3. Port Activities

In Costa Rica, there are five major international ports ··· Caldera, Puntarenas, Punta Morales, Quepos and Golfito ··· on the Pacific coast, and two major international ports ··· Limón and Moín ··· on the Atlantic coast. The locations of these ports are shown in Fig. I −4.

The total port cargo throughput in Costa Rica is shown in Fig. II −5 and Table II −1 by coast. Overall, import cargo volume exceeds export cargo volume. About 75% of the total cargo volume is handled on the Atlantic coast. On the Atlantic Coast, large volumes of petrochemical products and bananas are imported and exported at the Port of Moín. The import cargo volume is larger than the export cargo volume on the Pacific coast. Generally, the total national throughput has been increasing. Especially, the cargo volume on the Pacific coast rapidly increased during the three years after the Port of Caldera was opened in 1982. Table II −2 shows port cargo throughput by major port and Table II −3 shows the number of calling ships by major port.

The major ports are briefly described below. Fig. II −6∼Fig. II −10 show the port layouts of five of these ports. The most important Costa Rican ports are the Ports of Caldera and Puntarenas on the Pacific coast and the Ports of Limón and Moín on the Atlantic coast. The Port of Caldera is described in detail in CHAPTER III.

The Port of Puntarenas was constructed in 1927. It has an offshore type pier. This pier handled most of the public cargoes on the Pacific Coast until the Port of Caldera was opened. After the opening of the Port of Caldera, the pier has mainly been used to handle grain imports. However, this pier is already superannuated as noted in CHAPTER III and CHAPTER X. The Port of Caldera was constructed to take over the port functions of the Port of Puntarenas. The new port was opened in December 1981.

The Port of Punta Morales is owned and operated by the sugar-manufacturing company LAICA. There is one detached pier and a long pier with a belt conveyor. There is also a large warehouse for sugar exports. All these facilities are used exclusively for sugar exportation. The water area around the pier is shallow due to siltation.

The Port of Quepos was formerly owned and operated by a private banana company. It was used solely for the export of bananas. However, the ownership of the port was transferred to the joint port authority of MOPT and the local autonomous body, JAPOQ, after the withdrawal of the banana company. About five vessels loaded with palm oil from Southeast Asia enter the port to unload the cargo every year. The port is located at an estuary and faces the Pacific ocean almost directly. Thus, the berth area may be influenced by sand drift and rough sea conditions. MOPT has a plan to develop a fishing port by the foot of the pier.

The Port of Golfito is located in Golfito Bay, and the water area is well protected from the rough sea. The port had been owned and operated by a private banana company, but its ownership was transferred to MOPT at the end of 1985. The deep steel-frame pier has been well maintained. However, there is currently no plan to use this facility due to a lack of demand. However, port demand should grow in the future along with the development of agriculture in the hinterland of the port.

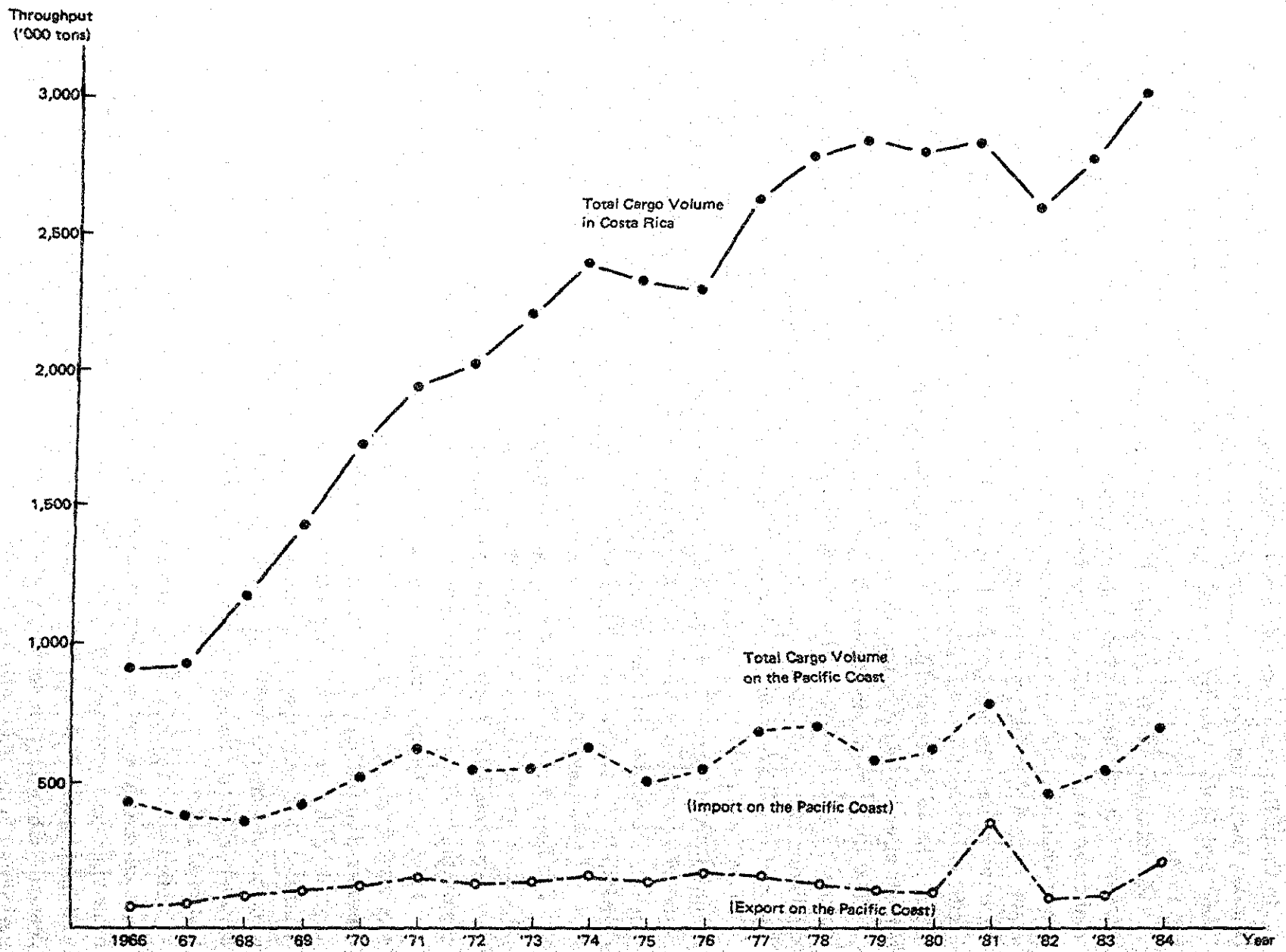


Fig. II-5 Port Cargo Throughput in Costa Rica

Table II-1 Port Cargo Throughput in Costa Rica

	Imports			Exports			Total			Share (%)		
Year	Puntarenas	Limón	Total	Puntarenas	Limón	Total	Puntarenas	Limón	Total	Puntarenas	Limón	Total
1966	361,079	224,675	585,736	82,371	250,593	333,324	443,450	475,250	918,700	48.3	51.7	100
1967	307,540	293,119	600,659	87,847	242,687	330,534	395,387	535,806	931,193	42.5	57.5	100
1968	255,912	443,300	699,212	119,758	366,922	486,680	375,670	810,222	1,185,892	31.7	68.3	100
1969	307,166	497,778	804,944	127,487	491,253	648,740	434,653	989,031	1,423,684	30.5	69.5	100
1970	390,173	559,615	949,788	152,539	615,757	768,296	542,712	1,175,372	1,718,084	31.6	68.4	100
1971	446,968	599,439	1,046,407	185,983	703,970	889,953	632,951	1,303,409	1,936,360	32.7	67.3	100
1972	392,115	649,236	1,041,351	159,618	826,118	985,736	551,733	1,475,354	2,027,087	27.2	72.8	100
1973	378,312	688,761	1,067,073	178,347	953,770	1,132,117	556,659	1,642,531	2,199,190	25.3	74.7	100
1974	457,967	844,343	1,302,310	190,247	896,257	1,086,504	648,214	1,740,600	2,388,814	27.1	72.9	100
1975	353,940	876,004	1,229,944	166,182	929,676	1,095,858	520,122	1,805,680	2,325,802	22.4	77.6	100
1976	360,584	856,960	1,217,544	200,999	864,801	1,065,800	561,583	1,721,761	2,283,344	24.6	75.4	100
1977	518,203	1,081,922	1,600,125	188,633	831,089	1,019,727	706,841	1,913,011	2,619,852	27.0	73.0	100
1978	554,356	1,179,524	1,733,880	167,273	881,488	1,048,761	721,629	2,061,012	2,782,641	25.9	74.1	100
1979	415,258	1,318,223	1,733,481	143,064	953,022	1,096,086	558,322	2,271,245	2,829,567	19.7	80.3	100
1980	502,111	1,232,267	1,734,378	127,343	930,018	1,057,361	629,454	2,162,285	2,791,739	22.5	77.5	100
1981	422,394	998,549	1,420,943	378,030	1,027,939	1,405,969	800,424	2,026,488	2,826,912	28.3	71.7	100
1982	372,208	1,031,103	1,403,311	109,148	1,074,261	1,183,409	481,356	2,105,364	2,586,720	18.6	81.4	100
1983	434,415	1,088,980	1,523,395	116,894	1,127,702	1,244,596	551,309	2,216,682	2,767,991	19.9	80.1	100
1984	470,945	1,082,131	1,553,076	246,088	1,218,490	1,464,578	717,033	2,300,621	3,017,654	23.8	76.2	100

SOURCE: CUADROS ESTADISTICOS SOBRE SECTOR TRANSPORTES, DGP/MOPT
NOTE : Cargo Volume at the Ports of *Caldera* and *Moín* is included in that at the Ports of Puntarenas and Limón, respectively.

Table II-2 Port Cargo Throughput by Major Port

	Year								
	1976	1977	1978	1979	1980	1981	1982	1983	1984
[IMPORT]									
Total	1178.0	1601.0	1784.2	1771.6	1772.2	1460.6	1435.8	1547.4	1575.9
The ports of Limón and Moín	856.9	1050.5	1179.5	1318.2	1232.5	998.5	1031.1	1089.0	1082.2
The Port of Puntarenas	260.7	503.2	554.4	415.3	502.1	422.4	335.0	253.4	—
The Port of Golfito	60.4	47.3	50.3	38.1	37.6	39.7	32.5	24.0	23.6
The Port of Caldera	—	—	—	—	—	—	37.2	181.0	470.1
[EXPORT]									
Total	1370.2	1313.3	1384.1	1380.9	1292.9	1626.0	1396.9	1410.7	1630.4
The ports of Limón and Moín	864.8	831.1	923.8	959.7	930.0	1028.0	1074.2	1127.7	1216.5
The Port of Puntarenas	205.9	182.7	165.3	144.1	127.4	185.0	95.4	1.9	—
The Port of Golfito	299.5	299.5	295.0	277.1	235.5	220.0	213.7	166.1	167.9
The Port of Caldera	—	—	—	—	—	193.0	13.6	115.0	246.0

Source:CUADROS ESTADISTICOS SOBRE SECTOR TRANSPORTES 1984, DGP/MOPT

Table II-3 Number of Calling Ships by Major Port

Year	Pacific Ocean					Caribbean Sea	Total
	Caldera	Puntarenas	Golfito	Quepos	Sub-toal	Limón/Moín	
1967	—	490	189	3	682	447	1129
1968	—	473	115	1	589	537	1126
1969	—	494	240	1	735	733	1468
1970	—	438	300	1	739	734	1473
1971	—	452	275	—	727	742	1469
1972	—	505	300	—	805	807	1612
1973	—	509	270	1	780	826	1606
1974	—	398	210	—	608	795	1403
1975	—	389	207	—	596	794	1390
1976	—	394	172	—	566	824	1390
1977	—	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1978	—	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1979	—	n.d.	n.d.	n.d.	n.d.	861	n.d.
1980	—	n.d.	n.d.	n.d.	n.d.	841	n.d.
1981	41	176	n.d.	n.d.	n.d.	830	n.d.
1982	109	48	n.d.	n.d.	n.d.	907	n.d.
1983	180	30	n.d.	n.d.	n.d.	933	n.d.
1984	156	26	n.d.	n.d.	n.d.	849	n.d.

Note) n.d. : no data

In addition to these major ports on the Pacific coast, there are also the FERTICA port with an approximately 360 m long and 3 to 2 m deep berth for fertilizer imports and exports and some fishing ports north of the Puntarenas peninsula. The water channel which leads to the above small ports is greatly affected by siltation. According to MOPT, it frequently requires maintenance dredging.

The cargo volume at the Port of Limón is the largest among all Costa Rican ports. It has one container berth and one roll on/roll off berth. There has also been sand sedimentation in the harbour at Limón.

The Port of Moín has two deep berths for banana exports and one berth for the import of petrochemical products. The former is managed and operated by JAPDEVA and the latter is run by RECOPE. The port suffers siltation from the river in the rainy season.

Major port facilities at the ports described above and at the Port of Caldera are summarized in Table II-4.

