table 4-4-2 Results of Population Forecast

Year	Population (thous pers)	Ave increase rate (%)	Remark
1992	11,797	2.7	1999/1992
1999	14,180		Madagascar government
2000	14,520		
2001	14,870		
2002	15,230		
2003	15,590		
2004	15,970		2025/1999
2005	16,350	2.4	The World Bank
2006	16,740		
2007	17,140		
2008	17,550		
2009	17,980		
2010	18,410		

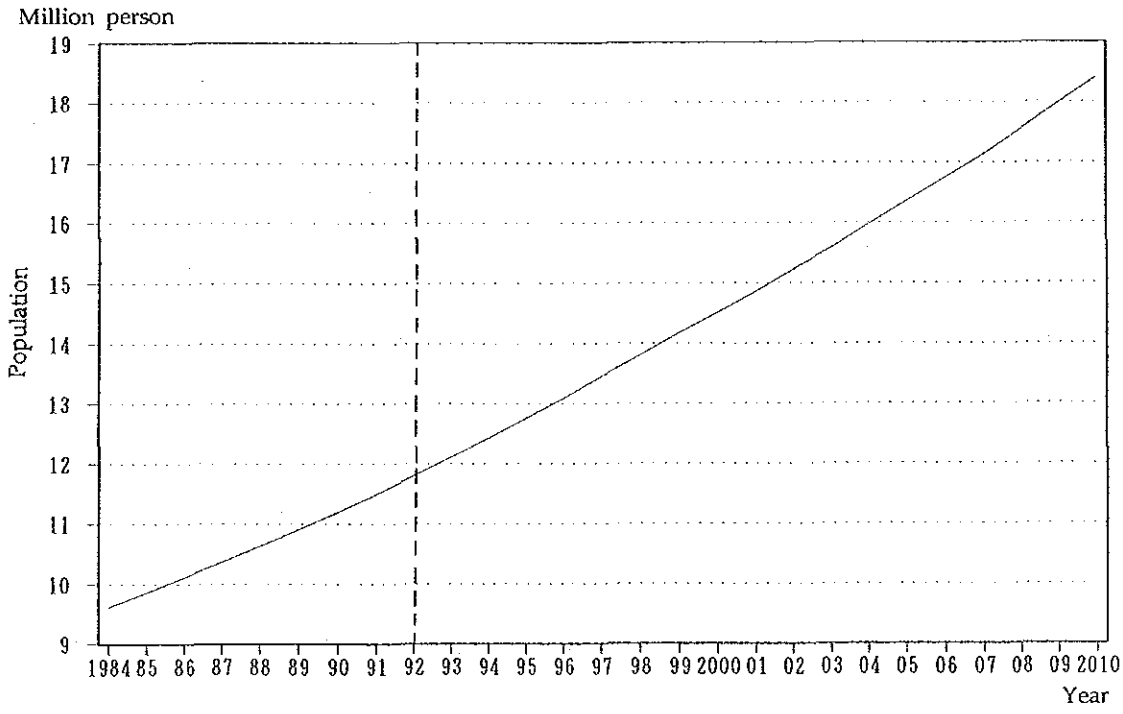


Figure 4-4-1 Results of Population Forecast

2) Antsiranana province

Population trends in Antsiranana province is shown in Table 4-4-3. Based on the these trends, if the political and economic situation remain stable, it is surmised that the average increase rate of population in the future will be over 2 %.

Therefore it is estimated that the average increase rate of population in Antsiranana province is 2.2 % until 1998, which is the same as the average increase rate of the western part of Antsiranana province in the last 3 years. The annual increase rate of population after 1999 is assumed 2.4 % which is the same as the average increase rate of Madagascar. The result of the estimate is shown in Table 4-4-4.

Table 4-4-3 Trend of Population in Antsiranana Province

(Unit:person, %)

	Population				Average increase rate		
	1983	1986	1990	1992	86/83	90/86	92/90
Antsiranana 1	75,100	79,000	71,683	77,863	1.702	-2.401	4.222
Antsiranana 2	65,902	68,767	68,268	62,179	1.429	-0.182	-4.564
Ambilobe	116,402	128,930	144,878	138,427	3.466	2.958	-2.252
Ambanja	87,750	93,604	100,082	114,036	2.176	1.687	6.744
Nosy-be	34,602	40,205	29,932	41,165	5.130	-7.111	17.273
ANTSIRANA WEST	379,756	410,506	414,843	433,670	2.629	0.263	2.244
Vohemar	140,491	134,559	149,901	154,099	-1.428	2.736	1.391
Sambava	194,457	201,396	219,080	214,432	1.176	2.126	-1.066
Antalaha	166,155	162,202	181,118	195,752	-0.799	2.796	3.961
Andapa	199,449	129,113	141,976	150,072	-13.494	2.403	2.812
ANTSIRANA EAST	700,552	627,270	692,075	714,355	-3.616	2.488	1.597
PROVINCE TOTAL	1,080,308	1,037,776	1,106,918	1,148,025	-1.330	1.626	1.840

Source: Ministere de L' Interieur/Faritany d'Antsiranana

Table 4-4-4 Result of Population Forecast in Antsiranana Province

Year	Population(thousand person)			Ave increase rate (%)
	West	East	Total	
1992	434	714	1148	2.2
1998	494	814	1308	
1999	506	834	1340	
2000	518	854	1372	
2001	531	874	1405	
2002	543	895	1438	
2003	556	916	1472	2.4
2004	570	938	1508	
2005	583	961	1544	
2006	597	984	1581	
2007	612	1008	1620	
2008	626	1032	1658	
2009	641	1057	1698	
2010	657	1082	1739	

(2) GDP of Madagascar

Trend of GDP in 1990 price is shown in Table 4-4-5. It is expected that the average growth rate of GDP in the future is 6 %, the same as the average growth rate of world low-income countries from 1980 to 1990. This is because the future growth rate of GDP needs to be at a considerably higher level than the growth rate of population to achieve a higher standard of living. But it will take a long time before Madagascar obtains a GDP growth rate of 6 % because few incentives for foreign companies exist and export industries have not fully matured. In this case, it is considered appropriate to assume the average growth rate of GDP at 3 % until 1998, 4.5 % from 1999 to 2003 and 6 % from 2004 to 2010.

Regarding individual sectors, it is thought that the service sector will maintain its share of about 50 % in the future, which is in line with middle-income countries at present. Considering the average growth rate of the agriculture sector achieved so far in other countries, high growth in the agricultural sector in Madagascar cannot be expected. It is thought that the average growth rate of the agricultural sector in the future is 4 % which is slightly higher than the actual rate in the last decade. Regarding the industrial sector, although Madagascar is rich in agricultural products and mining products, industrialization shows no sign of progress at present. In order to obtain high economic growth, industrial sector must lead the GDP of Madagascar through industrial development. The results of forecast are shown in Table 4-4-6 and Figure 4-4-2.

Table 4-4-5 Trend of GDP in 1990 Price

(UNIT:BILLION FMG, %)

YEAR	AGRICULT		INDUSTRY		SERVICE		TOTAL	
	PRICE	SHARE	PRICE	SHARE	PRICE	SHARE	PRICE	SHARE
1984	1155	31.2	531	14.3	2016	54.5	3702	100
1985	1168	31.2	538	14.4	2034	54.4	3740	100
1986	1206	31.6	558	14.6	2048	53.8	3812	100
1987	1236	32.0	585	15.1	2044	52.9	3865	100
1988	1263	31.6	596	14.9	2135	53.5	3994	100
1989	1329	32.0	603	14.5	2223	53.5	4155	100
1990	1357	31.8	597	14.0	2310	54.2	4264	100
1991	1364	33.4	590	14.4	2132	52.2	4086	100
1992	1383	33.6	577	14.0	2155	52.4	4115	100
Ave growth rate 92/84	2.3		1.0		0.8		1.3	
90/84	2.7		2.0		2.3		2.4	

Original source: "Bulletin d'information et de statistiques"
;Banque Centrale de Madagascar

Table 4-4-6 Result of GDP Forecast in 1990 Price

(UNIT:BILLION FMG, %)

YEAR	AGRICULT		INDUSTRY		SERVICE		TOTAL	
	PRICE	SHARE	PRICE	SHARE	PRICE	SHARE	PRICE	SHARE
1992	1383	33.6	577	14.0	2155	52.4	4115	100
1993	1424	33.6	597	14.1	2217	52.3	4238	100
1994	1467	33.6	618	14.2	2281	52.2	4366	100
1995	1511	33.6	640	14.2	2346	52.2	4497	100
1996	1557	33.6	662	14.3	2412	52.1	4631	100
1997	1603	33.6	685	14.4	2482	52.0	4770	100
1998	1651	33.6	709	14.4	2554	52.0	4914	100
1999	1709	33.3	755	14.7	2671	52.0	5135	100
2000	1769	33.0	804	15.0	2793	52.0	5366	100
2001	1830	32.6	856	15.3	2922	52.1	5608	100
2002	1895	32.3	912	15.6	3053	52.1	5860	100
2003	1961	32.0	971	15.9	3193	52.1	6125	100
2004	2039	31.4	1063	16.4	3388	52.2	6490	100
2005	2121	30.8	1164	16.9	3595	52.3	6880	100
2006	2206	30.2	1275	17.5	3812	52.3	7293	100
2007	2294	29.7	1396	18.1	4040	52.3	7730	100
2008	2386	29.1	1529	18.7	4279	52.2	8194	100
2009	2481	28.6	1674	19.3	4530	52.2	8685	100
2010	2581	28.0	1833	19.9	4793	52.1	9207	100
Ave growth rate								
1998/1992	3.0		3.5		2.9		3.0	
2003/1998	3.5		6.5		4.6		4.5	
2010/2003	4.0		9.5		6.0		6.0	
2010/1992	3.5		6.6		4.5		4.6	

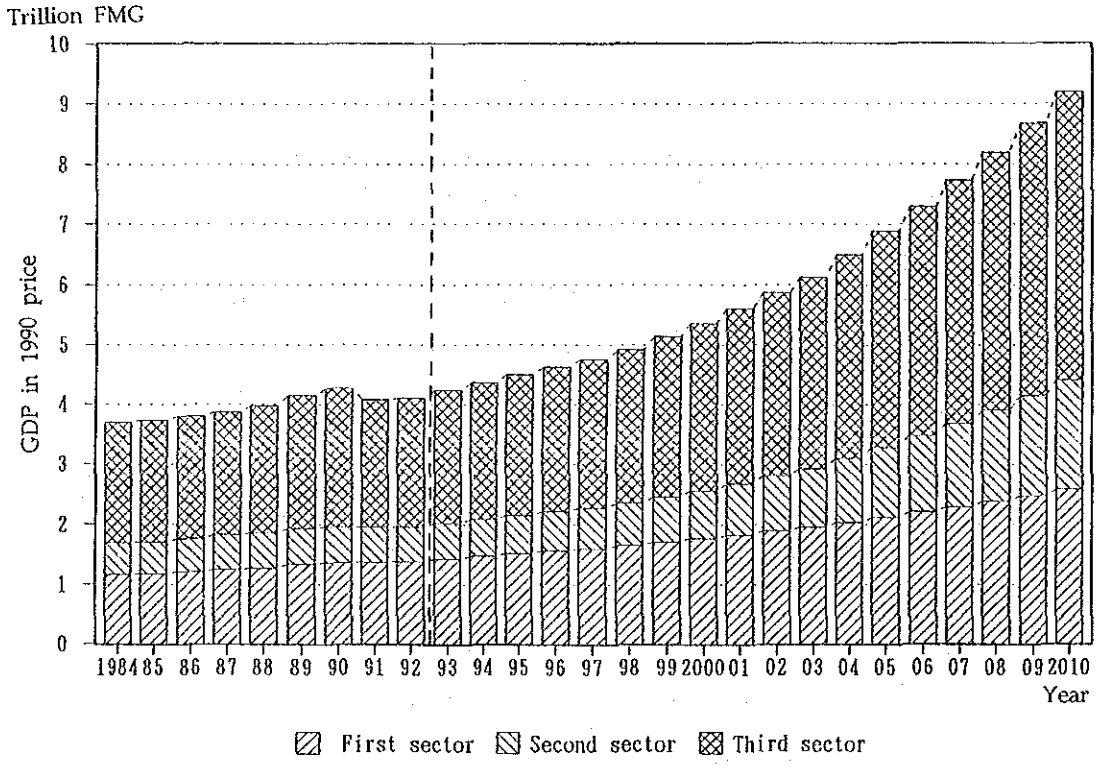


Figure 4-4-2 Results of GDP Forecast

4.4.2 Hinterland

(1) The present situation

Regarding the connection between the port of Antsiranana and its hinterland, cargo transport by truck between the port of Antsiranana and the eastern part of Antsiranana province and Mahajanga province is not very practicable, because the roads connecting Ambilobe with Vohemar and Ambanja with Antsohihy are dirt roads in poor condition. Regarding the activities of maritime transportation, the port of Antsiranana plays in some degree the role of collection and distribution center, mainly in Antsiranana province, of foreign cargoes except for imported petroleum products. Imported petroleum products and salt are distributed to areas beyond the province of Antsiranana.

Based on the actual road network and maritime transportation, the hinterland connected directly to the port of Antsiranana is the western part of Antsiranana province, while its secondary hinterland is the whole country. The results of OD-survey are shown in Table 4-4-7.

Table 4-4-7 Results of OD-Survey Based on Handling Cargoes of the Port of Antsiranana in 1992

(Unit; MT)

Origin or Destination	Foreign	Domestic						Marine	Unknown	Total
		Mahajanga	Morondava	Nosy be	Toamasina	Vohemar	Total			
Loading										
Tuna	2893	0	0	0	0	0	0	0	1512	4405
Salt	178	644	200	120	175	1410	2549	0	5854	8581
Petroleum pro	0	0	1200	0	4	0	1204	0	0	1204
Others	10932 cannedfood 7230 container 1182	125 coconuts 87	0	0	15	747 star prod 438 lumber 263	887	0	20	11839
Total	14003	769	1400	120	194	2157	4640	0	7386	26029
Unloading										
Tuna	0	0	0	0	0	0	0	58283	211	58494
Salt	0	200	0	0	0	0	200	0	0	200
Petroleum pro	0	0	0	0	9	0	9	0	0	9
Others	2108 container 1114 steel 499	695 flour 540	48	621 container 586	5771 cement 4752 bottle 329	92	7227	0	1641	10976
Total	2108	895	48	621	5780	92	7436	58283	1852	69679
TOTAL										
Tuna	2893	0	0	0	0	0	0	58283	1723	62899
Salt	178	844	200	120	175	1410	2749	0	5854	8781
Petroleum pro	0	0	1200	0	13	0	1213	0	0	1213
Others	13040	820	48	621	5786	839	8114	0	1661	22815
Total	16111	1664	1448	741	5974	2249	12076	58283	9238	95708

Original source; DTM

(2) The future situation

It is thought that the future hinterland of Antsiranana port will not discernibly change from the present situation because the Government does not have an improvement plan of roads connecting Ambilobe with Vohemar and Ambanja with Antsohihy. Moreover, the Government is studying a plan which reinforces the coastal transportation in East Antsiranana province by connecting Antsiranana port and Toamasina port, but even if the plan is realized in the future, the hinterland of Antsiranana port will probably not be extended because Toamasina port is near East Antsiranana province, and Toamasina port has a very large hinterland and many regular ocean lines.

It is important, however, for Antsiranana port to reinforce the coastal transportation in the western part of Antsiranana province and Mahajanga province because these areas are far from Toamasina port and there are no major ports for foreign trade in these areas. But a project to reinforce the coastal transportation in the Northwest area has yet to be proposed.

The future hinterland situation of Antsirananan port is shown in Figure 4-4-3.

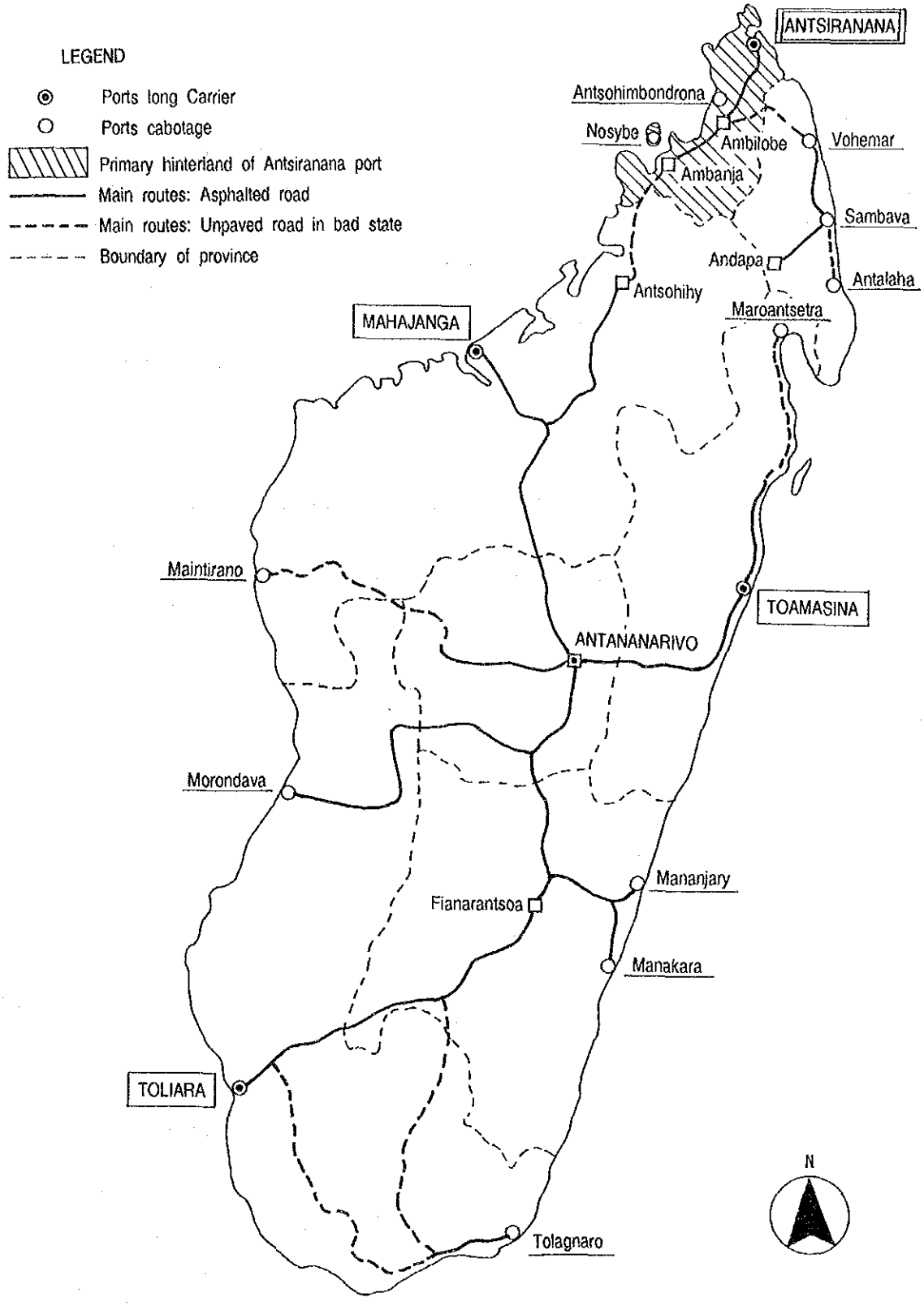


Figure 4-4-3 Future Hinterland Situation of the Port of Antsiranana

4.4.3 Cargo Volume Forecast

(1) Methodology

Two methods are used generally to forecast the commercial cargo volume handled at the port. One is a macro forecast which is a method to estimate the cargo volume as a group including various commodities, regardless of the volume of each commodity. The other is a micro forecast, which is a method to estimate the cargo volume of each commodity individually.

In this cargo volume forecast, a macro forecast is not used for the following reasons:

1) There are no standardized statistics on cargo handling including both general merchandise and petroleum.
2) Petroleum products, tuna-related products and salt have a combined share of about 80 % of the entire cargo volume handled at Antsiranana port in 1992, and the future cargo volume of Antsiranana port seems to be controlled greatly by the future production plans of the companies which produce these products.
3) The volume of tuna-related cargoes and transhipment cargoes of petroleum has increased rapidly since 1991.

(2) Micro forecast

Judging from the major cargoes handled at the port of Antsiranana, the handling cargoes are classified into 4 categories, that is, tuna-related cargoes, salt, petroleum products and other general cargoes. The future cargo volume is forecast for each category.

1) Tuna-related cargoes

i. Tuna factory cargoes

PFOI has a factory expansion plan to raise the production capacity of canned tuna from 55 million to 100 million by 1996. Based on this new capacity, tuna factory related cargoes are forecast. Since PFOI has not yet formulated the next expansion plan after 1996, however, the capacity of the tuna factory is not expected to change further until 2010.

