Table 7.3.13 Estimated Export Volume (9)
(Manufactured Goods)

Year	Export ('000 t)	Growth (%)
1990	92	
1995	148	10
2000	189	
2005	241	5

Source : Study team estimates

7.3.2 Import Commodity Group

(1) Wheat

According to the production and import statistics shown in Table 7.3.14, the gross consumption of wheat in Guatemala during the past 10 years shows an average increase rate of 5.3 %. When considering the improvement of nutrition for Guatemalan nationals, the demand for wheat is expected to increase in the future.

Table 7.3.14 Production and Consumption of Wheat

Year	Area ('000 ha) *1	Produc. ('000 t) *1	Yield (kg/ha) *1	Import ('000 t) *1	Consum ('000 t) *1	Consum (kg/per) *1	Import ('000 t) *2
1976	44.8	57.7	1288	60.7	118.4	19.1	0.0
1977	26.7	36.2	1356	87.5	123.7	19.4	0.0
1978	36.1	55.2	1529	65.3	120.5	18.4	0.2
1979	31.5	57.9	1838	96.4	154.3	22.9	0.4
1980	31.5	46.0	1460	115.9	161.9	23.4	16.1
1981	31.5	42.1	1337	118.1	160.2	22.5	26.6
1982	29.6	42.6	1439	97.1	139.7	19.1	54.6
1983	33.1	55.2	1668	111.6	166.8	22.2	54.9
1984	32.2	50.6	1571	124.1	174.7	22.6	61.7
1985	31.5	52.9	1679	135.5	188.4	23.6	74.6

Source : *1 Banco de Guatemala
*2 EMPORNAC

(a) Production

The production of wheat during 1976-85 showed a fluctuation, however the total production has not remarkably increased as a whole. This fact means that it would be difficult to estimate a high increse of production in the future. As for the crop area, it showed a slight decrease in the beginning of this period then remained constant. On the other hand, the yield per unit area increased at an average rate of 2% during the same period. Therefore, the production of wheat is expected to increase at a rate of 2-3% in the future considering the increase in the domestic demand.

(b) Gross Consumption

The gross consumption of wheat increased at an average annual rate of 5.3 % during 1976-85. The gross consumption per capita also increased at a rate of 5.2 % in 1976-80, however the consumption remained around 22 kg per person in 1981-85. The consumption of wheat in the future, however, is expected to increase in accordance with the improvement of nutrition. Therefore, the gross consumption per capita in the future is assumed to be 25 kg in 1995 and 30 kg in 2005 considering the actual consumption of 22 kg under a stagnant economy.

(c) Import

It is assumed that the shortage of wheat production in domestic supply will be covered by imports. As for the import ports, the Port and the port of Puerto Barrios which face the Caribbean Sea are suitable for importing wheat because of their geographical advantage to the United States. It is expected that wheat will continue to be imported at Puerto Barrios in the future taking the actual imports (about 60 thousand tons per year) into consideration. Therefore, the wheat import volume at the Port is estimated as shown in Table 7.3.15.

Table 7.3.15 Estimated Import Volume (1)
(Wheat)

Year	Gross consumption Per capita (kg)	Gross consumption Total ('000 t)	Production ('000 t)	Import Barrios ('000 t)	Import S.Tomas ('000 t)
1990	25	230	59	60	111
1995	25	266	65	60	152
2000	30	367	75	70	222
2005	30	419	87	70	262

Source : Study team estimates

(2) Basic Grains and Other Agricultural Products

The import volume of basic grains excluding wheat and maize at the Port is not stable. Compared with the import volume in the 1970's, the import volume decreased about 10-20 thousand tons in the 1980's. However, the import volume began to increase recently. Other agricultural products, the import volume of which is very low, have also shown a similar tendency. Therefore, the import volume is assumed to recover to the level of the 1970's up to the year 1995 in accordance with the improvement of the food situation and national income, and then to increase at the rate of the GDP. The estimated import volume of these commodities are shown in Table 7.3.16.

Table 7.3.16 Estimated Import Volume (2)
(Basic Grains and Other Agricultural Products)

Year	Basic Grains ('000 tons)	Other Agri. ('000 tons)
1990	25	2
1995	35	2
2000	41	3
2005	47	4

Source : Study team estimates

(3) Petroleum Products

Petroleum products are used for private consumption, the industry and transport sectors, power stations, etc., and the future demand for petroleum products is expected to increase more and more. Direccion General de Hidrocarburas (DGH) in MEM estimates the short-term consumption demand up to the year 1991 as follows.

Commodity	Volume (million bbl)
Gasoline	2,416
Diesel	3,695
LPG	1,059
Kerosene	1,018

Source : D.G.H.

And the domestic petroleum refinery plant located in Escuintla is estimated to reach its maximum production capacity by 1995 in LBPE conducted by MEM and UNDP. However there is no plan to establish a new refinery at present.

The import of petroleum products at the Port in the future is estimated in the following sections considering the above mentioned situation.

(a) Gasoline

Reflecting the increase of prices, the consumption of gasoline has been decreasing since 1979. Therefore, the data from a period of relatively stable prices, 1975-78, is utilized for the estimation of the actual demand situation in this study. THe historical trends of production and consumption are shown in Table 7.3.17.

Table 7.3.17 Production and Consumption of Gasoline

(unit : million bbl)

Year	Product.	Import	Export	Consump.	Stock
1975	n.a.	n.a.	n.a.	1957.6	n.a.
1976	n.a.	n.a.	n.a.	2153.2	n.a.
1977	n.a.	n.a.	n.a.	2487.6	n.a.
1978	n.a.	n.a.	n.a.	2558.9	n.a.
1979	n.a.	n.a.	n.a.	2556.2	n.a.
1980	919.2	1242.3	0.0	2230.9	200.5
1981	922.7	1056.5	0.0	2008.8	170.9
1982	844.9	1083.0	0.0	1897.9	200.9
1983	882.7	1062.9	0.0	1950.0	196.5
1984	1023.4	1021.1	0.0	2087.6	153.7
1985	933.4	1049.6	0.0	2008.7	128.0

Source : Actualidad petrolea en Guatemala

Gasoline is generally used for private consumption, so the correlation between the consumption volume and private consumption expenditure is considered. The growth rate of consumption is 9.0% in 1975-78. On the other hand, that of private consumption expenditure is 6.5 %. The elasticity of gasoline demand to private consumption expenditure is 1.38 under steady economic growth. Therefore, the elasticity of demand for estimating the consumption in this study is assumed to be 1.1 - 1.2 considering the recovery of the economy. The estimation of the import volume is based on the the following assumptions.

i) production volume to reach a maximum of 180 thousand tons in 1995 based on the result of LBPE

ii) import share at the Port (at present 66 %) to increase against the port of San Jose because of limited capacity at San Jose

The results of the estimation of gasoline imports area shown in Table 7.3.18.

Table 7.3.18 Estimated Import Volume (3)
(Gasoline)

Year	P.C.Expend. (million Q)	Consumption ('000 t)	Production ('000 t)	Import ('000 t) Total	S.Tomas
1990	2,660	284	177	107	75
1995	3,136	340	180	160	120
2000	3,611	402	180	222	178
2005	4,159	476	180	296	237

Source : Study team estimates

(b) Diesel and Fuel Oil

The domestic consumption of these products showed a rapid increase during the 1970's, however the consumption has since gradually decreased in accordance with the economic recession in the 1980's. Production and consumption of diesel oil is shown in Table 7.3.19.

Table 7.3.19 Production and Consumption of Diesel Oil
(unit : million bbl)

Year	Product.	Import	Export	Consump.	Stock
1975	n.a.	n.a.	n.a.	1943.2	n.a.
1976	n.a.	n.a.	n.a.	2262.8	n.a.
1977	n.a.	n.a.	n.a.	3087.8	n.a.
1978	n.a.	n.a.	n.a.	3579.2	n.a.
1979	n.a.	n.a.	n.a.	3562.4	n.a.
1980	1750.5	1883.2	0.0	3661.8	410.8
1981	1602.1	1674.7	0.0	3409.1	278.5
1982	1475.5	1598.3	0.0	3048.3	304.0
1983	1444.4	1324.0	0.0	2814.2	258.2
1984	1680.5	1386.5	0.0	3105.1	220.1
1985	1643.0	1690.2	0.0	3348.0	205.3

Source : Actualidad petrolea en Guatemala

These products are used for the transport and industry sectors. Especially, considering that more than 60 % of diesel oil is used for the transport sector and the cargo volume at the Port is almost all diesel oil, the consumption is estimated by the elasticity of consumption to the GDP of the transport sector. The annual increase rate of consumption during 1975-1985 is 5.6%, and the GDP share of the transport sector is

3.3%. Thereforé the elasticity of consumption is 1.70 during the period. However, this high elasticity is not expected to continue in the future, so it is assumed to decline gradually to 1.5 in 1995 and 1.2 in 2005. As for the domestic production, it is assumed that the production volume will reach a maximum capacity of 200 thousand tons considering the estimation of LBPE. And the import share at the Port is assumed to be 50% taking the existing shares of 57% and 55% in 1985 and 1986 into consideration. The results of the estimation are shown in Table 7.3.20.

Table 7.3.20 Estimated Import Volume (4)
(Diesel and Fuel Oil)

Year	Consumption ('000 t)	Production ('000 t)	Import ('000 t)	
			Total	S.Tomas
1990	578	200	378	189
1995	751	200	551	276
2000	924	200	724	362
2005	1,138	200	938	469

Source : Study team estimates

(c) LPG

The consumption volume has steadily increased during 1975-86 as shown in Table 7.3.21.

Table 7.3.21 Production and Consumption of LPG
(unit : million bbl)

Year	Product.	Import	Export	Consump.	Stock
1975	n.a.	n.a.	n.a.	385.5	n.a.
1976	n.a.	n.a.	n.a.	390.4	n.a.
1977	n.a.	n.a.	n.a.	462.0	n.a.
1978	n.a.	n.a.	n.a.	457.6	n.a.
1979	n.a.	n.a.	n.a.	513.1	n.a.
1980	19.3	600.0	101.3	509.4	24.8
1981	22.3	598.5	89.5	542.6	13.5
1982	24.5	560.0	8.2	571.3	18.5
1983	31.6	633.0	0.0	664.7	18.4
1984	57.9	669.4	0.0	737.7	8.0
1985	73.6	823.5	0.0	858.5	46.6

Source : Actualidad petrolea en Guatemala

Almost all the LPG is used for private consumption such as cooking and heating. Firewood is also traditionally used for the same purposes in rural areas. At present, LPG is expanding its share of the the market, and therefore the trend of consumption is not linked to either private consumption expenditure or private income. Thus, the LPG consumption is assumed to increase along with the population. The historical relation between LPG consumption and population is expressed as the following equation.

$$Y = 0.230\ P - 1047.4 \qquad (R = 0.915)$$

where, Y : consumption (million bbl)
P : population ('000 persons)

As for the domestic production, it is assumed to reach a maximum production capacity of 16 thousand tons in 1990 based on the estimation of LBPE. The import share of LPG at the Port is about 55 % (based on three years available data) at present, and it is assumed to increase to 60 % and 70 % in 1995 and 2005 respectively, considering export countries. The result of the estimation of import LPG is summarized in Table 7.3.22.

Table 7.3.22 Estimated Import Volume (5)
(LPG)

Year	Consumption ('000 t)	Production ('000 t)	Import ('000 t) Total	S.Tomas
1990	153	16	137	75
1995	200	16	184	110
2000	252	16	236	153
2005	310	16	294	206

Source : Study team estimates

(d) Kerosene

Kerosene is mostly used for private consumption. The historical domestic consumption has moved in accordance with the Guatemalan economy as shown in Table 7.3.23.

Table 7.3.23 Production and Consumption of Kerosene
(unit : million bbl)

Year	Product.	Import	Export	Consump.	Stock
1975	n.a.	n.a.	n.a.	358.3	n.a.
1976	n.a.	n.a.	n.a.	363.8	n.a.
1977	n.a.	n.a.	n.a.	391.7	n.a.
1978	n.a.	n.a.	n.a.	417.8	n.a.
1979	n.a.	n.a.	n.a.	424.4	n.a.
1980	285.8	186.0	0.0	483.7	23.5
1981	270.6	305.2	0.0	562.2	37.1
1982	238.1	304.6	0.0	534.3	45.5
1983	245.5	200.9	0.0	455.9	36.0
1984	237.5	241.8	0.0	484.6	30.7
1985	209.5	251.8	0.0	451.3	40.7

Source : Actualidad petrolea en Guatemala

Therefore, the following equation relating the consumption and private consumption expenditure is used for estimating future consumption.

$$Y = 0.3794\ G - 380.3 \qquad (R = 0.728)$$

where, Y : consumption (million bbl)
G : private consumption expenditure (million Q)

As for the domestic production, in order to meet the domestic demand the production has to be increased at an annual rate of more than 10 %. According to the estimation of LBPE, the maximum production capacity is 90 thousand tons, so the production will reach the maximum capacity in the year 2000. The import share of the Port is assumed to increase from 70 % at present to 100 % in 2000. The estimated import volume is shown in Table 7.3.24.

Table 7.3.24 Estimated Import Volume (6)
(Kerosene)

Year	P.C.Expend. (million Q)	Consumption ('000 t)	Production ('000 t)	Import ('000 t) Total	S.Tomas
1990	2,660	81	43	38	30
1995	3,136	104	70	34	31
2000	3,611	127	90	37	37
2005	4,159	153	90	63	63

Source : Study team estimates

(4) *Other Petroleum Products*

The volume of other petroleum products handled at the Port has fluctuated because of the stagnation of the economy and a change of statistical classification at the Port. Though it is difficult to estimate the future import volume, it is assumed to increase at the same rate as the GDP using the volume in 1985 as the base year. The estimated import volume of other petroleum products is shown in Table 7.3.25

Table 7.3.25 Estimated Import Volume (7)
(Other Petroleum Products)

Year	Import ('000 t)
1990	51
1995	61
2000	71
2005	82

Source : Study team

(5) Fertilizer

Based on the agricultural policy to promote the increase and diversification of agricultural products, it is necessary to use fertilizer to increase the yield per unit area. The historical trade figures are shown in Table 7.3.26.

Table 7.3.26 Import and Export of Fertilizer

Year	Import ('000 t) *1	Export ('000 t) *1	Import ('000 t) *2	Import ('000 t) *2	Import ('000 t) *3	Import ('000 t) *4
1976	n.a.	n.a.	n.a.	n.a.	n.a.	24.5
1977	n.a.	n.a.	n.a.	n.a.	n.a.	31.4
1978	n.a.	n.a.	209.8	0.1	n.a.	15.2
1979	251.2	0.2	225.0	0.2	n.a.	26.3
1980	224.7	27.7	224.7	27.7	231.4	19.6
1981	233.3	60.3	164.6	58.8	195.5	185.5
1982	211.1	62.2	n.a.	n.a.	186.4	172.5
1983	155.0	55.8	n.a.	n.a.	107.7	122.5
1984	n.a.	n.a.	n.a.	n.a.	199.3	189.9
1985	n.a.	n.a.	n.a.	n.a.	202.1	154.3

Source : *1 Comercio Exterior
*2 Trade Statistics (UN)
*3 Banco de Guatemala
*4 EMPORNAC

(a) Production

Almost all the fertilizer used in Guatemala is produced and sold by DISAGRO, which produces mixed fertilizer at Escuintla and Teculutan and chemical fertilizer using imported materials. According to an interview with DISAGRO, the domestic production is 102 thousand tons and is all consumed domestically. A new factory which started operations at Zacapa in 1987 has an annual production capacity of 150 thousand tons using imported materials.

(b) Consumption

There is no available data concerning domestic consumption. According to the statistics of FAO Fertilizer Yearbook 1985, however, the consumption of fertilizer per unit crop area in the 1970's increased at an annual rate of 7.0 %. On the other hand, the growth rate of the GDP of the agricultural sector during the same period was about 4.4 %. So the elasticity of the consumption to the GDP of the agricultural sector is 1.6. Therefore, the future domestic consumption is assumed to increase at the same elasticity of consumption considering the policy promoting agricultural products. The consumption of fertilizer including imported chemical fertilizer is estimated to be about 200 thousand tons based on the interview with DISAGRO.

(c) Import

The fertilizer is imported at three ports (Puerto Barrios, Quetzal and the Port) at present. However, according to the foreign trade statistics, about 60 thousand tons is exported at the Port. Based on the observation at the Port, some of the imported fertilizer is transported to El Salvador. However, it is difficult to estimate the future demand in that country so a transshipped volume of 80 thousand tons in 1995 and 100 thousand tons in 2005 is assumed. As for the import share at the Port, the average share of national import volume is 73% over the past 4 years. However, this share is assumed to decrease slightly to 70% in 1995 and 65% in 2005 considering the increase at the port of Quetzal because the export share of Asian countries is increasing. Therefore, the fertilizer imported at the Port in the future is estimated as shown in Table 7.3.27.

Table 7.3.27 Estimated Import Volume (8)
(Fertilizer)

Year	Consumption ('000 t)	Export ('000 t)	Import ('000 t) Total	S.Tomas
1990	258	70	328	230
1995	326	80	406	285
2000	400	90	490	319
2005	492	100	592	385

Source : Study team estimates

(6) Paper and Printing Paper

Generally, the demand for paper and printing paper increases in accordance with the improvement of the standard of living. A factory producing papers had operated domestically, however the factory has quit operations because of environmental concerns. Then the supply still fully depends on imported papers. The correlation between imported papers at the

Port and the GDP during 1976-85 is expressed as the following equation.

$$Y = 0.0864\ X - 154.7 \qquad (R = 0.900)$$

where, Y : imported papers at the Port ('000 t)
X : GDP (million Q)

The total imports of papers at the Port in the future is estimated using the above equation, and the results are shown in Table 7.3.28.

Table 7.3.28 Estimated Import Volume (9)
(Paper and Printing Paper)

Year	Import ('000 t)
1990	145
1995	202
2000	259
2005	324

Source : Study team

(7) Machinery and Equipment

Generally, machinery and equipment are used for manufacturing industry, and therefore the import volume is estimated by the correlation between the import volume at the Port and the private fixed capital formation. The correlation is shown as the following equation.

$$Y = 0.282\ X - 28.5 \qquad (R = 0.946)$$

where, Y : import volume at the Port ('000 t)
X : private fixed capital formation (million Q)

The estimated import volume at the Port is shown in Table 7.3.29.

Table 7.3.29 Estimated Import Volume (10)
(Machinery and Equipment)

Year	P.C.Form. ('000 t)	Import ('000 t)
1990	275	49
1995	330	65
2000	428	92
2005	555	128

Source : Study team estimates

(8) Fiber Resin and Plastic Materials

The import volume of these material at the Port increased in proportion to time during 1976-85. However, the import volume decreased after 1980 and then started increasing again. The three-year average increase rate of import at the Port is 6.2 % (10.6 % in the 1970's and 3.0 % in the 1980's). This shows a strong growth in demand even though the Guatemalan economy was stagnant. Therefore, the import volume at the Port is estimated based on the historical trend at the Port as shown in the following equation.

$$Y = 2.051\ t - 4027.8 \qquad (R = 0.800)$$

where, Y : import volume at the Port ('000 t)
t : year

According to the equation, the future import volume at the Port is estimated as shown in Table 7.3.30.

Table 7.3.30 Estimated Import Volime (11)
(Fiber Resin and Plastic Materials)

Year	Import ('000 t)
1990	54
1995	64
2000	74
2005	84

Source : Study team

(9) Chemical Products and Metal Products

The import volume of these products show an increase in the 1970's and a decrease in the 1980's in accordance with the economic activity in Guatemala. These products are generally used in the industrial sector. Although chemical products recorded an import volume of 112 thousand tons in past years, about 85 thousand tons was imported in recent years. Metal products also showed a large import volume of around 136 thousand tons in the 1970's. However, since 1980 the volume has begun to decline and fell to 76 thousand tons in 1985. It seems that the domestic demand for imported intermediate goods and capital goods like these products has decreased in accordance with a decrease of private investment, even though there is final domestic consumption demand. Therefore, it is expected that imports of these products will increase in accordance with the growth of the industrial sector based on the policy of encouraging private investment. The estimated import volume of these products is shown in Table 7.3.31.

Table 7.3.31 Estimated Import Volume (12)
(Chemical Products and Metal Products)

Year	Chemical P. ('000 t)	Metal P. ('000 t)
1990	118	92
1995	142	110
2000	169	131
2005	202	157

Source : Study team estimates

(10) Vegetable and Animal Oil

The import volume at the Port during 1976-85 rapidly increased. Excluding irregular data from two years, the import volume increased constantly. The following equation is considered for estimating import volume.

$$Y = 4.472\ t - 8835.3 \qquad (R = 0.951)$$

where, Y : import volume at the Port ('000 t)
t : year

(a) Production

There is little available data concerning the production of these oils. However, the average production in 1980 and 1981 was 87.6 thousand tons and about 90 % of the production is consumed. Though there is no available data since 1981, it is considered that the domestic production has slightly decreased at present considering the decrease in the number of producing factory from 7 to 6. However, it can be assumed that the production of these oils will gradually increase at a rate of 1.5 % per year in 1995 and 2.0 % in 2005 in accordance with the increase of production capability due to the encouragement of private investment under the intermediate national plan.

(b) Import

The gross domestic consumption based on the volume of production and import in 1985 is about 120 thousand tons. The future consumption is assumed to increase at a growth rate at least equal to the growth rate of the GDP. Based on the above assumptions, the import volume at the Port is estimated as shown in Table 7.3.32.

Table 7.3.32 Estimated Import Volume (13)
(Vegetable and Animal Oil)

Year	Consumption ('000 t)	Production ('000 t)	Import ('000 t) (1)	(2)	(3)
1990	143	84	59	64(*)	62
1995	169	91	78	86(*)	82
2000	196	100	96	109(*)	103
2005	227	111	116	131(*)	124

Source : Study team estimates

Note : (*) figures calculated by the equation

The figures calculated by the equation are about 10 % greater than the estimated figures based on the deficit of production and consumption. Therefore, the average figures (3) of the two estimates (1) and (2) are adopted in this study.

(11) Textiles and Leather Products

The import volume of these products at the Port increased at an annual rate of 10 % during the 1970's and reached 20 thousand tons in 1981. In accordance with the stagnation of domestic demand due to the economic recession, the import volume during the 1980's fluctuated. However, the average import volume is 17 thousand tons. It is clear that the import volume will increase when the economy recovers, and therefore the import volume is assumed to increase at the same growth rate as the GDP. The estimated import volume is shown in Table 7.3.33.

Table 7.3.33 Estimated Import Volume (14)
(Textiles and Leather Products)

Year	Import ('000 t)
1990	24
1995	28
2000	32
2005	38

Source : Study team

(12) Other Foods

There is a remarkable diversity of foods available in Guatemala. At present, many kinds of manufactured foods are imported in accordance with the improvement of the standard of living. In order to estimate the future import volume at the Port, the correlation between the import volume and private consumption expenditure is calculated as the following equation.

$$Y = 0.0714\,X - 118.8 \qquad (R = 0.878)$$

where, Y : import volume ('000 t)
X : private consumption expenditure (million Q)

As a result of the estimation based on the above equation, the import volume at the Port is summarized in Table 7.3.34.

Table 7.3.34 Estimated Import Volume (15)
(Other Foods)

Year	P.C.E. (million Q)	Import ('000 t)
1990	2640	70
1995	3136	105
2000	3587	137
2005	4159	178

Source : Study team estimates

(13) Other Manufactured Products

The import volume of other manufactured products at the Port increased at a rate of 17 % during the 1970's, but suddenly showed a large decrease in 1980. And the import volume increased again at a average rate of 20 % since 1983. However this rapid increase is not expected to continue in the future. Therefore, the import volume at the Port is assumed to recover to the import volume in the 1970's in 1995 and then continue increasing at an annual growth rate of 5 % greater than the growth rate of the GDP.

Table 7.3.35 Estimated Import Volume (16)
(Other Manufactured Products)

Year	Import ('000 t)
1990	85
1995	137
2000	175
2005	223

Source : Study team

7.3.3 Cargo Traffic Forecast

The estimated cargo volume by major commodity group is shown in Table 7.3.36.

Table 7.3.36 Estimated Cargo Volume at the Port

(unit : thousand tons)

Commodity Group	1990	1995	2000	2005
(Export)				
Bananas	414	482	547	621
Coffee	213	223	249	279
Fresh Fruits and Veg.	45	57	69	84
Sesame and Cardamom	32	42	54	69
Maize	-	-	22	66
Other Agriculture Prod.	44	51	58	66
Crude Oil	663	1073	805	537
Minerals	5	10	15	20
Manufactured Products	92	148	189	241
Sub Total	1508	2086	2008	1983
(Import)				
Wheat	111	152	222	262
Basic Grains	25	35	41	47
Other Agriculture Prod.	2	2	3	4
Gasoline	75	120	178	237
Diesel and Other Fuel Oils	189	276	362	469
LPG	75	110	153	206
Kerosene	29	31	39	66
Other Petroleum Products	51	61	71	82
Minerals	5	10	15	20
Fertilizer	230	284	319	385
Paper and Printing Paper	145	202	259	324
Machinery and Equipment	49	65	92	128
Fiber Resin and Plastic Mat.	54	64	74	84
Chemical Products	118	142	169	202
Metal Products	92	110	131	157
Vegetable and Animal Oil	62	82	103	124
Textiles and Leather Prod.	24	28	32	38
Other Foods	70	105	137	178
Other Manufactured Prod.	85	137	175	223
Sub Total	1491	2016	2575	3236
Grand Total	2999	4102	4583	5219

Source : Study team estimates

7.3.4 Forecast by Cargo Packing Type

In order to estimate the cargo by packing type, the present cargo flow at the Port in 1986 is classified into four groups as shown in Table 7.3.37.