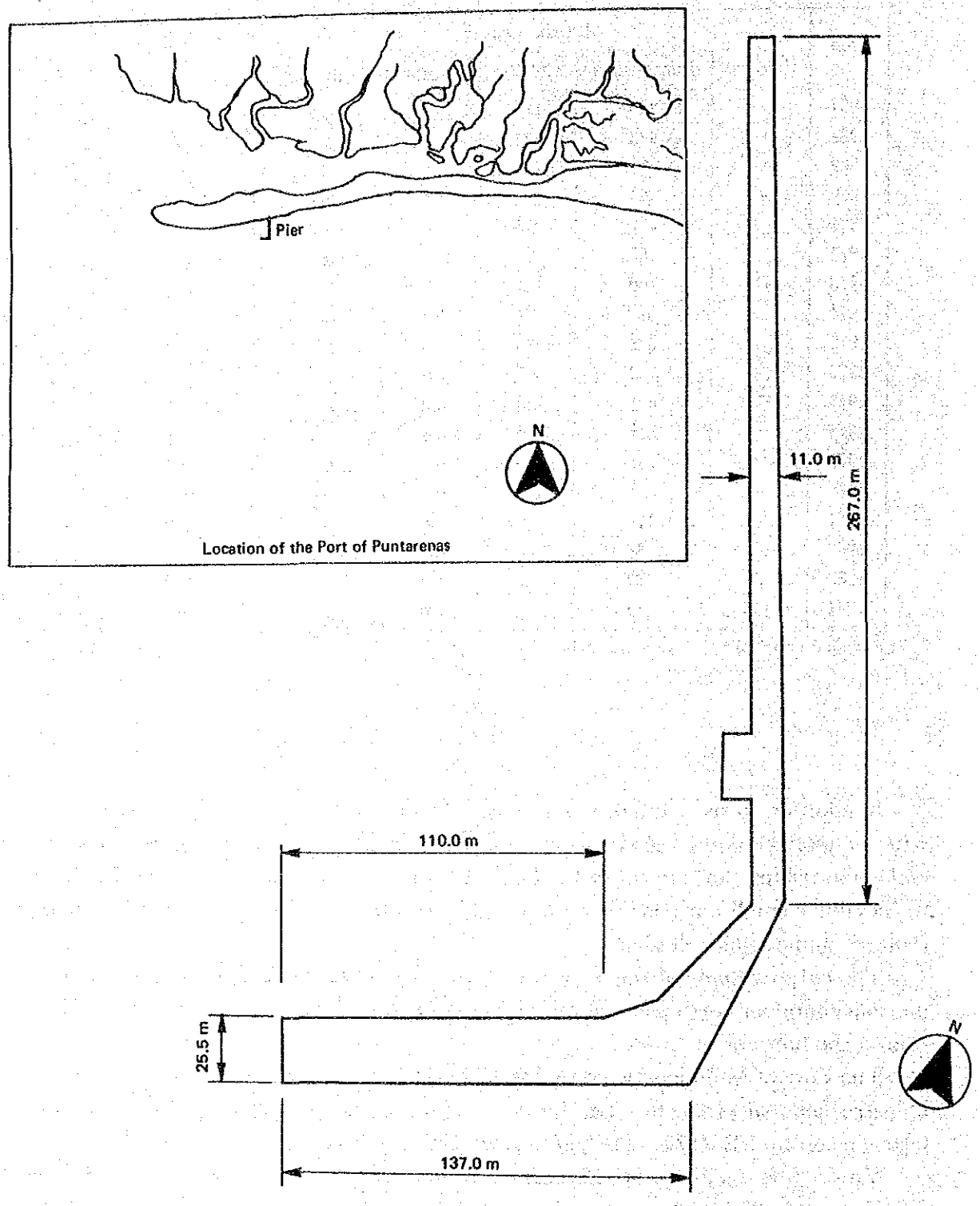


Fig. II-6 Port Layout of the Port of Puntarenas

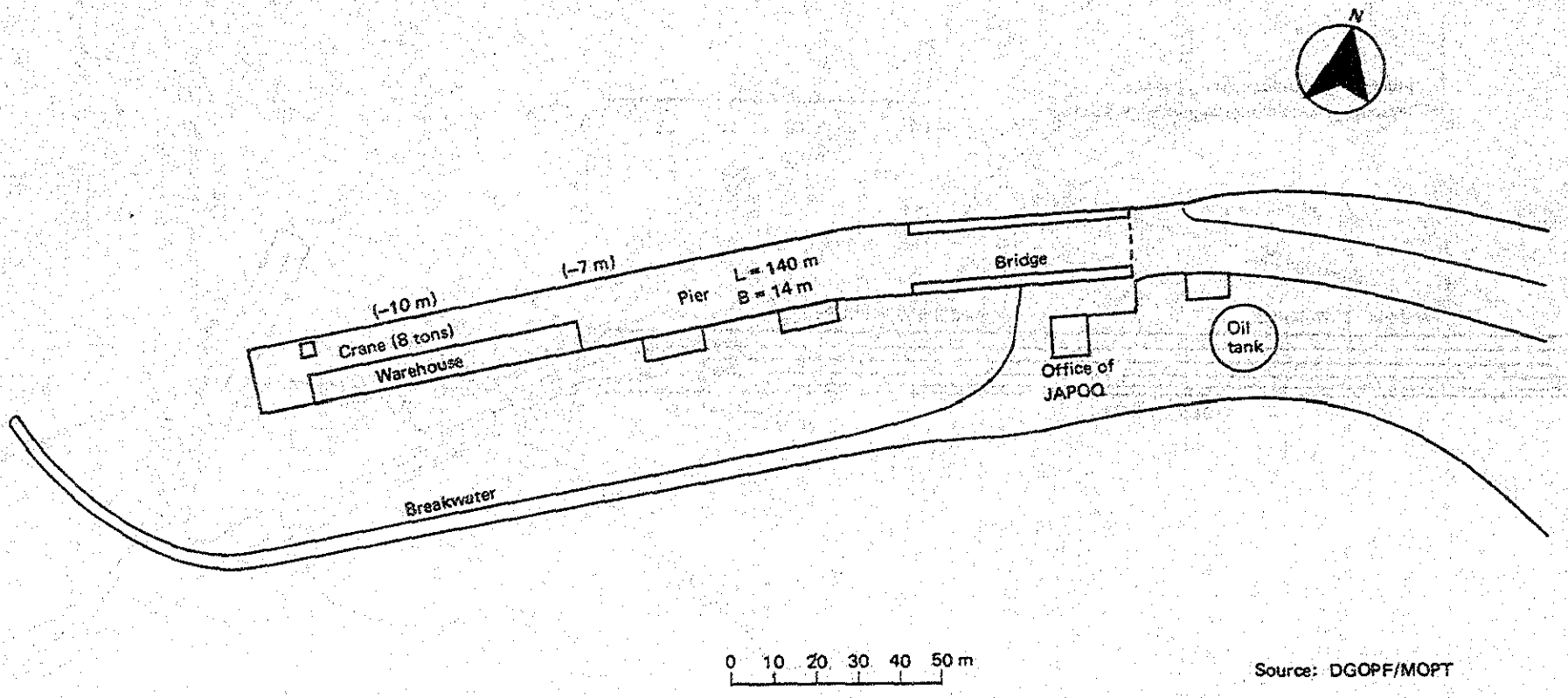
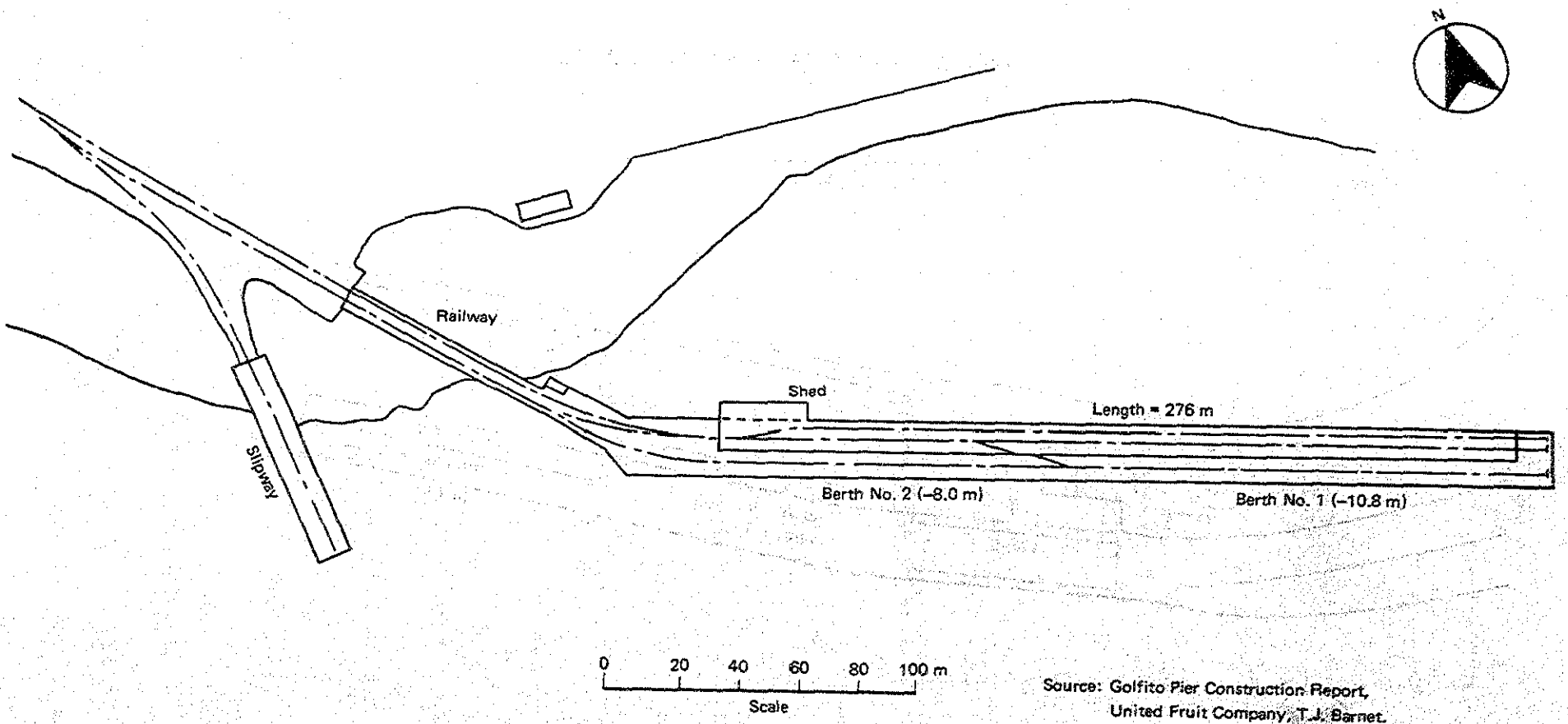
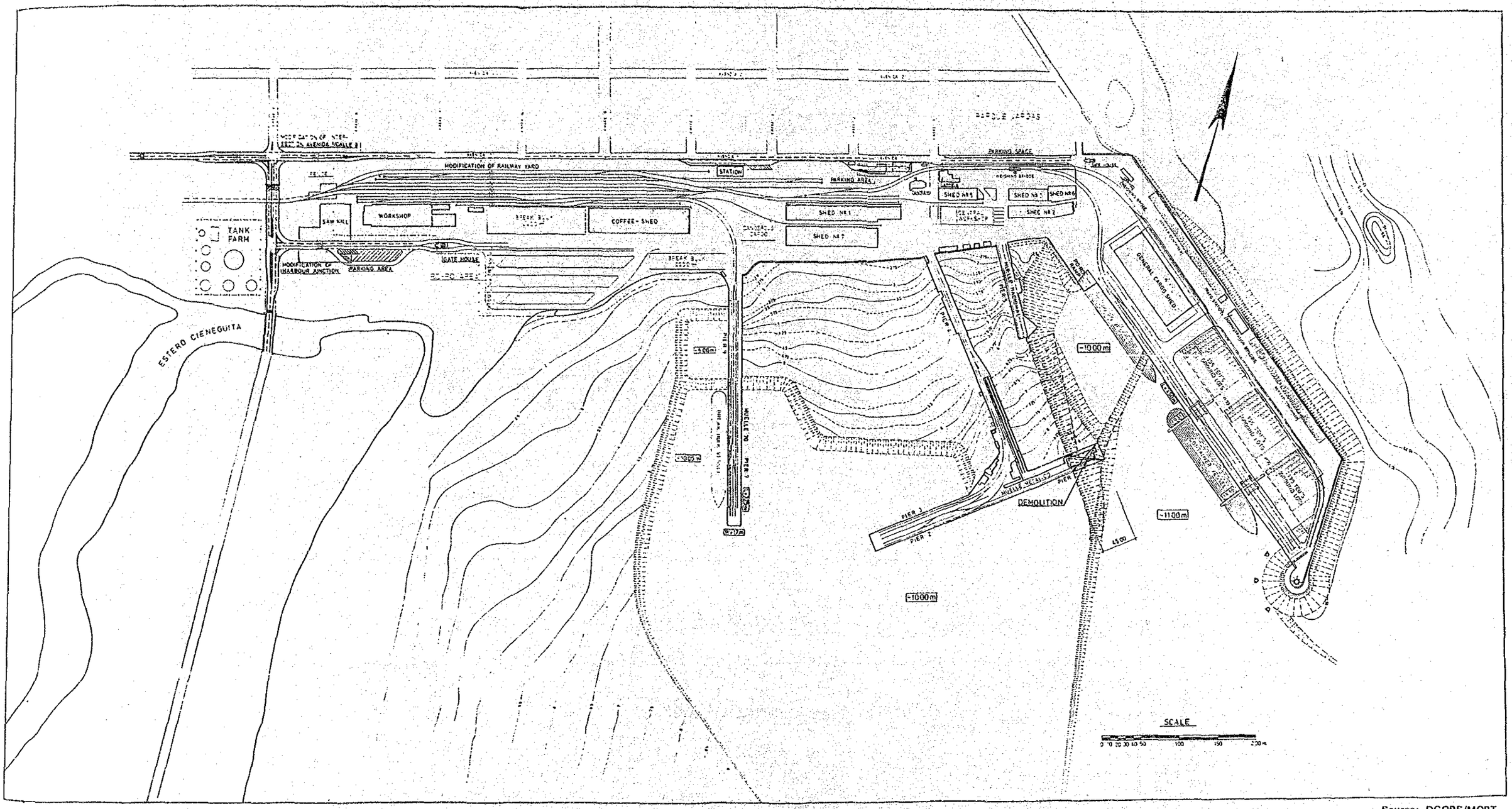


