CHAPTER 3
PRESENT SITUATION OF THE PORT

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3.1 Natural Conditions

3.1.1 Location

The Philippines has more than 7,000 islands which are divided into three groups of islands: Luzon, Visayas and Mindanao. Of those islands, Luzon is the biggest, most developed, and therefore, most populous (Refer to Fig. 3.1.1).

Manila Bay is situated in the middle of Luzon Island, connecting at its mouth with the South China Sea. The Port of Manila is located at the innermost eastern shore of the Bay and it is the biggest port in the country and the main gateway to the Philippines. The Port of Manila is separated into three sections: South Harbor, Manila International Container Terminal (MICT) and North Harbor. South Harbor and MICT are used for international trade and North Harbor for domestic trade.

When the Spanish were still ruling the Philippines, they began to use Manila as the base port for foreign trade in the middle of the 19th century. After the United States of America took over the colonial occupation from Spain around the beginning of the 20th century, they started to construct new wharves for foreign trade at South Harbor and reclaimed the narrow strip between Bonifacio Drive and the wharves, followed by the construction of South Breakwater.

Until the beginning of World War II, the Pasig River banks were used for domestic trade, and the North Breakwater was also being constructed around that time. After the war, the existing North and South Harbor facilities were gradually developed and Pier 16 was constructed in the early 1960s. The offshore area west of North Harbor was reclaimed and it is now called the Manila International Container Terminal (MICT).

3.1.2 Topography

The Port of Manila lies at the west end of the City of Manila which occupies the central part of Metro Manila, with 4 adjacent cities and 13 municipalities.

The City of Manila rests on low alluvial land along the Pasig River and the river itself splits the Port of Manila into two parts: the South Harbor and North Harbor area including MICT. The Port of Manila directly faces Manila Bay, the southwestern part of which is narrow and connected with the South China Sea through the North and South Channels off Corregidor Island, approximately 45 km from the estuary of the Pasig River.

The water depth of the two channels is deep enough for large ships to enter. The seabed is not so steep inside the Bay and the water depth about 30 km off the Port is still about 20 m below MLLW. The Bay is surrounded by the Bataan Peninsula to the west and Cavite Province to the south. The Zambales mountain range stretches north of Bataan and northwest of the city. East of Manila the Sierra Madre mountain range runs from north to south. Spacious plains, known as the Central Plains of Luzon, run northwards.

These topographical characteristics protect Manila from strong east winds caused by typhoons and from high waves generated by southwest monsoon winds.

Fig. 3.1.2 shows the site of the Manila South Port Rehabilitation Project. The Study Team made a field reconnaissance throughout the area of Manila North and South Harbors and completed the topographical drawing shown in Fig. 3.1.3.

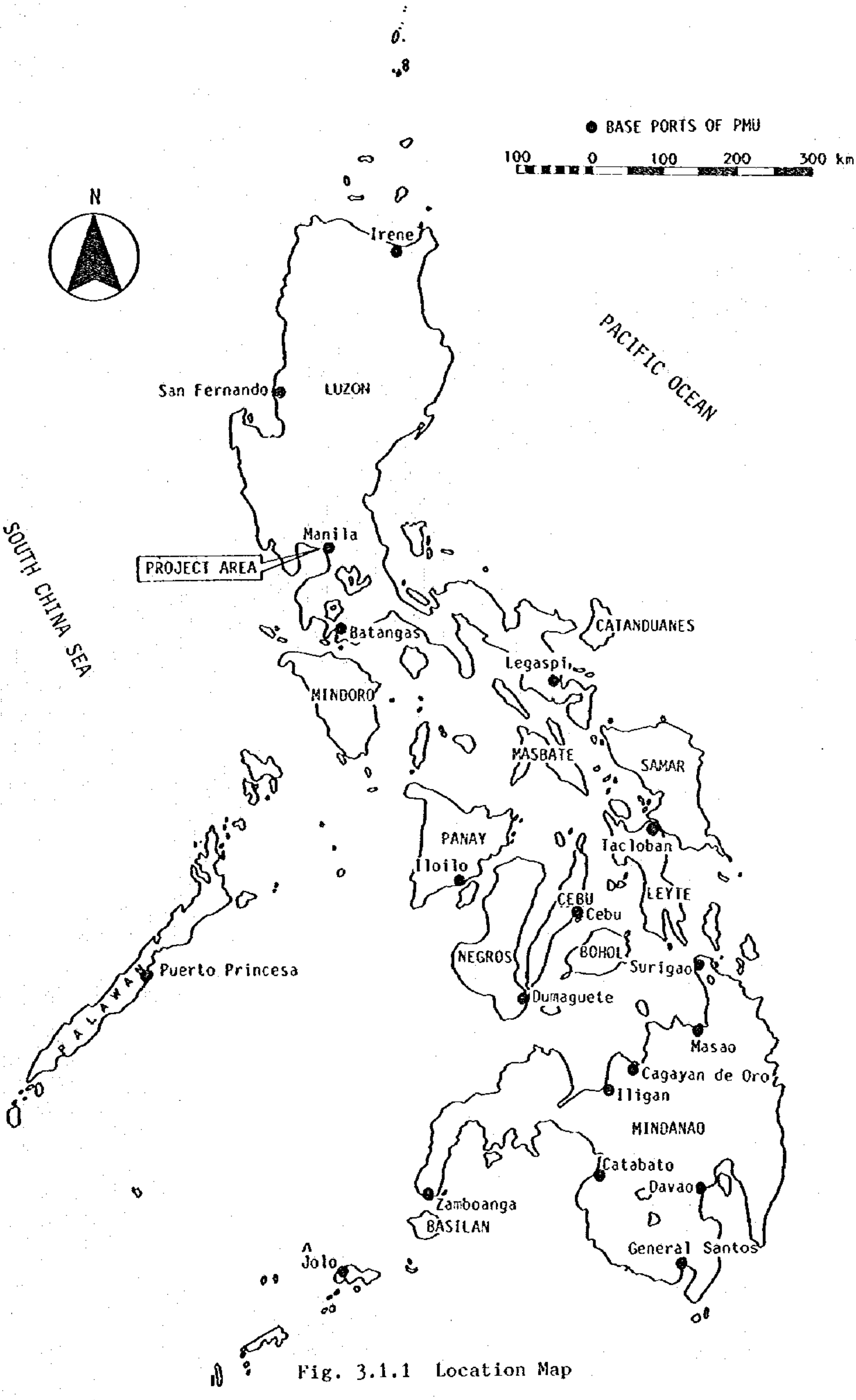

Fig. 3.1.1 Location Map

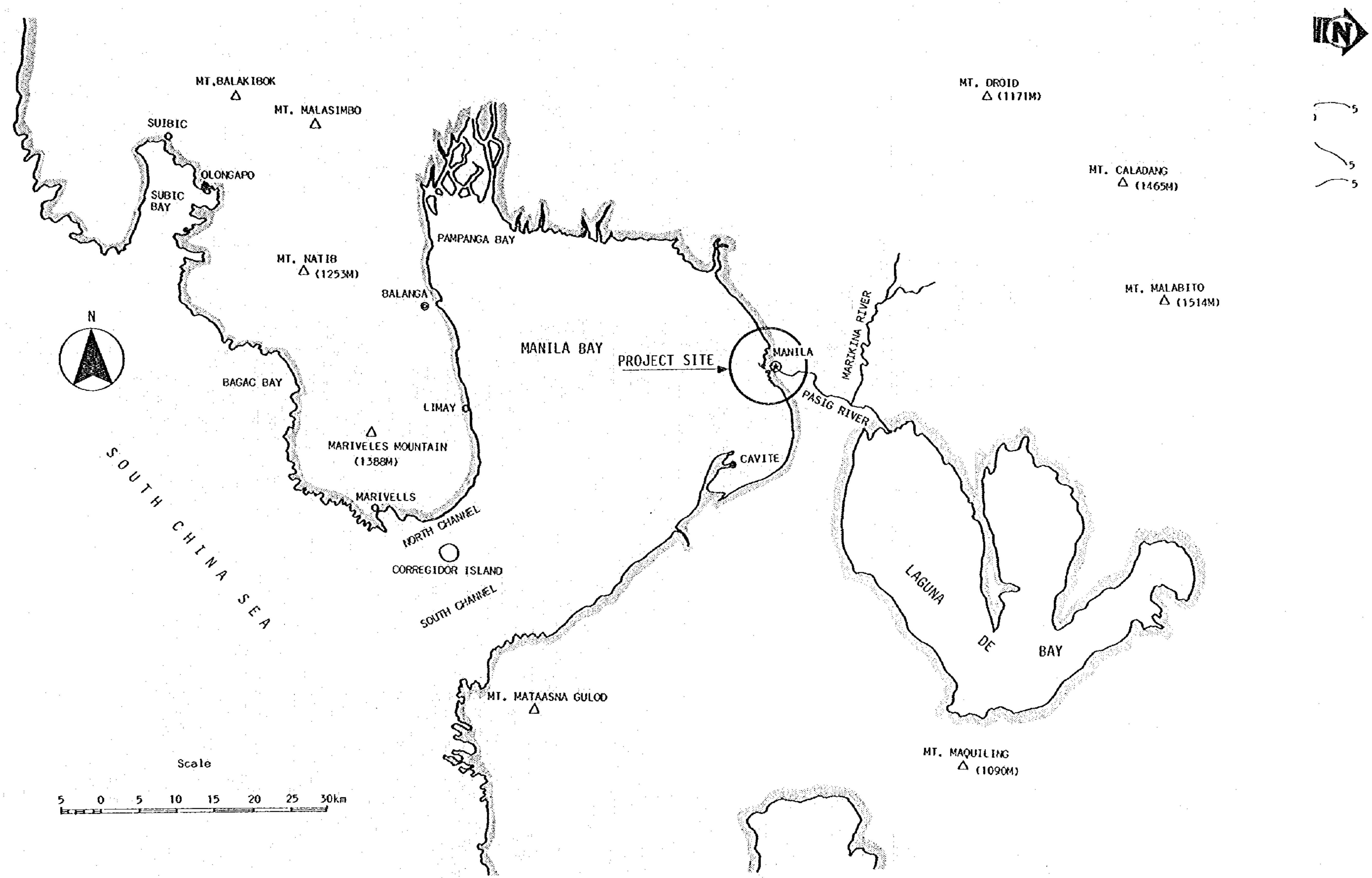

Fig. 3.1.2 Manila Bay and Surrounding Area

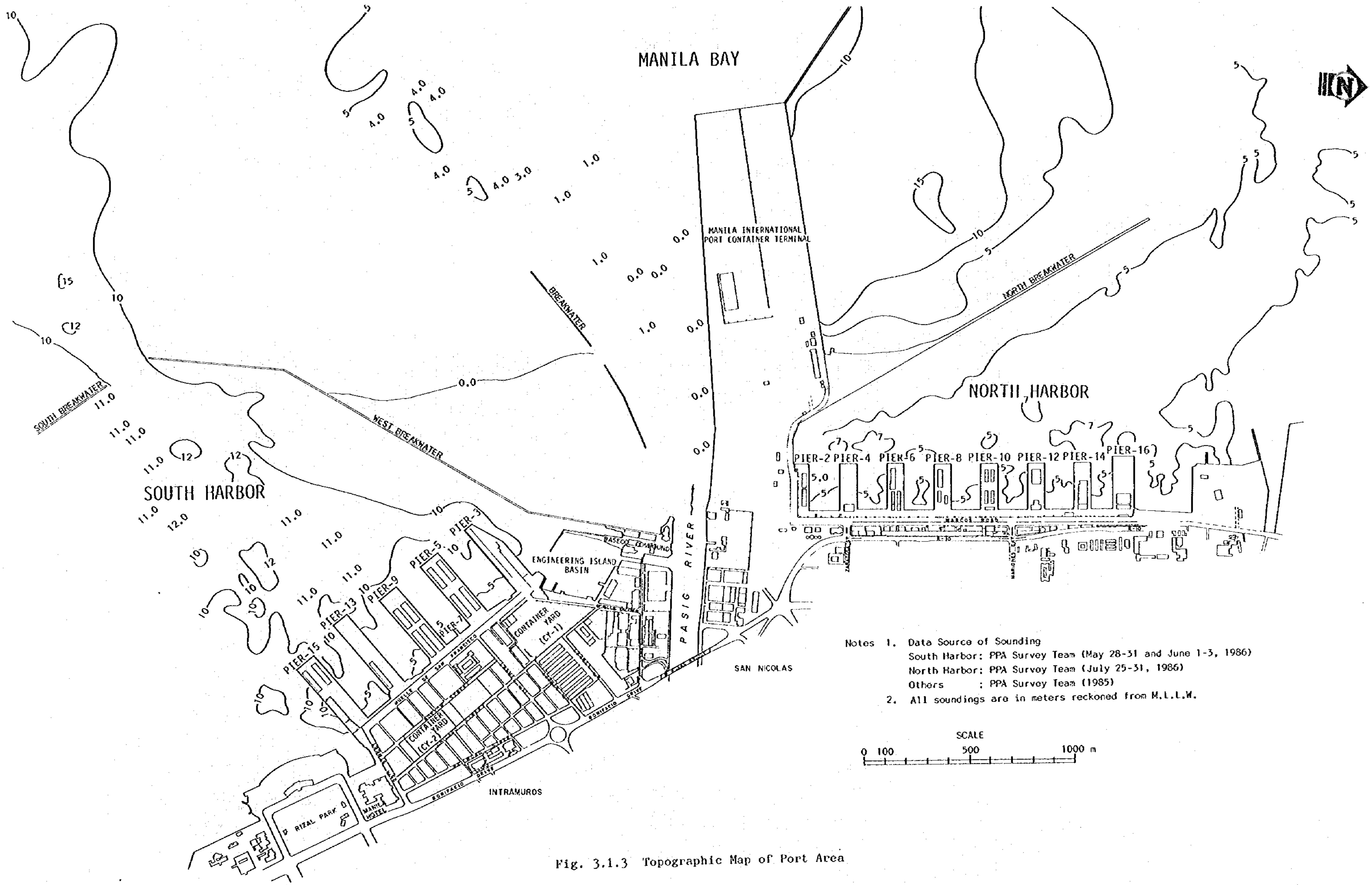

Fig. 3.1.3 Topographic Map of Port Area

3.1.3 Meteorology

3.1.3.1 General

A set of meteorological data was collected at the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). The data include records for the six years from 1977 to 1982.
Appendices 3.1.1 to 3.1.8 show general information on the following items:

1) monthly mean, monthly mean maximum and monthly mean minimum temperatures
   (monthly mean: 27.5°C)
2) monthly mean rainfall, rainy days and daily maximum rainfall
   (monthly mean: 160 mm)
3) monthly mean humidity, monthly mean maximum and monthly mean minimum humidity
   (monthly mean: 74.5%)

Judging from the information on rainfall, it can be said that the heavy rainfall begins in May and peaks in July. The rainfall decreases suddenly after November. Therefore, the rainy season is from June to September. Typhoons or tropical cyclones also come during this season and typhoons often bring 400 mm of rainfall a day at the peak of the period. According to Appendix 3.1.5, there are on average almost six rainy days in the July-September period with rainfall of more than 20 mm/day.

Fog is another factor which can affect port operation, but no foggy days have been observed in the Manila area.

3.1.3.2 Winds

Various wind data are compiled in Appendices 3.1.9 to 3.1.13. They are processed based on the data recorded over ten (10) years (1971-1978 and 1982-1983) at the port area.

According to Appendices 3.1.11 and 3.1.13, the prevailing wind directions can be calculated as follows:

SE Trades	- from February to May
SW Monsoons	- from June to September
NE Monsoons	- from October to January

The wind speeds change every month. According to Appendix 3.1.13, it can be concluded that the occurrence of wind speeds of more than 11 m/sec (40 km/h) is mainly observed from June to October. The period during these months is not only the rainy season but also the typhoon season.

3.1.3.3 Typhoons

The Philippines is affected by typhoons on a regular basis. About 20 typhoons occur near or pass through the Philippine Islands every year. As shown in Table 3.1.1, the islands are hit by about 10 typhoons annually. Severe typhoons in the Philippines generally take courses moving westward after originating in the region of the Caroline Islands.

Most severe typhoons occur during the period from June to December. Typhoons passing over the north or middle of Luzon Island are most common from June to October. Most of the typhoons recorded in Novermber and December in Table 3.1.2 hit Bicol, Visaya and other southern areas. Forty-two typhoons passed within 100 km of Manila during the 36 years from 1948 to 1983 (Table 3.1.2). This means that Manila is, on the average, struck by more than one typhoon every year.

Table 3.1.1 Frequency of Typhoons Crossing the Philippines
(1948 to 1984 - 37 Year Period)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1948	0				0		2	1	2	2	4	2	13
1949	0					0	1	1	2	2	3	2	11
1950				0	1	0	0	1	1	1	1	1	5
1951						0	1	1	3	0	1	1	8
1952						2	2	1	2	3	2	3	15
1953	0	0			0	2	0	3	1	2	2	0	10
1954			1		1		0	1	0	1	3	1	8
1955	1	0		0			0	2	1	0	1	0	5
1956			0	2			2	1	1	1	3	2	12
1957	1			0		2	1	0	3	1	1	0	9
1958	0						0	0	1	1	2		4
1959		0	0				0	1	1	0	2	2	6
1960	0			1	1	1	0	1	2	2		0	8
1961	0	0	0		1	0	1	2	1	0	1	0	6
1962		0			1		1	2	1	0	2		7
1963					0	2	1	1	1	0		1	6
1964					0	1	1	1	4	3	2	2	14
1965	1	0	1		0	2	2	0	1	0	0		7
1966				0	2	0	6	1	0	1	2		14
1967		0	1	1	0	1	0	2		1	2	2	8
1968		0				0	1	2	1	0	3	0	7
1969				0	0		2	0	1	1	0		4
1970		0	0			1	1	1	2	3	3	0	11
1971	0			1	3	2	4	1	1	4	0		16
1972	2					1	1	0	1	1	1	1	8
1973						1	0	0	1	3	1		6
1974	0					1	1	1	1	4	3	2	13
1975	1						0	0	1	2	1	1	6
1976	0	0		0	1	1	1	1			0	2	5
1977	0				0	0	0	0	3	0	1	0	6
1978			0	1		1	0	1	2	3	0	2	10
1979			1	1	1	0	1	2	1	2	1	1	10
1980		1		0	2	1	4	1	1	1	2	0	14
1981		0	2			1	1	0	2	1	2	1	8
1982					0		1	1	1	1		2	8
1983							3	1	2	3	1	0	10
1984						0	1	1	2	1	1	0	6
TOTAL	6	1	6	7	14	23	44	36	51	51	54	31	324
%OF'	2	0.3	2	2	4	7	14	11	15.7	15.7	16.7	9.6	100

Source: (Annual Tropical Cyclone Report - 1984 PAGASA National Weather Office)

Table 3.1.2 Frequency of Typhoons in Metro Manila (1948 to 1983 - 36 Year Period)

Year	Center very closer to Manila			Center within 50 Km from Manila			Center within 150 - 100km from Manila			Total		
	TD	TS	T	TD	TS	T	TD	TS	T	TD	TS	T
1948				1						1	0	0
1949				1						1	0	0
1950			1							0	0	1
1951						1				0	0	1
1953					1					0	1	0
1957				1						1	0	0
1960				2		1				2	0	1
1961								1		0	1	0
1962				1						1	0	0
1964			1		2					0	2	1
1966				1				1		1	1	0
1967			1							0	0	1
1970			2					1		0	1	2
1971							1	1	1	1	1	1
1972			1							0	0	1
1974					1				1	0	1	1
1975				1						1	0	0
1977						1		1		0	1	1
1978						1	1		2	1	0	3
1979	1			1	1					2	1	0
1980				1			1			2	0	0
1981							1		2	1	0	2
1983			1							0	0	1
Total	1	0	7	10	5	4	4	5	6	15	10	17

TD : Maximum winds near the center of the disturbance up to 17 meters per second.