According to the interview with PFOI, the unit volume of material per one carton of canned tuna and other related data are shown as follows.

- Unit volume of material per one carton

Material	Volume(kg)	
	Oil can	Non-oil can
Tuna	18.239	17.279
Steel sheet	2.223	2.223
Paper box	0.255	0.255
Cooking oil	2.769	0

- Number of canned tuna

Products	Number(million)	
	can	carton
Oil can	50	1.042
Non-oil can	50	1.042
Total	100	2.084

Based on these data, the volume of tuna-related cargoes handled at Antsiranana port is forecast as shown in Table 4-4-8.

Table 4-4-8 Results of Tuna-related Cargo Forecast

(Unit: ton)

		1991	1992	1998
Nom of can (million)		15	40	100
Cargo volume				
Unload	Tuna	5875	14696	37000
	Steel sheet	415	1200	4600
	Paper box	80	212	500
	Cooking oil	0	46	2900
	Total	6370	16154	45000
Load	Canned tuna	2273	6059	15200
Total		8643	22213	60200

ii. Transhipment volume of tuna

Considering the data of Association Thoniere Commission de l'ocean Indien, the volume of tuna handled in the future at the port of Antsiranana is forecast to increase.

As it is though that most of the increased cargo will be carried into the canning factory, the transhipment volume of tuna after 1994 will remain the same volume as that in 1992.

2) Salt

According to data provided by CSM, it controls 95 % of the country's entire production, of which 30 % is exported to the East African region and about 50 % of domestic cargoes uses maritime transportation. The data from 1991 to 1992 cannot be used on account of socioeconomic confusion. As domestic consumption of salt has a

large share in its total production, the future production volume is forecast by correlation of the past production volume with the total Madagascan population. The data used in the forecast and correlation equation are as follows. The result of the forecast is shown in Table 4-4-9.

Year	Product volume (ton)	Population of Madagascar (thousand)
1983	25000	
1984	35000	9608
1985	33000	9855
1986	37000	10109
1987	35000	10369
1988	35000	10635
1989	41000	10909
1990	42000	11197
1991	33000	11493
1992	29000	11797
2010	85400	18410

Y=6.113X-27094 (r=0.72)

where Y: Product volume(ton)
X: Population of Madagascar(thousand)

Table 4-4-9 Results of Salt Forecast

	Product volume	Loading			OTHERS
		Export		Cabotage	
		Container	Others		
Share(%)	100	10	20	35	35
Volume in 2010(ton)	85400	8500	17100	29900	29900

3) Petroleum products

According to SOLIMA's data related to supply and demand of petroleum products in Madagascar, volume of products made of crude petroleum fails to meet the demand. To make up for the deficiency, kerosine and gas oil are imported and overproduced fuel oil is exported. Based on an interview with SOHMA, volume of import crude petroleum is decided by consumption of gasoline, and shares of products made of crude petroleum are nearly constant.

The cargo volume handled at the Port of Antsivanana is forecast on the premise that the capacity of refinery in Toamasina is expanded in the future according to the increase in demand. The flow chart of the forecast is shown in Figure 4-4-4.

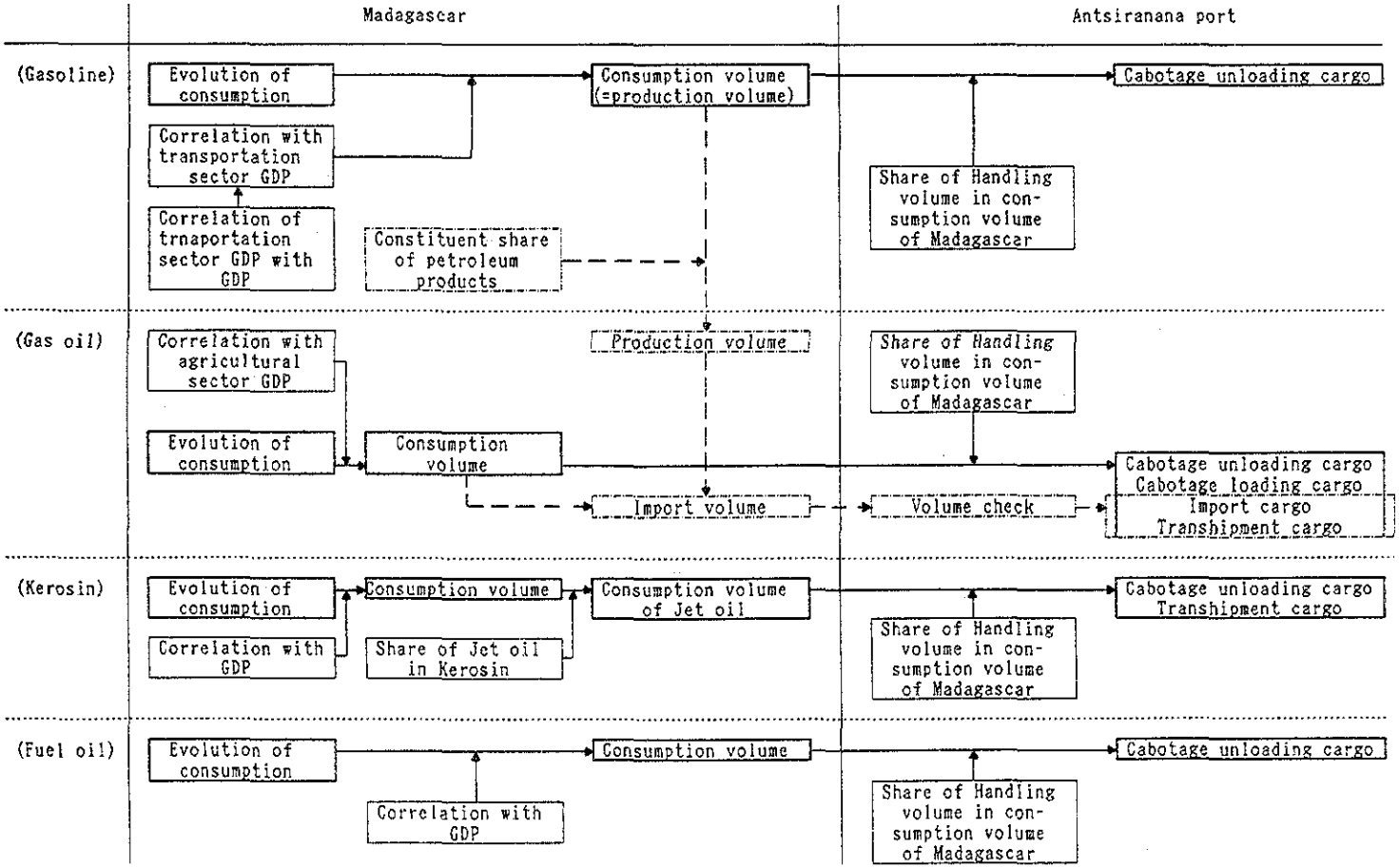


Figure 4-4-4 Flowchart of Petroleum Products Forecast

i) Gasoline

The correlation between GDP of transportation sector and total GDP is shown below.

YEAR	Transportation sector GDP 1990 price (billion FMG)	GDP 1990 price (billion FMG)
1984	458.4	3702
1985	457.2	3740
1986	466.2	3812
1987	476.5	3865
1988	511.1	3994
1989	541.1	4155
1990	580.1	4264
1991	482.9	4086
1992		4115
2010	1657.7	9207

Y=0.21977X-365.72 (r=0.98)

where Y: Transportation sector GDP in 1990 price (billion FMG)
X: GDP in 1990 price (billion FMG)

The correlation between consumption volume in Madagascar and GDP of transpotation sector is shown below.

YEAR	Consumption volume (M3)	Transportation sector GDP 1990 price (billion FMG)
1983	80274	
1984	78093	458.4
1985	76000	457.2
1986	74000	466.2
1987	72000	476.5
1988	71641	511.1
1989	75104	541.1
1990	79809	580.1
1991	70905	482.9
1992	76561	
2010	165508	1657.7

Y=80.41X+32212 (r=0.88)

where Y: Consumption volume in Madagascar (M3)
X: Transportation sector GDP in 1990 price (billion FMG)

Based on the handling share of Antsiranana port in consumption volume of Madagascar, unloading volume in Antsiranana port is forecasted as shown in Table 4-4-10.

Table 4-4-10 Results of Gasoline Forecast

YEAR	Consunption volume of Madagascar		Share of Antsiranana	unload volume MT
	(M3)	MT(M3*0.70)		
2010	165508	115856	0.05	5800

Share; average for the latest 5 years

ii) Gas oil

The correlation between consumption volume of Madagascar and GDP of agricultural sector shown below.

YEAR	Agricultural sector GDP 1990 price (billion FMG)	consumption volume in Madagascar (M3)
1983		150805
1984	1155	164375
1985	1168	170120
1986	1206	173500
1987	1236	177000
1988	1263	180550
1991	1364	194548
1992	1383	210791
2010	2581	409257

Y=171.54X-33477.7 (r=0.93)

where Y: Consumption volume in Madagascar (M3)
X: Agricultural sector GDP in 1990 price (billion FMG)

Based on the handling share of Antsiranana port in the consumption volume of Madagascar, handling volumes of Antsiranana port are forecasted as shown in Table 4-4-11.

Table 4-4-11 Results of Gas Oil Forecast

	Antsiranana port				Consunption volume in Madagascar	
	Cabotage unload	Import unload	Import transhipment	cabotage load	M3	MT(=M3*0.85)
Share in 2010	0.01	0.14	0.31	0.035	100	100
Volume in 2010 (MT)	3500	48700	107800	12200	409257	347868

Share; actual share in 1992

Based on constituent ratio of gasoline and gas oil in crude petroleum, import volume of gas oil in Madagascar is forecasted as follows. The resultant volume in Antsiranana port is deemed reasonable.

YEAR	Constituent ratio in crude petroleum		Production volume in Madagascar		Gas oil		
	Gasoline	Gas oil	Gasoline (M3)	Gas oil (M3)	Consumption volume (M3)	Import volume (M3)	(MT)
2010	0.148	0.201	165508	224778	409257	184479	156800

Import volume in Madagascar > Import volume in Antsiranana port

156800 > 156500 (=48700+107800)

iii) Kerosine

As most kerosine handled at Antsiranana port is jet oil, the jet oil volume was forecast.

The correlation between consumption volume of Madagascar and GDP is shown below.

YEAR	GDP 1990 Price (billion FMG)	Consumption vol. Madagascar (M3)
1983		59739
1984	3702	60816
1985	3740	62030
1986	3812	63300
1987	3865	64500
1988	3994	65800
1989	4155	67100
1990	4264	68440
1991	4086	62792
1992	4115	64957
2010	9207	131034

Y=12.60X+15001.3 (r=0.96)

where Y: Consumption volume in Madagascar (M3)
X: DGP in 1990 price (billion FMG)

Based on the share of jet oil in the volume of kerosine, consumption volume of jet oil in Madagascar is given below.

YEAR	Consumption volume		Share of jet
	kerosin (M3)	jet (M3)	
2010	131000	43230	0.33

Share; average for the latest 3 years

Based on the handling share of Antsiranana port in the consumption volume of Madagascar, handling volumes of Antsiranana port are forecasted as shown in Table 4-4-12.

Table 4-4-12 Results of Kerosine Forecast

Year	Share of Antsiranana port		Volume(MT=M3*0.80)	
	Cabotage *unload*	Import *tranship*	Cabotage *unload*	Import *tranship*
2010	0.12	0.12	4200	4200

Share; average for the latest 5 years

iv) Fuel oil

The correlation between consumption volume of Madagascar and GDP is shown below.

YEAR	GDP 1990 Price (billion FMG)	consumption vol. Madagascar (M3)
1983		55445
1984	3702	46578
1985	3740	47510
1986	3812	48460
1987	3865	49430
1988	3994	50420
1989	4155	51430
1990	4264	52460
2010	9207	100831

Y=9.74X+11154.4 (r=0.96)

where Y: Consumption volume in Madagascar (M3)
X: GDP in 1990 price (billion FMG)

Based on the handling share of Antsiranana port in the consumption volume of Madagascr, handling volume of Antsiranana port is forecasted as shown in Table 4-4-13.

Table 4-4-13 Results of Fuel Oil Forecast

Year	Consumption vol. Madagascar (MT=M3*0.80)	Share of Antsiranana	Cabotage unload vol Antsiranana (MT)
2010	80700	0.070	5600

Share; average for the latest 5 years

v) Results of forecast

Results of petroleum cargo forecast are shown in Table 4-4-14.

Table 4-4-14 Results of Petroleum Cargo Forecast in 2010

(Unit: MT)

Products	Import			Cabotage			Grand Total			
	Unload	Tranship	Total	Unload	Load	Total	Unload	Load	Tranship	Total
Gasolin	0	0	0	5800	0	5800	5800	0	0	5800
Jet oil	0	4200	4200	4200	0	4200	4200	0	4200	8400
Gas oil	48700	107800	156500	3500	12200	15700	52200	12200	107800	172200
Fuel oil	0	0	0	5600	0	5600	5600	0	0	5600
Total	48700	112000	160700	19100	12200	31300	67800	12200	112000	192000

4) Other general cargoes

i) Rice

(a) Unloading cargo

There is a positive correlation between handling volume at Antsiranana port and import volume in Madagascar. There is a negative correlation between import volume in Madagascar and GDP of agricultural sector, and import volume in Madagascar has tended to decrease. The data are shown in Table 4-4-15.

But as there is a regional imbalance between production and consumption in Antsiranana province(Table 4-4-16), and road networks are in poor condition, and moreover rice constitutes aid from foreign countries, handling of rice at Antsiranana port will continue in the future. Therefore the unloading volume was forecast based on the average of past unloading volume.

Table 4-4-15 Trend of Unloading Rice Volume

year	Antsiranana Unload (MT)	Madagascar Import (MT)	Agricultural GDP(1990 price) (billion FMG)
1983	15855	232709	
1984	11846	130759	1155
1985	10637	249659	1168
1986	0	209738	1206
1987	3130	138991	1236
1988	3939	37251	1263
1989	5609	99026	1329
1990	4868	58969	1357
1991	4044	31300	1364
1992	4872	52413	1383
2010	4600		2581

Table 4-4-16 Production and Consumption of Rice in Antsiranana Province

	PRO. VOLUME (1989) (A) (TON)	CONSUMPTION (B)			(A)-(B) (TON)
		POPULATION	PER HABIT (TON)	VOLUM CON (TON)	
ANTSIRANANA	26380	142900	0.187	26722.3	-342.3
AMBILOBE	38800	140700	0.187	26310.9	12489.1
AMBANJA	14905	98400	0.187	18400.8	-3495.8
NOSY BE	325	32100	0.187	6002.7	-5677.7
ANTSIRA WEST	80418	414100		77436.7	2981.3
VOHEMAR	9200	145900	0.151	22030.9	-12830.9
SANBAVA	24800	214500	0.151	32389.5	-7589.5
ANTALAHA	12500	176200	0.151	26606.2	-14106.2
ANDAPA	58000	138600	0.151	20928.6	37071.4
ANTSIRA EAST	104500	675200		101955.2	2544.8
TOTAL	184918	1089300		179391.9	5526.1

Original source: "REGIONS ET DEVELOPPEMENT"; Ministere de l'economie et duPlan

(b) Loading cargo

Trend of loading volume does not have a specific trend, nor is there a correlation between loading volume and unloading volume. Therefore the loading volume was forecast based on the past average ratio of loading volume to unloading volume.

(C) Results of forecast

Table 4-4-17 Results of Rice Forecast

(Unit: MT)

Year	Load			Unload			Total
	Export	Cabotage	Total	Import	Cabotage	Total	
2010	0	1500	1500	0	4600	4600	6100

ii) Flour

(a) Unloading cargo

The unloading volume was forecast based on the correlation between unloading volume at Antsiranana port and the population of The western part of Antsiranana province. The data used in the forecast and correlation equation are shown below.

year	Antsiranana (MT)	Population West Antsi
1983	1124	379756
1984	1275	389740
1985	1528	399986
1986	1626	410506
1987	2328	411586
1988	2295	412668
1989	1389	413753
1990	2017	414843
1991	2041	424152
1992	1053	433670
2010	7200	657000

Y=0.02195X-7247.7 (r=0.93)

where Y: Unloading flour volume (MT)
X: Population of west Antsiranana

(b) Loading cargo

Trend of loading volume does not have a specific trend, nor is there a correlation between loading volume and unloading volume, but import volume in Madagascar has been increasing. Therefore the loading volume was forecast based on the past average ratio, of loading volume to unloading volume.

(c) Results of forecast

Table 4-4-18 Results of Flour Forecast

(Unit: MT)

Year	Load			Unload			Total
	Export	Cabotage	Total	Import	Cabotage	Total	
2010	0	2200	2200	0	7200	7200	9400

iii) Cement

(a) Unloading cargo

Consumption volume in Madagascar has a correlation with GDP of the construction sector, and the consumption volume in 2010 was forecast as about 320 thousand tons. The average production volume in the last 5 years is about 33 thousand tons. As

cement is an industrial product that can be produced in Madagascar, it is thought necessary for Madagascar to increase the production capacity in the future. The production volume in 2010 is forecast as 200 thousand tons. The data used in the forecast and correlation equation are shown below. If a cement factory is built in Antsiranana in the future, cargo volumes at Antsiranana port must be reconsidered.

Year	Production volume(MT)	Import volume(MT)	Consumption volume(MT)	Construction sector GDP (billion FMG)
1983	36237	53343	89580	
1984	36580	41822	78402	37.6
1985	28383	68940	97323	41.5
1986	51213	30347	81560	51.2
1988	32820	86433	119253	49.9
1989	23607	83951	107558	52.5
1990	28600	82650	111250	62.7
1991	31555	66003	97558	47.8
1992	30184	99354	129538	
2010	200000	115000	315000	236.3

Y=1153.68X+42557 (r=0.79)

where Y: Consumption volume in Madagascar (MT)
X: GDP of construction sector in 1990 price (billion FMG)

As there is a correlation between unloading volume at Antsiranana port and import volume in Madagascar, the unloading volume at Antsiranana was forecast based on this method. The data used in the forecast and correlation equation are shown below.

Year	Madagascar Import volume (MT)	Antsiranana unload volume (MT)
1984	41822	4137
1985	68940	9951
1986	30347	175
1987	24591	2433
1989	83951	6707
1990	82650	7862
1991	66003	7118
1992	99354	6947
2010	115000	10300

Y=0.08336X+665.9 (r=0.90)

where Y: Unload volume in Antsiranana port (MT)
X: Import volume in Madagascar (MT)

(b) Loading cargo

Trend of loading volume does not have a specific trend, nor is there a correlation between loading volume and unloading volume. Therefore the loading volume was forecast based on the past average ratio of loading volume to unloading volume.

(c) Results of forecast

Table 4-4-19 Results of Cement Forecast

(Unit: MT)

Year	Load			Unload			Total
	Export	Cabotage	Total	Import	Cabotage	Total	
2010	0	400	400	6200	4100	10300	10700

iv) Fertilizer

(a) Unloading cargo

Unloading volume at Antsiranana port does not have a correlation with import volume in Madagascar. Both unloading volume at Antsiranana port and import volume in Madagascar seem to have a decreasing trend, and unloading fertilizer at Antsiranana port has not been handled since 1990.

The unloading volume at Antsiranana port was forecast based on the past average volume because fertilizer is needed in order to increase the agricultural production in the future.

Year	Antsiranana unload volume (MT)-A-	Madagascar Import volume (MT)-B-	Ratio A/B
1983	3343	20004	0.167
1984	2153	33310	0.065
1985	1938	30430	0.064
1986	0	23460	0.000
1987	2237	51383	0.044
1988	118	8562	0.014
1989	1628	12101	0.135
1990	0	35132	0.000
1991	0	12320	0.000
1992	0	11740	0.000
2010	1900		

(b) Loading cargo

As there is a correlation between loading volume and unloading volume, the loading volume was forecast by this method. The data used in the forecast and correlation equation are shown below.

Year	Unload (MT)	Load (MT)
1983	3343	2282
1984	2153	2363
1985	1938	1408
1986	0	0
1987	2237	2491
1988	118	5
1989	1628	1310
1990	0	0
1991	0	0
1992	0	0
2010	1900	1700

$Y=0.8376X+29.6$ $(r=0.91)$

where Y: Loading volume in Antsiranana (MT)
X: Unloading volume in Antsiranana (MT)

(c) Results of forecast

Table 4-4-20 Results of Fertilizer Forecast

(Unit: MT)

Year	Load			Unload			Total
	Export	Cabotage	Total	Import	Cabotage	Total	
2010	0	1700	1700	1900	0	1900	3600

v) Coffee

Unloading coffee is transhipment cargo for export from other ports, and the volume is not stable. Export volume of coffee at Antsiranana port is unknown, because there are no exact statistics available for each commodity. Therefore the unloading volume was forecast based on the past average volume.