Table 7.3.37 Share of Cargo by Packing Type

Commodity Group	Box (%)	S.Bulk (%)	L.Bulk (%)	Loose (%)	Total (%)
(Export)					
Bananas	11	-	-	89	100
Coffee	84	-	-	16	100
Fresh Fruits and Veg.	99	-	-	1	100
Sesame and Cardamom	76	-	-	24	100
Maize	-	-	-	-	-
Other Agriculture Prod.	72	-	-	28	100
Crude Oil	-	-	100	-	100
Minerals	75	-	-	25	100
Manufactured Products	80	-	-	20	100
(Import)					
Wheat	1	99	-	-	100
Basic Grains	12	57	-	31	100
Other Agriculture Prod.	95	-	-	5	100
Gasoline	-	-	100	-	100
Diesel and Other Fuel Oil	1	-	99	-	100
LPG	-	-	100	-	100
Kerosene	-	-	100	-	100
Other Petroleum Products	72	-	11	16	100
Minerals	100	-	-	-	100
Fertilizer	-	81	-	19	100
Paper and Printing Paper	26	-	-	74	100
Machinery and Equipment	76	-	-	24	100
Fiber Resin and Plastic Mat.	87	-	-	13	100
Chemical Products	41	-	32	27	100
Metal Products	18	-	-	82	100
Vegetable and Animal Oil	5	-	93	2	100
Textiles and Leather Prod.	83	-	-	17	100
Other Foods	61	-	-	39	100
Other Manufactured Prod.	59	-	-	41	100

Source : EMPORNAC
Note : Box means Container and Furgon

(1) Base Cargo

Before estimating the future containerized cargo, the base cargo volume is identified against the containerizable cargo based on the present situation. Therefore, the following percentage of each commodity is eliminated from the base cargo for estimation of containerizable cargo volume.

Commodity	Loose (%)	S.Bulk (%)	L.Bulk (%)	Total (%)
(Export commodity)				
Bananas	90			90
Crude Oil			100	100
Maize		100		100
(Import commodity)				
Wheat		100		100
Gasoline			100	100
Diesel & Fuel oil			100	100
LPG			100	100
Kerosene			100	100
Other Petroleum P.			10	10
Fertilizer	10	90		100
Animal & Veg. Oil			95	95
Basic Grains		80		80
Chemical products			30	30

Note: About 10 % of bananas is assumed to be exported by containers

The remaining volume of major commodity group is selected as the base cargo for estimating the future containerizable cargo.

(2) Containerized Cargo

At first, the cargo which can be transported by container and furgon (hereinafter refered to as box cargo) is estimated based on the past trend at the Port. Second, the future containerized rate is estimated against the box cargo based on the transition of the containerized rate for the box cargo.

The precise data for estimating the past box cargo rate is not available. However, the following rates are calculated by the study team based on the actual situation in 1986.

Table 7.3.38 Historical Box Rate at the Port

Year		Cont. (%)	Furg. (%)	Total (%)	Con./Total (%)
1980	Import	19.0	24.5	43.5	43.7
	Export	32.3	18.8	51.1	63.2
1981	Import	16.3	18.8	35.1	46.4
	Export	45.0	20.9	65.9	68.3
1982	Import	19.2	16.8	36.0	53.3
	Export	40.8	23.7	64.5	63.2
1983	Import	28.1	13.8	41.9	67.1
	Export	57.3	28.9	86.2	66.5
1984	Import	33.2	14.7	47.9	69.3
	Export	49.4	30.0	79.4	62.2
1985	Import	33.4	11.1	44.5	75.1
	Export	67.1	25.0	92.1	72.9
1986	Import	37.7	12.6	50.3	75.0
	Export	67.4	25.4	92.8	72.6

Source : Study team calculation

Furthermore, considering the characteristics of each commodity and the present situation, the future box cargo rate in each commodity group is estimated as shown in Table 7.3.39.

Table 7.3.39 Estimated Box Rate at the Port

Commodity	Base cargo rate (%)	Box rate (%)
(Export)		
Coffee	100	100
Fresh Fruit & Veg.	100	100
Sesame & Cardamom	100	100
Other Agri. Products	100	100
Minerals	100	100
Manufactured Prod.	100	100
(Import commodity)		
Basic Grains	20	30
Other Agri. Products	100	100
Minerals	100	100
Other Petro. Products	90	100
Paper & Printing	100	30
Fiber Resin & Plast.	100	100
Chemical Products	70	70
Metal Products	100	20
Veg. & Animal Oil	5	100
Textiles & Leather Prod.	100	100
Other Foods	100	100
Other Manufactured	100	80
Machin. & Trans. Equip.	100	80

Source : Study team estimates

Therefore, the final box cargo rate and the containerized rate in the future are assumed as follows:

Export : Box cargo rate against the base cargo 99 %
Containerized rate against the box cargo 80 %
Import : Box cargo rate against the base cargo 70 %
Containerized rate against the box cargo 90 %

The box cargo rate and the containerized cargo rate in the target year are calculated by using the following logistic curve based on the historical transition data.

$$P = \frac{Pm}{1 + C^{t-t0}}$$

where, Pm : the rate in the future
P : the rate in the target year
t : the target year
t0 : the year of 50% of Pm
C : a constant defined historically

The results of the calculation for estimating the box cargo rate and containerized rate are summarized as a whole in Table 7.3.40.

Table 7.3.40 Estimated Containerized Rate

Year	Box rate (%)	Container rate (%)
(Export)		
1990	97.8	75.3
1995	98.8	77.5
2000	99.0	78.8
2005	99.0	79.3
(Import)		
1990	56.3	85.3
1995	62.9	88.9
2000	66.5	89.8
2005	68.3	89.9

Source : Study team estimaes

(3) Cargo by Packing Type

The estimated cargo volume by packing type in the target year is summarized in Table 7.3.41.

Table 7.3.41 Cargo Volume by Packing Type

(unit : thousand tons)

Year	Container	Furgon	Bulk	Liquid	Others	Total
(Export)						
1990	362	105	0	663	378	1,508
1995	457	118	0	1,073	438	2,086
2000	549	134	22	805	498	2,008
2005	656	155	66	537	569	1,983
(Import)						
1990	318	55	338	468	312	1,491
1995	497	62	436	664	357	2,016
2000	665	75	542	888	410	2,575
2005	851	96	646	1,165	478	3,236
(Total)						
1990	680	160	338	1,131	690	2,999
1995	954	180	436	1,737	795	4,102
2000	1,214	209	564	1,693	908	4,583
2005	1,507	251	712	1,702	1,047	5,219

Source : Study team estimates

CHAPTER 8 MASTER PLAN FOR THE PORT DEVELOPMENT

8.1 The Basic Concept of the Port Development

The purpose of the Master Plan is to serve as a target and guideline for the port development. The Master Plan shall be an integrated plan covering the layout of port facilities, land use and effective management and operation systems.

There has been a continuous increase in the volume of cargoes handled at the Port since the commencement of port operation in 1955. In 1986, the volume of cargoes amounted to around 2.3 million metric tons, and the berth occupancy rate of the existing mooring facilities was more than 70 %. In the year 2005, the target year of the Master Plan of this project, 5.2 million metric tons are forcast to be handled at the Port, more than double the present volume. Hence, the Port will require additional facilities.

In formulating the Master Plan, many items should be taken into account, especially economic transportation and safe operations. In the first step of the planning, effective utilization of the existing facilities is critical. Calling vessels at Santo Tomas are divided into five types: container ships, bulk carriers, petroleum tankers, Ro-Ro vessels, and others, mainly comprising conventional vessels. The utilization plan of the existing terminal is studied based on the following premises by vessel type.

1. Container ships

In the year 2005, the number of containers in terms of TEU transported by full container ships through the Port is estimated as 192 thousand, around four times the present number. If these containers were handled at the existing terminal, almost all the berths would be occupied by container ships due to the large amount of containers and the low productivity of cargo handling without container gantry cranes and with only a narrow yard. In this case, only small size container ships would be recieved due to the shallow water depth along the berths, resulting in costly transportation. Moreover, new terminals to accomodate other types of vessels which do not require a deeper water depth would have to be constructed. Hence, it is not economical to use the existing terminal for container ships in the future.

2. Petroleum Tankers

At present, petroleum products including liquified petroleum gas, crude oil and refined oil are loaded and unloaded at the No.6 Berth without keeping a sufficient distance from other port activities. In addition, the volume of these dangerous cargoes is increasing. From the standpoint of safe operation at the Port, it is advisable to separate the petroleum terminal from the other terminals by constructing a new petroleum terminal as soon as possible.

3. Bulk Carriers

In the year 2005, the volume of solid bulk transported by bulk carriers through the Port is estimated to reach 646 thousand metric tons. To handle bulk cargoes, one specified berth with cranes with a larger lifting capacity than the existing ones will be required. To prepare such a bulk terminal, there are two alternatives: improvement of the existing terminal or construction of a new terminal. The optimum case is selected from the economic point of view.

4. Ro-Ro Vessels

In the year 2005, the volume of cargoes carried by Ro-Ro vessels is estimated as only 254 thousand metric tons. Considering the small amount of cargoes and the comparatively high productivity of cargo handling, it is not economical to construct a new specialized terminal for the Ro-Ro vessels.

The water depth along the existing terminal seems to be sufficient for Ro-Ro vessels even in the future.

5. Other Vessels

Other vessels are mainly conventional vessels. Almost all of these vessels are less than 25 thousand Dead Weight Tons and the ship size is not increasing. Hence, it is advisable to continue the use of the existing terminal mainly for conventional vessels.

Thus, as for the use plan of the existing terminal in the target year

2005, the following three alternatives are proposed:

Case 1: Five of the six berths of the existing terminal will serve conventional and Ro-Ro vessels, and one berth will be serve bulk carriers instead of constructing a new terminal.

Case 2: The existing terminal comprising six berths will serve conventional and Ro-Ro vessels, and a new bulk terminal will be constructed.

Case 3: The existing terminal comprising six berths will serve conventional and Ro-Ro vessels, and an additional terminal for conventional and Ro-Ro vessels and a new bulk terminal will be constructed.

In the examination of the alternatives, the difference of ship waiting cost between the three cases and the construction cost for the new terminals in the latter two cases are compared. The ship waiting costs are estimated according to the following preconditions using queuing theory:

1 Cargo volume handled in the target year: Break bulk: Total 1,122,000 MT
Bananas 561,000 MT
Others 561,000 MT
Cargoes in Trailers : 251,000 MT

2 Average Ship Size: Banana Ships: 7,700 DWT
Other Conventional Vessels: 6,600 DWT
Ro-Ro Vessels: 6,900 DWT

3 Cargo-handling Productivity: Bananas: 50 Tons / Hour
Other Break Bulk: 29 Tons / Hour
Cargoes in Trailers: 91 Tons / Hour

4 Daily Ship Cost: Banana Ships: 15,250 Q / Day
Other Conventional Vessels: 14,000 Q / Day
Ro-Ro Vessels: 25,080 Q / Day

5 Construction Cost of a New Terminal:

Initial Investment:	21.65 Mil. Q
Foreign Currency:	13.03 Mil. Q
Local Currency:	8.63 Mil. Q
Transformed Annual Cost:	0.96 Mil. Q
Service Life:	50 Years
Interest Rate of Soft Loan:	4 %

According to the above conditions, the ship waiting costs of conventional and Ro-Ro vessels are computed as follows:

Unit: Mil. Q / Year

	Berth No. for Conventional and Ro-Ro Ships	Ship Waiting Cost of Conventional and Ro-Ro Ships	Difference of Costs		
			Ship Waiting Cost	Construction Cost	Total Cost
Case 1:	5	3.96	0	0	0
Case 2:	6	1.08	-2.88	+0.96	-1.92
Case 3:	7	0.35	-3.61	+1.92	-1.69

In Case 2, the sum of the differences of the ship waiting costs and the construction costs of new terminal is the minimum, so the case is the most economical. Thus, the existing terminal will handle only conventional and Ro-Ro vessels in the target year.

From the above, the following new terminals are planned in the Master Plan:

- Container Terminal
- Bulk Terminal
- Petroleum Terminal

When planning the container and bulk terminals, the optimum number of berths and water depth are examined mainly from the economic point of view taking the dredging cost of the access channel into account. The petroleum terminal is also planned emphasizing safe operations in the port area.

Though the year 2005 is adopted as the target year, new terminals will continue to function after the target year. Hence, in this planning, the period after the year 2005 is also considered to select the optimum plan among the proposed alternatives.

8.2 Required Scale of New Terminals

8.2.1 Container Terminal

(1) Forecast Number of Containers through the Port

The number of containers in terms of TEU transported through the Port are forecast based on the following premises.

1. Unit Weight per TEU: Import: 10 MT / TEU, Export: 10.5 MT / TEU
2. Empty Container Ratio: 0.15
3. Ratio of Container Number Transported by Full Container Ship: 0.95
4. Ratio of Container Number by Shipping Route:

	Import	Export
- USG / CARIB	0.85	0.75
- E / CARIB	0.15	0.25

5. Net Cargo Volume:

Unit: Thousand MT

Year	Total	Import	Export
2005	1,507	851	656
2015	2,230	1,259	971
2025	3,301	1,864	1,437
2035	4,886	2,759	2,127

According to the above premises,the number of containers to be handled at the new container terminal is as follows:

Unit: Thousand TEU

Year	Shipping Route	
	USG / CARIB	E / CARIB
2005	158	34
2015	234	50
2025	346	74
2035	512	110

(2) Container Ships Calling at the Port

The following ship sizes are considered (see Fig.8.2.1- Fig.8.2.3):

Ship Size	Capacity	Principal Dimensions(M)			Daily Cost (Thousand Q)		
DWT	TEU	L.O.A.	Breadth	Full Draft	Ship Cost	Fuel Cost	
						Port	Navigation
12,000	500	138	21	9	27.51	0.37	14.13
22,000	1,200	205	31	10	48.88	0.51	17.29
27,000	1,500	232	32	11	56.41	0.59	19.81
35,000	2,000	260	32	12	65.44	0.57	23.29
50,000	3,000	289	32	13	82.30	0.57	30.21

(3) Staying Days at Port

The following premises are adopted to estimate the average staying days at port.

- TEU / Box : 1.7
- Cargo Handling Productivity: 25 Boxes per Hour
- Cargo Handling Efficiency: 0.95
- Number of Container Gantry Cranes per Berth: 2
- Operation Hours per Day: 20 Hours
- Non-operation Hours per Ship: 5 Hours
- Spare Days per Ship: 0.5 Days
- Loading and Unloading Ratio to Hold Capacity: USG/CARIB: 1.0, E /CARIB: 0.3

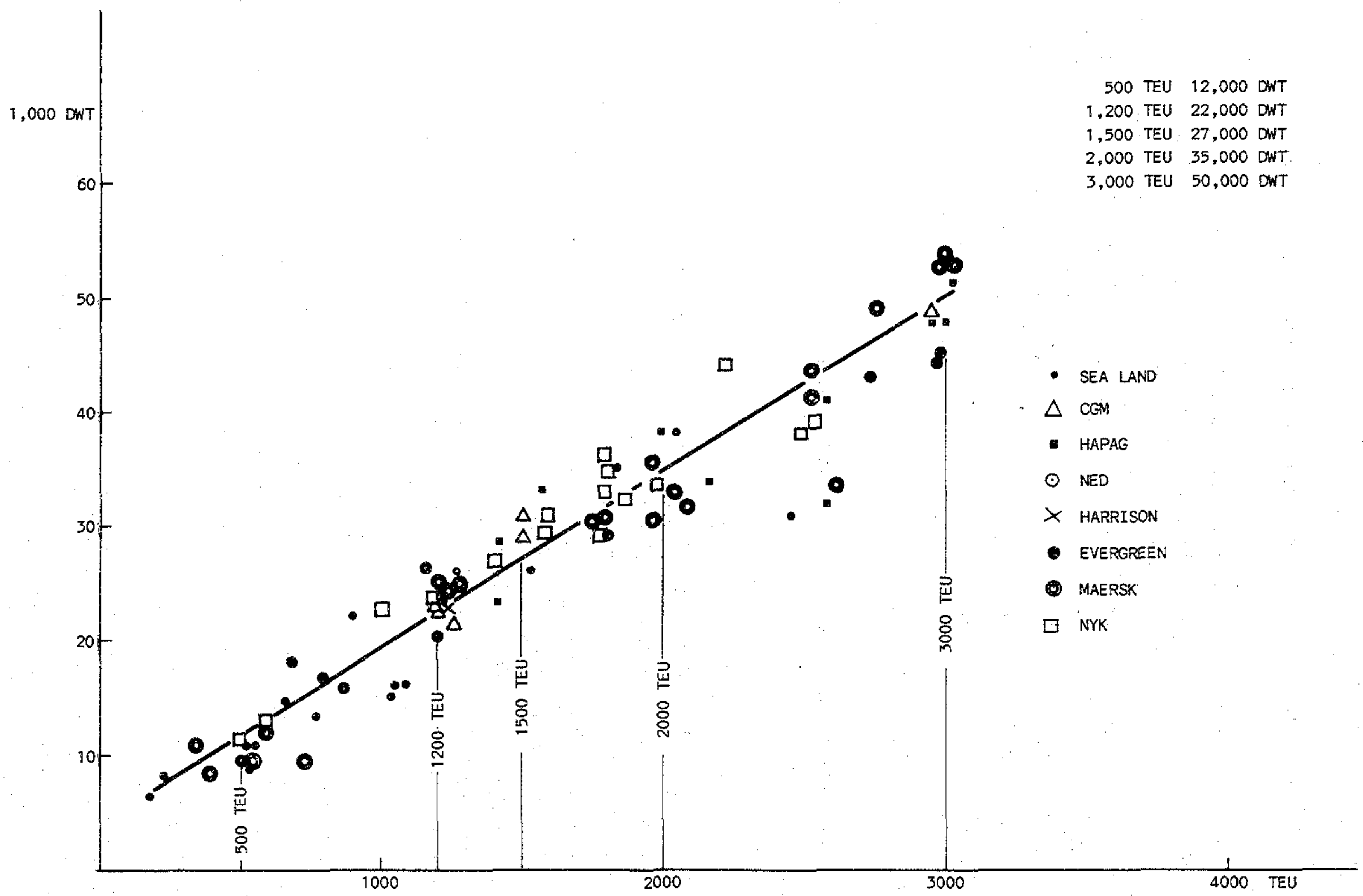


Fig. 8.2.1 Relationship Between DWT and TEU

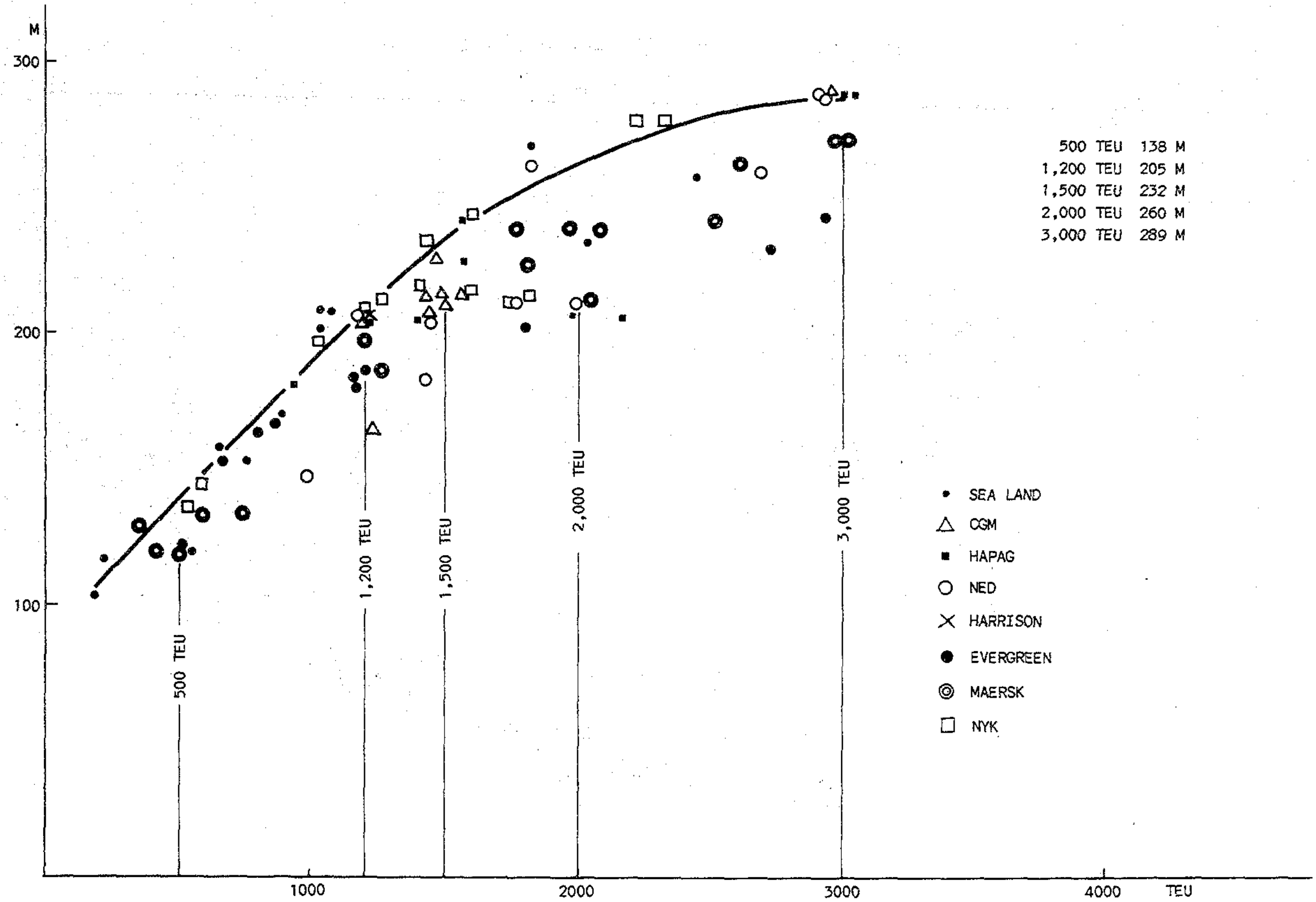


Fig. 8.2.2 Relationship Between LOA and TEU

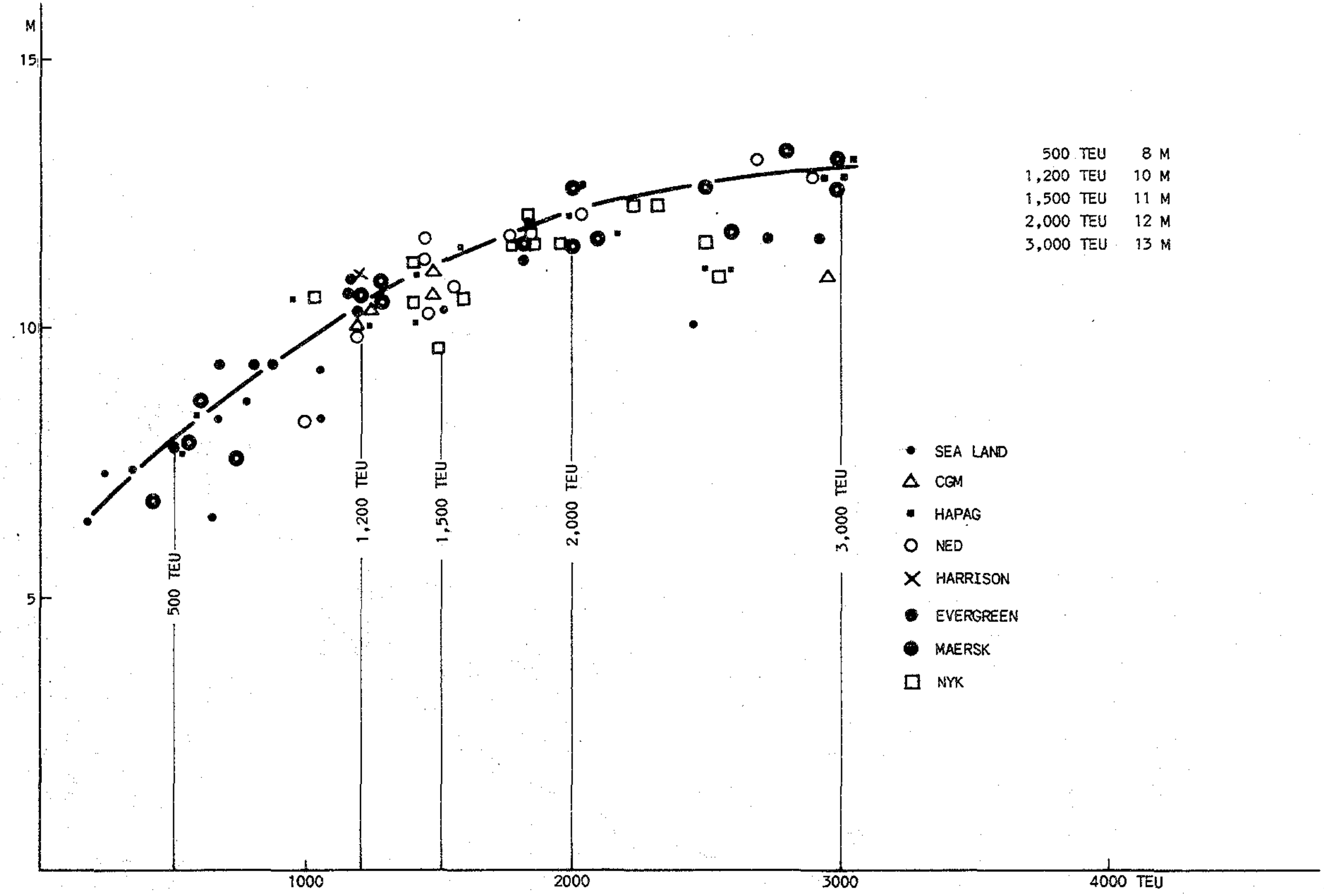


Fig. 8.2.3 Relationship Between Full Draft and TEU

Staying days are calculated by shipping route as follows:

Ship Size DWT	Staying Days The Port USG/CARIB	E/CARIB	Destination Port
12,000	1.1	0.8	1.4
22,000	1.5	1.0	2.2
27,000	1.7	1.0	2.6
35,000	2.0	1.1	3.2
50,000	2.6	1.3	4.5

(4) Round Trip Days

Round trip days by shipping route are shown as follows:

Shipping Route	Destination	Round Trip Distance Sea Miles	Speed Knots	Round Trip Days
USG / CARIB	New Orleans	2,406	20	5
E / CARIB	Hamburg	11,852	20	25

(5) Transportation Cost by Container Ship

Transportation cost by container ship excluding waiting cost at basins is computed based on the above premises as follows:

Ship Size DWT	Transportation Cost USG / CARIB Q/TEU	E / CARIB Q/TEU
12,000	305.48	1235.18
22,000	245.10	868.35
27,000	240.26	814.98
35,000	230.42	731.42
50,000	229.71	651.24

(6) Terminal Cost

Construction and maintenance costs of a new container terminal per berth are shown as follows:

Unit: Quetzales

Case	Water Depth M	Berth Length M	Yard Area Ha.	Infrastructure Mil.	Superstructure Mil.	*Dredging of Basin Mil.	Cargo-handling Facilities Mil.	*Total Initial Cost Mil.	Maintenance Cost Mil./Y	*Transferred Annual Cost Mil./Y
1	9	170	6.8	26.43	2.02	1.95	36.88	67.29	1.38	6.99
2	11	250	10.0	42.39	2.77	12.11	36.88	94.12	1.56	8.16
3	12	280	11.2	49.43	3.27	21.48	36.88	111.06	1.63	8.89
4	13	300	12.0	55.09	3.53	26.38	36.88	121.83	1.69	9.37
5	14	350	14.0	66.81	3.75	31.24	36.88	138.68	1.81	10.12

Note: Service Life: Infrastructure and Superstructure: 50 Years

Cargo Handling Facilities: 10 Years

Interest Rate of International Financial Institution: 4 % per annum

Repayment Periods are assumed equal to the respective service lives.