TS : Maximum winds near the center of the disturbance range from 18 to 32 meters per second.

T : Maximum winds near the center of the disturbance 33 meters per second or more.

Source : (Operational Manual Tropical Cyclone Forecasting - 1985 PAGASA National Weather Office)

3.1.4 Oceanography

3.1.4.1 General

According to the results of the Team's survey in this field, no systematic observation record has been kept with regard to the current, wave height and period in Manila Bay. Only the Bureau of Coast and Geodetic Survey (BCGS) publishes "Tide and Current Tables, Philippines" every year, which presents predictions of tidal and current behavior in the Philippines.

In 1981 a German and a Philippine consultant conducted a kind of siltation investigation in the Manila Port areas except South Harbor.[1] This investigation does not, however, make clear the mechanism of sedimentation or siltation in Manila North Harbor and Manila International Port.

3.1.4.2 Tides

According to the "Tide and Current Tables, Philippines 1986" published by BCGS, the basic tidal levels for Manila Bay are as follows:

MHHW	+0.980 m	MLLW
MHW	+0.838 m	MLLW
MSL	+0.462 m	MLLW
MLW	+0.101 m	MLLW

(MLLW: Mean Lower Low Water)

Following are the highest and lowest tides observed and recorded in Manila Bay:

Highest observed tide	+1.770 m	MLLW	(Jul. 23, 1911)
Lowest observed tide	-0.690 m	MLLW	(Feb. 3, 1912)

Fig. 3.1.4 shows the tide levels described above. In connection with the elevation, there are ten fundamental benchmarks in the Port area. Each tidal elevation described above is easily reckoned from any one of the benchmarks certified by the BCGS. The elevation of the benchmark GM-1A, for example, is +3.556 meters above MSL (Mean Sea Level) and it is on the concrete base of the rotonda (rotary) fountain at the intersection of

1) Master Plan Study (1978), by Salzgitter Consult GmbH and others

Bonifacio Drive and Aduana Street in the port area of Manila. According to the "Tide and Current Tables, Philippines 1986", the greatest greatest tidal range occurs on June 23 (tidal difference 1.89 M) and Dec. 3 (tidal difference 1.87 m), while the least is on July 25 (tidal difference 0 m) followed by July 26 (tidal difference 0.03 m).

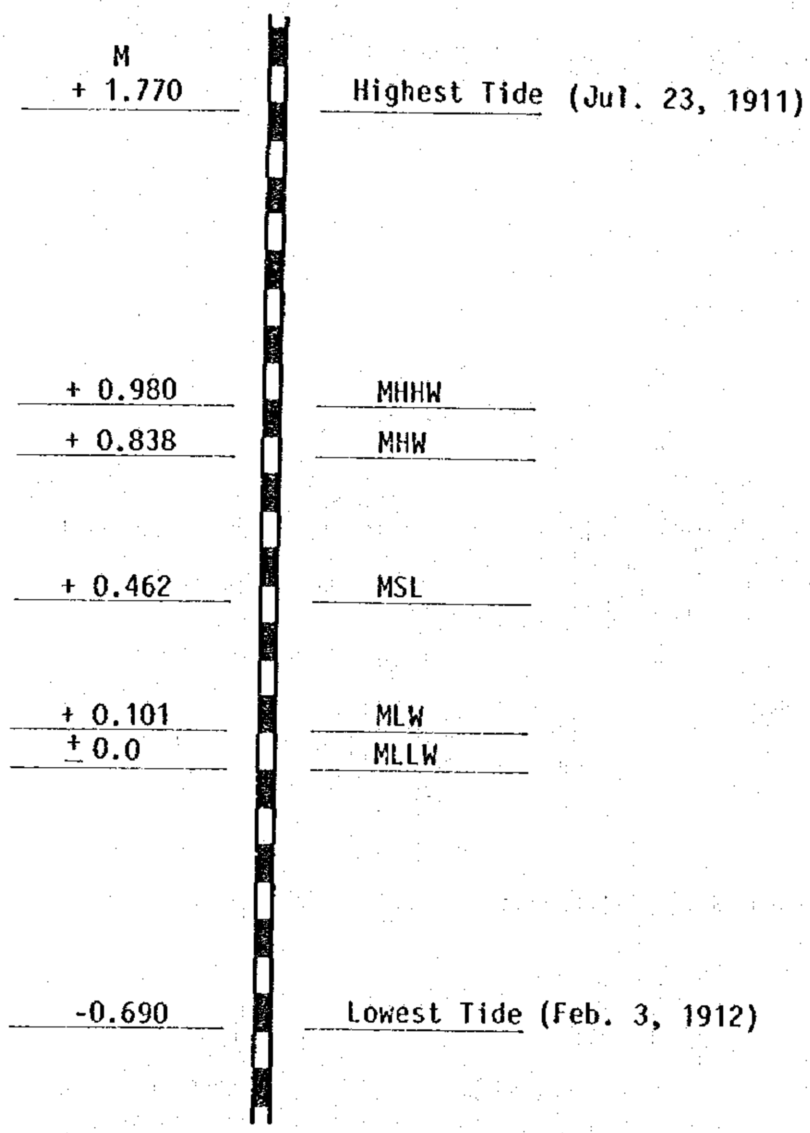

Fig. 3.1.4 Oceanographic Data of Manila Bay

3.1.4.3 Currents

There are three recent studies with regard to the tidal current. They are Master Plan Study (1978), Sewage and Sanitation Master Plan for Metro Manila (1979)[1), and Manila Siltation Investigation Study (1981).[2) According to the Master Plan Study (1978), no effective disturbance was expected even under the most adverse conditions. On the other hand, the Sewage and Sanitation Master Plan (1979) states that the wind-driven current was expected to be in the order of 0.05 m/sec, if the wind comes from the southwest. Tidal current was also estimated to be in the order of 0.05 m/sec near shore, although at the entrance of the mouth of Manila Bay a faster current velocity was found.

Even under the superposition of the tidal and the wind currents, it is easily recognized that the current near Manila Port does not seriously affect ship maneuvering.

According to an interview with the PMU Pilot Association, the pilots stated that the currents in the bay caused no disturbance in actual ship maneuvering.

The Manila Siltation Investigation Study includes surveys of the directions and speeds of currents in Manila North Port, Manila International Port (MIP) and the area off the estuary of the Pasig River. But no direct measurement of the current direction and speed were taken in South Harbor and therefore, no definite conclusion can be introduced regarding current behavior there.

3.1.4.4 Waves

Generally, it is desirable to estimate wave height on the basis of the actual observation data. However, no wave observation records for Manila Bay are available. Therefore, the estimation of the wave height was conducted by a simulation based on the typhoon model as shown in Fig. 3.1.5. Ijima's formula was used for the calculation because the effects of the water depth in Manila Bay which is shallower than the open sea must be taken into account.

For the simulation, ten typical typhoons which had low central atmospheric pressure near Luzon Island and took courses where south to west winds caused high waves in Manila Bay were chosen from records covering a 30 year period (Refer to Appendix 3.1.14).

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1) James M. Montgomery - DCCD - Kampsax - Kruger Consultants

2) Manila Siltation Investigation (1981), by Salzgitter Consult GmbH and BASICTEAM

To simulate waves coming into the Bay from the open sea, calculations were conducted for three stages divided by area (Refer to Appendices 3.1.15 and 3.1.16).

Table 3.1.3 shows the wave simulation results for the ten typhoons. The typhoon T7719 caused the highest wave (2.13 m) with a period of 4.7 sec. and a direction of WSW. The actual courses of the four typhoons causing the highest waves in the simulation were east to west, north of Luzon Island (Appendix 3.1.17). The probability of return calculated from the simulation of the ten typical typhoons is as shown in Fig.3.1.6. A maximum wave height of 2.13 m with a 50-year return period is found. Waves with a 10-year return period have a height of about 1.8 m.

But those wave heights are expected only outside the breakwaters in Manila Port and the breakwaters effectively lessen the wave heights. According to our hindcasting study within South Harbor (See Appendix 3.1.18), the wave heights are reduced to less than 50% along their main directions. This is because the existing arrangement of the breakwaters effectively works to disperse wave energy to a considerable extent.

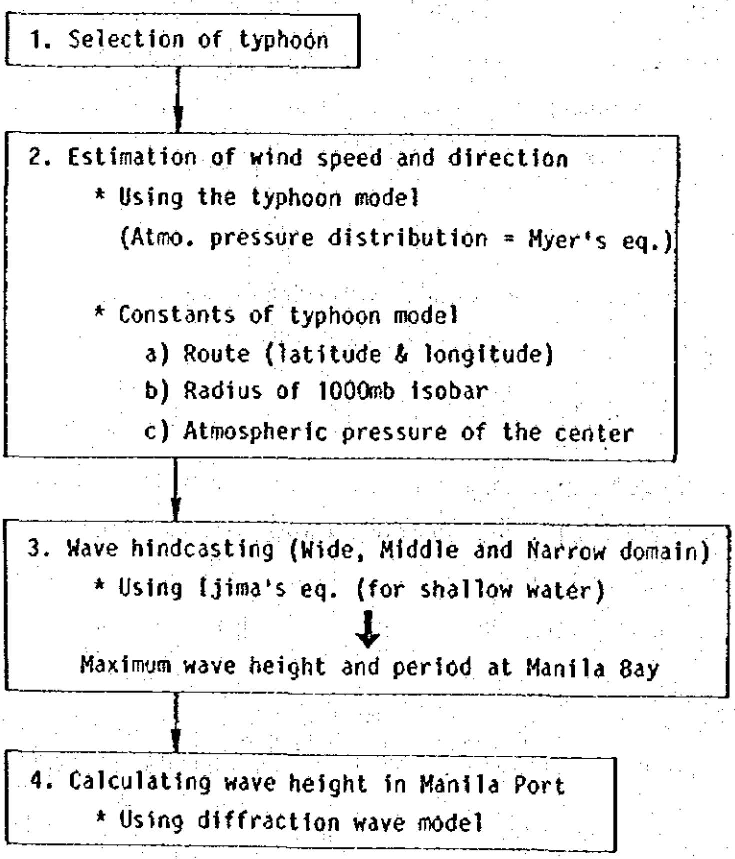

Fig. 3.1.5 Flow of Wave Hindcasting

Fig. 3.1.3 Result of Wave Hindcasting

Case	Wave		Wind	
	Max-$H_{1/3}$ (m)	Period (sec)	Direction	Velocity (m/s)
T6735	1.20	3.4	S	22.7
T7019	0.94	2.8	SSE	21.9
T7025	1.13	2.9	SSE	29.1
T7410	1.54	4.1	W	16.8
T7607	1.60	4.1	W	16.9
T7719	2.13	4.7	WSW	24.4
T8009	1.35	3.8	W	13.9
T8021	1.80	4.4	W	18.5
T8126	1.47	4.0	W	14.3
T8214	1.38	3.5	SW	19.1

(T6735 means Typhoon No.35, observed in 1967)

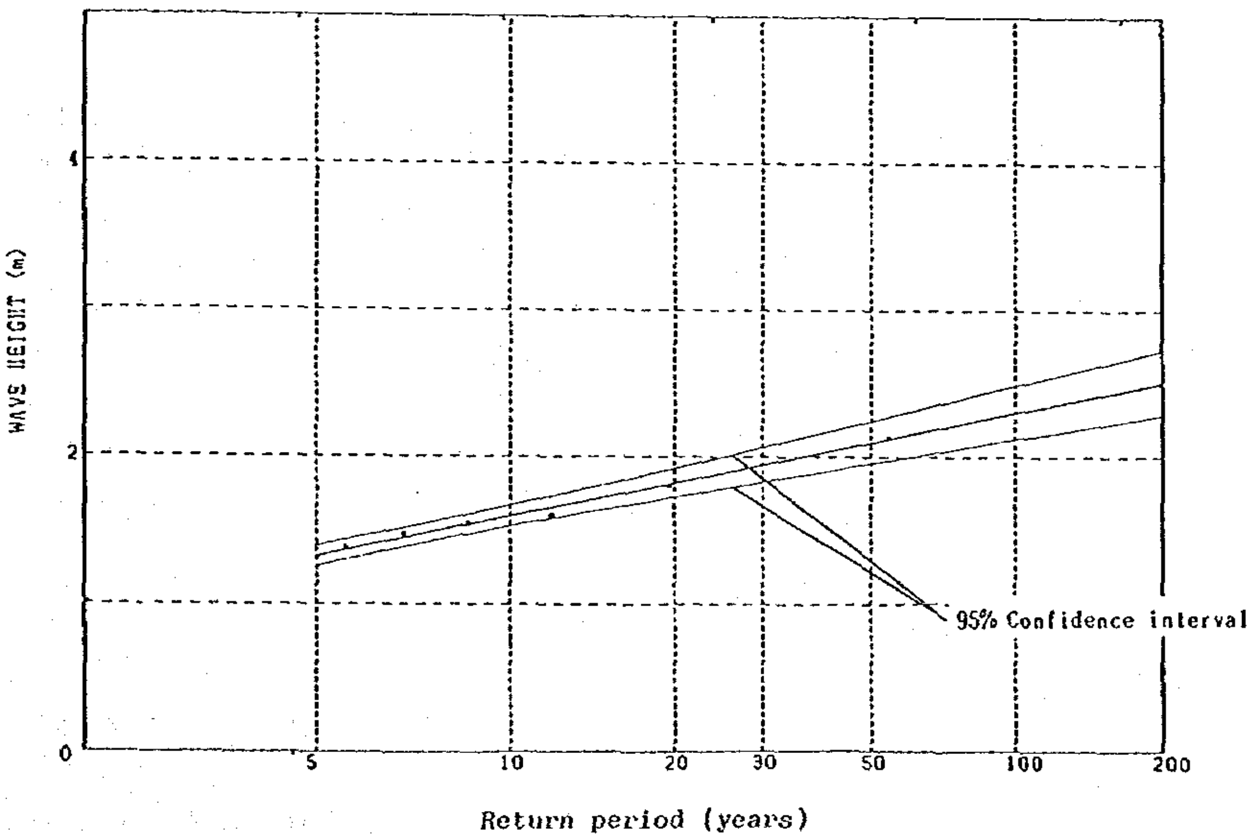

Fig. 3.1.6 Relationship Between Return Period and Wave Height at Manila Port (Gumbel Distribution)

3.1.4.5 Siltation

Major rivers such as the Pampanga, Ragonoy, Bulacan, Pasig, Paranaque and Maragondon flow into Manila Bay, and they are presumed to be the main suppliers of the sediments covering the sea bottom of the Bay. Among these rivers, the Pasig River is probably the biggest contributor to the siltation problem in South Harbor. Some part of the sediment could possibly be transported in the body of water via the channel connecting the Pasig river with the Engineering Basin.[1] But no quantitative amount of siltation volume has been referred to in past siltation investigations.[2]

According to a study derived from a mathematical model, the sedimentation rate is estimated to be less than 5 cm/year along the seashore around Manila North and South Harbors.[3]

In connection with the siltation in Manila South Harbor, the study team has tried to obtain a reliable picture of the siltation problem by using the following two methods.

1) study of the past dredging records in South Harbor
2) comparison of the two bathymetric contour lines with the same depth surveyed in 1983 and 1985

Table 3.1.4 shows the past 25-year dredging record for Manila South Harbor. The data indicates that the PPA and its predecessor dredged a total volume of about 17.58 million cubic meters during the period from mid-1960 through mid-1980 in Manila South Harbor. During the period between 1980 and 1985, the PPA dredgers removed about 1.35 million cubic meters of sediment materials from the seabed. Therefore, the total volume of dredged material is about 18.93 million cubic meters in the past 25 years. This means that an average volume of 757,000 cubic meters per year was removed from South Harbor. This volume is divided into three Parts: 477,000 m^3/year for Anchorages, 262,000 m^3/year for Fairways and 18,000 m^3/year for the Piers/Slips.

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1) Master Plan Study (1978), by Salzgitter GmbH and others
2) Manila Siltation Investigation (1981), by Salzgitter Consult GmbH and BASICTEAM
3) A study on the Estimation Rate in Manila Bay, by Jorge G. de las Alas, Dep. of Meteorology and Oceanography, College of Science, University of the Philippines.

Fig. 3.1.7 shows the changes between the two bathymetric contour lines with the same depth surveyed in 1983 and 1985. Judging from the data, the area enclosed by the 1985 contour line of 10m below MLLW has become smaller than that enclosed by the 1983 contour line, and the former has gone farther off-shore in the basin than the latter. This indicates that a greater amount of sediment was laid during the two years than was removed by the PPA dredgers during the same time.

Table 3.1.4 25-Year Dredging Record for Manila South Harbor

Fiscal Year (Jul.-Jun.)	Anchorage (m3)	Fairways (m3)	Piers & Slips (m3)	Total Dredging (Million m3)	Remarks
1960 - 61	585,834	44,036	-	0.630	
1961 - 62	853,858	136,198	1,197	0.991	
1962 - 63	571,608	-	-	0.572	
1963 - 64	1,107,927	385,707	4,492	1.498	
1964 - 65	1,727,884	-	-	1.728	
1965 - 66	654,856	81,239	-	0.736	
1966 - 67	1,670,227	347,555	17,960	2.036	
1967 - 68	1,560,257	927,190	52,374	2.540	
1968 - 69	768,000	-	20,790	0.289	
1969 - 70	467,250	653,143	69,190	1.192	
1970 - 71	151,150	-	3,900	0.155	
1971 - 72	-	144,861	76,010	0.221	
1972 - 73	108,650	55,060	7,410*	0.171	*Estimated volume
1973 - 74	500,500	-	621	0.501	
1974 - 75	165,500	-	8,978	0.174	
1975 - 76	20,000	-	88,450	0.108	
1976 - 77	-	30,009	-	0.030	
1977 - 78	-	155,868	18,700	0.175	
1978 - 79	-	-	-	0.	
1979 - 80	1,027,866	2,760,039	52,150	3.840	
Sub Total*1	(11,441,361)	(5,722,896)	(422,222)	17.587	
1980 - 81	-	-	-		Data not available
1982 - 83	-	-	-		Data not available
CY 1982	-	-	33,000	0.033	
CY 1983	-	-	-	0	
CY 1984	388,592*	388,592*	-	0.777	*50% of total dredging volume of Channel and Basin
CY 1985	97,904	447,926	-	0.546	
Sub Total*2	(486,496)	(836,518)	(33,000)	1.356	
Total	(11,927,857)	(6,559,414)	(455,222)	18.943	

Source: *1 Economic Feasibility Study for Domestic Container Terminal for the Philippine Ports Authority (1980/1981)

*2 Accomplishment of PPA Dredgers for CY 1982 through 1985 (The Project depth is 10.67 meters (35 feet) reckoned from the MLLW.)