Fig. II-7 Port Layout of the Port of Quepos



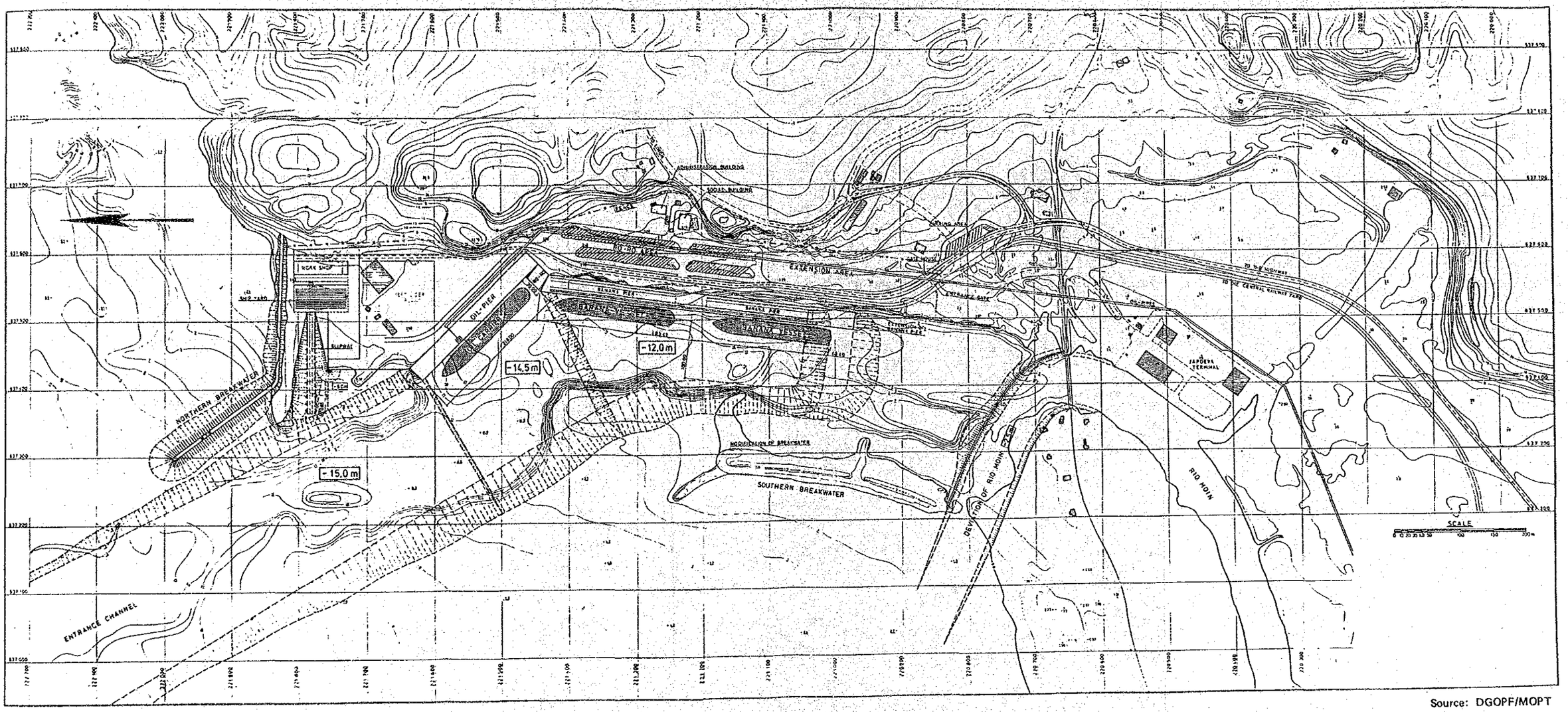
Source: Golfito Pier Construction Report, United Fruit Company, T.J. Barnet.

Fig. II-8 Port Layout of the Port of Golfito



Source: DGOPF/MOPT

Fig. II-9 Port Layout of the Port of Limón



Source: DGOPF/MOPT

Fig. II-10 Port Layout of the Port of Móin

Table II-4 (1) Port Facilities at Major Ports

Name of port	Principal facilities	Remarks
Caldera	No.1 berth (steel sheet pile quaywall) : 210m long, −11.0m deep No.2 berth (steel sheet pile quaywall) : 150m long, −10.0m deep No.3 berth (steel sheet pile quaywall) : 130m long, −7.5m deep Ro/Ro pier : 1 berth Mooring basin : −11.0m deep, 148,000m² −10.0m deep, 43,000m² − 7.5m deep, 28,000m² Breakwater (rubble mound breakwater) : Main breakwater : 250m long Wing jetty : 115m long (as of Oct.1985) Transit shed : 7,200m² Warehouse : 5,400m² Open storage yards : for general cargo : 25,440m² for container : 34,000m² Cargo handling equipment : 2 units Forklift : 32 units Mobile crane : 4 units Container Tractor : 2 units Mobile chassis : 4 units Others : 30 units	Administration : INCOP Start of use : 1981
Puntarenas	Steel-pile pier : 140m long, 24m wide Connecting bridge : 320m long, 9m wide No.1 berth : 137m long, −9.1 & −12.2m deep No.2 berth : 110m long, −7.6 & −10.7m deep Ancillary facilities : Railway sidings	Administration : INCOP Start of use : 1929

Table II-4 (2) Port Facilities at Major Ports

Name of port	Principal facilities	Remarks
Punta Morales	Dolphin 1 berth : −12~−14m deep Ancillary facilities: Belt conveyors	Administration: INCOP Start of use: 1976 Exclusively for export of sugar
Quepos	Pier (Steel H pile and concrete cylinder pile pier) 140m long, −7~−10m deep	Administration: JAPOQ
Golfito	Whart 2 berths: 276m long, −7~−10m deep	Administration: JAPDEVA
Limón	Muelle Metalico (steel-piled pier.): 320m long, 24m wide Connecting bridge: 366m long No.1 berth: 160m long, −8.8m deep No.2 berth: 160m long, −7.9m deep No.3 berth: 122m long, −6.7m deep Ancillary facilities: Railway sidings, belt conveyors for loading of bananas. Muelle Nacional (steel-piled Pier): 156m long, −6~−7m deep Ancillary facilities: Railway sidings Muelle Setenta (concrete-piled pier) 340m long, 17m wide 2 berths: −9m deep 1 berth : −6m deep Ancillary facilities: Railway sidings 20 tf crane Ro/Ro berth: −8m deep Proyecto Aleman (concrete-piled open-type wharf): 360m long, −11m deep Ro/Ro berth (concrete-block wharf): 90m long, −10m deep	Administration: JAPDEVA Start of use: 1904
Moín	Pertroleum unloading facility (mooring buoy) Crude oil berth (steel-piled open-type wharf): 200m long, −14m deep Ro/Ro berth: 30m wide, −12m deep Banana handling berth (steel-piled open-type wharf): 400m long, −12m deep	Administration: RECOPE Start of use: Jan. 1979

CHAPTER III PORT ACTIVITIES AT THE PORTS OF CALDERA AND PUNTARENAS

1. Present Management Situation of INCOP

1. 1 Administrative Structure

INCOP is a service enterprise with administrative autonomy and with its own legal personality, belonging to the nation. The organization is comprised of three divisions: Engineering and Maintenance, Administration and Finance, and Port Operations. In addition to these, there is a Planning and Development Unit which functions as an advisor to the three divisions.

As of December 1985, the total number of INCOP personnel is 986. The Engineering and Maintenance Division consisting of three Department, i.e. Civil Works, Maintenance of Machinery and Equipment, and Electromechanical, employs 152 personnel. The Port Operation Division which is in charge of ship operations, cargo handling including cargo storage and port security employs 604 personnel.

1. 2 Relations with Other Institutions

(a) Port tariffs
The port tariffs are approved by MOPT.

(b) Budget
The budget of INCOP is approved by the Board of Audit of the Government.

(c) Investment
The investment budget is approved by MIDEPLAN.

(d) Development Projects
The port development projects to be executed directly by INCOP are approved by MOPT.

1. 3 Financial Situation

As shown in Table III−17 INCOP's total assets at the end of September 1985 were 449 million colones consisting of 127 million colones of current assets (28% of the total), 318 million colones of fixed assets (71% of the total), and 4 million colones of deferred charges (1% of the total). The net worth ratio, i.e. capital divided by total assets, was 32% at the end of September 1985.

As shown in Table III−2, INCOP has maintained a good financial situation for many years except for 1982 when INCOP went into the red because of a sudden decrease in cargo volume.

Almost all of the revenues of INCOP come from port tariffs. Port tariffs have been reduced gradually as shown in Table III−3, taking into consideration the balance between revenues and expenses.

Table III-1 Balance Sheets

Unit: '000 Colones

Items \ Year	End of 1982	End of 1983	End of 1984	End of Sept. 1985
Current Assets	12,745	17,141	88,718	126,746
Cash and Temporary Investment	1,171	10,014	14,308	10,904
Trade Receivables	5,401	△ 599	54,099	81,007
Inventories of Materials and Supplies	5,293	6,468	13,926	18,601
Other Assets	880	1,258	6,385	16,234
Fixed Assets	107,990	188,130	315,665	317,538
Land	35,835	35,835	35,835	35,835
Plant and Equipment of INCOP	164,832	187,771	179,203	179,172
Depreciation of Plant and Equipment	△ 119,356	△ 128,365	△ 138,106	△ 145,086
Plant and Equipment of Caldera		7,018	158,546	165,662
Depreciation of Plant and Equip of Caldera		△ 391	△ 859	△ 1,340
Construction in Progress	26,679	83,417	78,287	80,581
Other Assets	0	2,845	2,759	2,714
Deferred Charges		788	2,042	4,374
Total Assets	120,735	206,058	406,425	449,454
Current Liabilities	62,066	85,362	140,722	178,323
Long-Term Liabilities	7,191	66,416	134,184	128,962
Shareholders' Equity	51,478	54,279	131,520	142,169
Initial Capital	7,612	7,612	7,612	7,612
Contribution	1,196	— 3,259	35,357	37,833
Retained Earnings		36,728	36,923	82,799
Net Income	42,670	13,198	51,628	13,925
Total Liabilities and Shareholders' Equity	120,735	206,058	405,425	449,454

Table III-2 Revenue and Expense

Unit : '000 colones

Year	Revenue	Expense	Profit
1976	61,764	57,853	3,911
1977	56,359	39,607	16,752
1978	60,749	55,652	5,097
1979	64,330	61,221	3,109
1980	75,365	75,145	220
1981	106,935	103,380	3,555
1982	108,591	121,653	−13,196
1983	232,278	219,079	13,199
1984	373,224	321,596	51,028

Table III-3 Port Tariffs

Unit: Colones

	'82.10/7	'84.10/16	'85.2/16	'85.4/16	'85.7/16	'85.9/1
(1) Charge for usage of navigation aids (by T.R.B.)	6.50	6.30	5.90	5.30	4.50	2.50
(2) Charge for towing service (by T.R.B.)	9.00	→	→	→	→	→
(3) Charge for pilotage (by T.R.B.)	1.50	→	→	→	→	→
(4) Charge for mooring and untying (by T.R.B.)	8.00	→	→	→	→	→
(5) Charge for use of quaywall (by ship length/day)	350.00	347.00	341.00	332.00	320.00	290.00
(6) Charge for cleaning wharves (by M.T of cargo)	7.00					
(7) Charge for use of wharves (by M.T of cargo)						
(a) Genera cargo	485.00	484.40	483.10	481.20	478.70	472.40
(b) Bulk cargo	120.00	119.40	118.10	116.20	113.70	107.40
(8) Loading/unloading charges (by M.T of cargo)						
(a) Importation						
o General cargo	216.00	212.70	206.10	196.20	183.00	150.00
o Vehicles	216.00	212.70	196.10	196.20	183.00	150.00
o Cargo larger than 6m³	266.00	262.70	256.10	246.20	233.00	200.00
o Cargo longer than 5m	216.00	212.70	206.10	196.20	183.00	150.00
(b) Exportation						
o General cargo	166.00	162.70	156.10	146.20	133.00	100.00
o Cargo brought alongside	116.00	112.70	106.10	96.20	83.00	50.00
(9) Port dues (by M.T of cargo)						
(a) Importation						
o Cargo to be divided	83.00	80.50	75.50	68.00	58.00	33.00
o Containerized cargo	96.00	93.50	88.50	81.00	71.00	46.00
o Roll-on, Roll-off	120.00	107.50	102.50	95.00	85.00	60.00
o Bulk cargo	100.00	97.50	92.50	85.00	75.00	50.00
(b) Exportation						
o Cargo to be divided	80.00	77.50	72.50	65.00	55.00	30.00
o Containerized cargo	96.00	93.50	88.50	81.00	71.00	46.00
o Roll-on, Roll-off	110.00	107.50	102.50	95.00	85.00	60.00
o In transit	100.00	97.50	92.50	85.00	75.00	50.00

Note: T.R.B. means gross registered tonnage.

2. Port Facilities

2. 1 Port Layout of the Port of Caldera

Fig. III－1 shows the layout of the Port of Caldera. There are three berths as shown in Table III－4. In addition, there are a small roll－on/roll－off pier and a small craft basin. The berths are located along a marginal wharf with a length of 490 m. There is a turning basin in front of the wharf. The turning basin is divided into three sections. Their depths are －11.0 m, －10.0 m and －7.5 m, respectively, in accordance with the berth depths. To protect the harbour area there is a 250 m long breakwater with a 115 m long wing jetty to the south of the wharf. Overall, the harbour is well protected from rough sea conditions.

Table III-4 Present Berth Allotment

Berth No.	Depth (m)	Length (m)
No 1	－11.0	210
No 2	－10.0	150
No 3	－ 7.5	130

2. 2 Basic Port Facilities

2. 2. 1 Main Facilities at the Port of Caldera

The structure and other particulars of the principal port facilities are briefly described below. Standard cross－sections of the items are shown in Figs. III－2～III－7.