*: In this case, the number of berths is two.

(7) Required Number of Berths by Water Depth

The optimum number of berths is determined by comparing alternative numbers and their respective costs comprising port costs and ship waiting costs. The ship waiting costs are computed using queuing theory. Thus, the required number of berths is calculated by water depth. The results are indicated in Table 8.2.1.

Table 8.2.1 Required Number of Berths by Water Depth

Case No.	Water Depth (M)	Average USG/CARIB (TEU Capacity)	Ship Size E/CARIB (TEU Capacity)	Ship Arrival (Ships/D)	Average Service Rate (Ships/D/B)	Berth Occupancy Ratio	Average Waiting Hours	Required Berth No.
(Year:2005)								
1	9	500	1,200	1.125	0.96	0.59	8.4	2
2	11	1,200	1,200	0.619	0.79	0.39	3.6	2
3	12	1,200	1,500	0.568	0.76	0.37	3.4	2
4	13	1,200	2,000	0.516	0.73	0.35	3.1	2
5	14	1,200	3,000	0.464	0.69	0.67	44.6	1
(Year:2015)								
1	9	500	1,200	1.663	0.96	0.58	4.2	3
2	11	1,200	1,200	0.915	0.79	0.58	9.8	2
3	12	1,200	1,500	0.839	0.76	0.55	8.9	2
4	13	1,200	2,000	0.763	0.73	0.52	7.9	2
5	14	1,200	3,000	0.686	0.69	0.50	7.4	2
(Year:2025)								
1	9	500	1,200	2.459	0.96	0.64	3.9	4
2	11	1,200	1,200	1.353	0.79	0.57	4.9	3
3	12	1,200	1,500	1.240	0.76	0.54	4.3	3
4	13	1,200	2,000	1.128	0.73	0.52	3.8	3
5	14	1,200	3,000	1.015	0.69	0.49	3.4	3
(Year:2035)								
1	9	500	1,200	3.643	0.96	0.76	6.4	5
2	11	1,200	1,200	2.006	0.79	0.64	4.5	4
3	12	1,200	1,500	1.839	0.76	0.61	3.9	4
4	13	1,200	2,000	1.671	0.73	0.57	3.2	4
5	14	1,200	3,000	1.504	0.69	0.73	14.4	3

Note(1): When applying queuing theory, a Poisson distribution for arrival and a fourth degree Erlan distribution for service at berths are adopted referring to the actual distributions at the Port in 1986.

Note(2): On the USG/CARIB route, 1,200 TEU capacity is regarded as the the maximum size considering the small savings of transportation cost by larger ships

(8) Total Transportation Cost from Origin to Destination Ports

The total transportation cost from origin to destination ports comprises transportation cost by container ship (see 8.2.1(5)), terminal construction and operation costs (see 8.2.1 (6)) and ship waiting cost at ports (see 8.2.1(7)). Total transportation costs by water depth and by benchmark year are summarized in Table 8.2.2.

Table 8.2.2 Total Transportation Cost from Origin to Destination Ports

Unit: Mil. Q/Year

Case No.	Berth Depth (M)	Transportation Cost by Ship	Terminal Construction and Maintenance Costs	Ship Waiting Cost	Total Cost	Berth No.
(Year:2005)						
1	9	38.89	13.99	2.34	55.24	2
2	11	34.13	16.33	0.83	49.54	2
3	12	33.21	17.78	0.76	50.87	2
4	13	31.79	18.74	0.66	51.21	2
5	14	30.44	11.41	8.96	50.83	1
(Year:2015)						
1	9	57.45	20.93	1.74	80.12	3
2	11	50.39	16.33	3.37	70.09	2
3	12	49.06	17.78	2.95	69.79	2
4	13	46.96	18.74	2.50	68.23	2
5	14	44.96	20.23	2.18	67.38	2
(Year:2025)						
1	9	84.98	27.83	2.36	115.19	4
2	11	75.43	24.01	2.48	101.05	3
3	12	72.56	25.83	2.13	100.51	3
4	13	69.47	27.05	1.76	98.28	3
5	14	66.51	29.07	1.51	97.07	3

Table 8.2.2 Total Transportation Cost from Origin to Destination Ports
(Continued)

Case No.	Berth Depth	Transportation Cost by Ship Mil.	Terminal Construction and Maintenance Costs	Ship Waiting Cost	Total Cost	Berth No.
(Year:2035)						
1	9	125.97	34.79	5.82	166.58	5
2	11	110.51	31.66	3.43	145.60	4
3	12	107.56	33.87	2.82	144.25	4
4	13	102.98	35.36	2.24	140.56	4
5	14	98.56	29.07	9.37	137.01	3

Note: Assuming that half of the total ship cost will be carried by the country and the rest by foreign countries.

The optimum required water depth along the berths in each benchmark year is selected by comparing total costs including channel dredging cost and the transportation cost of dry bulk cargoes.

8.2.2 Bulk Terminal

(1) Forecast Cargo Volume through the Port

According to the result of the demand forcast and referring to the actual cargo flow, the volume of cargoes carried by bulk carriers through the Port is estimated by shipping route as follows:

Unit: Thousand MT

Year	Shipping route	
	USG/CARIB	E/CARIB
2005	426	220
2015	630	326
2025	933	482
2035	1,382	713

Notes: (1) Assuming that imported grains will be from U.S.A.
(2) Assuming that 60 % of imported fertilizer will be from Europe and the rest will be from U.S.A.
(3) Excluding a small amount of grains which will probably be exported to neighboring countries.

(2) Bulk Carriers Calling at the Port

In this plan, the following ship sizes are considered:

Ship Size	Principal Dimensions(M)			Daily Cost (Thousand Q)		
DWT	L.O.A.	Breadth	Full Draft	Ship Cost	Fuel Cost	
					Port	Navigation
10,000	128	18.7	8.1	14.70	0.83	4.77
15,000	141	20.0	9.0	17.43	0.92	4.90
20,000	159	22.9	10.0	21.57	1.06	5.02
30,000	175	26.0	10.8	27.88	1.31	5.40
50,000	208	32.2	11.9	36.21	1.97	7.35
65,000	229	32.2	12.8	38.96	2.40	9.00

(3) Staying Days at Port

The following premises are adopted to estimate the average staying days at port.

- Type of Cranes: Mobile Cranes with Clamshell Grabs
- Lifting Capacity: 10.4 Tons Excluding Grab Weight with 18 M Reach,
  Maximum Capacity: 150 Tons
- Cycle Time: 3 Min.
- Cargo-handling Efficiency: 0.85
- Number of Cranes per Berth: 2
- Operation Hours per Day: 20 Hours
- Non-operation Hours per Ship: 5 Hours
- Spare Days per Ship: 0.5 Days

Staying days are calculated as follows:

Ship Size	Staying Days	
DWT	Santo Tomas	Destination Port
10,000	2.0	1.4
15,000	2.6	1.8
20,000	3.2	2.3
30,000	4.5	3.2
50,000	7.1	4.9
65,000	9.0	6.3

(4) Round Trip Days

Round trip days by shipping route are shown as follows:

Shipping Route	Destination	Round Trip Distance Sea Miles	Speed Knots	Round Trip Days
USG/CARIB	New Orleans (Tampa)	2,406	13	8
E /CARIB	Antewerp	11,336	13	36

(5) Transportation Cost by Bulk Carrier

The transportation cost by bulk carrier excluding waiting cost at basins is computed based on the above premises as follows:

Ship Size DWT	Transportation Cost USG/CARIB Q/MT	E/CARIB Q/MT
10,000	23.13	83.71
15,000	19.28	65.58
20,000	18.74	60.05
30,000	18.16	52.66
50,000	17.91	45.01
65,000	17.32	40.27

(6) Terminal Cost

Construction and maintenance costs of a new terminal per berth are shown as follows:

Case No.	Water Depth M	Berth Length M	Yard Area Ha.	Infra-structure Mil.Q	*Dredging of Basin Mil.Q	Cargo-handling Facilities Mil.Q	*Total Initial Cost Mil.Q	Mainte-nance Cost Mil.Q/Y	*Transferred Annual Cost Mil.Q/Year
1	9	150	4.5	18.21	3.43	6.39	28.03	0.37	1.93
2	11	190	5.7	25.74	8.27	6.39	40.40	0.44	2.48
3	12	210	6.3	29.93	12.57	6.39	48.89	0.50	2.86
4	13	250	7.5	37.42	18.19	6.39	62.00	0.57	3.44
5	14	270	8.1	42.33	22.03	6.39	70.75	0.62	3.82

* : In this case, the number of berths is one.

Note : The premises listed in Section 8.2.1 (6) are also adopted here.

(7) Required Number of Berths by Water Depth

The optimum required number of berths is determined by the same method used in Section 8.2.1 (7), and shown in Table 8.2.3.

Table 8.2.3 Required Number of Berths by Water Depth

Case No.	Water Depth (M)	Average USG/CARIB	Ship Size E/CARIB (DWT)	Ship Arrival (Ships/D)	Average Service (Ships/D/B)	Berth Occupancy	Average Waiting Hours	Required Berth No.
(Year:2005)								
1	9	10,000	10,000	0.197	0.51	0.386	19.8	1
2	11	15,000	20,000	0.120	0.36	0.333	22.2	1
3	12	15,000	30,000	0.109	0.33	0.330	23.9	1
4	13	15,000	50,000	0.100	0.31	0.323	24.6	1
5	14	15,000	65,000	0.097	0.30	0.323	25.5	1
(Year:2015)								
1	9	10,000	10,000	0.291	0.51	0.571	41.7	1
2	11	15,000	20,000	0.177	0.36	0.492	43.0	1
3	12	15,000	30,000	0.161	0.33	0.488	46.2	1
4	13	15,000	50,000	0.148	0.31	0.477	47.2	1
5	14	15,000	65,000	0.143	0.30	0.477	48.6	1
(Year:2025)								
1	9	10,000	10,000	0.431	0.51	0.423	7.1	2
2	11	15,000	20,000	0.263	0.36	0.365	7.2	2
3	12	15,000	30,000	0.238	0.33	0.361	7.6	2
4	13	15,000	50,000	0.219	0.31	0.353	7.7	2
5	14	15,000	65,000	0.212	0.30	0.353	8.0	2
(Year:2035)								
1	9	10,000	10,000	0.638	0.51	0.625	20.5	2
2	11	15,000	20,000	0.389	0.36	0.540	18.7	2
3	12	15,000	30,000	0.353	0.33	0.535	19.9	2
4	13	15,000	50,000	0.324	0.31	0.523	19.9	2
5	14	15,000	65,000	0.314	0.30	0.523	20.6	2

Note: When applying queuing theory, a Poisson distribution for arrival and a third degree Erlan distribution for service at berths are adopted referring to the actual distribution at the Port in 1986.

(8) Total Transportation Cost from Origin and Destination Ports

The total transportation cost from origin and destination ports is estimated by the same method used for container transportation, and summarized in Table 8.2.4.

Table 8.2.4 Total Transportation Cost from Origin and Destination Ports

Unit: Mil. Q / Year

Case No.	Berth Depth (M)	Transportation Cost by Ship	Terminal Construction and Maintenance Costs	Ship Waiting Cost	Total Cost	Berth No.
(Year:2005)						
1	9	14.13	1.93	0.46	16.51	1
2	11	10.70	2.48	0.39	13.58	1
3	12	9.90	2.86	0.41	13.17	1
4	13	9.05	3.44	0.39	12.89	1
5	14	8.54	3.82	0.39	12.74	1
(Year:2015)						
1	9	20.93	1.93	1.44	24.28	1
2	11	15.87	2.48	1.14	19.49	1
3	12	14.66	2.86	1.17	18.67	1
4	13	13.40	3.44	1.12	17.94	1
5	14	12.64	3.82	1.10	17.55	1
(Year:2025)						
1	9	30.95	3.73	0.35	35.04	2
2	11	23.46	4.65	0.28	28.40	2
3	12	21.69	5.22	0.28	27.17	2
4	13	19.84	6.14	0.27	26.27	2
5	14	18.69	6.74	0.27	25.70	2

Table 8.2.4 Total Transportation Cost from Origin and Destination Ports (Continued)

Unit: Mil. Q / Year

Case No.	Berth Depth (M)	Transportation Cost by Ship	Terminal Construction and Operation Costs	Ship Waiting Cost	Total Cost	Berth No.
(Year:2035)						
1	9	45.83	3.73	1.54	51.03	2
2	11	34.72	4.65	1.08	40.45	2
3	12	32.09	5.22	1.10	38.57	2
4	13	29.38	6.14	1.03	36.56	2
5	14	27.67	6.74	1.03	35.45	2

Note: Assuming that half of the total ship cost will be carried by the country and the rest by foreign countries.

8.2.3 Optimum Water Depth

In Section 8.2.1 and 8.2.2, various water depths from 9 M to 14 M along the berths of container and bulk terminals are proposed as alternatives. In the cases when water depths are over 9 M, the access channel needs to be deepened. The optimum water depth is selected by comparing the total cost comprising transportation costs of containers and dry bulk cargoes (see Section 8.2.1(8) and 8.2.2 (8)) and dredging cost of the access channel.

The deeper channel would be created by dredging the existing channel. Channel widths are determined taking into account the principal dimensions of container ships, which have a longer L.O.A. than bulk carriers. The widths and dredging volumes of the access channel by water depth are shown as follows:

Water Depth (M)	Maximum Ship Size (Container Ship) Full Draft	L.O.A.(M)	Width (M)	Dredging Volume (Mil. Cu.M)
11	10	205	200	3.1
12	11	232	250	6.5
13	12	260	250	9.3
14	13	289	300	14.9

Thus, total transportation costs by container ship and bulk carrier are summed up including the dredging cost of the access channel as indicated in Table 8.2.5. According to the Table, in the middle of the service life of the new terminals, namely from the year 2015 to the year 2025, 13 meters is selected as the optimum water depth. However, in the year 2005, the optimum water depth is 11 meters. Considering the durability of the infrastructures through their service lives and the capability of flexible dredging along with an increase in cargo volume, it is advisable to construct new terminals with water depth of 13 meters around the target year 2005. As for the access channel and the basins in front of the new terminals, it is advisable to dredge up to 11 meters around the year 2005 and to deepen the basins to 13 meters later on.

Table 8.2.5. Total Transportation Cost by Container Ships and Bulk Carriers

Year: 2005 Unit: Quetzales
Cargo Volume: Containers: 192,000 TEU, Solid Bulk: 646,000 MT

Case	Berth Depth M	Transportation Cost Container Mil/Year	Transportation Cost Solid Bulk Mil/Year	Channel Dredging Mil/Year	Total Cost Mil/Year	Least Cost	Berth No. Container	Berth No. Solid Bulk
1	9	55.20	16.51	0.00	71.71		2	1
2	11	51.30	13.58	0.99	65.89	X	2	1
3	12	51.77	13.17	2.09	67.04		2	1
4	13	51.19	12.89	3.00	67.07		2	1
5	14	50.73	12.74	4.79	68.26		1	1

Year: 2015
Cargo Volume: Containers: 284,000 TEU, Solid Bulk: 956,000 MT

Case	Berth Depth M	Transportation Cost Container Mil/Year	Transportation Cost Solid Bulk Mil/Year	Channel Dredging Mil/Year	Total Cost Mil/Year	Least Cost	Berth No. Container	Berth No. Solid Bulk
1	9	80.12	24.28	0.00	104.40		3	1
2	11	70.09	19.49	0.99	90.58		2	1
3	12	69.79	18.67	2.09	90.56		2	1
4	13	68.23	17.94	3.00	89.17	X	2	1
5	14	67.38	17.55	4.79	89.72		2	1

Year: 2025
Cargo Volume: Containers: 420,000 TEU, Solid Bulk: 1,415,000 MT

Case	Berth Depth M	Transportation Cost Container Mil/Year	Transportation Cost Solid Bulk Mil/Year	Channel Dredging Mil/Year	Total Cost Mil/Year	Least Cost	Berth No. Container	Berth No. Solid Bulk
1	9	115.19	35.04	0.00	150.23		4	2
2	11	101.05	28.40	0.99	130.44		3	2
3	12	100.51	27.17	2.09	129.78		3	2
4	13	98.28	26.27	3.00	127.55	X	3	2
5	14	97.07	25.70	4.79	127.56		3	2

Year: 2035
Cargo Volume: Containers: 622,000 TEU, Solid Bulk: 2,095,000 MT

Case	Berth Depth M	Transportation Cost Container Mil/Year	Transportation Cost Solid Bulk Mil/Year	Channel Dredging Mil/Year	Total Cost Mil/Year	Least Cost	Berth No. Container	Berth No. Solid Bulk
1	9	166.58	51.03	0.00	217.61		5	2
2	11	145.60	40.45	0.99	187.04		4	2
3	12	144.25	38.57	2.09	184.91		4	2
4	13	140.56	36.56	3.00	180.12		4	2
5	14	137.01	35.45	4.79	177.25	X	3	2

8.2.4 Petroleum Terminal

(1) Outlines

As noted in Section 8.1, a new petroleum terminal is planned to be constructed apart from the existing terminal and apart from the other new terminals proposed in Section 8.2.1 and Section 8.2.2 for securing safe port operations. Petroleum products which will be loaded or unloaded at the new terminal are propane gas, crude petroleum and refined oils. At present, they are handled by different private companies, respectively. As for crude petroleum and refined oils, there are storage tanks near the existing port area. Propane gas tanks are still located within the port area. However, these tanks will be dismantled and new storage tanks will be installed outside of the port area by one of the private companies. The new petroleum terminal will be connected with the storage tanks by pipelines.

As the new terminal will be used exclusively by those three companies, the terminal should be planned by the companies themselves. However, the planning of the petroleum terminal as a private terminal needs to be adjusted with the planning of the public terminals to ensure efficient and safe port activities as a whole. For the purpose of smooth adjustment with the private sector, a new petroleum terminal is also proposed in this Master Plan. It is recommendable that the distance between dangerous cargo handling facilities and the other port facilities should be at least 500 meters for safety.

Some of the private companies might be reluctant to move from the existing public berth of EMPORNAC to their own berthing facilities to be constructed by themselves from the financial point of view. In this case, it may by advisable that EMPORNAC prepare the infrastructure of a public terminal for petroleum handling on the premise of open use for many users in addition to the above three companies.

(2) Forecast Cargo Volume through the Port

According to the demand forcast, the volume of cargoes to be carried by petroleum tankers through the Port is estimated as follows:

Year	Propane Gas	Cargo Volume Crude petroleum	Thousand MT Refined oils
2005	206	537	780

(3) Petroleum Tankers Calling at the Port

In this plan, referring to actual ship sizes at present, the following ship sizes are considered:

Type	Ship Size DWT	Principal Dimensions(M) L.O.A.	Breadth	Full Draft	Berth Length (M)
Propane Gas Tanker	6,200	122	19.0	6.3	150
Crude Petroleum Tanker	60,000	228	32.2	12.0	270
Refined Oil Tanker	30,000	160	25.4	10.6	200

Note: Proposed ship sizes are the same as the present sizes. At present, petroleum is being transported by partially-loaded tankers. It is assumed that petroleum will be transported by tankers of the same size under full draft in the future (see Section 8.2.3).

(4) Required Number of Berths

In this plan, two berths, one for propane gas tankers and the other for crude and refined petroleum tankers, are proposed to reduce ship waiting. Berth occupancy ratios of the respective berths are shown as follows:

	*Cargo-handling Productivity MT / Hours	Berth Occupancy Ratio
Berth for Propane Gas Tankers:	65	0.36
Berth for Other Petroleum Products:		0.40
(Crude Petroleum) :	(454)	(0.14)
(Refined Oils) :	(378)	(0.24)

*: Cargo-handling productivities are estimated referring to the present productivities.

8.3 Land Use Plan

As part of the Master Plan of the port development, it is necessary to prepare a comprehensive land use plan for the coastal area in and around the project site to harmonize land use for port activities with other uses such as for industrial and urban activities. As for EMPORNAC's land, a zoning plan has already been proposed. When making the Master Plan, however, areas outside of EMPORNAC's land need to be considered to cope with the long term beyond the year 2005. Here, a land use plan is proposed referring to the existing zoning plan,

The area to the west of the existing port is mountainous and there is a park adjacent to the port. On the other hand, the area to the east of the existing port is flat, and is reserved for the future extension of the Port. Water areas near the river mouths of the Seca River and the Cacao River cannot be reclaimed as they are necessary for the river flows. The costal areas outside of the east end of EMPORNAC's land are mainly used for urban activities. Water areas in front of the coastline along the access channel can be reclaimed economically owing to their shallowness.

Thus, the area extending to the east of the existing port and the waters area between the Cacao River and the Port of Barrios are proposed for the port development in the future (see Fig. 8.3.1).

As the economy of Guatemala is developing gradually, demand for industrial and urban use of land surrounding port area is expected to gradually increase.

Sufficient areas are reserved for these purposes.

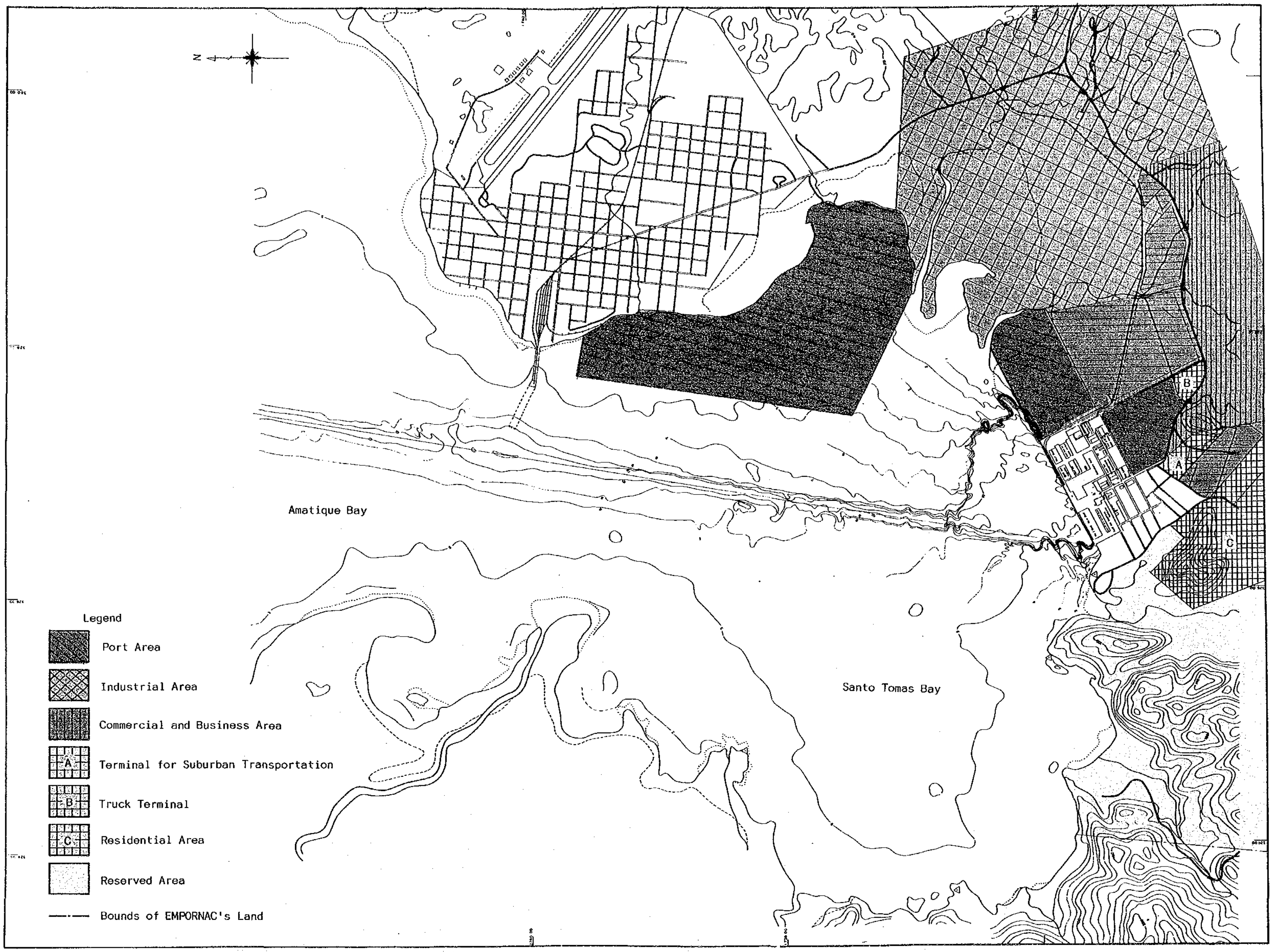


Fig. 8.3.1 Land Use Plan

8.4 Layout of the New Terminals

The required terminals proposed in Section 8.2.1 - Section 8.2.3 including container, bulk and petroleum terminals are allocated taking account of their required scales, related natural conditions, the land use plan, etc.

The container and bulk terminals need vast yards immediately behind their berthing facilities. Hence, it is advisable that these terminals be allocated in the area to the east of the existing port or to the east of the Cacao River along the access channel.