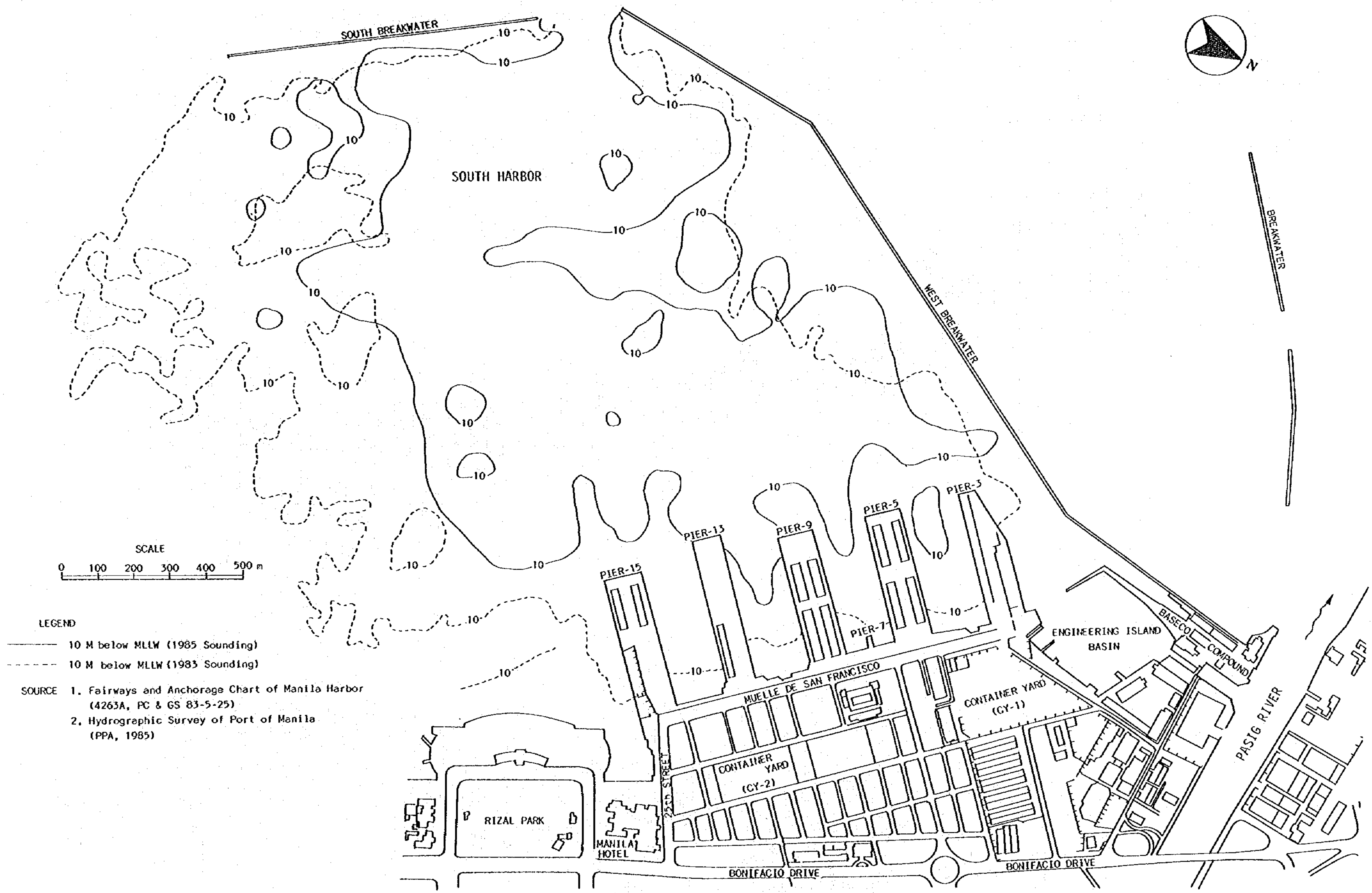


Fig. 3.1.7 Siltation Condition in South Harbor

3.1.5 Soil Conditions

Soil investigations which porvide basic data for the Manila South Port Rehabilitation Project were made to grasp the sub-soil conditions and the soil behavior characteristics.

The items of the investigations are as follows:

1) Drilling

2) Standard penetration test

3) Collection of undisturbed samples and disturbed samples.
   Laboratory test of these samples.

4) Plate bearing test

These investigations were made to conform to JIS and provisions of JSSMFE (The Japanese Society of Soil Mechanics and Foundation Engineering).

The locations of investigations are shown in Fig. 3.1.8 and 3.1.9.

The laboratory results of the soil investigations are shown in Table 3.1.5.

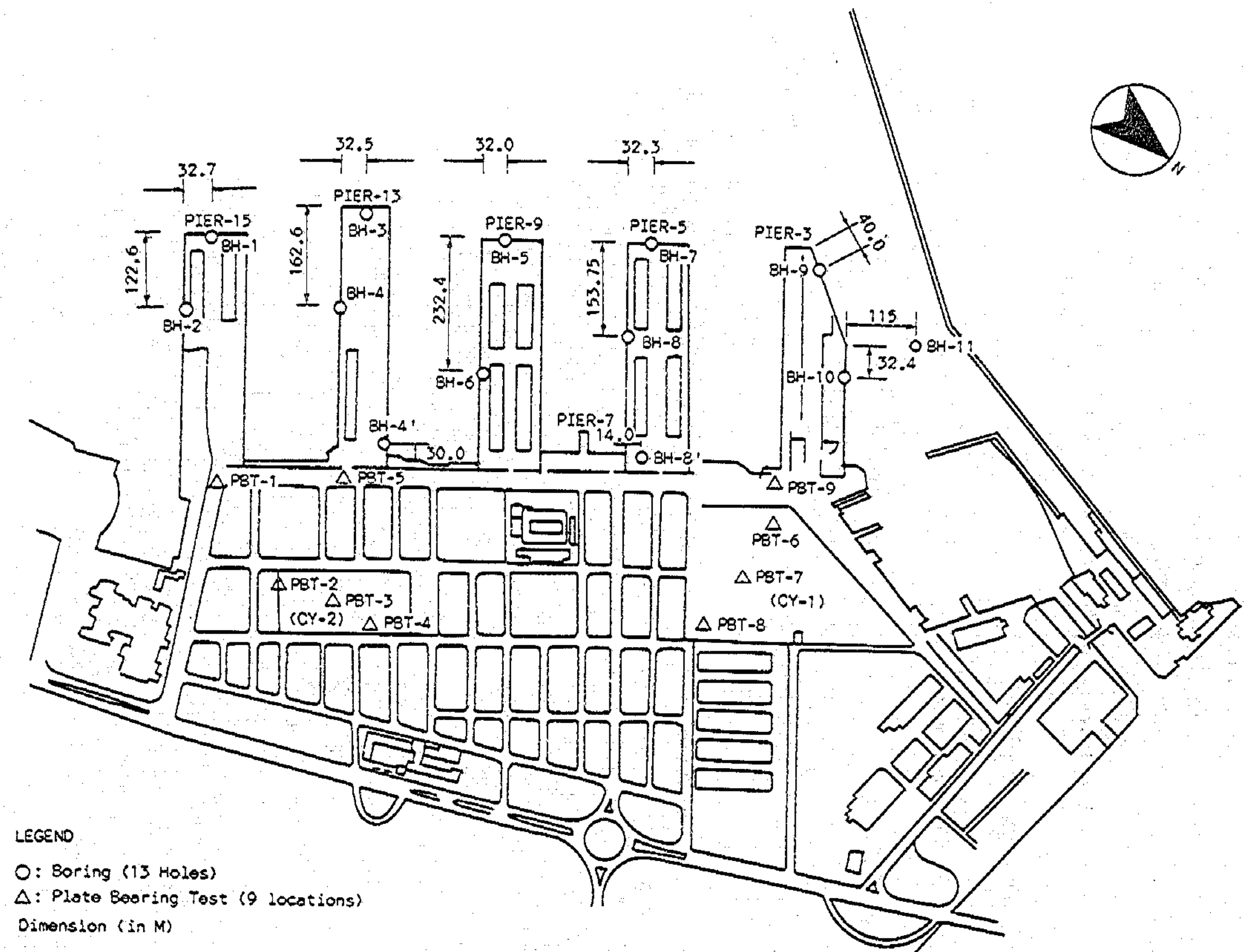


Fig. 3.1.8 Boring Locations in South Harbor

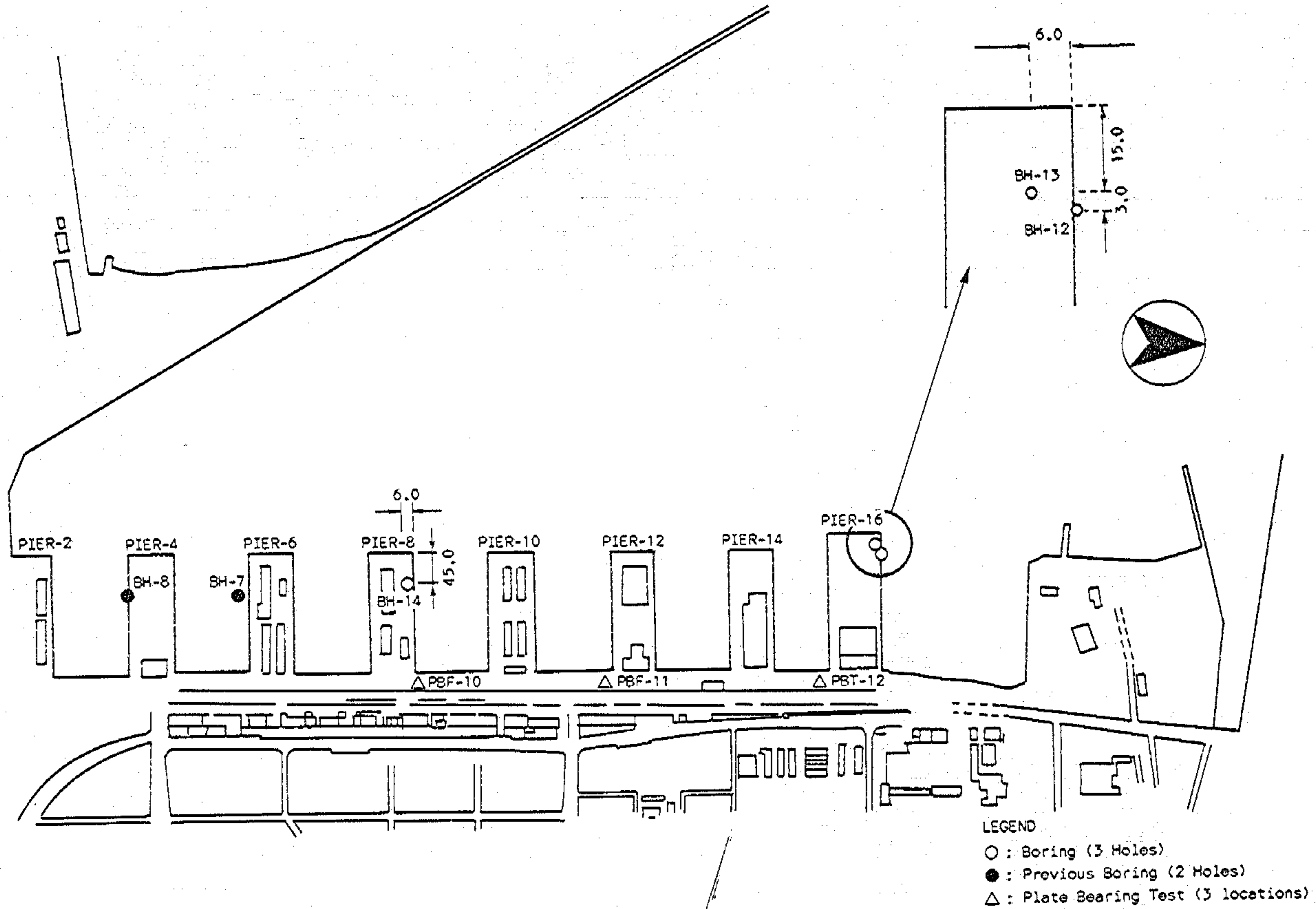


Fig. 3.1.9 Boring Locations in North Harbor

Table 3.1.5 Laboratory Results of the Soil Investigations

Location	Borehole No.	Drilling Depth (m)	Standard Penetration Test (Pcs.)	Undisturbed Sample (Pcs.)	Laboratory Test * (Pcs.)							REMARKS
					Gs	Wn	Ma	LL PL	Yt	qu	Pc	
South Harbor	1	42	41		18	18	18	18	1			
	2	30	22	6	13	13	13	13	5	5	6	
	3	50	51		20	20	20	20	1			
	4	20	21		10	10	10	10				
	4'	31	31									
	5	41	37	4	18	18	18		4	4		
	6	32	25	7	16	16	16	13	7	7	7	
	7	42	29	13	26	26	26	20	13	13		
	8	47	48		14	14	14					
	8'	41	42		21	21	21					
	9	33	33		15	15	15	6				
	10	33	27	7	17	17	17	17	7	6	4	
	11	35	14		9	9	9					Off-Shore
North Harbor	12	20	19	1	11	11	11	11	1	1	1	
	13	30	26	2	10	10	10	9	2	2	2	
	14	40	33	7	23	23	23		6	6	4	
TOTAL		568	499	47	241	241	241	137	47	44	24	

- Plate Bearing Test: 12 Locations
- CBR Test : 2 Pcs.
- Pile probing : 4 trials 50.45^{m}

* Gs : Specific Gravity
Wn : Moisture Content
Ma : Grain-size Analysis
LL-PL : Consistency Limits

Yt : Unit Weight
qu : Unconfined Compression
Pc : Consolidation

3.1.5.1 Geology of Manila Bay

The investigation area is located in the mouth of the Pasig River which passes through Metro Manila. Topographically speaking, Luzon Island can be divided into three physiographic provinces, namely:

I) Western Physiographic Province

II) Central Physiographic Province

III) Eastern Physiographic Province

Metro Manila is located in the Luzon Central Plain within the Central Physiographic province.

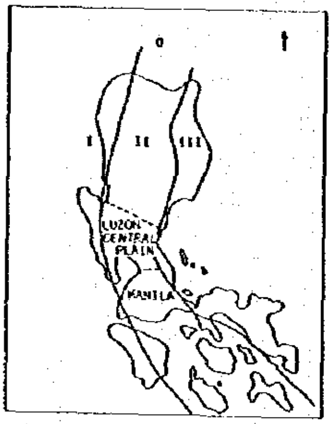


Fig. 3.1.10 Physiographic Provinces Luzon

The Physiographic Provinces of Luzon are shown in Fig. 3.1.10.

The alluvial plain and the tertiary plateau between the Zambales Range and the Sierra Madre comprise the Luzon Central Plain. The Plain has many rivers which empty into Manila Bay.

The Pampanga and Angat Rivers, which are the largest in the Philippines, follow a winding course into Pampanga Bay which is north of Manila Bay. The lowland along the river sides is widely alluvial.

The Pasig River supplies the cohesive deposits along the coastal area. There are wide areas of alluvial lowland in the northwest section of the investigation area, and tertiary plateau formations can be found in the east side. Specifically, this plateau is known as the Guadalupe Formation.

The Guadalupe Formation is composed of tuffaceous sandstone or mudstone (locally called Adobe), and is located at the outcrop in Diliman, Quezon City. The tuff in Diliman is 1300 to 2000 meters thick. The bed Rock of the investigation area is composed of a tuff tertiary deposit.

The base of the coastal area of Manila is a Tertiary Stratum (Bedrock), and several types of sedimentation overlay this stratum.

A geological map of the central physiographic province is shown in Fig.3.1.11, and a schematic geological profile of the Manila Bay area is shown in Fig. 3.1.12. The geological ages and features of the coastal area are indicated in Table 3.1.6.