Table 4-4-21 Results of Coffee Forecast

(Unit: MT)

Year	Unload		
	Import	Cabotage	Total
2010	0	1600	1600

vi) Animal & vegetable oil

Trend of unloading volume does not have a specific trend, nor is there a correlation between unloading volume and import volume in Madagascar.
Therefore the unloading volume was forecast based on the past average volume.

Table 4-4-22 Results of Animal and Vegetable Oil Forecast

(Unit: MT)

Year	Unload		
	Import	Cabotage	Total
2010	1100	200	1300

vii) Metal products

Trend of unloading volume does not have a specific trend, nor is there a correlation between unloading volume and import volume in Madagascar.
Therefore the unloading volume was forecast based on the past average volume.

Table 4-4-23 Results of Metal Products Forecast

(Unit: MT)

Year	Unload		
	Import	Cabotage	Total
2010	1100	300	1400

viii) Other general cargoes

(a) Loading cargo

As most of other general cargoes are agricultural products, the loading volume was forecast based on the correlation between loading volume and GDP of agricultural sector in Madagascar. The data used in the forecast and correlation equation are shown below.

Year	Loading volume (MT)	Agricultural sector GDP 1990 price (billion FMG)
1983	9189	
1984	5189	1155
1985	7871	1168
1986	4880	1206
1987	6155	1236
1988	6955	1263
1989	12980	1329
1990	12877	1357
1991	13760	1364
1992	15879	1383
2010	60400	2581

Y=37.976X-37664 (r=0.94)

where Y: Loading volume in Antsiranana port (MT)
X: GDP of agricultural sector in 1990 price (billion FMG)

(b) Unloading cargo

The unloading volume was forecast based on the correlation with GDP of Madagascar. The data used in the forecast and correlation equation are shown below.

Year	Antsiranana unload (MT)	GDP 1990 price (billion FMG)
1984	7430	3702
1985	6118	3740
1987	5932	3865
1988	8342	3994
1989	9507	4155
1990	9137	4264
1992	8474	4115
2010	33000	9207

Y=4.750X-10709 (r=0.78)

where Y: Unloading volume in Antsiranana port (MT)
X: GDP in 1990 price (billion FMG)

(c) Results of forecast

Table 4-4-24 Results of Other General Cargo Forecast

(Unit: MT)

Year	Load			Unload			Total
	Export	Cabotage	Total	Import	Cabotage	Total	
1992	6810	9069	15879	3828	2236	8474	24353
2010	48300	12100	60400	19800	13200	33000	93400

(3) Results of cargo volume forecast

Results of cargo volume forecast based on micro forecast are shown in Table 4-4-25, 4-4-26, 4-4-27, 4-4-28 and Figure 4-4-5, 4-4-6.

Table 4-4-25 Results of Cargo Volume Forecast (1)

(UNIT:TON)

	YEAR	1988	1989	1990	1991	1992	2010
FOREIGN	EXPORT	13372	22970	22745	23022	14468	89100
	IMPORT	15715	19351	14614	30436	35605	86800
	TOTAL	29087	42321	37359	53458	50073	175900
DOMESTIC	LOAD	20781	22466	15830	16831	27176	60000
	UNLOAD	29022	31226	26343	36607	32471	87300
	TOTAL	49803	53692	42173	53438	59647	147300
TRANSHIP		10889	16735	35058	61316	108694	164000
TOTAL	LOAD	34153	45436	38575	39853	41644	149100
	UNLOAD	44737	50577	40957	67043	68076	174100
	TRANSHIP	10889	16735	35058	61316	108694	164000
	TOTAL	89779	112748	114590	168212	218414	487200

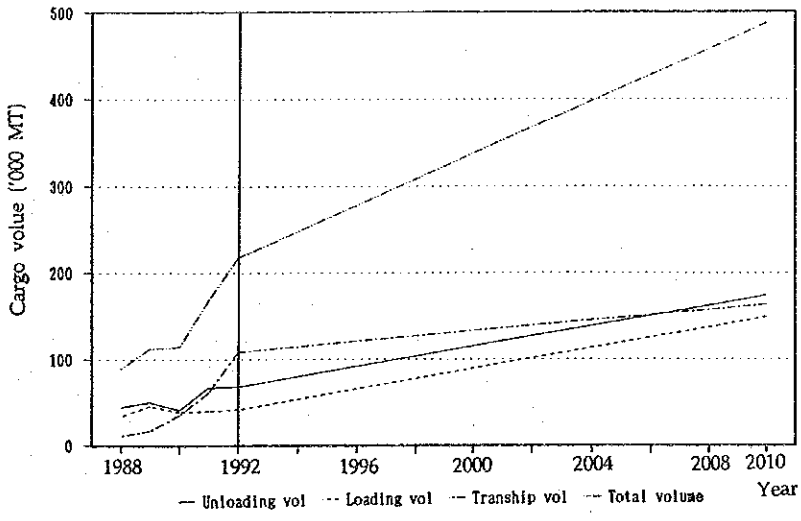


Figure 4-4-5 Results of Cargo Volume Forecast (1)

Table 4-4-26 Results of Cargo Volume Forecast (2)

(UNIT:TON)

YEAR		1988	1989	1990	1991	1992	2010
LOAD	FOREIGN	13372	22970	22745	23022	14468	89100
	TUNA-related	0	0	0	2273	6059	15200
	SALTS	8359	12826	10655	8229	753	25600
	PETROLEUM	0	0	0	0	0	0
	OTHERS	5013	10144	12090	12520	7656	48300
	DOMESTIC	20781	22466	15830	16831	27176	60000
	TUNA-related	0	0	0	0	0	0
	SALTS	13444	17906	12747	12751	10163	29900
	PETROLEUM	5200	0	2030	2840	5890	12200
	OTHERS	2137	4560	1053	1240	11123	17900
	TOTAL	34153	45436	38575	39853	41644	149100
	TUNA-related	0	0	0	2273	6059	15200
	SALTS	21803	30732	23402	20980	10916	55500
	PETROLEUM	5200	0	2030	2840	5890	12200
	OTHERS	7150	14704	13143	13760	18779	66200
UNLOAD	FOREIGN	15715	19351	14614	30436	35605	86800
	TUNA-related	0	0	0	495	1458	8000
	SALTS	0	0	0	0	0	0
	PETROLEUM	9792	6676	0	9732	24269	48700
	OTHERS	5923	12675	14614	20209	9878	30100
	DOMESTIC	29022	31226	26343	36607	32471	87300
	TUNA-related	0	0	0	5875	14696	37000
	SALTS	0	0	0	0	0	0
	PETROLEUM	14171	14952	12579	18609	5770	19100
	OTHERS	14851	16274	13764	12123	12005	31200
	TOTAL	44737	50577	40957	67043	68076	174100
	TUNA-related	0	0	0	6370	16154	45000
	SALTS	0	0	0	0	0	0
	PETROLEUM	23963	21628	12579	28341	30039	67800
	OTHERS	20774	28949	28378	32332	21883	61300
TRANSHIP	TOTAL	10889	16735	35058	61316	108694	164000
	TUNA	4007	16735	35058	41161	51841	52000
	PETROLEUM	6882	0	0	20155	56853	112000
TOTAL	FOREIGN	29087	42321	37359	53458	50073	175900
	TUNA-related	0	0	0	2768	7517	23200
	SALTS	8359	12826	10655	8229	753	25600
	PETROLEUM	9792	6676	0	9732	24269	48700
	OTHERS	10936	22819	26704	32729	17534	78400
	DOMESTIC	49803	53692	42173	53438	59647	147300
	TUNA-related	0	0	0	5875	14696	37000
	SALTS	13444	17906	12747	12751	10163	29900
	PETROLEUM	19371	14952	14609	21449	11660	31300
	OTHERS	16988	20834	14817	13363	23128	49100
	TRANSHIP	10889	16735	35058	61316	108694	164000
	TUNA	4007	16735	35058	41161	51841	52000
	PETROLEUM	6882	0	0	20155	56853	112000
	TOTAL	89779	112748	114590	168212	218414	487200
	TUNA-related	4007	16735	35058	49804	74054	112200
	SALTS	21803	30732	23402	20980	10916	55500
	PETROLEUM	36045	21628	14609	51336	92782	192000
	OTHERS	27924	43653	41521	46092	40662	127500

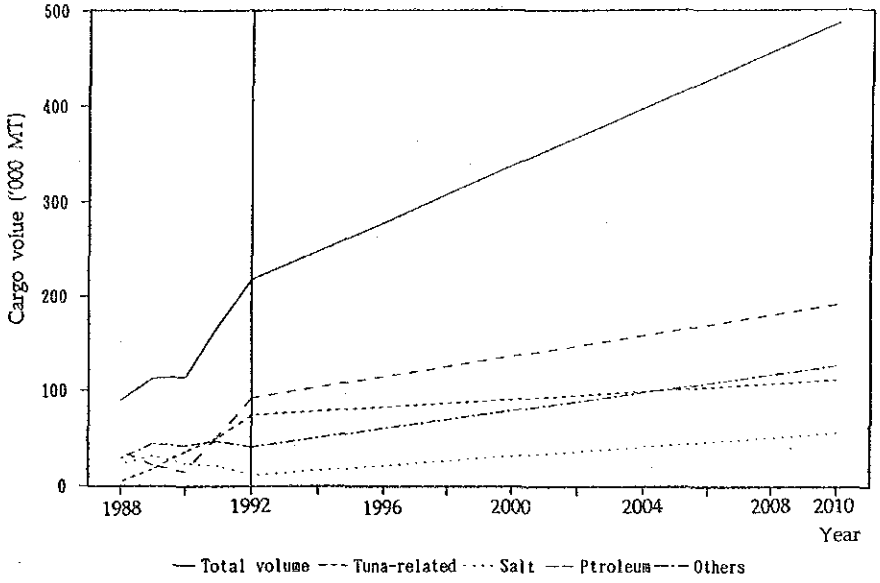


Figure 4-4-6 Results of Cargo Volume Forecast (2)

Table 4-4-27 Results of Forecast in Loading General Cargo

(Unit:ton)

	1988	1989	1990	1991	1992	2010
Foreign cargo	17,379	39,705	57,803	64,183	66,309	141,100
Tuna(tranship)	4,007	16,735	35,058	41,161	51,841	52,000
Salts	8,359	12,826	10,655	8,229	753	25,600
Rice	0	0	0	0	0	0
Flour	0	23	0	0	846	0
Cement	0	0	0	0	0	0
Fertilizer	0	0	0	0	0	0
Canned food	0	0	0	2,273	6,059	15,200
Others	5,013	10,121	12,090	12,520	6,810	48,300
Domestic cargo	15,581	22,466	13,800	13,991	21,286	47,800
Tuna(tranship)	0	0	0	0	0	0
Salts	13,444	17,906	12,747	12,751	10,163	29,900
Rice	1	0	0	0	2,001	1,500
Flour	189	158	66	0	22	2,200
Cement	0	224	200	0	31	400
Fertilizer	5	1,310	0	0	0	1,700
Canned food	0	0	0	0	0	0
Others	1,942	2,868	787	1,240	9,069	12,100
Total	32,960	62,171	71,603	78,174	87,595	188,900
tuna(tranship)	4,007	16,735	35,058	41,161	51,841	52,000
Salts	21,803	30,732	23,402	20,980	10,916	55,500
Rice	1	0	0	0	2,001	1,500
Flour	189	181	66	0	868	2,200
Cement	0	224	200	0	31	400
Fertilizer	5	1,310	0	0	0	1,700
Canned food	0	0	0	2,273	6,059	15,200
Others	6,955	12,989	12,877	13,760	15,879	60,400

Table 4-4-28 Results of Forecast in Unloading General Cargo

(Unit:ton)

	1988	1989	1990	1991	1992	2010
Foreign cargo	5,923	12,675	14,614	20,704	11,337	38,100
Rice	0	0	0	0	4,000	0
Flour	0	91	60	0	0	0
Tuna-related	0	0	0	495	1,458	8,000
Cement	54	6,132	5,140	7,118	2,195	6,200
Coffee	0	30	0	0	0	0
Fertilizer	118	1,494	0	0	0	1,900
Animal & Vegetable oil	5	1	1,090	0	437	1,100
Metal products	201	994	1,342	1,222	877	1,100
Others	5,545	3,933	6,982	11,869	2,370	19,800
Domestic cargo	18,858	33,009	48,823	59,159	78,542	120,200
Rice	3,939	5,609	4,868	4,044	872	4,600
Flour	2,295	1,298	1,957	2,041	1,053	7,200
Tuna-related	4,007	16,735	35,059	47,036	66,537	89,000
Cement	3,672	575	2,722	0	4,752	4,100
Coffee	0	1,938	1,383	0	303	1,600
Fertilizer	0	134	0	0	0	0
Animal & Vegetable oil	1,400	587	355	0	45	200
Metal products	748	559	324	0	334	300
Others	2,797	5,574	2,155	6,038	4,646	13,200
Total	24,781	45,684	63,437	79,863	89,879	158,300
(TRANSHIP)	4007	16735	35059	41161	51841	52000
Rice	3,939	5,609	4,868	4,044	4,872	4,600
Flour	2,295	1,389	2,017	2,041	1,053	7,200
Tuna-related	4,007	16,735	35,059	47,531	67,995	97,000
(TRANSHIP)	4007	16735	35059	41161	51841	52000
Cement	3,726	6,707	7,862	7,118	6,947	10,300
Coffee	0	1,968	1,383	0	303	1,600
Fertilizer	118	1,628	0	0	0	1,900
Animal & Vegetable oil	1,405	588	1,445	0	0	1,300
Metal products	949	1,553	1,666	1,222	1,211	1,400
Others	8,342	9,507	9,137	17,907	7,016	33,000

4.5 Required Port Facilities and Equipment

4.5.1 Forecast of Vessel Size by Vessel Type

In order to formulate the port plan, it is necessary to forecast the maximum calling vessel size in terms of dead weight tonnage.

Since the port of Antsiranana will have various functions and roles such as international and coastal commercial port, fishery port and harbor of refuge or rest and waiting, the maximum ship size for port planning needs to be determined by ship type.

At first, the present situation of calling vessels is analyzed and then future trends are examined.

(1) Present calling vessels

According to the data of calling vessels in 1990, there are 30 vessels having over 150m length overall or 7.7% of all (392) vessels. While the monthly number of calling vessels is not always stable, at least more than one vessel is calling the port monthly.

The largest vessel is 26,409 GRT (about 30,000DWT) while another vessel has the longest length of 205m. On the other hand, it is said that tankers for SOLIMA are calling about once a month and that the largest one is 31,600 DWT with an overall length of 177m.

As to coastal vessels, the largest is 4,205 GRT (about 8,800 DWT) with an overall length of 108m.

The largest fishery boat is 2,775 GRT with an overall length of 101m. However, according to the report of "ASSOCIATION THONIERE, COMMISSION DE L'OCEAN INDIEN , October, 1992", fishery cargo vessel with freezers is 4,000 GRT, of which overall length is 110m and its draught is 7m.

It is rather difficult to identify the distinct characteristics of calling vessels to refuge, rest or wait to be repaired by SECREN. In general, the size of those vessels are mostly under 2,000 DWT.

(2) Forecast vessel size in 2010

First, it is rational to assume that the kind of vessels calling to the port of Antsiranana in 2010 will not change drastically, since there is little possibility that full

container vessel will call. The future size of calling vessels are assumed, therefore, the same as the present.

It is said that the enlarging trend of conventional cargo vessel size has almost reached the limit. Except for a small number of vessels, 30,000 DWT class is maximum. Considering operational mode, that is to say maritime network of cargo vessels calling to Madagascan ports, the maximum vessel size is restricted by port facilities, above all, quay depth among the present network. Maximum quay depths range between about 10m and 13m, also indicates that 30,000 DWT class is maximum.

As to ocean-going tankers, there are many vessels over 30,000 DWT. However, considering the role of oil distribution base of SOLIMA's Antsiranana branch in Madagascar and the capacity of oil tanks, it is thought that there is little possibility of over 30,000 DWT tankers calling the port.

As a result, the maximum size of calling vessel is determined as 30,000 DWT.

Next, judging from the data, it can be assumed that almost all coastal vessels will be under 5,000 DWT. But near 10,000 DWT vessels are also operated at present. Therefore, it is thought appropriate to adopt 10,000 DWT as the maximum coastal vessel size for the Master Plan.

Fishery boat size is naturally decided by fishing activities, in particular, tuna fishing in the Indian Ocean. There is no reason to believe that the structure or situation of tuna fishing activities will change in the near future. So, referring to the report of "ASSOCIATION THONIERE", it is thought that the maximum fishery boat size is equivalent to 5,000 DWT cargo vessel.

Finally, it can be assumed that vessels for refuge, rest or repair will remain unchanged. This is because these vessels are closely related to geographical features, maritime situation or fishing activities etc., which will not change greatly in future.

4.5.2 Required Berth Dimension by Vessel Size

On the basis of statistics of Lloyd's Register, standard dimensions of vessels by type and standard berth dimensions are determined in "TECHNICAL STANDARDS FOR PORT AND HARBOUR FACILITIES IN JAPAN". Dimensions of vessels mentioned in section 4.5.1 and of berths corresponding to vessels are as follows:

Table 4-5-1 Berth Dimension by Vessel Size

Tonnage (DWT)	Vessel Size			Berth Dimension	
	Overall Length (m)	Moulded Breadth (m)	Full Load Draft (m)	Length of Berth (m)	Water Depth of Berth (m)
2,000	81	12.7	4.9	100	5.5
5,000	109	16.4	6.8	130	7.5
10,000	137	19.9	8.5	170	10.0
30,000	186	27.1	10.9	240	12.0

Note : Vessel size is for cargo vessel and it differs a little from oil tankers, but berth dimension of both is the same.

4.5.3 Required Number of Berths

(1) Method of determining berth number

For planning, various methods are used to determine the required number of berths. In this Study, a method considering the frequency of ship entry and cargo handling productivity is used.

This method is summarized as follows:

Number of berths = (Total number of berthing days) / (Annual number of workable days * Berth occupancy ratio)

where

-Total number of berthing days:
(Number of vessel calls) * (Average berthing days per vessel)

-Number of vessel calls:
(Annual cargo volume handled) / (Average cargo volume handled per vessel)

-Average berthing days per vessel:
(Average cargo volume handled per vessel) / (Average cargo handling productivity per vessel per day) + (Number of days necessary other than

productivity per vessel per day) + (Number of days necessary other than cargo handling)

According to the UNCTAD report (Port development, A handbook for planners in developing countries), the berth occupancy ratio for conventional general cargo operations should be set so as not to exceed the figures given in Table 4-5-2.

Table 4-5-2 Berth Occupancy Ratio

Number of Berths in the Group	Recommended Maximum Berth Occupancy (%)
1	40
2	50
3	55
4	60
5	65
6 - 10	70

(2) Premises for calculation

1) Annual number of workable days

Number of days available for using berths is set considering holidays and non-working days due to meteorological causes. According to the interview, present working days by CMDM are 320/330 days a year and those by SOLIMA are about 340 days. In 2010, it is thought that 310 days will be appropriate, taking one day off a week into account.

2) Cargo handling hours per day

In principle eight hours is adopted for planned cargo-handling hours, and eighteen hours for import of oil products by SOLIMA. However, the more important matter is the cargo handling productivity per vessel per day, which is mentioned later. If the cargo handling is not completed within the set limits, overtime becomes necessary.

3) The number of days necessary other than for cargo handling

The necessary average hours of berthing vessels other than for cargo handling (such as vessels' maneuvering activities for berthing/deberthing and the procedure for vessels' entrance/departure) can be set at about four hours while this may be a little bit shorter

than the actual level, It is justifiable assuming that the communication system among shipping companies, port office and stevedore will be improved in future. In 2010, it is expected to be improved so that a period of 0.2 days per vessel is adopted for the number of days necessary other than for cargo handling.

4) Average cargo handling productivity per day by vessel

a. Conventional general cargo vessel

Referring to the report produced by a French consultant, the UNCTAD report etc. and the interview to CMDM, average handling productivities of coastal and ocean-going cargo vessel are 300 tons and 500 tons per day respectively.