1) Breakwater

Type of structure : Rubble mound type breakwater
Length : First Stage Construction Project 250 m
Subsequent extension 115 m (as of October, 1985)
Crown height : First Stage Construction Project +8.2 m
: Subsequent extension +8.4 m
Date of completion : October 1980

2) Seawall and Revetment

Type of Structure : Rubble mound type seawall and revetment
Length : Seawall 500 m (outside the port)
Revetment 340 m (inside the port)
Crown height : Seawall +7.5 m
Revetment +5.0 m
Date of completion : October 1980

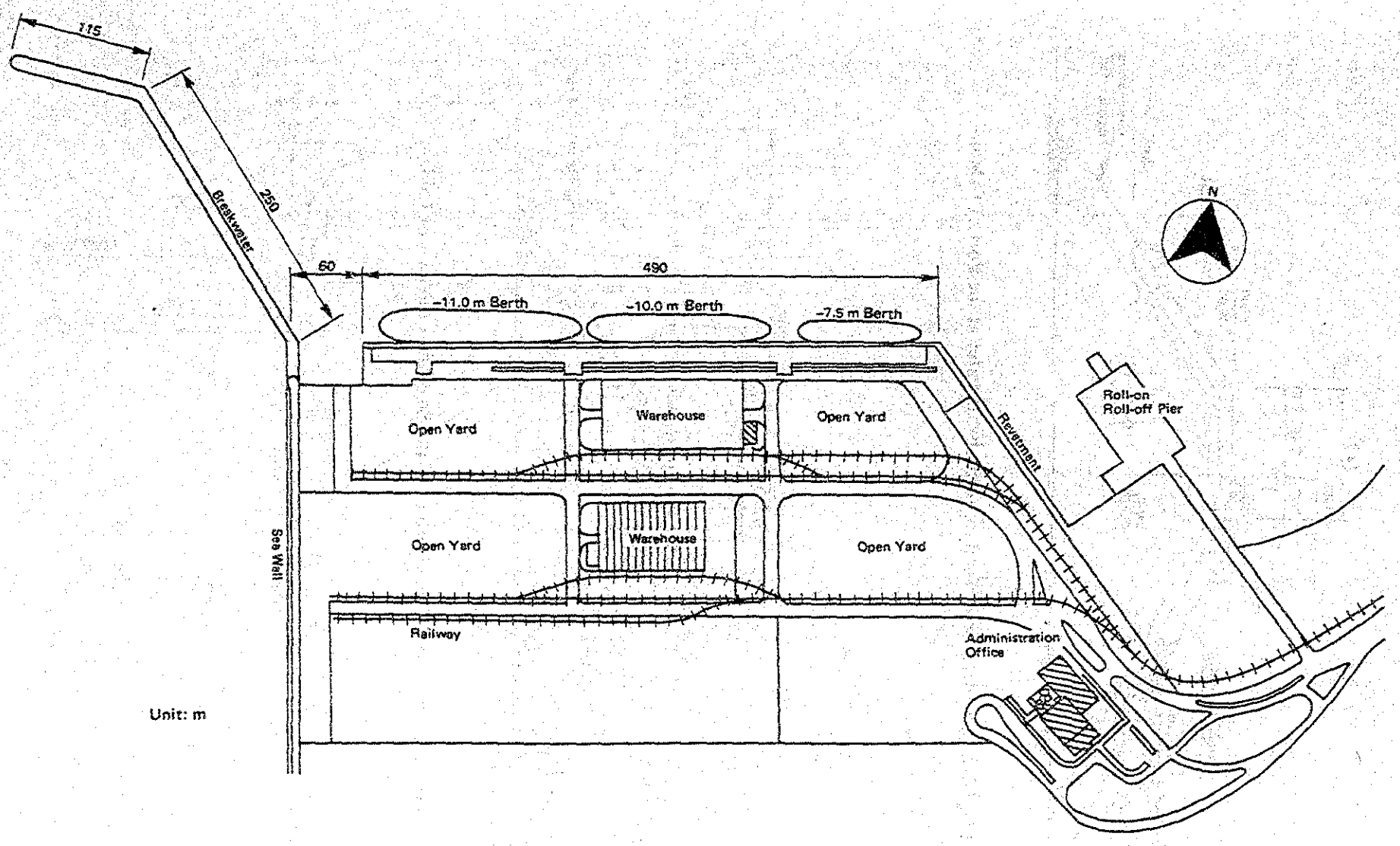


Fig. III-1 Layout of the Port of Caldera

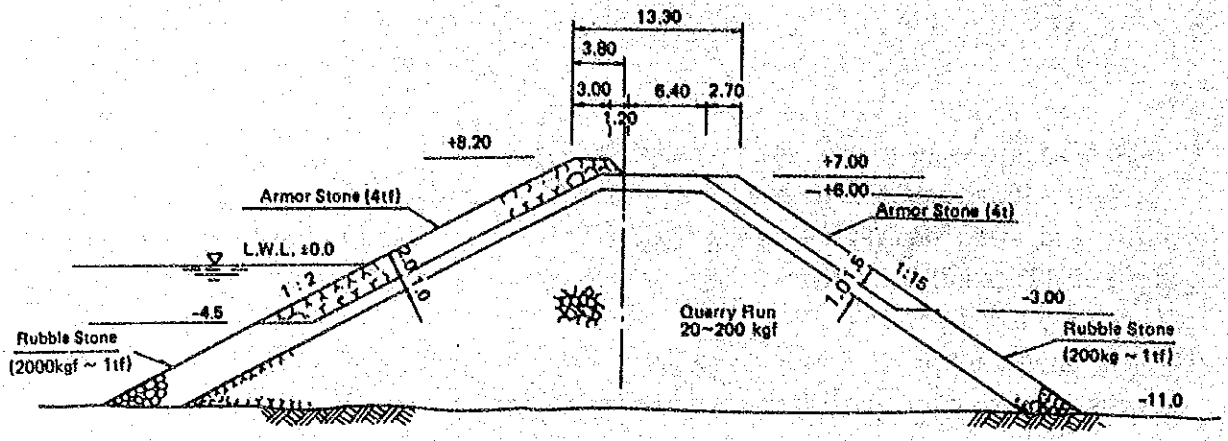


Fig. III-2 Standard Cross Section of the Breakwater at the Port of Caldera

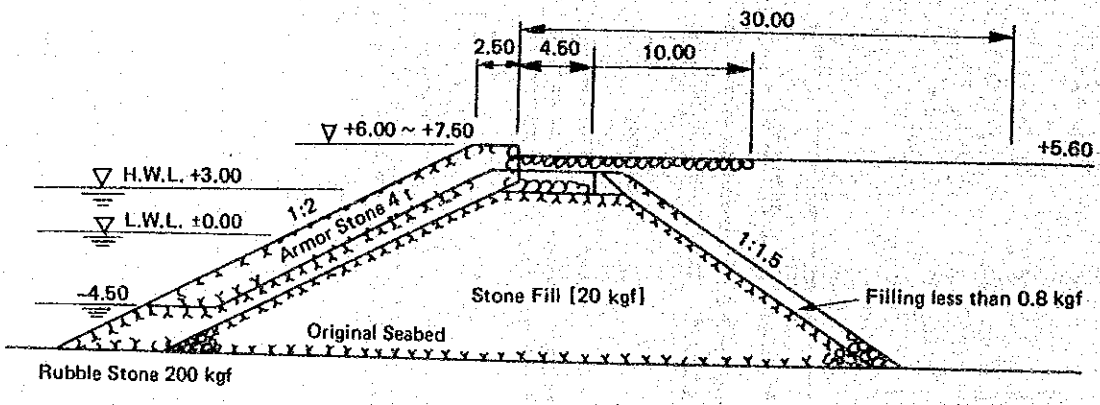
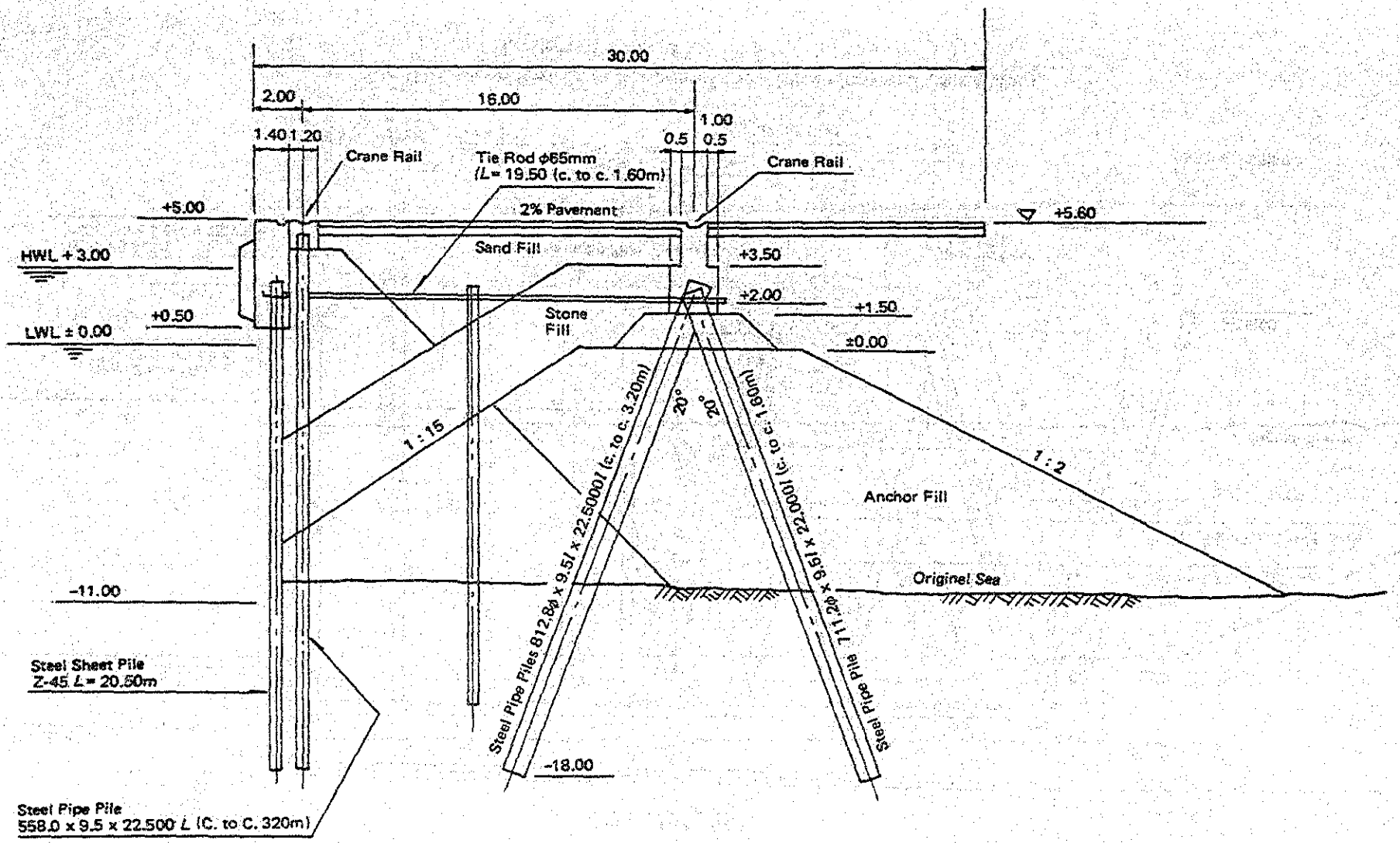


Fig. III-3 Standard Cross Section of the Seawall at the Port of Caldera



Source: MOPT

Fig. III-4 Standard Cross Section of the –11 m Quaywall (East Side) of the Port of Caldera