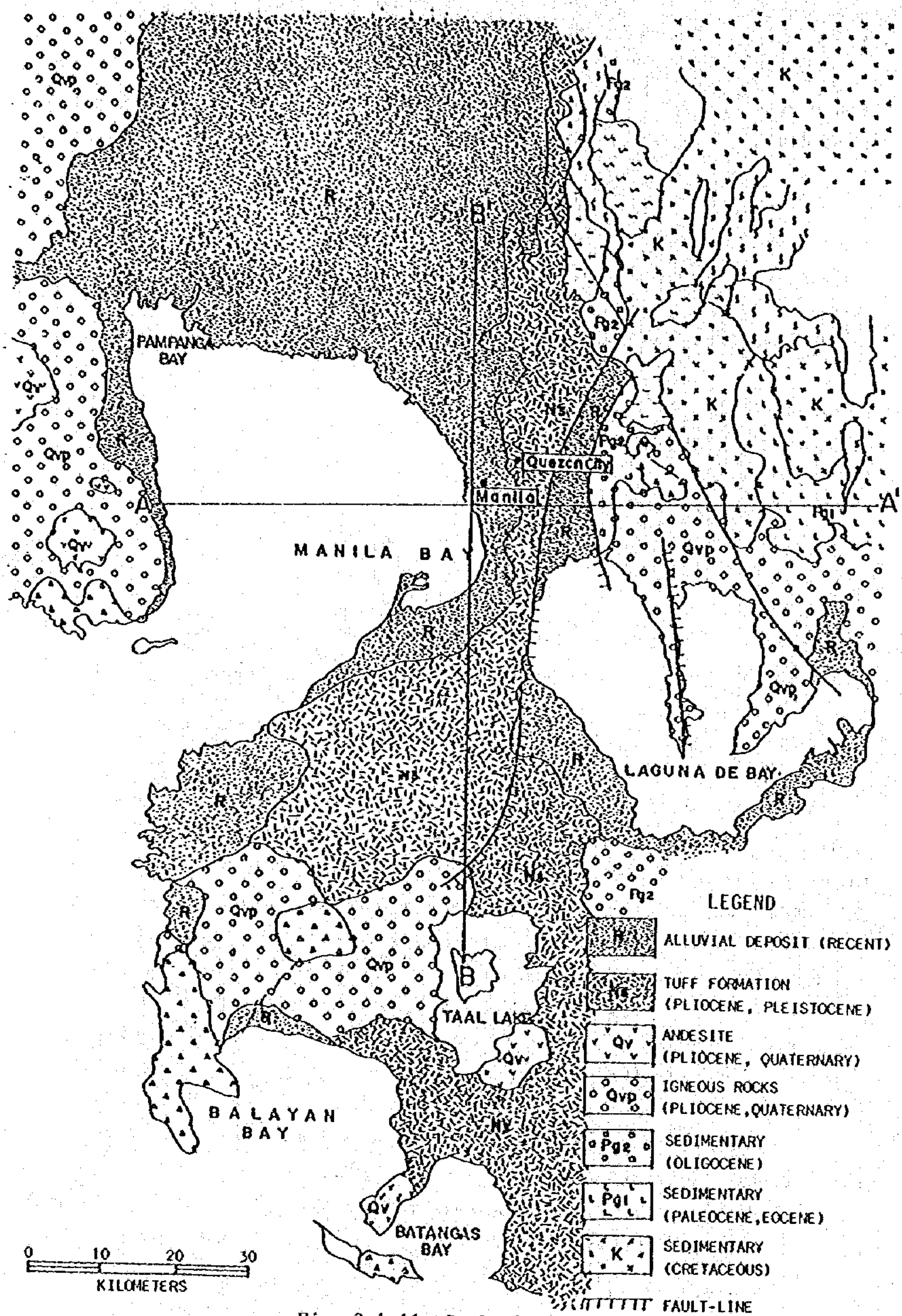


Fig. 3.1.11 Geological Map

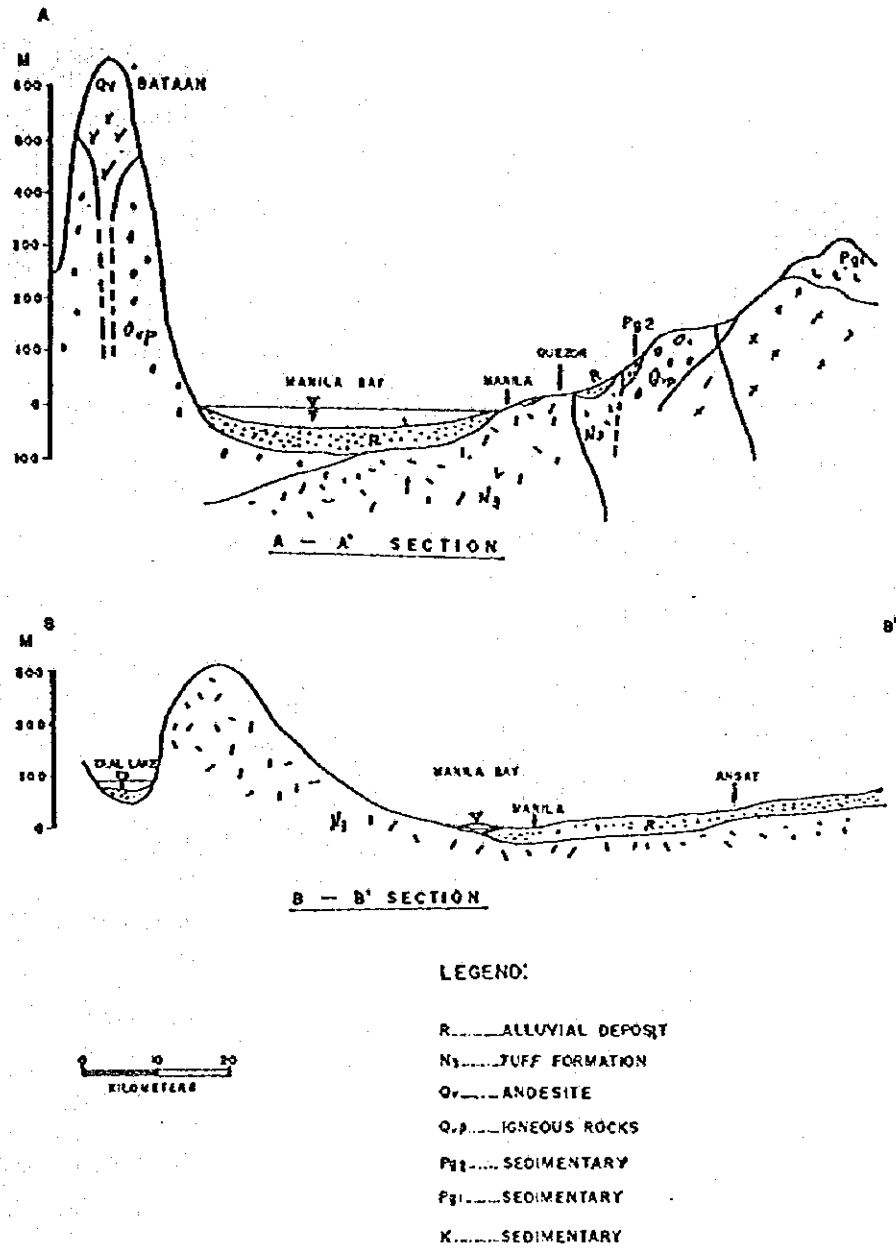


Fig. 3.1.12 Schematic Geological Profile

Table 3.1.6 Geological Age and Features

Age		Deposit	Features
Quaternary	Holocene	Alluvial deposit	Poor cohesive soil Loose sandy soil
	Pleistocene	Diluvial deposit	Hard clay or silt Gravelly soil
Tertiary	Pliocene		
	Miocene	Tertiary formation	Tuffaceous sand-stone and mud-stone

3.1.5.2 Outline of the Soil Conditions in the Investigation Area

The investigation area is formed of tertiary stratum (bedrock), diluvial deposit (sandy, gravelly, cohesive layers) and alluvial deposit (sandy, cohesive layers).

In South Harbor, the level of diluvial formation is remarkably erratic. Soil conditions in this area are also complicated.

The strata of North Harbor are characterized as follows: alluvial deposit is considerably scarce; diluvial deposit is developed sufficiently at Pier 8. The soil profile of the investigation area is shown in Fig. 3.1.13, 14 and 15.

The characteristics of each deposit are as follows:

1) Bed rock (Tsc)

This formation is a tertiary stratum which is tuffaceous sand or mudstone. The N-Value is almost 50. Cemented mud and sand core samples can be obtained by drilling. The color is brown.

2) Diluvial deposit (Dc,Dg)

This stratum is divided into two formations - cohesive soils (Dc) and gravel soils (Dg).

The Dc layer is sufficiently developed in diluvial deposit, and is also remarkably thick at Pier 8 in North Harbor. The maximum and minimum N-values are about 10 and 50, and N-values of 10 to 20 are must common. The Dc layer consists of silt and clay, traces of light weight stones (pumice), and organic materials. The color is dark gray to brown.

The Dg layer consists of angular gravel poor in continuity and thin with an N-value of 10 to 50. The color is dark gray to brown.

3) Alluvial deposit (Ac, As)

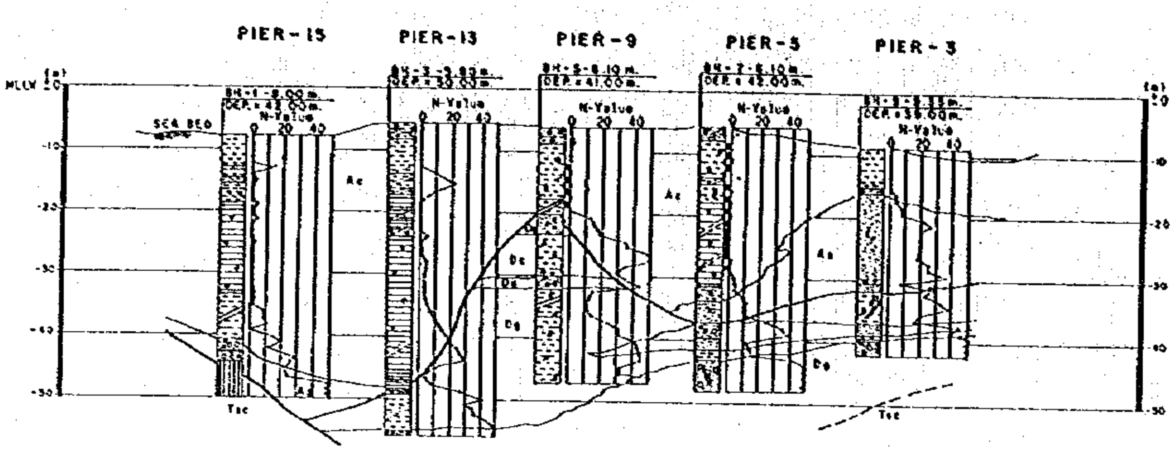
This stratum is divided into two layers - cohesive soils (Ac) and sandy soils (As).

The Ac layer consists of silt and clay. It is remarkably thick in South Harbor, and thin in North Harbor. Specifically, this layer becomes thicker at the top of Pier 13 with a thickness of over 40 meters. The N-value varies from 0 to 5. It remains near 0 from the surface down to about -20 meters, and increases thereafter with the depth. This layer has traces of broken shell, including contents with finer sand at -10 meter depth, and organic materials at depths below -10 meters.

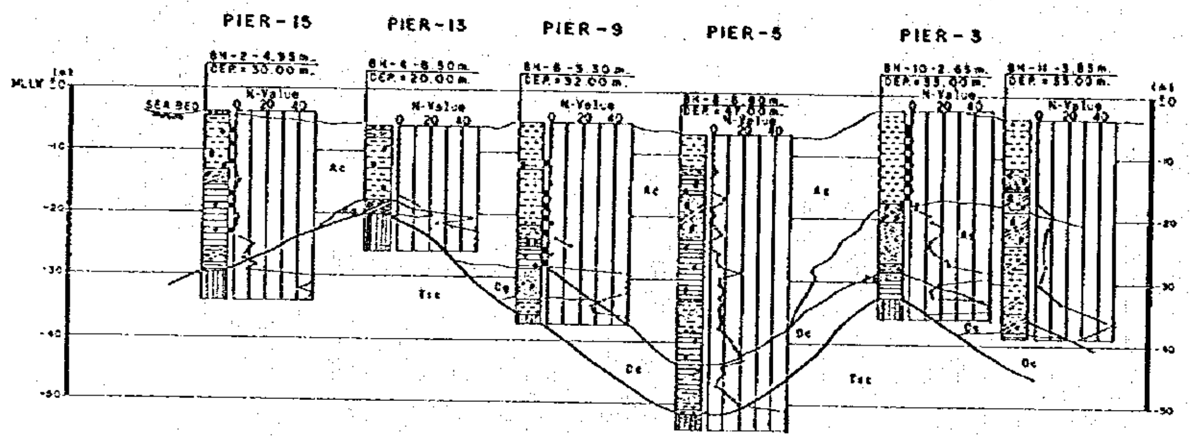
The layer consists of fine sand, as found at the near end of Pier 3 and Pier 13 in South Harbor, and is poor in continuity. The N-Value is 10 to 30. The color is dark gray.

The characteristics of the strata of South and North Harbors are shown in Tables 3.1.7 and 3.1.8.

SECTION 1-1



SECTION 2-2



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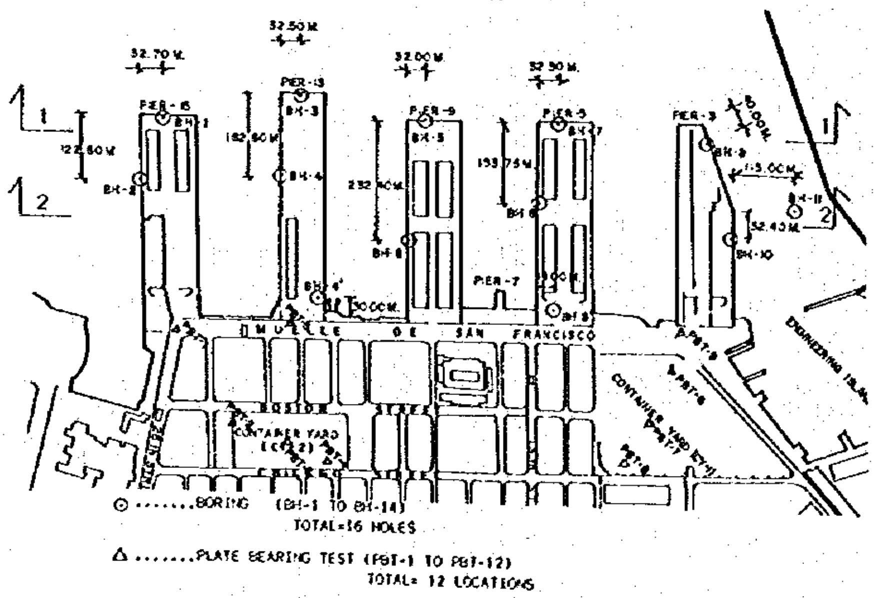


LEGEND

Mark	Deposit
Ac	Alluvial Cohesive Soils
As	Alluvial Sandy Soils
Ag	Alluvial Gravelly Soils
Dg	Diluvial Gravelly Soils
Dc	Diluvial Cohesive Soils
Tsc	Tertiary Formation

▪ - Undisturbed Sampling

Fig. 3.1.13 Soil Profile of South Harbor (1 of 2)

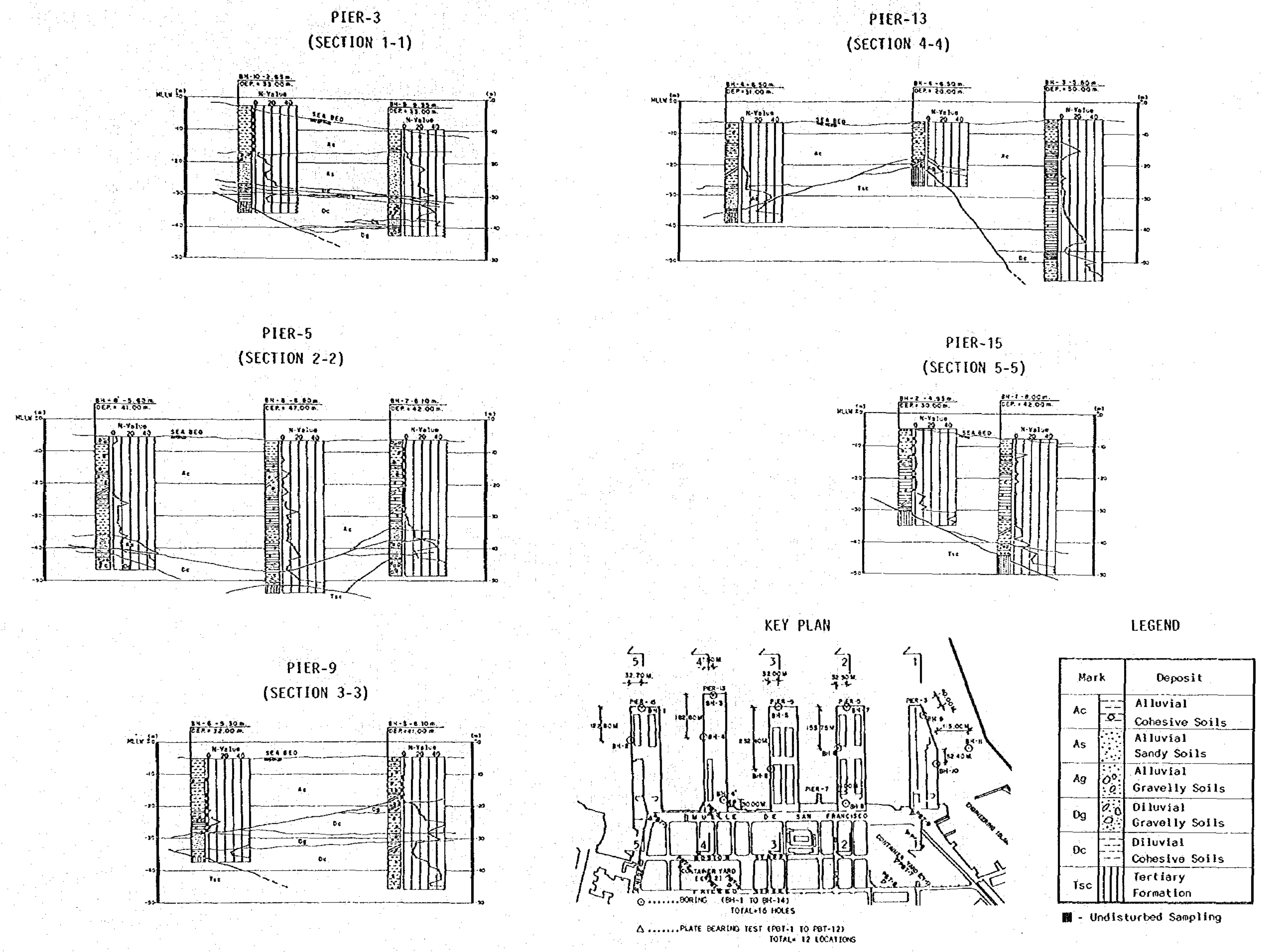
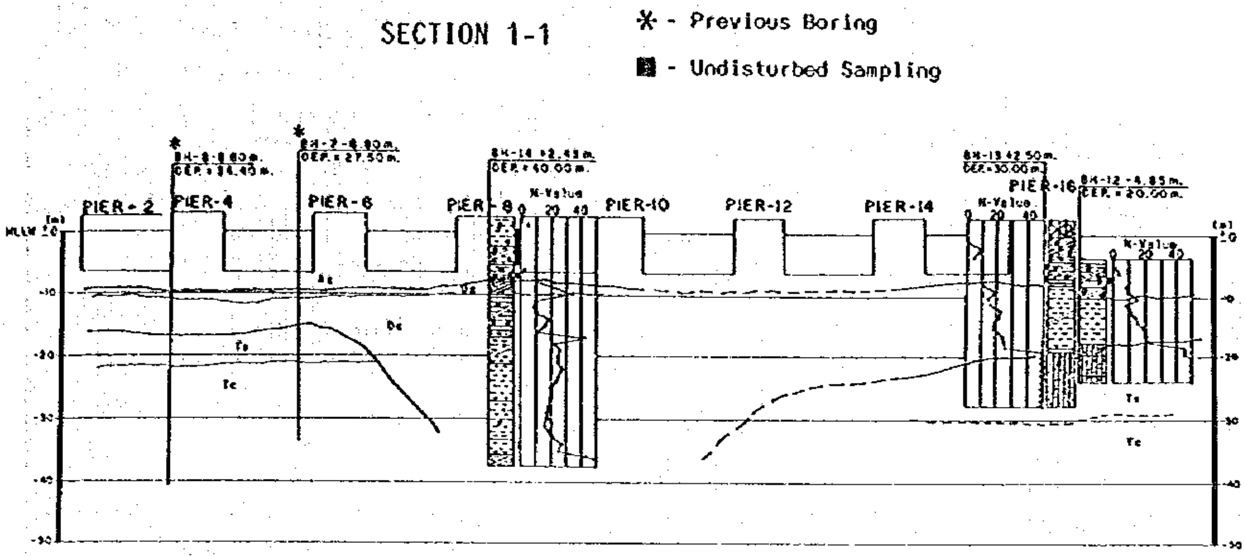
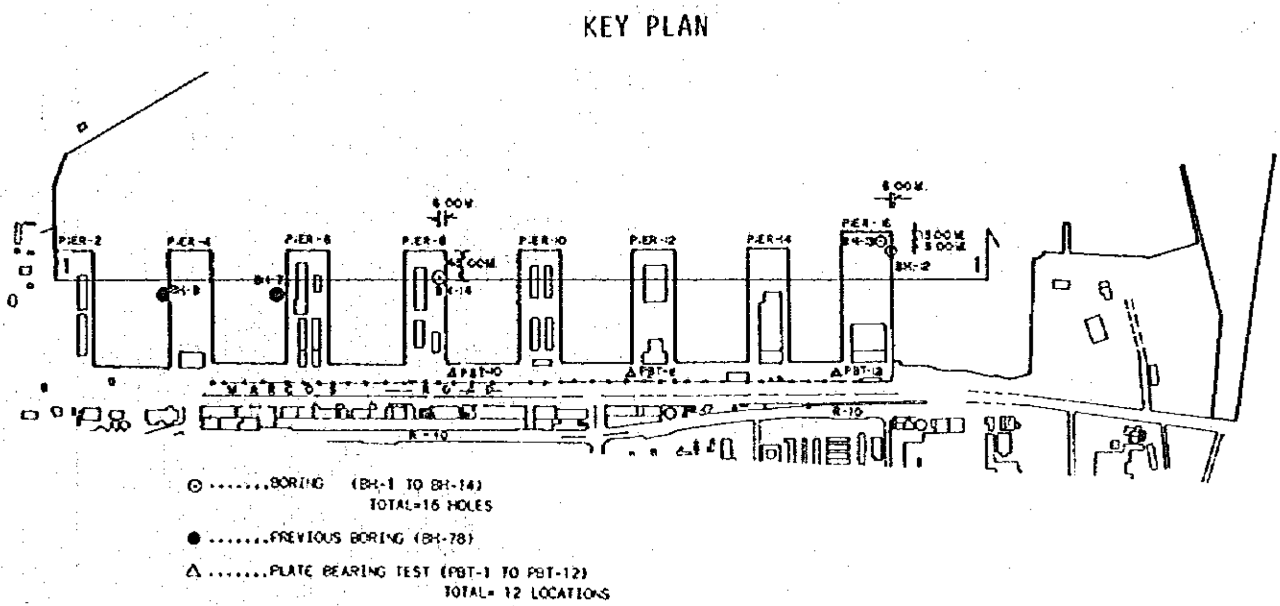