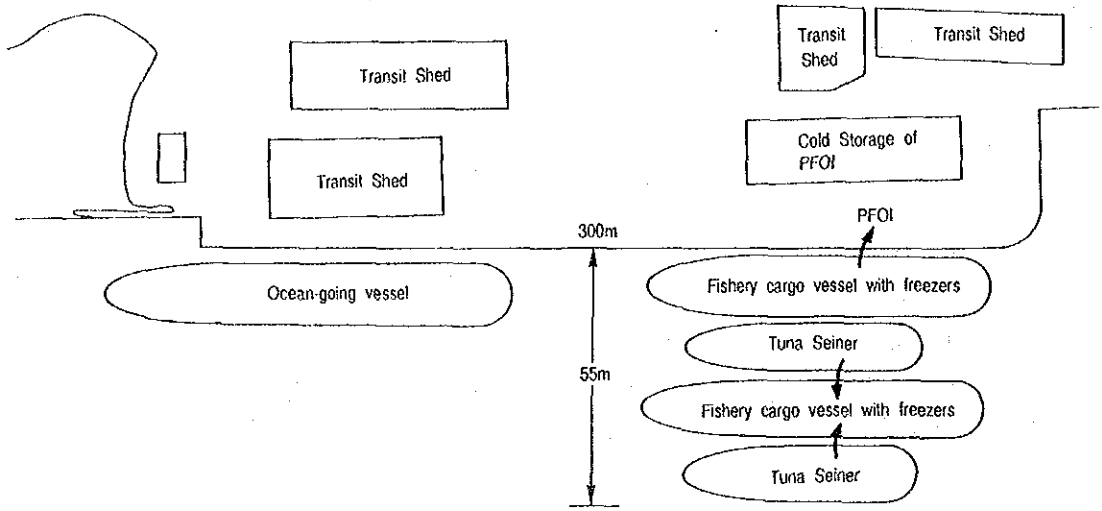
b. Tanker operated by SOLIMA

Considering capability of pipeline and working condition for oil handling, average handling productivities of coastal and ocean-going tankers are 3,000 tons, 7200 tons per day respectively.

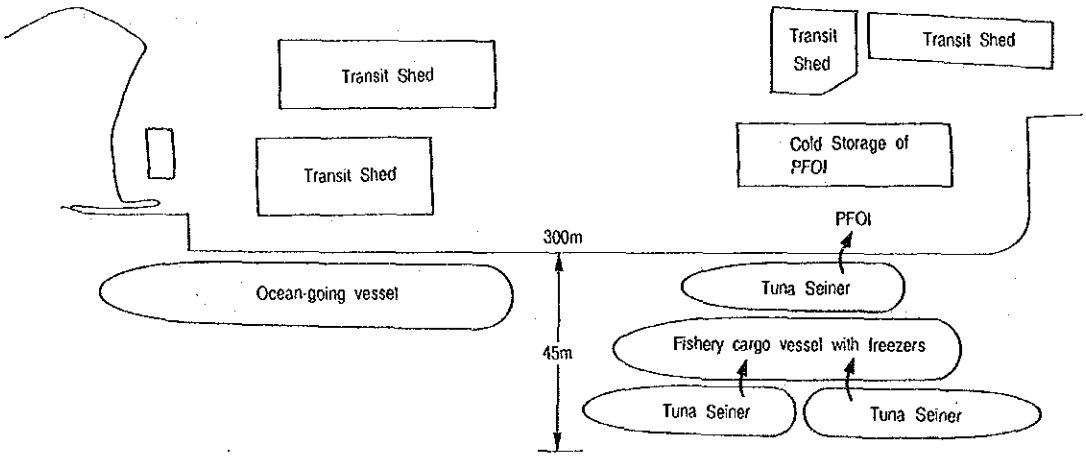
c. Fishery boat to handle tuna

Based on the interview, average handling productivity of transhipped tuna is 200 tons per vessel per day. Taking into account that two tuna seiners are moored at one large quay simultaneously, the productivity is 400 tons per day (See Figure 4-5-1)

Case 1 Unloading and Transhipment



Case 2 Unloading and Transhipment



Case 3 Optimal Capability of Transhipment

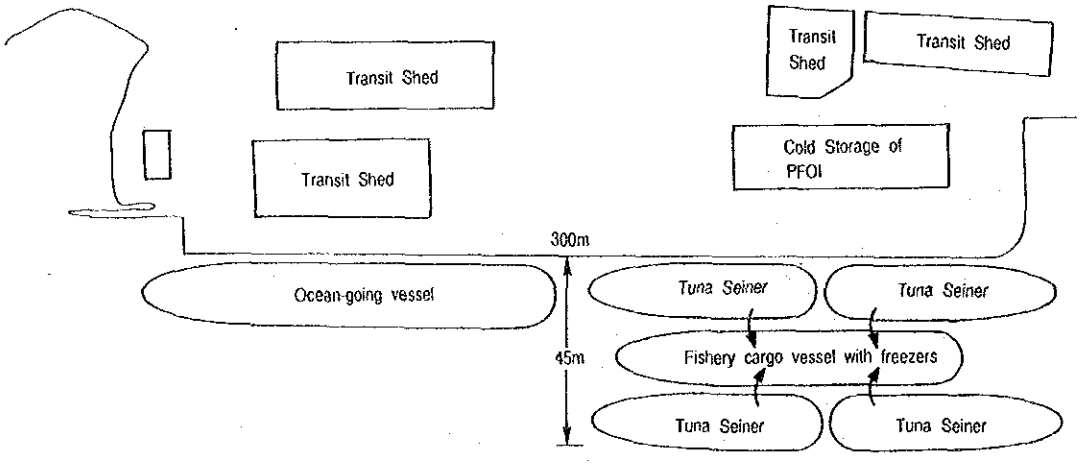


Figure 4-5-1 Present Situation of Tuna Handling

5) Average cargo volume carried per vessel

a. Conventional general cargo vessel

According to the data in 1990, average cargo volume carried by both ocean-going and coastal vessels is rather small, estimated at about 500 tons and 420 tons respectively. There volumes are too low to support large investment required for port development as well as to realize efficient usage of the developed facilities and equipment. A rate of increase of two and one and half times respectively is assumed, raising the volumes to 1,000 tons and 650 tons.

b. Tanker operated by SOLIMA

At present both ocean-going and coastal tankers are semi- regularly operated by SOLIMA, which is considered due to the capacity and revolving frequency of oil tanks. In the future, even if SOLIMA will build more oil tanks and supply more oil products, the calling pattern of tankers will be similar to the present one. Considering these situations, it is thought that average cargo volume carried by ocean-going and coastal tankers will be 10,000 tons and 3,000 tons respectively.

c. Tuna

As to tuna, the report of "ASSOCIATION THONIERE" is adopted, that is, average volume of tuna carried by fishery boat and fishery cargo vessel with freezers is 900 tons and 3,000 tons respectively.

(3) Berth requirements

Following the method mentioned above, the total berthing days are calculated. However, considering the characteristics of the port, they are specified for the use of international vessels, coastal vessels and tuna seiners as shown in Table 4-5-3.

Table 4-5-3 Calculation of Berthing Days

Items	Unit	Calculation	General Cargo		Petroleum by SOLIMA		Tuna	
			Domestic	International	Domestic	International	Factory	Tranship
① Cargo Volume	1,000 tons		79.00	127.20	179.80	112.00	37.00	52.00
② Average Cargo Volume per Vessel	tons		650.00	1,000.00	3,000.00	10,000.00	900.00	3,000.00
③ Number of Calling Vessels	calls	①/②	122.00	128.00	60.00	12.00	42.00	18.00
④ Handling Productivity per Day	tons		300.00	500.00	3,000.00	7,200.00	400.00	400.00
⑤ Berthing Days per Vessel	days	②/④	2.17	2.00	1.00	1.39	2.25	7.50
⑥ Number of Days Necessary other than Cargo Handling	days		0.20	0.20	0.20	0.20	0.20	0.20
⑦ Total Berthing Days per Vessel	days	⑤+⑥	2.37	2.20	1.20	1.59	2.45	7.70
⑧ Total Berthing Days	days	③*⑦	290.00	282.00	72.00	19.00	103.00	139.00

For international cargo
Total berthing days = 301 days
For coastal cargo
Total berthing days = 362 days
For tuna cargo
Total berthing days = 242 days

The berthing days to handle fish except tuna are included in the time for coastal cargo.

Based on the UNCTAD report, required number of berths is calculated as follows:

For international cargo	301/310/0.5=1.9
For coastal cargo	362/310/0.5=2.3 or 362/310/0.55=2.1
For tuna cargo	242/310/0.5=1.6

The results of calculation show that two berths are required for international and tuna cargo handling, while two or three are required for coastal cargo handling. The berth occupancy ratios of berths for international and tuna cargo handling are not high.

The same calculation shows that the total number of required berths is five when all kinds of cargoes are handled in case that berth assignment is not specified and that the total required berth number is four when international and coastal cargo are handled together.

This means that coastal cargoes can be handled at other berths (for international and tuna cargo handling), even if two coastal berths are occupied.

On the other hand, during the busiest period of tuna fishing in the Indian Ocean, from March to June, it is said that many fishery boats rush to the port for a berth. At that time, two berths would not be sufficient to moor all tuna seiners, but if four berths are available for commercial cargo handling other than for tuna handling, no significant problems would occur. This can be verified this through the same calculation. During offseason of tuna fishing, fishery boats do not necessarily require two berths simultaneously. So, considering the tuna handling situation, the required number of berths for fishery boats is basically one and another berth is used for both coastal and fishery cargo handling through the year.

As a result, two berths for international and coastal cargo handling are respectively required, one berth for fishery cargo handling and one berth for both coastal and fishery cargo handling, so that the total number of required berths is six.

As to berths for vessels to refuge, rest or wait to be repaired by SECREN, basin for small crafts may be used. To moor two vessels of 2,000 DWT class, required berth length is about 30/35 m.

4.5.4 Required Scale of Facilities

(1) Required Scale of Berths

Based on the results mentioned from sections 4.5.1 to 4.5.3, required scale of berths is as follows:

For international cargo

- maximum ship size	30,000 DWT class
- number of berth	2
- depth	12 m
- total length	480 m (240 m * 2)

For coastal cargo

- maximum ship size	10,000 DWT class
- number of berth	2 (one berth is served for 5,000 DWT class vessel)
- depth	10 m, 7.5 m
- total length	300 m (170 m + 130 m)

For fishery cargo

- maximum ship size	5,000 DWT class
- number of berth	1
- depth	7.5 m
- total length	130 m

For both coastal and fishery cargo

- maximum ship size	5,000 DWT class
- number of berth	1
- depth	7.5 m
- total length	130 m

The berths listed above do not include the facilities for vessels to refuge, rest or be repaired by SECREN because these facilities are expected to be dealt with by the ongoing project, which is the 47.5m southward extension of the existing quay, (named "the New Quay"), including construction of basin for small crafts.

(2) Required Scale of Water Basin

The water basin for vessels' turning should ensure an area larger than a circle with a diameter of 3*L(L:overall length of maximum vessel size for the berth, See Table 4-5-1) in order, to allow the safe turning of vessels maneuvering by them selves. In case of using tugboats to assist, the water basin of a circle with a diameter of 2*L should be secured. This water area should be planned for the center of the water basin in front of the corresponding planned berth.

In general, up to 5,000 DWT class vessels can maneuver without assistance of tugboats.

Therefore, water area in front of berths for 5,000 DWT class is planned to ensure water basin with 7.5 m depth and a circle with a diameter of 327 m(L=109 m). In case of berths for 10,000 DWT class, a water basin with 10m depth and diameter of 274m (L = 137m) is prepared, while for 30,000 DWT class, a water basin with 12m depth and diameter of 372m (L = 186m) is prepared.

(3) Required Scale of Storage Area

There are two kinds of cargo to be handled and stored temporarily in the port, one in transit sheds and the other in open yards.

Containers, iron and metal products are stored in open yards, while almost all cargoes except oil products through pipeline are usually stored in transit sheds.

The storage area besides container stacking area can be calculated as follows:

$$A=(W*c)/(R*a*w)$$

where

-A: Storage area(m^2)
-W: Annual cargo volume to be stored(ton)
-c: Peak ratio
-R: Revolving frequency per year
-a: Utilization ratio
-w: Unit storage cargo volume per area(ton/m^2)

Annual cargo volume to be stored(W) is given from the result of forecasted cargo volume in 2010, the standard of unit storage cargo volume per area(w) is proposed by the kind of cargo, utilization ratio(a) is usually 0.5-0.7 and peak ratio(c) and revolving frequency per year(R) is determined by the characteristics of the port.

The calculation result using this formula gives 11,700 m^2, the breakdown of which is 3,000 m^2 for salt and 8,700 m^2 for others.

By similar calculation, it was determined that an open yard of 100 m^2 is required for iron and metal products.

The net container stacking area can be calculated as follows:

$$A=(N*S)/(R*H)$$

where

-A: Net container stacking area(m^2)
-N: Annual container throughput in open yard(TEUs)
-S: Unit area per 1 TEU(m^2)
-R: Revolving frequency per year
-H: Stacking height

Annual throughput number of container(N) is given from the result of forecasted cargo Volume in 2010, unit area per 1 TEU(N) is about 16 sq.m, stacking height(H) is two for laden containers and three for empty containers. Revolving frequency per year(R) is decided by the shipping service, which is 12 because of the monthly service. The practical stacking area including road, working space of machine such as fork lift is about two times the calculated result, A.

As a result, area of open yard for container stacking is planned at 7,200 sq.m for laden containers and 1,950 sq.m for empty containers.

Other than the above mentioned, a new refrigerator warehouse will be needed for the increase of canned tuna products. According to the interview with the executives of PFOI, that is scheduled in the near future, and the place is not inside the port. So, it is not necessary to plan that here.

(4) Protective Facilities for harbours

As to calmness of basin, reference is made in "TECHNICAL STANDARDS FOR PORT AND HARBOUR FACILITIES IN JAPAN", which states:

" A basin in front of a pier should secure the calmness to allow mooring for days corresponding to 95 to 97.5 % or more of the year (of each season, too, when the seasonal variation of calmness is extreme). However, this may not apply when the frequency of mooring is low and when special mooring rules have been established."

Judging from the study based on the field survey, it is estimated that the basin does not satisfy the Japanese standard at a part of the area of extension. However, the period is relatively short and the frequency of mooring will not be high in 2010, the target year.

Therefore, it is thought unnecessary to plan a breakwater in the Master Plan.

4.5.5 Safety Back-up Facilities

(1) Navigation marks

All calling vessels to the port of Antsiranana have to go through the mouth into /from the bay and the open sea, where the current is rapid and is complicated. In order to secure the maneuvering, proper navigation marks are indispensable.

According to the interview and survey, navigation marks are installed in the right places in the proper way but they do not often work because of failure of power etc. However, replacement or renewal including the introduction of a solar battery system is now in progress so that it is expected for them to work well and be maintained carefully and regularly. In particular, the three navigation marks on both sides of the mouth, the one in the center of the bay and the lighthouse on the top of the port office are very important. They have to conform to the IALA Buoyage System and it is desirable that they have a back-up energy source.

(2) Tugboat

With regard to the maneuverability of a large ocean-going vessel in the turning basin of an internal port, the main engine and the rudder are incapacitated. A tugboat to assist the vessel, in the final phase of the manoeuvering, is indispensable as the lateral and turning force source. In the port site, a strong trade wind sometimes blows. Thus, the port of Antsiranana will need to have a capable tugboat fleet to maintain safe and efficient use of the quays by the time the facilities are completed.

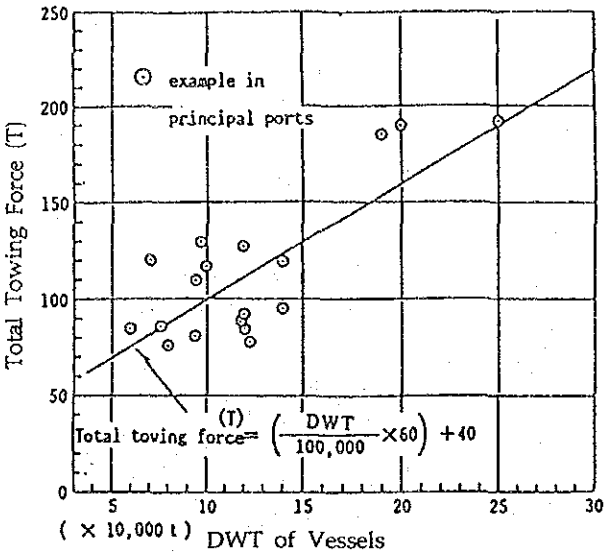
According to accepted wisdom, the total necessary towing (pushing) force to move the vessel athwart ships is given by the empirical formula below:

Total Towing Force (ton) = (DWT of vessel / 100,000 * 60) + 40 (ton)

Thus, in the case of the port of Antsiranana, where the maximum vessel is estimated at 30,000 DWT, the towing force needs to be 58 tons at maximum.
However, the towing force can be reduced taking load factor into account.

The towing force of a tug boat by propulsion type per 100 ps is given in Table 4-5-4.

Table 4-5-4 Towing Force of a Tugboat by Propulsion Type



Propulsion type	Towing force/100ps
F.P.P	1.1
F.P.P nozzle	1.3
C.P.P	1.3
C.P.P nozzle	1.4
V.S.P	1.0
Z	1.3

From the account above mentioned, it is thought that the tug fleet for the port of Antsiranana is desired to be composed of two Z type tug boats with power of 2,000 ps each (Photo 4-5-1). However, considering possible budget constraints, the provision of one 2,000 ps tug boat is recommended.

(3) Pilotage system

According to the law, all vessels over 150 GRT are obliged to use a pilot. There is a pilot boat owned by DTM in the port of Antsiranana. Taking the sea condition into account, pilotage system is indispensable to secure safety. Consequently, it is not only important to maintain the pilot boat and the pilotage system properly, but it is necessary to replace the current boat by 2010, the target year.

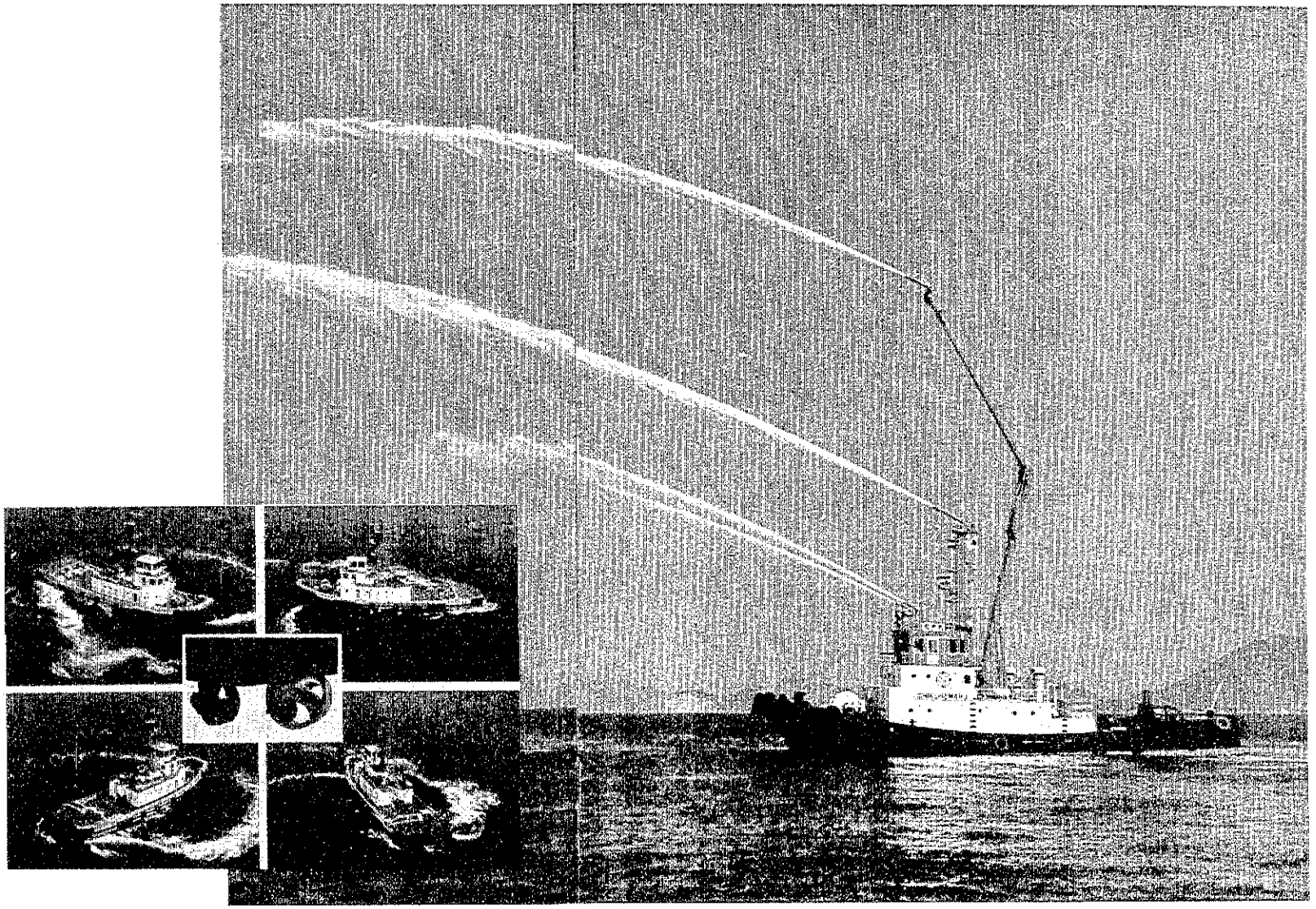


Photo 4-5-1 Z Type Tug Boat

4.5.6 Cargo Handling System

CMDM is the only stevedore and handles all cargoes except oil products transferred by pipeline by SOLIMA at the port of Antsiranana. It is difficult to tell whether it will continue to be a monopoly in future, but there is no doubt that the private sector will deal with cargo handling.