On the other hand, the petroleum terminal only needs berthing facilities which can be alocated off the coast and connected with depots located on land by pipelines. The petroleum terminal has to be separated from the existing port, the container and bulk terminals, populated districts, etc. Thus, the water areas off the river mouths of the Cacao and Seca Rivers are proposed for the berthing facility of the petroleum terminal. The water areas outside of Santo Tomas Bay and along the access channel are considered as alternative sites for the petroleum terminal (see Fig. 8.4.1).

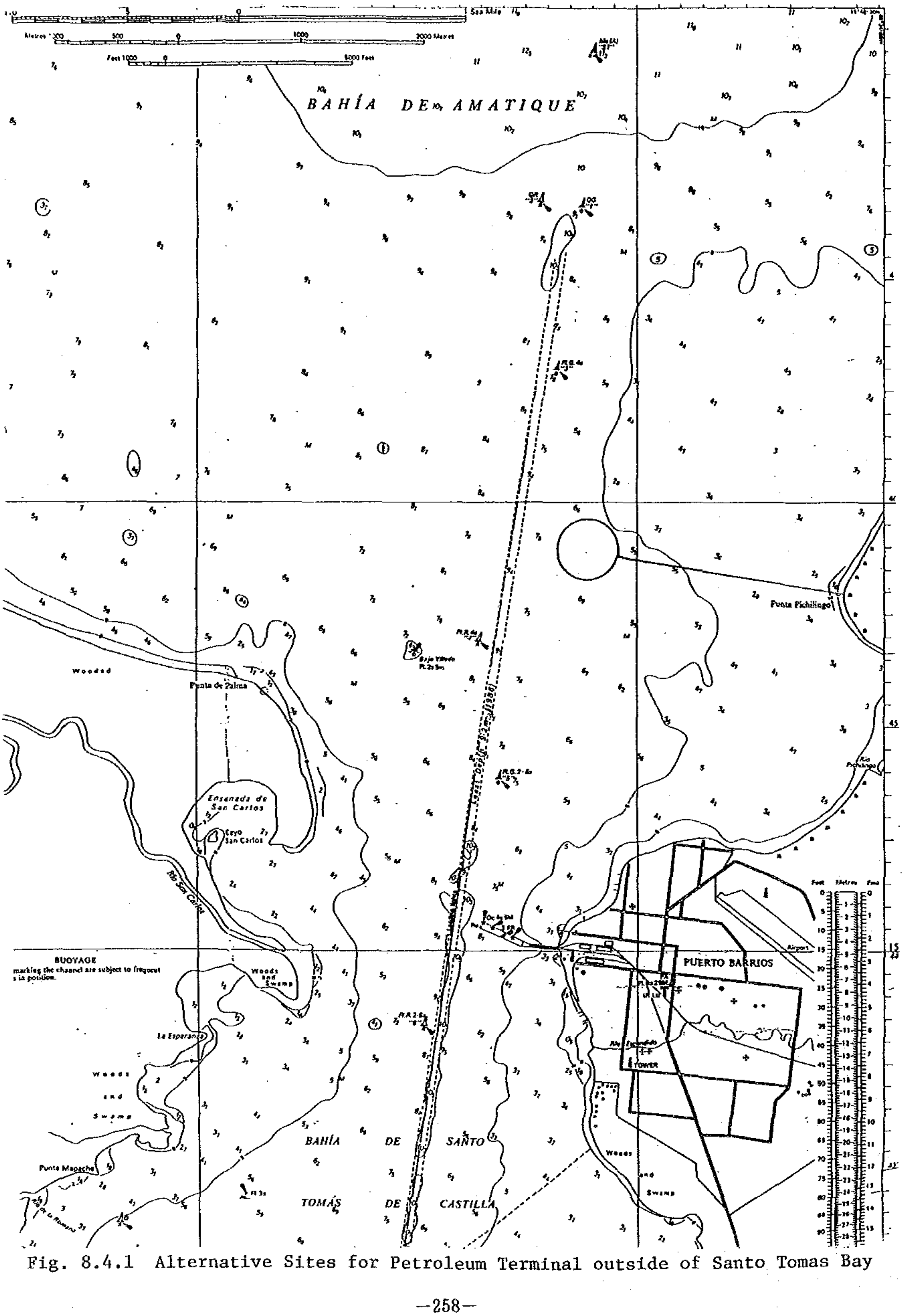


Fig. 8.4.1 Alternative Sites for Petroleum Terminal outside of Santo Tomas Bay

8.5 Access Channel and Basins

(1) Access Channel

The necessary dimensions of the access channel are shown in Section 8.2.3 by vessel size. The forecast traffic in the year 2005 is shown as follows:

Ship Type	Ship Traffic Ships per Year 2005	(2035)
Container Ships	226	(610)
Bulk Carriers	44	(118)
Petroleum Tankers	77	(77)
Others	1,025	(3,324)
Total	1,372	(6,164)
Average per Day	3.8	(16.7)

The width of the access channel is decided so as to allow two-way traffic of oceangoing vessels, following the international standard.

Judging from the forecast traffic, the traffic capacity of the access channel will be sufficient far beyond the target year of the Master Plan.

(2) Basins

Basins in front of the proposed terminals are considered assuming the use of tug boats when mooring and unmooring. A circle with a diameter double the maximum L.O.A. of calling vessels is considered as the minimum area of the basins.

8.6 Roads and Railways in the Port Area

At present, not only trucks but also freight trains are used for transportation between the Port and its hinterland. For example, around 50 % of bananas, 40 % of wheat and 20 % of fertilizer are transported by freight trains. Coffee is also being transported by train. In addition to such bulk cargoes, some containers are also being transported by train. Considering the present conditions and interviews with related organizations, railways are expected to continue to play an important role in the future. Hence, both roads and railways are considered in the port plan.

8.7 Alternative Layout Plans

Considering the layout of the terminals, access channel and basins, and roads and railways in the port area in Section 8.4 - Section 8.6, alternative layout plans of the Master Plan are proposed as follows (see Fig.8.7.1 - Fig.8.7.3):

	Allocation of the Terminals		
	Container Terminal	Bulk Terminal	Petroleum Terminal
Case 1 :	East of the Existing Terminal	East of the Cacao River	Off the Mouth of the Cacao River
Case 2 :	East of the Cacao River	East of the Existing Terminal	Off the Mouth of the Cacao River
Case 3 :	East of the Cacao River	East of the Cacao River	Off the Mouth of the Cacao River
Case 4 :	--	--	Outside of Santo Tomas Bay

The comparison of the alternatives is shown in Table 8.7.1. Though these alternatives have advantages and disadvantages as mentioned in the table, there is no decisive difference between them in the Master Plan itself with the target year 2005. However, taking account of construction works including the works based on the Short-term Plan, Case 1 has a great advantage by using the existing land possessed by EMPORNAC as the site for the new container terminal. Moreover, in the first stage, using dredged materials, reclaimed land will be created which can be used for the second stage with sufficient time to stabilize reclaimed soft soil. Thus, Case 1 is selected as the optimum plan.

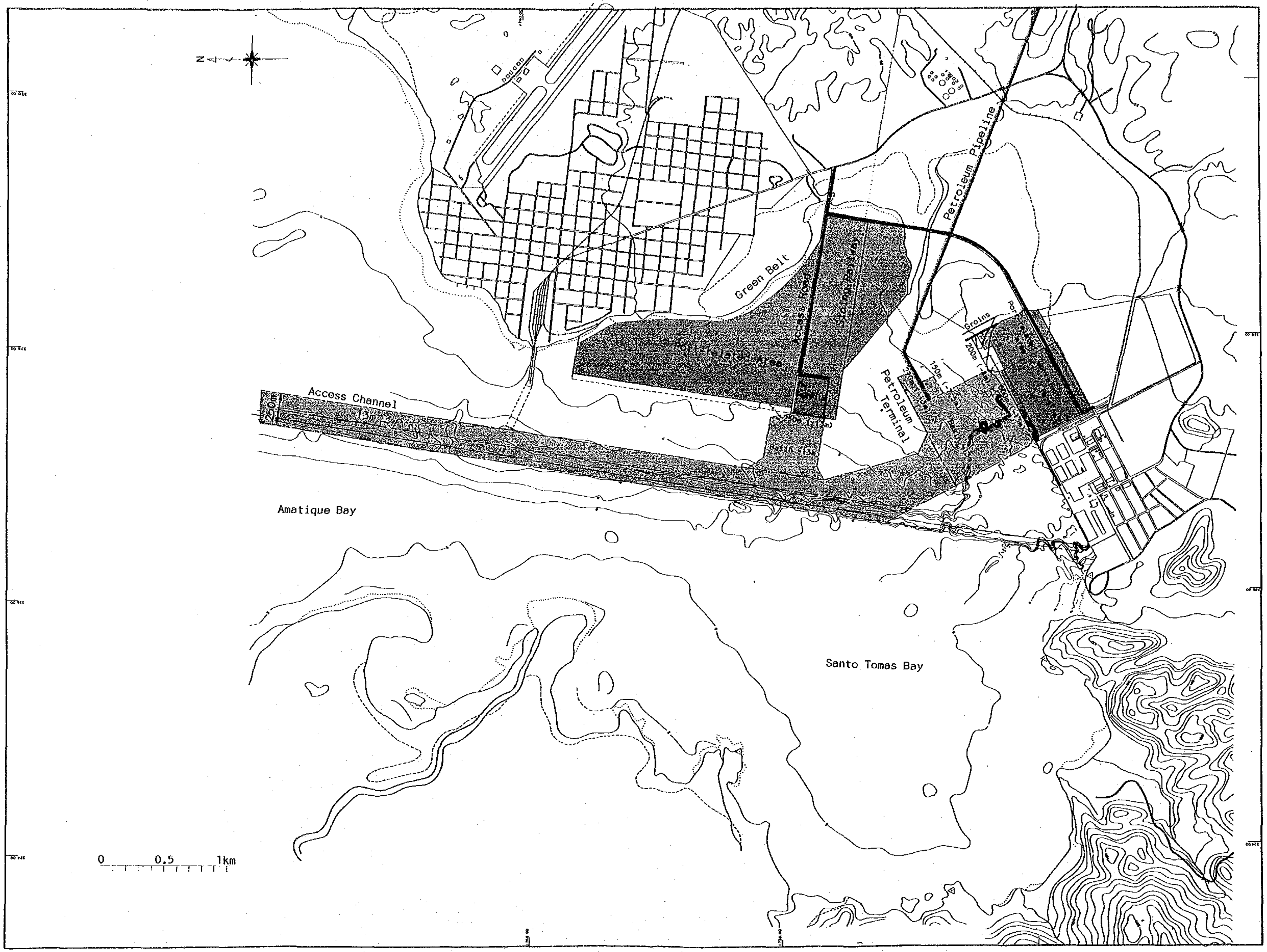


Fig. 8.7.1 Alternative Layout Plan — Case 1

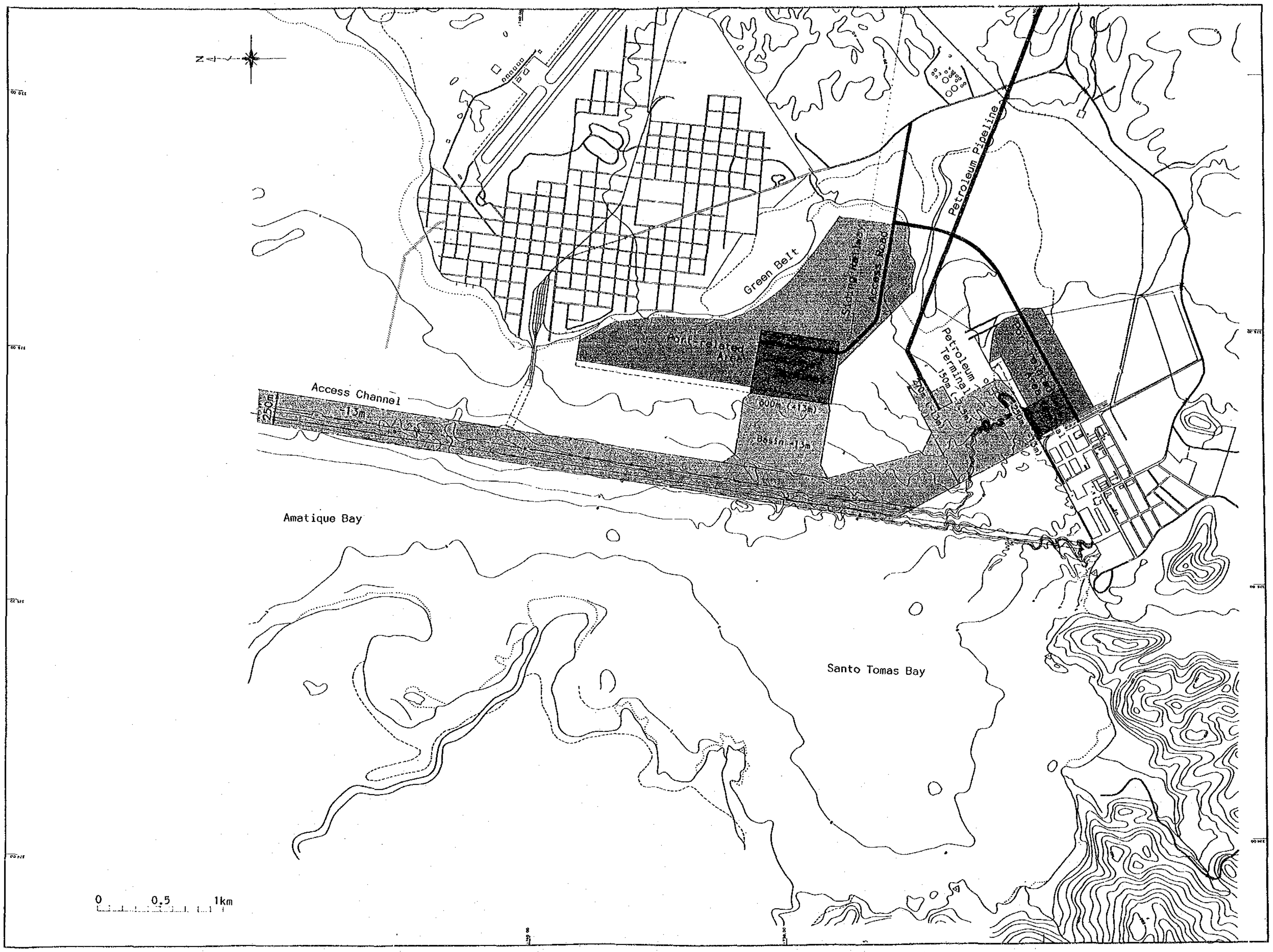


Fig. 8.7.2 Alternative Layout Plan -- Case 2

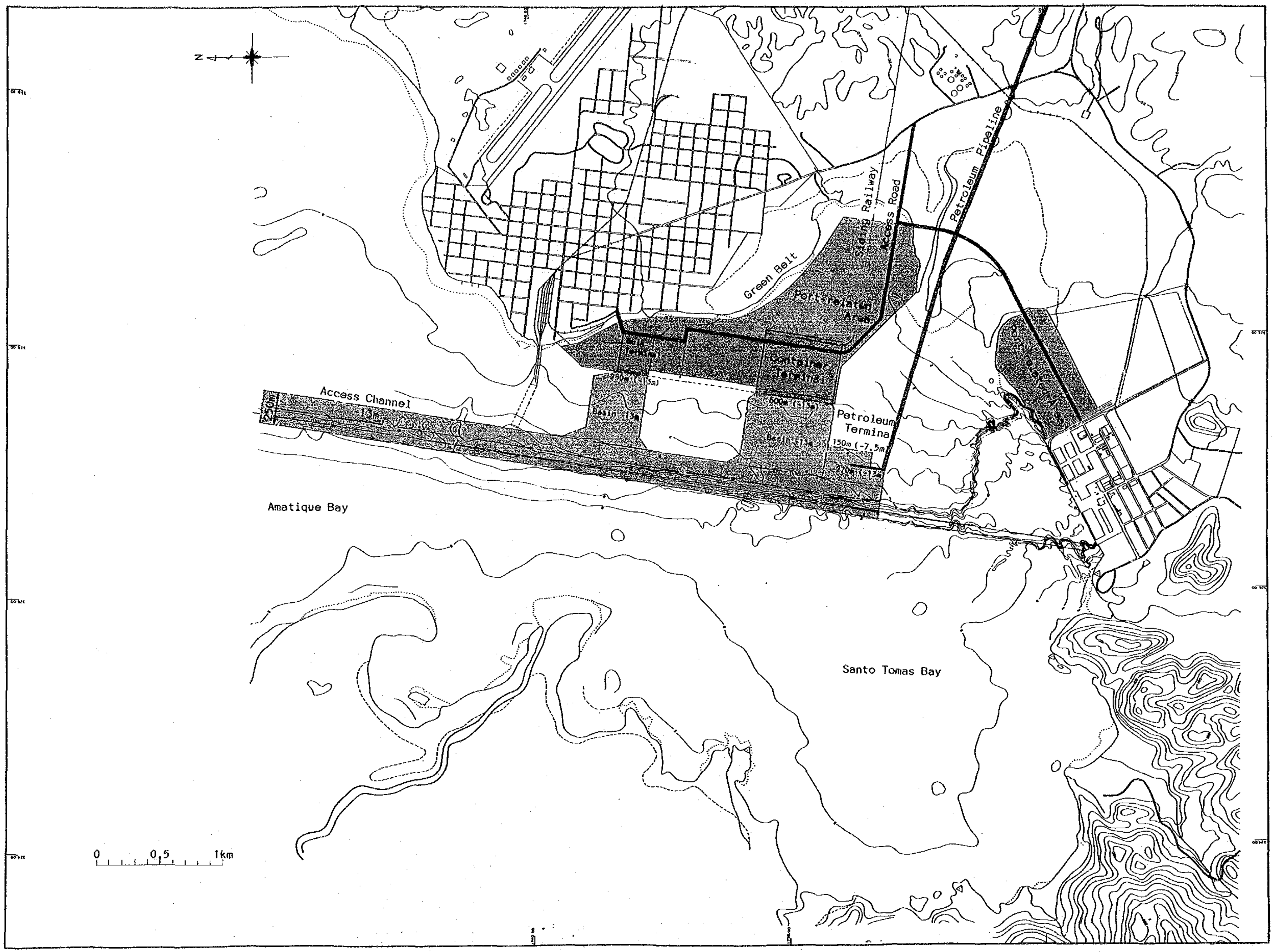


Fig. 8.7.3 Alternative Layout Plan — Case 3

Table 8.7.1 Comparison of the Alternative layout Plans of the Master Plan

Item	Case 1	Case 2	Case 3	Case 4
1. Acquisition of sites for the Container and Bulk Terminals	It is not necessary to acquire the site for the proposed container terminal since that is already possessed by EMPORNAC. However, there is no sufficient space behind the site for port-related industries or business due to the location of ZOLIC. On the other hand, the site for the bulk terminal must be reclaimed using dredged materials from the access channel and basins. As the dredged materials seem to be soft, after reclamation, soil stabilization will be needed.	The site for the proposed container terminal must be reclaimed using dredged materials.. After reclamation, soil stabilization will be needed. On the other hand, the site for the bulk terminal is already possessed by EMPORNAC.	The sites for the proposed container and bulk terminals must be reclaimed using dredged materials. After reclamation, soil stabilization will be needed. The area neighboring the existing terminal will remain unused.	
2. Construction Cost Excluding Cost for the Petroleum Terminal	456 Mil. Quetzales	454 Mil. Quetzales	430 Mil. Quetzales	
3. Port Administration and Operation	At the site for the container terminal neighboring the existing terminal, only two berths can be constructed due to the limited area. Hence, additional container berths required beyond the target year 2005 will be separated from the proposed first stage container terminal which will be constructed east of the Cacao River.	Additional container and bulk berths required beyond the target year 2005 can be constructed adjacent to the respective proposed first stage terminals. Thus, each of the terminals can be administrated and operated as a single unit, even in the far future.	The same as Case 2.	
4. Handling of Dangerous Cargoes	Dangerous cargoes will be separated from other cargoes by construcing a new petroleum terminal.	The same as Case 1.	The same as Case 1.	Dangerous cargoes will be separated from other cargoes by constructing a new petroleum terminal. As the distance between the terminal and existing or planned storage tanks located near the existing port is great, this case is costly compared with the other alternatives.

8.8 Navigation Aids Planning

The placement and maintenance of navigation aids are fundamentally managed by central government agencies in the developed countries, since the responsibility to secure safe navigation of ships is considered to belong to the state.

However in Guatemala, it is not clear which agency is responsible for these functions legally and actually.

As it is not appropriate for a port management body such as EMPORNAC to engage in such activities because the port management body governs just a limited port area, the required navigation aids around the port of Santo Tomas are studied to formulate a suitable system to be implemented by the responsible agency.

8.8.1 Development and Improvement

The port development plan is proposed as shown in Fig. 8.8.1 and 8.8.2. To secure the safety of navigation at sea, establishment of navigation aids and other relevant facilities is necessary.

Visual and electronic navigation aids are complementary.

Neither one is sufficient by itself. Visual range is limited and affected by weather, while electronic range is extended and not affected by weather.

It is most desirable for marines that both visual and electronic facilities be provided for position fixing by cross bearing.

1) Roles of Visual Navigation Aids

The functional roles of visual navigation aids are to provide ships with immediate assistance and guidance in precise positioning, land approaching, avoiding dangers, and marking turning points on traffic routes, so as to cruise to their destinations safely and efficiently.

2) Roles of Electronic Navigation Aids

Electronic navigation aids are useful in all weather, extensive in range, and basically free from fog and rain, which are their outstanding advantages and differences from lighthouses and buoys.

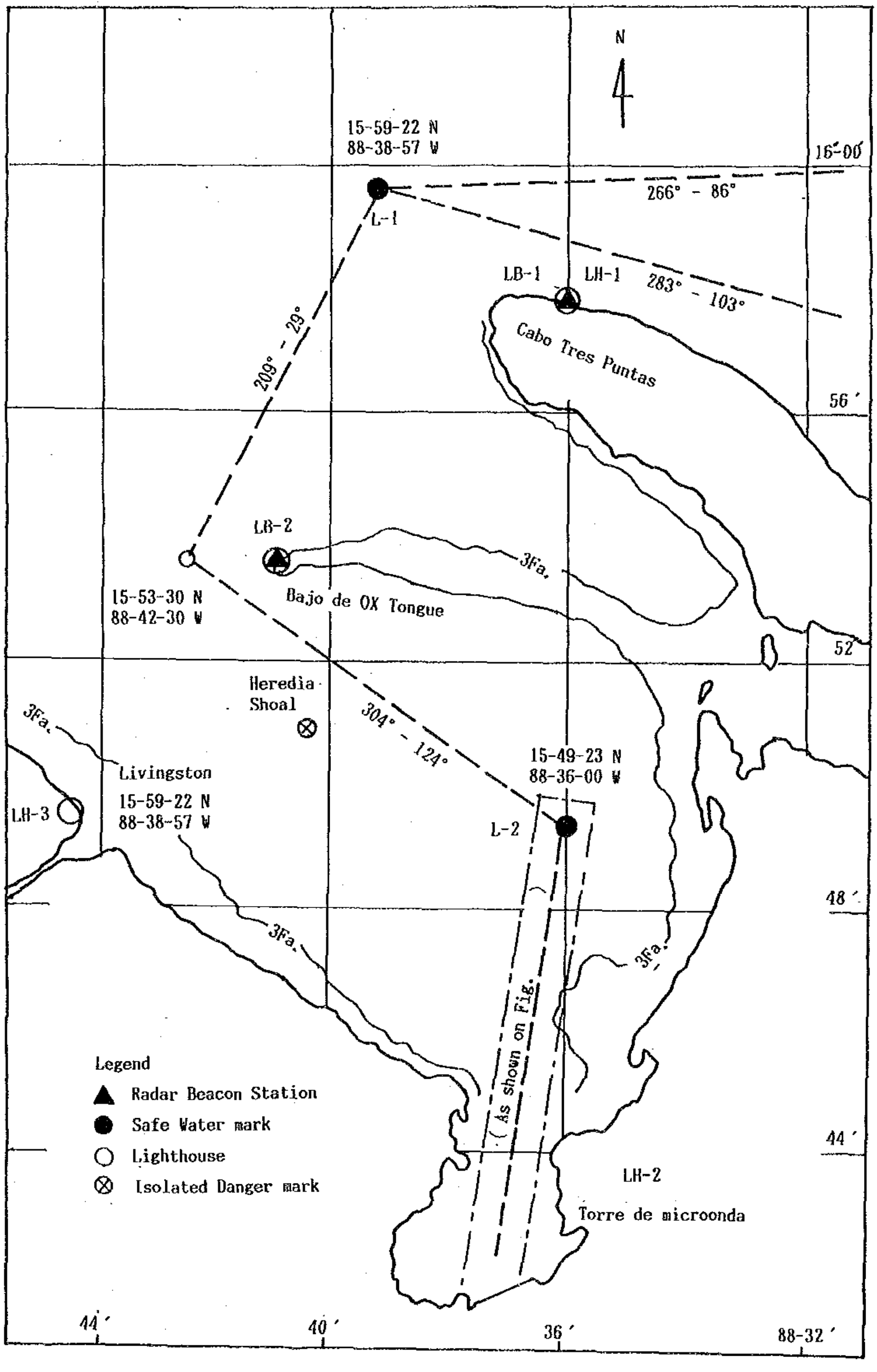


Fig. 8.8.1 Long Term Development Plan for Aids to Navigation
(Entrance channel)

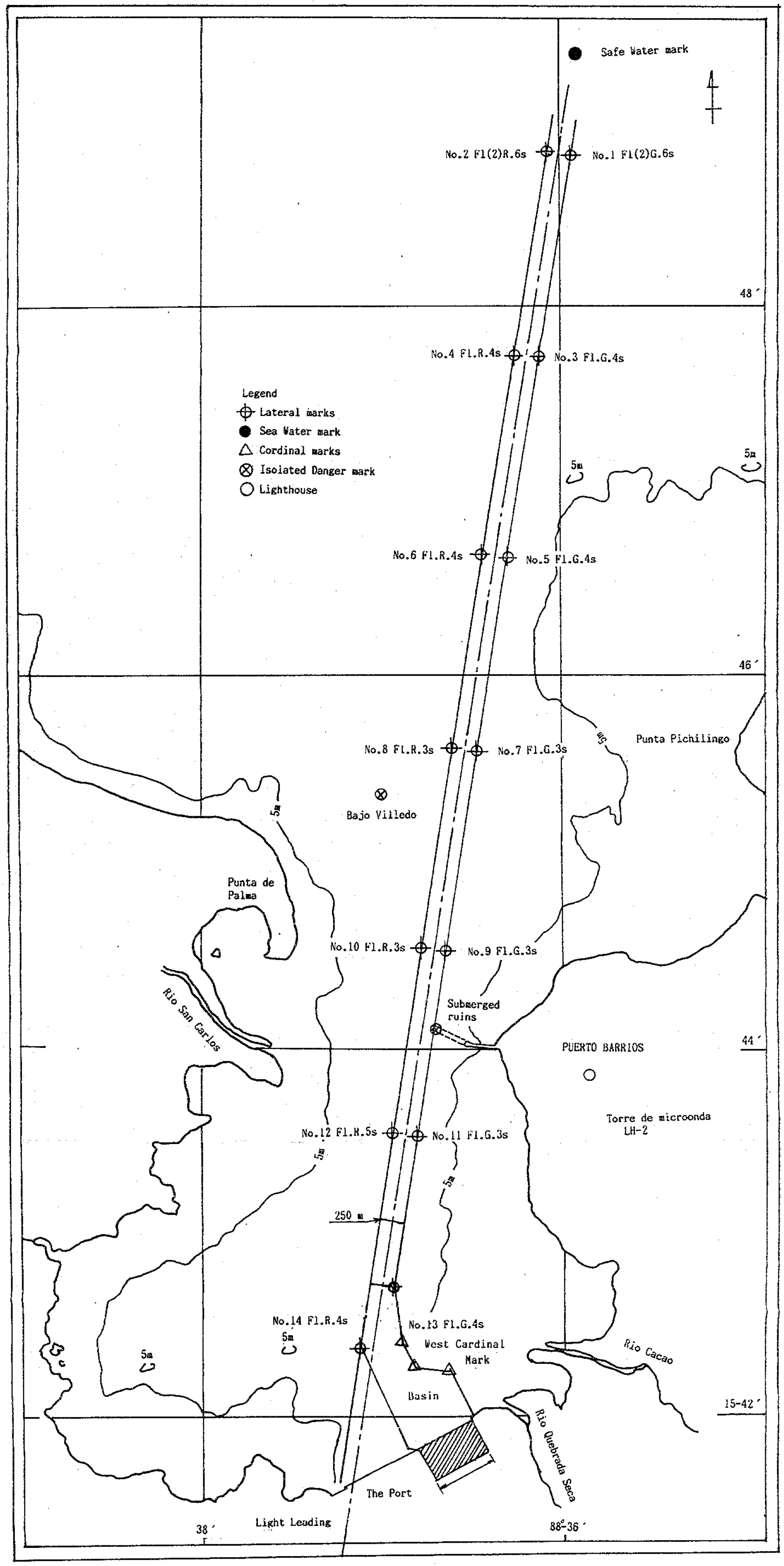


Fig. 8.8.2. Long Term Development Plan for Aids to Navigation (Approach channel)

Radar Beacon is an extremely useful system to mark turning points in traffic routes, navigational dangers and so on.