Fig. 3.1.14 Soil Profile of South Harbor (2 of 2)





LEGEND

Mark	Deposit
Fsc	Filling Material
Ac	Alluvial Cohesive Soils
Ds	Diluvial Sandy Soils
Dc	Diluvial Cohesive Soils
Ts	Tertiary Formation
Tc	

Fig. 3.1.15 Soil Profile of North Habor

Table 3.1.7 Summary of the Characteristics of the Strata of South Harbor

Deposit	Mark	N-Value	Color	Article
Alluvial Cohesive Soils	Ac	0 to 5	Dark Gray Black	Very soft clay and silt, -10m sandy, contains shells or organic material
Alluvial Sandy Soils	As	0 to 25	Dark Gray	Loose fine sand
Alluvial Gravely Soils	Ag	10 to 35	Dark Gray	Loose coarse sand
Diluvial Gravely Soils	Dg	10 to 50 over	Dark Gray Yellowish Brown	Dense to medium density sandy gravel to gravely sand
Diluvial Cohesive Soils	Dc	10 to 50 over	Dark Gray Yellowish Brown	Cemented clay to silt, hard to very hard, contains volcanic and organic material
Tertiary Formation	Tsc	50 over	Yellowish Brown	Tuff, sand to mudstone, contains volcanic material

Table 3.1.8 Summary of the Characteristics of the Strata of North Harbor

Deposit	Mark	N-Value	Color	Article
Filling Cohesive Soils	Fsc	--	---	Sandy or cohesive soils, gravel and concrete
Alluvial Cohesive Soils	As	0 to 5	Dark Gray	Sandy, contains plenty of shells
Diluvial Sandy Soils	Ds	10 to 50 over	Yellowish Brown Dark Gray	Very thin Fine coarse sand
Diluvial Cohesive Soils	Dc	10 to 25	Dark Gray Green	Hard clay to silt
Tertiary Cohesive Soils	Ts	50 over	Dark to Yellowish Brown	Tuff - Sandstone
	Tc	50 over	Yellowish Brown	Mudstone

3.1.5.3 Soil Properties in the Investigation Area

Undisturbed and disturbed samples were subjected to soil testing. Laboratory tests were made to conform to JIS and provisions of JSSMFE. The results of the laboratory tests are shown in Appendices 3.1.19 to 3.1.21.

1) Physical Characteristics

The moisture content and unit weight are remarkably scattered due to the irregular mixture of these layers with sand or broken shell.

2) Shear characteristics

The undrained shear strength of saturated cohesive soils in South Harbor are as follows:

$$Qu = 0.05 \quad Kgf/cm^2 \quad (0 \leq Z \leq 4.0m)$$

$$Qu = \{0.05 + 0.042\ (Z-4)\}\ Kgf/cm^2 \quad (Z > 4.0m)$$

Where, Qu : Unconfined compressive strength

Z : Depth

The Qu-values of Ac strata in North Harbor are 0.2 kgf/cm^2 to 0.7 kgf/cm^2.

3) Consolidation characteristics

The Pc-value (consolidation yield stress) is higher than the overburden pressure. This is due to the high sand and broken shell contents. These soils are normally consolidated.

The Cv-values (coefficients of consolidation) are used in the calculation of the consolidated time.

The Cv-values of the Ac strata are as follows:

South Harbor: Cv = 1,000 cm^2/day (normally consolidated limit)

Cv = 2,000 cm^2/day (over-consolidated limit)

North Harbor: Cv = 2,000 cm^2/day (normally consolidated and over-consolidated limit)

The Mv-values (coefficient of volume compressibility) are used in the calculation of the consolidated volume. In general, Mv-values have a inclination which is negative forty-five degrees (45°) in normally consolidated limit. Mv-values of the Ac strata are as follows:

South harbor: Mv = 0.27/P (Normally consolidated limit)
Mv = 0.15 cm^2/kgf constant (Over-consolidated limit)

North Harbor: Mv = 0.17/P (Normally consolidated limit)
Mv = 0.08 cm^2/kgf constant (over-consolidated limit)

3.1.5.4 Results of Plate Bearing Tests

Plate bearing tests, which were executed for the purpose of obtaining the coefficients of the bearing capacity of the subgrades, were conducted inside the container yards (CY-1, CY-2) and along the main service roads inside South Harbor. Thereafter, similar plate bearing tests were executed at selected points along the service roads inside North Harbor. The tests were conducted in conformity with JIS A 1215 (Refer to Appendix 3.1.22).

According to the results of the plate bearing tests, the values shown in Table 3.1.9 were obtained as the design coefficients of the bearing capacity of the subgrades.

Table 3.1.9 Design Coefficient of Bearing Capacity

Area	Design coefficient of bearing capacity (kgf/cm^3)	Remarks
South Harbor container yard	4	PBT -2,3,4,6,7,8
South Harbor road	5	PBT -1,5,9
North Harbor road	22	PBT -10,11,12

3.1.6 Earthquakes

The Philippines is located in the Circum-Pacific Seismic Zone and, therefore, is subject to frequent earthquakes. Based on PAGASA's data, "Catalogue of Significant Philippine Earthquakes, 1960 - 1983", the epicenter map centering on Manila was compiled. Fig. 3.1.16 shows the epicenters of earthquakes with a magnitude over 5.0 on the Richter Scale. It indicates that while no strong earthquakes occurred in the vicinity of Manila, there are three dense areas of epicenters within 150 km to 200km of the city, that is, the west coast of Zambales, the northeast area of Polillo Island and the north area of Lubang and Mindoro Islands.

The two earthquakes with a magnitude over 6.0 that occurred on the north of Polillo Island were observed at intensity VII (Rossi-Feosel Scale) in Manila. Particularly, the Luzon Earthquake on August 2, 1968 with a magunitude of 7.4 was the most severe and destructive in recent years. This earthquake has been described in detail in the UNESCO report "The Luzon Earthquake of August 2, 1968." The following information is from the report.

> "Many buildings were severely damaged and about 270 persons were killed. Besides the buildings in downtown Manila, the Overseas Passenger Terminal for South Harbor was subject to severe damage. A maximum ground acceleration of 70 gal was recorded at the Observatory built on fairly firm ground. The report also states that it is assumed that the acceleration in downtown Manila on thick alluvial layers of soft material might have been two, three, or even more times greater than observed".

Furthermore, judging from the list of violent earthquakes that have struck Manila during the past 300 years, it is said that Manila has been shaken by a destructive earthquake, on average, once every 15 years. In the past 60 years, destructive earthquakes have not been as frequent as they were before.

Accordingly, it is recognized that due consideration of seismic force should be given when designing port facilities.

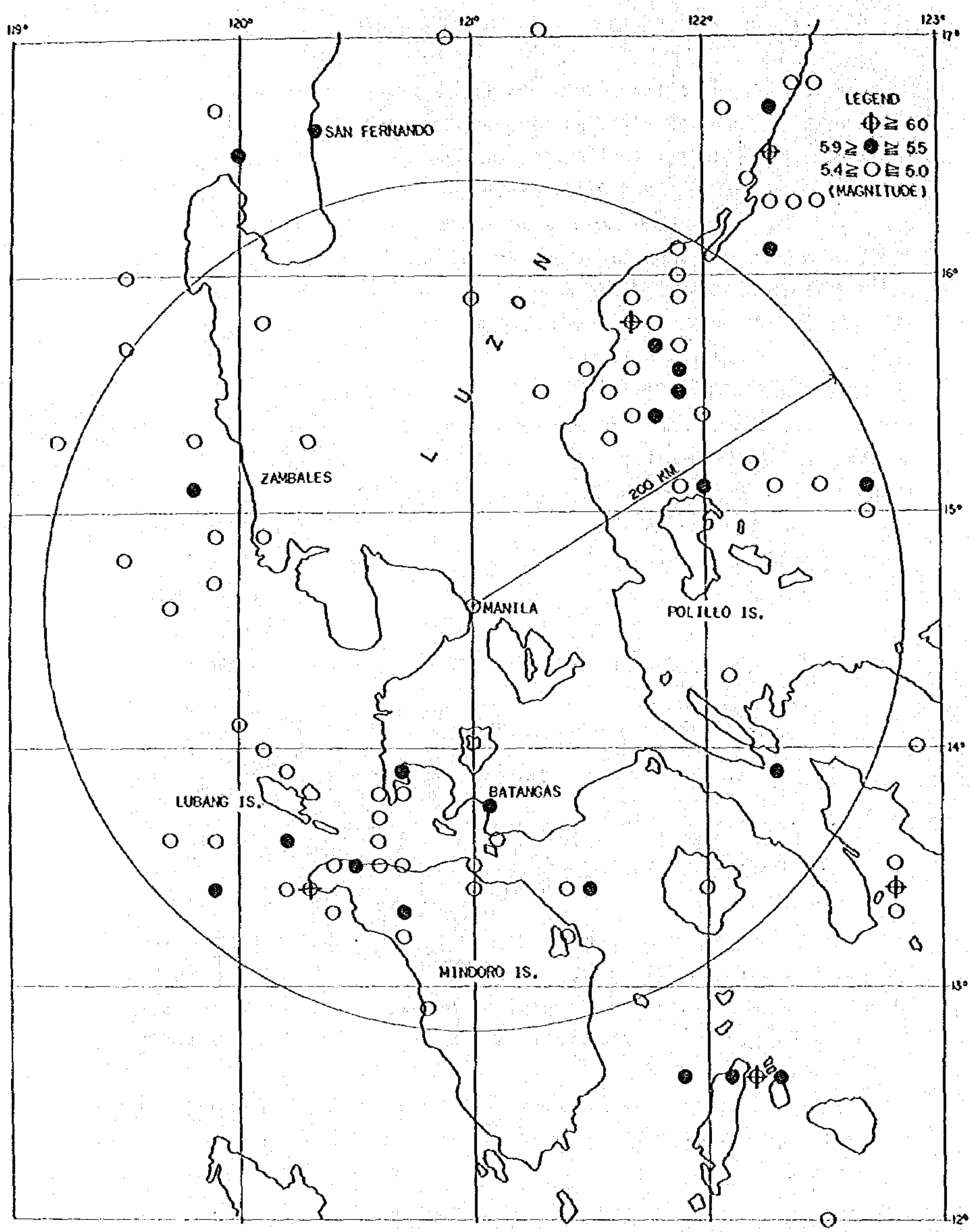


Fig. 3.1.16 Epicentre Map

3.2 Existing Port Facilities and Equipment

3.2.1 South Harbor

South Harbor has 6 piers in all together with anchorages, a fairway and related facilities in the water area protected by the West Breakwater and the offshore South Breakwater. Also it has a back-up area of about 100 hectares, half of which is the existing port zone and the other half is now planned to be included in the port zone. This additional port zone, however, is not included in the engineering survey. The following is an outline of these facilities.

3.2.1.1 Port Facilities

1) Piers

In South Harbor, there are 6 piers numbered 3, 5, 7, 9, 13 and 15. These are large piers, 80 m to 100 m wide, and 350 m to 400 m long except Pier 7. Pier 7 is a small pier which is used for small craft such as ferry boats and tugboats. Most of the piers are comprised of a reinforced concrete deck supported mainly by so called monotube piles. (A monotube pile is a pile filled with reinforced concrete inside a vertically corrugated steel pipe with a wall thickness of about 6 mm.) Piers 5, 9, 13, and 15 have transit sheds. Pier 3 has no transit shed, but has two container cranes called Tango Cranes. The level of Pier 13 is comparatively low, i.e., about + 3.3 m above MLLW. As for the other piers, the level is about + 4.5 m above MLLW, which is about 2.0 m higher than the road behind the Piers. There is a lowered passageway for cargo handling vehicles running down the center of Piers 3, 5, 9, and 15. Fig. 3.2.1 shows the typical section of the piers.

2) Berths

The number of berths and the length and depth of each Pier are shown in Fig. 3.2.2.

3) Fenders

The fendering system is one of the most important port facilities. At present, there are two types of fendering systems used at South Harbor. Their general features are described below.

a. Cluster of timber piles or monotube piles

This type has long been used and the fenders are located about 2 m to 3 m away from the side of each pier at approximately 20 m intervals.

b. Resilient fender type

(Combination of timber piles and small-sized rubber fender)

This type has been applied to the new berth extension.

The fender types and their present conditions at each pier are shown in Fig. 3.2.3.

Most of the fenders of both types are damaged and do not necessarily function properly in absorbing the berthing energy of vessels.

4) Mooring fixtures

Basically, bitts are provided at both sides of the berths, and bollards are installed between the bitts at intervals of about 20 m. Most of the mooring fixtures and their foundations are in good condition.

5) Sheds, Warehouses, Buildings, and Container Yards

There are 11 sheds (total area 36,000 m^2) and 19 warehouses (total area 70,000m^2).

Fig. 3.2.4 shows the location of these facilities. The size and type of the structures are taken from the inventory list (1981) of the PPA, and the results of the inspection are listed in Appendices 3.2.1 to 4. The structures are categorized into three classes. Class "A" indicates that the structures are sound; class "B" shows that the structures are usable but damaged; and class "C" indicates that the structures are worn out and show some structural problems.

There are two container yards (CY-1 and CY-2) in the Port area (total area 88,600 m^2). CY-1 is located in the north of the area and CY-2 in the south. The former is operated by the PPA and the latter by a private company. CY-1 has neither pavement nor an efficient drainage system and therefore, satisfactory cargo handling is difficult, especially after rain. CY-2 is paved, but the surface condition is not good enough for efficient cargo handling.

6) Lighting

There are two types of lighting in the Port area: one along main roads and the other in open storage areas and container yards. San Francisco Street is equipped with mercury lamps on both sides at intervals of 35 m to

40 m. These lamps are sufficient in number and quantity, and will work effectively for the time being, if they are appropriately maintained. However, there is an insufficient number of lights along Boston Street and other branch roads.

As for the lighting in the open storage areas and container yards, the transit sheds on some piers have incandescent flood lamps on their roof tops which illuminate the aprons. Mercury flood lamps are installed in the container yards and the piers without transit sheds. The abovementioned piers have a sufficient quantity of lighting fixtures, but they are not necessarily in good condition due to poor maintenance.

Pier 3 and the container yards are furnished with a sufficient number of lighting fixtures, but Pier 13 seems not to have the necessary amount of flood lighting for effective port operation at night.

7) Breakwaters

The West Breakwater, approx. 2,300 m long, was constructed under the Spanish regime. The structure is a gravity type with concrete blocks laid on a rock mound, and the top is about 2.0 m wide with a height of 2.0 m to 2.7 m above MLLW.

According to a visual inspection, the structure itself is generally sound, and this breakwater will properly function to protect the harbor from waves of the estimated height.

The South Breakwater is approx. 880 m long. It is located 2000 m off the shore and extends southeast from a point 300 m away from the end of the West Breakwater. The structure is of a rock mound type and the top is 2.0 m to 3.0 wide, 1.5 m to 2.0 m high above MLLW. Rocks at the upper part are of a comparatiavely large size, weighing 1 to 2 tons each.

Based on a visual inspection, the rocks at and near the top have loosened and become dislodged except for the part near the West Breakwater, and so the height has been lowered to MLLW or about 1.0 m above it. Therefore, this breakwater requires repairs along with a part of the West Breakwater.

8) Navigation aids[1)]

a. Vessels entering the main entrance to South Harbor are guided by two lighthouses, namely, the LS Manila Jetty NR 1 at the end of the West Breakwater and the LS Manila Jetty NR 2 at the end of the South

1) For more information, refer to "Guidelines for Vessel Traffic Service", International Maritime Organizaion (IMO).

Breakwater. Both lighthouses have weak flashing lights which are emitted at intervals of 5 seconds. They are powered by solar energy and batteries, respectively (Refer to Fig. 3.2.5).

b. Vessels entering via the other approach to South Harbor are guided by the LS Manila Jetty NR 3 installed at the end of the South Breakwater. The solar powered lighthouse has normal flashing lights emitted at intervals of 5 seconds.

c. One mooring buoy with light is located outside the West Breakwater and complements the other navigational aids at South Harbor. In addition, one normally operating lighthouse is positioned at the entrance of the Pasig River to guide navigation at that point.

d. The adjacent International Port and North Harbor have two normally operating lighthouses and two unlighted mooring buoys.

e. Despite the apparent lack of navigation aids in the South Harbor basin and adjacent areas, the Philippine Coast Guard reports that only minimal or minor sea accidents have occurred and these have only taken place during very inclement weather conditions, i.e., strong typhoons. Virtually no dangerous collisions have been noted while vessels are entering or mooring at South Harbor.

f. The areas for dangerous cargo, anchorage and quarantine are sufficient.

Considering the present conditions of the navigation aids in the Port of Manila, the following addition is recommended as soon as possible to ensure safe navigation.

A brighter lamp should be equipped in a higher lighthouse made of reinforced concrete. With this addition, ships far off-shore will be able to easily recognize each lighthouse during the day and at night. The present characteristics of light colors should be kept as they are (Refer to Appendices 3.2.5 and 3.2.6).