Cargo handling is one of the key factors in making efficient use of modern facilities, but the productivities are not high at present. For example, CMDM's executive says that 25 tons per gang per hour and 200 tons per day are the cargo handling productivities for bagged salt and transhipped tuna respectively. On the other hand, a report of UNCTAD says that the average tonnage loaded or unloaded per ship per seven hour shift is 400/500 t/shift, which usually are small consignments, palletized and preslung cargoes.

Basically, package types will not change and neither will cargo handling system by the target year, 2010. In that case, the main composition of cargo handling equipment is forklift, trailor, mobil portal crane, shipping gear and so on. In order to determine the number and type of the equipment, it is necessary to consider the number of gangs per vessel, the total number of vessels at berths in peak handling condition and the process of work.

As mentioned above, higher cargo handling productivity should be achieved by all means to make the best use of the new facilities. Generally speaking, the disunity of the package types of conventional cargoes causes low cargo handling productivity, that is to say that there are various kinds of package types such as bag, pallet, carton, roll, drum, barrel and wooden case.

Some means by which to increase the cargo handling productivity are discussed. First of all, it is necessary to promote unitization of the package type such as containerization, palletization and use of returnable flexible big bag. Secondly, swift cargo handling operations can be achieved by using forklifts inside ships' holds. It is also effective to use appropriate slings for lifting cargoes for efficient handling. Then, for swift operations, it is good to introduce conventional vessels equipped with ship cranes. This means that stevedore, shipping company, shipper etc. must corporate and coordinate their functions.

It is thought that roughly about two times the present cargo handling capacity is required at the target year but the final decision has to be determined considering labour cost as to whether or when new equipment is introduced.

As to the pipelines for oil products transportation by SOLIMA, replacement or renewal of them is required in correspondence with implementation of the project.

4.5.7 Other Infrastructures and Utilities

The number or scale of major facilities is proposed in the Master Plan. Besides those, other infrastructures and utilities are necessary to operate and manage the port. In this Study, their dimension, structure, capacity and so on, are not proposed because they should be decided very flexibly. The costs are roughly calculated. The main infrastructures and utilities are as follows:

Office(Port office, Custom office, Workshops)
Lighthouse
Reception and delivery area for the goods
Road (from main road to the terminal)
Parking for vehicles
Fence and checkpoint at the terminal entrance and exit
Electricity transmission line (within the terminal)
Electricity transformer station
Water supply pipeline (from main pipeline to the terminal)
Oil supply pipeline
Drainage
Fire department

4.6 Proposed Master Plan

4.6.1 Basic Concept

In evaluating possible sites for the port development, the conclusion has been reached that the area around the port is the only suitable place. The rear side of the port is limited by the low hill and is connected to the downtown of Antsiranana. Therefore, the space to be developed is spread out to the sea area.

At present, in order to handle increased tuna, the extension project of "New Quay" is planned under the French aid. So, it is necessary to work in harmony with those preceding projects, which means keeping down total construction costs.

On the other hand, it has been a long time since all facilities (except the refrigerator warehouse) were built. Taking into account the fact that it will cost more to maintain or repair old facilities and they will not be less convenient in the future, it is proposed that all facilities except rehabilitated or relatively new ones be constructed or reorganized.

As mentioned before, the port of Antsiranana has various roles and functions such as commercial, fishery cargo handling and refuge etc. It is thought that appropriate for each berth to be specified for the use of international vessels, coastal vessels, fishery boats and basin of small crafts in principle, so as to operate and manage orderly, smoothly and efficiently.

4.6.2 Layout of Facilities

As to the layout of facilities, the following factors are considered essential:

- Careful consideration of the actual geographical, meteorological and sea condition
- Securing sufficient area for cargo handling and storage
- Keeping low level of construction costs
- Ensuring Potential for the future usage or expansion

Considering the above, the layout is envisioned as follows:

- In principle, each berth will be specified in the following way: a part of "the New Quay" and the extension southward are for fishery boat use, the left part of the existing quay and the planned extension northward are for coastal vessel use, while the extension eastward is for international vessel use. However, this principle does not preclude exceptional usage. For example, during the busiest

period of tuna fishing, flexible usage will have to be ensured (Figure 4-6-1).
- As mentioned above, the quay line is extended northward, from the existing quay, and is then extended eastward.
- As to the ground plan, rectangular area with enough width behind the quay should be ensured to allow the smooth and efficient movement of cargo. According to the UNCTAD report, the optimum width for a conventional general cargo terminal is 125/150 m. In case of a large fishery port, about 100 m of width is said to be sufficient. Therefore, it is planned that the average width of the commercial port will be at least 125 m.
- Related to the rectangular ground area, the road will be straight and offer easy access to each berth and facility.
- The aprons will be 30 m wide.
- The face line of transit sheds and open yards will be unified.
- Office area will be placed near the center of the port, making the site easy to operate and manage.
- In the layout of the international commercial berths, multi-purpose or container vessels will be accommodated in future so that transit sheds will be placed not to block the movement of handling equipment.

As a result, the Master Plan will be proposed as follows (Figure 4-6-2):

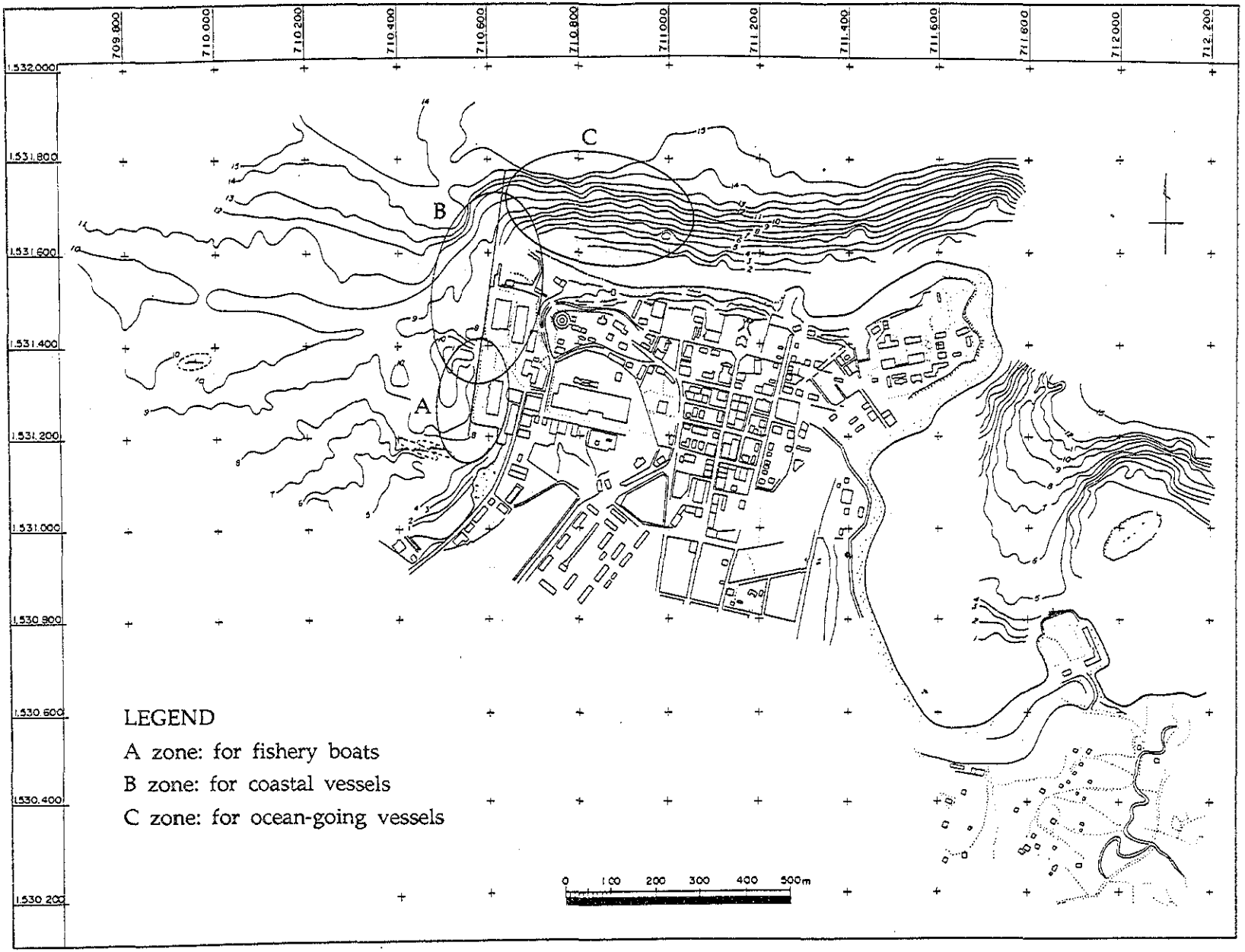
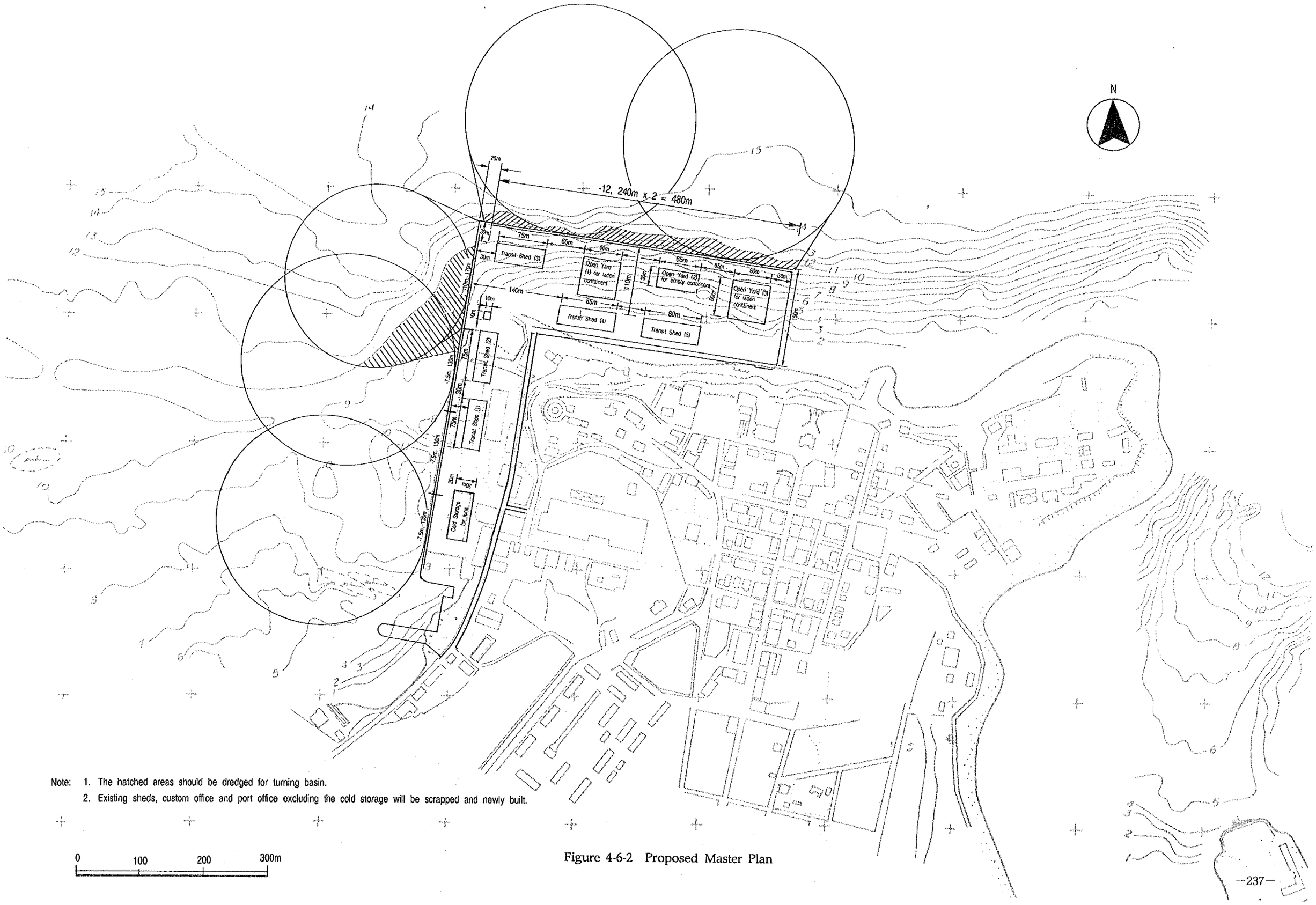


Figure 4-6-1 Principle of Berth Assignment



Note: 1. The hatched areas should be dredged for turning basin.
2. Existing sheds, custom office and port office excluding the cold storage will be scrapped and newly built.

Figure 4-6-2 Proposed Master Plan

4.7 Structural Design

4.7.1 Design Premises

Port facilities planned in the Master Plan are designed according to the following premises.

- Existing port facilities are properly repaired and utilized as much as possible.

- Planned port facilities are fully adapted to the existing facilities.

4.7.2 Existing Port Facilities

(1) Rehabilitation of Old Quay

The deterioration is concentrated on the superstructure. Although the beam BM and the slab S1 have severely deteriorated and their load-carrying capacities have dropped to the half of their initial value, the situation is not critical, because no falling of the slab or breakage of the beam has been observed up to now.

It is reasonable to assume that the slab S2, which was improved with reconstruction in 1971 and is still in good condition, supports almost all the loads. There is no data on design and construction of this slab and it cannot be confirmed definitely if the superstructure of the old quay will be stable without repair work of the slab S2.

Considering that the load condition will increase in the near future, the superstructure may possibly become unstable in the coming years.

Therefore, to maintain the stability of the old quay, two alternatives for rehabilitation are compared as shown in Table 4-7-1. From the comparison shown in the Table, the reconstruction of slab S2 is preferable and adopted for the rehabilitation plan of the old quay.

Table 4-7-1 Rehabilitation Plan of the Old Quay

	Alternative-1	Alternative-2
Measure of rehabilitation	Reconstruction of slab S2	Reinforcement of beam BM
Load condition	Surcharge : 2 tf/m^2 Forklift truck :20 to 40 tf Truck crane : 40 tf	
Workability	◎	△
Construction speed	○	△
Utilization	△	○
Evaluation	○	△

Note : ◎: High ○: Medium △: Low

(2) Rehabilitation of New Quay

The new quay is of a steel sheet pile cellular-bulkhead structure and is stable under the present situation. It is considered that reconstruction will not be needed before 2010, the target year of Master Plan. Only preventing the corrosion of steel sheet piles is required.

Two alternatives for anti-corrosion are compared as shown in Table 4-7-2. From the comparison shown in the Table, cathodic protection is preferable and adopted for the rehabilitation plan of the new quay.

Table 4-7-2 Rehabilitation Plan of the New Quay

	Alternative-1	Alternative-2
Measure of rehabilitation	Cathodic protection method	Painting and lining method
Load condition	Surcharge : 2tf/m^2	
Workability	◎	△
Construction speed	○	○
Utilization	△	△
Evaluation	○	△

Note : ◎: High ○: Medium △: Low

4.7.3 Planned Port Facilities

(1) Fundamental design conditions

The fundamental design conditions for the planned facilities are as follows:

- Tidal Level : H.W.L.+2.35 m, L.W.L.+0.52 m
  CDL 0.00 m
- Wave Height : H= 1.6 m, T= 3.9 sec
- Seismic Coefficient : Kh= 0.0
- Crown Height of Wharf : +4.00 m
- Surcharge : -10 m Berth : 2.0 tf/m^2
  -12 m Berth : 3.0 tf/m^2
- Life Time : 50 years

(2) Soil Conditions

1) North area of the port

The quay for coastal cargo vessels is planned in the north area of the port. The typical soil conditions in this area are shown in Figure 4-7-1. The surface soft soil layer consisting of soft clay, plastic clay or silty sand is ignored in designing and soft limy

marl or basalt boulders and pebbles which has an N-value of less than 15 is also ignored. Limy marl layer with N-value of over 50 is considered as the reliable bearing stratum.

2) North-east area of the port

The quay for ocean-going cargo vessels is planned in the north-east area of the port. The soil conditions obtained from the boring data at the points No.6 and No. 7 are relatively good with sand and no soft soil layer on surface, but those boring points are shifted a little to the coastal side. Considering the slope of the sea bottom (1 : 10) is very steep, the depth of the limy marl layer at the design site may possibly be much deeper than that of boring points No. 6 and No. 7, which means that the same surface soft soil layer found in the north area may also be found here as well.

Therefore, the soil conditions in the north area are applied to the structural design of the quay for ocean-going cargo vessels.

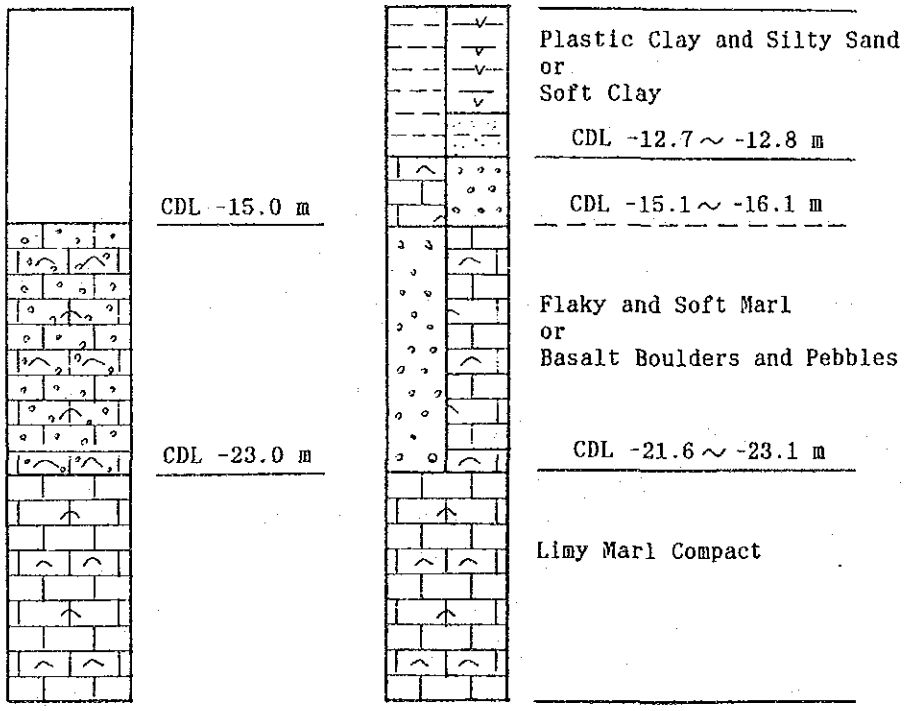


Figure 4-7-1 Soil Condition

(3) Main Port Facilities

The three basic alternatives of the new berths, gravity wall, steel sheet pile and steel pipe pile type, are compared as shown in Table 4-7-3. From the comparison shown in the Table, the adoption of gravity type is difficult. Steel sheet pile type is better than steel pipe pile type considering that the steel pipe pile type requires smaller scale construction equipment and has a shorter construction period.

For the new berth, therefore, steel sheet pile type will be selected as the fundamental structure.

However, the steel pipe pile type will be reexamined if the mooring pier in the Short-Term Development Plan does not have backfilling.

Table 4-7-3 Structural Type Comparison of Berths

Structural type	Steel Sheet Pile Type	Steel Pipe Pile Type	Gravity Wall type
Stability	○	◎	△
Workability	○	○	△
Workload	◎	○	△
Construction speed	◎	○	△
Material procurement	○	○	○
Corrosion protection	△	△	◎
Evaluation	◎	○	△

Note : ◎: High ○: Medium △: Low

1) Quay for coastal cargo vessels

A typical cross-section of a quay for coastal cargo vessels is shown in Figure 4-7-2. As shown in the Figure, a combined type(VL type + VL type) of steel sheet pile is

adopted and the section of the combination is 14 meters in length, which is 70 % of the total pile length of 20 meters. The replacement of the surface soft soil layer with sand is required.

2) Quay for ocean-going cargo vessels

A typical cross-section of a quay for ocean-going cargo vessels is shown in Figure 4-7-3. As shown in the Figure, a combined type(VIL type + VIL type) of steel sheet pile is adopted and the section of the combination is 17 meters in length, which is 74 % of the total pile length of 23 meters. The replacement of the surface soft soil layer with sand is on a smaller scale compared to the coastal cargo berth.