3) Proposed Navigation Aids

(1) Visual Navigation Aids

(a) Landfall aids will be installed around the mouth of the bay and the entrance to the port.

(b) Navigation aids marking entrances will be installed at the entrance to approach channels with the cardinal marks properly spaced to indicated the restricted navigable waters.

(c) Cardinal marks will be installed for showing dredged area at basins.

(d) Special marks will be installed near such navigation dangers as reefs, rocks, tiny islands, etc.

(2) Electronic Navigation Aids

Radar beacon stations should be provided for overall coverage of the capes and remarkable landscape features at Cabo Tres Puntas and Bajo de Ox Tongue, and are shown in Table 8.8.1 and Fig. 8.8.3, 8.8.4.

8.8.2 Facility and Equipment Plan

1) Light Buoys

	Deep Water	Shallow Water
(1) Luminous range:	6 NM or over (T=0.74)	4 NM or over (T=0.74)
(2) Geographical range:	6 NM or over	6 NM or over
(3) Buoy:		
(a) Material:	Iron	Iron
(b) Diameter:	2,600m/m or over	2,400m/m or over
(c) Weight:	Approx. 5.5tons	Approx. 3tons
(d) Total height:	Approx. 8.5m	Approx. 5m
(4) Mooring		
(a) Chain:	32mm	30mm
(b) Length:	Subject to oceano-	Do

	graphic conditions	
(c) Sinker:	Concrete	Concrete
(5) Power Source:	Batteries	Batteries
	Solar cells	Solar cells

2) Development Criteria for Electronic Navigation Aids

Radar beacon stations are to be installed to indicated main landfalls, navigation dangers, and turning points widely covering the whole areas at Cabo Tres Puntas and Bajo de Ox Tongue.

The covering range of the radar beacon stations shall be 10-20 NM.

Table 8.8.1 Plan of Aids to Navigation

Lateral marks

No	Position	Buoy color	Light color	Rhythm	Buoy shape	Remark
1	15-48-50N,88-35-56 W	Green	Green	Fl(2)G6s	Light Buoy	Repair
2	15-48-51N,88-36-04 W	Red	Red	Fl(2)R6s	〃	〃
3	15-47-43N,88-36-08 W	Green	Green	Fl.G 4s	〃	〃
4	15-47-43N,88-36-16 W	Red	Red	Fl.R.4s	〃	〃
5	15-46-39N,88-36-18 W	Green	Green	Fl.G.4s	〃	〃
6	15-46-40N,88-36-25 W	Red	Red	Fl.R.4s	〃	〃
7	15-45-36N,88-36-29 W	Green	Green	Fl.G.3s	〃	〃
8	15-45-36N,88-36-36 W	Red	Red	Fl.R.3s	〃	〃
9	15-44-32N,88-36-39 W	Green	Green	Fl.G.3s	〃	New
10	15-44-32N,88-36-47 W	Red	Red	Fl.R.3s	〃	〃
11	15-43-32N,88-36-48 W	Green	Green	Fl.G.3s	〃	〃
12	15-43-32N,88-36-56 W	Red	Red	Fl.R.5s	〃	〃
13	15-42-32N,88-36-58 W	Green	Green	Fl.G.4s	〃	〃
14	15-42-33N,88-37-06 W	Red	Red	Fl.R.4s	〃	〃

Note: 1) Shape(Buoys): Cylindrical(can), pillar or spar

Sea Water Marks

No.	Position	Buoy color	Light color	Rhythm	Buoy shape	Remark
L-1	15-49-23N,88-36-00W	☆	White	Mo(A).8s	Light Buoy	Repair
L-2	15-59-22N,88-38-57W	〃	〃	〃	〃	New

Note: ☆ Red and white vertical stripes

Cardinal Marks

No.	Position	Buoy color	Light color	Rhythm	Buoy shape	Remark
C-1	15-42-24N,88-36-39W	★	White	Q(9) 15s	Light Buoy	West
C-2	15-42-14N,88-36-27W	〃	〃	〃	〃	〃
C-3	15-41-52N,88-37-14W	※	〃	Q(3) 10s	〃	South

Note: ★ Yellow with a single broad horizontal

※ Yellow above black

Isolated Danger Mark

Position	Name	Buoy shape	Light color	Rhythm	Buoy color	Remark
15-53-37N,88-41-07W	Ox Tongue Shoal	Optional	White	Fl.3s	black	Repair
15-50-48N,88-40-24W	Heredia Shoal	〃	Red	Fl.R.6s	〃	〃
15-45-18N,88-37-00W	Bajo Villedo	〃	White	Fl.2s	〃	〃
15-44-08N,88-36-42W	Puerto Barrios	〃	〃	Oc.4s	〃	〃

Radar Beacon Station

No.	Name of Station	Position	Height	Remark
LB-1	Cabo Trea Puntas	15-57-47 N,88-36-00 W	40 m	New
LB-2	Bajo de Ox Tongue	15-53-37 N,88-41-07 W	10 m	〃

Lighthouse

No.	Name of Lighthouse	Position	Height	Range	Remark
LH-1	Cabo Tres Puntas	15-57-47 N,88-36-00 W	40 m	17 M	Repair
LH-2	Torre de Microonda	15-43-50 N,88-35-51 W	20 m	25 M	〃
LH-3	Livingston	15-49-42 N,88-44-57 W	30 m	20 M	New

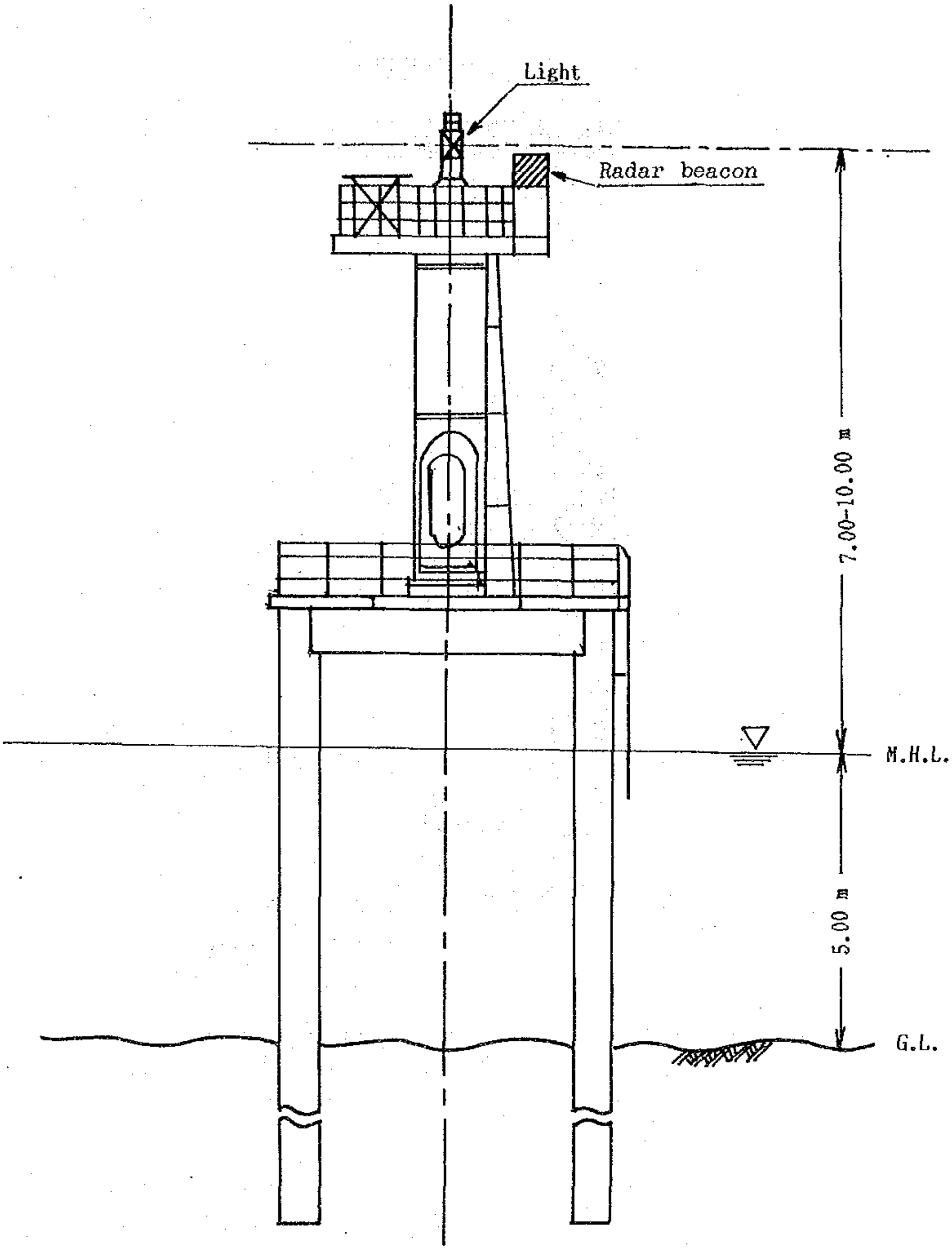


Fig. 8.8.3 Light Beacon (Bajo de Ox Tongue)

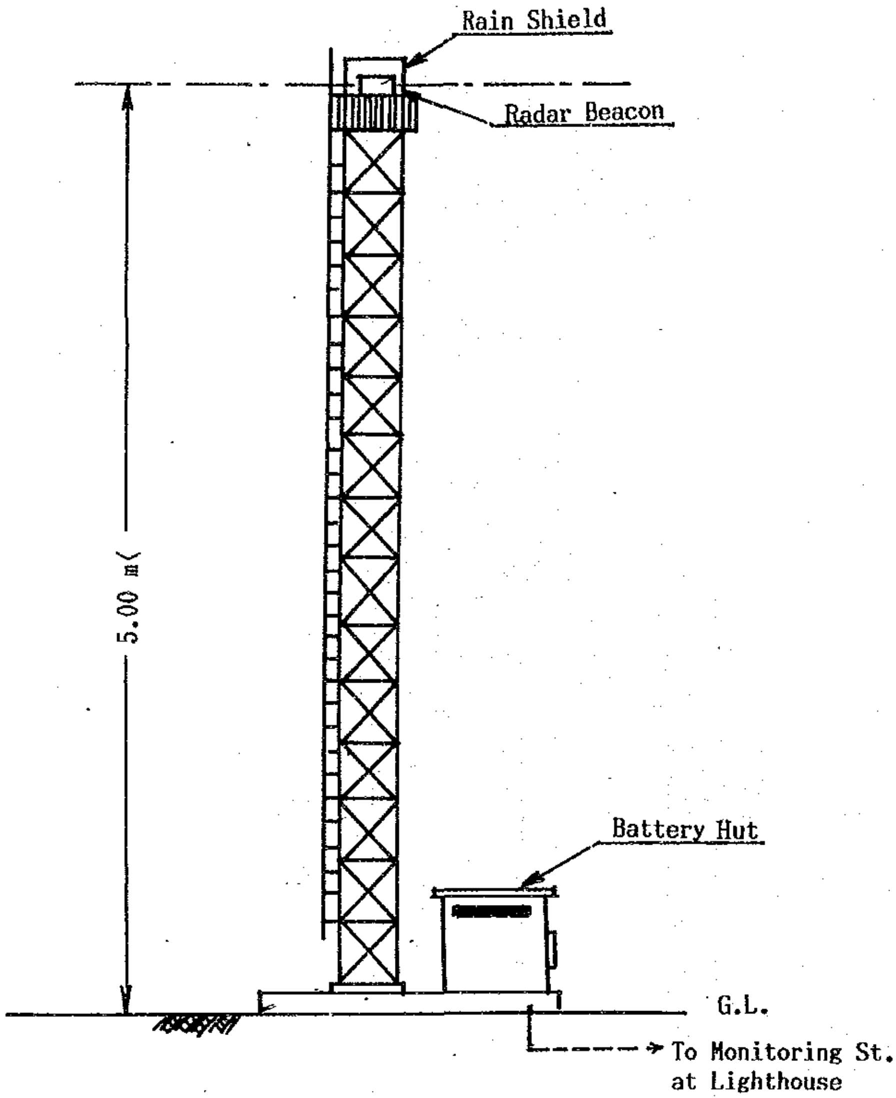


Fig. 8.8.4 Radar Beacon Station (Installation Plan)
(Cabo Tres Puntas)

(1) Criteria for Facility Plan

The criteria for the facility plan shall follow the following standards:

(a) A dual system shall be applied with an automatic changeover unit.

(b) The output power of a transmitter shall be 5W for coastal installations.

(c) The antenna shall be an omni-directional high gain type.

(d) The antenna mast for coastal installations will be an independent iron tower (Cabo Tres Puntas), and that for navigational danger shall be together with a light tower (Bajo de Ox Tongue).

(e) Power supply: A combination of solar cells and batteries will be used for both radar beacon stations.

(2) Equipment Planning

(a) Major Specifications

Standard system:

- Landfall Marking: Dual system with automatic changer.
- Output Power: 5 W
- Service Range: 10 - 20 NM
- Danger Marking: Dual system with automatic changer.

3) Development Plan

According to the development schedule of the Master Plan and of this study, the development plan of navigation aids shall be as follows:

(1) Number of Visual Navigation Aids

(a)	Lateral Marks	14 (8)
(b)	Cardinal Marks	3 (0)
(c)	Isolated Danger Marks	5 (5)
(d)	Safe Water Marks	2 (1)
(e)	Leading Light	1 (1)

(f) Lighthouse 3 (2)

(2) Number of Electronic Navigation Aids

(a) Radar Beacon Station 2 (0)

Note: Figures in parentheis show the number of existing facilities

8.8.3 Administrative and Maintenance Setup

The performances of buoys installed at sea are fated to deteriorate, as time passes by, due to colour weathering, rust and corrosion on buoy bodies, tear and wear of mooring, malfunction of light devices and so on. Maintaining a certain level of the functional performance of buoys is an essential service to be performed through regular checking and repairs in order to secure the safety of navigation.

The sea conditions, where buoys are installed, greatly affect the degree of deterioration in colour painted on buoys and wear and tear of moorings.

General overall estimation has shown that bi-yearly maintenance in average for buoys will be sufficient to maintain the standard performances. However, there is a case where annual maintenance is required for those installed at such locations with adverse weather conditions, fast current, and rocky or sandy bottom conditions.

On the other hand, maintenance intervals of 2-4 years may be conceivable in inner ports, small bays or calm wasters. Since the majority of the water areas under this Study seem to be in the latter case, a two year complete replacement system is recommended for buoys, including light device, power source, mooring and sinker. Fig. 8.8.5 shows the flow of the process.

Any complete set of buoys removed is to be taken ashore to the relevant buoy base for repair and maintenance. This checking and repair of buoys is not possible on board. Accordingly, the reliability of buoys will be remarkably improved along with shortening the time required on board for the maintenance works.

Further advantages are a decrease in the number of failures, prolonging the useful life of the buoys and so on.

It is expected that development of this system will result in at least doubling the present useful life of 7-10 years for buoys.

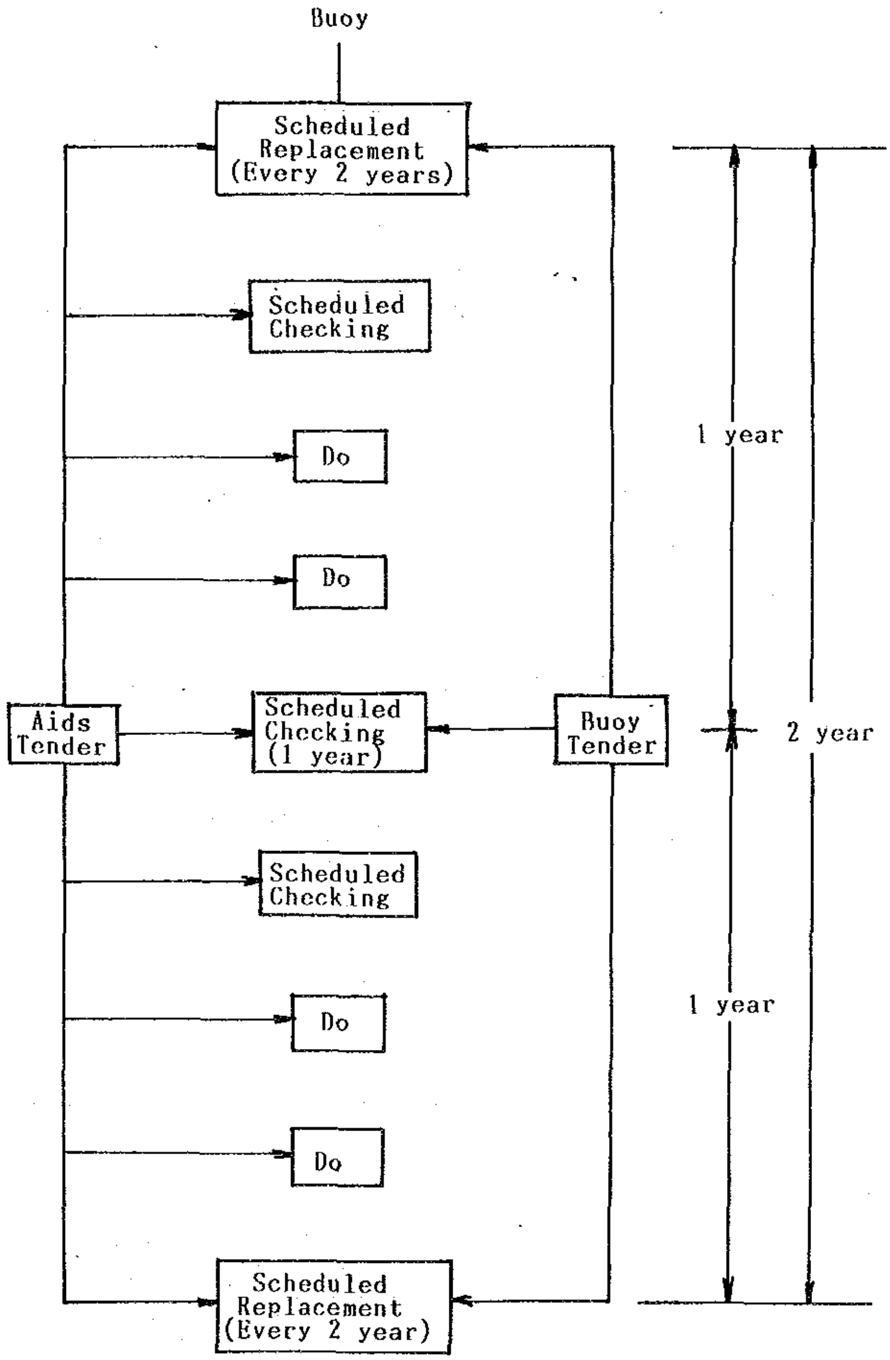


Fig. 8.8.5 Buoy Maintenance System "Scheduled Replacement of Buoys"

8.9 Dredging Plans

Based on the size of vessels assumed to call at the port and the wharf expansion plan, the channel and basins are planned as follows.

8.9.1 Channel and Basins

1) Channel

The existing channel is relatively free from deposit of littoral materials, easy to maintain and extends in a straight line for easy operation of ships, but is not sufficiently wide for navigation of vessels.

Therefore, the existing channel will be dredged to increase its depth and width.

To minimize the obstruction to navigation of vessels during the dredging work, the channel will be widened to the east side where the volume of dredging is considered to be less in view of submarine topography.

Depending on the required water depth of the channel, the length of the dredged channel will be as shown below.

Water Depth	Length of Dredged Channel
11.0 m	11.5 km
12.0 m	12.5 km
13.0 m	13.3 km
14.0 m	15.0 km

The channel will be dredged to the same depth as the basins.

2) Basins

A general plan of the basins with the planned water depth is shown in Fig. 8.9.1.

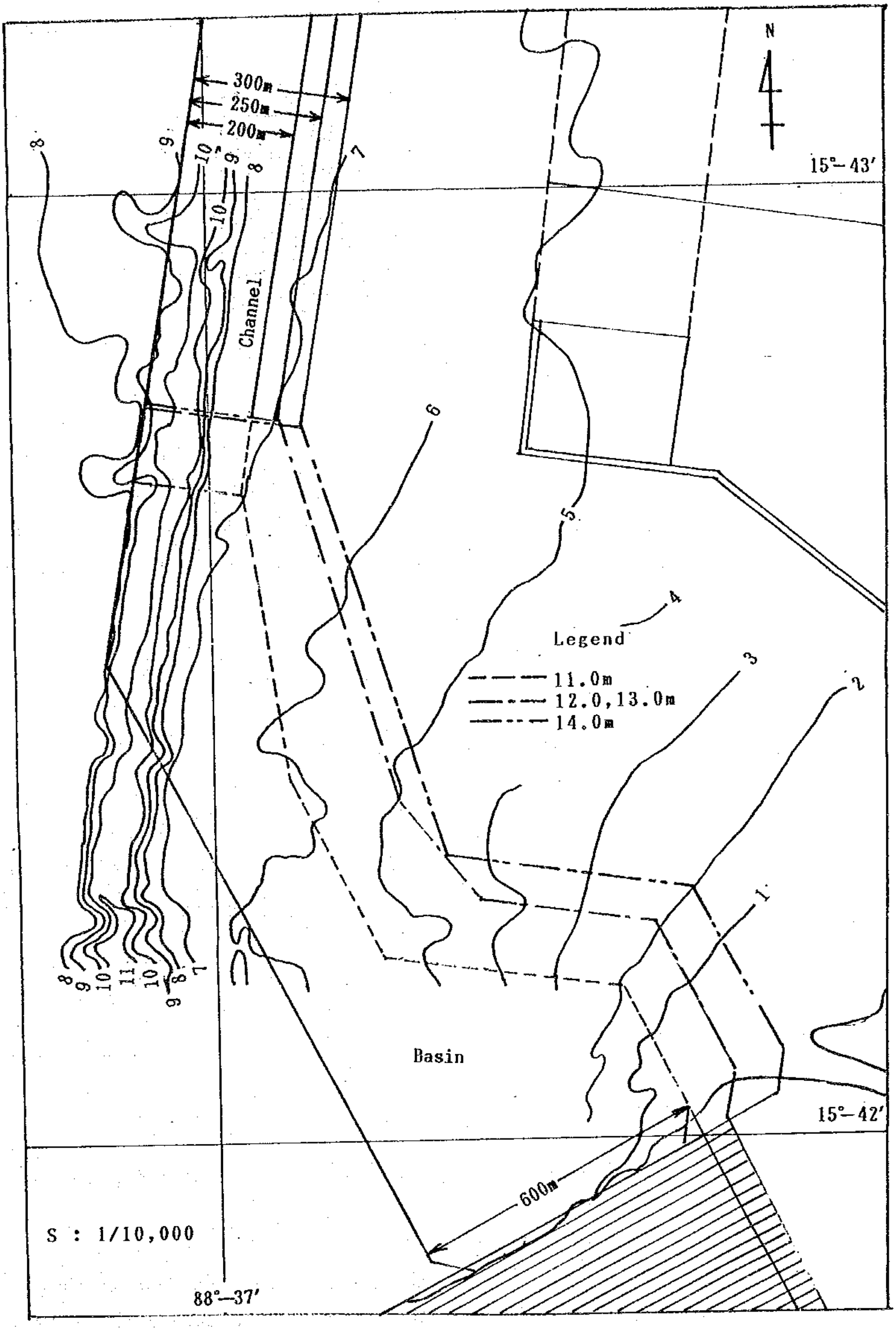


Fig. 8.9.1 Types of Basin

The area of dredging in the basins for the planned water depths is as shown below.