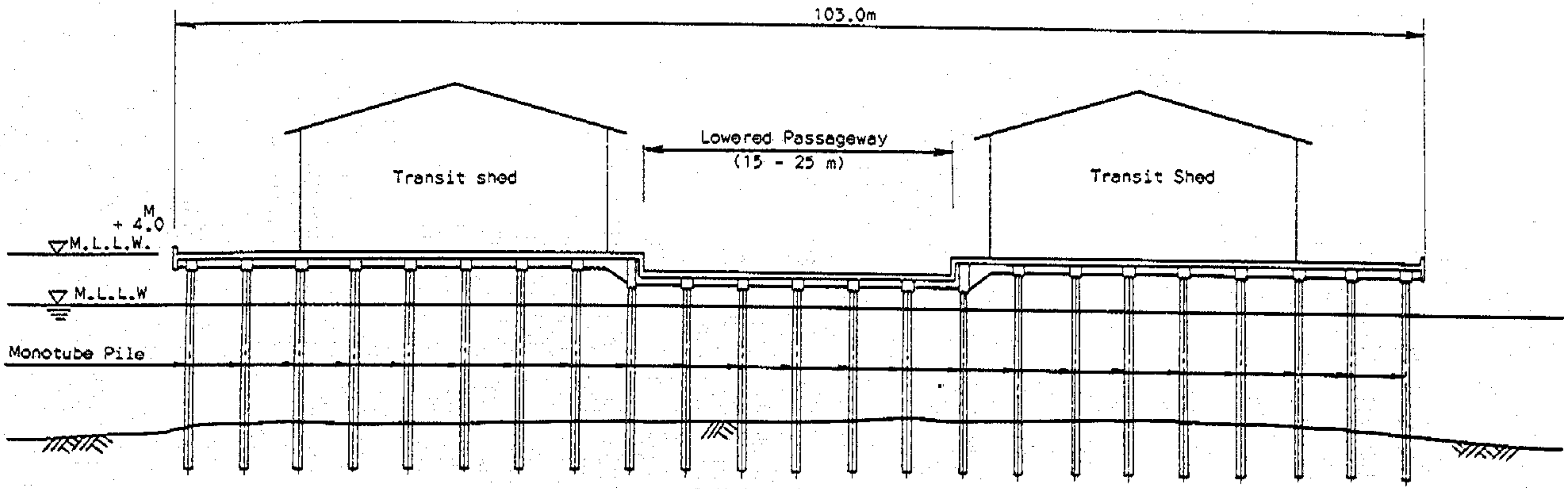
3.2.1.2 Anchorage and Fairway

The fairway (navigation channel) of South Harbor is about 200 m wide and 3 km long. It runs through an opening about 300 m wide between the South and West Breakwaters. The depth of the channel is approximately 10.5 m below MLLW or deeper along its full length.

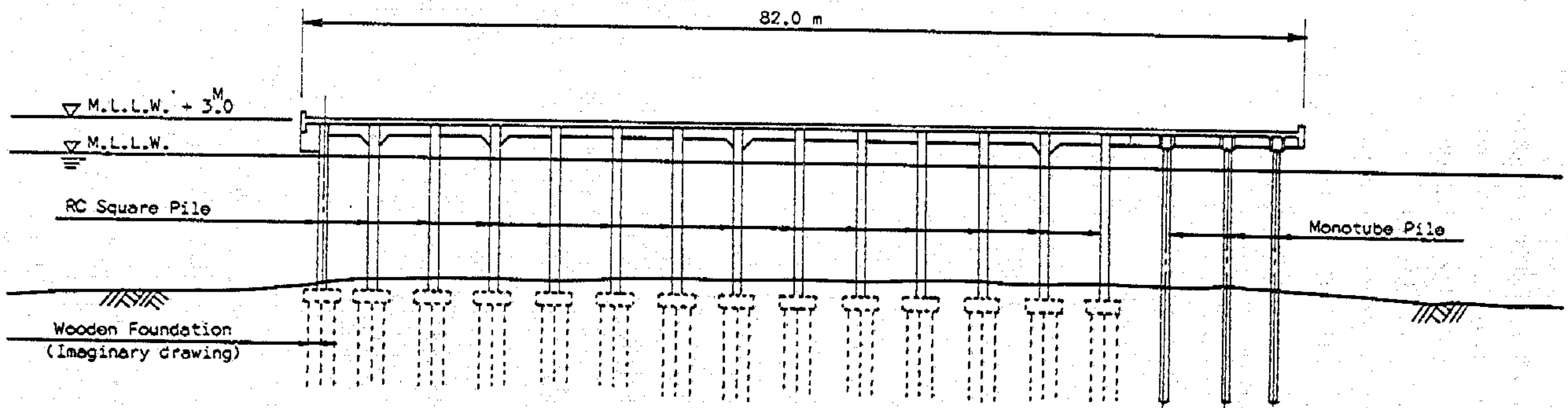
In South Harbor, there are four (4) anchorage basins: A, B, C and Q. Anchorage A is inside the South and West Breakwaters while anchorage B and C are outside both Breakwaters. Anchorage Q is located far off-shore and is exclusively used for quarantine activities for entering vessels.

3.2.1.3 Handling Equipment

All handling equipment is owned and operated by private companies. The existing handling equipment is shown in Table 3.2.1.

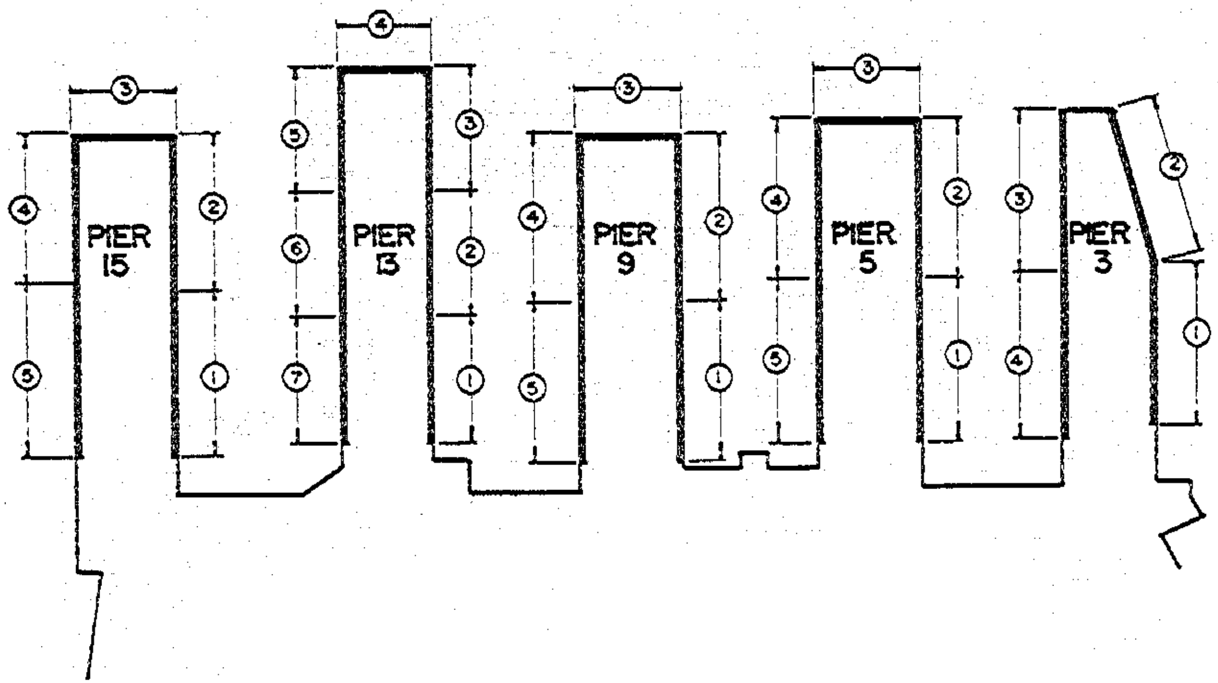


Piers 3, 5, 9 and 15



Pier 13

Fig. 3.2.1 Typical Section of Piers of South Harbor



PIER No.	BERTH No.	LENGTH (M)	AVERAGE DEPTH* (M)
3	1	161.60	2.50
	2	158.50	7.30
	3	163.10	9.80
	4	163.10	7.50
5	1	163.10	6.50
	2	163.10	9.60
	3	103.70	6.70
	4	163.10	9.00
	5	163.10	8.20
9	1	167.70	6.30
	2	167.70	8.60
	3	100.60	7.90
	4	167.70	9.30
	5	167.70	5.90
13	1	127.00	6.40
	2	127.00	9.20
	3	127.00	9.70
	4	82.70	7.20
	5	127.00	8.90
	6	127.00	9.00
	7	127.00	8.90
15	1	163.10	8.60
	2	163.10	10.20
	3	100.60	9.00
	4	152.40	9.70
	5	173.80	9.50

* 1. Based on sounding by JICA (July. 1986)
2. Depths are reckoned from MLLW.

Fig. 3.2.2 Berth Length and Depth

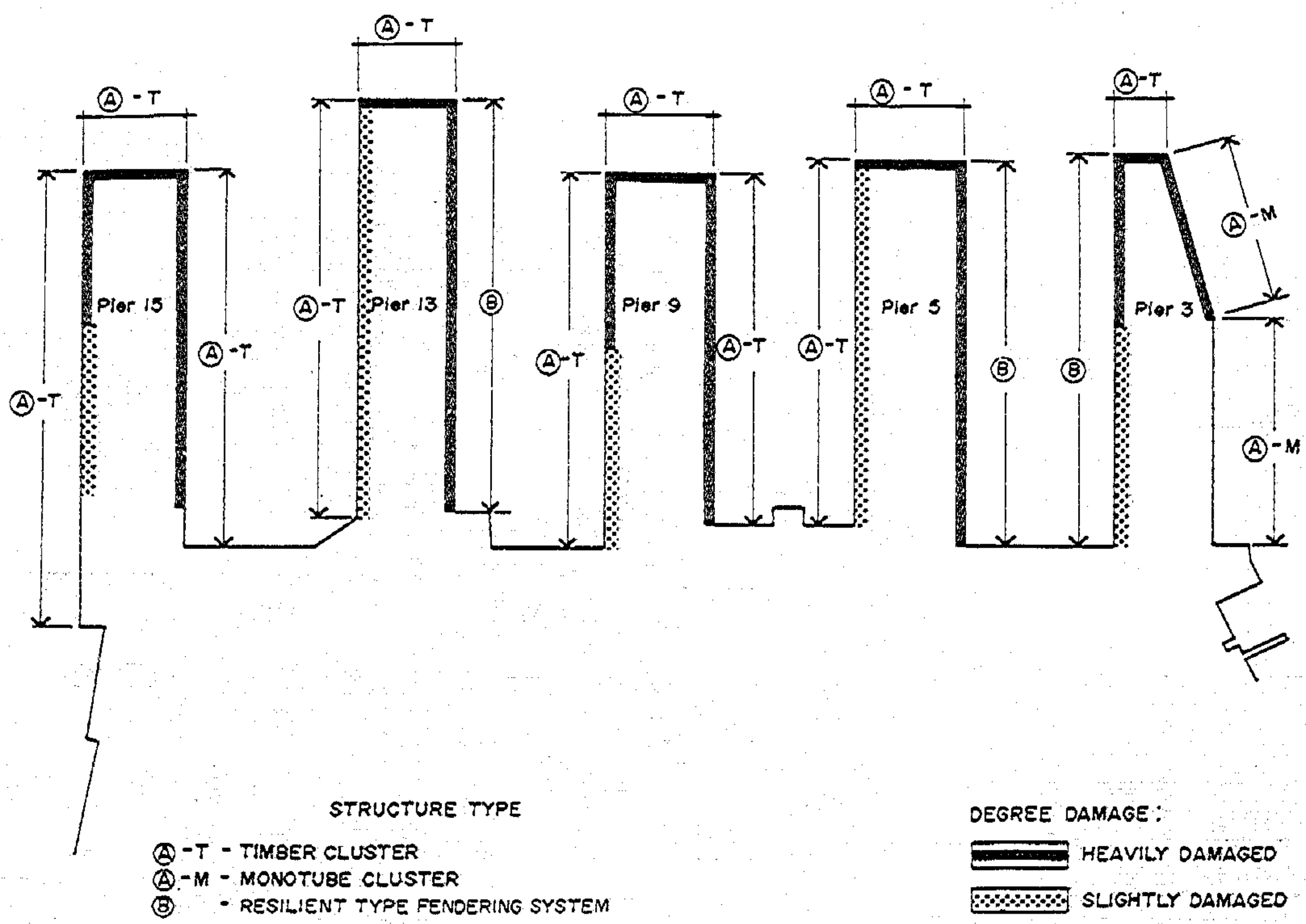


Fig. 3.2.3 Result of Investigation for Fender

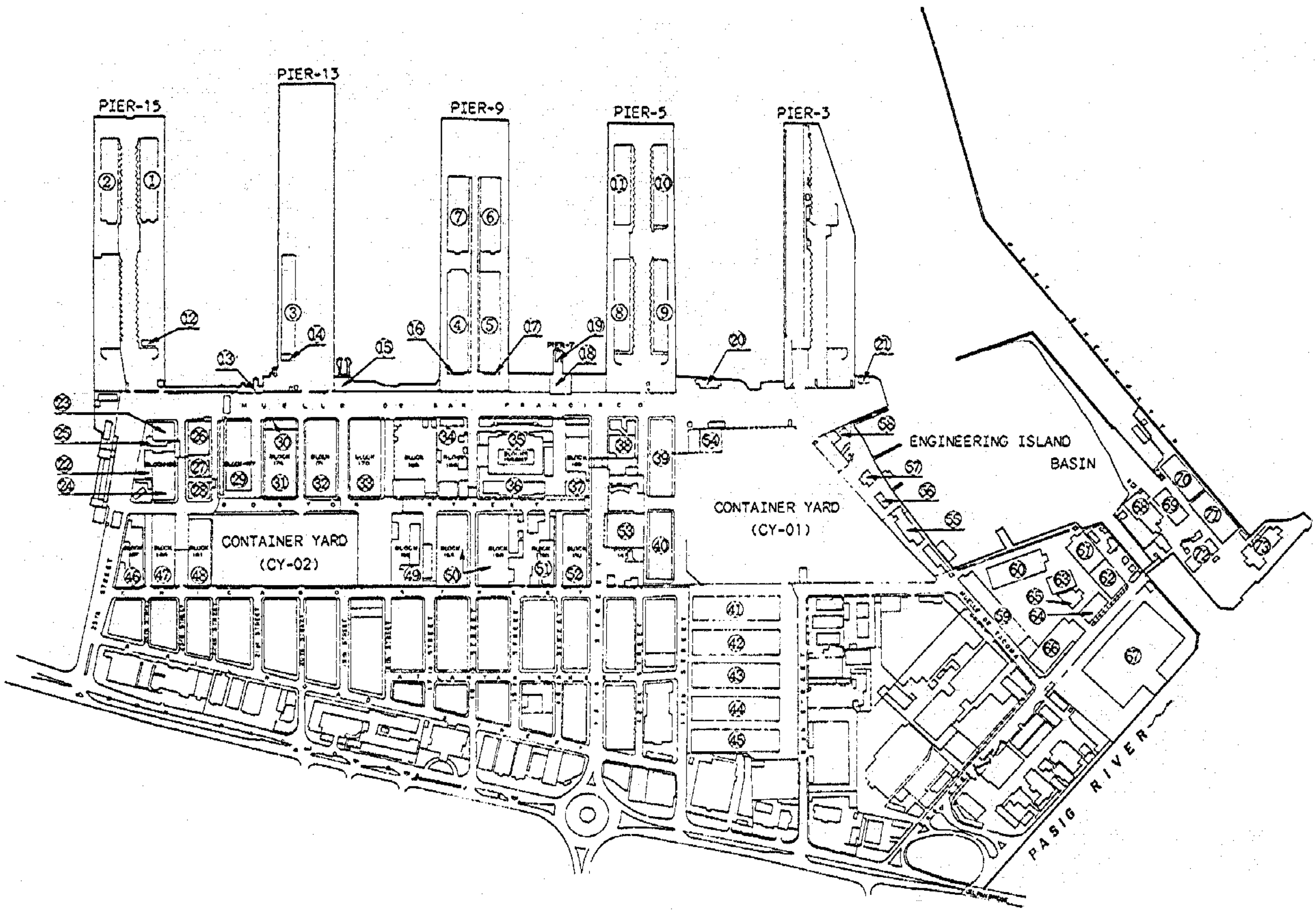


Fig. 3.2.4 Location of Existing Facilities in South Harbor

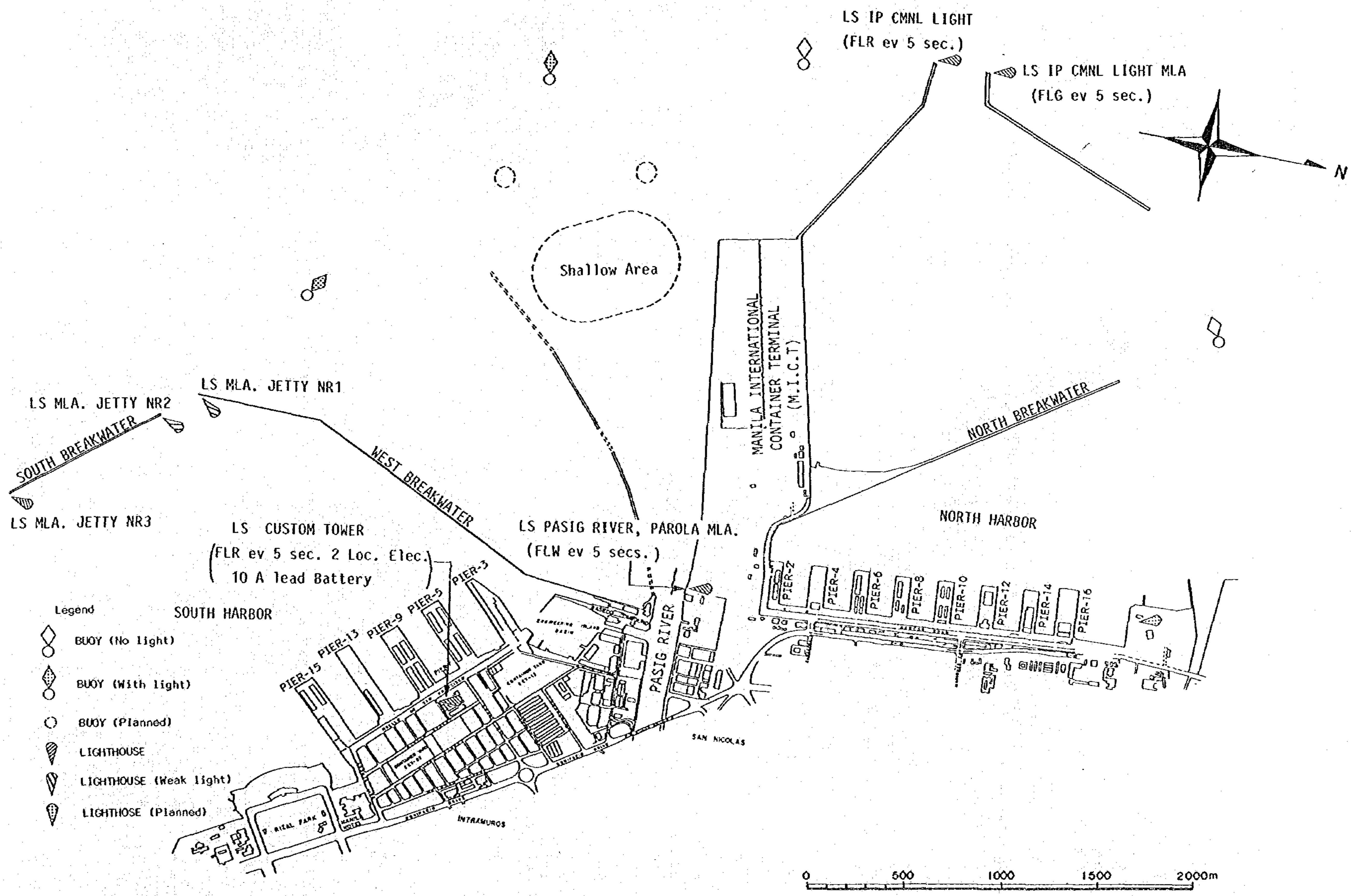


Fig. 3.2.5 Location of Existing and Planned Lighthouses and Buoys

Table 3.2.1 List of Cargo Handling Equipment (South Harbor)

Type of Equipment	Capacity	Number	Remarks
Forklift	2.5-3 ton	161	19: Need major repairs
	5 ton	4	
	10 ton	3	
	20 ton	2	1: Needs major repairs
Top Loader	25 ton	4	
	40 ton	1	
Shifter (Transfer Crane)	35	8	1: Non-operational
Mobile Crane	10-35	8	
	65	1	
Prime Mover		66	17: Need major repairs
Trailer	40 foot FB/HB	22	
	40 foot Grandspan	30	
	20 foot FB	8	
	20 footer Chassis	12	
Container Crane	35 ton	2	
Gravity Discharge Hopper		2	
Payloader		3	
Wheel Loader		6	

3.2.2 North Harbor

North Harbor has 8 piers numbered 2, 4, 6, 8, 10, 12, 14 and 16, and it is used for domestic trade. Each pier has buildings such as transit sheds, passenger terminal buildings, etc. (Refer to Fig. 3.2.6 and Table 3.2.2). The bulkheads of all the piers are made of concrete sheet piles and Pier 16 has an additional structure called a relieving platform built in the ground about 2.5 m below the ground level. The piers in North Harbor are leased to shipping companies. There is a road just behind the piers, and the road is extremely crowded. A plan to widen the back-up area by relocating the road is under way.