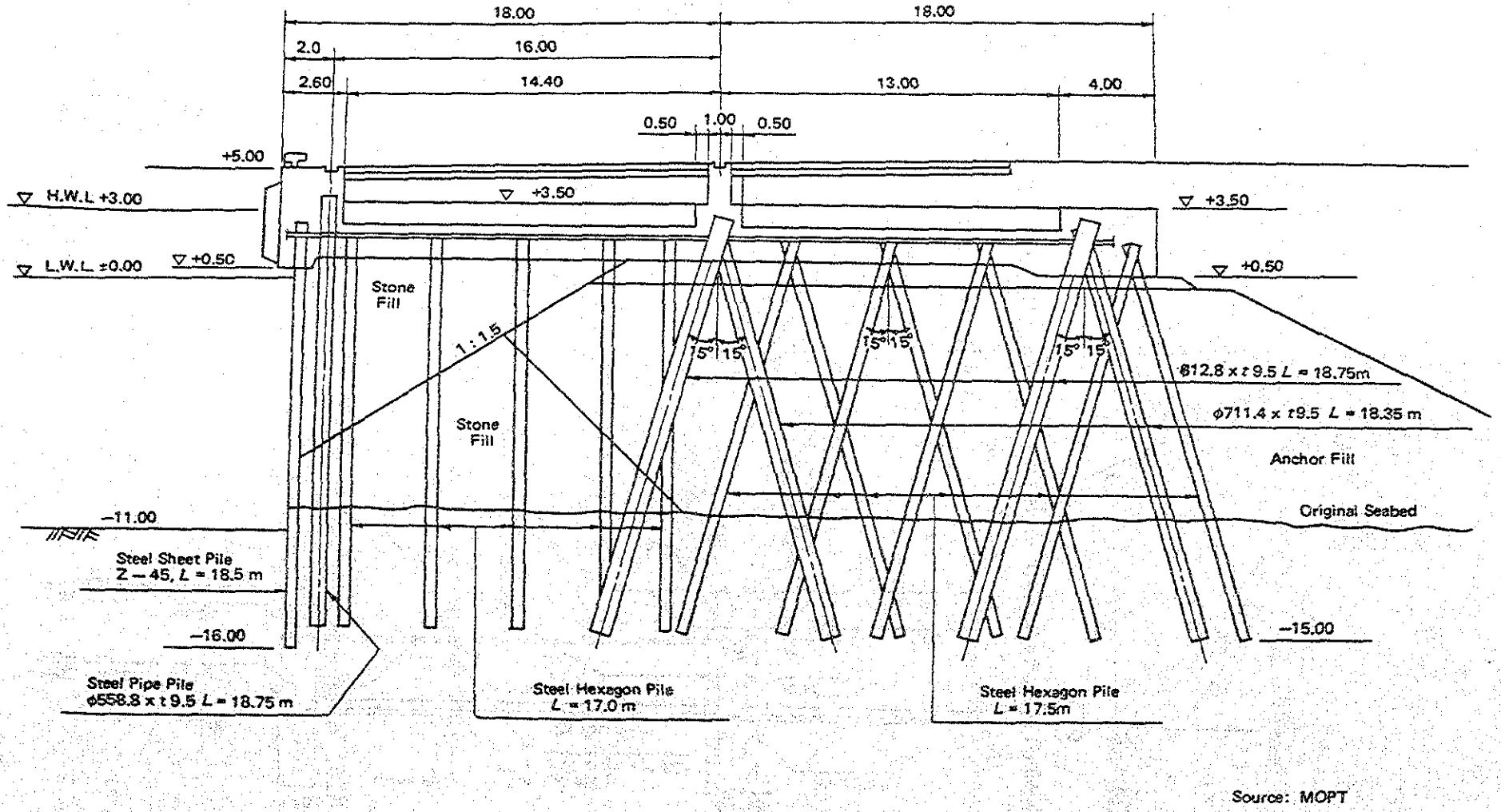
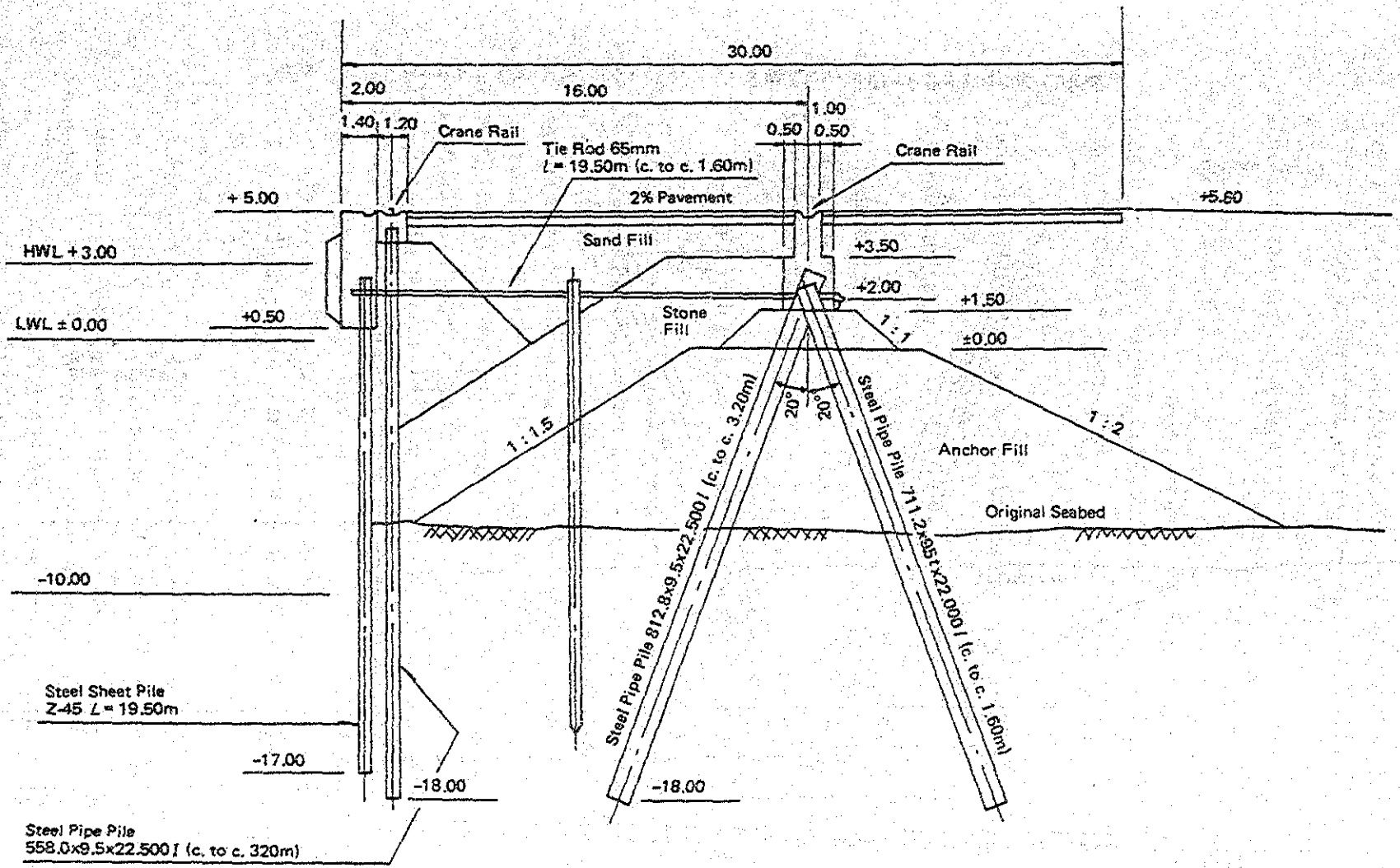
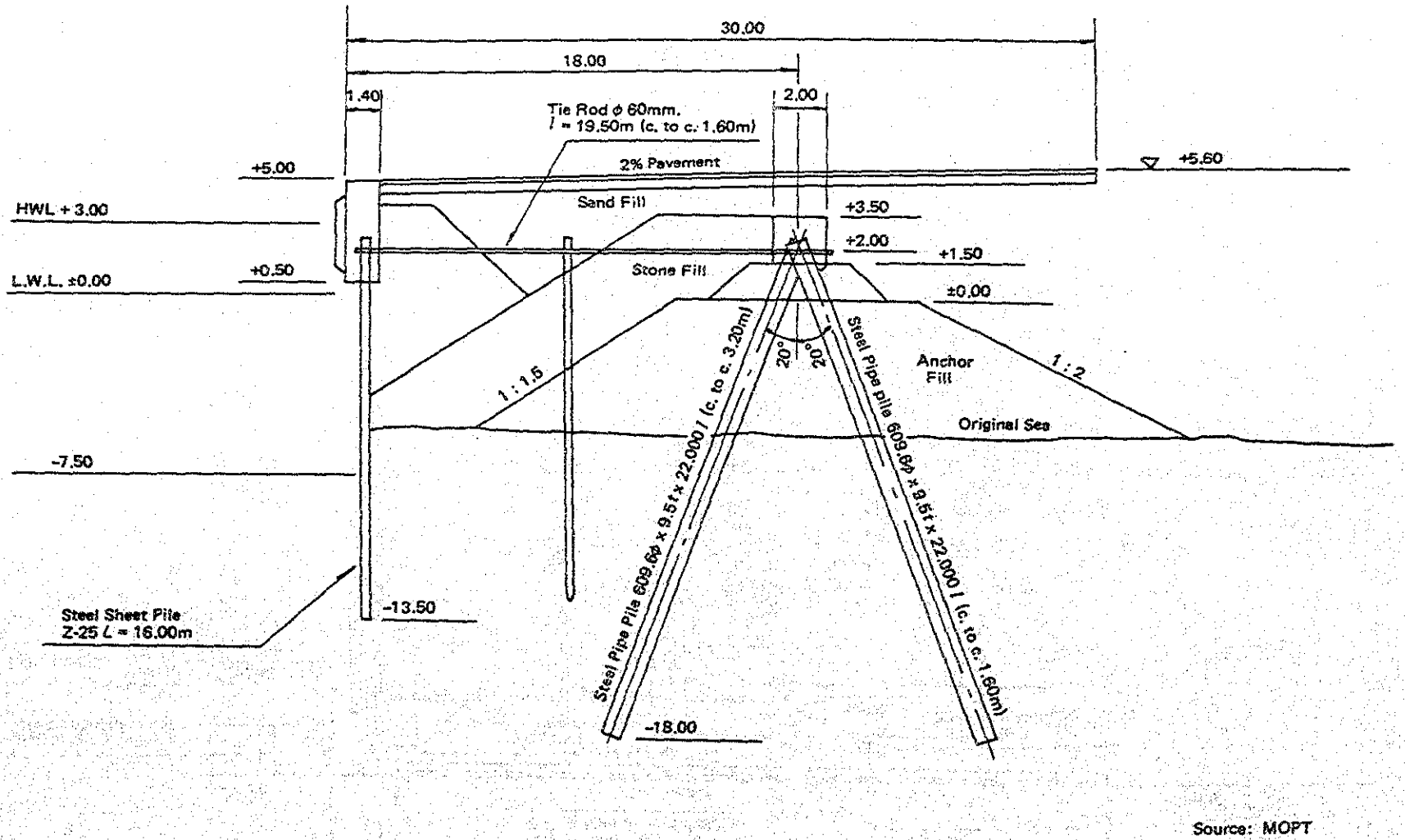


Fig. III-5 Standard Cross Section of the −11 m Quaywall (West Side) of the Port of Caldera



Source: MOPT

Fig. III-6 Standard Cross Section of the -10 m Quaywall of the Port of Caldera



Source: MOPT

Fig. III-7 Standard Cross Section of the −7.5 m Quaywall of the Port of Caldera

3) Quaywall

a) −11 m Quaywall

Type of structure : Coupled anchoring pile type steel sheet pile quaywall
(the western end is provided with a 43.5 m relieving platform)
Length : 210 m
Date of completion : February 1982

b) −10 m Quaywall

Type of structure : Coupled anchoring pile type steel sheet pile quaywall
Length : 150 m
Date of completion : June 1980

c) −7.5 m Quaywall

Type of structure : Coupled anchoring pile type steel sheet pile quaywall
Length : 130 m
Date of completion : June 1980

d) *Mooring Basin*

Volume of dredged material : 355,535 m^3
Date of completion : August 1980

2. 2. 2 Main Facilities at the Port of Puntarenas

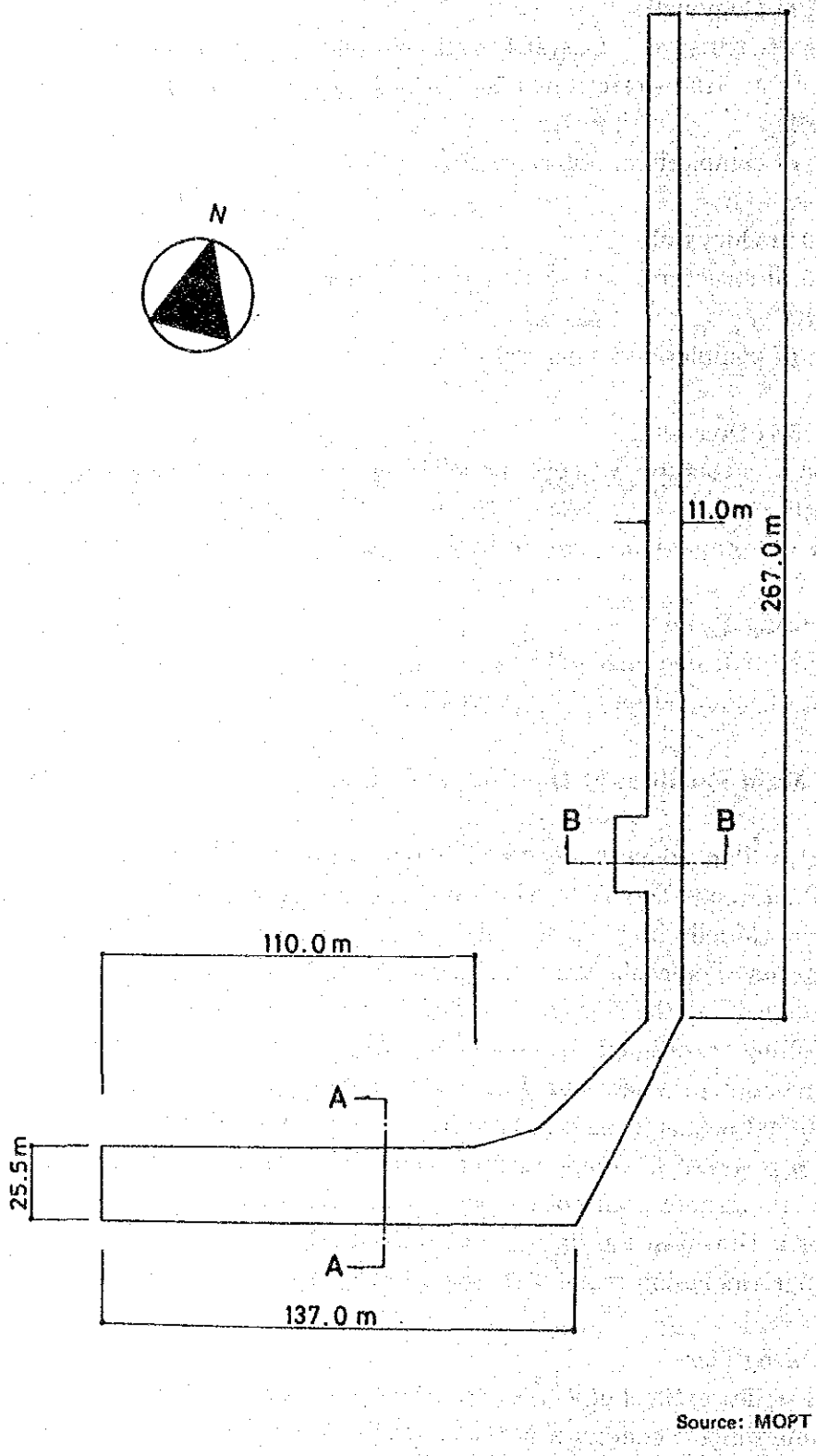
The Port of Puntarenas comprises the national pier (Muelle Nacional) on the southern side of the Puntarenas Peninsula which provides a mooring facility for oceangoing ships, a municipal pier (Muelle Municipal) which faces the estuary (El Estero) on the northern side of the Puntarenas Peninsula and which provides mooring facilities for small coastal ships and ferries bound for the Nicoya Peninsula, and additional mooring facilities used by a number of fishing vessels and pleasure boats. Also, MOPT is in the midst of reclaiming land for the construction of a new wharf for use as a fishery harbour which will face the estuary.

The national pier is located 2.3 km from the tip of the Puntarenas Peninsula and takes the form of a reversed L−shape jutting out to the south from roughly the center of urban Puntarenas. Its structure and other particulars are explained below. A plan view of the national pier is shown in Fig. III−8, and standard cross−sections of the mooring pier and the access pier (including crane pier) are shown in Fig. III−9 and III−10.