Water Depth	Area of Dredged Basins
11.0 m	509,900 m2
12.0 m	817,450 m2
13.0 m	817,450 m2
14.0 m	931,900 m2

8.9.2 Dredging

1) Dredging Volume

The dredging volume of the channel and basins for the planned water depth is shown in Table 8.9.1. Sections of the channel after dredging are shown in Fig. 8.9.2. Also, the following conditions are considered for calculation of dredging volume.

(1) Width of extra dredging : 5 m (on both sides)
(2) Depth of extra dredging : 0.6 m
(3) Side slope of dredging area : 1 : 3.0

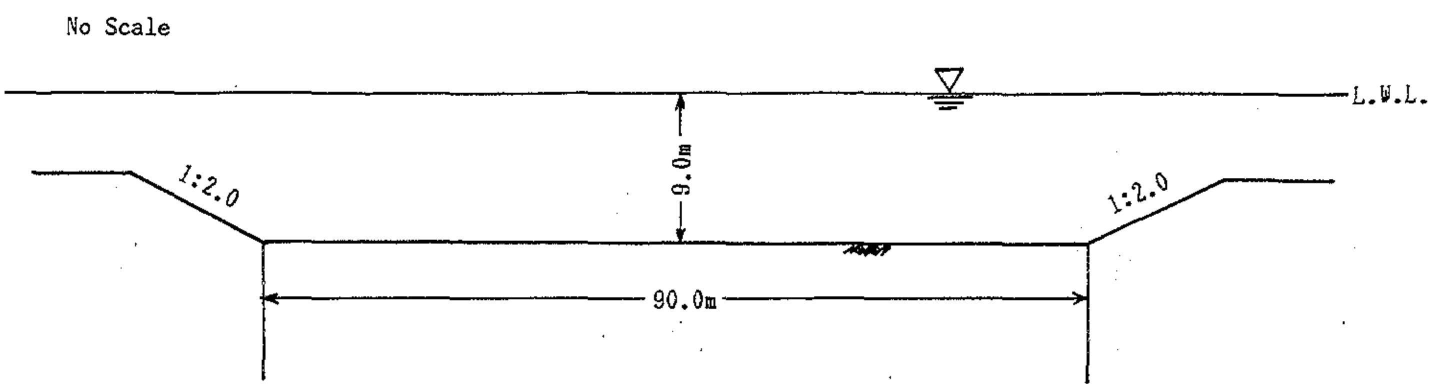
Table 8.9.1 Dredging Volume of Channel and Basins

Depth	Channel	Container	Bulk	Total
11.0m	3,100,000 m3	3,100,000 m3	940,000 m3	7,140,000 m3
12.0	6,500,000	5,500,000	1,330,000	13,330,000
13.0	9,300,000	6,800,000	2,130,000	18,230,000
14.0	14,900,000	8,000,000	2,780,000	25,680,000

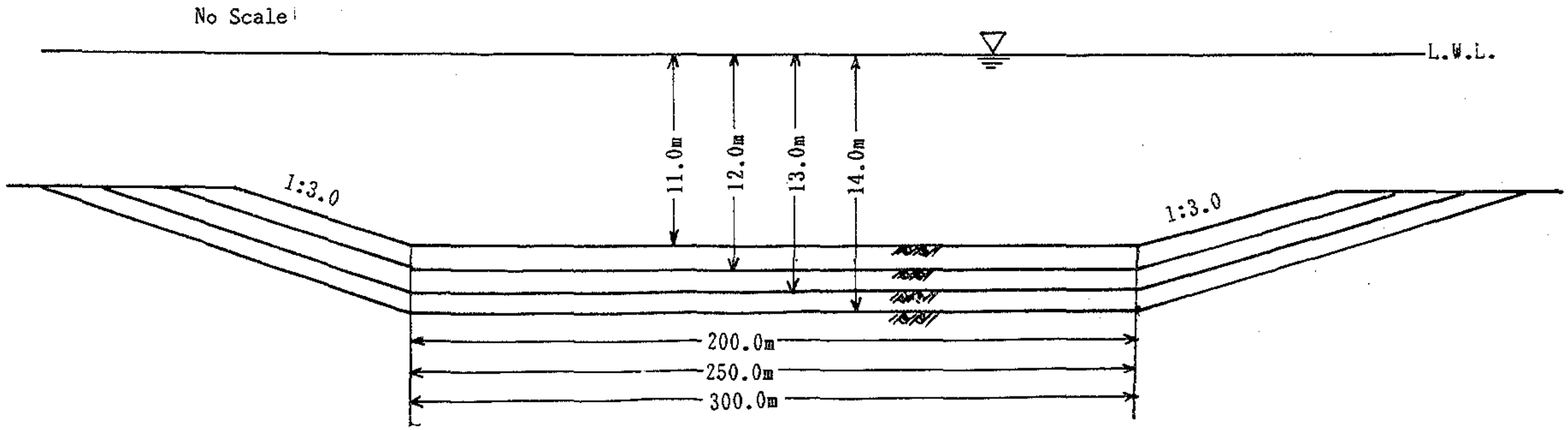
2) Disposal of dredged materials

Disposal of dredged materials is planned taking the following factors into consideration.

(1) Dredged materials should not be dumped into open water areas. Revetments should be constructed to prevent the spread of dredged



Existing



Plan

Fig. 8.9.2 Sections of Channel

materials in the water.

(2) Possible dumping sites should be selected in view of the capacities of dredging pumps, economic dredging operations and future land use plans for the reclaimed land.

(3) Foundation improvement should be considered later for use of reclaimed land if necessary.

(4) River improvement plans should be considered for rivers flowing through the planned reclaimed land.

3) Considering the location, volume of dredging and capacity of dredging pumps, the dredged materials will likely be dumped at two possible sites shown in Fig. 8.9.3.

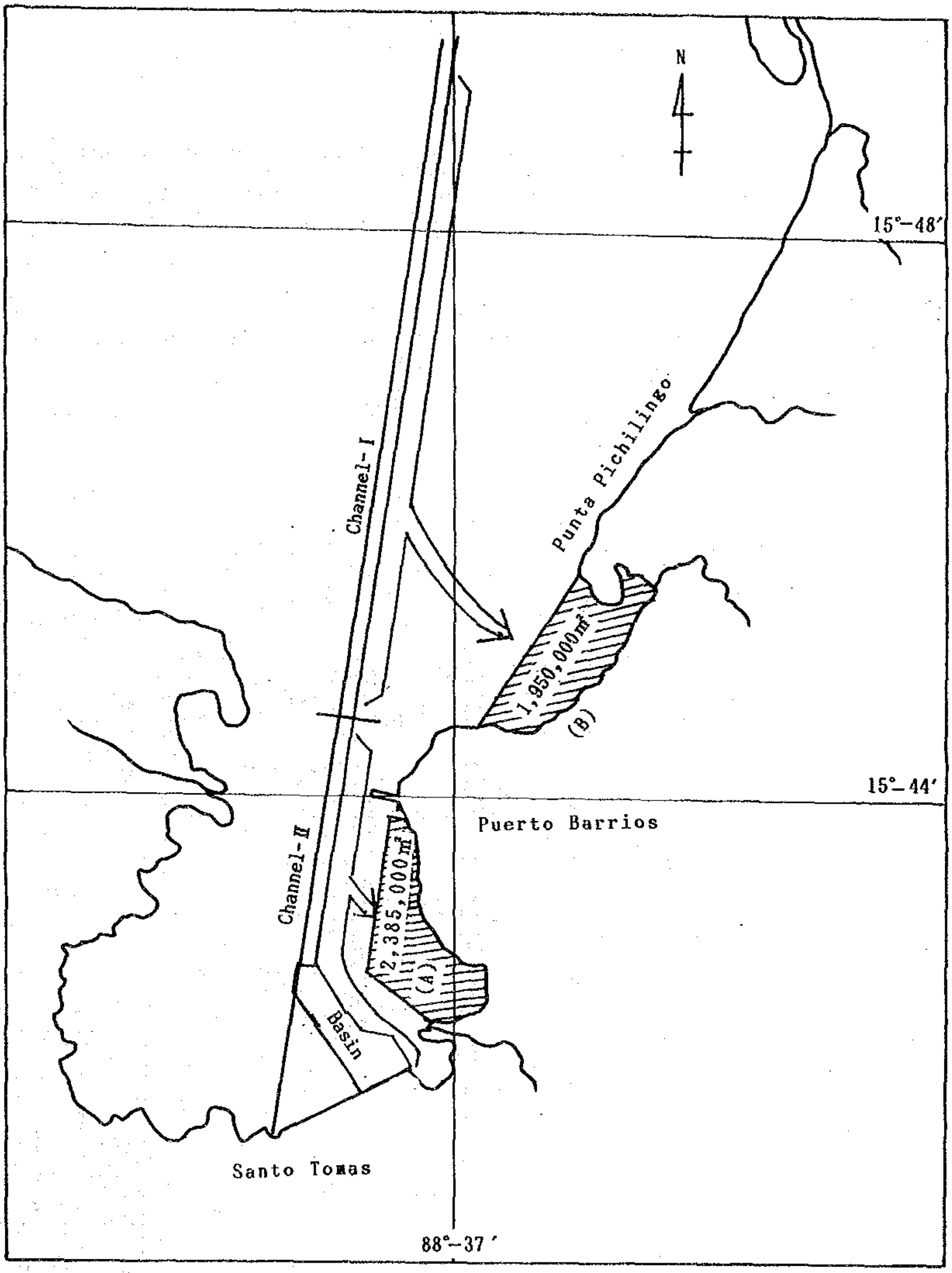


Fig. 8.9.3 Dumped Location of Materials

8.10 Rough Design and Cost Estimation

8.10.1 Design of New Port Facilities

The soil condition in the new port expansion area is worse compared with the existing port area, that is, the depth of the alluvial marine clay layer is deeper. The new port facilities shoud be designed with a 13 meter depth according to the master plan.

The soft clay is derdged and replaced with rubble stone for the wharf stability. The wharf is made of steel piles and concrete platforms. Fig 8.10.1 shows standard section of the wharf.

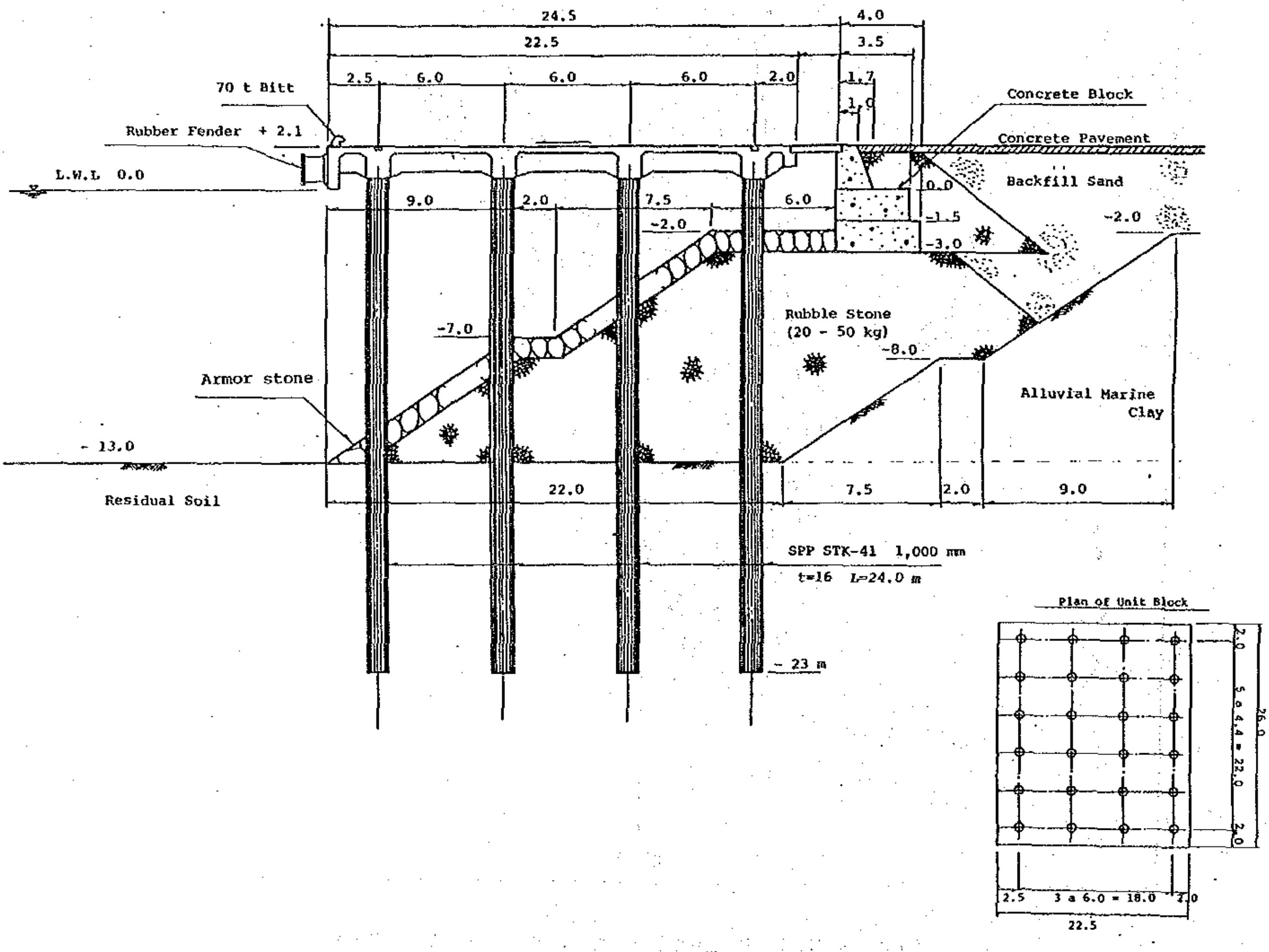


Fig 8.10.1 Standard Section of Wharf

8.10.2 Cost Estimation

The costs of facilities and equipment as shown in Table 8.10.1 are used in the Master Plan of the new port.

Table 8.10.1 Construction Cost

Unit: Million Quetzales

Item	Unit	Case 1 Quantity	Case 1 Cost	Case 2 Quantity	Case 2 Cost	Case 3 Quantity	Case 3 Cost
1.Container Terminal							
1 Quaywall	M	600	56.57	600	56.57	600	56.57
2 Yard	Ha.	24.0	59.53	24.0	59.53	24.0	59.53
3 Superstructures	-	-	14.45	-	14.45	-	14.45
4 Cargo Handling Facilities	-	-	73.77	-	73.77	-	73.77
5 Basin Dredging	Mil.Cu.M	6.75	52.73	2.91	22.72	2.91	22.72
6 Siding Railways	KM	1.37	8.63	4.10	11.29	4.10	11.29
Subtotal			265.68		238.32		238.32
2.Bulk Terminal							
1 Quaywall	M	250	23.57	250	23.57	250	23.57
2 Yard	Ha.	7.5	15.67	7.5	15.67	7.5	15.67
3 Superstructures	-	-	31.95	-	31.95	-	31.95
4 Cargo Handling Faciliteis	-	-	6.39	-	6.39	-	6.39
5 Basin Dredging	Mil.Cu.M	2.33	18.21	5.95	46.47	2.33	18.21
6 Siding Railways	KM	4.00	3.34	0.64	0.35	1.45	1.06
Subtotal			99.13		124.41		96.86
3.Oil Terminal							
1 Jetty	set	1	11.06	1	11.06	1	11.06
2 Trestle	M	600	7.41	600	7.41	1500	18.53
3 Basin Dredging	Mil.Cu.M	1.85	12.95	1.85	12.95	1.85	12.95
Subtotal			31.42		31.42		42.54
4.Common Facilities							
1 Access Channel	Mil.Cu.M	9.35	73.02	9.35	73.02	9.35	73.02
2 Access Roads	KM	5.00	12.78	5.00	12.78	6.40	16.36
3 Wharf for Small Boats	-	-	5.52	-	5.52	-	5.52
Subtotal			91.32		91.32		94.91
Grand Total			487.55		485.47		472.63

CHAPTER 9 PORT MANAGEMENT AND OPERATION

9.1 Port Management and Operation System

As mentioned in Chapter 6, the port administration, management and operation system in Guatemala is quite complicated.

Out of 5 major ports in Guatemala, the port of Santo Tomas de Castilla is the largest, and santo Tomas is the only port controlled directly by Ministry of Finance. EMPORNAC is the sole body responsible for planning, construction, management and operation of the port.

In general, the status of port management bodies may be classified as follows:

Central government
Local government
Joint committee of public and private sector
Public corporation
Private enterprise
Other (some modification of the above)

In developed countries, both the public and private sectors play important roles to ensure smooth and efficient activities in and around port areas. The consensus to establish the port management body at each port is slightly different depending on historical, socio-economical and institutional factors. Tables 9.1.1 and 9.1.2 show some examples of the status of port management bodies.

A worldwide tendency has been observed whereby the participation of the private sector is increasing especially in the field of port operations. Various kinds of activities are conducted in port areas. The major activities taking place at Santo Tomas are classified and listed in Table 9.1.3. These activities are indispensable for modern ports. In the case of Santo Tomas Port, EMPORNAC has been engaging in all these activities.

While cargo volume is not so great, one organization may be able to provide all the required services at a port. However, port activities develop year by year in accordance with the economic growth of the state. It may be assumed that in the near future the scale of the port activities at Santo Tomas may exceed the moderate size which can be managed by one organization.

An oversized body may sometimes cause internal friction, and obstruct effective utilization of a port. To prevent such an organizational disadvantage, it is essential to carefully examine the appropriate port management and operation system in the Master Plan study.

Public sector management has advantages as well as disadvantages. Port facilities including water area are regarded as public property, or social infrastructure. thus the administration of port facilities should strictly follow the national interest. In addition, since the initial investment for port facilities is huge and requires a long recovery period, only the public sector can bear such a heavy burden, especially in the developing countries. Furthermore, the public sector can enjoy lower-interest rates utilizing foreign aid loans.

However, as the public sector lacks the profit native, there are sometimes problems such as rigid organization, slow decision making, fixed budget and inefficient performance.

In order to obtain smooth and effective cargo flow in the port area, the perception of the private sector in the field of port operation should be considered in the near future. However, sudden drastic changes would be harmful, causing social conflict. As numerous activities are performed in the port, it is quite reasonable to let the private sector participate in some activities step by step. At any rate, it is advisable for EMPORNAC to study a privatization plan, considering which port services may be provided by the private sector.

Table 9.1.1 Examples of Port Management Bodies

Responsible Organization	Port Administrative Body	P o r t (Example)
Central Government	Direct management by the central government	Cherbourg (France), Port Horke (Canada)
	Public corporation established by the central government	Southampton (U.K), Marseille (France) Montreal (Canada)
Local Government	Direct management by the local government	Bristol (U.K), Rotterdam (Netherlands) Bremerharen (West Germany), Oakland (U.S.A)
	Public corporation established by the local government	New York, New Jersey (U.S.A)
Others	Central and local government	Manchester (U.K)
	Management body established by law	London (U.K), Halifax (Canada)
	Private enterprise	Port Per (U.K)

Table 9.1.2 Examples of Port Administrative Systems at Leading Ports in Developed Countries

Name of Country	Name of Port	Port Administrative Body		Financial Resources	Role of the Central Government
		Name	Category		
The United Kingdom	Southampton	B T D B (British Transport Docks Board)	Public corporation established by the central government	Mainly self-finance, loans from the government and private sector	Advising for port planning, finance, etc. by NPC (National Ports Council)
France	Marseille	P A H (Port Autonome de Marseille)	Public corporation established by the central government	Subsidies from the central government for infrastructure, self-finance, loans	Overall supervision and financial assistance to a great extent
Netherlands	Rotterdam	Rotterdam Municipality	Local government	Mainly self-finance in port sector, loans, municipal budget for deficit (financially not independent)	Limited mainly to navigation channel dredging and construction and maintenance of breakwaters
Belgium	Antwerp	Antwerp Municipality	Local government	Subsidies from the central government for infra and super structures, self-finance in port sector, municipal budget (financially not independent)	Administrative guidance and financial assistance to a great extent
West Germany	Hamburg	Hamburg State	Local government	Self-finance in port sector, municipal budget (financially not independent)	Limited mainly to navigation channel dredging
The United States	New York	Port Authority of NY & NJ	Public corporation established by NY & NJ States	Self-finance	Limited mainly to navigation channel dredging
Japan	Kobe	Kobe Municipality	Local government	Subsidies from the central government, municipal budget, bonds	Making national port improvement plan, guidance, adjustment and approval of individual long-term plans, financial assistance

Table 9.1.3 List of Management and Operation Activities at Ports

1. Control of Reclamation and Facility Construction within the Port Area

2. Provision of Port Facilities

   1) Plan-making for Port Development
   2) Fund Raising for Port Development and Improvement
   3) Construction of Port Facilities
   4) Maintenance and Repair of Facilities
   5) Assignment and Leasing of Facilities to Users
   6) Collection of Dues, Rent and Fees

3. Preservation of Orderly Port Use and Safety

   1) Coordination of Activities
   2) Quarantine for Persons and Immigration Control
   3) Marine and Land Traffic Control
   4) Police and Smuggling Control
   5) Monitoring and Control of Pollution
   6) Fire Fighting
   7) Search and Rescue

4. Licensing of Businesses

5. Training of Workers

6. Ship Handling

   1) Pilot Service
   2) Tug Service
   3) Line Handling
   4) Ship Chandlery
   5) Ship Repair

7. Cargo Handling

1) Freight Forwarding
2) Stevedoring
3) Longshoring
4) Warehousing
5) Tallying
6) Measurement
7) Surveying
8) Export Commodity Standards Inspection
9) Quarantine for Plants, Animals and Animal Remains
10) Customs Clearance
11) Leasing of Containers and Cargo Handling Equipment
12) Maintenance and Repair of Containers and Cargo Handling Equipment

8. Inland Transportation

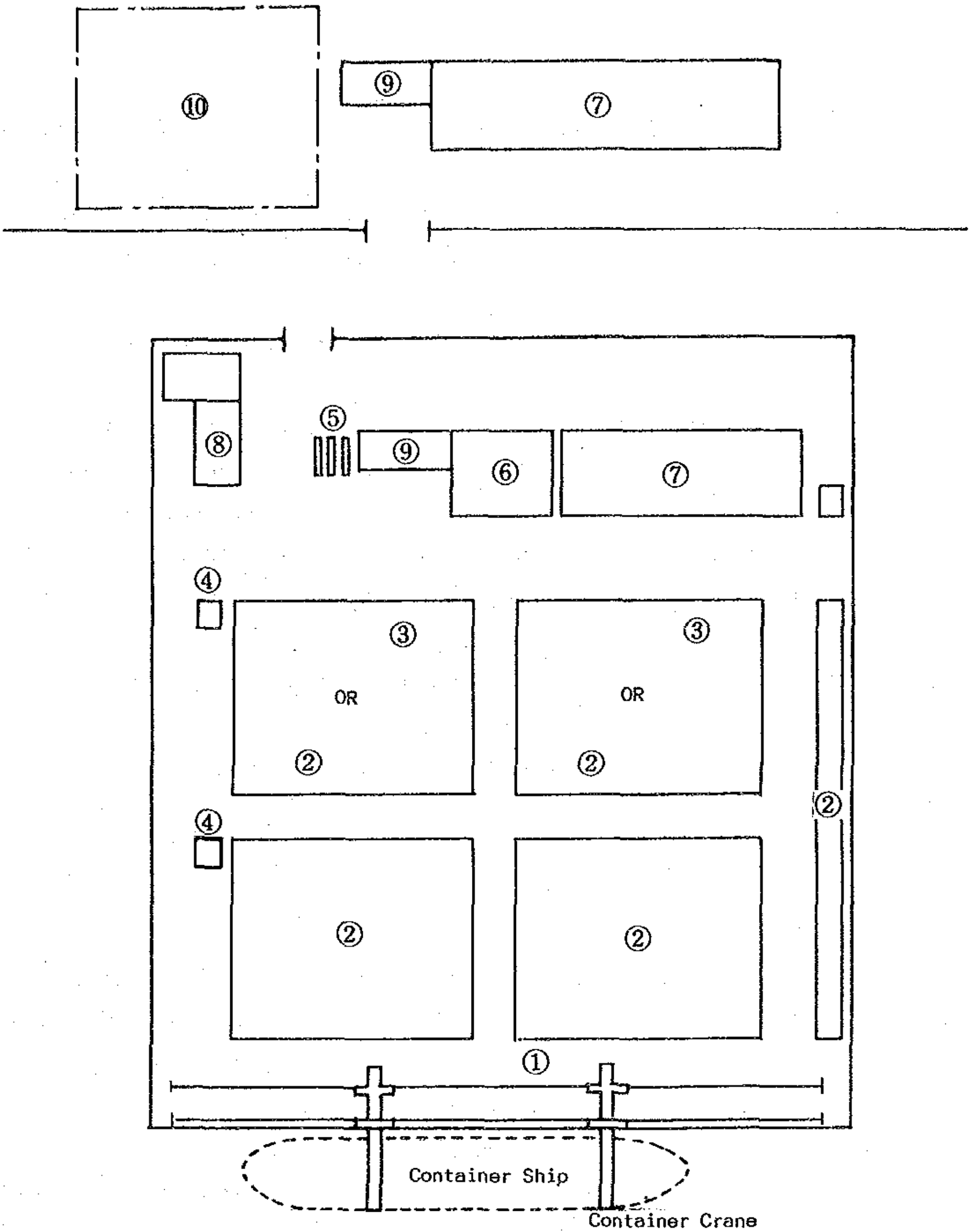
1) Vehicle Transport
2) Rail Transport
3) Barge Transport

9. Supporting Activities

1) Insurance on Ships and Cargoes
2) Ferry Service
3) Provision of Office Space for Port Businesses
4) Provision of Welfare Facilities, Medical Care and Catering Service
5) Water, Electricity and Fuel Supply
6) Communications and Information Service
7) Cleaning of Holds, Offices and Port Area
8) Security within the Port Area

10. Chart Drawing and Statistics

11. Public Relations and Port Promotion Activities



Legend
① : Quay and apron
② : Marshalling yard
③ : Container yard
④ : Switching space
⑤ : Gate
⑥ : Control tower
⑦ : Container freight station
⑧ : Maintenance shop
⑨ : Office and welfare facilities for workers
⑩ : Van pool

Fig. 9.3.1 Typical Arrangement of Container Terminal

Source: Technical Forum on Construction Technology of Container Terminals

9.2 Container Terminal Operations

Container terminals are a links between land transportation and sea transportation. Functions at the terminals include stevedoring, cargo and container storage and transportation to/from land. The principal purpose of container transportation is to provide rapid cargo handling and door to door transportation service.