The quay of each pier has a set of fenders and mooring fixtures, the conditions of which are generally not good. Piers 2 to 14 are equipped with a wooden fendering system made of timber piles driven at intervals of about 10m. Most of the timber piles are damaged at the top. The fenders of Pier 16 are combinations of timber piles driven in clusters and rubber cushions installed at intervals of about 20 m, and are in comparatively good condition.

As for the mooring fixtures, bitts are installed at a spacing of 30 m to 40 m, and cleats are provided in between. Many of them are damaged, although at some piers these were recently repaired. Most of the cleats are broken at their foundations.

All piers except Pier 16 are concrete paved. Generally the pavement is not necessarily in good condition with local settlements and cracks. Pier 16 was formerly paved with asphalt, but it is now covered with sand and gravel to build up the level. However, the irregularities of the surface make port operation difficult especially after rainfall.

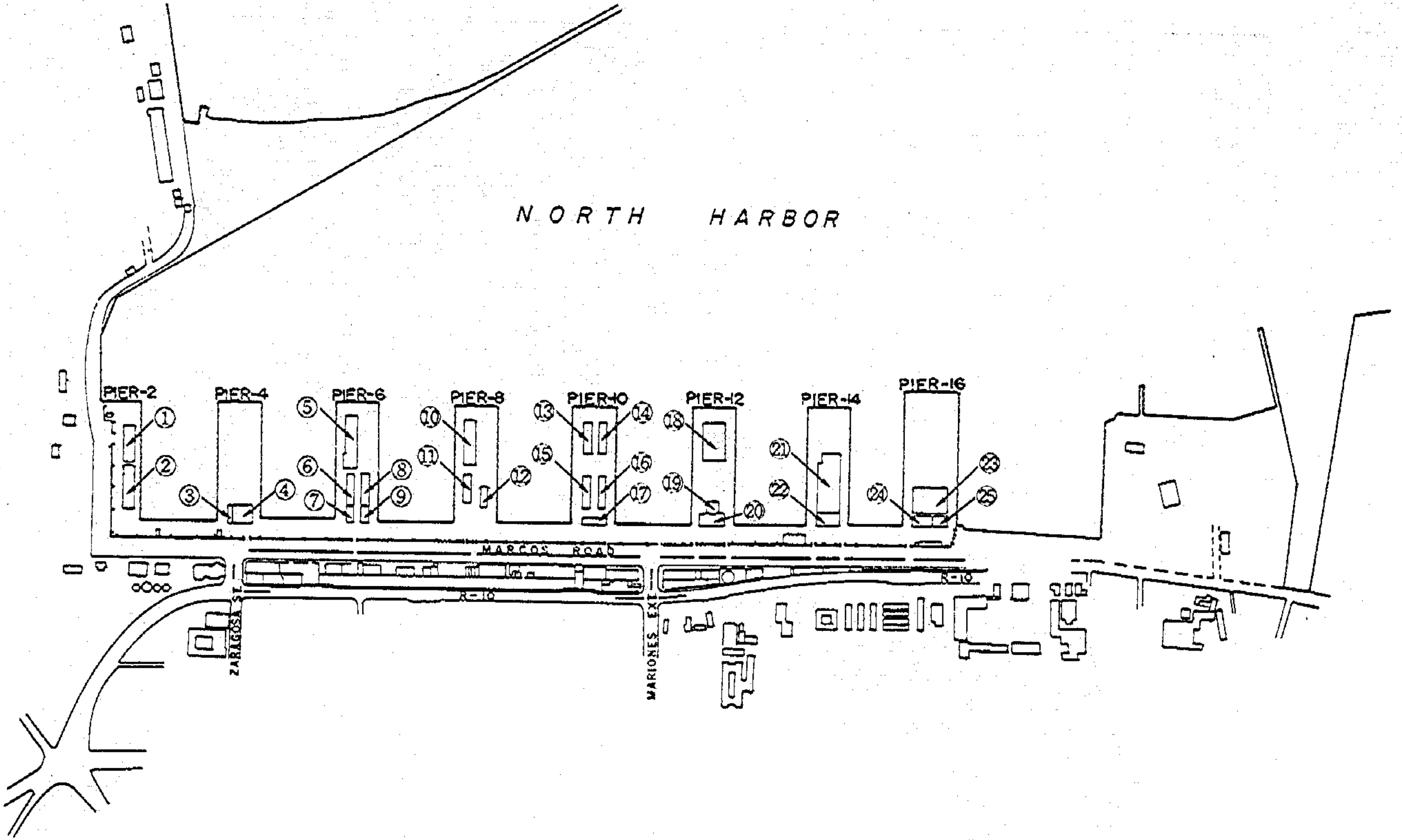


Fig. 3.2.6 Location Map for Facilities in North Harbor

Table 3.2.2 List of Facilities in North Harbor

No.	Location	Application	Area (m^2)	User
1	Pier 2	Transit Cargo Shed	1,292.80	Negros Navigation
2	- do -	- do -	1,437.60	- do -
3	Pier 4	--	263.20	Sea Transport
4	- do -	Passenger Terminal Building	912.80	Aboitiz Shipping
5	Pier 6	Transit Shed (Rolling Shed, etc.)	2,036.25	Sweet Lines, Inc.
6	- do -	Transit Shed	720.00	- do -
7	- do -	Passenger Terminal	375.00	- do -
8	- do -	Transit Shed	773.38	N & S Lines
9	- do -	Passenger Terminal	375.00	- do -
10	Pier 8	Transit Shed	1,503.00	Solid Shipping
11	- do -	Warehouse No. 1	720.00	Candano Shipping
12	- do -	Transit Shed	486.08	Compania Maritima
13	Pier 10	- do -	750.00	Lorenzo Shipping
14	- do -	- do -	747.84	- do -
15	- do -	- do -	375.00	Solid Shipping
			401.32	Premier Shipping
16	- do -	- do -	747.84	Lorenzo & Gothong
17	- do -	Passenger Terminal	1,260.00	Lorenzo Shipping
18	Pier 12	Transit Shed	2,800.00	Sulpicio Lines
19	- do -	Back Loading Warehouse	--	- do -
20	- do -	Passenger Terminal	--	- do -
21	Pier 14	Transit Shed	3,280.00	William Lines, Inc.
22	- do -	Passenger Terminal Bldgs.	--	- do -
23	Pier 16	Transit Shed	990.00	NIPSEA Shipping
			1,800.00	Escano Lines
24	- do -	Passenger Terminal	600.00	NIPSEA
25	- do -	- do -	600.00	ESCANO

3.2.3 Manila International Container Terminal (MICT)

The MICT is located on approximately 69 ha of reclaimed land west of the North Breakwater. The Phase I construction work was started in 1978 and it has almost finished.

The terminal facilities were partially opened for container cargo handling operation late in the 1970's. The MICT has the following main facilities:

Quay wall	920 m
Container cranes	2 units (30.5 tons)
Transit sheds	2 units
Container freight station	1 unit (8,400 m^2)
Administration building	1 unit
(Refer to Fig. 3.2.7 and Table 3.2.3)	

The MICT has an access road adjacent to North Harbor and the road is not in a good condition. The road is congested with jeepneys and other vehicles transporting passengers to and from domestic passenger ships at North Harbor.

The Phase II construction work has just begun and it is a kind of expansion program. This project includes the construction/installation of the following main facilities:

Berth extension	220 m
Ro-Ro facilities	1 unit
Container stacking/marshalling yard	15,000 m^2
Container freight station	2 units 16,000 m^2
Other buildings	
Additional cranes	
Container cranes	4 units
Other cranes	12 units
Access road	
Other necessary equipment/facilities	

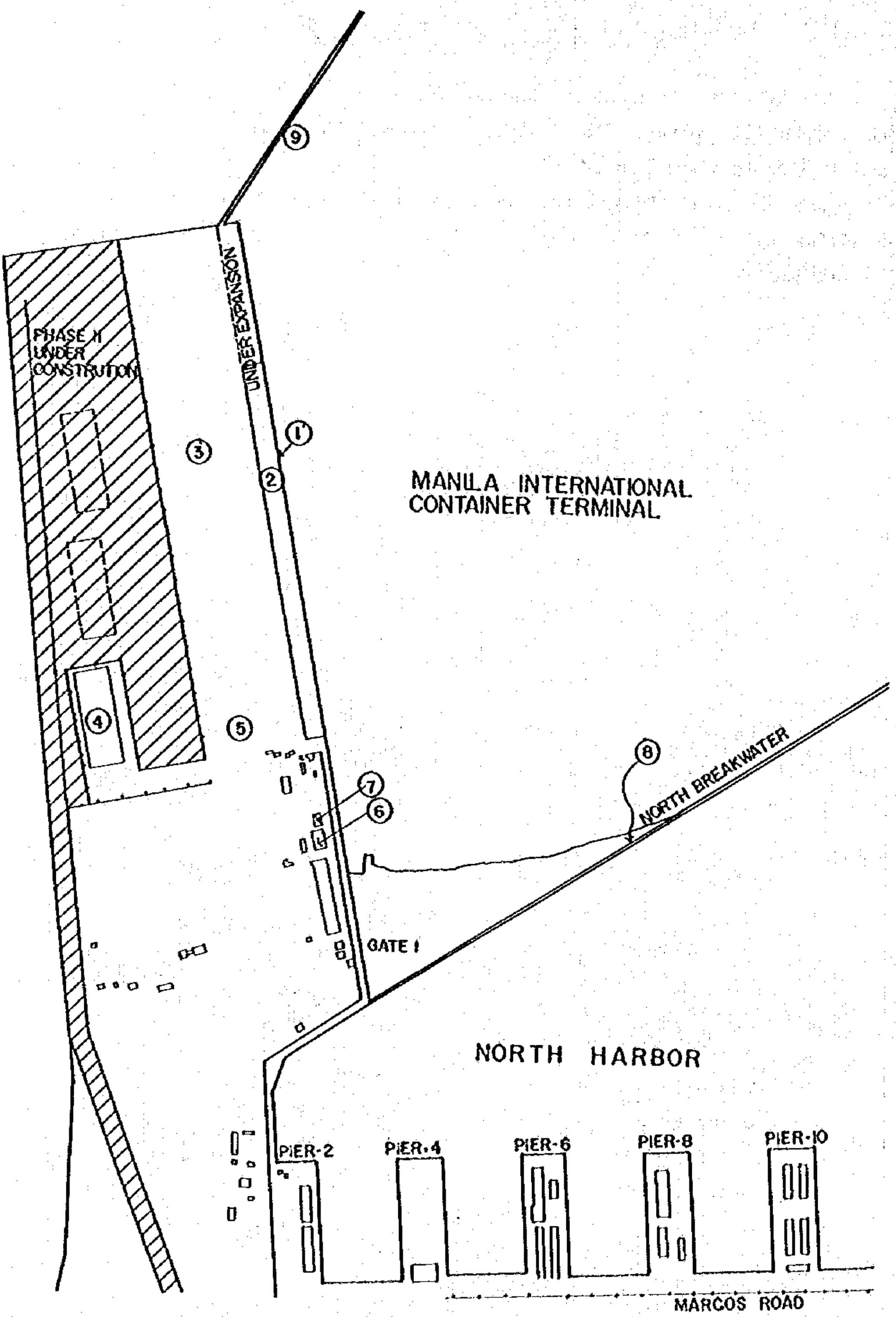


Fig. 3.2.7 Location Map for Facilities in MICT

Table 3.2.3 List of Facilities in MICT

No.	Name of Facility	Structure Type	Size	Remarks
1	Container Berth	Monotube steel pile, and concrete slab supporting crane rail Rubber fender	Number of Berths: 4 Berth length: about 1,000m.	Water depth = 10.7m
2	Apron	---	4.6 ha	---
3	Container Yard	---	17.0 ha	Import and Export Stack
4	CFS	Steel frame with aluminum roof and concrete hollow block wall	8,400 m^2	New Structure
5	Chassis Parking Area	---	---	---
6	Administration Building	Two-story, concrete building	360 m^2	---
7	Engineering Building	Two-story, semi-concrete building	144 m^2	---
8	North Breakwater	Rubble-mound type	About 1,700 m	---
9	Breakwater	Rubble-mound type	About 1,210 m	---

3.2.4 Pasig River

The Pasig River connecting the Laguna de Bay with the Bay of Manila passes through the Metro Manila Area. This river is a very important traffic way with many factories along both banks. However, due to the lack of water depth in the dry season and insufficient clearance under some bridges in the rainy season, navigation of tugboats is sometimes restricted.

Locations of the cargo handling facilities along the Pasig River are shown in Fig.3.2.8. The figure was compiled on the basis of the leasing map and cargo flow list prepared by PPA.

The berths from the river mouth to the Jones Bridge are owned by the PPA, and cargo handling companies use these berths. The quaywalls are of the concrete block type. There are few fenders, except for simple timber piles for mooring. In addition, the aprons behind the quays are very narrow.

The banks upstream of the Jones Bridge are mostly occupied by private companies which are related mainly to the petro-chemical industry and to flour milling. The petro-chemical companies have well-maintained dolphin type piers. The flour mill companies also have well-maintained piers and use mechanized handling equipment, such as pneumatic unloaders.

Generally, the public berths have markedly inferior facilities to the berths owned by private companies.

The clearances of the bridges are also shown in Fig. 3.2.8.

These clearances are taken from "Fairways and Anchorage Chart of Manila Harbor 4236A, revised 83-5-26" published by the P.C. & G.S.