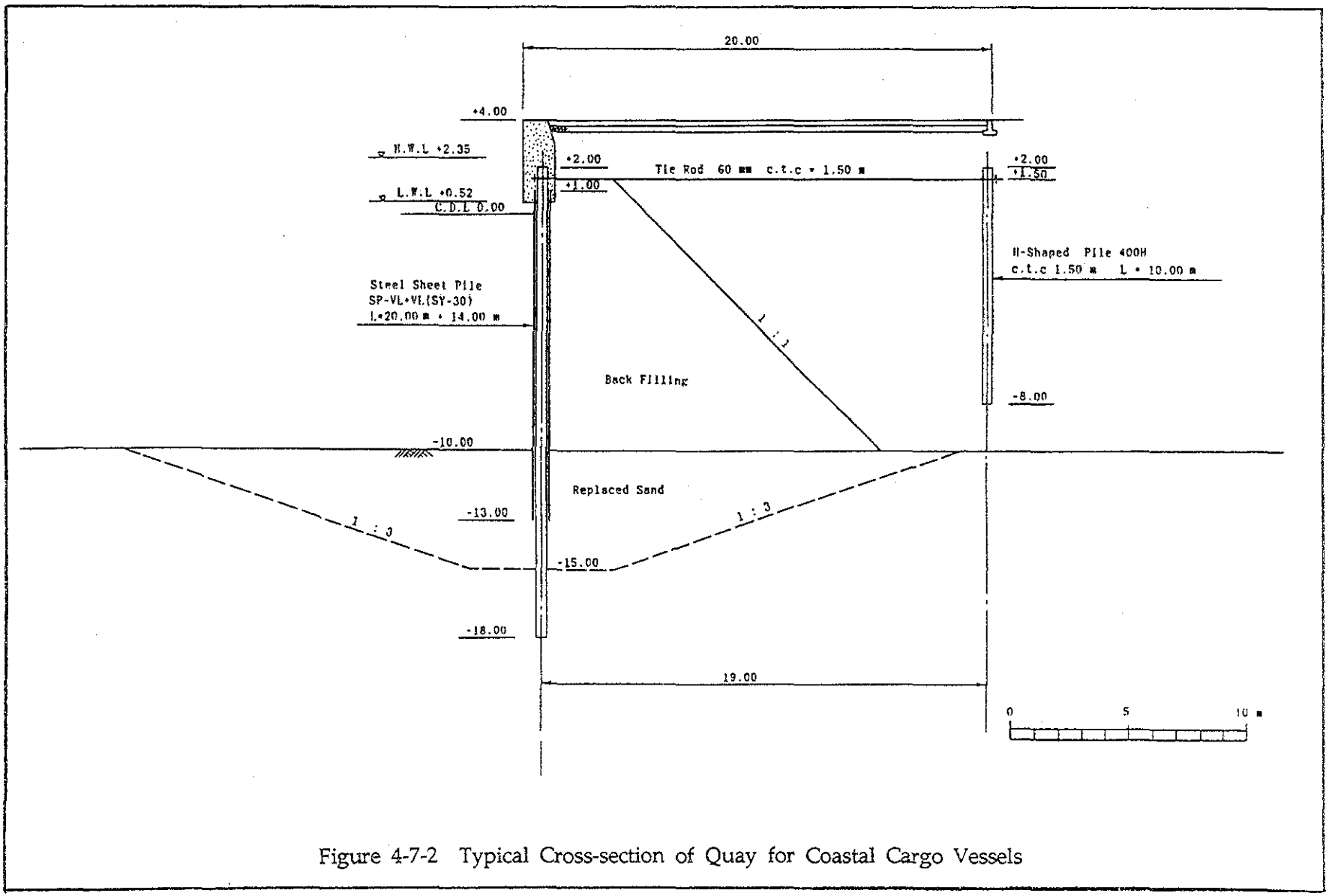


Figure 4-7-2 Typical Cross-section of Quay for Coastal Cargo Vessels

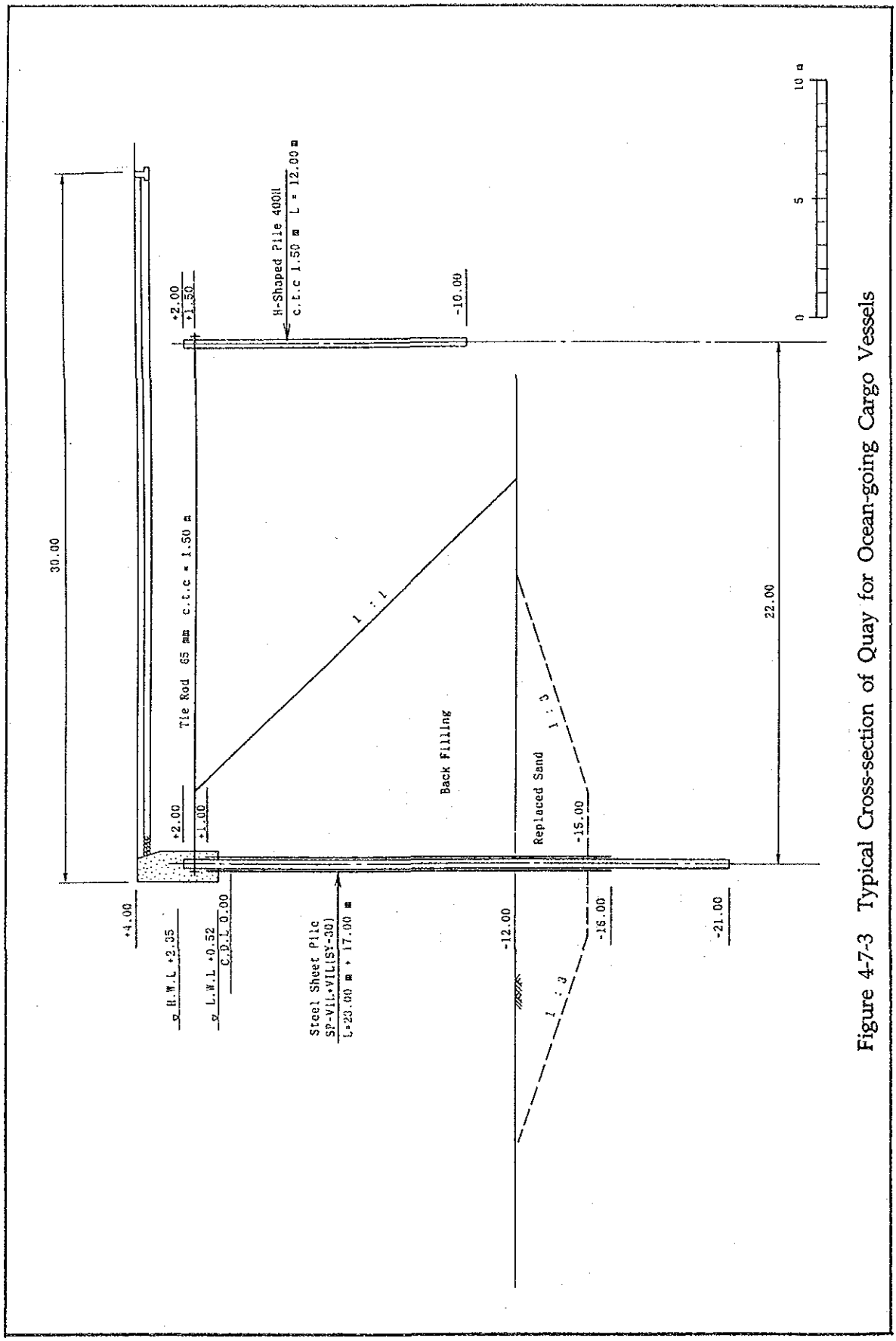


Figure 4-7-3 Typical Cross-section of Quay for Ocean-going Cargo Vessels

(4) Other Facilities

1) Buildings

The warehouses and transit sheds are steel frame structure.

2) Roads and open yard

Roads in the port are paved with concrete, 30 cm in thickness, and have 2 lanes with 10 m width. In principal, the open yard is paved with concrete, 30 cm in thickness.

3) Revetment

The structure of the revetment is rubble-mound type.

4.8 Construction Plan

4.8.1 Construction Quantities

(1) Facilities

The construction quantities of the main port facilities including the existing quay rehabilitation are presented in Table 4-8-1.

The quay extension in the south end of the existing quay carried out individually is excluded from the Project. Cargo handling equipment for containers and for general use is excluded due to consignment of carge handling works in Antsiranana.

The dredging and reclamation volumes in the Table are calculated using the sounding data in September, 1993.

Table 4-8-1 Port Facility and Construction Quantities

Facility		Unit	Quantity	Remarks
Item	Sub Item			
1.Dredging	(1)-12.0m Berth	m^3	38,000	Berthing Area
	(2)-10.0m Berth	m^3	24,000	Berthing and Turning Basin
2.Reclamation		m^3	825,000	Reclaimed Area 91,000 m2
3.Quays	(1)-12.0m Berth	m	500	20 m Buffer Included
	(2)-10.0m Berth	m	170	
	(3)-7.5m Berth	m	41.5	North Side
	(4)Revetment	m	450	150m x 3 units
4.Rehabilitation	(1)Old Quay	m	120	
	(2)New Quay	m	181	
5.Road	(1)Road	m	700	10m width, Concrete Pavement
	(2)Fence and Gate	m	1,100	with 2 Gates
6.Buildings and Transit Sheds	(1)Port office	m^2	500	Coverage Rate(0.6) Capacity Rate(1.8)
	(2)Custom Office	m^2	3,000	Coverage Rate(0.6) Capacity Rate(1.8)
	(3)Transit Shed(No.1)	m^2	2,250	
	(4)Transit Shed(No.2)	m^2	2,250	
	(5)Transit Shed(No.3)	m^2	2,250	
	(6)Transit Shed(No.4)	m^2	2,550	
	(7)Transit Shed(No.5)	m^2	2,400	
7.Land	(1)Open Yard(No.1)	m^2	3,600	for Laden Container
	(2)Open Yard(No.2)	m^2	1,950	for Empty Container
	(3)Open Yard(No.3)	m^2	3,600	for Laden Container
	(4)Open Yard(No.4)	m^2	100	for Steel Product
	(5)Pavement	m^2	61,000	Concrete Pavement
8.Aids to Navigation	(1)Light Marker	set	1	Corner of Quay
	(2)Tug Boat	set	1	2,000 PS
9.Demolition	(1)Maritime Structure	LS	1	Mooring Dolphin, Breakwater
	(2)Land Structure	LS	1	Port Office, Custom Office Transit Shed, Warehouse

(2) Materials

The main materials needed for the construction are listed in Table 4-8-2. Consumption of water, fuel and electricity for the construction works is not included in this Table.

As shown in the Table, a great amount of construction materials are required for the port construction. Therefore, the supply method of the construction materials should be examined prior to the commencement of construction.

Table 4-8-2 Main Construction Materials

Item	Main Materials					Others
	Steel (t)	Concrete (m3)	Stone (m3)	Gravel (m3)	Filling (m3)	
1.Dredging	---	---	---	---	---	
2.Reclamation	---	---	---	---	825,000	
3.Quays	7,660	11,430	190,100	10,850	66,700	Fender, Bollard, Curbing, Corrosion Protection
4.Rehabilitation	70	850	---	---	---	Fender, Bollard, Curbing, Corrosion Protection
5.Road	---	2,540	---	3,170	---	Fence, Gate
6.Buildings and Transit Sheds	13,180	8,280	---	6,210	---	
7.Land	---	14,780	---	25,320	---	
8.Aids to Navigation	---	---	---	---	---	Light Beacon, Tug Boat
9.Demolition	---	---	---	---	---	
Total	20,910	37,880	190,100	45,550	891,700	

4.8.2 Construction Procedure

(1) Basic Concept

Experience in the construction of port facilities is quite limited in Madagascar, so the port facilities proposed in the Project will be conducted in co-operation with foreign engineers. Respecting to the port construction works, large-sized construction machinery and equipment, construction vessels and skilled labor for special works will have to be procured from other countries.

(2) Construction of Each Facility

Construction procedure of the major facilities are as follows:

1) Dredging and reclamation

The dredging area adjacent to the newly proposed quay is relatively small and the nature of the bottom and subsurface material is composed of relatively soft soil and sand. A grab dredger is expected to be suitable for the dredging work at the site.

Dredged sea bed material will be used for the reclamation. Unsuitable dredged soil will be dumped in the appropriate dump site.

The reclamation of the yard should be carried out with filling material of good quality. Before the reclamation works, it is necessary to conduct a soil survey to establish whether the filling materials can be easily obtained.

2) Construction of the quay

The anchored sheet pile quaywall, the installation of which is more economical and more efficient than other structural types, is adopted to the newly proposed quay in considerating of the site condition in Antsiranana.

According to the flow of the construction procedure shown on Figure 4-8-1, the construction method of the anchored sheet pile quaywall is as follows:

i) Before driving sheet piles, dredging must be carried out up to the required water depth. Soft soil of bottom material is removed at this time.

ii) Sheet piles must be driven into the required embedded depth using a diesel hammer of 3.0 ton ram weight or the equivalent equipped on a floating pile driving barge.

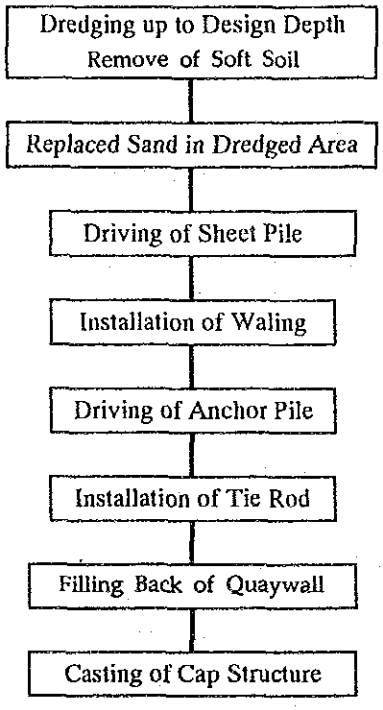


Figure 4-8-1 Flow of Construction Procedure of Quay

iii) The fixing of waling must precede the installation of tie rod. The joint of the waling should be bolted or welded by electric welding or oxyacetylene welding.

iv) Anchoring piles must be driven into the required embedded depth using a diesel hammer of 1.0 ton ram weight or the same. Where the embedded depth of the anchoring pile is above the existing sea bottom, advanced filling up to the required depth for piling will be considered.

v) Tie rods are installed at a rate of one for every three or four sheet piles. They should be supported invariably by piles to prevent unequal settlement or settlement due to consolidation. The tightness of tie rods is adjusted by mean of nuts or turnbuckles.

vi) After the installation of tie rods, back filling of the quaywall should be carried out as soon as possible to protect the whole structure from wave attack.

vii) The cap structures should be constructed after the completion of back filling settlement.

3) Rehabilitation of the old quay

Rehabilitation of the old quay is considered, which is constructed as a concrete cell pier type. Contents of the rehabilitation works of the old quay are as follows:

i) Rehabilitation and improvement of the existing slab

After the removal of the existing asphalt pavement, concrete base and filling, new reinforced concrete will be replaced to cater for the loading condition of the Mater Plan.

ii) Replacement of the front wall

The front wall of the old quay is severely damaged, so that the whole of the front wall is demolished and renew.

iii) Repair of the pier

Portion of the concrete pier of the quay is partially damaged around the water level, in which the reinforced bar of the casing concrete appears on the surface. In order to repair the pier, underwater concrete will be filled in the damaged portion.

iv) Installation of fenders, bitts and curbing.

For safe activities and efficient berthing and deberthing, new fenders, bits and curbing will be installed.

4) Rehabilitation of the new quay

Rehabilitation of the new quay is considered, which is constructed as a steel sheet pile cellular-bulkhead type. The improvement works of the new quay will be carried out for the extent of 180 m, of which the bulkhead portion facing the small ship basin is excluded due to the reclamation area planned by the other independent project. The contents of the Rehabilitation works are as follows:

i) Installation of cathodic corrosion protection for steel sheet pile

The cathodic corrosion protection for the steel sheet pile of the cellular structure will be installed on the existing sheet pile surface.

ii) Installation of fenders, bitts and curbing

As a safe measure and for efficient berthing and deberthing, new fenders, bits and curbing will be installed.

4.8.3 Construction Schedule

The construction schedule of the quay and the relevant port facilities is presented in Table 4-8-3. The construction schedule for the fishery quay extended in the south end of the existing quay should be established considering the proposed construction schedule of the Project.

The construction schedule is comprised of 3 phases, as followings:

Phase I: 1994 to 1998.
Rehabilitation of the existing quay.
Construction of the -7.5m, -10.0m quay and relevant facilities.

Phase II: 1999 to 2004.
Construction of one berth of the -12.0m quay and relevant facilities.

Phase III: 2005 to 2010.
Construction of one berth of the -12.0m quay and relevant facilities.

Table 4-8-3 Construction Schedule

Facility		Construction Year																	
Item	Sub Item	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.Dredging	(1)-12.0m Berth																	
	(2)-10.0m Berth																	
2.Reclamation																		
3.Quays	(1)-12.0m Berth																	
	(2)-10.0m Berth																	
	(3)-7.5m Berth																	
	(4)Revetment																	
4.Rehabilitation	(1)Old Quay																	
	(2)New Quay																	
5.Road	(1)Road																	
	(2)Fence and Gate																	
6.Buildings and Transit Sheds	(1)Port office																	
	(2)Custom Office																	
	(3)Transit Shed(No.1)																	
	(4)Transit Shed(No.2)																	
	(5)Transit Shed(No.3)																	
	(6)Transit Shed(No.4)																	
	(7)Transit Shed(No.5)																	
7.Land	(1)Open Yard(No.1)																	
	(2)Open Yard(No.2)																	
	(3)Open Yard(No.3)																	
	(4)Open Yard(No.4)																	
	(5)Pavement																	
8.Aids to Navigation	(1)Light Marker																	
	(2)Tug Boat																	
9.Demolition	(1)Maritime Structure																	
	(2)Land Structure																	

4.9 Cost Estimation

4.9.1 Estimation Basis

(1) Estimation limit

Some limits for the estimation are as follows:

i) The costs of the main port facilities proposed in the Master Plan are estimated.

ii) Land rents, compensation and insurance costs are excluded.

iii) Rehabilitation of the existing quay is included.

iv) Extension of the fishery quay planned individually is excluded.

v) The demolition of the existing buildings such as the port office, the custom office and the warehouses is included. Removal of wrecked vessels and submerged obstacles is excluded.

vi) Road and utilities such as electricity, water supply, drainage and so forth connected outside of the port area is excluded.

(2) Domestic and foreign portion

In general, the cost of the foreign portion includes the followings:

i) Articles and goods which have never been produced domestically.

ii) Articles and goods which are seldom produced domestically.

iii) Articles and goods which cannot be supplied locally because of low domestic production and high domestic consumption.

Based on the above criteria, the foreign portion comprises:

i) Labor cost of the foreigners who work for foreign contractors, and the rental of construction machinery and equipment which belongs to foreign contractors.

ii) Equipment and machinery, electric facilities, special steel products, bitts, fenders and aids to navigation.

Customs duties imposed on the imported goods are excluded in the cost estimation.

(3) Exchange rate

Exchange rate among U.S.$, Madagascan Franc and Japanese Yen are as follows:

1 U.S.$ = 1860 FMG = 108 Yen

The exchange rate of foreign currency is variable, so the construction costs are estimated on the basis of the rate as of October, 1993.

(4) Physical contingency

Estimated costs include physical contingency. Contingency rates are as follows:

0 %	Aids to navigation.
5 %	Dredging cost, construction cost of road and land.
10 %	Construction costs of the quays, revetment, buildings, transit sheds and warehouses.

4.9.2 Estimation Procedure

The estimation procedure of the project cost of the Master Plan is as follows:

i) Prices in Japan are used for the estimation of the costs of imported materials and goods.

ii) If the prices are unavailable, they are estimated by comparing the prices of other goods both in Madagascar and Japan.

iii) The project costs of the Master Plan are estimated considering the new wage rates released on January 25, 1994

vi) An administration cost is fixed as 20 % of the total construction cost at the site.

v) The additional tax rate of T.S.T. imposed on the materials and the rental construction machinery at site is estimated as 7.5 % and 15 % respectively.

4.9.3 Estimation Result

The summary of the construction cost estimate is presented in Table 4-9-1. The construction cost of each of the major facilities is listed in Table 4-9-2.