1) *Mooring pier*

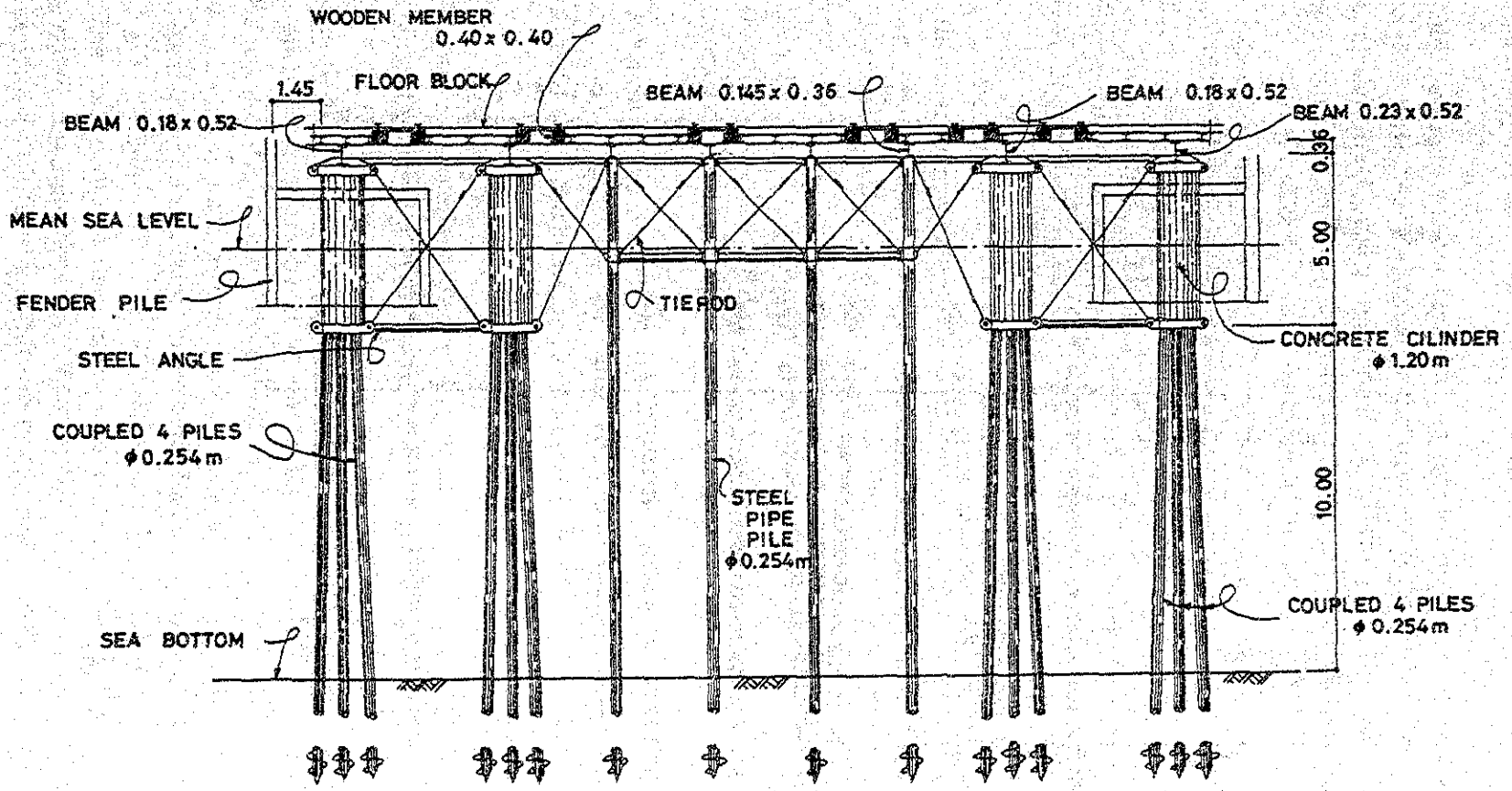
Type of struture: Steel pipe pile pier (the tips of the piles are of a spiral configuration). Double column support configurations close to the water line of the berths intergrate the tops of four radiating steel piles by means of concrete cylinders.

Water depth : South side berth ··· minimum −9.1 m
North side berth ··· minimum −7.6 m
Length : South side berth ··· 137 m



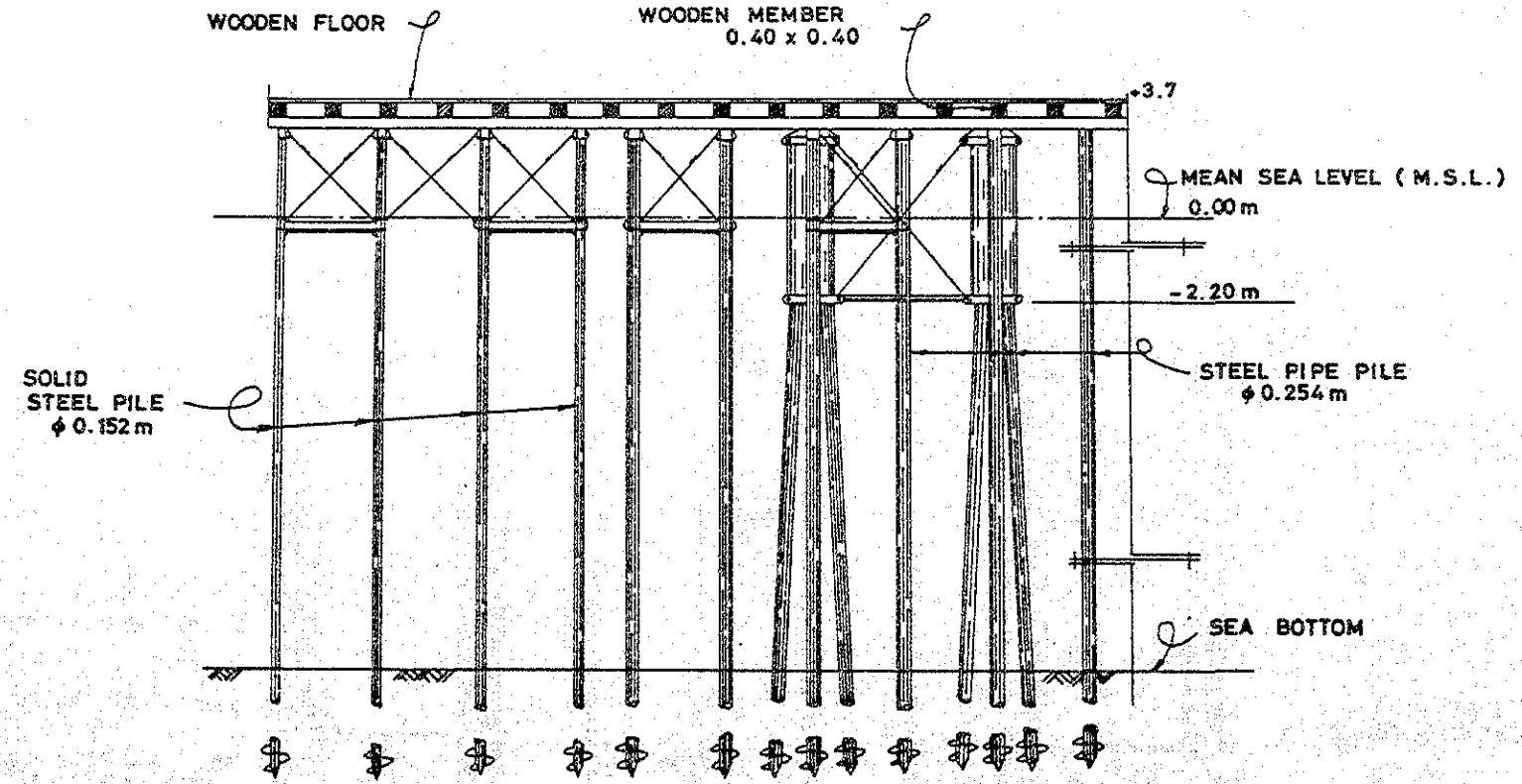
Source: MOPT

Fig. III-8 Plan View of the National Pier at the Port of Puntarenas



Source: MOPT

Fig. III-9 Standard Cross Section of the Berthing Pier of the National Pier at the Port of Puntarenas (Section A-A)



Source: MOPT

Fig. III-10 Standard Cross Section of the Access Platform of the National Pier of the Port of Puntarenas (Section B-B)

North side berth ··· 110 m
Width of pier : 25.5 m
Date of completion : 1929

Fender pilings of frame construction comprising H-shaped steel piles and hexagonally shaped piles have been furnished at the front surfaces of each berth (completed in 1979) to cancel the affect of ship berthing force on the pier structure. Two buoys are placed offshore each berth to which ships are berthed using a special mooring rope. In this manner, ships do not make direct contact with the fender pilings.

2) Access Pier
Type of structure : Pier using solid steel cylinder pilings.
Length : 167 m
Pier width : 11 m
Date of completion : 1929

3) Crane Pier
This crane pier widens one part of the access pier to enable the handling of barge cargo.
Type of structure: Steel pipe pile pier (the tips of the piles are of a spiral configuration.). Four of the supporting columns integrate the tops of four radiating steel piles by means of concrete cylinders.
Length : Approximately 28 m
Width : Approximately 10 m
Date of completion : 1961

2. 3 Engineering Aspects of the Existing Facilities

2. 3. 1 Port Facilities at the Port of Caldera

(1) Breakwater

During construction, the breakwater at the Port was damaged by waves several times. The biggest damage occurred on May 21, 1981. The breakwater had reached the planned 250 meters, but the installing of the armour stones on the breakwater head was not complete. As a result of the damage, the rubble filling material in the breakwater proper was scattered over an area of 120 m by 80 m within the harbour. This breakwater was designed to withstand significant wave heights of $H_{1/3}$ =3 m. However, the waves which caused the damage had a maximum significant wave height of $H_{1/3}$ =3.55m, and a period of $T_{1/3}$ =18s as measured by an ultrasonic wavemeter located at a point outside the harbour at a water depth of −13.5 m.

The source of the damage can be traced to the action of waves in excess of the anticipated maximum wave. In addition, the breakwater was only partially constructed and the armour stones for the breakwater head had not yet been installed, or had not yet been installed in the correct interlocking arrangement. The precision of the armour stone

arrangement must, at a minimum, be brought up to a level equivalent to that of the breakwater at the Port of Moín.

On September 13, 1985, the breakwater extension portion suffered damage despite the fact the maximum significant wave height at the time was only $H_{1/3}$ =2.77 m. An additional hypothesis to explain the damage is that the Tertiary sedimentary rock quarried in North Caldera and used as armour stone had a mean specific gravity of only 2.35, less than the value of 2.6 called for in the design specifications. When the specific gravity is low like this, armour stone of approximately 1.5 times the design weight is considered necessary.

(2) Mooring Basin

The mooring basin in front of the −11 m quaywall is shoaling and becoming shallower due to sand sedimentation. In September 1985, the water depth at a 100 m portion at the south end of the quaywall was shallower than −10 m and the water depth at the western corner was no more than −1 m. The water depth at other portions of this berth have become less than the planned −10 m water depth over an area extending approximately 200 m from the front of the face line of the wharf.

The mooring basin in front of the −10 m quaywall has become somewhat shallower than the projected water depth. However, the prescribed design water depth of −10 m is being maintained throughout most of the basin. The prescribed design depth of −7.5 m is being maintained at the mooring basin in front of the −7.5 m quaywall.

(3) Other Facilities

Other harbour facilities are generally being maintained in a satisfactory condition.

2. 3. 2 Port Facilities at the Port of Puntarenas

The steel piles of the national pier at Puntarenas have served more than 50 years since their installation in 1929 and are extremely corroded. Piles in which the entire circumference of the steel pipe portion near the waterline has been pitted due to corrosion are a common sight.

MOPT investigated the corrosion of this pier, and in March 1984 prepared a maintenance and repair plan with a goal of providing 10 additional years of serviceable life. The principal construction method for the repair work for the mooring piers comprises the driving of hexagonal hollow steel piles into the space between support pillars, said support pillars integrating, by means of concrete cylinders, the top portions of four steel pipe pilings furnished in a radiating configuration. Then, while supporting the coping by means of I-beams, the hexagonal steel piles are mutually coupled and integrated with bracing and tie rods to substitute for the original support pillars. A construction method has been proposed in which the corroded portions of the single steel piles of the mooring pier and the solid steel piles of the coupling pier which are corroded over their entire circumference would be replaced, and the other piers would be reinforced at their corroded portions by means of semicircular steel plates provided with flanges and attached with securing bolts. In addition, the performance of necessary repairs to the concrete cylinders and the coping is also planned.

The maintenance and repair plan will be carried out by INCOP under the planning and supervision of MOPT. Construction work has already been completed on the connection between the east edge of the mooring pier and the access pier, the area with the most advanced degree of corrosion.

The cost of this construction work has been estimated at approximately 20 million colones. Construction has been estimated to require 50 weeks; however, considering the financial situation of INCOP and interruptions due to cargo handling work, completing the work within this period will be very difficult.

2. 4 Storage Facilities and Cargo Handling Equipment

2. 4. 1 Storage Facilities

There are two warehouses at the Port of Caldera. The No.1 warehouse is located behind the apron of the −10 m berth. The No.2 warehouse is located behind the No.1 warehouse. The No.1 warehouse is mainly for general cargoes. Part of the warehouse is used as a container freight station. The No.2 warehouse is mainly used for large lot imported cargoes. The size and capacity of these warehouses are shown in Table III−5. The total floor space is 12,600 m² and the total storage capacity is 6,300 tons.

Table III-5 Existing Warehouses at the port of Caldera

Warehouse No.	$L \times W$ (m)	Floor Space (m²)	Capacity (tons)
No 1	120×60	7,200	3,600
No 2	90×60	5,400	2,700
Total		12,600	6,300

Existing open yards consist of four sections, with a total area of 55,600 m². However only the No.1 yard behind the −11 m berth is paved. As it is not desirable to use forklifts for handling containers in unpaved yards, the pavement of these yards is an urgent matter for cargo handling. Details of the open yards at the Port of Caldera are shown in Table III−6 .

Table III-6 Existing Open Yards at the Port of Caldera

Yard No	Length (m)	Width (m)	Area (m²)	Pavement	Usage
No 1	160	85	13,600	paved	for containers
No 2	160	85	13,600	not paved	for containers
No 3	113	85	9,600	not paved	for steel goods
No 4	221	85	18,800	not paved	for vehicles
Total			55,600		

2. 4. 2 Cargo Handling Equipment

The cargo handling machinery currently owned by INCOP is shown in Table III−7. These machines are for general cargoes and containerized cargoes. INCOP owns variety of machines manufactured by different makers, and spare parts are currently insufficient. This causes serious problems for cargo handling.

The apron, which is 490 m × 30 m, is paved with small concrete blocks.

Table III-7 Existing Cargo Handling Machinery

Type of Machinery	Capacity (tons)	Number of Units(1985)	Remarks
Forklift	2～2.5	21	for general and steel goods
	3～3.5	5	〃
	5～6	5	〃
	10	1	〃
	20	0	〃
Tractor	0.7～2.5	6	〃
Trailer	—	24	〃
Mobile Crane	9～30	4	〃
Container Frontloader	30～35	2	for loaded containers
	10	0	for empty containers
Container tractor		2	for containers
Chassis		4	for containers
Sub total		74	

3. Port Operations

3. 1 Port Services

At present, all port operations in Caldera and Puntarenas ports are under the control of INCOP. As cargo handling services are described in detail in CHAPTER VIII, only other services such as pilots, tug boats, water supply, and line handling are considered here.