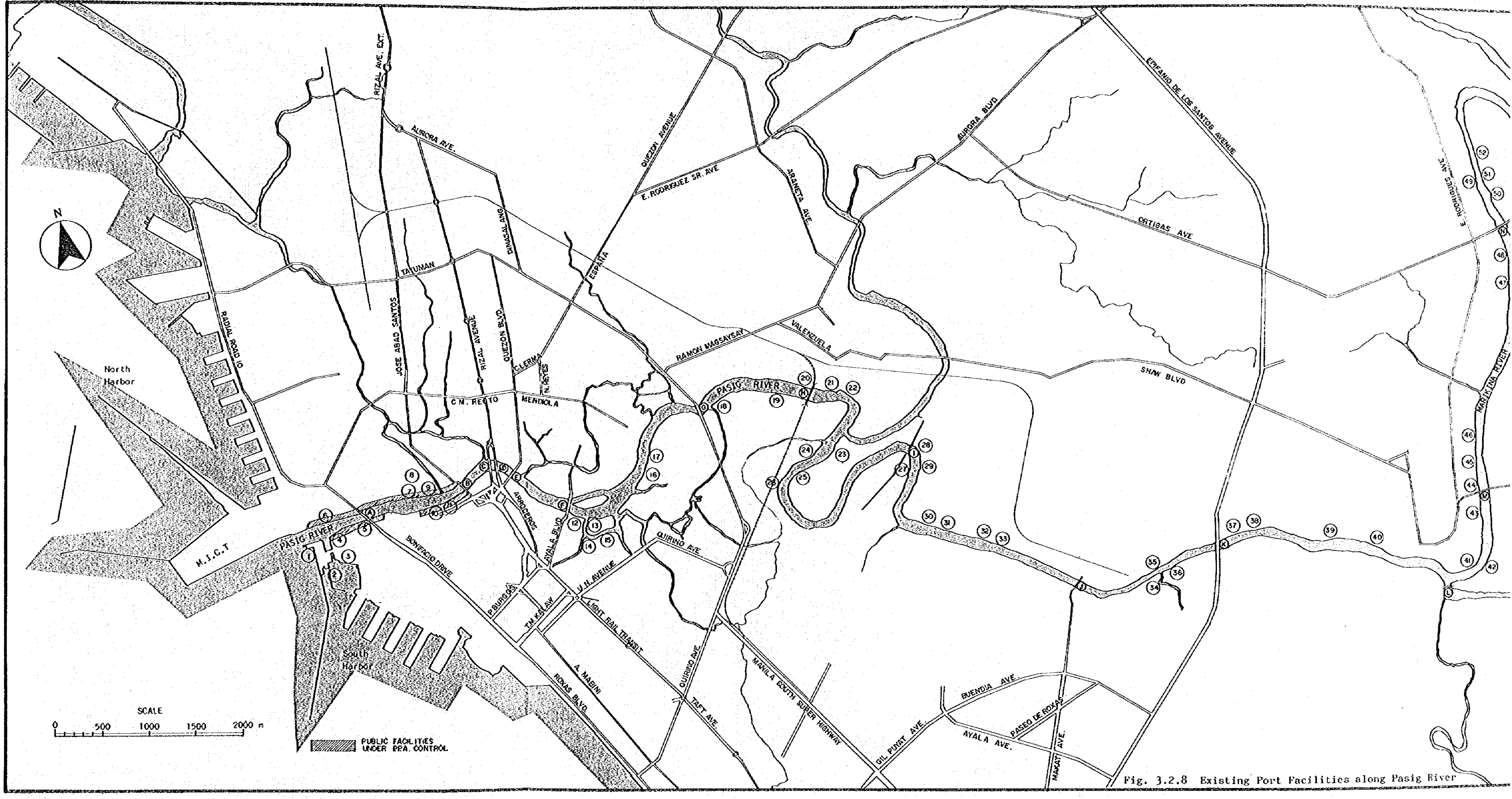


Fig. 3.2.8 Existing Port Facilities along Pasig River

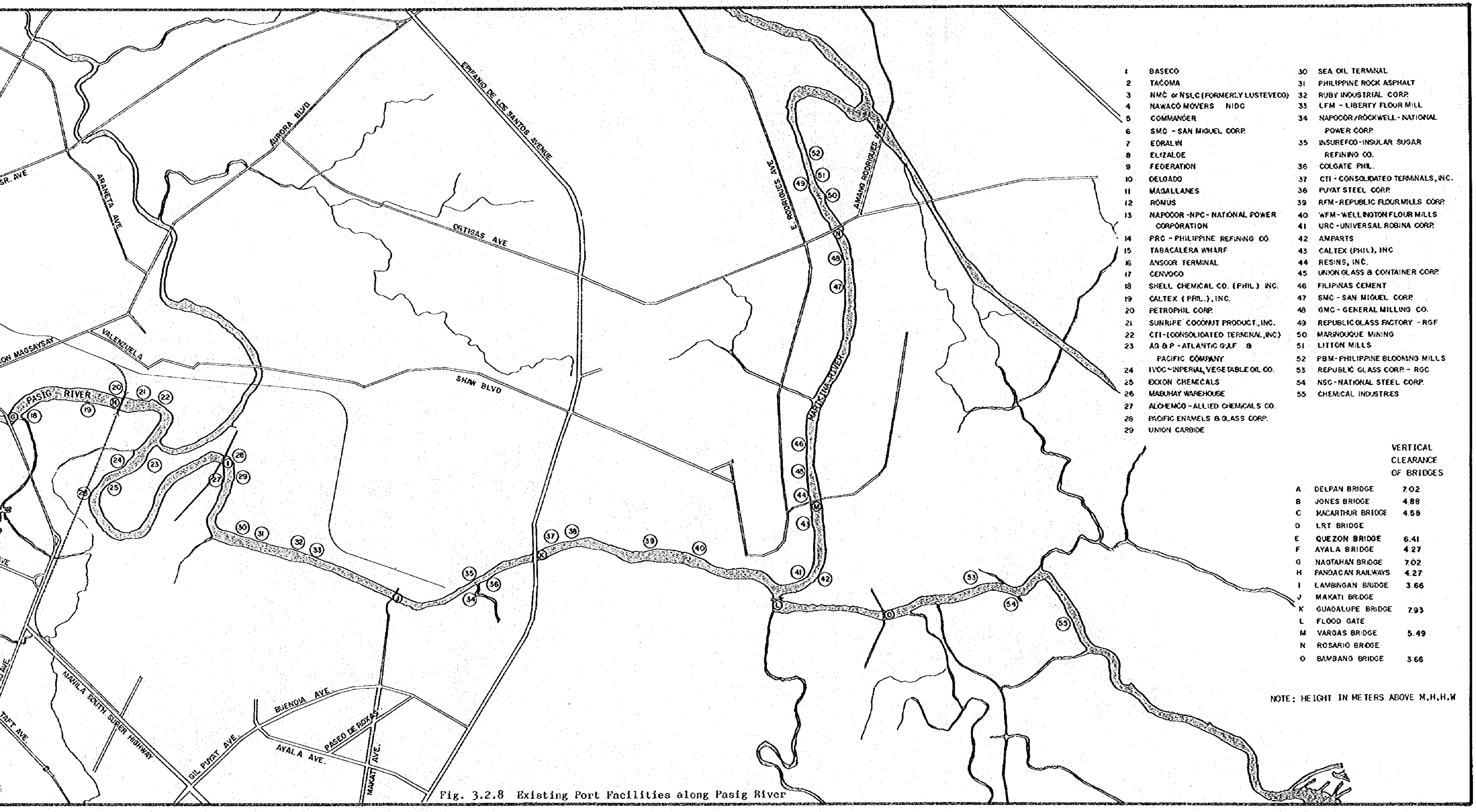


Fig. 3.2.8 Existing Port Facilities along Pasig River

3.2.5 Major Land Traffic

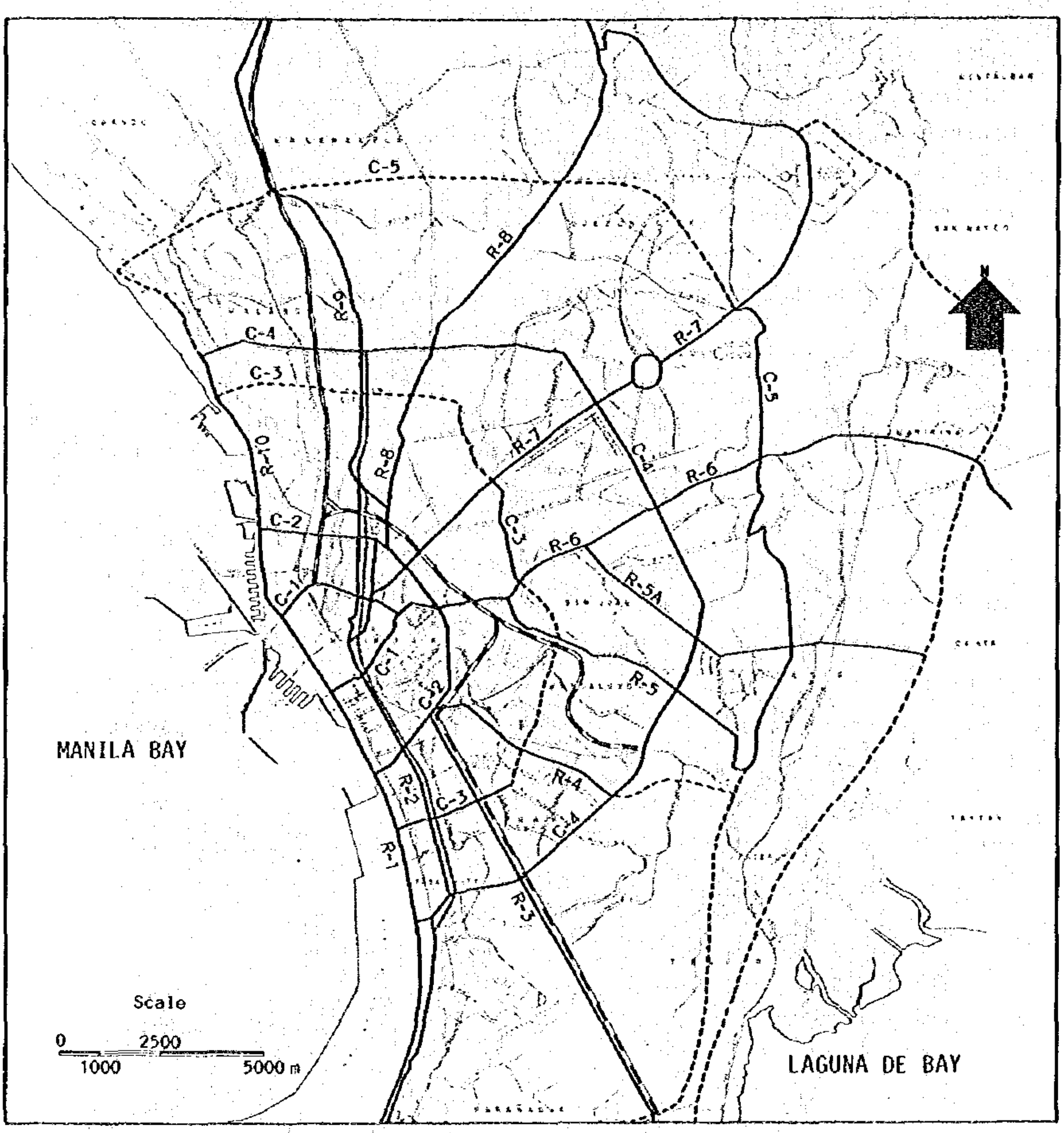
3.2.5.1 General Features of the Roads in Manila

Motorized vehicles are the principal means of transportation in the Metropolitan Manila Area (MMA). The MMA road network is made up of several radial and four (4) circumferential roads - one of them is still under construction. The circumferential roads are planned to traverse the Central Business District (CBD). Circumferential roads C-2 and 4 have a high capacity for heavy traffic. Most of the radial roads are completed and they extend from the CBD to the outlying areas (Refer to Fig.3.2.9.).

The Manila road network is not sufficient enough to handle the present heavy traffic except for some trunk roads. Most of the roads were constructed some time ago, and they are in poor condition with inadequate drainage and poor maintenance considering the present heavy traffic demand. Some main intersections are controlled by traffic signal lights and the major barriers causing congestion in traffic flow are the Pasig River and the numerous esteros (streamlets).

Generally, the construction of roads to meet the increase in traffic in the urban center is moving at a slow pace. C-4 and the north-south bound expressway will serve as major transport axes in MMA and they are primarily designed to act as the quickest approach to other economic centers in Luzon. The newly constructed radial road R-10, which also falls basically under this category, is of prime importance to port-related traffic.

The roads in Manila are extremely congested. Though several efforts have been made to relieve the traffic congestion in MMA, very little has been accomplished.



Legend
—— ROAD (Existing)
---- ROAD (Under Construction or Planned)
PNR
LRT

Fig. 3.2.9 Major Traffic System in Metro Manila

3.2.5.2 Land Access to the Port Areas (Refer to Fig. 3.2.10)

Bonifacio Drive, a six-lane asphalt-concrete paved road, serves as the main access for South and North Harbor related traffic. Vehicles can reach the South Port area via two main connecting roads:

25th Street (incoming and outgoing for cars but outgoing only for cargo trucks from 7:00 a.m. to 7:00 p.m.) and 13th Street (incoming traffic only).

25th Street is a four-lane undivided concrete paved road which runs to the southern part of the Port via Gate 1.

There are traffic jams on this street several times a day. Chicago Street, parallel to Bonifacio Drive, is a four-lane undivided concrete paved road and also has traffic problems. Both roads are used as parking areas and this exacerbates the problem. Likewise, a traffic bottleneck is also experienced at the junction of 25th Street and Chicago Street/Bonifacio Drive.

8th Street is a 2-lane asphalt-paved road. This is an access road to Gate No. 6 which is presently not open for incoming traffic to the Port.

13th Street is an asphalt-paved 4-lane road. It connects Gate 4 with Bonifacio Drive at Anda Circle. It is only used for incoming vehicles.

North Harbor Road or Marcos Road is the main road for passengers and cargoes in North Harbor.

This divided road is paved with asphalt and has three lanes running in each direction. Zaragoza and Mariones Streets, which are the main branch roads, are connected with North Harbor Road.

Zaragoza Street now serves as a feeder crossing R-10 for cargoes to and from the commercial districts of Binonda and Divisoria.

Moriones Street is a divided six lane concrete paved road and it serves as the main access to and from Dagat-Dagatan, Divisoria, J.

Abad Santos and Dagupan Streets.

Del Pan Bridge connects South Harbor with North Harbor.

The bridge has a steel deck-girder with a 4-lane divided concrete paved roadway.

But the access roads to the bridge on both sides are six lane roads, and therefore traffic is sometimes hampered especially during rush hour. However, this bridge is presently being widened, and it will extend to R-10 as an elevated highway running toward the Manila International Port. Radial road R-10 is completed up to Novotas Fish Port.

South Harbor has three main gates, No. 1, 4 and 6, while there is no gate at North Harbor because no customs control is executed. Passenger and cargo checking in North Harbor is conducted at individual gates along North Harbor Road (Marcos Road).

3.2.5.3 Railways (Refer to Fig. 3.2.9)

There used to be a single line railway in North Harbor (Piers 2, 4 and 6) which was connected with the PNR rail network in Luzon via PNR Tutuban Station. The main purpose of the railway was to transport sugar into North Harbor.

The line ran down the center of the main road of North Harbor to PNR Tutuban Station, and was not an elevated. The railway (North Harbor-PNR Tutuban Station) was used until the beginning of 1970s. However, at present, the track line condition is very bad and almost ruined. The demand for rail transport has decreased along with the increased use of road vehicles which cause heavy traffic. This may take a long time before cargo is again transported by train.

3.2.6 Small Craft

The number of tugboats, speed boats, and launches of Government Agencies are shown in Table 3.2.4.

A general description of the tugboats and barges which ply South Harbor and the Pasig River is presented in Appendix 7.3.2. This table is based on data provided by two of the large lighterage companies.

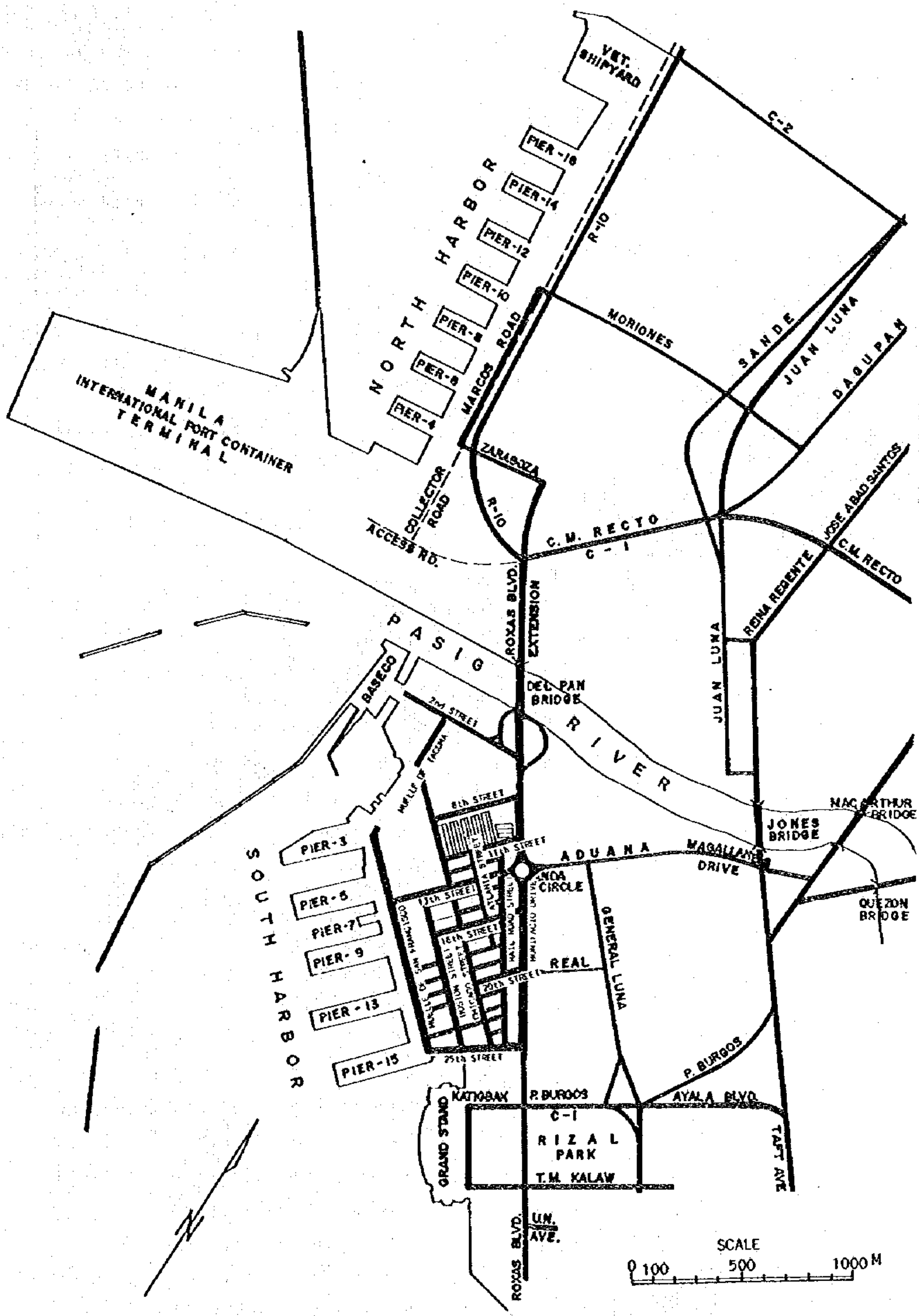


Fig. 3.2.10 Road Network in the Vicinity of Manila Port

Table 3.2.4 Small Craft (Number)

Government Agency	Tugboat	Dredger	Boat	Berthing / Mooring Area	Remarks
1. Cost Guard	-	-	-	Basin in front of the Manila Hotel	Restricted data
2. Navy	-	-	-	--	Restricted data
3. Harbor Pilots	6			Landing between Pier 15 and 13	
4. Customs			5	Engineering Island Basin	
5. PPA		4	3	M. I. C. T.	
6. MPWH				Parola area	Total 40
7. Quarantine			1		Source: PPA

3.2.7 Public Utilities

a) Water Supply

There are currently six companies engaged in supplying water at the Port of Manila, namely:

1) Harbor System and Supply, Inc.
2) Malayan Towage Company
3) Vlason Company
4) Gaerlan Company
5) Manila Metro Water Service
6) Roque Trading Company

Their sources of water supply are located at Pier 2 and at Quiapo at the foot of the Quezon Bridge. Water supply at North Harbor is not a problem due to the existence of pipelines at every pier which are utilized by the shipping lines occupying each of the piers.

South Harbor has the opposite situation with no pipelines at the piers. This will no longer be a problem when the rehabilitation takes place because the Metropolitan Waterworks Sewerage System (MWSS) has already made plans for the installation of a water pipeline system at the

South Harbor Piers. It will then only be a matter of adjusting the sizes of pipes to meet the water demand. At present there are high-pressure water supply pipelines in the back-up area of South Harbor designed to meet the water demand including the piers. In the first half of 1986 about 15,000 to 18,000 tons of water per month were required at South Harbor and Anchorage. This water was supplied by the five (5) companies listed above. The Vlason Company supplies the Philippine Navy (Refer to Appendix 3.2.7). There is no serious problem with the current water supply system.

b) Oil Supply

The vessels calling at the Port of Manila enjoy a stable supply of oil throughout the year, but they are required to inform the supplier of their arrival date and time in advance.

c) Electricity Supply

At present the Manila Electric Company (MERALCO) supplies North and South Harbors with electricity. MERALCO has primary distribution lines of either 3,600 V or 20,000 V with a secondary voltage utilization of either 230 V or 440 V. Electric lines are installed overhead along the streets. At the piers electicity is supplied from lines installed underground.

According to an interview with MERALCO concerning the expected electricity demand under the short-term development plan, the company confirmed that MERALCO is always ready to supply any amount of electricity.