Table 4-9-1 Construction Cost

Facility	Construction Cost(US$)		
	Total	Foreign Portion	Local Portion
1.Dredging	2,400,000	2,152,000	248,000
2.Reclamation	14,336,000	3,368,000	10,968,000
3.Quays	46,452,000	35,637,000	10,815,000
4.Rehabilitation	2,772,000	2,141,000	631,000
5.Road	1,711,000	931,000	780,000
6.Buildings and Transit Sheds	35,849,000	24,362,000	11,487,000
7.Land	9,420,000	4,988,000	4,432,000
8.Aids to Navigation	3,071,000	3,069,000	2,000
9.Demolition	1,047,000	832,000	215,000
Sub Total	117,058,000	77,480,000	39,578,000
Tax	2,416,000	---	2,416,000
Total	119,474,000	77,480,000	41,994,000

Table 4-9-2 Construction Cost of Each of the Facilities

Facility		Unit	Quantity	Construction Cost (US$)		
Item	Sub Item			Total	Foreign Portion	Local Portion
1.Dredging	(1)-12.0m Berth	m^3	38,000	1,471,000	1,319,000	152,000
	(2)-10.0m Berth	m^3	24,000	929,000	833,000	96,000
	Sub-total	LS	1	2,400,000	2,152,000	248,000
2.Reclamation	(1)Reclaimed Area	m^3	825,000	14,336,000	3,368,000	10,968,000
	Sub-total	LS	1	14,336,000	3,368,000	10,968,000
3.Quays	(1)-12.0m Berth	m	500	25,485,000	20,962,000	4,523,000
	(2)-10.0m Berth	m	170	8,954,000	7,329,000	1,625,000
	(3)-7.5m Berth	m	41.5	3,006,000	2,339,000	667,000
	(4)Revetment	m	450	9,007,000	5,007,000	4,000,000
	Sub-total	LS	1	46,452,000	35,637,000	10,815,000
4.Rehabilitation	(1)Old Quay	m	120	1,907,000	1,342,000	565,000
	(2)New Quay	m	181	865,000	799,000	66,000
	Sub-total	LS	1	2,772,000	2,141,000	631,000
5.Road	(1)Road	m	700	1,504,000	763,000	741,000
	(2)Fence and Gate	m	1,100	207,000	168,000	39,000
	Sub-total	LS	1	1,711,000	931,000	780,000
6.Buildings	(1)Port office	m^2	500	1,180,000	802,000	378,000
and	(2)Custom Office	m^2	3,000	7,075,000	4,808,000	2,267,000
Transit Sheds	(3)Transit Shed(No.1)	m^2	2,250	5,306,000	3,606,000	1,700,000
	(4)Transit Shed(No.2)	m^2	2,250	5,306,000	3,606,000	1,700,000
	(5)Transit Shed(No.3)	m^2	2,250	5,306,000	3,606,000	1,700,000
	(6)Transit Shed(No.4)	m^2	2,550	6,016,000	4,088,000	1,928,000
	(7)Transit Shed(No.5)	m^2	2,400	5,660,000	3,846,000	1,814,000
	Sub-total	LS	1	35,849,000	24,362,000	11,487,000
7.Land	(1)Open Yard(No.1)	m^2	3,600	570,000	289,000	281,000
	(2)Open Yard(No.2)	m^2	1,950	216,000	115,000	101,000
	(3)Open Yard(No.3)	m^2	3,600	570,000	289,000	281,000
	(4)Open Yard(No.4)	m^2	100	17,000	9,000	8,000
	(5)Pavement	m^2	61,000	8,047,000	4,286,000	3,761,000
	Sub-total	LS	1	9,420,000	4,988,000	4,432,000
8.Aids to	(1)Light Marker	set	1	47,000	45,000	2,000
Navigation	(2)Tug Boat	set	1	3,024,000	3,024,000	0
	Sub-total	LS	1	3,071,000	3,069,000	2,000
9.Demolition	(1)Maritime Structure	LS	1	58,000	46,000	12,000
	(2)Land Structure	LS	1	989,000	786,000	203,000
	Sub-total	LS	1	1,047,000	832,000	215,000
Total				117,058,000	77,480,000	39,578,000
Tax				2,416,000	---	2,416,000
Grand Total				119,474,000	77,480,000	41,994,000

4.10 MANAGEMENT AND OPERATION

4.10.1 General Concept of Port Management

Concerning port operation and administration, there is no one definitive system that has been adopted in ports all over the world. The structure of the port management body at each port is slightly different depending on historical, socio-economic and institutional factors. Port activities are conducted by a port management body or private company or both.

Taking into consideration the following issues, smooth and efficient management and operation systems should be introduced.

- Port activity has a great influence on the national economy. Safeguarding the national interest should be the first priority issue concerning port management and operation.

- The basic role of ports is normally considered to function as a public facility. Port infrastructure and facilities should be basically operated in open use to the public.

- It is necessary to establish a basic policy and plan for proper development and conservation of port area.

- Safe and efficient transfer of cargo is vital. Cargo handling efficiency is strongly required in particular.

4.10.2 General Principals of Port Management and Operations

In principal, the following three points are commonly required for port management and operation around the world.

(1) Efficiency

In order to ensure efficient utilization of the port facilities and port services, and to minimize the cost of transportation through the port, efficient port management and operations are indispensable.

(2) Provision of services at reasonable charges

The following points should be considered in terms of the port tariff structure.

- The revenue from the tariff can cover costs for construction, management, maintenance and repair.
- The tariff should be relational in correspondence with the service provided.
- The tariff structure should include a system which leads to more effective management and operation of the port. This implies that the tariff structure provides an incentive for vessels and cargo to move efficiently through the port.
- The tariff structure and the way of imposition should be as simple as possible.

(3) Reliability and safety

Delivery/receiving or unloading/loading of cargo and arrival/departure of vessels must be carried out on time and correctly. Operation of cargo handling and vessels must be carried out safely.

Even if the above factors are given different priorities, it is impossible to attract users to ports without all of them. They are especially important for container terminals as compared with other cargo terminals. When the above requirements are satisfied, port activities can be promoted and the port management body can make the best use of port facilities.

4.10.3 The Formation of Port Management

The management is best undertaken by an independent organization that follows the framework described below;

(1) Semi-autonomous body

In general, the port which is of greatest importance to country should be managed by an independent organization comprised of a Port Authority and Port Trust under control of the government. Port Authority has a committee to make decisions, although before proceeding with important matters, the government's permission is required. Examples in which the government's permission would be required are as follows;

- Security of the nation and diplomatic policies.
- Annual budget
- Loans
- Level of port charge
- Property development
- Nomination of chairman and director of committee

(2) Unified management by a single body

Unified management by a single body is the most important principal to have competence of permission for port area and main function and increase efficiency of port operation.

(3) Original budget

To preserve the port's identity, the budget is independent of the government's budget. Also port charges, which account for most of the revenue, need to be kept at a reasonable level. If the level of port charge is reasonable, it is possible to operate the port by revenue from port charges including the repayment of loans and also depreciation and renewal of port facilities. In general, large projects involving new port planning, water way, break water etc., are funded by the government.

(4) Introduction of commercial management

The last factor is the application of modern commercial management to port management. In this respect, it is necessary to clarify responsibility under a well-structured organization from the beginning. It is also necessary to transfer rights of management to the semi-autonomous body.

4.10.4 Examples of Port Management in Foreign Countries

(1) Japan

Ports in Japan have been integratively administrated and managed by each public sector (Port Management Body) which is established by one or more local governments, or a local government itself.

According to the Port and Harbour Law, the function of a Port Management Body covers a wide range of activities which relate to development and maintenance of port facilities, their administration and management, as well as the enhancement of port use such as marketing activities and others. National Government also plays an important role in port development, administration and management. But function of the Ministry of Transport is limited mainly to matters related to national interests or financial support for port construction projects. Private enterprises execute their business under control of Port Management Bodies, Ministry of Transport, and other ministries concerned.

Main roles of the Port Management Body and National Government (Ministry of Transport) prescribed by the Port and Harbour Law are as follows;

a. Role of Port Management Body

- To establish port and harbour plans
- To maintain port area and port facilities in good operating conditions
- To carry out construction and maintenance works for port facilities
- To undertake land reclamation works in the port area
- To maintain and improve, where necessary, environmental conditions of port (e.g. ship sludge treatment, oil pollution contingency plan, waterfront amenity facilities)
- To control by means of permit systems both public and private use of land and water areas of the port
- To restrict the disorderly use of land and water areas in and nearby port
- To enforce necessary regulations on the use of water facilities and public mooring facilities
- To ensure safety in the port area in collaboration with other agencies concerned (e.g. vessel navigation, handling of dangerous cargoes, vehicle traffic, etc.)
- To prepare the port tariff and collect fees and charges from port users
- To install necessary facilities for fire-fighting and rescue, and provide oil fences, chemicals, and other materials, for oil pollution
- To conduct surveys and studies and compile statistics for port development, and promote publicity of the port
- To ensure the adequate provision of port services (water and bunker supply, etc.)
- To establish and control welfare facilities for seamen and harbour workers
- Other services necessary for development and management of the port such as public relation activities

As an example of a Port Management Body, the organization chart of the Port of Kobe, which is the largest port in Japan, is shown in Figure 4-10-1.

b. Role of National Government (Ministry of Transport)

- To formulate national port development policies, and establish necessary laws and regulations for port administration and development
- To give advice to Port Management Bodies on port administration and development
- To examine and coordinate port and harbour plans of major ports
- To finance port construction projects
- To execute port construction by itself
- To develop and maintain channels out of port areas
- To establish technical standards for port planning, design, and construction
- To pursue technical innovation in ports

The organization chart of the Ministry of Transport is shown in Figure 4-10-2.

(2) Other foreign countries

In general, a port authority system in which the port management body is independent of the government is adopted throughout the world. Management can roughly be separated into two systems: the Continental system and the British and American system.

In the Continental system, there are various types of port management and operation because of differences in historical backgrounds. The port can be managed by government, local public body, independent or private entities.

In the British and American system, usually, the port is constructed by a private enterprise for its own purpose. But after development of the port has reached its limit, the port management body is shifted from the private enterprise to a public corporation.

For examples of the two systems, organization charts of the Port of Rotterdam and Port of Los Angeles are shown in Figure 4-10-3 and 4-10-4.