(1) Ship's calling schedule list

Shipping companies or their agents report their ship's calling schedule to the INCOP office about one month before arrival. INCOP then makes an overall calling schedule list and delivers it to related sections.

(2) Pilot service

Shipping companies or their agents inform the INCOP operations division about ship's precise arrival times two days before arrival. The marine department pilot section has three pilots, and pilot service is available 24 hours a day including Sundays and holidays.

(3) Tug boat service

There are two tug boats with 1800 PS and 1700 PS engines and three launches. The newest one (1800 PS) was purchased from Argentine in 1984. The purchase date of the old one (1700 PS) may be before 1940.

(4) Water supply service

Water is supplied to calling vessels from pierside water pipes.

(5) Line handling

36 line handling labourers are separated into three shifts. Thus 12 men are always available 24 hours a day.

(6) Fuel service for ships

INCOP does not supply ships with fuel. If needed, shipping agents have to arrange for transport of fuel by tank truck.

3. 2 Port Cargo Operations, Stowage and Distribution Systems

(1) Port cargo operations

All port cargo operations are carried out by INCOP workers using a direct landing system. No cargo landing (barge) operations are executed (details are presented in CHAPTER Ⅷ).

(2) Cargo stowage system

Within the Caldera port area there are two warehouses which are mainly utilized for

export and import cargo while awaiting customs procedures or ship's arrival. Part of one of these warehouses is also utilized as a container freight station for container cargo.

(3) Inland distribution systems

There are two main methods of transporting the cargo : one is by the railway between Puntarenas-Caldera-San José, and the other is by trucks or trailers with tractors. The railways in Costa Rica are outdated. They are mostly still single track. On the other hand, trucking transportation is more modernized and road conditions are getting better. The present inland distribution system is shown in Table III-8.

Table III-8 Present Inland Distribution System

Cargo Type	Transportation	Destination
General Cargo	By truck	Central Highland
Containers	By truck	Central Highland
Automobiles	Self Moving	Central Highland
Iron/Steel Goods	By Railway	Central Highland
Bulk wheat (25%)	By Railway	Barranca Silo
Bulk wheat (75%)	By Railway	Molinos de C.R. Silo

3. 3 Customs Clearance

Generally, there are two ways to clear customs for imported cargo at the Port of Caldera. The procedure can only be executed by customs forwarders.

3. 3. 1 Customs Clearance at the Port

One is the execution of customs procedures including collection of import taxes at the Port of Caldera.

Necessary documents are as follows :

1) Import Declaration (Official form)
2) Original Invoice
3) Original Bill of Lading (2 copies)
4) Import Authorization (Issued by the Central Bank)
5) Packing List
6) Health Certificate, if any
7) Other Documents as Required

Usually, clients receive their cargo 5 or 6 days after the ship's arrival.

3. 3. 2 Customs Clearance in San José

The other is the execution of customs procedures at the main customs office in San José. Cargoes are transported under bonded conditions with the permission of Caldera customs office. It takes half a day to get a bond transportation permit from the Caldera customs office. If the consingnee so desires, cargo such as steel goods, automobiles and containers can be moved from ship side directly onto trailers. These cargoes are then transfered to the consignee's bonded warehouse which has already been approved by the main customs office in San José. There are 15 to 20 such bonded warehouses around San José City. In this case, it takes 12 to 13 days for the cargoes to be delivered to consignees after the ship's arrival.

4. Port Traffic

4. 1 Port Cargo Volume

The cargo volume handled at the Ports of Caldera and Puntarenas over the last nineteen years is shown in Fig. III－11. According to the figure, the overall cargo volume has generally been increasing. It drastically decreased in 1982 due to economic recession. However, it has been recovering rapidly since 1982.

Roughly speaking, import cargo volume accounts for about 70%, and export cargo volume accounts for about 30% of the total cargo volume. The total cargo volume at the Ports of Caldera and Puntarenas was 717,033 tons in 1984 including the cargoes handled at the Port of Punta Molares and the FERTICA berths. The breakdown of the cargo volume by major commodity by package type is shown in Table III－9. Most of the cargoes at the Ports of Caldera and Puntarenas are such general cargoes as iron and steel, fertilizer and containerized cargoes.

Table III-9 Actual Cargo Volume Composition

(Unit : tons)

	Imports	Exports	Total
The ports of Caldera and Puntarenas			
Grain	131,167	—	131,167
Automobiles	4,816	—	4,816
General Cargo			
Iron and Steel	53,185	—	53,185
Fertilizer	—	5,500	5,500
Others	198,157	78,668	276,825
(Containerized)	(28,452)	(26,760)	(55,212)
Sub-total	387,325	84,168	471,493
FERTICA			
Fertilizer	83,620	21,970	105,590
Punta Morales	—	139,950	139,950
Sugar			
Total	470,945	246,088	717,033

Source : Cuadro Estadisticos Sobre Sector Transportes, 1984, DGP/MOPT
Note : These figures are provisionally issued by DGP/MOPT

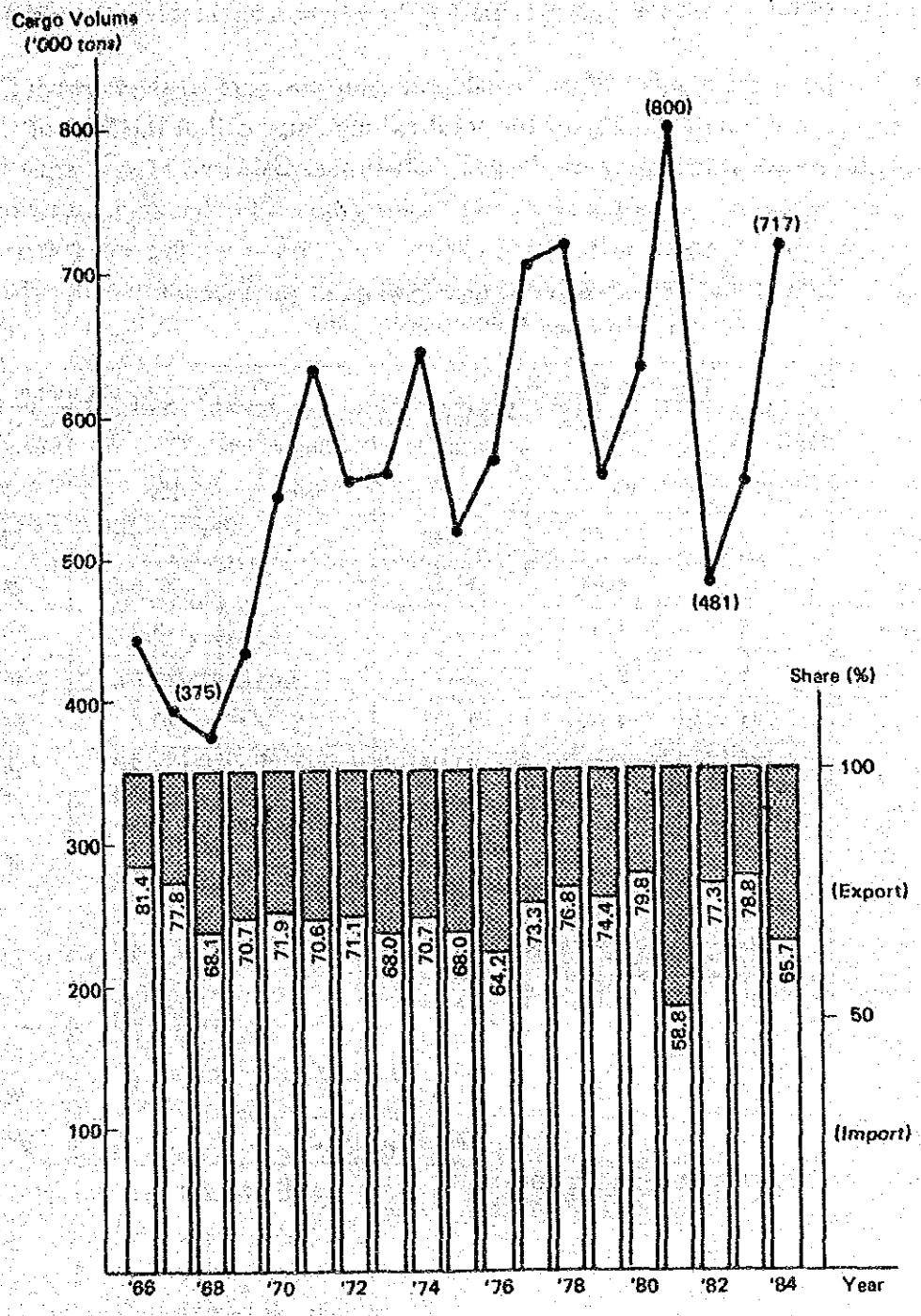


Fig. III-11 Cargo Volume at the Ports of Caldera and Puntarenas

Source: Cuadro Estadisticos Sobre Sector Transportes 1984, DGP/MOPT
Note: *Cargo volume at the Ports of Punta Morales and FERTICA are included.*

4. 2 Calling of Ships

Table III－10 shows the number of calling ships by ship size rank at the Ports of Caldera and Puntarenas. Approximately, 90% of the total calling ships call at the Port of Caldera. About 20% of the total calling ships are larger than 15,000 GRT.

Table III-10 The Number of Calling Ships at the Ports of Caldera and Puntarenas in 1984

Ship Size Rank (GRT)	The Port of Caldera			The Port of Puntarenas		
	Number of Calling Ships	Share(%)	Accumulated Share(%)	Number of Calling Ships	Share (%)	Accumulated Share (%)
TOTAL	237	100		30	100	
～1,000	13	5.49	5.49	1	3.33	3.33
1,001～2,000	19	8.02	13.51	6	20.00	23.33
2,001～3,000	4	1.69	15.20	1	3.33	26.66
3,001～4,000	6	2.53	17.73	6	20.00	46.66
4,001～5,000	11	4.64	22.37	2	6.67	53.33
5,001～6,000	15	6.33	28.70	1	3.33	56.66
6,001～7,000	1	0.42	29.12	—	—	—
7,001～8,000	15	6.33	35.45	1	3.33	59.98
8,001～9,000	17	7.17	42.62	—	—	—
9,001～10,000	34	14.34	56.96	4	13.34	73.33
10,001～12,000	40	16.88	73.84	3	10.00	83.33
12,001～15,000	13	5.49	79.33	—	—	—
15,001～20,000	6	2.53	81.86	4	13.34	96.67
20,001～28,000	43	18.14	100	1	3.33	100

Soace : INFORME ESTADISTICO MENSUAL, INCOP

5. Past Port Development and Ongoing Construction Works

5. 1 The First Stage Construction Project

The First Stage Construction Project at the Port of Caldera got under way in November 1974 and was completed in February 1982. The reclamation of the site and the construction of the breakwater commenced in 1974 under the direct management and control of MOPT. The construction of mooring facilities was undertaken in 1978 by a Costa Rican construction company, Carrez S.A.

5. 1. 1 Classification of the Construction Works

The works of the First Stage Construction Project for the Port of Caldera were divided into the following groups.

Group A : Maritime construction of the following facilities :

1. Wharfs
2. Light Beacon
3. Mooring Basin
4. Light Buoys

Group B : Maritime construction of the following facilities :

1. Breakwater
2. Seawall
3. Revetment
4. Land Reclamation

Group C : On land construction of the following facilities :

1. Administration Building
2. Transit Shed A
3. Office in Transit Shed A
4. Transit Shed B
5. Office in Transit Shed B
6. Lighting facilities
7. Railroad
8. Drainage Channel
9. Water Supply System
10. Pavement
11. Fence and Gate
12. Security Station

The items in Group B were constructed directly by MOPT, and the items in Groups A and C were carried out under contract by Carrez S.A.

5. 1. 2 Outline of the Construction Works

The principal maritime construction works of the first stage of construction at the Port

of Caldera are summarized below :

(1) Wharf Site Land Reclamation

Most of the reclamation material for the wharf site consists of Tertiary sedimentary rock found in the mountains immediately behind the wharf. The material was excavated using earth moving equipment and then conveyed to the reclamation site and dumped. Near the end of the reclamation work, part of the wharf site immediately behind the −7.5 m quaywall was reclaimed using material dredged from the forward mooring basin using a cutter suction dredger owned by MOPT.

(2) Breakwater, Seawall and Revetment

The rubble material for breakwater, seawall, and revetment construction was excavated at the Dantas quarry, managed by MOPT, where located approximately 30 km east of the Port of Caldera. The rubble was conveyed to Caldera by rail, whereupon it was reloaded into dump trucks, transported to the site, and dumped. The armour stones for the breakwater and seawall were lifted and positioned using a 127 ton capacity mobile crane furnished with a grab bucket.

The rubble material used for the 115 m extension constructed subsequent to the completion of the original 250 meters was excavated at the North Caldera quarry located approximately 6 km north-northwest of Caldera, and then conveyed to the site and dumped. All of this work was done under the supervision of MOPT using bulldozers, wheel-loaders, mobile cranes, and dump trucks owned by MOPT. The rubble quarried in North Caldera is Tertiary sedimentary rock and its mean specific gravity in comparison to the igneous rock quarried at Dantas is a light 2.35. Further, its durability is also inferior; however, the transport costs from Dantas are high, and since there are limits to the transport capacity of the railway, the quarry was switched accordingly.

(3) Quaywall

The steel sheet piles and steel pipe piles for sheet pile type quaywalls and relieving platform type sheet pile quaywalls were driven from temporary piers constructed on the sea. The equipment used for driving the pipe and sheet piles are listed below.

Mobile cranes	: 80 ton capacity (1)
	45 ton capacity (1)
	40 ton capacity (2)
	30 ton capacity (2)
Diesel pile hammers	: K− 45 (1)
	K− 35 (1)
Vibro hammer	: VS−400 (1)

The length and number of pipe piles and sheet piles driven are listed below.

Steel sheet piles : Z-45 type, length 22 m, 1,410

Steel pipe piles : diameter 61－81 cm, length 22 cm, 537

Temporary pile driving piers were erected on top of 12 inch and 14 inch H－shaped steel piles which were driven using pile driving scaffolding furnished on pontoons. The driving of the H－shaped steel piles was accomplished with a K－13 diesel pile driving hammer, and subsequently extracted upon completion of the construction work by a 40 ton capacity mobile crane and a VS-400 vibro hammer.