The main operations at container terminals are as follows;

(1) Container cargo loading to and unloading from container ships
(2) Management of containers going out and coming into the container yard
(3) Storage and arrangement of containers in the marshalling yard
(4) Stuffing and unstuffing of containers in the container freight station
(5) Container loading to and unloading from chassis
(6) Packing and Palletizing container cargo
(7) Maintenance of containers, cargo handling equipment and vehicles.
(8) Customs clearance
(9) Information management on cargoes, vessels and containers

9.3 Container Terminal Facilities

In order to load and unload a large volume of containerized cargo rapidly, the container terminal should be designed to provide integrated use of berthing and mooring facilities, sea transport systems, cargo handling facilities, ship supply and other services.

To structure the optimum system for the Port of Santo Tomas de Castilla, facilities and main equipment are planned as shown in Fig. 9.3.1.

Major facilities consist of apron pavement along the quaywall which accomodates container ships, a container yard, a container freight station, a control tower, a maintenance shop and a gate.

The number of required facilities and the layout of the container terminal vary by operation system, kinds and volume of commodities, the operator's situation, etc.

So, detailed consideration is necessary to finalize the plans for an effective cargo handling system at the Port of Santo Tomas de Castilla.

9.3.1 Main Facilities

1). Quaywall and Apron

The quaywall is equipped with fenders, mooring posts, required water depth and length to accommodate container ships. The apron is paved with enough thickness and width to accommodate heavy cargo handling equipment.

2). Marshalling Yard

The marshalling yard is an open area provided for storage and arrangement of containers to be received and dispatched from/to the hinterland. In this yard sufficient space must be reserved for containers and empty containers to be stored.

3). Container Freight Station (C.F.S.)

A transit shed where LCL (less than container load) cargo is stuffed and unstuffed from containers.

EMPORNAC presently carries out these works, but the existing sheds are not used effectively.

4). Control Tower and Office

The function of the control tower is to oversee terminal operations such as handling containers, supervising loading and unloading and generally controlling yard operations.

Therefore the control tower is located in a high place providing a good view of the entire terminal, and includes office space necessary for operating staff, shipping agents, etc.

5). Maintenance Shop

The maintenance shop performs inspection, repair and cleaning of containers and maintenance of cargo handling machines and equipment used in the container terminal.

The scale of the maintenance shop depends upon the cargo handling machines serviced such as transfer cranes, straddle carriers and forklifts.

A new maintenance shop is necessary at the terminal, because the existing shop is already fully utilized.

6). Cleaning Facilities

The container terminal will be equipped with cleaning facilities for vehicles, cargo handling machines and container vans using pressurized water. The cleaning area requires a drainage ditch to collect polluted water, and an oil separator and sink are also necessary.

7). Van Pool

This is a space for storing and managing empty vans.

8). Fuel Oil Supply Station

Large vehicles such as transfer cranes, straddle carriers and trailers use fuel, and therefore the container terminal must include a fuel oil supply station.

9). Power Receiving Facilities

Power receiving facilities are installed to provide power for lighting, container cranes, refrigerated containers and computers.

At present, the electric power supply conditions around Santo Tomas de Castilla are rather poor, and therefore EMPORNAC should consult the power supply corporation about increasing capacity. On the other hand, EMPORNAC should increase its own generation capacity.

10). Parking Area

A parking area is prepared for vehicles on port-related business to separate general traffic from container traffic.

11). Chassis Parking Area

A parking area for chassis is necessary.

12). Gate

A gate is provided at the terminal to process documents for the delivery and receipt of cargo, check the condition of cargo and designate loading and unloading points in the container yard.

A 50 ton capacity truck scale is provided at the gate for weight inspection of container cargo, charge calculation and preparing ship loading plans.

13). Lighting Facilities

Lighting facilities are installed in the terminal for cargo handling at night.

14). Power Source for Refrigerated Containers

As for electric power outlets for refrigerated containers, there are two types depending upon the cargo handling system and container stacking system: the stand type above ground and the mould type at the ground surface.

15). Inspection Space for Customs and Quarantine

Inspection space is provided in the terminal for customs and quarantine for plants and animals.

9.3.2 Cargo Handling Machines

Cargo handling machines and equipment for effective yard operations are as follows.

1). Container Cranes

Container cranes with spreaders are installed on the apron of the container terminal for unloading import containers from ships and loading export containers onto ships speedily and efficiently.

2). Straddle Carriers

There are many types of straddle carriers. Straddle carriers carry containers between the apron and the marshalling yard.

3). Transfer Cranes

Transfer cranes are installed in the marshalling yard for stacking, storing, sorting and delivering containers, usually combined with chassis.

4). Tractors

Tractors pull the containers which are loaded onto chassis.

5). Chassis

These are a flat bed type chassis which are designed specifically for marine containers with pins to lock the containers.

6). Forklifts

Forklifts are used as handling equipment in some yards such as the van pool.

7). Computer

It is necessary to provide a computer system to increase cargo handling efficiency and improve terminal operation.

9.3.3 Handling Systems

There are many different systems to transport containers from the quaywall to the marshalling yard, and to stack containers in the yards.

The main handling systems are as follows;

1. Chassis system
2. Straddle carrier system
3. Tire-Mounted Transfer Crane system

(1) Chassis system

This system has been developed by Sea-Land Service, Inc.

Its advantages are:

1) Containers can be handled more easily and quickly.
2) Container loading and unloading in the stacking area requires no cranes.
3) Very flexible, safe and simple system.
4) The possibility of damage is lessened.
5) There is no need for skilled personnel.
6) The system is advantageous for ports with many Ro-Ro ships calling.

Its disadvantages are:

1) It is necessary to prepare as many chassis as the number of stored containers. This requires a major investment.
2) It is necessary to prepare a large stacking area as containers are stacked in only one layer.
   Sufficient distance between chassis is needed.
   Many traffic lanes are needed.
3) Rail traffic has to use a different system such as the side loader system.
4) Automatization is very difficult.

(2) Straddle carrier system

Its advantages are:

1) It is a very flexible and simple system.
2) Quick dispatch of containers is possible.
3) Containers can be stacked in layers, so the container yard area can be used efficiently.
4) The required number of operating personnel is low.
5) EMPORNAC has experience using this system.

Its disadvantages are:

1) High maintenance cost.
2) Skilled personnel are needed.
3) Moderate use of stacking area, as it is requires many traffic lanes.
4) Wheel load is very heavy, so the marshalling yard requires thick pavement.
5) Automatization is very difficult.

(3) Tire-mounted Transfer Crane System

Its advantages are:

1) Multiple number of containers can be stacked.
2) Low maintenance cost.
3) Initial investment is not so large, and investment is step by step.

4) Automatization is possible, but not so easy.

5) This system is suitable for terminals with multiple users.

6) It is easy to control cargo handling.

7) Rather thin pavement can be used in the stacking yard.

Its disadvantages are:

1) Requires heavy pavement along crane traveling route.

2) Requires highly skilled maintenance personnel.

3) It must be supported by chassis or straddle carriers.

(4) Comparison of handling systems

A comparison of the three handling system is summarized in Table 9.3.1 and 9.3.2.

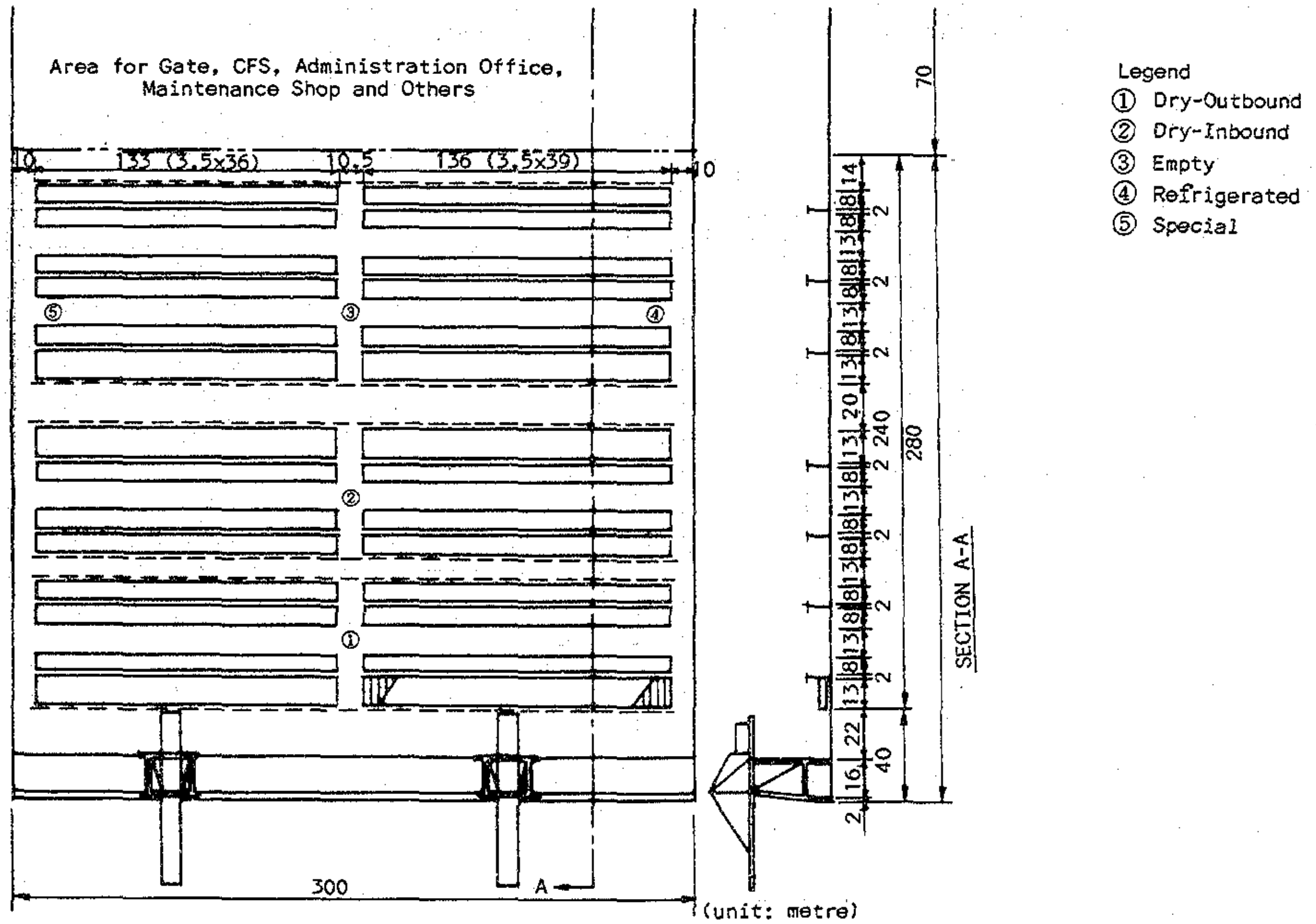


Fig. 9.3.2 Example Layout of Chassis System

Source: Japan Port and Harbour Association

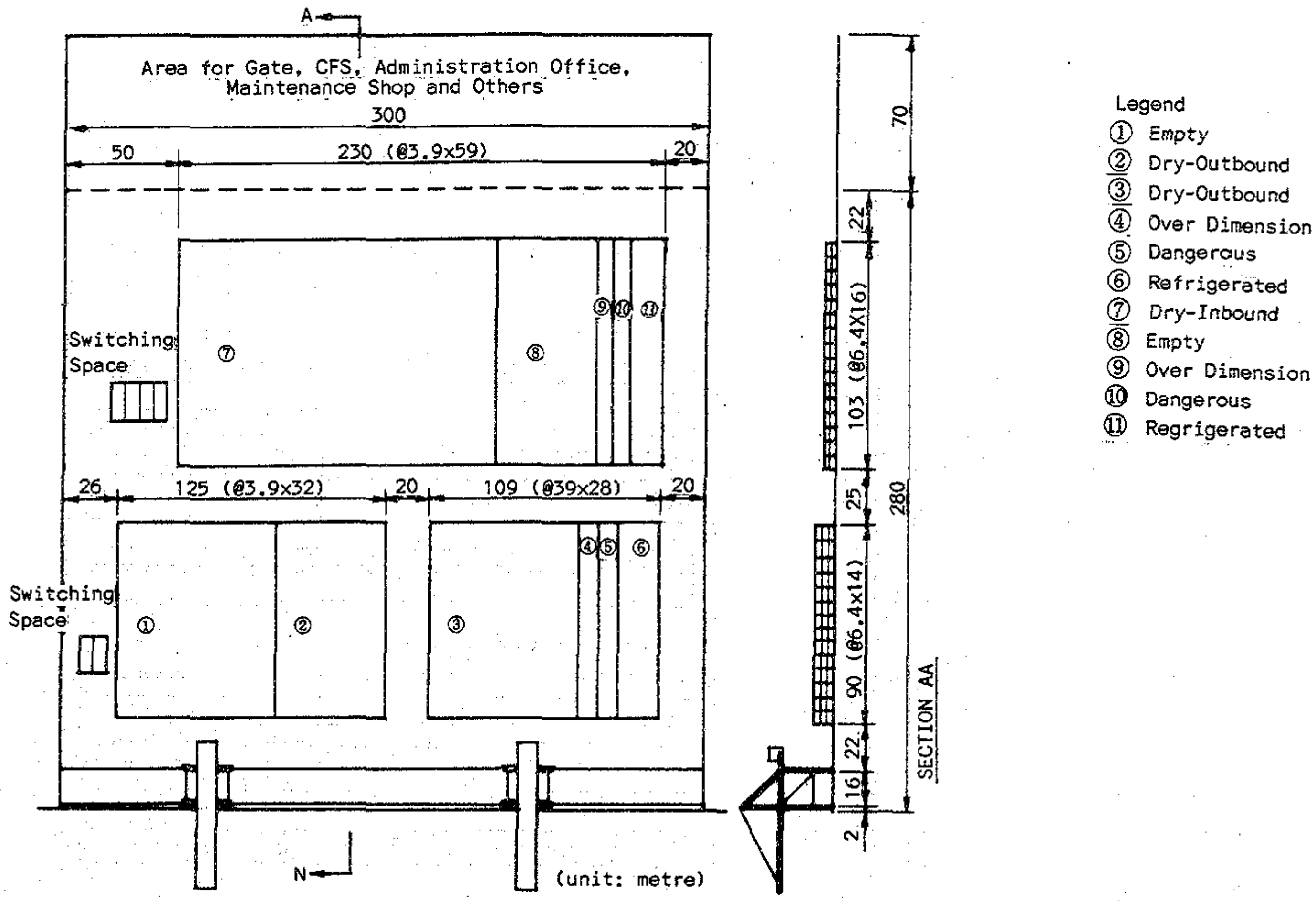


Fig. 9.3.3 Example Layout of Straddle Carrier System

Source: Japan Port and Harbour Association

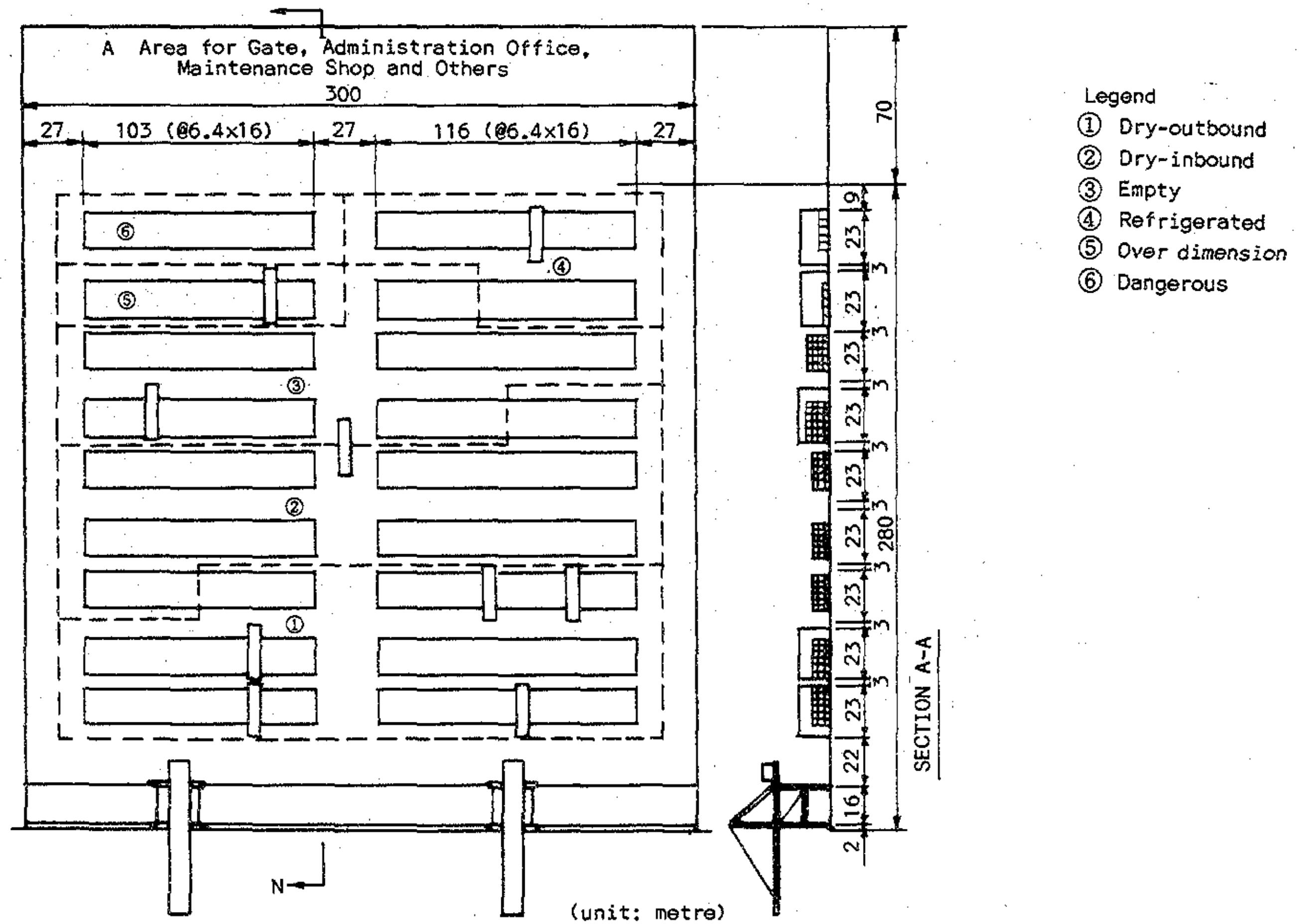


Fig. 9.3.4 Example Layout of Transfer Crane System

Source: Japan Port and Harbour Association

Table 9.3.1 Comparison of Handling Systems

System / Item	Chassis	Straddle Carrier	Tire - Mounted Transfer Crane	Present System
Storage Capacity	△	○	◎	△
Initial Cost	△	○	○	○
Flexibility of Operation	◎	○	○	○
Expandability	◎	◎	○	○
Labor	○	○	◎	△
Maintenance Cost	○	△	◎	△
Adaptability to Automation	△	△	○	△
Operation Cost	◎	○	◎	△
Skilled Lobor	◎	○	○	○
Skill to maintain machines	◎	○	△	○
Wharf Efficiency	△	◎	△	△
Total Judgment	△	○	◎	△

Key: ◎; Excellent, ○; Good, △; Some problem

Table 9.3.2 Comparison of Handling Systems

System / Item	Chassis	Straddle Carrier	Tire - Mounted Transfer Crane
Number of Berths	2	2	2
Number of Container Cranes	3-4	3-4	3-4
Number of Handling Machines for Marshaling yard	Tractors in yard 9-12 Chassis 1,600	Straddle Carriers 11-14	Transfer Cranes 7-9 Chassis 18-24
Required space per Container (20ft)	3.5m X 11.6m = 40.6m2	3.5m X 6.5m = 22.7m2	2.7m X 6.5m = 17.6m2
T.E.U's per hectare	246	440	568
T.E.U's per hectare (including ways)	134	270	360
Rate of passageway for yard	0.455	0.372	0.364
Number of Tiers	(Export) 1 (Import) 1	3 2	3 2
Number of Storage Containers (T.E.U)	134	675	900

9.4 Container Terminal Operation

Container transportation has various advantages as follows:

(1) Shortened cargo handling time.
(2) Raising ship activities.
(3) Cost reduction for packing.
(4) Cost reduction for land transportation.
(5) Decreasing interest for commodities by reduction of transportation term.
(6) Decreasing cargo damage.
(7) Decreasing stock by planning around the schedule of calling ships.

Terminal operation must be smooth and effective to fully realize these merits.

As container terminal operation is an integrated system with container cranes and various cargo handling machines, specific know-how is necessary for effective operation.

The optimum operation system for the Port of Santo Tomas is examined.

9.4.1 Facility Utilization System

The utilization system of port facilities may be divided into three types as follows:

a) Open use
b) Priority use
c) Exclusive use

Table 9.4.1 Utilization System of Port Facilities

	Open use	Priority use	Exclusive use
Publicity of facilities	All kinds of users	←	A specified user
Efficiency of cargo handling	Waiting time for mooring berth rather long. Double handling of cargoes often occurs.	Priority ships can get first service.	Users will be able to use facilities effectively, because of prior planning for operation.
Charges	Collect charges from many users	Extra charges will be collected from priority users	Revenues are obtained constantly by rental fees.
Initial cost for facilities	Recovered from charges	←	Main and common facilities are constructed by Port management body, and movable assets are brought into terminal by lessee.
Operating body	EMPORNAC	←	Lessee

9.4.2 Management and Operation Systems

Management and Operation Systems for container terminals may be divided into three types as follows:

a) Direct management and operation of all facilities in the container terminal by the port management body (P.M.B.)
b) Management of main facilities such as quaywalls and aprons by P.M.B. and other facilities are operated by users.
c) Users manage and operate all facilities in the container terminal.

Examples of construction, management and operating systems in major ports are presented in Table 9.4.2.

In the port of Santo Tomas, all port facilities are managed and operated by EMPORNAC which is the public sector, but the existing operation system for the container terminal is not effective. It is necessary to study and decide which system would be most efficient.

Note:

In Guatemala, waterfront areas such as quaywalls and aprons can not be leased out to private enterprises, by present regulations.

The following container terminal operation and management systems are considerd for the port of Santo Tomas.

(1) EMPORNAC operates and manages all facilities

In this case, as EMPORNAC has little experience in modern container terminal operation, EMPORNAC should make great efforts to improve efficiency, otherwise there may be many troubles in the link of sea and land transport.

(2) The private sector engages in some terminal operation.

One alternative is to allow the participation of the private sector for partial operation of the terminal by contract.

Some activities which the private sector might engage in are as follows.

a) Operation of maintenance shop.
b) Operation of van pool
c) Stuffing and unstuffing at C.F.S.
d) Operation of container cranes and cargo handling machines
e) Stevedoring
f) Others

The purposes of introducing the private sector into terminal operations are summarized as follows.

a) To ensure more flexible operation
b) To improve the efficiency of operation
c) To avoid full time employment of specific skilled workers
d) To emphasize competition among private firms
e) To save cost as a whole

It is needless to say that the private firms should be selected by careful consideration of their experience, capability, eagerness and financial background.

(3) Private company operates all facilities in the terminal

All facilities, as a unit, are leased out to a private sector firm which operates the entire terminal. As the container terminal needs an integrated operational system, a sole terminal operator is ideal to realize the most effective operation.

At almost all major ports in developed countries this principal is adopted.

Although the lease out system has attractive advantages, this system can not be applied unless there is a sufficient cargo volume and number of terminals. If the total cargo handling volume does not reach a sufficient level, no company will be interested in engaging in terminal operation and if there is an insufficient number of terminals, proper competition among terminals can not be expected.

9.4.3 Terminal Operators

Container terminals are located at the nucleus of the entire container transport from shippers to consignees. It is said, in general, out of the total transport cost of containers one-third (1/3) is spent at the container terminal.

Therefore it is very important for terminal operators to improve the efficiency of operation so as to reduce the cost.

Container terminal operators at major ports may be classified into six categories, as shown in Table 9.4.3.

Table 9.4.2 Example of Construction, Management and Operation System for Container Terminals in Major Ports.

Name of Port	Construction Body			Management and Operation System
	Facility	Port Management Body	Lessee of Container Yard	
Port of Marseille	Quays and land	○		. Port management body manages quaywalls, yards within 50m from quaywall and container cranes for public use.
	yard pavement	○ within 50m from quaywall	○ behind 50m from quaywall	
	Container cranes	○		. Lessee manage the yards behind 50m from quaywalls which are leased from P.M.B. and the yards are for exclusive use.
	Sheds and cargo handling machines		○	
Port of Algeciras	Quays and land	○		. P.M.B. manages quaywalls and yards within 80m from quaywall and these are for public use.
	yard pavement	○ within 80m from quaywall	○ behind 80m from quaywall	. Operator sets the container cranes on the aprons which are managed by P.M.B. and operates the cranes.
	Container cranes		○	. Operators manage the yards behind 80m from quaywall which are leased from P.M.B. and the yards are for exclusive use.
	Sheds and cargo handling machines		○	
Ports of Hamburg Rotterdam and Antwerp	Quays and land	○		. Lessee manages all the facilities in the container yard such as quaywalls and land which is leased by P.M.B.
	yard pavement		○	. Cargo handling equipment is all purchased by lessee.
	Container cranes		○	
	Sheds and cargo handling machines		○	
	Public Sector*			
Ports of Tokyo, Yokohama, Osaka, and Kobe (Public Sector*)	Quays and land	○		. Public corporation leases out all container terminal facilities to shippers.
	yard pavement	○		. Terminals are for exclusive use and the real operators of the terminal are assigned by the lessee.
	Container cranes	○		
	Sheds and cargo handling machines	○ Shed	○ cargo handling equipment	

* Public corporations which are established in each port by central and local government to construct and manage the container terminals for foreign trade.