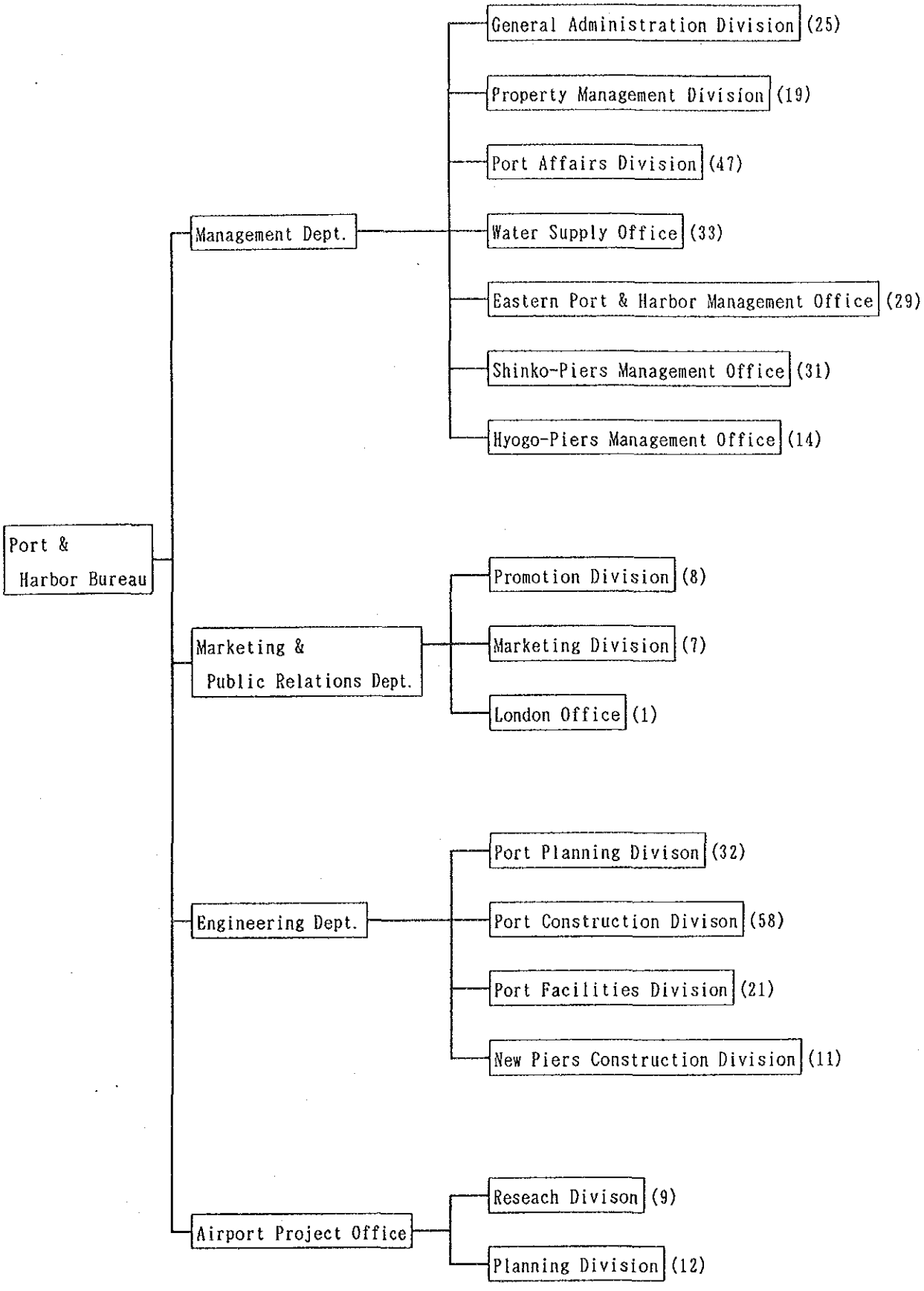


Figure 4-10-1 Organization Chart of the Port of Kobe

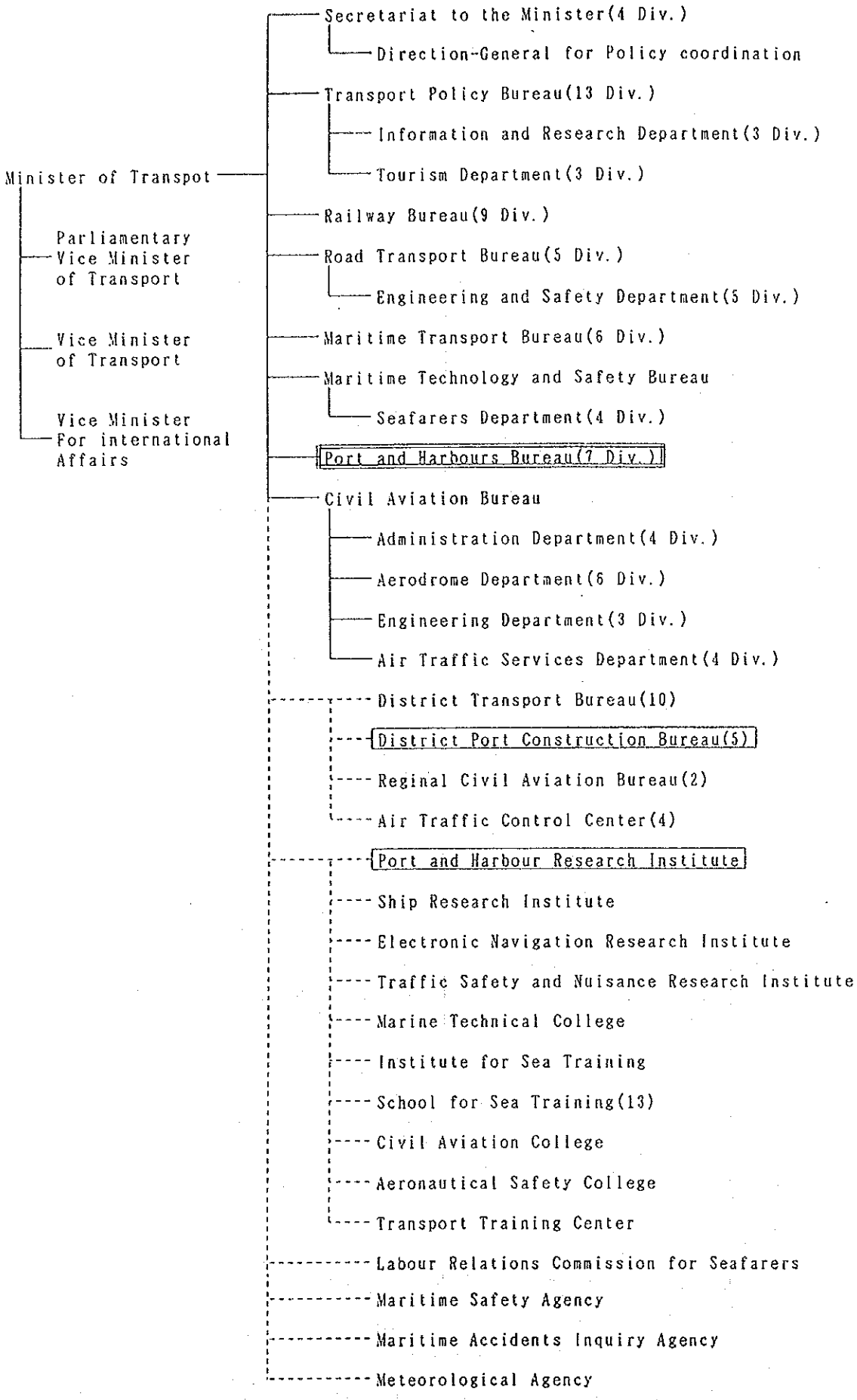


Figure 4-10-2 Organization Chart of Ministry of Transport

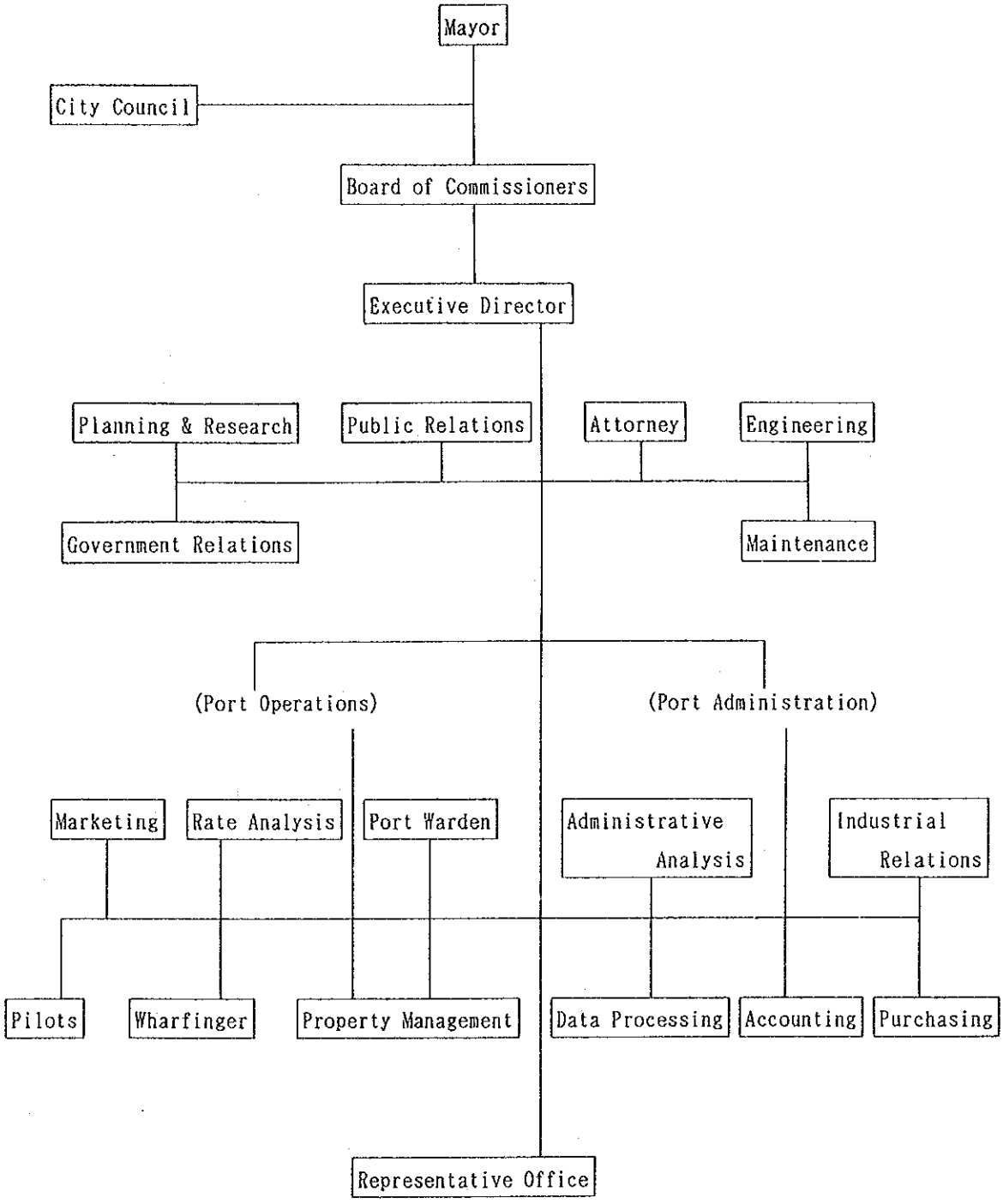


Figure 4-10-3 Organization Chart of Port of Los Angels

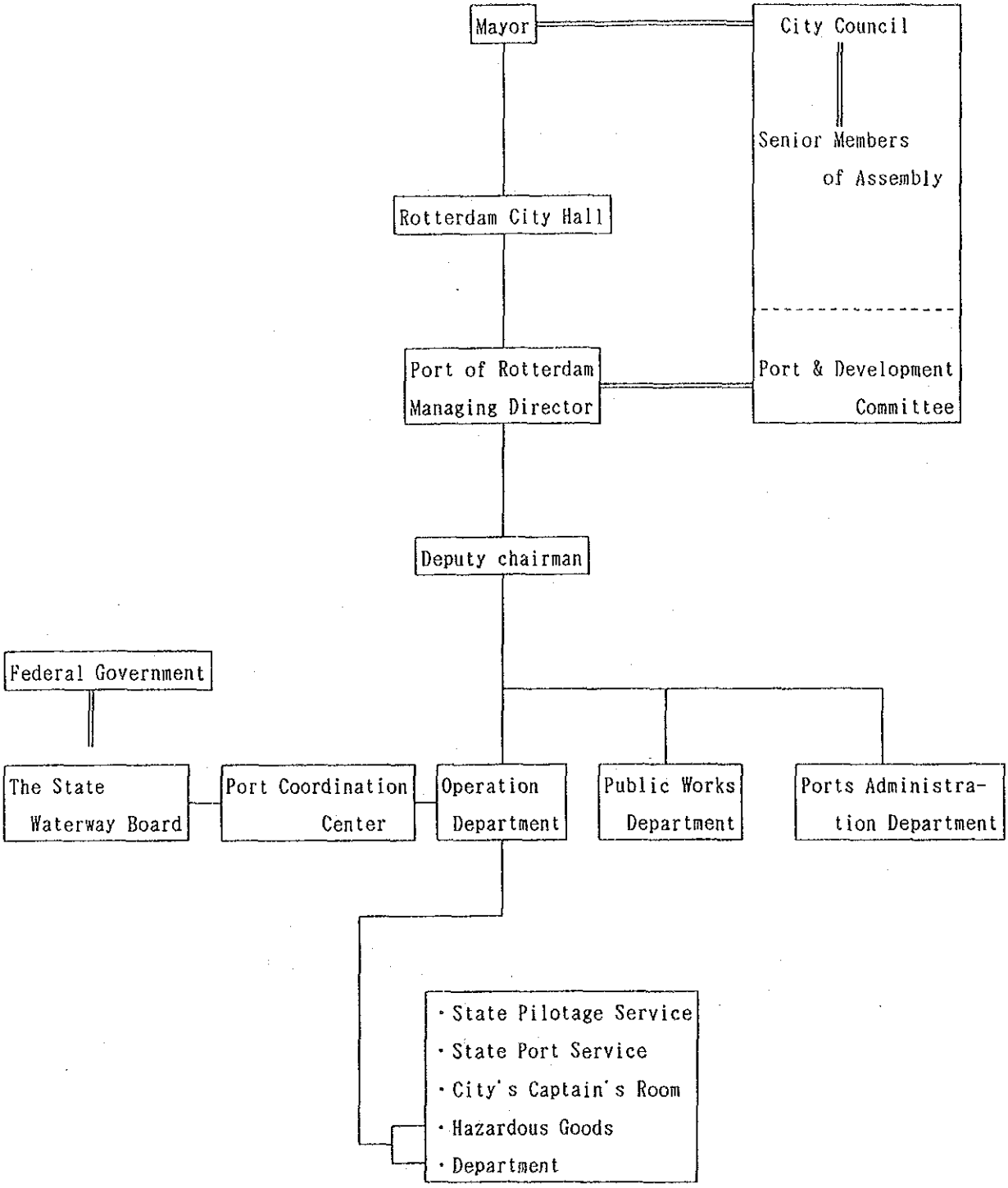


Figure 4-10-4 Organization Chart of Port of Rotterdam

4.10.5 Privatization of the Port

(1) Concept of privatization

Generally, privatization means that public property and management are transferred from government to private commercial enterprise. The means of privatization are very diverse including following cases;

- A public organization is converted to a joint-stock company through the issue of shares.

- Public works are subcontracted and entrusted to private enterprise.

- A joint venture is entered into by the public and private sectors.

(2) Trend of port privatization

Throughout the world, there is a tendency for port administration and management to move toward privatization. If it is appropriately applied to the local conditions of the target project, efficient port management and good financing may be realized by privatization.

Port of Antsiranana is a public port. Basic concept of public ports is indicated as follows;

Public ports should be considered as economic infrastructure, or social capital, or as a national asset which is vital in promoting the national economy and upgrading total welfare of citizens. For countries like Madagascar in particular, where cargo transportation is greatly dependent on maritime transportation, sound port activity is very important in providing the framework of national economic security. Under the concept, ports should be owned by the public sector (national or regional government). At the same time, basic facilities should be controlled by the government.

In addition to the above mentioned points, it is very important from an administrative point of view that a public agency maintains uniform control over the entire area of a public port. The existence of privately owned space or facilities in the public port area can often jeopardize normal port administration on the various aspects of port development and operation. From this point of view, the land and water area as well as major port facilities should be owned by the public sector to secure sound and effective port development and activities.

(3) Application of privatization policy

Under the basic understanding on the nature of a public port illustrated above, it is considered that the following guidelines be taken into account in examining the government's privatization policy.

1) The ultimate objective of privatization of port operation is to maximize economic return from the target port activity for both the public and private sectors under careful consideration on effective removal of possible inefficiency of public sector as well as adverse effects of monopoly by private sector.

2) Port functions and activities to be privatized should be limited within the areas where the privatized activities can be fully controlled under DTM administrative authority, and the areas where the effects of privatization can be fully expected without any negative impact to sound performance of the port.

3) The target areas to be privatized should be planned and arranged appropriately to guarantee the necessary conditions under which the free market system can be fully activated.

4) In principle, ownership of the land and water area necessary for DTM port administration, and the basic port facilities such as water area for navigation channels and turning/berthing basins, public wharves, main access roads, utility mains, power supply, reserved space/land for public use or future expansion, should belong to DTM.

5) Basic port facilities and major cargo handling equipment should be open to public use, in principle, but can be leased out to private firms on a contract basis for their exclusive use under appropriate conditions.

4.10.6 Conclusion

Since ancient times, ports and harbours have been developed mainly as the nucleuses of maritime and land transportation and as places of trade, commerce and other socio-economic activities, in accordance with socio-economic conditions of its hinterland.

(1) Administration and management

In the development of a port, it is important to harmonize management with planning and construction. Administration of port is the responsibility of DTM: all commercial ports are under its control. Port management and operation is the

resporsibility of SERVICE DE L'EXPLOITATON MARITIMES while port planning and maintenance is the responsibility of SERVICE DE PROJET PORTUAIRE. Their budgets and policies regarding port management and port planning are prepared independently without harmonization. Ports are operated (including minor maintenance) with the revenue from port charges, but all investment projects identified by port planning are financed by foreign cooperation capital. In particular, all revenue has been spent solely on port operating costs without new investment. In order to improve the above situation, following items need to be carefully considered for effective port management and operation.

- Strengthening the organization and establishment of adequate budget system to promote harmonized port management and operation and port planning
- Making effort to increase the port revenue (reconsider the port tariff)
- Preparing the nationwide development and improvement plans

(2) Operations

In Madagascar, the works of port operation are divided broadly into two parts which are public and private works. Public works are as follows;

- Berth assignment
- Levy of charge
- Permission of using port facilities
- Coordination between public authorities and private companies concerned with port management

At present, there are two types of private works, cargo handling and pilot service.

In this sense, share of public and private works of port operation is deemed appropriate. Regarding the public works, port management body must do the following;

- Maintain port area and port facilities in good conditions and carry out construction and maintenance works for port facilities

- Conduct surveys and studies and compile statistics for port development

Regarding the private works,they should ensure efficient operation responding to the demand of cargo.

(3) The relationship between the headquarters and local agencies of DTM

The problem concerning port operation is that all important decisions are made by DTM, while local agencies including Antsirananan Port have no authority to participate in the decision-making. Therefore, port operation isn't adapted to the actual condition.

The local agency should have more authority to deal with the issues related to daily usage of facilities.

4.11 Environmental Examination

4.11.1 General

Issues regarding development and environmental conservation have been a common concern of the international community, i.e. both in developed and developing countries.

Particularly, in Madagascar, there are a lot of precious species of animals and plants which must be preserved.

In this Master Plan, it is required that development will be compatible with the environment.

4.11.2 Present Environmental Policy in Madagascar

It is only recently that the government has begun to deal with environmental issues.

The principal environmental policy is based on "The Environmental Charter", promulgated on 21st, December, 1990. The contents of this law are vast, i.e. starting from the analyses of causes of environmental degradation, then referring to National Environmental Policy (POLITIQUE NATIONALE DE L'ENVIRONNEMENT:PNE), Environmental Action Plan (LE PLAN D'ACTION ENVIRONNEMENTAL:PAE), PAE program, the organizations to execute the policy or program and so on. Following this Environmental Charter, the Decree No 92-926 was promulgated. The law aims to create a harmonious balance between development and the environment. According to this decree, those who wish to promote a development project likely to affect the environment have to ensure that the development will be compatible with the environment. The promoter submits an environmental impact report to The National Office for the Environment (L'OFFICE NATIONAL POUR L'ENVIRONNEMENT:ONE), established in December, 1990. ONE examines the report and can require that modifications to the project be made to deal with environmental problems, if any are thought to exist. At present, the Environment Charter is not applied in its strict sense because all relevant decrees and application details necessary for its application are currently in the preparatory stages.

The province of Antsiranana does not have its own separate regulations or policies regarding environmental issues.

4.11.3 Method of Environmental Examination

In general, environmental consideration consists of two stages, i.e. Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA).

IEE is conducted to determine whether a detailed EIA would be needed by grasping possible environmental impacts associated with development projects based on existing materials and the results of field survey.

EIA provides a detailed assessment of the environmental impacts indicated in IEE, proposes countermeasures including alternative plans and gives a final assessment from an environmental standpoint.

In this Study, an environmental impact checklist is used for IEE. It is a common method. Impact size is examined for each item and then impact on the background area and the present level of the environment will be assessed. The obtained results will be ranked in the right column of the checklist according to the size of the impact.

4.11.4 Results of Environmental Examination

Based on the checklist, the results of IEE are shown in the following Table 4-11-1:

Here, a brief comment on the results is given. As mentioned in the present situation of the port of Antsiranana, there seems to be no valuable fauna or flora to be protected around the Diego-Suarez bay. In the province, there is a national park named "Parc Natioanl de la Montagne d'Ambre", which is located over 20 km away from the port. Sea pollution may, however, possibly become one of the most important issues because as population increases and people use more water, the amount of sewage water pouring into the bay increases, consequently water pollution may arise in future. At present, no serious pollution problem exists according to the field survey.

In this IEE, the main issues taken into account are as follows: there is a hospital about 400 m away from the project site and the implementation of the project may cause some environmental problems. In addition, the activities of the port and factories will be promoted with the port development, resulting in an increase in the number of calling vessels, road traffic to/from the port and tuna cargo to be handled.

In consideration of the above, a further environmental examination will be carried out in EIA on items with "small" and "moderate" impact according to the checklist.

Table 4-11-1 Environmental Impact Checklist for Port Development

Environmental impact factors	Environmental impact	Size of impact (check appropriate boxes)			
		No	Small	Moderate	Major
1. Impact from construction works					
1.1 Operation of working boats, construction machines	1.1.1 Air pollution	✓			
	1.1.2 Generation of noise/vibration			✓	
	1.1.3 Changes in terrestrial ecosystem	✓			
1.2 Dredging, stirring of bottom soil, soil dumping into water	1.2.1 Pollution of water and bottom sediments (SS, hazardous materials)	✓			
	1.2.2 Offensive odor	✓			
	1.2.3 Reduction of aquatic lives	✓			
	1.2.4 Pollution of marine products	✓			
	1.2.5 Devaluation of tourism esources (water color, coral reef)	✓			
1.3 Soil removal	1.3.1 Changes in topography, underground water system	✓			
	1.3.2 Extinction of terrestrial ecosystem	✓			
1.4 Generation of surplus soil, wastes, dumping of dredged soil on ground	1.4.1 Pollution of water/bottom sediments	✓			
	1.4.2 Impact on terrestrial ecosystem	✓			
1.5 Employment of laborers	1.5.1 Inflow of alien cultures	✓			
	1.5.2 Change in economic activities				+
1.6 Congestion of work vehicles and boats	1.6.1 Economic loss (traffic jam)	✓			
	1.6.2 Devaluation of fishing ground	✓			
2. Impact from port facilities and site					
2.1 Emergence of site (including landfill)	2.1.1 Pollution of water and bottom sediments	✓			
	2.1.2 Beach erosion and accretion	✓			
	2.1.3 Changes in coastal currents	✓			
	2.1.4 Decrease of habitats for aquatic lives	✓			
	2.1.5 Decrease of habitats for terrestrial lives	✓			
	2.1.6 Change in scenic beauty	✓			

Table 4-11-1 Environmental Impact Checklist for Port Development (continued)

Environmental impact factors	Environmental impact	Size of impact (check appropriate boxes)			
		No	Small	Moderate	Major
	2.1.7 Resettlement of local residents and culture	✓			
	2.1.8 Extinction of fishing grounds	✓			
2.4 Emergence of anchorage	2.4.1 Change in coastal current	✓			
	2.4.2 Decrease of habitats for aquatic lives	✓			
3. Impact from utilization of facilities in water area and anchorage					
3.1 Impact from boats	3.1.1 Air pollution		✓		
	3.1.2 Water pollution (bilge)		✓		
	3.1.3 Beach erosion caused by furrow wave	✓			
	3.1.4 Generation of wastes (dredged material included)		✓		
	3.1.5 Obstruction to fisheries activities	✓			
4. Impact from cargo loading and utilization of storage facilities					
4.1 Cargo loading activities and utilization of storage facilities	4.1.1 Air pollution (dust)	✓			
	4.1.2 Pollution of water and bottom sediments	✓			
	4.1.3 Generation of noise	✓			
	4.1.4 Generation of offensive odor	✓			
	4.1.5 Change in coastal ecosystem	✓			
	4.1.6 Generation of wastes	✓			
	4.1.7 Employment effect		+		
5. Impact from operation of facilities handling hazardous materials					
5.1 Operation of oil distribution base and facilities handling hazardous materials	5.1.1 Air pollution	✓			
	5.1.2 Pollution of water and bottom sediments (oil)	✓			
	5.1.3 Generation of offensive odor	✓			
	5.1.4 Change in coastal ecosystem	✓			
	5.1.5 Change in terrestrial ecosystem	✓			
	5.1.6 Decrease in amount of agricultural products, fisheries products and price	✓			

Table 4-11-1 Environmental Impact Checklist for Port Development (continued)

Environmental impact factors	Environmental impact	Size of impact (check appropriate boxes)			
		No	Small	Moderate	Major
6. Impact from traffic function					
6.1 Road traffic	6.1.1 Air pollution	✓			
	6.1.2 Generation of noise/vibration		✓		
	6.1.3 Change in terrestrial ecosystem	✓			
	6.1.4 Change in local population distribution	✓			
	6.1.5 Traffic jam/accidents		✓		
7. Impact from industrial production activities					
7.1 Operation of factories and plants	7.1.1 Air pollution	✓			
	7.1.2 Pollution of water/bottom sediments			✓	
	7.1.3 Generation of noise/vibration	✓			
	7.1.4 Generation of offensive odor		✓		
	7.1.5 Ground subsidence	✓			
	7.1.6 Change in coastal ecosystem	✓			
	7.1.7 Change in terrestrial ecosystem	✓			
	7.1.8 Generation of wastes		✓		
	7.1.9 Change in local population distribution	✓			
	7.1.10 Employment effect		+		

Note: In this table, ✓ and + indicate negative and positive impact on environment respectively.

CHAPTER 5

SHORT-TERM DEVELOPMENT PLAN OF THE PORT OF ANTSIRANANA

5. SHORT-TERM DEVELOPMENT PLAN OF THE PORT OF ANTSIRANANA

5.1 The Basic Concept of the Short-Term Development Plan

The target year of the Short-Term Development Plan is 1998, not far from the present. Since the duration of the Short-Term Development Plan is limited, it cannot be expected that all problems facing the port of Antsiranana can be solved or that all future demands can be met within the period of the Plan. Accordingly, it is necessary to identify and select those issues which are of the highest priority in the Master Plan.

In accordance with the agreement reached between the Study Team and the counterparts and the results of the additional surveys conducted during the second visit to Madagascar, the following items should be considered.

- Direction of Maritime Transport, Ministry of Transport and Meteorology strongly desires the development of the port of Antsiranana to be stepped forward into implementation as soon as possible.

- Total construction cost should be minimized, in particular, by means of rehabilitation instead of demolition of some existing facilities.

Based on the ideas above the following points are adopted as basic concepts in the formulation of the Short-Term Development Plan:

- to solve the problems caused by the existing facilities, in particular, urgent problems such as superannuation or deterioration of quays

- to provide better services to smoothly handle forecast cargoes in 1998

- to make best use of the existing facilities through rehabilitation works to minimize new construction works

- to set up a port facility plan and implementation program to ensure that port activities continue even during rehabilitation works

- to harmonize the expansion and rehabilitation works with concept of the Master Plan in line with the growth of port activities

- to clarify responsibility and to build a cooperative relationship between the public and private sectors or construction and operational bodies

- to continue the ongoing project, that is to say, the quay extension southward, mainly for fishery boats, assisted by the French aid

Here, the relationship between the concept of the Master Plan and that of the Short-Term Development Plan is briefly examined.

As to the roles and functions of the port of Antsiranana, five items are summarized in section 4.2.1. These five items are also incorporated and treated in the Short-Term Development Plan. In other words, it is necessary to expand port facilities etc., to deal with the high demand in 1998. To be concrete, the third, fourth and last items are more important, considering characteristics and kinds of cargoes to be handled at present and in the near future i.e. the target year, 1998. In 1992, the three major commodities, tuna related, salt and oil products occupied over 80 % and are estimated to account for about three fourths of the total even in 1998, as will be mentioned in detail later. Therefore, ensuring that these cargoes are handled smoothly is given priority in the formulation of the Short-Term Development Plan. And in doing so the first and second roles and functions will be ensured in the Plan as a matter of course.

As to management and operation of the port, the principle in which each berth is assigned a specific use should be also kept in the Short-Term Development Plan. This leads to order, safety and efficiency of port management and operations in the narrow port area.

Last of all, as to the background of the port development, greater importance is given to solving the present problems rather than to coping with the future needs, because the target year is very near and while the present problems such as superannuation or deterioration of quays are very urgent, a longer period of time is needed to develop the hinterland. In section 4.1, three problems were identified. In this case, it is not possible to cope with all of them simultaneously and thus priorities will be established. For example, it is evident that the shortage of berth length is more urgent than that of berth depth, considering the results of analysis of calling vessels, namely, operating mode of large vessels. Taking into account the differences in the degree of present problems, the resolution of some of them such as shortage of quay depth or replacement of transit sheds will have to be deferred to the completion of the Master Plan.

5.2 Demand Forecast

Demand forecast for the target year of 2010(Master Plan) was already carried out in section 4.4. Therefore, the results of the socioeconomic frame and the cargo volume forecast for the target year of the Short-Term Plan(1998) are only summarized in this section because the methodology is the same in both cases.

5.2.1 Socioeconomic Framework

(1) Population

The population of Madagascar and Antsiranana province in 1998 is summarized in the following table.

Table 5-2-1 Result of Population Forecast in 1998

		Population ('000 person)		Average increase rate (%)
		1992	1998	
Madagascar		11,797	14,180	2.7
Antsiranana province	Total	1,148	1,308	2.2
	West	434	494	
	East	714	814	

(2) GDP

The GDP of Madagascar in 1998 is summarized in the following table.

Table 5-2-2 GDP Forecast of Madagascar in 1998 (1990 Price)

(UNIT:BILLION FMG, %)

		AGRICULT		INDUSTRY		SERVICE		TOTAL	
		PRICE	SHARE	PRICE	SHARE	PRICE	SHARE	PRICE	SHARE
GDP	1992	1383	33.6	577	14.0	2155	52.4	4115	100
	1998	1651	33.6	709	14.4	2554	52.0	4914	100
Average growth rate(%)		3.0		3.5		2.9		3.0	