Quaywall backfill material was quarried from the riverbed of the Barranca River approximately 10 km north of the Port of Caldera, transported to the site by dump truck, and dumped from the temporary pier.

(4) Dredging

Most of the dredging work was carried out by means of a hopper suction dredger owned by a Dutch construction company, Volker Stevins, and the dredged matter was disposed of at sea. Part of the dredging work was accomplished with a 375 PS cutter suction dredger owned by MOPT, and this dredged material was used for land reclamation immediately behind the －7.5 m quaywall. Bottom materials in front of the quaywall were excavated by a mobile crane furnished with a grab bucket positioned on top of the quaywall.

5. 1. 3 Construction Expenses

The construction costs of each of the harbour facilities in the First Stage Contruction at the Port of Caldera are shown in Table III－11.

Table III-11 Construction Costs of the First Stage Construction at the Port of Caldera

(Unit : '000 ¢)

	Description	Cost
Land	Reclamation and Dredging	98,991
Amortized Assets	Breakwater	33,590
	Wharf, seawall and revetment	316,020
	Administration building	47,710
	Related facilities	116,150
	Transit shed and offices	40,430
	Navigation aids	2,460
	Dock railway sidings	29,960
	Pavement	43,920
	Electric power, water supply, and sewage	26,920
	Cargo handling equipment	24,590
	Sub Total	681,750
Total		780,741

Source : MOPT

5. 2 Ongoing Construction Works

5. 2. 1 Breakwater Extension at the Port of Caldera

MOPT has been extending the breakwater 150 meters from its turn point (refer to Fig. III－1). As of the end of September 1985, the length of the extension had reached 115 m. A standard cross－section of the extension is shown in Fig. III－12. The construction method of constructing the breakwater extension is basically similar to the method used for constructing the breakwater in the First Stage Construction. However, the rubble and the armour stones currently being used are Tertiary sedimentary rock quarried in North Caldera rather than the igneous rock quarried at Dantas. During the rainy season, there are times when work must stop due to breakdowns in the construction equipment and the like, and at these times, 4 to 8 ton stones are used to cover the breakwater head. When work resumes, these stones are reinstalled as armour stones for the breakwater extension.

This breakwater frequently suffers from wave damage during rainy season construction, and the completion of the breakwater to the prescribed length has been delayed. As an example, the length of the breakwater on September 11, 1985 had reached 133 m, however setbacks due to wave action were suffered on September 12 and 13, 1985, and 20 m of the breakwater were lost.

5. 2. 2 Floating Dry Dock at the Port of Caldera

Construction of a floating dry dock for fishing boat repair in the water expanse between the －7.5 m quaywall and the roll on / roll off pier has been planned by a private corporation, and work is already underway. This plan is further based on an agreement between the governments of Costa Rica and Italy. A plan of the proposed construction and a cross-sectional view of the floating dry dock are shown in Figs. III－13 and III－14, respectively.

An ou'line of the ship repair company is given below.

Name of Company	: U.C.S.A.
Capital	: US $ 500,000
Shareholders	: Dena S.A. 51%, INCOP 49%
Number of Employees	: 100
Ship Repair Capacity	: Fishing boats (Length by Width by Depth) 50 m by 10 m by 3 m

Construction began in October 1985, and completion was planned for April 1986. In November, 1985 the foundation pilings of the structure were being driven. The body of the dry dock is fabricated in Italy. The dry dock placement site had a water depth of －3 m in November 1985 ; however, dredging to－7.0 m by April 1986 is planned. The volume of material to be dredged is approximately 35,000 m^3, and the plan is to carry out the operation using MOPT's cutter suction dredger.

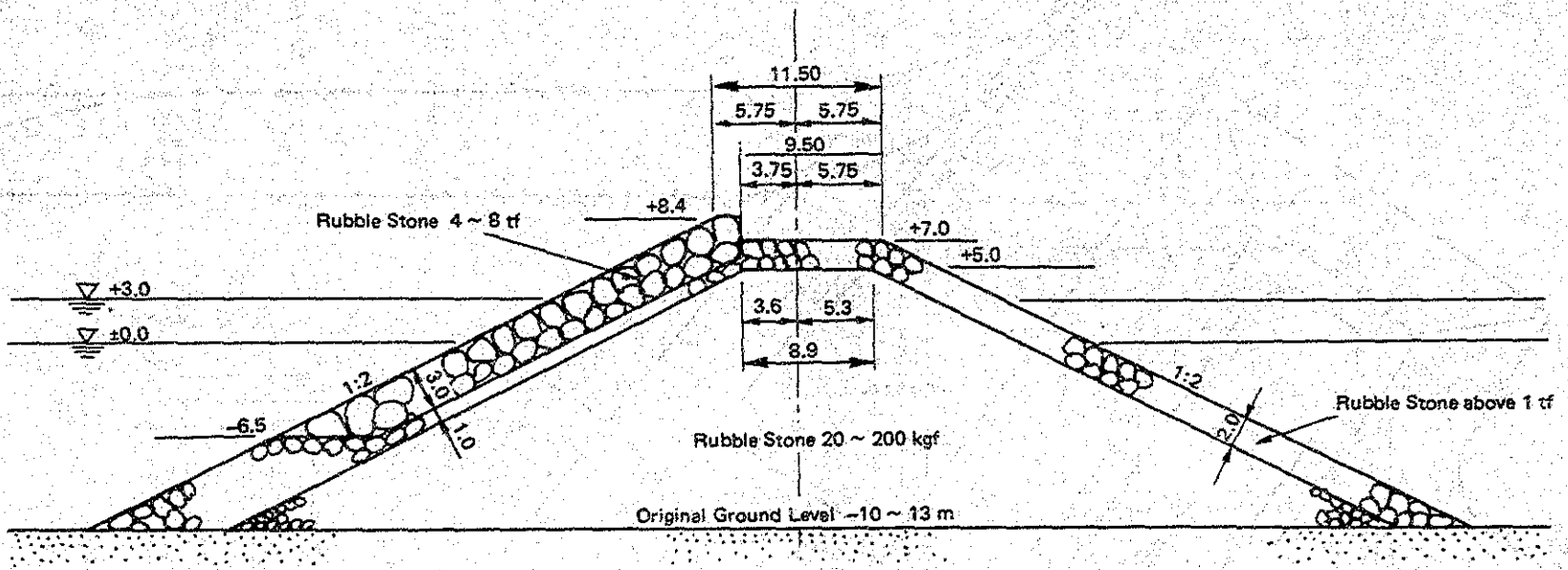


Fig. III-12 Standard Cross Section of the Breakwater Extension

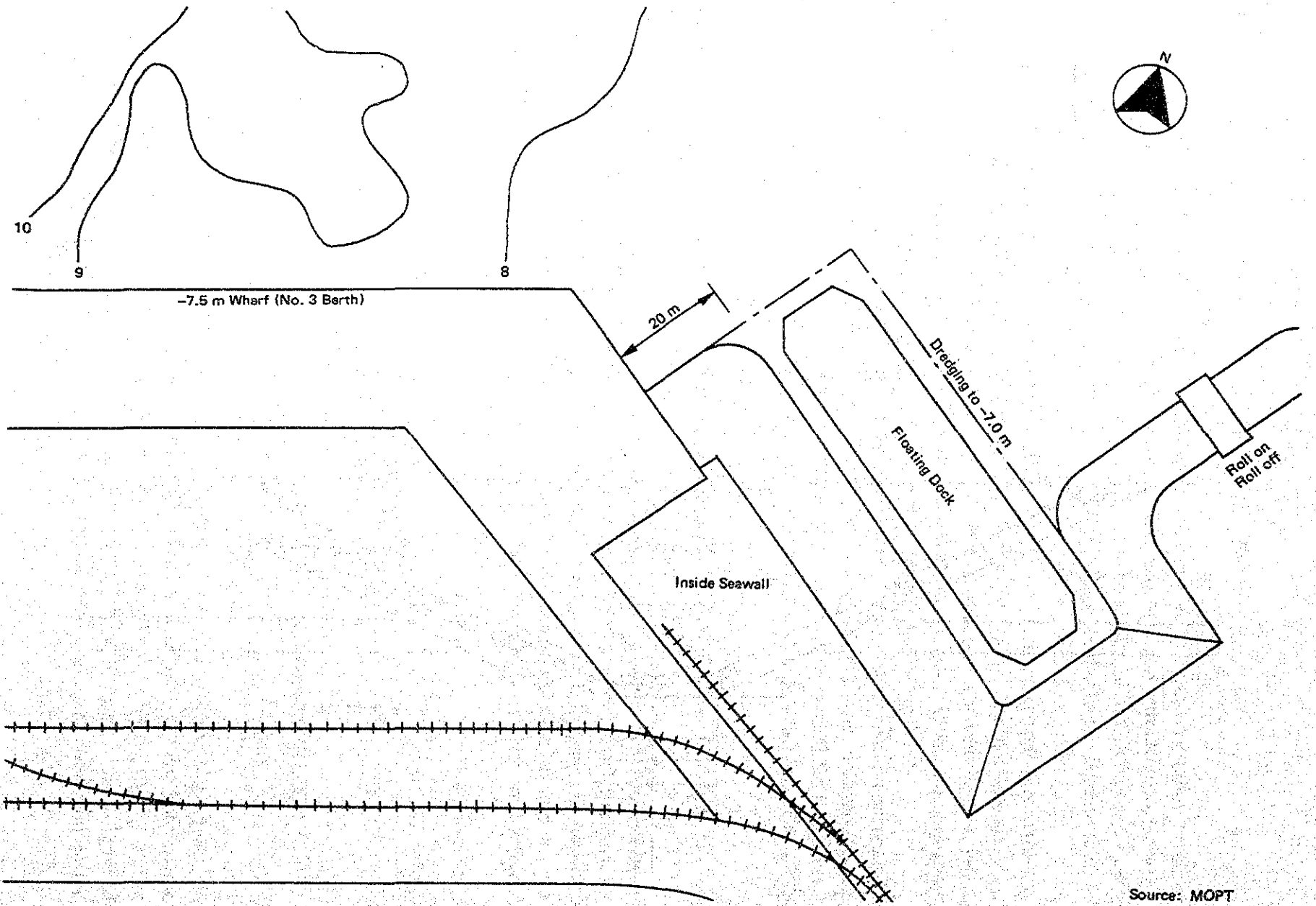


Fig. III-13 Plan View of the Planned Floating Dock at the Port of Caldera

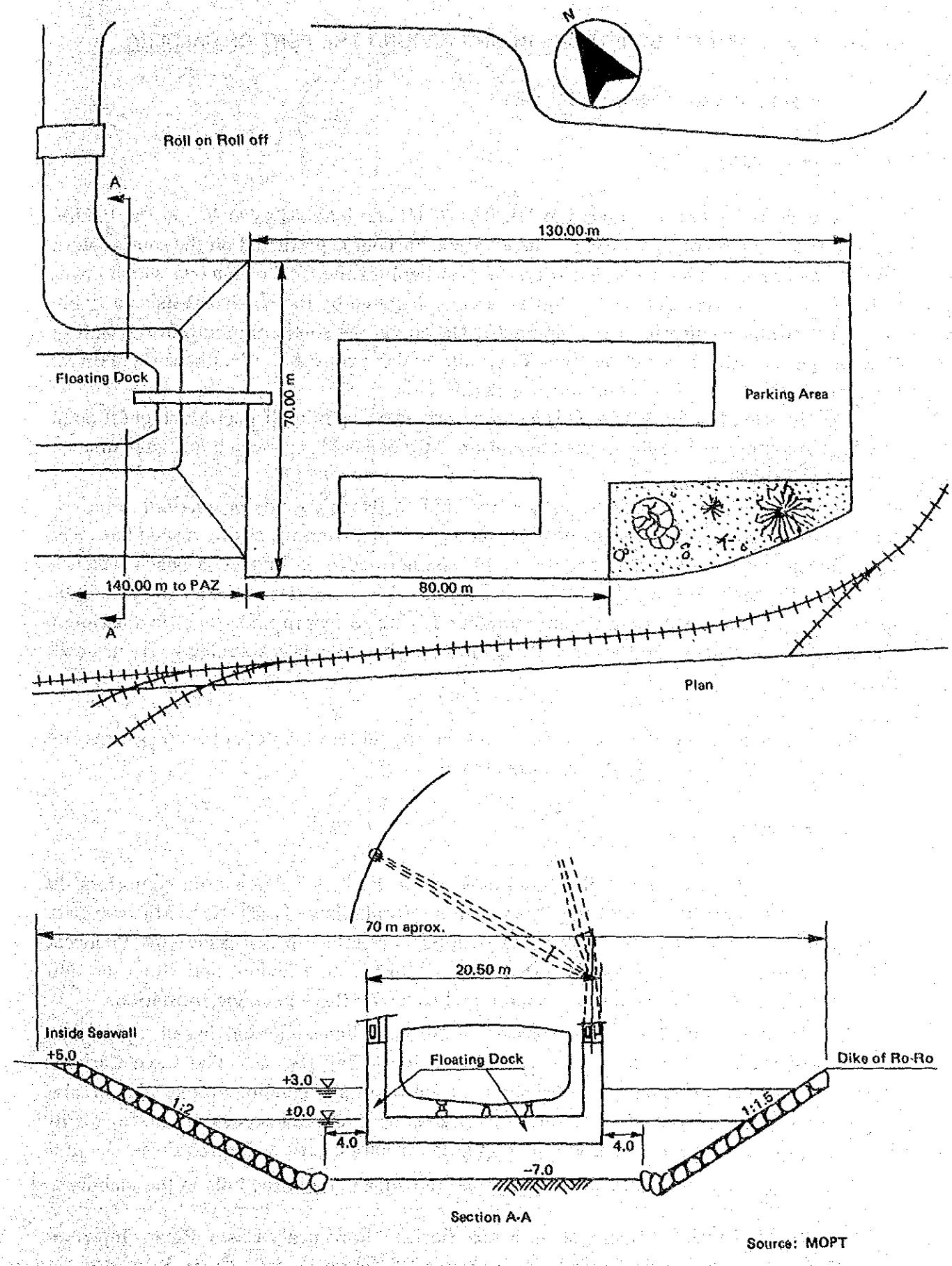


Fig. III-14 Standard Cross Section of the Planned Floating Dock at the Port of Caldera