Table 9.4.3 Terminal Operators

Operator	Port (Example)
Port Management Body	Kao-hsiung, Chi-lung (Taiwan), Seattle, Boston (U.S.A), Singapore (Singapore)
Lessee	San Francisco (U.S.A), Sydney (Australia), Hamburg (West Germany)
Terminal operating firm selected by lessee	Tokyo, Yokohama, Osaka, Kobe (Japan)
Stevedoring, longshoring, shipping agent or warehousing firms selected by shipping company	Jacksonville (U.S.A) Kobe, Yokohama (Japan)
Company established by Port Management Body	Manila (Philippines)
Others	Kran (Malaysia), Kitakyusyu (Japan)

9.5 Organization of Container Terminal

9.5.1 Organization of Container Terminal

The container terminal consists of several types of facilities, cargo handling equipment and computers. It is necessary to establish a reasonable organization in order to ensure efficient cargo flow and processing of documents for customs, shipping lines, shippers and land transporters.

Considering the basic functions at the terminal, the organization of the operator should be independent from other terminals.

Following is a sample organization for management of a small-scale (one or two berth) terminal.

Section	Function
Management of container terminal	Berth assignment, coordination with related organizations, management of computer system, documentation.
Control of container yard	Stacking plan for marshalling yard Control of gate Control and examination of refrigerated containers
Operation of cargo handling	Operation of cargo handling machines Management of stevedores
Maintenance of machinery and containers	Maintenance of cargo handling and related machinery Repair and cleaning of container vans

EMPORNAC is going to increase the capacity of the computer system which is installed at the Data Processing Division. However, an exclusive computer system for the container terminal may be necessary.

Table 9.5.1 Some Examples of Organization for Container Terminals

* *Terminal Operation and Management Organization of the Port of Pusan*

- General Affairs Div.
  - Planning Section
  - General Affairs Section
  - Accounting Section
  - Data Processing Section

- *Yard Management Div.*
  - Yard Operation Section
  - *Container Freight Station Section*
  - Maintenance Section

The port management body owns the container terminal, including quays and yards which are leased to the Pusan Container Terminal Corporation (public sector) which is responsible for operation and management.

* Organization of Container Terminals in Japan

Management Terminal Division

Terminal Operation Division

Maintenance Division

Machinery Operation Division

* *Examples of Stevedoring for Container Ships*

General organization of container gangs in Japan

Average productivity 25 - 30 containers per gang per hour

	1 container crane	1 transfer crane	3 chassis	on ship	total
Number of laborers	3	2	1 * 3	6	14

Highest productivity of container terminal in Japan

Average productivity about 50 containers per gang per hour

	1 container crane	2 transfer cranes	4 chassis	on ship	total
Number of laborers	2	2 * 2	1 * 4	6	16

Port of Kao-hsiun in Taiwan (example of straddle carrier system)

Productivity 17 - 23 containers per gang per hour

Number of laborers are one crane man, one foreman and one deck man per container crane.

9.5.2 Method of Maintenance of Cargo Handling Machines

There is no existing maker of cargo handling machines in Guatemala. Therefore, all maintenance work is carried out by EMPORNAC. However, as mentioned in Chapter 3, the condition of the existing machines is not so good, due to some problems in the maintenance section despite their great efforts.

EMPORNAC's maintenance system consists of regular checks including oil changes, changing brake shoes, etc. and repair of damaged machinery. They do carry out necessary regular maintenance work such as overhauls every few years.

In Japan, a daily check is carried out and parts are changed at regular intervals, therefore the operating ratio is raised by minimizing obstacles to cargo handling. Examples of regular checks in Japan are as follows.

(1) Check before work — Operators have to check for leaks of water and oil, test brakes and check for abnormal conditions such as unusual noise.

(2) Report after work — Operators write a working report of operating conditions such as braking and acceleration. If something is wrong, it is repaired by the maintenance section during non-working time. At that time, necessary parts are ordered.

(3) Monthly check — Repair and adjustment of all abnormal points noted in the daily working report.
Change lubricating oil and parts in accordance with working time and/or traveling distance.
Function check, test run (inspection)

(4) Regular inspection authorized by law
Check inspection items as authorized by law, and all worn parts are changed.

As cargo handling machines at container terminals are expensive, it is difficult to keep spare machines. It seems to be essential to change the system of maintenance to a more regular system in order to avoid stopping terminal operations due to breakdowns of major machines.

EMPORCAC's maintenance staff are listed in Table 9.5.2.

Table 9.5.2 EMPORNAC's Maintenance Stuff

			Number of personnel
Mechanic	III	(Crane, Straddle Carrier)	5
	II	(Forklift, other cargo handling machines)	5
	I	(Assistant)	22
Lather	II		1
	I		3
Welder	II		3
	I		2
Painter	II		2
	I		2
Electric mechanic	II		2
	I		2
Tire repair			3
Secretary			3
Chief (Supervisor)			3
Battery repair			1
Clearer			1
TOTAL			60

As mentioned before, improvement of the maintenance system is quite crucial. However, in the course of the change there may be some troubles caused by lack of proper engineers, spare parts and budget. To prevent such troubles, EMPORNAC should commence a study to formulate the most effective maintenance system as soon as possible.

9.6 Container Handling Tariff

It may be necessary to review the present port tariff rate for the new container terminal system. Principles of charges may differ depending on the management and operation systems. Charging policy should be carefully examined according to the operation system.

Charges for container handling for example are as follows:

	Items
1). Container handling charge	Separate empty containers, stuffed containers 20ft, 35ft, 40ft container Conventional ship, full container ship
2). Rent of cargo handling machinery Container Crane Straddle carrier Trailer Transfer crane Tractor and chassis Forklift	Rental unit is per hour or container
3). Wharfage	
4). Measurement of container weight	
5). Tallying and measurement	
6). Storage charge	separate empty, stuffed
7). Storage charge for refrigerated container	
8). Night working charge	Extra charge for late night work
9). Cargo stuffing and unstuffing	Charge for working in C.F.S.
10). Tranship container	
11). Container shift within ship	
12). Container shift within container terminal	

13). Container loading to and unloading
from train

Note;

Other port charges such as pilotage, tug boat use, mooring and unmooring and water supply are the same as for general cargo vessels.

9.7 Computerized Automated Container Terminal

Responding to the increase of container cargoes, it becomes more difficult to carry out all operations manually. Container terminals of international standard size can handle more than 100,000 T.E.U. per year. As terminal operational activities are inter-related, one mistake can cause many errors. Moreover cargo movement, document action and information flow are also closely connected. These can not be treated separately. To prevent confusion at the terminal and improve handling efficiency, it is quite critical to introduce a computer system to assist terminal operations.

The computerization of container terminals may be divided into four steps, and the outline of each of the steps is as follows:

(1) Plan and Management Control System

1) Storage and slot control of the containers in the yard
2) Planning of ship loading/unloading
3) Planning of land transport loading/unloading
4) Inquiry from/to users such as shippers
5) Keeping data such as yard status, export container list, etc.

(2) Yard Operation Control System

1) Control of operation instruction data for each crane, with loading and unloading sequence decided by the planning system.
2) Optimum positioning of yard equipment by assessing the priority of each work.
3) Control of container handling works in the yard, by which works on ships, receiving and delivering containers are controlled, and work instruction outputs such as container number, size and address to handling equipments are controlled.

(3) Crane Operation Control System

1) Control of work instruction data, by which work instructions (container number, size, address) transmitted from the yard operation system are stored in a microcomputer installed on the yard crane and displayed in the operator's cab.
2) Control of crane operation which makes address arrival decision and

controls operating sequence of cranes, etc, with microcomputer installed on yard crane.

3) Automatic driving of crane which makes automatic control of crane's traveling and traversing.

(4) Automation System

Automatic systems catch and release containers automatically. There are two kinds of automation systems: fully unmanned systems and semi-automatic systems.

Table 9.7.1 Computerized Service for Container Yards

1. Navigation Control System

    Navigation Traffic Control System

    Navigation Traffic Schedule Control System

2. Container Yard Management System

    Marshalling Yard Management

    - Slot Control for Incoming Containers (Import)
    - Slot Control for Outgoing Containers (Export)
    - Slot Management for Empty Containers
    - Assignment of Stacking Containers

    Gate management

    - Management of Incoming Containers
    - Management of Outgoing Containers

3. Terminal Cargo Handling Planning

    Stevedoring Plan

    Unloading Plan

    Assignment of Cargo Handling Equipment

    Stuffing and Unstuffing

4. Document Control

    Business of Shippers and Vessels

    Business of Import/Export

    Vessel Control

    Making and Processing Container Terminal Documents

    Tallying and Measurement

    Charge Calculation and Financial Control

Table 9.7.2. Advantages of Computerized Terminal

The major advantages of a computerized terminal are listed below.

Flexibility for handling containers increases.

Effective use of marshalling yard.

Terminal operation may be managed quickly and correctly.

Business will be standardized and management of documents becomes easier.

It become easy to get container inventory, and to supply empty containers speedily.

Many statistics for analysis are readily available.

Many skilled personnel are not needed.

The movement of containers will be minimized.

Information on container flow can be obtained rapidly, and therefore effective service to consignees and shippers will be available.

The operation work may be simplified.

PART II SHORT-TERM PLAN

CHAPTER 1 SHORT-TERM PLAN FOR THE PORT DEVELOPMENT

1.1 The Basic Concept of the Short-term Plan

The Short-term Plan is prepared as a first stage plan with a target year of 1995 for the development of the Port of Santo Tomas de Castilla. The Short-term Plan is made within the framework of the Master Plan determined in Chapter 8.

In order to formulate the Short-term Plan, the use plan of the existing terminal is studied based on the following premises by vessel type.

(a) Container ships

In the year 1995, the number of containers in terms of TEU transported by full container ships through the Port is estimated as 116 thousand, 1.7 times the present number. On the other hand, the volumes of other cargoes such as general cargoes, solid bulk cargoes and cargoes carried by Ro-Ro vessels are also forecast to increase in the same period. Judging from the present high rate of berth occupancy at the existing terminal and the future increase of cargo volume , even if petroleum cargoes are shifted to a new terminal, it will be impossible to handle all the remaining cargoes at only the existing facilities in the future. Furthermore, it would not be economical to use the existing terminal for container ships because the existing terminal cannot accommodate full container vessels (see Part I, Section 8.1).

(b) Petroleum Tankers

From the standpoint of safe operations and considering the increasing volume of dangerous cargoes handled at the Port, it is advisable to construct a new petroleum terminal (see Part I, Section 8.1).

(c) Bulk Carriers

In the year 1995, the volume of solid bulk transported by bulk carriers through the Port is estimated as 436 thousand metric tons, 1.7 times the present volume. To handle the bulk cargoes in that year, there are three alternatives: preparation of new cranes with a larger capacity at the existing terminal, use of the present cargo handling system at the existing terminal and construction of a new terminal equipped with larger cranes. The optimum case is selected from the economic point of view.

(d) Other vessels

Other vessels are mainly conventional vessels and Ro-Ro vessels. As previously mentioned in Part I, Section 8.1, it is advisable to continue the use of the existing terminal mainly for these vessels.

Thus, as for the use plan of the existing terminal in the target year 1995, the following three alternatives are proposed:

Case 1: The existing terminal comprising six berths will serve conventional and Ro-Ro vessels, and a new bulk terminal will be constructed.

Case 2: Five of the six existing berths will serve conventional and Ro-Ro vessels, and one berth will serve bulk carriers instead of constructing a new terminal. But new mobile cranes with a larger lifting capacity will be procured.

Case 3: Four of the six berths of the existing terminal will serve conventional and Ro-Ro vessels and two berths will serve bulk carries with the present cargo handling system.

In the examination of the alternatives, the difference of ship waiting cost between the three cases, the construction cost for the new terminal and the purchase cost of the new cranes are compared. The ship waiting costs are estimated according to the following premises using queuing theory:

(a) Cargo volume handled in the target year (Unit: Thousand MT):

Break Bulk:	Total	843
	Bananas	432
	Others	411

Solid Bulk:

		Shipping Route	
		USG/CARIB	E/CARIB
Total	436	282	154
Fertilizer	256	102	154
Grains	180	180	-

(b) Average Ship Size:

Banana Ships:	7,700 DWT *(1,912 MT)
Other conventional Vessels:	6,600 DWT (1,169 MT)
Ro-Ro Vessels:	6,900 DWT (998 MT)
Bulk Carriers:	10,000 DWT (9,000 MT)

*: Average Cargo Handling Volume per Ship

(c) Cargo Handling Productivity:

Bananas:	50 Tons / Hour
Other Break Bulk:	29 Tons / Hour
Cargoes in Trailers:	91 Tons / Hour
Solid Bulk: Existing System:	44 Tons / Hour
*New System:	188 Tons / Hour

*: - Type of Cranes: Mobile Cranes with Clamshell Grabs
- Lifting Capacity: 10.4 Tons Excluding Grab Weight with 18 M Reach, Maximum Capacity: 150 Tons
- Number of Cranes per Berth: 2 (See Part I, Section 8.2.2(3))

(d) Daily Ship Cost (See Part I, Section 8.1 and 8.2.2 (2))

(e) Investment Cost:

Infrastructure of a New Terminal:	23.20 Mil. Q
Access Road:	5.06 Mil. Q
Mobile Cranes:	6.17 Mil. Q *(1.06 Mil. Q)
Total	34.43 Mil. Q *(2.21 Mil. Q)

*: Initial investment cost transformed to annual cost

According to the above conditions, the ship waiting costs of respective cases are computed. Thus, the comparison amoung the three alternatives is summarized as follows:

Unit: Mil. Quetzales / Year

Case	Berth No. Conventional & Ro-Ro Ships	Berth No. Bulk Carriers	Conventional & Ro-Ro Ships Waiting Cost	Bulk Carriers Trans. Cost	Bulk Carriers Waiting Cost	Berth Cost	Total Cost
1	6	1	0.18	9.71	0.18	2.21	12.11
2	5	1	0.62	9.71	0.18	1.06	11.56
3	4	2	2.54	12.14	0.96	-	15.64

Note: Assuming that half of the total ship cost will be carried by the country and the rest by foreign countries.

In Case 2, the total cost is the minimum, so this case is the most economical. Thus, the existing terminal will handle the conventional and Ro-Ro vessels, and the bulk carriers. Two mobile cranes with a larger lifting capacity will be prepared.

From the above, the following new terminals are planned in the Short-term Plan:

- Container Terminal
- Petroleum Terminal

When planning the container terminal, the optimum number of berths and water depth are examined using the same method adopted in Part I, Chapter 8.

1.2 Required Scale of New Terminals

1.2.1 Container Terminal

(1) Forecast Number of Containers through the Port

The number of containers in terms of TEU transported through the Port in the year 1995 is forecast based on the same premises adopted in Part I, Section 8.2.1(1).

(a) Net Cargo Volume:

Import: 497,000 MT
Export: 457,000 MT
Total: 954,000 MT

(b) The number of containers to be handled at the new container terminal:

Unit: Thousand TEU

	USG/CARIB			E/CARIB			Grand Total		
	Stuffed	Empty	Total	Stuffed	Empty	Total	Stuffed	Empty	Total
Import	40	6	46	7	5	12	47	11	58
Export	31	15	46	10	2	12	41	17	58
Total	71	21	92	17	7	24	88	28	116

(2) Terminal Cost

Herein, two alternative water depths along the berths of the new container terminal, -9 meters and -11 meters, are considered. The differences of construction and maintenance costs between the two alternative cases are shown as follows:

Unit: Quetzales

Case	Water Depth	Berth Length	Difference of Costs				
			Infra-structure	*Dredging of Basin	*Total Initial Cost	Mainte-nance Cost	*Transferred Annual Cost
	(M)	(M)	Mil.	Mil.	Mil.	Mil./Y	Mil./Y
1	9	170	-	-	-	-	-
2	11	250	+8.00	+21.48	+29.48	+0.08	+1.24

Note: (1) The same premises as in Part I, Section 8.2.1 (6).
(2) Two gantry cranes per berth will be prepared.
*: In this case, the number of berths is one.

(3) Required Number of Berths by Water Depth

The optimum number of berths is calculated by water depth by using the same method mentioned in Part I, Section 8.2.1 (7). The results are indicated as follows:

Case No.	Water Depth (M)	Average Ship Size USG/CARIB (TEU Capacity)	E/CARIB	Ship Arrival (Ships/D)	Average Service Rate (Ships/D/B)	Berth Occupancy Ratio	Average Waiting hours	Required Berth No.
1	9	500	1,200	0.687	0.96	0.71	37.5	1
2	11	1,200	1,200	0.393	0.79	0.49	18.1	1

(4) Total Transportation Cost from Origin to Destination Ports

The total transportation cost from origin to destination ports comprises transportation cost by container ship, terminal construction and maintenance costs and ship waiting cost at ports. The difference of total transportation costs between the two alternative cases is summarized as follows:

Unit: Mil. Quetzales / Year

Case No.	Berth Depth (M)	Transport Cost by Ship	Terminal Construction and Maintenance Costs	Ship Waiting Cost	Total Cost	Berth No.
1	9	-	-	-	-	1
2	11	-3.11	+1.24	-3.86	-5.73	1

(5) Optimum Water Depth

The optimum required water depth along the berth is selected by comparing total costs including access channel dredging cost. In Section 1.2.1 (2), water depths of 9 meters and 11 meters are proposed as alternatives. Judging from the forecast traffic through the access channel, a channel width for only one-way traffic will be sufficient in the year 1995 (refer to Part I, Section 8.5 (1)). Hence, in the former case, dredging will not be necessary. In the latter case, a new channel will be created alongside the existing channel and the dredging volume is estimated as around 1.8 million cubic meters. Thus, the total transportation costs by container ships are summed up including the dredging cost of the access channel as follows:

Unit: Mil. Quetzales / Year

Case	Berth Depth (M)	*Transport Cost of Containers	Channel Dredging Cost	Total Transport Cost	Least Cost	Berth No.
1	9	-	-	-		1
2	11	-5.73	+0.64	-5.09	X	1

*: See Section 1.2.1 (4).

Thus, in the year 1995, 11 meters is selected as the optimum water depth. For the same reasons mentioned in Part I, Section 8.2.3, it is also advisable to construct a quaywall which will be able to bear deepening of the waters immediately adjacent the quaywall from 11 meters to 13 meters in the future.

(6) Required Berth Length

Through the above examination, a container terminal with the following dimensions and facilities is considered economical:

Water Depth: 11 meters
Berth Length: 250 meters
No. of Container Gantry Cranes: 2

In this case, the terminal can serve only one container ship at a time. From this case, a derivative alternative can be considered. Without changing the water depth, superstructures and cargo handling facilities from the base case, the following alternative is proposed to be examined:

Water Depth: 11 meters
Berth Length: 500 meters
No. of Container Gantry Cranes: 2

In this alternative case, two container ships can berth at the same time. Though container gantry cranes can serve only one ship at the same time, another ship can receive other services such as mooring and unmooring operation, preparation of cargo handling, preparation and procedure of departure and draft check. Hence, in the alternative case, ship waiting time at the Port will be saved compared with the base case. The result of the comparison between the two cases is summarized as follows:

Unit: Mil. Quetzales / Year

Case No.	Water Depth (M)	Berth Length (M)	No. of Container Gantry Cranes	Savings of Ship Waiting Cost	Additional Construction Cost	Total
1	11	250	2	-	-	-
2	11	500	2	-0.99	+1.02	+0.03

According to the above result, there is not much difference between the two cases. However, the latter case has a great advantage that even if one berthing place will become unusable due to some accident, the container terminal will not be closed compared with the former case when only one berthing place will be prepared. Hence, 500 meters is proposed as the berth length in the year 1995.

(7) Required Number of Container Gantry Cranes Considering Maintenance and Repairs of the Cranes

In the above examination, it is proposed to prepare two container gantry cranes without considering the case where a crane will become unusable due to regular maintenance or repair. Taking account of this, the necessity of an additional crane is examined herein. In the case where only two gantry cranes will be prepared, there will be heavy congestion in those periods when a crane will be under regular maintenance or repair. On the other hand, in the case when an additional crane will be prepared, even if a crane is unusable, there will be no congestion and ship waiting cost will be saved at ordinary times by using three cranes compared with the former case. The comparison between the two cases is summarized as follows:

Unit: Mil. Quetzales / Year

Case No.	Water Depth (M)	Berth Length (M)	No. of Container Gantry Cranes	Saving of Ship Staying Cost at the Port	Additional Cost for Cargo Handling Facilities	Total
1	11	500	2	-	-	-
2	11	500	3	-1.94	+1.77	-0.17

According to the above result, there is not much difference between the two cases. However, in the former case, when one of the two gantry cranes is unusable due to regular maintenance or repair, the average ship waiting hours per ship are estimated as around 58 hours showing serious congestion. Hence, it is advisable to prepare three gantry cranes in the year 1995.

(8) Cargo Handling System at the Container Yard

As for the cargo handling system at the container yard, three systems, straddle carrier, transfer crane and chassis systems, are considered and these systems have various merits and demerits (see Section 9.3.3). Taking account that straddle carriers are being used at the existing terminal, to make the most use of EMPORNAC's experienced personnel and the existing machines,the straddle carrier system is proposed for the new container yard.

(9) Apron

An apron where containers are loaded or unloaded onto or from container ships by gantry cranes is planned as follows:

Length: 500 Meters
Depth : 40 Meters
Area : 20,000 Sq.Meters

(10) Marshaling Yard

The required area of the marshaling yard of the new terminal in the year 1995 is calculated according to the following premises:

(a) Number of Containers Handled at the Container Terminal

Unit: thousand TEU

	Stuffed	Empty	Total
Import	47	11	58
Export	41	17	58
Coffee	17	7	24
Others (Dry)	18	7	25
Others (Reefer)	6	3	9

(b) Required Number of Storage Spaces at the Marshaling Yard

$$L = My / Dy \times Ds$$

L : Required Number of Storage Spaces at the Marshaling Yard
My: Number of Containers Transported through the Port per annum
Dy: Operating Days: 365 Days
*Ds: Average Staying Days:
Import: 10 Days
Export: Coffee: 3 Days
Others: 5 Days

*: These days are estimated by referring to the actual days at the existing terminal.

	(Import)		(Export:Coffee)		(Export:Others)		(Stuffed Reefer)
L =	58,000/365x10	+	24,000/365x3	+	28,000/365x5	+	6,000/365x5
=	1,589 TEU	+	197 TEU	+	384 TEU	+	82 TEU

(c) Required Slot Number

$$Ns = L / H \times V$$

Ns: Required Slot Number
L : Required Number of Storage Spaces at the Marshaling Yard
H : Number of Layers of Stacked Containers:

	Maximum	Average
Import:	3	2
Export(Excluding Stuffed Reefer):	3	2.5
Stuffed Reefer:	2	2

V : Storage Variation = The Peak Number of Stored Containers / The Average Number of Stored Containers: *1.3

*: This value is estimated by referring to the actual variation record at the existing terminal.

Ns (Excluding Reefers) = (1,589 / 2 + 197 / 2.5 + 384 / 2.5) x 1.3
= 1,335 Slots in TEU per one Terminal

Ns (Reefers) = 82 TEU / 1.7 TEU / Box / 2 x 1.3
= 32 Boxes per one Terminal

(d) Dimensions of each Slot

The dimensions of each slot for a 20 foot container for the straddle carrier system are shown as follows:

Length: 6.5 Meters
Width : 3.6 Meters

(e) Arrangement of Slots

Slots are arranged rectangular to the berthing line. Ninety-eight slots are arranged parallel to the berthing line and fourteen slots perpendicular to the line.

Thus, the dimensions of the marshaling yard are planned as follows:

Length: 500 Meters
Depth: 116 Meters
Area: 58,000 Sq.Meters

The required number of straddle carriers is shown as follows:

To serve for container handling by gantry cranes:
2 / gantry crane x 3 gantry cranes = 6
To deliver and receive containers to and from chassis is or C.F.S.: 2
Total: 8

(11) Container Freight Station

The required area of the container freight station where L.C.L. cargoes are stuffed and unstuffed is computed according to the following premises:

(a) Number of Containers Carrying L.C.L. Cargoes in the Year 1995

Unit: Thousand TEU

	L.C.L.	F.C.L.	Total
Import	20	27	47
Export	*17	24	41

*: Assuming that the commodity is coffee.

(b) Transport Shares of Coffee through the Port by Truck and Railway

The transport shares of coffee through the Port by truck and railway are estimated by referring to the actual situation at the existing terminal as follows:

Truck : 72 %
Railway: 28 %

(c) Number of Containers at C.F.S. for Trucks

Thus, the number of containers which will be served at the C.F.S. for trucks is calculated as follows:

(20,000 TEU + 17,000 TEU x 0.72) / 365 Days x *1.5 = 132 TEU / Day

*: Daily Variation

(d) Required Number of Bays

The required number of bays at the C.F.S. for trucks is calculated as follows:

Productivity per Bay: 3.5 TEU / Day
132 / 3.5 = 38 Bays

(e) Dimensions of C.F.S. for Trucks

Width: 38 Bays x 3.5 M / Bay + *10 M = 143 Meters
Depth: 40 Meters
Area : 5,720 S.Meters
*: Width for office

(12) Railway Yard

At the railway yard, two tracks will be prepared. One track will be used for loading or unloading cargoes and the another track will be used as a sidetrack. An area for stuffing or unstuffing L.C.L. cargoes into or from container boxes along the track will be prepared. A storage area for containers will also be prepared. Thus, the following railway yard is planned:

Length: 480 Meters
Depth : 60 Meters
Area : 28,800 S.Meters
No. of Tracks: 2
Cargo Handling Machines: 1 Forklift

(13) Van Pool

A storage yard for empty container vans (hereinafter referred to as the van pool) which are not scheduled to be shipped away from the container terminal will be needed to ensure efficient operation at the marshaling yard. Such a van pool can be leased to private sector firms if they so desire. The van pool is planned according to the following premises:

No. of Layers of Stacked Containers: 4
Storage Capacity of one Block: 100 TEU
Dimensions of one Block:
Length: 6.4 M / Slot x 5 Slots = 32.0 Meters
Width : 2.7 M / Slot x 5 Slots = 13.5 Meters
No. of Blocks: 6

Thus, the dimensions of the van pool are indicated as follows:

Length : 216 Meters
Depth : 70 Meters
Area : 15,120 S.Meters

(14) Terminal Office

The head office of the container terminal is planned as follows: