3.2 Revision of Master Plan

Master Plan in this study is formulated for development of Apia Port to meet traffic demand forecast in 2015. Phased Improvement Plan is worked out as the first stage plan in line with Master Plan. The individual project component proposed in Master Plan is detailed in the following section.

The existing wharf has become insufficient in berthing capacity for the increasing number of ships calling the port in recent years. Further, Apia Port has imposed a load limitation to cargo handling equipment working on the existing wharf to prevent a possible collapse of the deteriorated wharf by overloading.

Through due consideration of this situation, Government of Samoa has given a high priority to this particular project. This current condition of Apia Port is to give rise to an increase of sea transport cost as a result of longer waiting and cargo handling time of ship. An increase of sea transport cost is to bring a heavy financial burden to the country which heavily relies on sea transport for import of most of daily requirements. While, a possible collapse of the wharf would give a destructive effect to the country's economy through closure of the only one wharf available for international trade.

On the above background, the Government of Samoa made a request to the Government of Japan to carry out a feasibility study to prepare a Master Plan with the target year of 2015. The Master Plan in this study is prepared by reviewing the previous master plan with the target year of 2005 proposed in JICA study in 1987.

3.2.1 Implemented Projects

After formulation of Master Plan of Apia Port in the feasibility study conducted in 1987, three projects were implemented for improvement and rehabilitation of Apia Port under Japan's grant aid program. The scopes of these projects are shown in Figures 3.2.1-1 to 3.2.1-3 and summarized as below.

(1) The Development of Apia Port, 1988

This project is a short term development plan proposed along with Master Plan formulated in 1987.

a) Repair of the Main Wharf	185 m
b) Expansion of the Main Wharf	61.5 m x 18.0 m
c) Expansion of the Container Yard	2,000 m^2
d) Ferry Boat Terminal	
Quay Wall	20 m
Dolphin	50 m

e) Ferry Terminal Building	522 m^2
f) Breakwater	100 m
g) Tug Boat	1 No, 1600 HP
h) Equipment for Management and Maintenance	
Computer System	1 set
Vehicles	3 units

(2) Rehabilitation of Cyclone-Damaged Port and Construction of Quarry Plant, 1991

a) Causeway and Seawall	323 m
b) Breakwater	265 m
c) Navigation Aids, Light Tower	2 Nos
d) Repair to Sheds, No 1 & 3	LS
e) Pilot/Work Boats	2 Nos
f) Pilot Office	215 m^2
g) Repair to Main Wharf, wooden fender	LS
h) Rehabilitation to other Ports	LS
i) Quarry Plant & Transport Equipment	LS

(3) Rehabilitation and Improvement of Cyclone-Damaged Port and Foreshore Protection, 1993

a) Repair to MOT Office	LS
b) Removal/Repair of Sheds No 1 & 4	LS
c) Repair to Main Wharf	LS
d) Navigation Aids, Beacon	2 No
e) Repair to Ferry Terminal	LS
f) Breakwater Reinforcement	LS
g) Rehabilitation to other Ports	LS
h) Foreshore Protection,	3,315 m

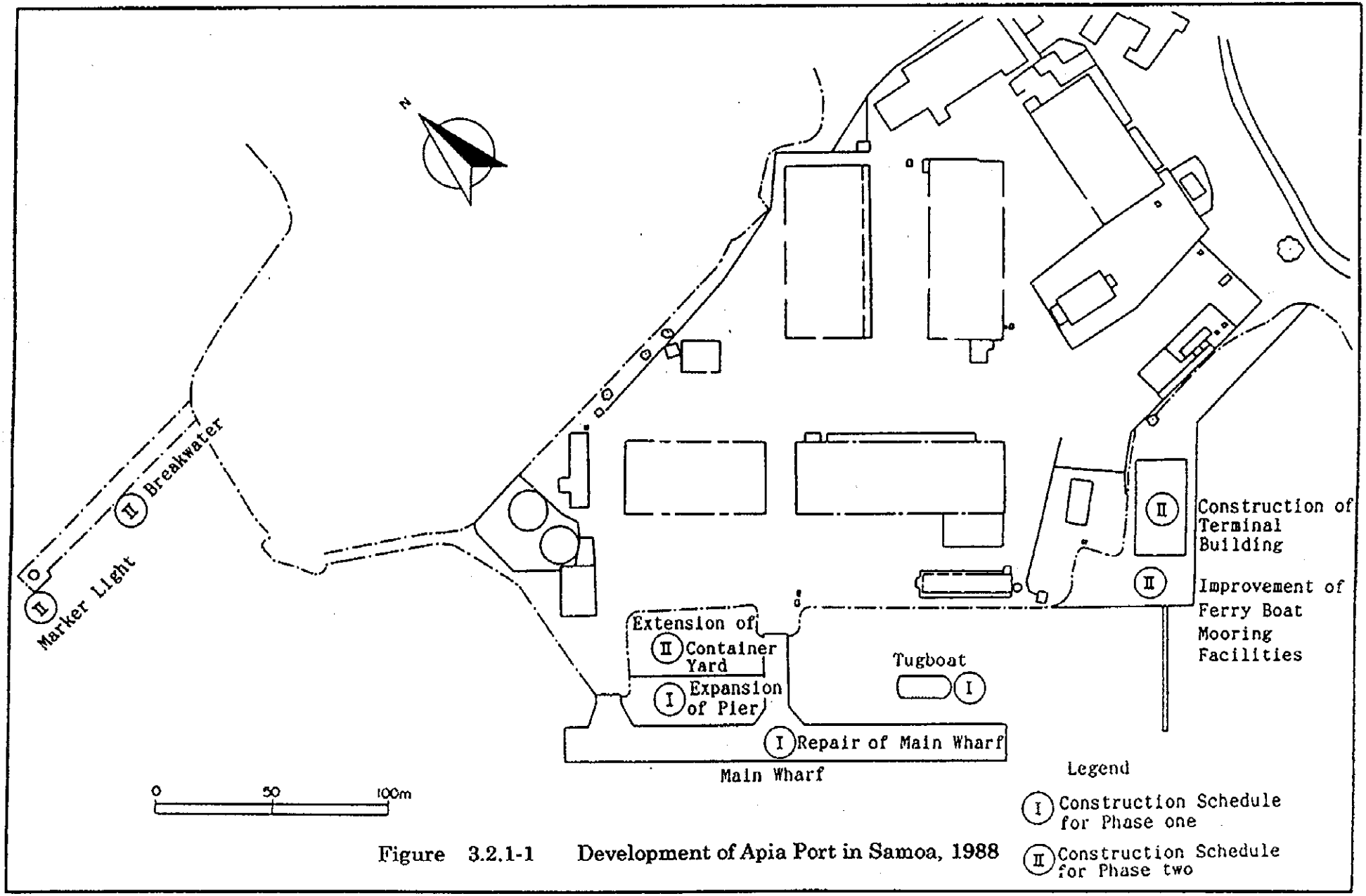


Figure 3.2.1-1 Development of Apia Port in Samoa, 1988

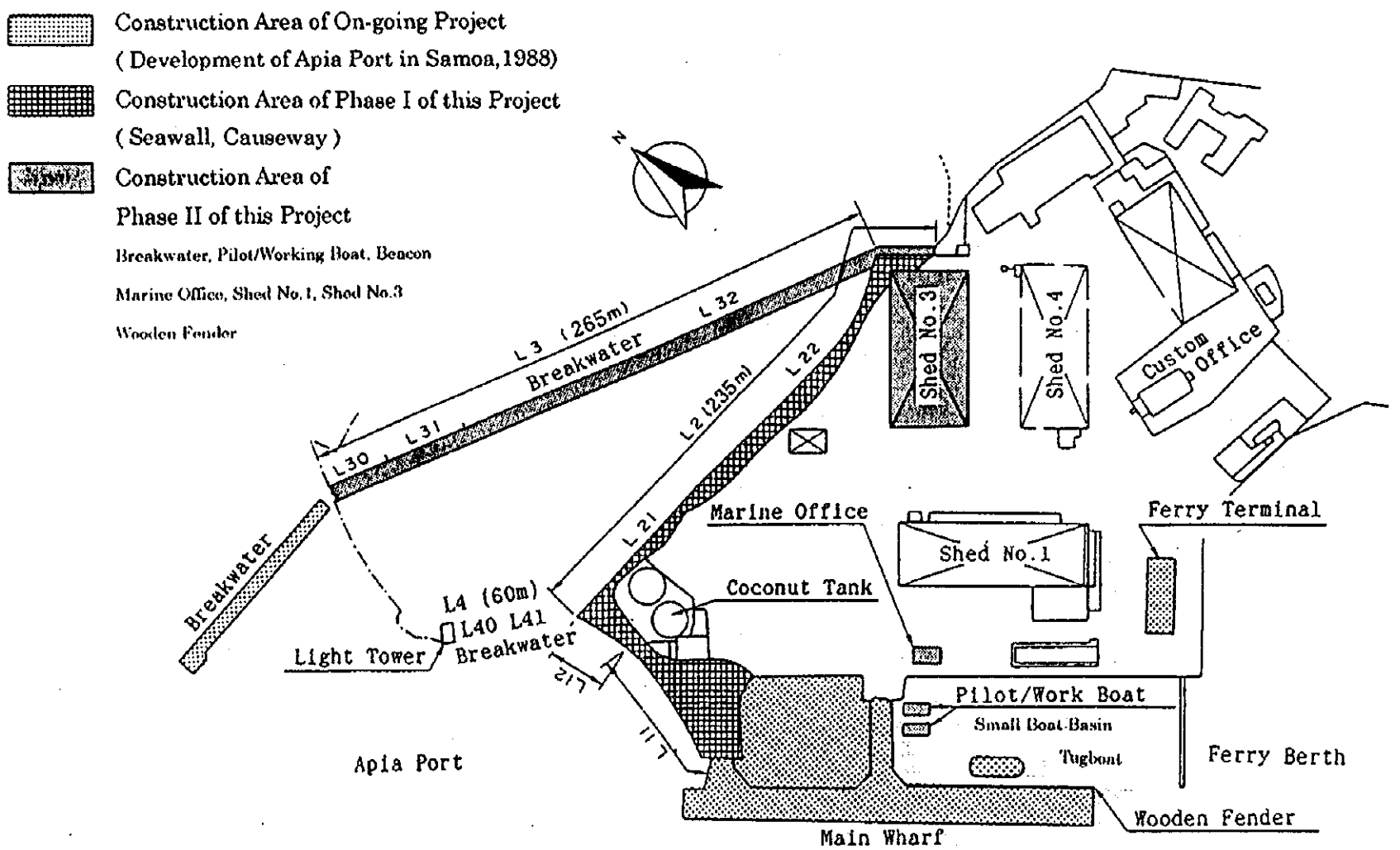
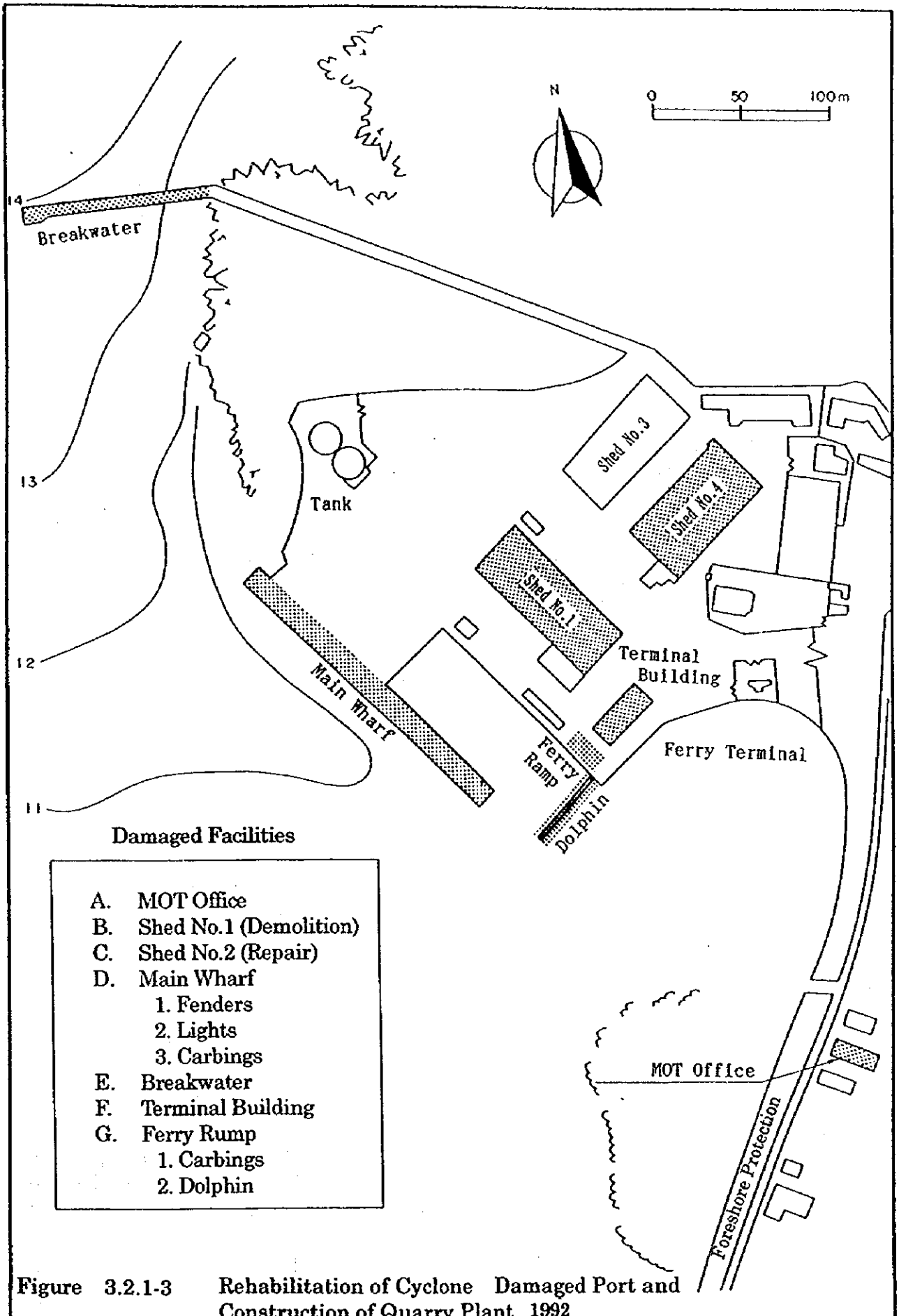


Figure 3.2.1-2 Rehabilitation of Cyclone Damaged Port and Construction of Quarry Plant, 1990



Damaged Facilities

A. MOT Office
B. Shed No.1 (Demolition)
C. Shed No.2 (Repair)
D. Main Wharf
   1. Fenders
   2. Lights
   3. Carbings
E. Breakwater
F. Terminal Building
G. Ferry Rump
   1. Carbings
   2. Dolphin

Figure 3.2.1-3 Rehabilitation of Cyclone Damaged Port and Construction of Quarry Plant, 1992

3.2.2 Cargo Forecast

The feasibility study report done by JICA in 1987 is basically followed in cargo and passenger traffic forecast with necessary amendments reviewing the latest port statistics up to the year 1997. Such socio-economic indicators as population, GDP, trade statistics, etc. have been analyzed and socio-economic frame up to the year 2015 has been set up by referring to the latest national development plans.

Based on the study of land use, industrial activities, distribution of population, transport network, etc. within the hinterland of the Port, the potentiality of regional development in the country up to the year 2015 has been evaluated, taking into account a national land use plan, an industrial development policy, a social infrastructure investment plan, etc.

Demand forecast for cargo and passenger has been prepared for the port up to the year 2015, the target year of the Master Plan. The macro economic and commodity-wise cargo forecasts have been carried out, taking into account GDP, industrial development and population increase in the country. In the forecast, a regression analysis is employed between specified industrial indicators and port cargo traffic by considering the economic growth of island country.

A number of passenger is forecast by the regression analysis against population or GDP, based on the latest passenger statistics. The future ship's call and ship size up to the year 2015, have been projected, based on the results of cargo and passenger demand forecasts, by taking into account international shipping trends.

(1) Future Socio-economic Situation

The population is forecast at 167,724 in 2003, 168,562 in 2005 and 172,425 in 2015, respectively as shown in Table 3.2.2-1. Table 3.2.2-2 shows the assumption and forecast of growth of real GDP. In A Statement of Economic Strategy 1998 - 1999, the annual growth rate of real per capita GDP is projected to be 3.5% from 1999 to 2001, with population increasing at 1%. Thus, the real GDP is to grow at annual rate of 4.5% over the next three years.

As described in Section 1.2.2, average annual growth rate of real GDP is 1.7% in 1981 - 1989 when no cyclone and taro blight disease occurred. In the case of average annual growth rate of 1.7%, real GDP is forecast to increase to 165.5 million Tala in 2003, 171.2 million Tala in 2005 and 202.6 Tala in 2015.

Real GDP after 1991 is calculated excluding production of wiring harnesses. GDP shall be revised to include 9.9 million Tala in 1996 and 10.9 million Tala after 1997. Real GDP of agriculture in 1996 is 6.5 million Tala less than that in 1981 - 1989 and is assumed to recover 50% of the level in 1981 - 1989 in 2003 and 100% in 2015.

Table 3.2.2-1 Population Forecast

$Y=7,611*X^{0.433}$ (r=0.999)	Year	Forcast
	1991	162,050
Y: Increased Population from 1966 (131,377)	2003	167,724
X: Year from 1966	2005	168,562
r: Correlation Coefficient	2015	172,425

Comparison of the actual with the forecast of population in 1991		
(1) population estimated by this eqation	162,050	
(2) Actual popultion of 1991 census	161,298	
(1)-(2) Difference	752	0.47%

Table 3.2.2-2 Forecast of Real GDP

		Economic Strategy		
Year	1996	1997	1998	1999
(A) Real GDP at 1982 prices(Tala million)	147.1	153.8	160.7	168.0
(B) GDP at current prices(Tala million)	431.5	483.1	540.9	605.5
(C) Population('000)	166.7	168.4	170.1	171.8
(A/C) Per Capita GDP(Tala)	882.4	913.3	945.3	978.4
(B/A) GDP Deflator	293.3	314.2	336.5	360.4
(A') Annual Growth Rate of Real GDP (%)	5.8%	4.5%	4.5%	4.5%

(unit : Tala million)

Assumption of Real GDP
(1) Converted to 1982 prices from 1980 prices.
(2) Production of Wiring Harnesses is included, and Real GDP in 1996 increases to 157 million Tala and by +10.9 million Tala after 1997.

Case	Max. Case		
Year	2003	2005	2015
GDP	200.2	218.6	339.5

Case	Min. Case		
Year	2003	2005	2015
GDP	165.5	171.2	202.6

Note ① Real GDP after 1991 excludes the wiring harnesses, it should be revised to include 9.9 million Tala in 1996 and 10.9 million Tala after 1997.
② Real GDP of agriculture in 1996 is 6.5 million Tala less than that in 1981-1989, it is assumed to recover 50% of the level in 1981-1989 till 2003 and to 100% till 2015.

Case	This Project		
Year	2003	2005	2015
GDP	180	186	220
Min.	165.5	171.2	202.6
①	10.9	10.9	10.9
②	3.3	3.8	6.5
annual rate	(+2.0%)	(+1.7%)	(+1.7%)

Through consideration of the above, the real GDP in the target year 2015 is forecast to be 220 million Tala with the average annual growth rate of 2.0% in 1996 – 2003 and 1.7% in 2004 – 2015. The real GDP is forecast as 180 million Tala in 2003 and 186 million Tala (91% of the forecast by 1987 Master Plan) in 2005.

Table 3.2.2-3 and Figure 3.2.2-1 show real GDP at 1982 prices by industrial origin in 1980 – 1996, revised forecast real GDP and the real GDP forecast in 1987 Master Plan in 2003, 2005 and 2015.

(2) Macro Forecast

Figure 3.2.2-2 shows the trend of general cargo and real GDP at factor cost in 1981 - 1997. Due to two cyclones and taro leaf blight, export structure has changed. The equation for forecasting general cargo volume of Apia Port by real GDP at 1982 prices is revised as follows,

$$Y = 3{,}591 \times X - 367{,}609 \qquad (r = 0.94501)$$

Y : General Cargo Volume of Apia Port (tons)
X : Real GDP at 1982 prices (million Tala)

General cargo volume of Apia Port is forecast to be 278,771 tons in 2003, 300,935 tons in 2005 and 423,688 tons in 2015.

Table 3.2.2-4 and Figure 3.2.2-3 show comparison among actual volume of general cargo handled in Apia Port, the forecast of 1987 Master Plan and the forecast of revised plan in this study. Actual volume agrees to the forecast of this study more than that of 1987 Master Plan.

(3) Micro Forecast

Main import commodities of motor spirits, fuel for airplane (kerosene or white spirits) and diesel oil are forecast as shown in Appendix 9. Total of import oil is forecast to be 44,999 tons in 2005, 59,849 tons in 2015.

Main import commodities of general cargoes, sugar, cement, steel, cereals and materials of wiring harnesses are shown in Appendix 9. Through consideration of import general cargo in 1990 –1996, the maximum and minimum base volumes of other general cargo set at 105,824 tons and 76,573 tons based on three years moving average in 1993 and1994. The volume of other general cargo is forecast at 143,737 tons at minimum to 186,523 tons at maximum in 2003 as shown in Appendix 9.

New import duty rates will be applied from 30 May 1998 as shown in Table 1.2.3-3. Here, the effect to import volume of new import duty is estimated as follows,

The example of elasticity rate is taken between increase of import cargo volume and reduced import price in Japan and Germany. In the case of 3.6% down per annum of import unit price index, import volume index increased by 4.8% per annum, giving the elasticity rate of –1.01.

As shown in Appendix 9, the old import duties occupy 23.5% of total import value in 1995 - 1997. While the new import duties occupy in 11.6%. Reduction of price of oil products is estimated as 6.3 million Tala (24.1% of 1995-1997 imports) and the increase of oil volume is estimated as 4,479 tons (11.3%of 95-97 import volume). Similarly, reduction of general cargo price and increase of import volume are estimated as 42.4 million Tala (19.6%) and 17,209 tons (9.2%), respectively. However, volume increase of cargo brought by new import duties is not expected to continue at the same rate for long term. And cargo increase rate is assumed as 100 % in 1998 - 2003, thereafter gradually decrease to 10% in 2015.

The remarkable decrease of such major agricultural exports as Coconut oil, Copra, Copra meal and Cocoa from 1990 to 1994, and taro export by leaf blight disease after 1994 is shown in Appendix 9. Export of timber from Asau Port shows a tendency to decrease under the intention of Government. Making up for the decrease of export cargoes, exporting structure has changed with the increase of fish catch and wiring harnesses instead of agricultural products.

According to the information from Agricultural Department, taro and cocoa need 15 years to recover the production level before 1990, 5 years to 30% and 10 years to 60%. Copra meal, copra and coconut cream are forecast based on three year moving average in 1996. Coconut oil is forecast to recover 100% in 5 years.

According to the information from Fishery Division, 85% of fish catch is exported from Apia Port with average annual growth rate of 10%.

Wiring harnesses are estimated to be exported with no growth after 1997.

Total value of import cargoes is forecast at 256,449～303,162 tons in 2003, 271,087～321,842 tons in 2005 and 427,107～519,037tons in 2015.

(4) Cargo Forecast

Cargo volume calculated by macro forecast falls within the range of micro forecast and adopted in this study as the future traffic demand.

The method of cargo forecast employed in this study is shown in Appendix 9. The results of above revised macro and micro forecasts are shown in Table 3.2.2-5. The total volume of imports (include oil) under the micro forecast in 2003, 2005 and 2015 is estimated as 256,449 -303,162 tons (oil 47,353 tons), 260,792 - 311,547 tons (oil 47,525 tons) and 422,140 - 574,071 tons (oil 60,507 tons), respectively. While, the total volume of exports under the micro forecast in 2003, 2005 and 2015 is estimated as 44,919 tons (oil 9,889 tons), 49,484 tons (oil 10,451 tons), 69,315 tons(oil 13,775 tons), respectively.

As shown in Table 3.2.2-6, the total volume of general cargo under the micro forecast in 2003, 2005 and 2015 is estimated as 290,839 - 244,126 tons, 311,547 - 260,792 tons and 514,071 - 422,140 tons, respectively.

As the projected volume of general cargo under the macro forecast, 278,771 tons in 2003, 300,935 tons in 2005 and 423,688 tons in 2015 are within the range of the micro forecast, the cargo volumes by macro forecast are adopted as the revised forecast in this study.

Table 3.2.2-7 shows the projected cargo volume. The import and export of general cargo in 2015 are forecast as 368,147 tons and 55,541 tons, respectively. The import and export of oil in 2015 are forecast as 60,507 tons and 13,775 tons, respectively.

Table 3.2.2-8 and Figure 3.2.2-4 show the comparison among actual cargo volume, forecast cargo volume by 1987 Master Plan and forecast of the revised plan of this study. The export volume in 2015 by Revised Plan is forecast less than that by 1987 Master Plan.

The cargo forecast by cargo type is shown in Table 3.2.2-11. The import and export volumes of container cargoes in 2015 are forecast as 331,332 tons and 41,655 tons, respectively.

The traffic demand of Apia – Pagopago ferry is forecast as 27,000 passengers in 2015, as shown in Table 3.2.2-12.

Table 3.2.2-3 Real GDPat 1982 prices and Forecast GDP of Master Plan Proposed in 1987

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	2003	2005	2015
(A) Real GDP at 1982 prices(Tala million)	124.6	123.2	123.9	131.7	129.5	134.1	140.9	142.4	140.8	144.5	133.7	130.4	130.2	135.6	126.8	139.0	147.1			
(A') Real GDP with wire harness												130.7	135.9	141.2	131.5	146.0	157.0			
(B) Forecast Real GDP (+1.7～ 2.0% per annum)																	157.0	180	186.2	220.4
(C) Forecast GDP in 1987 Master Plan(+2.1% per annum)	124.6	123.2	123.9	131.7	129.5	134.1	136.9	139.8	142.8	145.8	148.9	152.1	155.3	158.6	162.0	165.4	168.9	195.6	204.0	251.6

(unit : Tala million)

Figure 3.2.2-1 Real GDP at 1982 prices and Forecast GDP

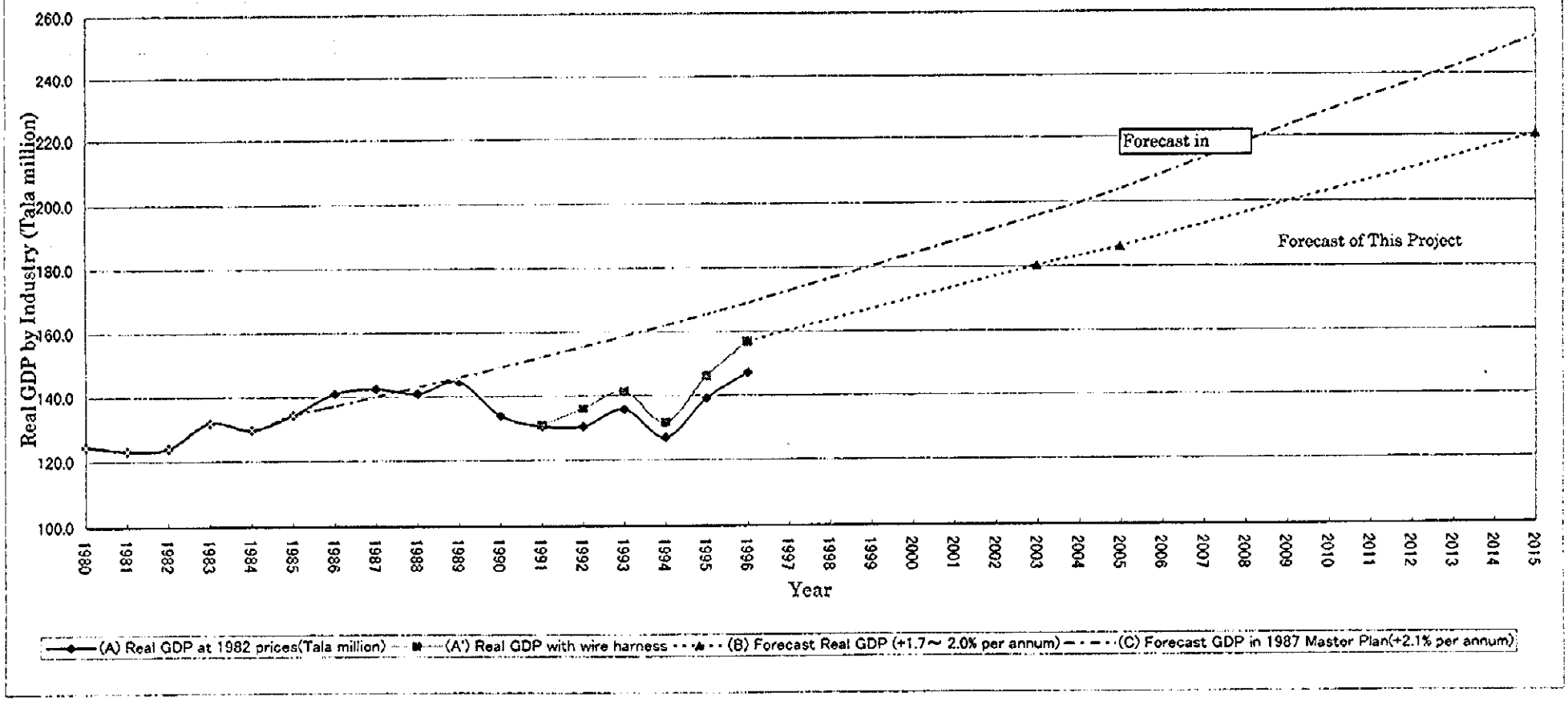
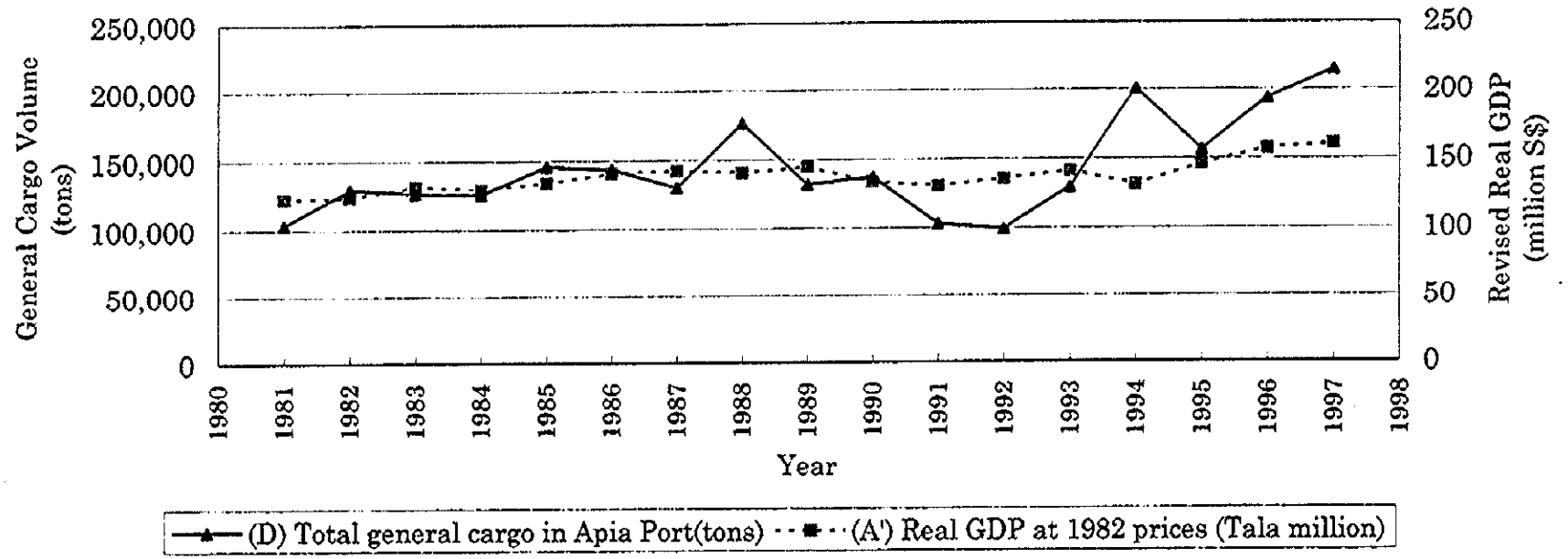


Figure 3.2.2-2 General Cargo Volume and Real GDP



								Target year		
Year	1990	1991	1992	1993	1995	1996	1997	2003	2005	2015
(A') Revised Actual Real GDP(Tala million)	133.7	130.7	135.9	141.2	146.0	157.0	160.1			
(D) General cargo of Apia Port (tons)	137,554	103,145	99,498	129,989	156,214	193,373	214,786			
(A") Forecast of Real GDP(Table 3.3.2-3)	143.6	146.2	148.8	151.5	154.2	157.0	160.1	180.0	186.2	220.4
(F) Forecast of General Cargo volume	148,066	157,348	166,797	176,417	186,209	196,178	207,454	278,771	300,935	423,688

Note 1) : The annual average growth rate is 2.0% in 1997- 2003 and 1.7% afte will continue until 2015.

2) : Real GDP at 1982 prices includes Automotive Wiring Harnesses after 1991.

[Equation of General Cargo Volume by Real GDP]

Due to two cyclone and Taro leaf blight, Export Structure has changed.

The Equation is revised as follows;

$Y = 3{,}591 * X - 367{,}609$ ($r = 0.94501$)

Y : General Cargo Volume of Apia Port (tons)

X : Real GDP at 1982 prices(million WS$)

in 1990-1997 except 1994(Leaf bright's disease decrease for Taro to be half of its production).

Table 3.2.2-4 Comparison between Actual Volume of General Cargo and the Forecast

(unit : tons)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	2003	2005	2015
Forecast of G. Cargo by 1987 Master Plan	143,764	157,780	165,680	174,699	183,731	192,662	201,747	210,931	219,886	229,340	236,678	248,521	310,271	333,733	467,047
Forecast of G. Cargo by 1998 Revised Plan	104,060	112,550	121,193	129,991	138,948	148,066	157,348	166,797	176,417	186,209	196,178	207,454	278,771	300,935	423,688
Actual Volume of General Cargo	143,764	130,445	175,963	132,200	137,554	103,145	99,498	129,989	200,538	156,214	193,373	214,786			

Figure 3.2.2-3 Comparison between Actual Volume of General Cargo and Forecast

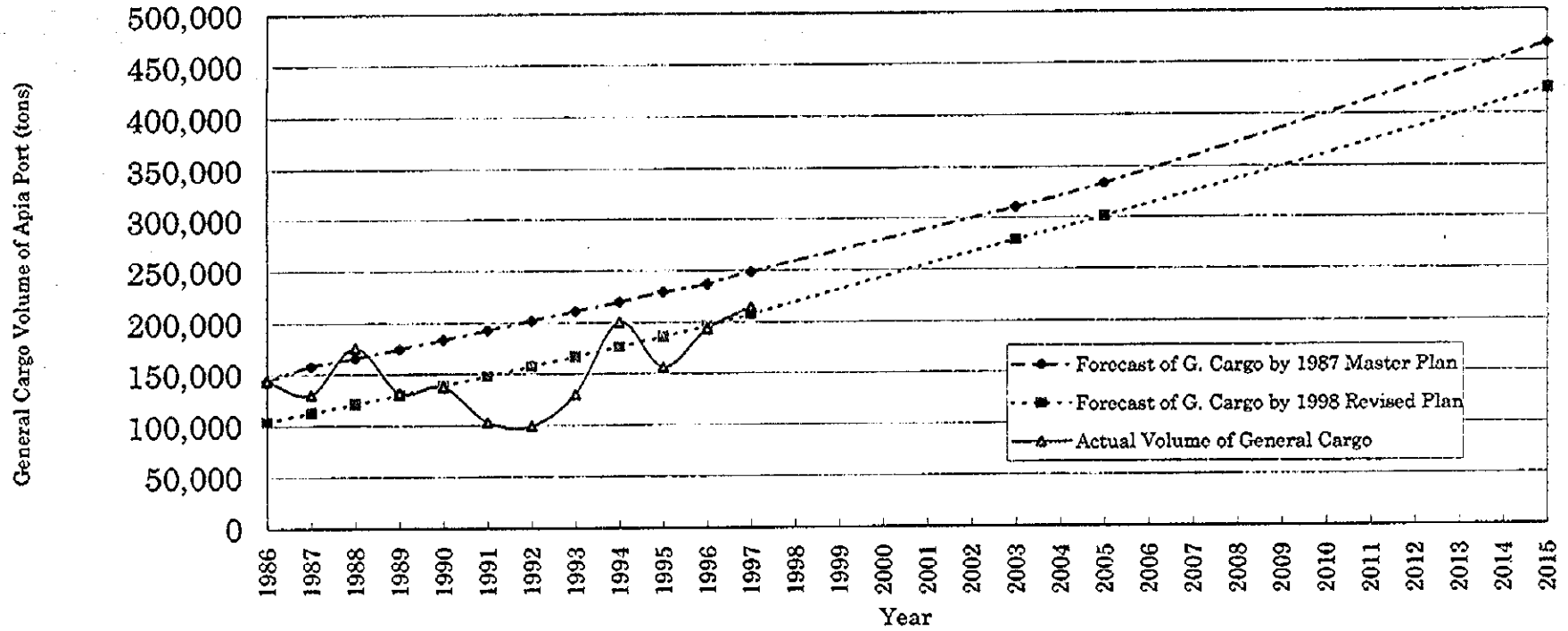


Table 3.2.2-5 Macro and Micro Forecast by Revised Plan

(1) Macro Forecast by Revised Plan

		1987 Master Plan		Revised Plan			Y= 3,591*X - 367,609 (r = 0.94501)							
	unit	1985	2005	1990	1991	1992	1993	1994	1995	1996	1997	2003	2005	2015
Revised Real GDP, 1982 prices (X)	Tala million	98.6	150	141.1	143.6	146.2	148.8	151.5	154.2	157.0	160.1	180.0	186.2	220.4
Forecast of General Cargo of Apia Port (Y)	tons	142,014	338,000	138,948	148,066	157,348	166,797	176,417	186,209	196,178	207,454	278,771	300,935	423,688
Actual data of General Cargo Volume (tons)	tons	146,134		137,554	103,145	99,498	129,989	200,538	156,214	193,373	214,786			

(2) Micro Forecast by Revised Plan

Commodity	unit	1985	2005	1990	1991	1992	1993	1994	1995	1996	1997	2003	2005	2015
(A)Motor Vehicles	numbers	4,372	7,170	5,181	6,036	7,151	5,038	7,370	6,669	6,829	6,992	8,050	8,433	10,619
(B)Population	1000persons	158	169	160.5	161.3	162.6	163.1	163.6	164.1	164.6	165.0	167.7	168.6	172.4
(A)/(B)	numbers	27.9	42.4	32.3	37.4	44.0	30.9	45.1	40.6	41.5	42.4	48.0	50.0	61.6
Oil Products	tons	18,044	29,600	18,496	21,549	25,529	17,986	26,311	23,807	24,379	24,963	28,737	30,107	37,911
Oil for airplanes (+4.3% per annum)	tons	6,100	14,200	7,529	7,853	8,191	8,543	8,910	9,293	9,693	10,110	13,015	14,158	21,570
Diesel oil (-6.2% per annum)	tons	2,900	800	1,821	1,709	1,603	1,503	1,410	1,323	1,241	1,164	793	697	368
Volume effect of New Import Duties after 1998	(average annual rate ; +11.3% in 1998-2003, +9.7% in 2004-2009, + 1.1% in 2010-2015)											4,808	4,365	658
Oil Product total	tons	27,044	44,600	27,847	31,110	35,322	28,032	36,631	34,423	35,313	36,236	47,353	49,327	60,507
Sugar (56.5 kg per Capita)	tons	8,870	9,500	9,066	9,113	9,185	9,215	9,243	9,271	9,298	9,325	9,476	9,524	9,742
Gross Investment, 1982 prices	Tala million	39.2	70.9	58.4	70.1	70.2	61.8	60.5	54.5	45.2	45.2	51.8	53.1	63.5
Cement	tons	9,700	17,600	14,451	17,346	17,371	15,286	14,981	13,483	11,191	11,191	12,828	13,136	15,702
Steel Products	tons	6,000	10,900	8,939	10,730	10,745	9,456	9,266	8,340	6,922	6,922	7,935	8,126	9,713
Cereals (+2.36% per annum)	tons	8,807	24,300	10,369	10,614	10,864	11,121	11,383	11,652	11,927	12,208	14,042	14,713	18,578
W/H Material	tons				76	1,310	1,311	1,311	1,980	2,970	3,443	3,500	3,500	3,500
Others-max, (+5.36% based in 1994)	tons	62,200	196,000	82,260	87,606	93,301	99,365	105,824	112,703	120,028	127,830	186,523	211,559	397,124
Others-min,(+5.36% based in1993)	tons	52,200	174,000	63,390	67,511	71,899	76,573	81,550	86,850	92,496	98,508	143,737	163,030	306,030
Effect of New Import Duties for Max. General Cargo after 1998	(average annual rate ; +9.2% in 1998-2003, +4.6% in 2004-2009, + 0.9% in 2010-2015)											21,506	11,958	4,170
Effect of New Import Duties for Min. General Cargo after 1998	(average annual rate ; +9.2% in 1998-2003, +4.6% in 2004-2009, + 0.9% in 2010-2015)											17,579	9,731	3,334
Import-max Total (Other-max)	tons	122,621	302,900	152,931	166,595	178,099	173,785	188,640	191,851	197,649	207,155	303,162	321,842	519,037
Import-min Total (Other-min)	tons	112,621	280,900	134,062	146,500	156,697	150,992	164,365	165,999	170,116	177,833	256,449	271,087	427,107

Commodity	unit	1985	2005	1990	1991	1992	1993	1994	1995	1996	1997	2003	2005	2015
Taro (+0.53% per annum)	tons	7,200	8,000	4,474	7,409	3,740	7,060	70	70	35	35	2,737	4,667	7,723
Cocoa (+10.6% per annum)	tons	600	4,500	222	2							214	284	801
Copra meal (+2.84% per annum)	tons	6,000	10,500	2,215		36			2,624	4,064	3,205	4,245	4,489	5,940
Copra(+2.04%)	tons			2,400				64	2,502	4,659	8,555	5,867	6,109	8,672
Coconut cream(+1.74%)	tons			1,576	1,557	1,295	960	1,211	1,380	1,413	1,343	1,687	1,620	2,362
Fish(+4%)	tons			47	21	15	33	34	90	478	2,576	4,564	5,523	10,000
Wiring harnesses(constant after 1998)	tons				104	1,787	1,788	1,788	2,700	4,050	4,696	4,700	4,700	4,700
Others (+2.8% per annum)	tons	24,300	41,000	6,112	12,551	4,128	7,058	17,324	13,256	7,357	6,886	11,015	11,640	15,343
General Cargo of Apia Port				17,045	21,645	11,001	16,898	20,491	22,621	22,056	27,296	35,029	39,033	55,541
Oil (Coconut Oil) (+2.8%)	tons	12,100	21,000	5,188	35	837			6,782	6,489	4,315	9,889	10,451	13,775
Export Total of Apia Port				22,233	21,680	11,838	16,898	20,491	29,403	28,545	31,611	44,919	49,484	69,315
Timber of Asau Port (annual increase +1.3%)	tons	3,000	20,000	68	33	33	126	645	865	3,407	512	3,798	3,898	4,435
Export Total	tons	84,800	184,500	22,301	21,713	11,871	17,024	21,136	30,268	31,952	32,123	48,717	53,381	73,751
										General Cargo Max		290,839	311,547	514,071
										General Cargo Min		244,126	260,792	422,140

Table 3.2.2-6 Demand Forecast by the Revised Plan

		unit	1986	1990	1991	1992	1,993	1994	1995	1996	1997	2003	2005	2015
(1) Macro Forecast (Total general cargo)		tons	146,800	138,948	148,066	157,348	166,797	176,417	186,209	196,178	207,454	278,771	300,935	423,688
1) General Cargo	Import-max	tons	105,700	125,084	135,485	142,776	146,754	152,008	157,428	162,336	170,919	255,809	272,515	458,530
	Import-min	tons	105,700	106,215	115,390	121,375	122,961	127,734	131,575	134,803	141,597	209,097	221,759	366,600
	Export	tons	41,100	17,045	21,645	11,001	16,898	20,491	22,621	22,056	27,296	35,029	39,033	55,541
	Total-max	tons	146,800	142,129	157,130	153,777	162,652	172,499	180,049	184,392	198,215	290,839	311,547	514,071
	Total-min	tons	146,800	123,260	137,035	132,376	139,859	148,225	154,196	156,859	168,893	244,126	260,792	422,140
2) Tanker Cargo	Import	tons	25,500	27,847	31,110	35,322	28,032	36,631	34,423	35,313	36,236	47,353	49,327	60,507
	Export	tons	13,800	5,188	35	837	0	0	6,782	6,489	4,315	9,889	10,451	13,775
	Total	tons	39,300	33,035	31,145	36,159	28,032	36,631	41,205	41,802	40,551	57,242	59,778	74,282
(2) Micro Forecast	Total-max	tons	186,100	175,164	188,275	189,937	190,683	209,131	221,254	226,194	238,766	348,081	371,326	588,352
	Total-min	tons	186,100	156,295	168,180	168,535	167,890	184,856	195,402	198,661	209,444	301,368	320,570	496,422

The total volume of general cargo under the micro forecast in 2003, in 2005 and in 2015 is respectively 290,839 -244,126 tons, 311,547 -260,792 tons and 514,071 -422,140 tons. As the projected volume of general cargo under the macro forecast, 278,771 tons in 2003, 300,935 in 2005, 423,688 in 2015 are respectively within the range of the micro forecast, herein the cargo volume by macro forecast are adopted as the study team estimate.

Table 3.2.2-7 Projected Cargo Volume by Commodity of Apia Port

(unit : tons)

	Commodity		1990	1991	1992	1,993	1994	1995	1996	1997	2003	2005	2015
General Cargo	Import	Sugar	9,066	9,113	9,185	9,215	9,243	9,271	9,298	9,325	9,476	9,524	9,742
		Cement	14,451	17,346	17,371	15,286	14,981	13,483	11,191	11,191	12,828	13,136	15,702
		Steel Products	8,939	10,730	10,745	9,456	9,266	8,340	6,922	6,922	7,936	8,126	9,713
		Cereals	10,369	10,614	10,864	11,121	11,383	11,652	11,927	12,208	14,042	14,713	18,578
		Wire harness material	0	76	1,310	1,311	1,311	1,980	2,970	3,443	3,500	3,500	3,500
		Others	79,078	78,542	96,872	103,511	109,742	118,863	131,815	137,069	195,960	212,903	310,912
		Total	121,903	126,421	146,347	149,899	155,926	163,588	174,122	180,158	243,742	261,902	368,147
	Export	Taro	4,474	7,409	3,740	7,060	70	70	35	35	2,737	4,667	7,723
		Cocoa	222	2	0	0	0	0	0	0	214	284	801
		Copra Meal	2,215	0	36	0	0	2,624	4,064	3,205	4,245	4,489	5,940
		Copra	2,400	0	0	0	64	2,502	4,659	8,555	5,867	6,109	8,672
		Coconut Cream	1,576	1,557	1,295	960	1,211	1,380	1,413	1,343	1,687	1,620	2,362
		Fish	47	21	15	33	34	90	478	2,576	4,564	5,523	10,000
		Wire harness products	0	104	1,787	1,788	1,788	2,700	4,050	4,696	4,700	4,700	4,700
		Others	6,112	12,551	4,128	7,058	17,324	13,256	7,357	6,886	11,015	11,640	15,343
		Total	17,045	21,645	11,001	16,898	20,491	22,621	22,056	27,296	35,029	39,033	55,541
Total General Cargo of Apia Port			138,948	148,066	157,348	166,797	176,417	186,209	196,178	207,454	278,771	300,935	423,688
Oil	Import	Oil Products	27,847	31,110	35,322	28,032	36,631	34,423	35,313	36,236	47,353	49,327	60,507
	Export	Coconut Oil	5,188	35	837	0	0	6,782	6,489	4,315	9,889	10,451	13,775
	Total oil of Apia Port		33,035	31,145	36,159	28,032	36,631	41,205	41,802	40,551	57,242	59,778	74,282
Total	Import		149,750	157,531	181,670	177,931	192,557	198,012	209,435	216,394	291,094	311,229	428,654
	Export		22,233	21,680	11,838	16,898	20,491	29,403	28,545	31,611	44,919	49,484	69,315
	Total Cargo of Apia Port		171,983	179,211	193,508	194,829	213,048	227,415	237,980	248,005	336,013	360,713	497,969

Table 3.2.2-8 Cargo Volume Handled and Forecast in Apia Port

(unit : tons)

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	2003	2005	2015
Import by 1987 Master Plan	112,526	92,470	111,372	109,318	118,117	125,594	132,814	140,167	147,652	155,267	163,012	170,883	178,879	186,996	195,231	203,581	221,389	264,538	284,500	370,647
Export by 1987 Master Plan	33,117	48,175	47,448	56,353	56,069	57,409	58,906	60,450	62,043	63,686	65,381	67,132	68,939	70,807	72,737	74,733	76,797	90,831	95,000	131,191
Total by 1987 Master Plan	145,643	140,645	158,820	165,671	174,186	183,003	191,720	200,617	209,695	218,953	228,393	238,014	247,818	257,803	267,969	278,314	298,187	355,370	379,500	501,838
Import by Revised Plan	99,732	103,875	112,501	102,866	126,124	128,768	110,142	178,272	130,742	130,144	102,139	132,361	154,346	215,244	160,643	203,216	227,020	291,094	309,427	428,654
Export by Revised Plan	33,117	48,175	47,448	56,353	56,069	51,871	42,075	47,097	28,463	22,233	21,680	11,838	16,898	20,491	29,403	28,545	31,611	44,919	49,484	69,315
Total by Revised Plan	132,849	152,050	159,949	159,219	182,193	180,639	152,217	225,369	159,205	152,377	123,819	144,199	171,244	235,735	190,046	231,761	258,631	336,013	358,911	497,969
Total Actual Import	99,732	103,875	112,501	102,866	126,124	128,768	110,142	178,272	130,742	130,144	102,139	132,361	154,346	215,244	160,643	203,216	227,020			
Total Actual Export	33,117	48,175	47,448	56,353	56,069	51,871	42,075	47,097	28,463	22,233	21,680	11,838	16,898	20,551	29,403	28,545	31,611			
Total Actual Cargo	132,849	152,050	159,949	159,219	182,193	180,639	152,217	225,369	159,205	152,377	123,819	144,199	171,244	235,795	190,046	231,761	258,631			

Figure 3.2.2-4 Cargo Volume Handled and Forecast in Apia Port

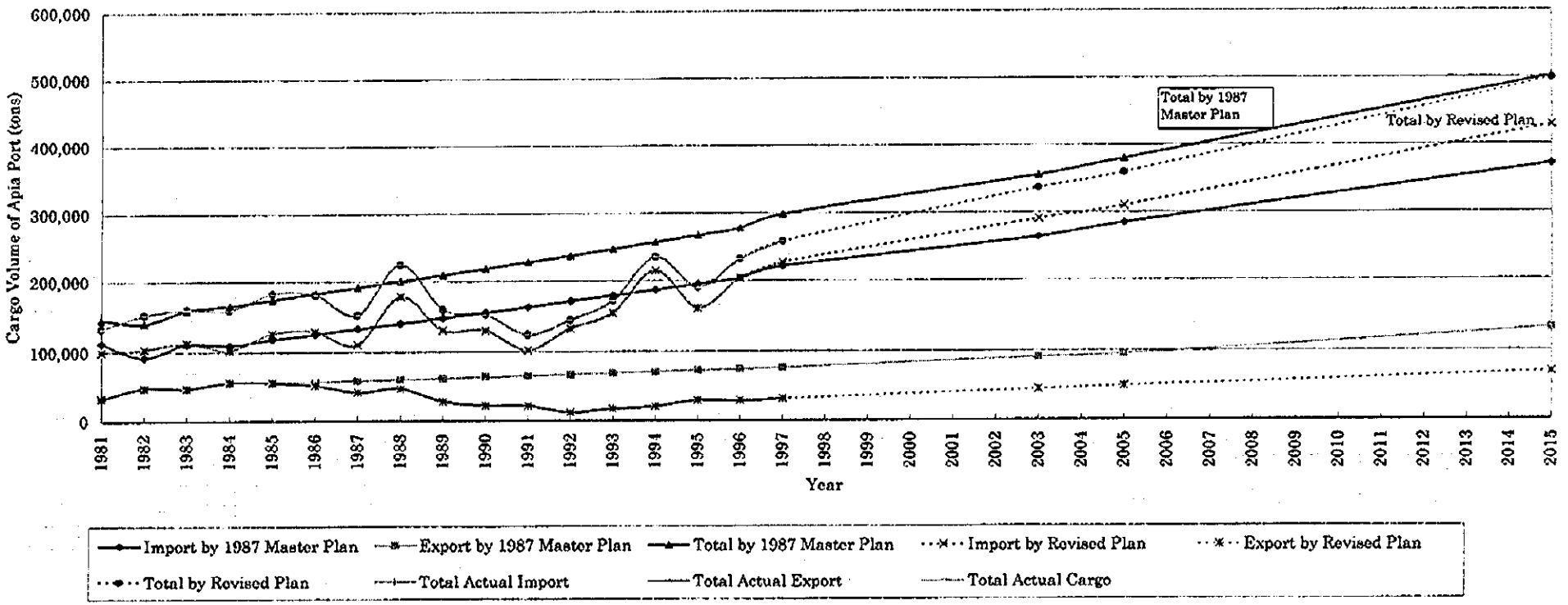


Table 3.2.2-9 Ferry Cargo in 1996

Sea Route	Sea-going frequency	Number of Passenger	Average cargo volume per ship	Cargo Volume (tons)	Cargo Revenue (WS$)	CargoUnit Price
Apia - Pagopago	56	9,992	62.78	3,516		
Pagopago - Apia	61	8,867	59.7	3,642		
Total	117	18,859	122.48	7,157	2,205,008	308

Table 3.2.2-10 Container Cargo

(unit : tons)

Cargo type	1996	Share (%)	1997	Share (%)
Containers	150,569	87.9%	164,485	87.7%
Convention	20,748	12.1%	23,005	12.3%
Imports of General Cargo	171,317	100.0%	187,490	100.0%
Containers	13,161	59.7%	17,325	63.5%
Convention	8,895	40.3%	9,971	36.5%
Exports of General Cargo	22,056	100.0%	27,296	100.0%

Cargo type	2003	Share (%)	2005	Share (%)	2015	Share (%)
Containers	219,367	90.0%	235,712	90.0%	331,332	90.0%
Convention	24,374	10.0%	26,190	10.0%	36,815	10.0%
Imports of General Cargo	243,742	100.0%	261,902	100.0%	368,147	100.0%
Containers	24,521	70.0%	27,323	70.0%	41,655	75.0%
Convention	10,509	30.0%	11,710	30.0%	13,885	25.0%
Exports of General Cargo	35,029	100.0%	39,033	100.0%	55,541	100.0%

Table 3.2.2-11 Cargo Forecast by Type

(unit : tons)

Cargo type	1996	2003	2005	2015
Containers	150,569	219,367	235,712	331,332
Ferry Cargo	3,642	5,182	5,568	7,826
Other Convention	17,106	19,192	20,622	28,988
Imports of General Cargo	171,317	243,742	261,902	368,147
Containers	13,161	24,521	27,323	41,655
Ferry Cargo	3,516	5,584	6,222	8,854
Other Convention	5,379	4,925	5,488	5,031
Exports of General Cargo	22,056	35,029	39,033	55,541
Imports of Oil	31,899	47,353	49,327	60,507
Exports of Oil	6,489	9,889	10,451	13,775
Imports	203,216	291,094	311,229	428,654
Exports	28,545	44,919	49,484	69,315
Total Cargo of Apia Port	231,761	336,013	360,713	497,969

note : It is estimated that the ferry cargo will increase at the same rate as the total general cargo at Apia Port

Table 3.2.2-12 Demand Forecast of Ferry Passengers

(unit : tons)

route	1996	2003	2005	2015
Population forecast	164,600	167,700	168,600	172,400
Apia - Pagopago	12,600	12,837	12,906	13,197
Pagopago - Apia	8,867	10,440	10,938	13,812
Total	21,467	23,277	23,844	27,009

note-1 : It is estimated that the passengers from Apia to Pagopago will increase at the same rate as the population of Samoa.

note-2 : It is estimated that the passengers from Pagopago to Apia will increase at the same rate as the annual average increase rate (+2.36%) of visitors from Amrican Samoa (19,121 in 1989, 21,482 in 1994) .

3.2.3 Ship Traffic Forecast

(1) Cargo Volume Forecast

Cargo volume in target year by cargo type is summarized in Table 3.2.3-1.

Table 3.2.3-1 Cargo Volume in Target Year (ton)

Target / Year / Cargo Type		1996	2003	2015
Inward	Container Cargo	150,569	219,367	331,332
	Non Container Cargo	20,748	24,374	36,814
	Oil	31,899	47,353	55,541
Outward	Container Cargo	13,161	24,521	41,655
	Non Container Cargo	8,895	10,509	13,885
	Oil	6,489	9,889	13,775

(2) Number of Ship's Call

Number of ship's call by ship type is calculated from import cargo volume in target year.

1) Container ship

In this study, the number of ship's call is calculated assuming that a half of increased TEU contributes to increase of ship's call. Therefore, TEUs per ship are assumed to increase as the cargo volume grows in future.

Table 3.2.3-1 shows that container cargo volume increases 1.46 times the present volume in 2003 and 2.20 times present volume in 2015. To carry this volume of cargo, number of container ship increases 1.23 times the present number in 2003 and 1.60 times the present number in 2015.

2) Non-Container Ship

In the future, it is assumed that to carry increasing cargo, number of ship's call will increase and at the same time cargo lot per vessel will increase. The

number of general cargo vessel calls is assumed that the half of the increase of the cargo volume will contribute to the vessel increase as the same as container ship. Table 3.2.3-1 shows that no-container cargo volume increases 1.17 times the present volume in 2003 and 1.77 times in 2015. Corresponding number of non container ship increase 1.09 times the present number in 2003, and 1.39 times in 2015.

3) Tankers

The oil companies plan to increase size of tanker which will carry oil products to Apia Port. Hence, the call of tanker is expected to increase at the same rate as container ship.

4) Cruise Ship

Cruise ship call at Apia Port is 5 to 15 times per year and increasing number of vessels are already cruising in the South Pacific region. The demand for cruising in this region is expected to increase and the Government of Samoa is to promote the tourism.

Therefore, the number of ship calls is assumed to increase at the same rate as container ship.

5) Others

Number of other ship's call is assumed to increase at the same rate as container ship.

Number of ship's call in the target year is shown in Table 3.2.3-2. Present condition in 1996 is averaged from data of 1995-1997 (shown in Table 2.2.3-7(1), Cargo ships less than 1000 GRT are counted as non container ship).

Table 3.2.3-2 Number of Ship's Call in Target Year

Target Year / Type of Vessel	1996	2003	2015
Container Ship	142	175	227
Non Container Cargo Ship (Include Car Carrier)	17	19	24
Tanker	21	26	34
Cruise Ship	13	16	21
Naval Boat	3	4	5
Others	17	21	27
Total	213	261	338

(3) Ship Waiting Time Simulation

Ship waiting simulation is conducted by using computer simulation program to check ship waiting time at present and then to estimate ship waiting time in the future when ship's call will increase according to the cargo forecast.

1) Condition of Simulation

Conditions of simulations are set as below,

a) Ship arrival time is given as the distribution of actual arrival time (shown in Table 2.2.3-4).

b) Ship type and size are given at random following the distributions shown in Table 3.2.3-1 and Table 2.2.3-7.

c) Cargo handling time is assumed as about two third of total port time according to the data of present cycle time of cargo handling measured in this study. In future it is expected to increase, with increase of cargo size per each ship.

d) In future, tankers will berth along the existing berth for discharging bunkering oil to the tank.

e) While, the other ships will stay longer at berth for receive bunkering service. Therefore, port time is expected to increase for bunkering.

f) Two ships can berth at the same time if they are small.

g) Berthing priority is given as below.

First : passenger boat
Ships of the other types are served in order of arrival.

2) Result of Simulation

Results of simulation are shown in Figure 3.2.3-1. Waiting time increases 2.1 times the present value in 2003 and 5.5 times in 2015.

The deterioration survey and structural analysis has revealed that provision of one container berth by either new construction or reconstructing/reinforcing the existing wharf is absolute and urgent necessity. The future conditions of port congestion are analyzed and compared for three cases of

1) one improved existing wharf for all ships,
2) one new wharf for container ships plus one rehabilitated existing wharf for the other ships and
3) one improved existing wharf plus one new wharf both for all ships as below,

Waiting Time per Ship (hour)

	1997	2015
Ship's Call	219 (100%)	338 (154%)
Case 1: 1 Berth		
Waiting Time/Ship	15.4	29.3
Case 2: New & Rehab. Berths		
Waiting Time/Ship	15.4	14.8
Case 3: 2 New Berths		
Waiting Time/Ship	15.4	10.3

Waiting time of ship in Case 1 increases to 1.90 times the present level in 2015, while in Case 2, waiting time remains at the acceptable level of 0.96 times the present level in the same years. Case 3 gives the waiting time much smaller than the present value in both years. Value of berth occupancy in the case of one berth indicates that the port has already reached saturation point of congestion and shall be provided with one container berth and one conventional berth in 2015.

To handle port cargoes of 497,969 tons, twice the present volume forecast in 2015, Case 1 of one container berth will be short of cargo handling capacity. While, calculation for Case 3 of two container berths gives waiting time much shorter than the current level suggesting that the investment is rather abortive.

Idea of Case 2 with, say 1.5 berths, is to make full use of the remaining life of the existing wharf. The existing wharf is, as clarified in corrosion survey and structural analysis, no longer strong enough to carry heavy container handling equipment. However, the wharf can be still serviceable for the other types of cargoes which do not give heavy load to the deck.

Approximately, one third of ships calling Apia Port are non-container carriers. Until the port will require two container berths, the existing wharf can serve for ships other than container carriers.

The serviceable life of the existing wharf can be extended by 18 years with rehabilitation cost of about 1 million Tala. If the wharf is rehabilitated in 2003 it will be serviceable beyond the target year of Master Plan 2015, until 2021. If the rehabilitation is done much earlier the wharf can be serviceable until around 2025.

It is estimated that the port will require two container berths around 2025 and the reconstruction of the existing wharf shall be planned well before expiration of its serviceable life through due consideration of updated information

on port development policies, cargo and ship traffic demand, etc. More detailed consideration of scope and schedule of port development plan is given in the economic analysis this study.

Economic feasibility of scale of berthing facilities is analyzed in detail in Chapter 7.

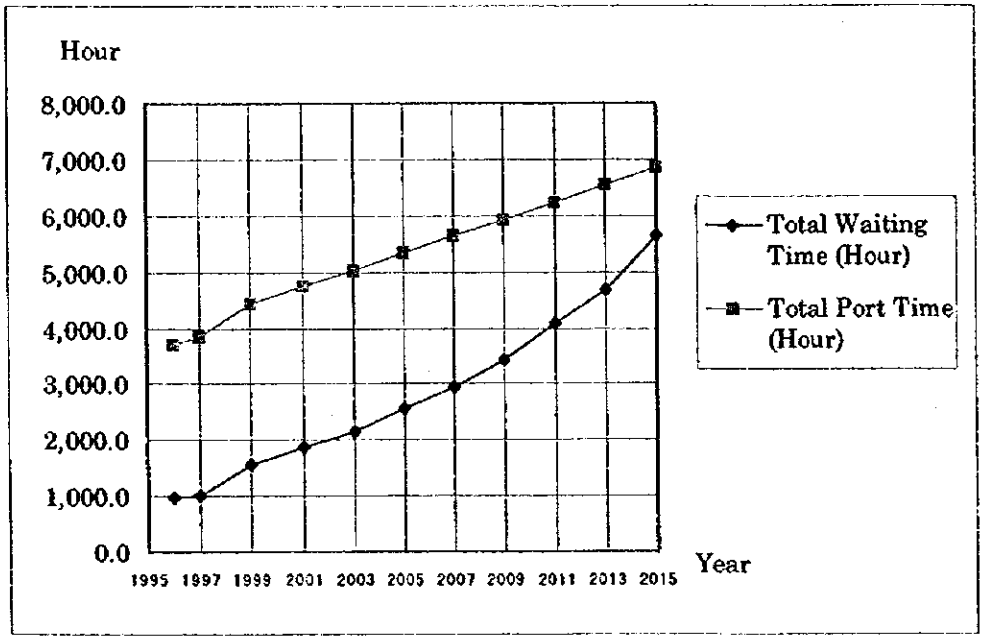


Figure 3.2.3-1 Waiting Time

3.2.4 Required Port Facilities (2015)

The capacity of Apia Port is evaluated from viewpoint of handling future port cargoes, and then improvement of the port facilities such as berth, container yard, open storage yard, sheds, cargo-handling equipment, access road, etc. is planned to meet future traffic demand as shown in Figure 3.2.4-1.

Necessity of improvement for all the port facilities is discussed below and summarized in Table 3.2.4-1.

(1) Dredging of Basin

Through analysis of siltation based on the past bathymetric surveys in the turning and berthing areas and consideration of navigational safety, necessity of the dredging work is determined. Water depth of Apia Bay is reported in the feasibility study done in 1987 to decrease by siltation at the rate of 7.5 cm/year. Analysis of sounding survey carried out in this study gives a smaller siltation rate of 4.1 cm/year than the previous estimate of 7 cm/year.

The turning basin is designed to have a diameter of two times the maximum length of ship which is assumed as 200 m. Water depth along the line perpendicular to the center of the wharf is estimated to decrease to about 9.5 m in 2015. This siltation will endanger safe ship maneuvering and the dredging work shall be planned. Volume of soil to be dredged in this area in 2015 is estimated at about 210,000 m^3.

(2) Breakwater

Breakwater has been already constructed and the damages caused by cyclones have already been rehabilitated. The berthing area in front of the new wharf is not sheltered enough for efficient cargo handling operation. The existing breakwater is planned to be improved to reduce transmitting waves in the phased improvement plan.

(3) Existing Wharf

According to the results of deterioration and corrosion survey and to meet the increasing traffic demand, adequate repair work to the existing wharf is required for conventional cargo handling. With an adequate repair work, a service life of the wharf is extended till several years after the target year of the Master Plan.

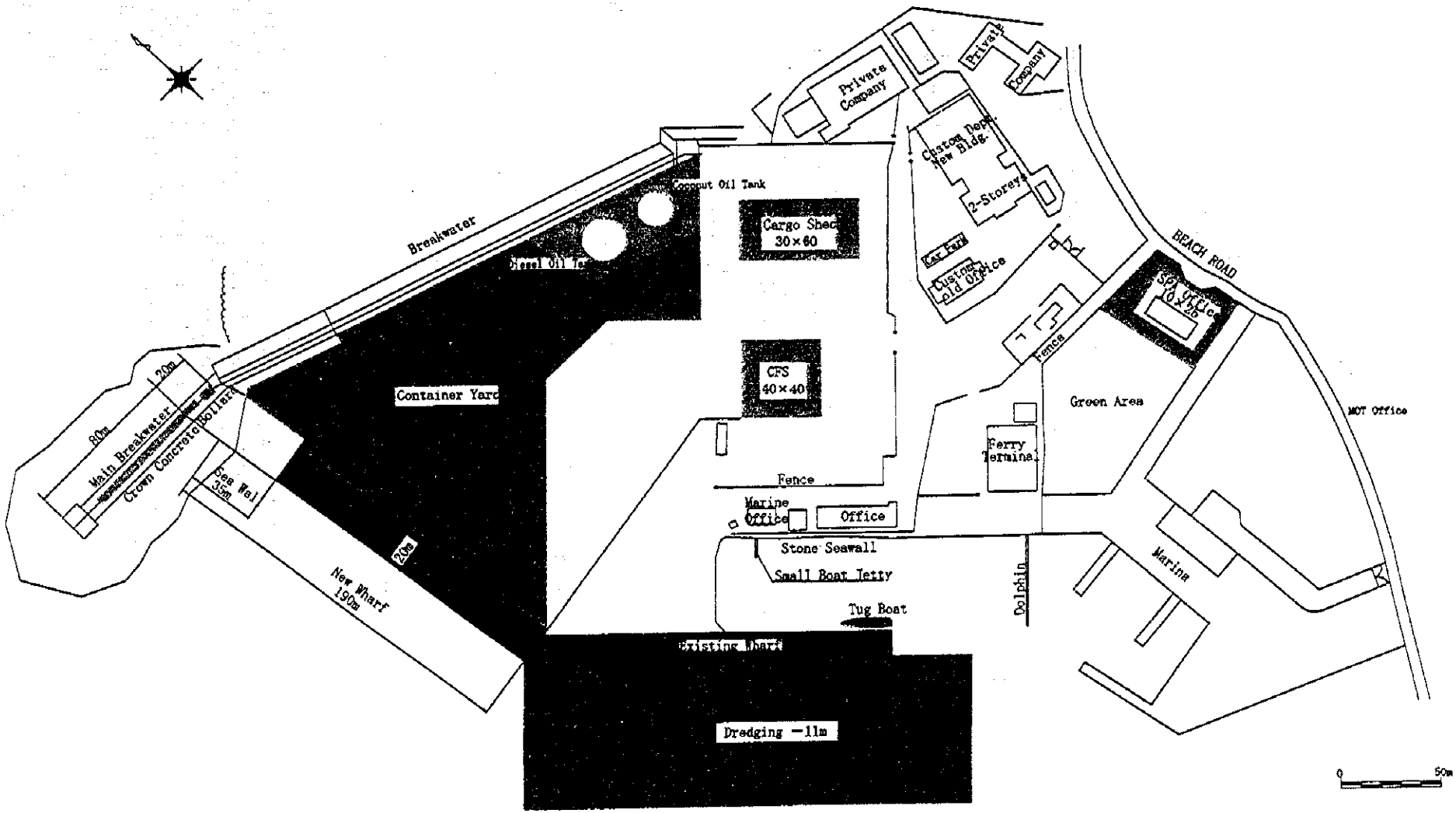
(4) New Wharf

Construction of a new wharf is planned in the phased improvement plan because of the limitation of service life extension by repair or reinforcement of the existing wharf as well as to cope with increasing port cargoes which can not be handled with the only one existing wharf.

Table 3.2.4-1 Port Facilities Planned in Master Plan, 2015

Port Facilities included in Master Plan '87			Implemented in the Subsequent Grant Aid Projects			Selection of Facility in this Study	
Function	Facility	Required Work	Apia Port Develoment Project in 1988	Cyclone Damage Rehabilitation Project in 1990	Cyclone Damage Rehabilitation Project in 1992	Facilities to be Improved in Master Plan	Facilities to be Improved in Short Term Plan
Sea Access to Port	Anchorage, Channel and Turning Basin	Dredging	×	×	×	○	×
	Berthing Area	Dredging	×	×	×	○	×
Wave Shelter	Breakwater	New Construction	○	×	Rehabilitation	×	Crown Concrete Block
Berthing	Existing Wharf	Rehabilitation	○ Corrosion Protection	○ Fender Repair	○ Fender/Curb Repair	×	○ Corrosion Protection /Reinforcement
	New Wharf	New Construction	×	×	×	×	○
	Ferry Wharf	New Construction	○	×	Rehabilitation	×	Rehabilitation
	Small Boat Wharf	New Construction	×	×	×	○	×
	Tanker Bouy	Relocation	×	×	×	○	×
Storage and Maintenance	Open Storage	Pavement	○ Existing Yard	×	×	×	×
	Container Yard	Pavement	×	×	×	○	○
	CFS	New Construction	×	×	×	○	×
	Maintenance Shop	New Construction	×	×	×	○	×
	Cargo Shed	Rehabilitation	×	Roof/Wall Repair	Repair/Removal Concrete Pavement	○ Removal & New Construction	×
	Oil Tanks	Relocation	×	×	×	○	×
Land Access to Port	Access Road	Gate Upgrade	×	×	×	○	×
Passenger Transport	Ferry Term'l Buildi	New Construction	○	×	Rehabilitation	×	×
Administration	Administration Offi	New Construction	×	×	×	×	○
	Marine Office	New Construction	×	○	×	×	×
Port Service	Tug Boat	Purchase 2 Boats	○ 1-Boat	×	×	×	○ 1-Boat
Aid to Navigation	Beacon	Renovation	×	×	○	×	×
	Light House	New Construction	○ Tip of Breakwater	×	Rehabilitation	×	×
Marina	Pontoon	New Construction	×	×	×	○	×
	Club House	New Construction	×	×	×	○	×
	Anchorage Area	New Construction	×	×	×	○	×
Landscaping	Green Area	New Construction	×	×	×	○	×

Figure 3.2.4-1 Master Port Development Plan, 2015



(5) Ferry Terminal

Ferry terminal has been implemented in the previous project.

(6) Small Boat Jetty

A small boat jetty is required in front of the existing marine office for efficient port services to be rendered by tug boats and pilot boats.

(7) Mooring Buoy for Tanker

Relocation of the mooring buoys for tanker is necessary to secure navigational safety in the channel and turning basin.

(8) Open Storage

A part of the existing paved container yard is converted to open storage area.

(9) Container Yard

A container yard is required at the back of the new wharf. Layout of the container yard is different from the layout proposed in the feasibility study in 1987 due to the construction of the breakwater on the reef flat located along the north boundary of the port area.

(10) Container Freight Station (CFS)

CFS is planned together with a cargo shed to replace the existing sheds.

(11) Maintenance Shop

Maintenance shop with adequate capacity for local needs is planned.

(12) Shed

A cargo shed are planned in the same manner of the CFS.

(13) Oil Tanks

The existing diesel and coconut oil tanks located in the center of the planned new container yard are planned to be demolished and the new tanks be constructed in the innermost part of the container yard for safe and smooth container handling operation. The diesel oil tank is reconstructed with the storage capacity of 3000tons double the present capacity while coconuts oil tank with 1500tons same as the present capacity.

(14) Access Road

A minor renovation to the existing gate is necessary with a gate house located in the center of the access road separating in and out traffic for smooth traffic flow and security purposes.

(15) Ferry Terminal

Ferry terminal has already been implemented.

(16) Administration Office

A new office is necessary to accommodate Port Authority Staff and planned in the phased improvement plan. Marine office has already been constructed.

(17) Tug Boat

One tug boat has already been granted in the previous project. Introduction of two tug boats was proposed in the JICA feasibility study in 1987. Introduction of the second tug boat with the same specifications as the previous one is planned in the phased improvement plan to replace the existing tug boat which was purchased in 1972.

(18) Navigation Aids

Navigation aids have already been improved.

(19) Marina Facilities

Because of the higher priority of tourism development in the Government policy, marina facilities are included in the JICA feasibility study in 1987. The marina facilities are recommended as planned previously.

(20) Green Area

A green area in the port area is planned in the master plan.

(21) Other Facilities

Currently, stevedoring machinery and equipment are owned and operated by private sectors such as Pacific Forum Line, Betham Brothers Enterprise, Transam and Apia Haulage. This situation is expected to continue even after establishment of Port Authority and purchase of cargo handling equipment is not included in this plan.

3.3 Design of Main Facilities

3.3.1 Face Line of New Wharf

The three alternative face lines shown in Figure 3.3.1-1 are examined from the viewpoint of total volume of dredging and backfilling works, calmness of berthing area, ship maneuvering, easiness of construction work, construction period and construction cost.

Line A : Line A is proposed in Master Plan in 1987. Since this face line crosses reclamation and coral flat area, the volume of hard coral excavation is lager than other lines. Calmness of water area is front of the existing breakwater is secured by improving the breakwater impermeable. Since the existing breakwater is close to the new wharf, careful maneuvering is necessary.

Line B : Line B is shifted 20m offshore from Line A to reduce volume of hard coral excavation. Calmness of water area in front of the existing breakwater is secured by improving the breakwater impermeable. Since the existing breakwater is close to the new wharf, carefully maneuvering is necessary. Since seawall is constructed in front of coral drop off, construction work is easy.

Line C : Line C is shifted 30m offshore from Line B to avoid hard coral excavation. The volume of backfilling is two times the other lines. In this line, water area in front of the new wharf is less sheltered from waves than other lines. The countermeasure against wave overtopping is necessary in cyclone season. Since the existing breakwater is close to the new wharf, careful maneuvering is necessary. Since the subsoil is composed of soft silty layer, the surface of backfilling is expected to be subject to differential settlement.

The comparison is summarized in Table 3.3.1-1 and Line B is selected as the best alignment.

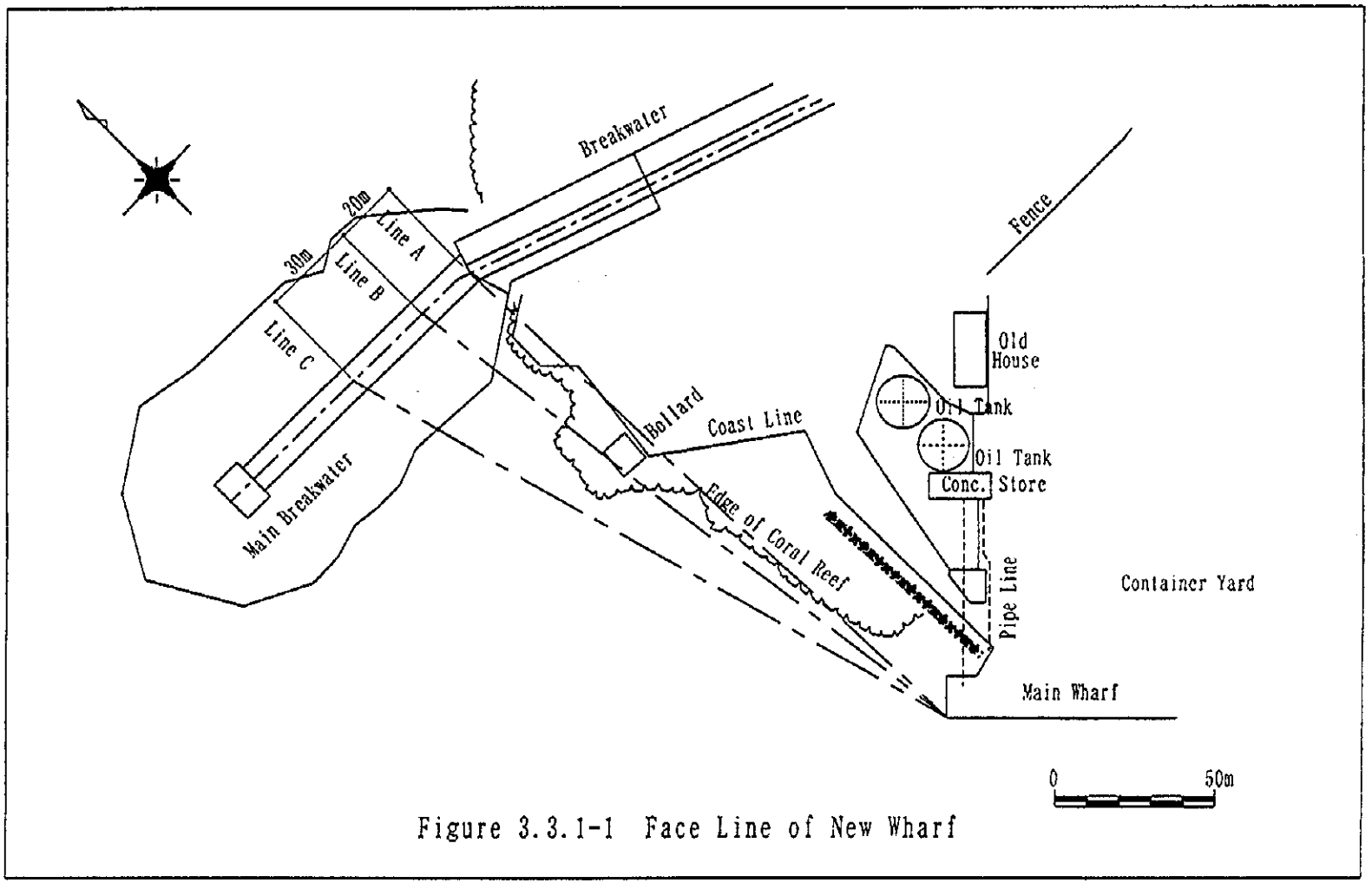


Figure 3.3.1-1 Face Line of New Wharf

Table 3.3.1-1 Comparison of Alternative Face Lines

Comparison item	Line A	Line B	Line C
Volume of dredging (m^3)	32,000	15,000	2,000
Volume of backfilling (m^3)	23,000	28,000	53,000
Calmness of berthing Area	○	△	×
Maneuvering of ship	△	△	△
Easiness of construction Work	×	○	×
Construction period	△	○	×
Construction cost ratio to Line B	1.1	1.0	1.2
Total Evaluation	2	1	3

3.3.2 Existing Wharf

According to the results of deterioration and corrosion survey, adequate rehabilitation work to the existing wharf is planned. The alternative plans are designed for different load conditions by cargo type and service life as presented in Section 4.3.2.

3.3.3 Other Facilities

(1) Breakwater

The faceline of the new wharf is shifted toward the channel due to existence of hard coral layer. Therefore, the breakwater is improved to reduce transmitting waves.

(2) Container Yard

1) Existing Yard

Existing Container Yard was planned by the Feasibility Study in 1987 as follows.

$$N = \frac{12{,}900 \times 0.9 \times 15 \times 1.1}{365} = 525 \text{ TEU}$$

where
N = number of dwelling containers at the same time
12,900 = yearly throughput in 2005 (TEU)
Container cargo 194,200 tons, 15 tons per TEU
0.9 = ratio of containerization
15 = dwelling time (days)
1.1= peak factor
365 = days per year

At present, existing container yard is 16,900 m^2 including staging area behind of the existing wharf.

13,000 (existing yard) + 3,900 (staging area) = 16,900 m^2

2) Required Area for Container Yard in 2015

Required container yard in 2015 is calculated to be 21,000 m^2 as the same manner used above.

$$N = \frac{22,100 \times 0.9 \times 15 \times 1.1}{365} = 899 \text{ TEU}$$

Where,
22,100 = yearly throughput in 2015 (TEU)
Container cargo 331,332 tons, 15 tons per TEU

(3) CFS

1) Width

The width of CFS was calculated to be 30 m in the Feasibility Study in 1987 as follows.

$$W = \frac{3.5 \times C}{V}$$

where
W = width of CFS
C = LCL cargo per day
Container cargo in and out is 242,400 tons per year
LCL ratio is 40 %
V = cargo sorting capacity per bay per day
2.5 TEU

3.5 = width of each bay

$$W = \frac{3.5 \times 242{,}400 \times 0.4}{300 \times 2.5 \times 15} = 30.2 \text{ m}$$

300 : working days per year

The width of CFS is calculated to be 30 m for LCL cargo volume in 2015 as follows.

$$W = \frac{3.5 \times 372{,}997 \times 0.25}{300 \times 2.5 \times 15} = 29.0 \text{ m}$$

C : 373,997 t = 331,332 t (in)+ 41,665 t (out)
LCL ratio will decrease to 25 % by the target year

The width of CFS is adopted to be 40 m considering the efficiency of cargo handling in CFS.

2) Depth

Though the depth of the CFS was set at 40 m in the Feasibility Study in 1987, in this study the depth is set at 40 m.

(4) Shed

Required floor area of shed is estimated to be 1,800 m^2 (30 m x 60 m) storing the imported cargoes such as cement, bulk cargo and container cargo stored for a long time as follows. Total of the imported cargoes stored in shed is estimated to be about 2,000 tons.

$$\frac{2{,}000}{2.5 \times 0.5} + 200 = 1{,}800 \text{ m}^2$$

where
2.5 : unit weight of cargo (t/m^2)
0.5 : ratio of cargo occupied
200 : office and forklift (m^2)

(5) Maintenance Shop

The maintenance shop should have sufficient space to repair one or two containers. The required space of the maintenance shop is about 200 m^2.

(6) Administration Office

The required administration office for the new Samoa Ports Authority is calculated as follows.

$A = a \times n = 450\ m^2$

where
A = floor area for the office
a = floor area per person (= 15 m^2)
n = number of persons in the office (= 30 staffs)

(7) Tug Boat

Normally two tug boats are necessary for 10,000 GRT ship without bow thruster and one for ship with bow thruster. Tug assistance to ships calling the port is indispensable to secure safe navigation.

Working records in 1997 of two tug boats, Tafola and Pualele are presented in Appendix 10. According to these records, the ratio of tug assistance for no bow thruster ship which is more than 10,000 GRT are 61 %. Therefore, introduction of one tug boat is planned to improve navigational safety.

The specification of the tug boat is the same size of Tafola as follows.

Tonnage	:	120 GT
Engine Power	:	1,600 HP (800 HP x 2)
Propeller	:	Twin

(8) Ferry Terminal Wharf

A dolphin supporting a gangway damaged by an impact of a ship moored at cyclone time. The dolphin is repaired and the gangway is widened for passenger traffic.

The concrete slope of the wharf is abraded by movement of a ramp of a ferry boat. The concrete slope damaged is removed and repaired.

3.4 Construction Plan and Cost Estimation

This section presents the construction plan and the cost estimation for the master development plan of Apia Port.

3.4.1 Construction Plan

The construction quantities of facilities of Apia Port are shown in Table 3.4.1-1. Port facilities proposed in alternative plan 1 in Section 4.4.1 are included in the table.

Table 3.4.1-1 Port Facilities and Construction Quantities

	Facility	Unit	Quantity	Remarks
1.	Dredging	m^3	210,000	-11m depth in turning and berthing area
2.	Improvement of Breakwater	m	70	Placing crown concrete blocks
3.	Rehabilitation of Existing Wharf	m	185	Corrosion protection to existing 307 piles
4.	New Wharf	m	190	Including seawall 35m
5,	Minor Repair Works	Ls	1	Repair of ferry wharf and ferry dolphin
6.	Small Boat Jetty	m	20	Mooring pilot boats
7.	Relocation of Mooring Buoy for Tanker	Ls	1	Three mooring buoys and a manifold for tanker
8.	Container Yard	m^2	21,000	Concrete Pavement
9.	Renovation of Existing Gate	Ls	1	Renovation of existing gate and separating in and out traffic
10.	Marina	m^2	10,000	Pontoon, clubhouse and basin
11.	Green Area	m^2	4,500	
12.	CFS	m^2	1,600	40m x 40m
13.	Shed	m^2	1,800	30m x 60m
14.	Maintenance Shop	m^2	200	
15.	Coconut Oil Tank	Ls	1	Reconstruction of coconut oil tank and diesel oil tank
16.	Administration Office	m^2	450	Accommodation of new Apia Ports Authority
17.	Tug Boat	No	1	1600 HP

3.4.2 Cost Estimation

The Construction cost of the master development plan of Apia Port is presented in Table 3.4.2-1. The total project cost is estimated at about 93 million Tala. The estimate conditions are described in Section 4.4.2.

Table 3.4.2-1 Construction Cost of Master Plan

No	Facility	Unit	Quantity	Unit Cost (Tala)	Construction Cost (Tala thousand)		
					Total	Foreign Portion	Local Portion
1	Dredging	m^3	210,000	50	10,500	8,400	2,100
2	Improvement of Breakwater	m	70	21,600	1,511	907	604
3	Rehabilitation of Existing Wharf	m	185	15,450	2,858	2,715	143
4	New Wharf	m	190	162,200	30,822	25,188	5,634
5	Minor Repair Works	Ls	1		409	245	164
6	Small Boat Jetty	m	20	3,300	70	60	10
7	Relocation of Mooring Buoy for Tanker	Ls	1		440	374	66
8	Container Yard	m^2	21,000	450	9,450	2,835	6,615
9	Renovation of Existing Gate	Ls	1		220	44	176
10	Marina	m^2	10,000	420	4,200	1,260	2,940
11	Green Area	m^2	4,500	160	720	144	576
12	CFS	m^2	1,600	3,400	5,100	1,530	3,570
13	Shed	m^2	1,800	2,300	3,450	1,035	2,415
14	Maintenance Shop	m^2	200	2,800	560	168	392
15	Oil Tanks	Ls	1		810	324	486
16	Administration Office	m^2	450	3,450	1,553	450	1,103
17	Tug Boat	No	1		7,063	7,063	0
	Sub-total				79,736	52,742	26,994
18	Engineering Services (No.1 to No.17) x 0.09	Ls	1		7,176	4,111	3,065
19	Physical Contingency (No.1 to No.11) x 0.10	Ls	1		6,120	4,217	1,903
	Sub-total				13,296	8,328	4,968
	Grand Total				93,032	61,070	31,962

1 Tala = 0.3280 US Dollar = 44.95 Japanese Yen

CHAPTER 4

PHASED IMPROVEMENT PLAN

CHAPTER 4 PHASED IMPROVEMENT PLAN

Principal policies of the Phased Improvement Plan are set up in line with the development direction of the Master Plan.

4.1 Improvement Policies

Principal policies of formulating Improvement Plan are set as follows,

1) To urgently relieve the port from serious damages or even collapse of the existing wharf and eventual inefficient operation or closure of the port
2) To recover a normal and efficient port operation free from a load limitation to the wharf
3) To provide appropriate facilities for successful launching of the planned port authority for efficient and smooth port management
4) To secure safety of ship maneuvering in the turning basin and cargo handling operation in the yard
5) To maintain the present participation of private sector in stevedoring service for efficient port operation.

It is clarified through examination to this point that the deteriorated existing wharf urgently needs to be replaced with a newly constructed wharf or to be reinforced/reconstructed for safe container handling operation.

4.2 Phased Improvement Plan

4.2.1 Required Port Facilities

The traffic demand of cargo and passenger is forecast for the Improvement Plan and to meet the traffic demand, the required port facilities are determined in the light of development direction of Master Plan. In determining priority to each facility in the phased improvement plan, following technical and economical considerations have been given as detailed below;

(1) Dredging of Channel and Turning Basin

According to the results of the bathymetric survey in the existing approach channel and turning and berthing areas, the minimum water depth is about 9 m. An average arrival draft of ships is observed considerably less than a full draft. According to the interviews to shipping agents and the harbour master, the water depth in the navigation area is considered to allow safe ship maneuvering. The existing water area allows safe ship navigation with appropriate clearance, and therefore, necessity of the basin dredging is considered not to be urgent.

Dredging works in the approach channel and turning basin are not planned in the phased improvement plan.

(2) Breakwater

The faceline of the new wharf is shifted toward the channel due to existence of hard coral layer. The new wharf is exposed to waves transmitting through the breakwater to the extent that a ship berthing alongside can not work more than 20 days a year. Extension of the breakwater shall be considered to secure the calmness in front of the wharf. However, the extension of the breakwater interfere with turning and navigation of large tankers and other ships along the channel as illustrated in Figures 4.2.1-1 to 4.2.1-4. Also, the extension of the breakwater needs the same high construction cost. Therefore, the extension of the existing breakwater is not proposed in the phased improvement plan, and instead placing of crown concrete block on top of the rubble mound of the existing breakwater is planned to reduce transmitting waves.

(3) Existing Wharf

Based on the results of corrosion/deterioration survey and structural analysis, the existing wharf is recommended to be rehabilitated with adequate anti-corrosion measures to extend service life for ships handling conventional cargoes other than container vessels. The existing wharf shall be used by such ships as cruise ship, copra boat, car carrier, local cargo ship, diplomatic ship, yacht, fishing boat, etc. after completion of the new wharf.

(4) New Wharf

A new wharf is necessary for safe and efficient container cargo handling operation and proposed to be constructed extending from the outer corner of the existing wharf to the existing breakwater. There exists a hard coral layer along the planned faceline of the new wharf and alternative improvement plans are proposed for economical and technical comparison. A steel pipe pile bulk head type is preferable in consideration of soil conditions at the proposed site.

(5) Ferry Terminal Wharf

A dolphin supporting a gangway is damaged by an impact of a ship moored at cyclone time. To meet the requirement of a new ferry boat due at the end of 1998, the gangway shall be widened for passenger traffic.

The concrete slope of the wharf is abraded by movement of a ramp of a ferry boat. Minor repair works are required for these damages.

(6) Small Boat Jetty

A small boat jetty is included in the Master Plan.

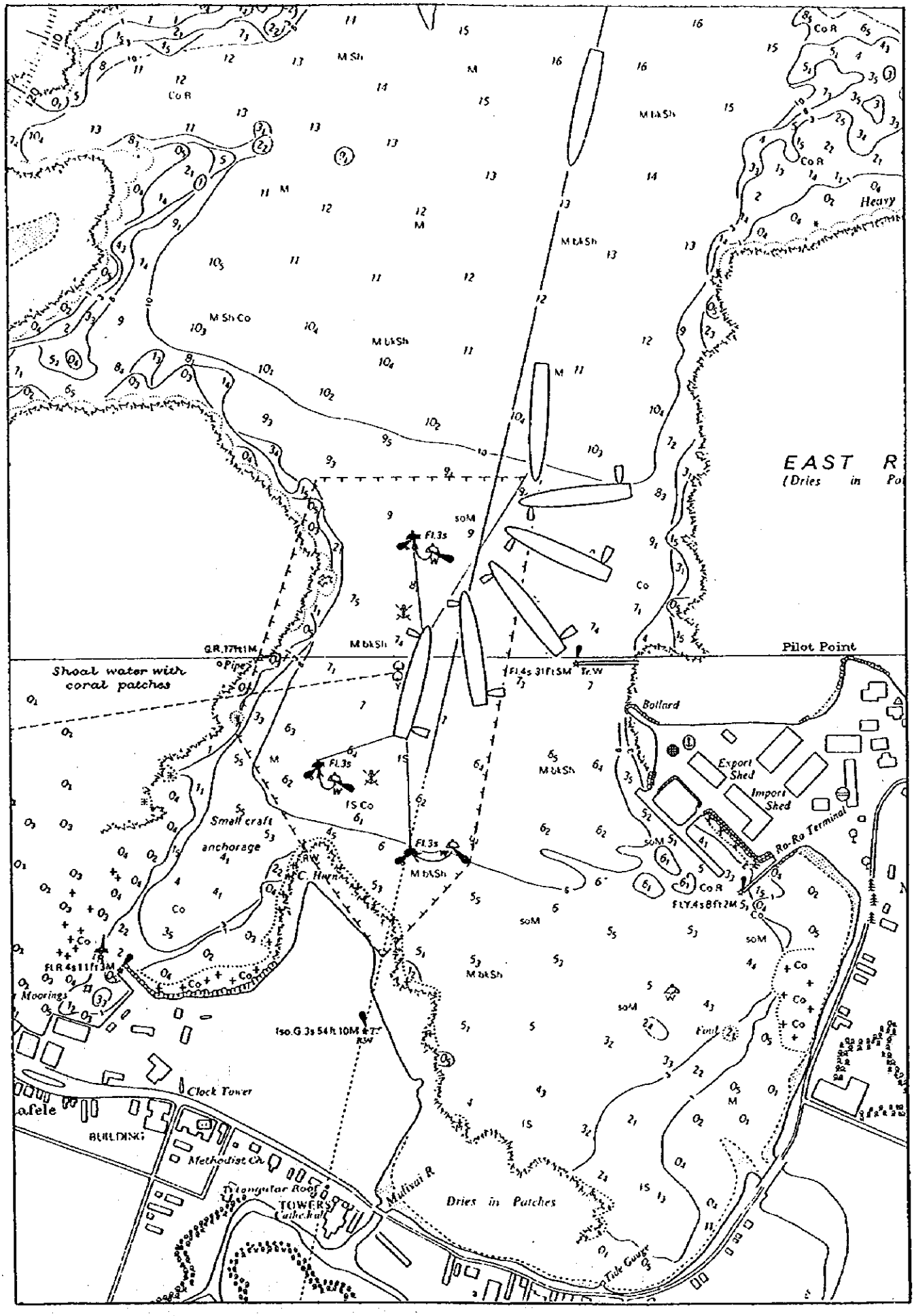


Figure 4.2.1-1 Ship Maneuvering, Tanker LOA 176m

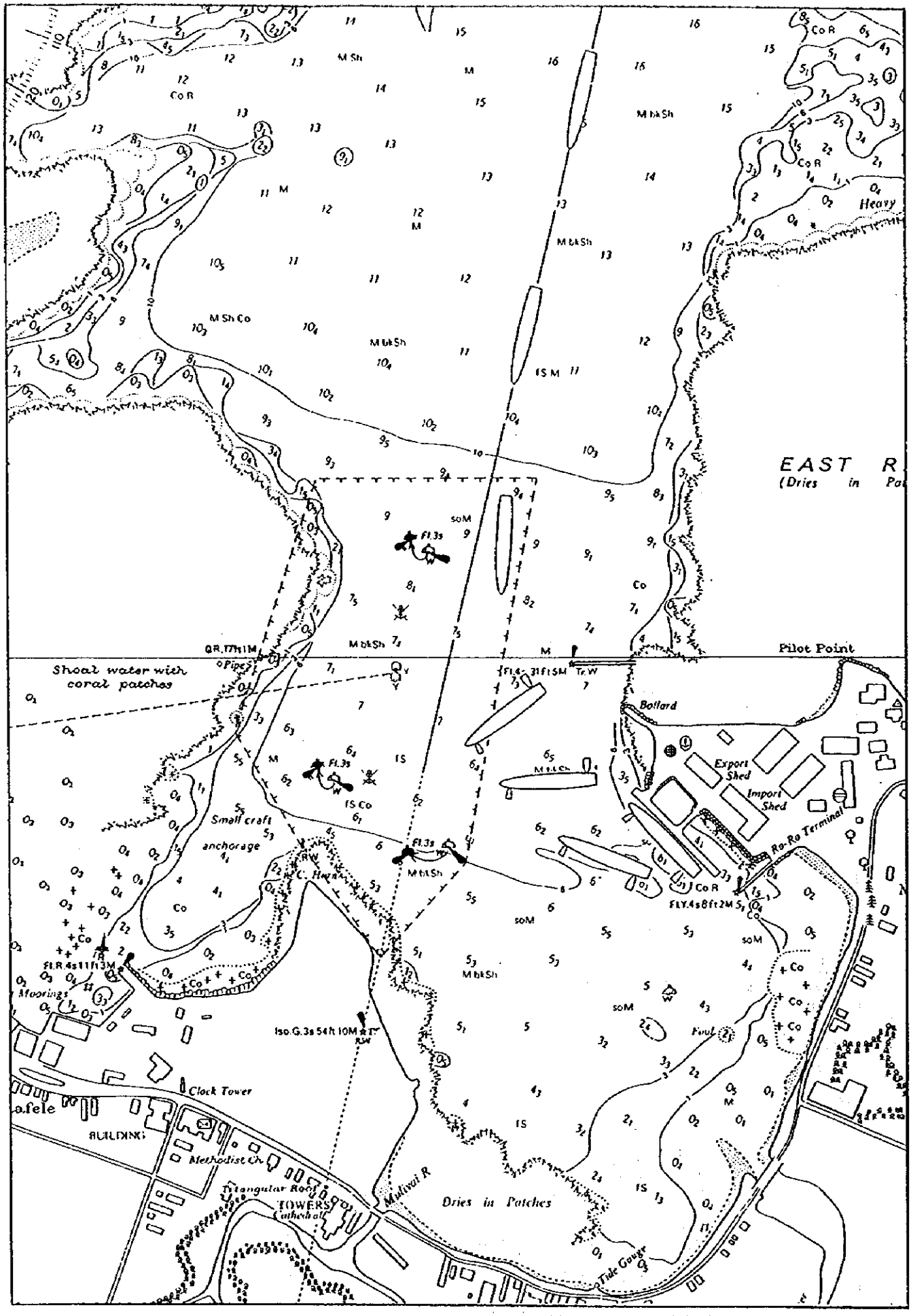


Figure 4.2.1-2 Ship Maneuvering, Container Carrier LOA 155m

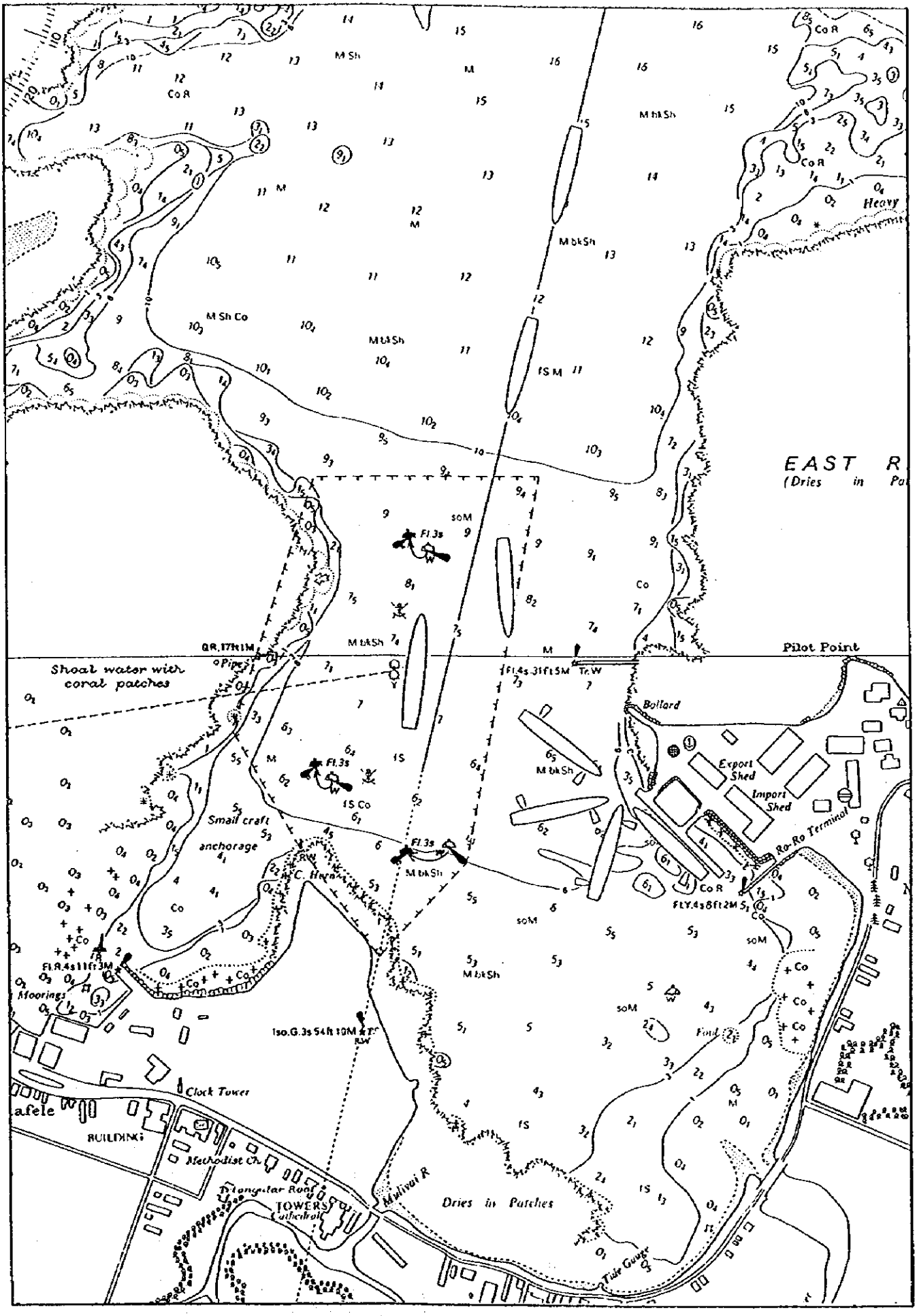


Figure 4.2.1-3 Ship Maneuvering, Container Carrier LOA 155m (when a tanker moored at buoy berth)

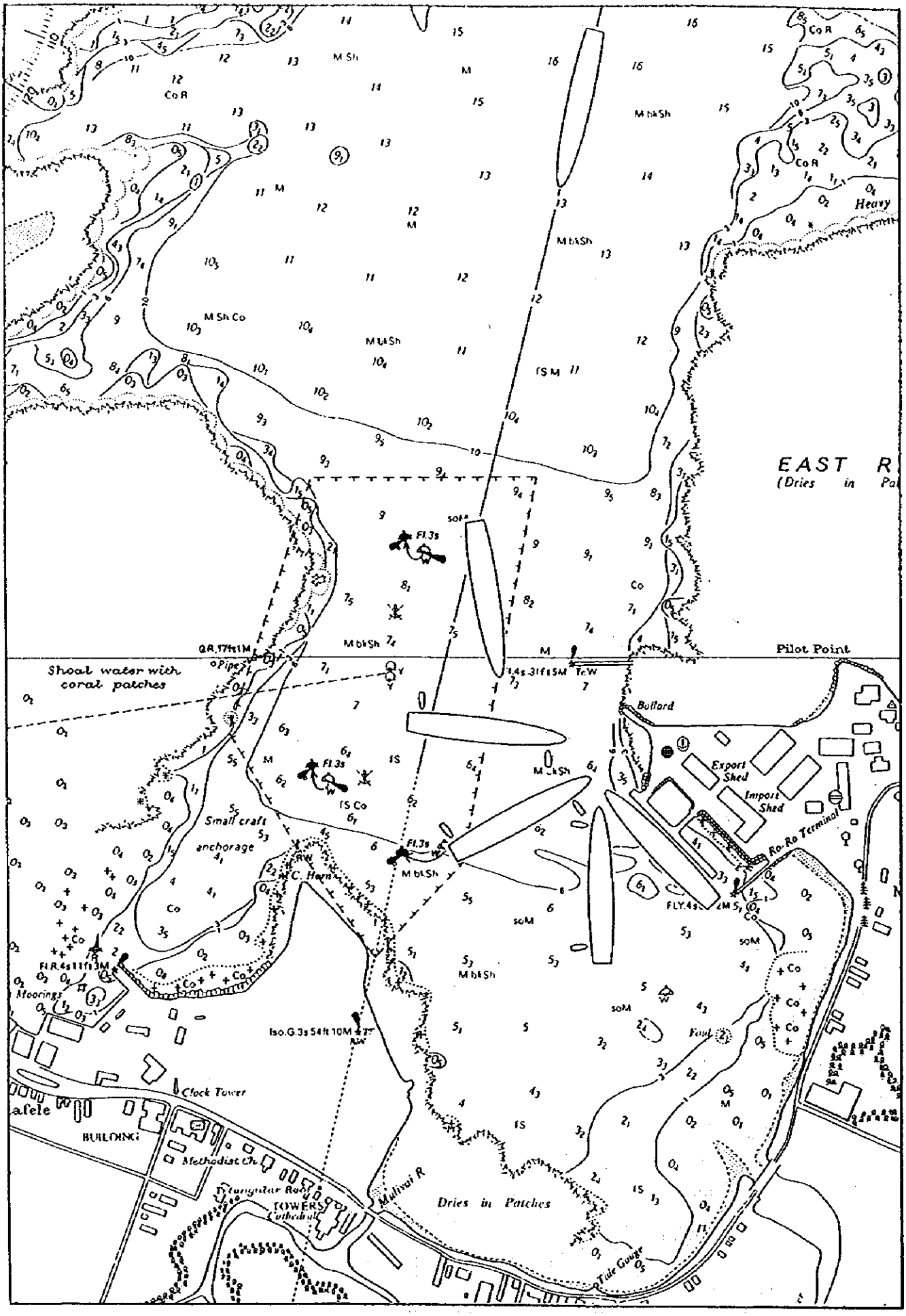


Figure 4.2.1-4 Ship Maneuvering, Cruise Ship LOA 240m

(7) Mooring Buoy for Tanker

Tanker buoys owned by private sector do not seriously interfere with navigation of ships in the channel and their relocation is not planned in the phased improvement plan.

(8) Staging Area

The area at the back of a new wharf is planned to be concrete paved for providing a staging area as described in the previous chapter.

(9) CFS

Volume of container cargo is not large enough to justify a full scale container freight station and is not planned in the phased improvement plan.

(10) Maintenance Shop

Full maintenance and repair works to containers are not proposed to be done in Apia Port and a maintenance shop is not planned in the phased improvement plan.

(11) Shed

Minor repair works to the existing sheds are necessary to their rooves, doors and walls to prevent rainwater leakage.

(12) Oil Tanks

The existing two tanks are located almost at the center of the container yard of a new wharf and seriously interfere with a heavy yard traffic. The tanks are planned to be demolished and newly constructed at the innermost part of a container yard in the Master Plan.

(13) Access Road

Improvement of the entrance gate and access road is planned in the Master Plan.

(14) Ferry Terminal Building

The existing facilities are enough for ferry passenger and cargo traffic and no facility is proposed in the phased improvement plan.

(15) Administration Office

The new Samoa Ports Authority will hold about 30 staff working in a main office as detailed in Chapter 5 and for convenience and efficiency of their works a new office building is an absolute necessity. An area near the existing Ferry Terminal Building is proposed as a site for the new office. For a transition period, the existing MOT office can be temporarily used.

(16) Marine Office

The existing office is enough to house staff working in Marine Division and no additional office space is required. A minor repair work to the existing building to prevent rainwater leakage is required.

(17) Tug Boat

The specification of the existing two tug boats are as follows;

Name	Year built	Capacity
Tafola	1991	1600 HP
Pualele	1972	425 HP

The engine of Pualele was seriously damaged in February 1987 and after repair, her horse power is estimated to have reduced down to about half with bollard pull of 2 - 3 tons. Pualele has been serving for 26 years since her purchase in 1972 and has already finished an economic service life. A new tug boat with the same specification as Tafola replacing Pualele is urgently required.

Turning and berthing water area in Apia Port is wide and not much congested, therefore, combination of Tafola and Pualele can narrowly maneuver the ships calling the port. Normally, two tugboats are necessary for 10,000 GRT ship without bow thruster and one tugboat for ship with bow thruster. Tug assistance to ships calling the port is indispensable to secure safe navigation as illustrated in Figures 4.2.1-1 to 4.2.1-4.

(18) Navigation Aids

Any additional navigation aids are not necessary nor proposed.

(19) Marina Facilities

All the facilities related to a marina are proposed to be constructed in Master Plan and are not included in the improvement plan.

(20) Other Facilities

There are cases where a stevedoring operation is done by a port authority, however the current situation in Apia Port is rather to continue the present system of private sector participation. Encouraging private sector participation in port operation with their own cargo handling equipment is the intention of Ministry of Transport.

Through consideration on urgency and importance of improvement to all the above facilities, major facilities to be improved in the phased improvement plan are selected to include 1) the existing wharf, 2) a new wharf, 3) a breakwater, 4) pavement of staging area, 5) SPA office building, 6) a tug boat and 7) miscellaneous works.

4.2.2 Alternative Plans of Berthing Facility

Improvement plan include major components of wharf, breakwater, staging area, office building, tug boat and minor works. Three alternative plans to improve berthing capacity are proposed and compared. Such other facilities as office building, tug boat and minor works are commonly included in all the alternative plans. The alternative phased improvement plans are summarized in Table 4.2.2-1. Figures 4.2.2-1 to Figure 4.2.2-3 show layout of port facilities of each alternative plan.

The scope and layout of the improvement plans are planned in line with the Master Plan.

Table 4.2.2-1 Alternative Phased Improvement Plans

Facility	Improvement Work	Plan 1 New Wharf Construction	Plan 2 Reconstruc-tion	Plan 3-1 New Piles + Reinforce-ment	Plan 3-2 Replacement of All piles
Existing and New Wharves Alternative					
Existing Wharf	Anti-corrosion & Reinforcement	O			
	Reconstructed in present place		O		
	Complete Rehabilitation			O	O
New Wharf	Extended from the existing wharf	O			
	Not constructed			O	O
Other Facilities					
Breakwater	Placing Crown Concrete Block	O	×	×	×
Staging Area	Pavement	O	×	×	×
Oil Tanks	Demolition/Reconstruction	×	×	×	×
SPA Office	New Construction	O	O	O	O
Tug Boat	New Boat, 1 No.	O	O	O	O
Others	Miscellaneous Repair Works	O	O	O	O

Figure 4.2.2-1 Alternative Improvement Plan 1

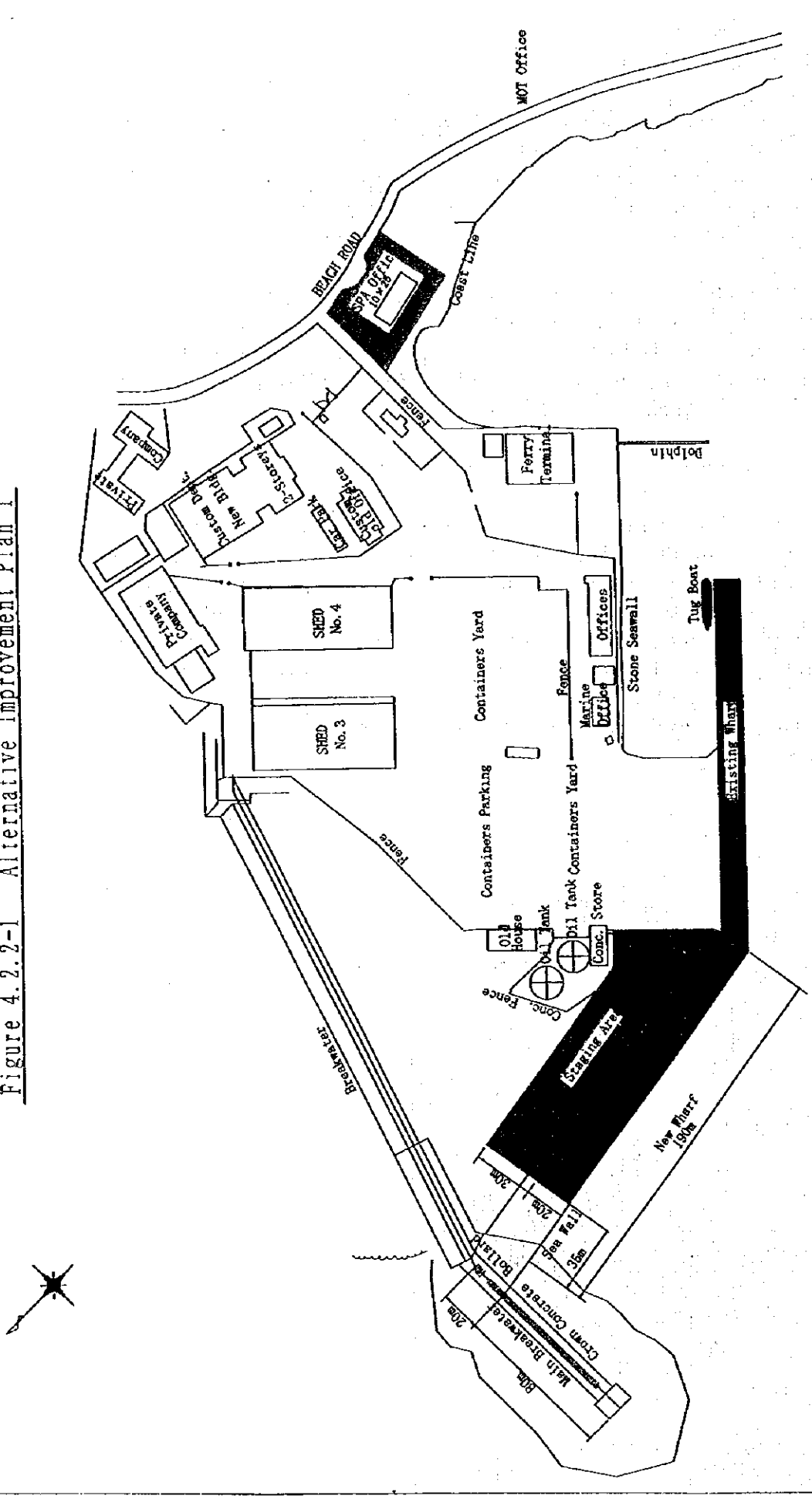


Figure 4.2.2-2 Alternative Improvement Plan 2

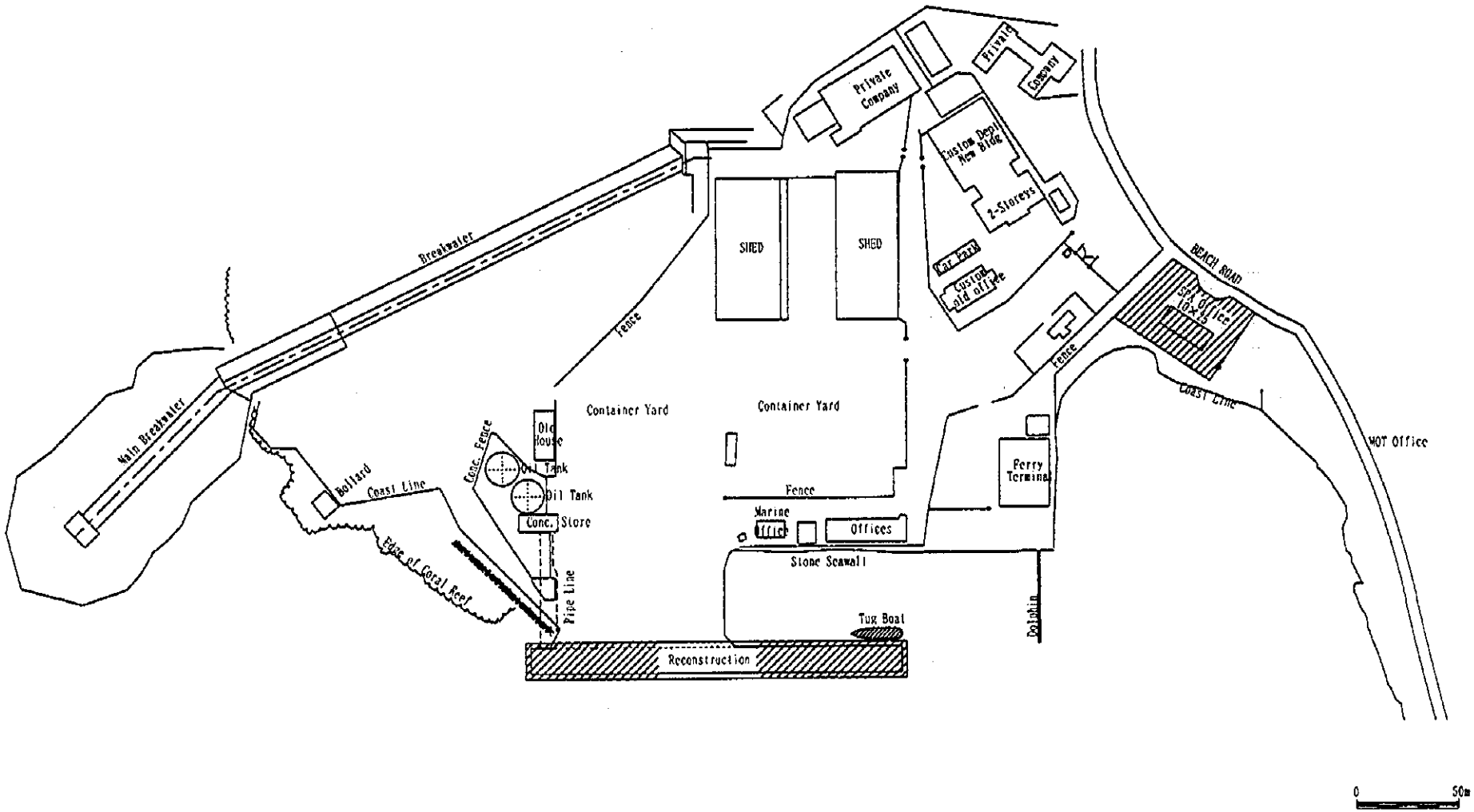
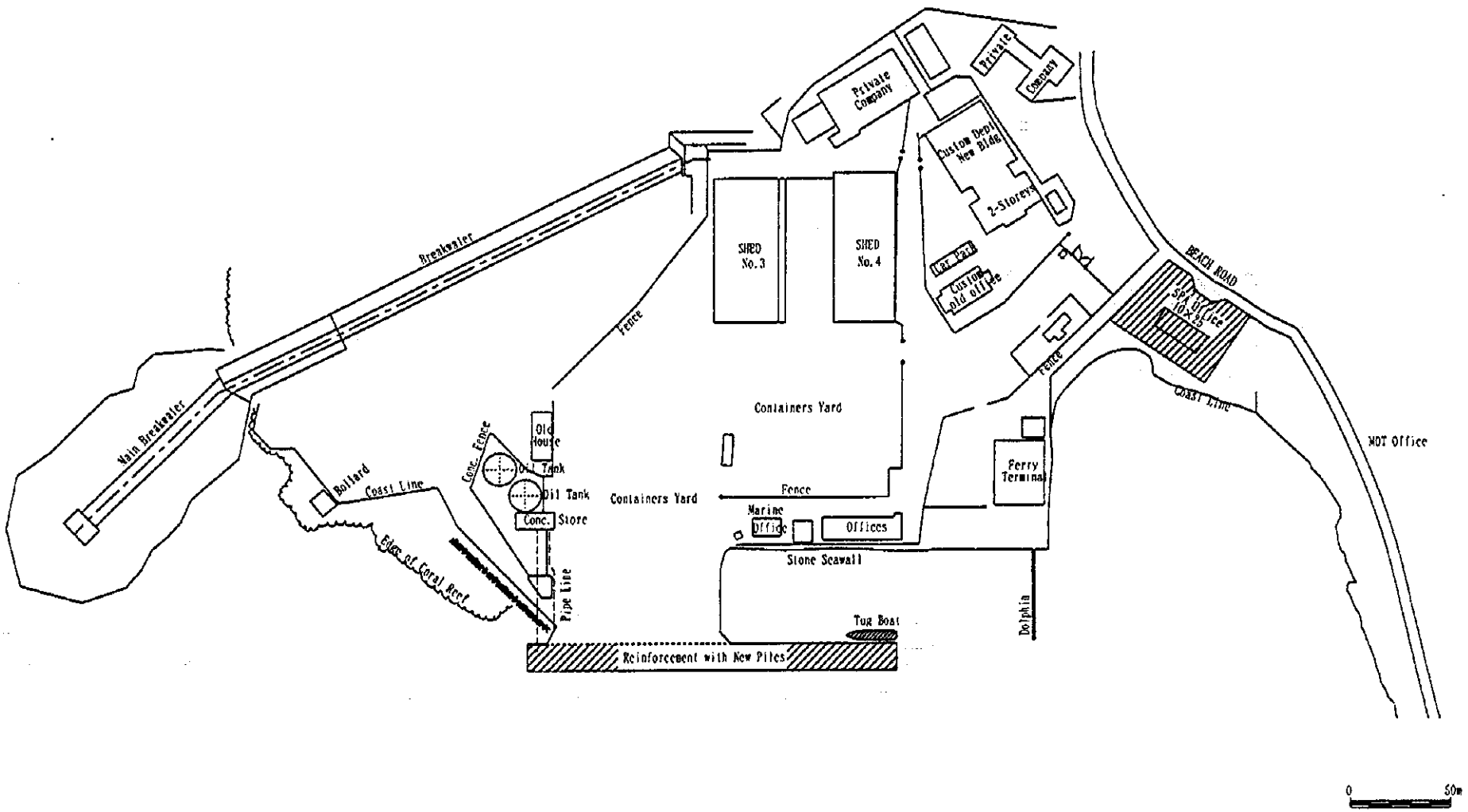


Figure 4.2.2-3 Alternative Improvement Plan 3



Three alternative plans are compared as below,

(1) Alternative Plan 1

This plan is to construct a 190m long new wharf (155m quay and 35m seawall) extending from the outer corner of the existing wharf to the landward end of the existing breakwater. The original faceline proposed in Master Plan 1987 is shifted 20m offshore to reduce volume of hard coral excavation.

Water area in front of the new wharf is less sheltered from waves than the other plans. The existing breakwater is improved in order to reduce wave transmission rate by placing crown concrete blocks.

Apron of the new wharf is concrete paved for an area of 20m x 155m and the area at the back is also concrete paved 30m wide to provide a staging area. The existing container yard is wide enough and is planned to be used for stacking containers handled in the new wharf. However, the existing staging area at the back of the existing wharf is remote from the new wharf and to maximize container handling efficiency at the new wharf, the 30m wide new staging area is planned.

The above yard pavement plan allows the existing tanks to remain in the present location. The pipelines connecting tanks and the wharf are aligned in a concrete duct.

The existing wharf is repaired with adequate anti-corrosion work to extend its service life for handling non-container cargoes. Non-container cargo handling does not require heavy equipment and the existing wharf can serve for conventional cargo handling operation with minor anti-corrosion works to the piles. The existing wharf can serve for such ships as cruise ship, copra ship, tanker, car carrier, fishing boat, ferry, etc. The existing wharf will greatly contribute to alleviate future congestion in Apia Port.

Interference of the construction work with port operation can be minimized by scheduling the repair work to the existing wharf after construction of the new wharf. Yard operation at the new wharf involves longer transport distance between the wharf and the yard and will be slightly inefficient than the other plans.

(2) Alternative Plan 2

This plan does not use any part of the existing wharf and is to enclose the existing wharf with a steel sheet pile wall. Inside of the wall is filled with soil and the surface is concrete paved after removing the existing concrete deck. The new concrete deck is designed 2m wider and longer than the existing one to allow driving work of steel piles. Since this plan does not rely on any structural members of the existing wharf, structural reliability is high and construction method is simple.

This plan involves pile driving work all along the edge of the existing concrete deck with a large crane. The existing batter piles obstruct new piles and must be pulled out. To minimize interference of the construction work with

port operation, a half of the wharf will be reconstructed and used for cargo handling before commencing the work to the other half of the wharf. Port operation considerably affect the construction work and vice versa.

Traffic between the wharf and the yard is smooth as at present and no work is required for the existing tanks.

The construction cost of this plan is the highest among the alternative plans.

(3) Alternative Plan 3

Deterioration of the existing wharf concentrates on the H shaped steel piles which are observed to have been heavily corroded on both above and under water sections. This plan is to use the existing concrete deck without any reinforcement and the existing piles supporting the deck with adequate reinforcement. Alternative plan 3-1 consists of reinforcement of the existing piles and driving of additional piles, while alternative plan 3-2 is to replace all the existing piles with new piles. Since alternative plan 3-1 involves lot of works under the concrete deck and under water affected by berthing ship and tide, the construction cost is estimated higher than alternative plan 3-2. Deterioration of piles are very much complicated and the reinforcing work shall be carefully planned and implemented to achieve high structural reliability.

Interference of the construction work with port operation is significant but not serious as that of alternative plan 2.

The other aspects of this plan is similar as those of alternative plan 2.

Three alternative improvement plans are compared as shown in Table 4.2.2-2.

Table 4.2.2-2 Comparison of Alternative Plans

	Plan 1	Plan 2	Plan 3-1	Plan 3-2
Interference with Port Operation	Negligible	Serious	Considerable	Considerable
Ease of Construction	Good	Fair	Bad	Fair
Construction Cost	Medium	High*	Low*	Low*
Economic Benefits	Excellent	Fair	Fair	Fair
Overall Evaluation	○	×	△	△

* denotes construction cost becomes higher than Plan 1 when 2nd berth is included.

Construction schedule of phased improvement plan in the cases of adopting Alternative Plan 1 and Plan 3-2 is shown below,

Improvement Schedule of Berthing Facilities

	1998	2003	2013	2015
Plan 1				
Existing Wharf repaired				
New Wharf				
Plan 3-2				
Existing Wharf no repair				
Reconstruction of Existing Wharf				
2nd Wharf				

-Plan 1

to construct a new container berth and rehabilitate the existing wharf serviceable beyond 2015 for conventional cargoes,

-Plan 3-2

to reconstruct the existing wharf and construct the second container berth later, until then accepting port congestion to some extent,

Above two plans are evaluated by means of internal rate of return (EIRR) and plan 1 has been ranked as the best. Economic internal rate of return is presented in detail in Chapter 7.

4.3 Design of Port Facilities

4.3.1 New Wharf

(1) Design Ship and Length and Depth of New Wharf

1) Design Ship

According to Table 2.2.3-6, the maximum size of container ship which regularly call at Apia Port is as follows,

Name of Vessel	L.O.A(m)	Draft(m)	GRT(ton)
Kassiakos	165.00	10.47	16,872
Coral Islander	155.52	7.31	14,294

The size of large container carriers with more frequent calls are as follows,

Name of Vessel	L.O.A(m)	Draft(m)	GRT(ton)
Forum Samoa	118.83	6.6	6,861
Kyowa Hibiscus	117.52	6.4	7,945

Container ships call at Apia Port with arrival draft shallower than full load draft. The size of design ship is adopted to be 10,000 GRT through consideration of actual draft and the large ships with frequent call. The above maximum size of container ships can be accommodated at the existing wharf at present.

2) Length and Depth of New Wharf

(a) Length

In Japan, typical wharf length for 10,000 GRT container ship is 170 m. Due to topographical condition at the proposed site, the length of the new wharf is determined to be 190 m (155 m quay and 35 m seawall).

(b) Depth

The typical wharf depth for 10,000 GRT container ship is 10 m below C.D.L. As swell causes disturbance in Apia Bay during November to February obstructing cargo handling operation, the depth of the new wharf is designed to be 11 m below C.D.L. adding a depth allowance of 1.0 m.

10.0 m + 1.0 m = 11.0 m

(c) Crown Height

The crown height of the new wharf is +3.00 m as the same as the existing wharf.

(2) Structural Design

1) Design Condition

Dimensions of facilities are presented as follows.

(a) Wharf

Overall length:	190m(155m quay + 35m seawall)
Depth:	D.L.-11m
Crown height:	+ 3.00m
Return wall length:	20m
Apron width:	20m

(b) Design Ship

Tonnage:	10,000 GRT

(c) External Force

Surcharge:	4.0 t/m^2
Berthing velocity:	10 cm/sec
Design seismic coefficient:	0.15

(d) Anti-Corrosion Method for Piles

Underwater:	Cathodic protection
Splash zone:	Mortar lining

(e) Natural Condition

Tidal level:	M.H.W.S + 1.00m
	M.L.W.S + 0.00m
	C.D.L + 0.00m

(f) Soil Condition

Boring survey adjacent to the proposed site was conducted in this study as shown in Figures 2.1.3-1 and 2.2.3-2. Based on the boring logs from the survey, the new wharf is designed. The subsoil at the site of new wharf is composed of very complicated soil layers. Specially hard coral layer is observed around the existing bollard. Consequently, it is necessary to conduct the detailed boring

survey in order to confirm the distribution and thickness of hard coral layer in detailed design stage. The proposed location and drilling length of the detailed boring survey are presented in Appendix 10.

2) Wharf Structure

Two structural types are examined for a new wharf. Cross sections of the new wharf are shown in Figures 4.3.1-1 and 4.3.1-2.

Type A: Steel Sheet Pipe Pile Bulk Head Type
Type B: Open Type Piers with Vertical Piles

Based on the results of comparison of structure design as shown in Table 4.3.1-2. According to this table, steel sheet pipe pile bulk head type (Type A) is adopted as shown in Table 4.3.1-2.

Table 4.3.1-2 Comparison of Wharf Structure

Comparison Items	Type A	Type B
Construction cost ratio to Type A	1.0	1.3
Easiness of construction work	○	△
Construction period	○	△
Total Evaluation	1	2

(3) Seawall

The rubble mound type covered with 4 ton concrete blocks which are used in the seawall toward north of the existing wharf. The cross section of the seawall is shown in Figure 4.3.1-3.

4.3.2 Existing Wharf

The following three alternative plans are designed for different load conditions by cargo type and service life as shown in Table 4.3.2-1.

Table 4.3.2-1 Design Conditions of Alternative Plans

Design Condition	Plan 1	Plan 2	Plan 3
Cargo Type	Conventional Cargo	Container Cargo	Container Cargo
Service Life	More than 15 years	30 years	30 years

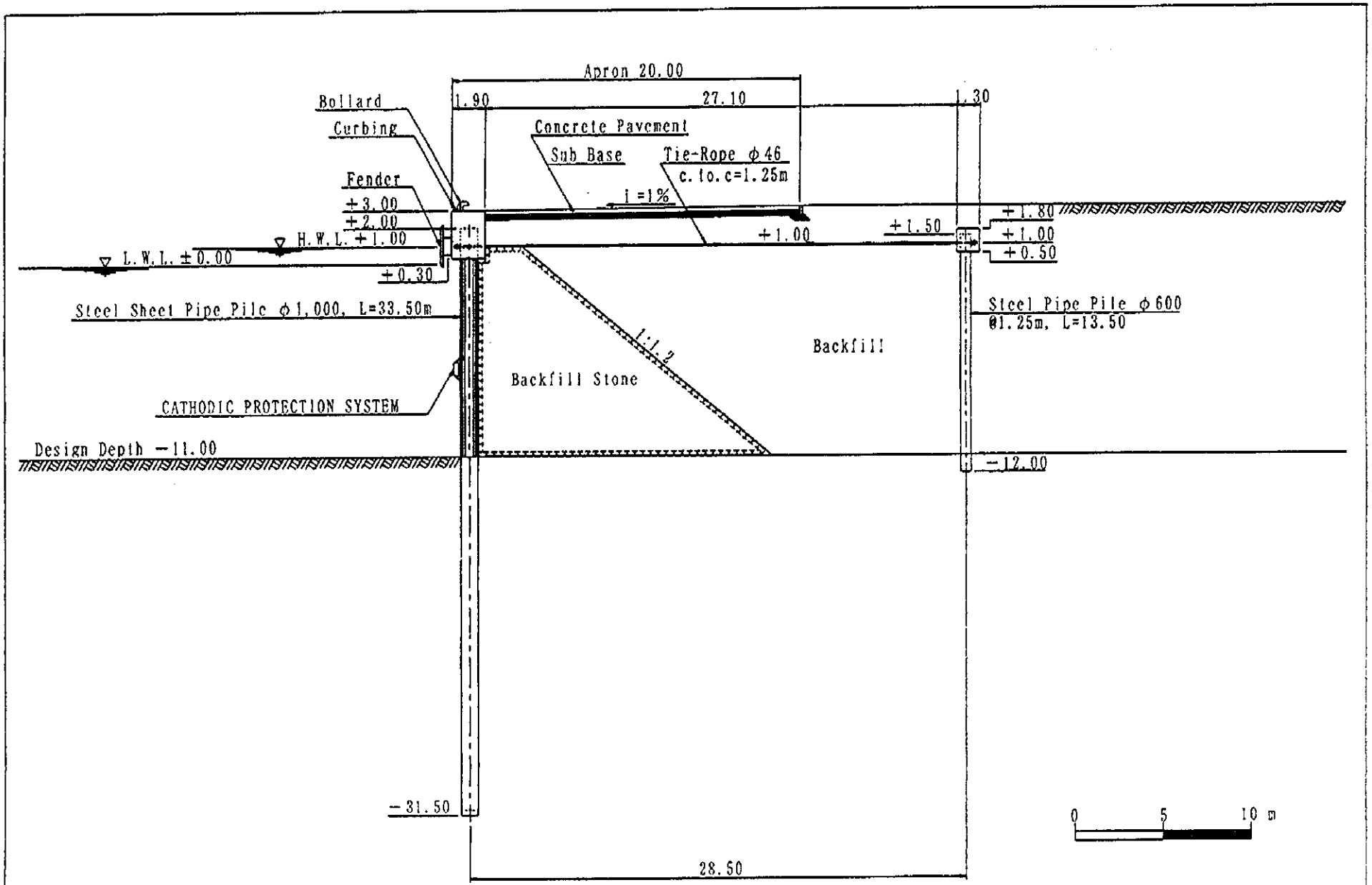


Figure 4.3.1-1 Cross Section of New Wharf(Type A)

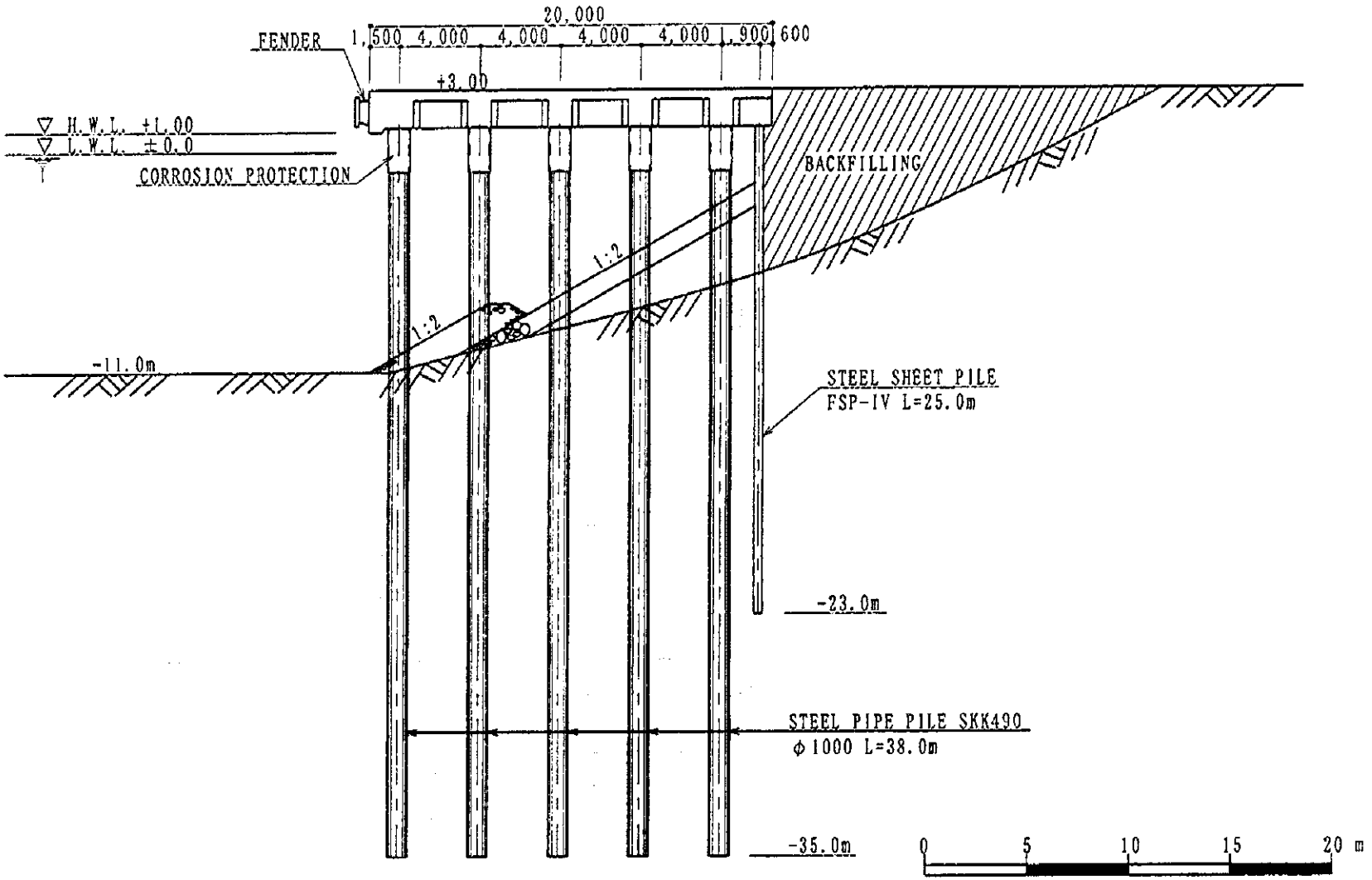


Figure 4.3.1-2 Cross Section of New Wharf(Type B)

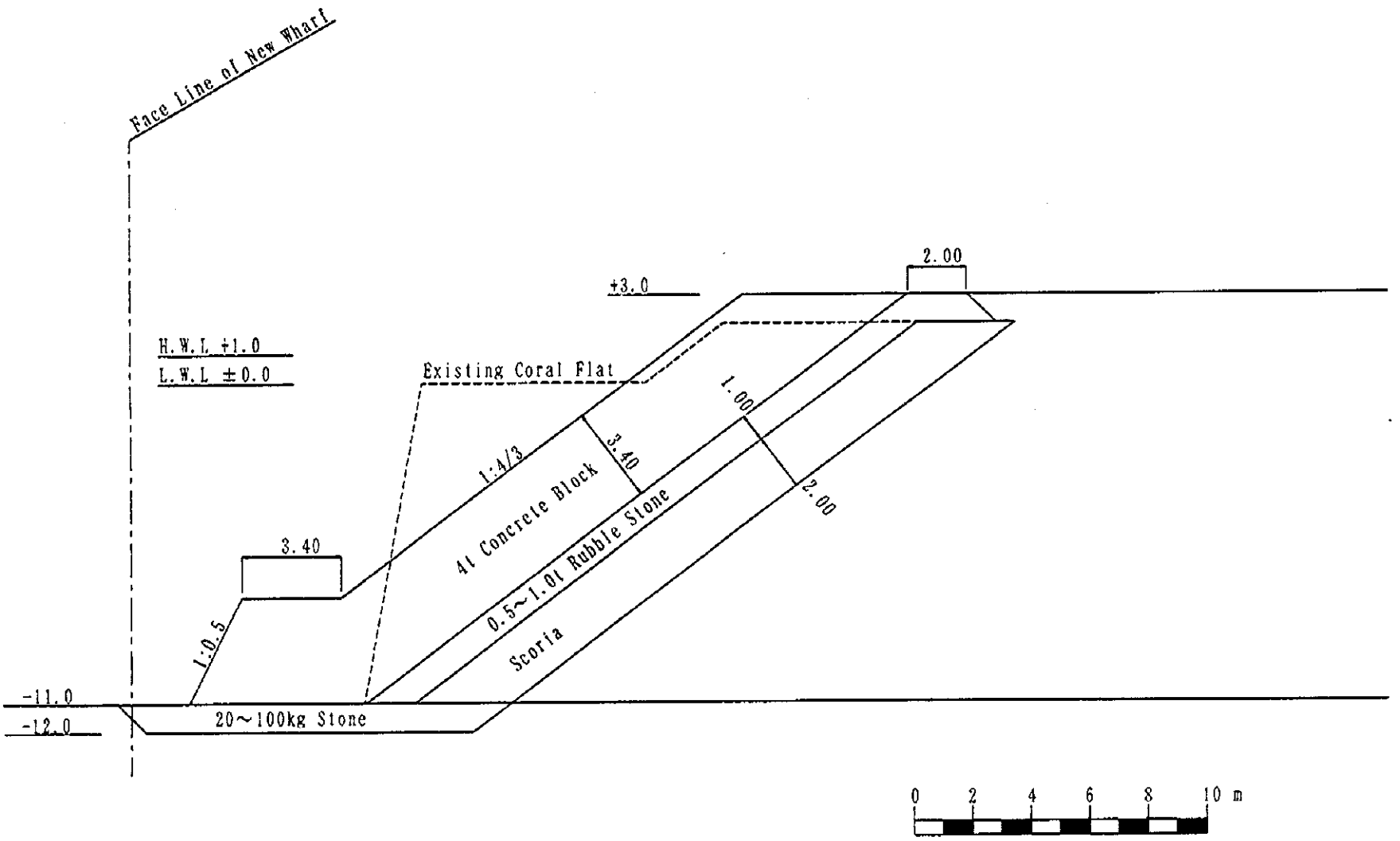


Figure 4.3.1-3 Cross Section of Sea Wall

(1) Alternative Plan 1

The existing wharf is repaired with adequate anti-corrosion work to extend its service life for handling non-container cargoes. The rehabilitation plan of the existing wharf is designed for conventional cargo handling operation with minor anti-corrosion works to the piles.

1) Design Load

The design load of the existing wharf for anti-corrosion work is adopted to be wheel load T-20 (10t truck loaded with 10t cargo).

2) Service Life

Service life of the existing wharf for anti-corrosion work is required more than 15 years. According to the structural analysis, its service life is calculated to be 18 years as presented in Appendix 10.

3) Anti-Corrosion Work

(a) Piles above Water

All 307 piles are repaired using epoxy repair techniques with the aim of providing an effective barrier against the access of oxygen, which progress corrosion of the H steel pile. All spalled concrete and loose material are removed and all the concrete surface are to be sand blasted. Then the surface would be primed with epoxy resin and epoxy resin mortar applied in layers until original profile obtained. Following curing a top coat of epoxy resin is applied. In cracked area, all concrete surface are cleaned by sand blast and epoxy resin coatings are executed.

(b) Piles below Water

Cathodic protection is adopted. All 131 existing galvanic anodes are replaced with new ones, its service life is 30 years and 12 anodes are installed at center approach of the existing wharf.

(c) Damaged Beams

35 damaged beams are restored using epoxy techniques as the same of piles below water.

(d) Other Repair Work

Two fenders torn off and three fenders torn are replaced with new ones.

(2) Alternative Plan 2

The existing wharf is reconstructed by enclosing the existing wharf with a steel sheet pipe pile wall. Inside of the wall is filled with soil. The existing batter piles are pulled out as they obstruct new pile driving. The existing concrete deck is removed and the surface is concrete paved.

The plan and cross section of reconstruction of the existing wharf are shown in Figures 4.3.2-1 and 4.3.2-2.

(3) Alternative Plan 3-1

The service life of the existing wharf is extended to be 30 years by the reinforcement of existing piles and driving additional piles. The plan and cross section of reconstruction of the existing wharf are shown in Figures 4.3.2-3 and 4.3.2-4.

1) Reinforcement of Existing Piles

All 307 piles including north and center approaches are reinforced by the following works.

(a) Piles above Water

The existing concrete around piles are removed and reinforced by reinforced concrete.

The casing concrete and tremie concrete around H steel pile are drilled and chipped away. Then surface of H steel pile is cleaned by sand blasting and new steel bars are arranged around H pile and new concrete poured into place. Following coating, epoxy resin is applied.

(b) Piles below Water

All 131 existing galvanic anodes are replaced with new ones, its service life is 30 years and 12 anodes are installed at center approach of the existing wharf.

(c) Piles near Seabed

At 81 points, lower portion of existing piles are reinforced by underwater concrete.

2) Additional Piles

At the reinforced existing piles D and F, the stress on pile head is calculated to exceed allowable stress for 30 years service life. Two additional piles are driven between the row of existing piles owing to reduce to allowable stress. The results of calculation is presented in Appendix 10.

3) Other Repair Work

Damaged beams are restored and damaged fenders are replaced with new ones. The thickness concrete 15 cm is overlaid on the existing concrete deck.

(4) Structural Alternative Plan 3-2

Structural Alternative plan 3-2 is to replace all the existing piles with new piles. New piles are driven between the rows of existing piles.

The plan and cross section of improvement of the existing wharf are shown in Figures 4.3.2-5 and 4.3.2-6.

4.3.3 Other Facilities

(1) Breakwater

The placement of crown concrete block on top of the rubble mound of the existing breakwater is planned. The length of breakwater improvement is 70 m from concrete base of the light beacon to the face line of the new wharf. The cross section of improvement of the existing breakwater is shown in Figure 4.3.3-1

The calmness of the water area greatly influence cargo handling operation. The water area in front of the new wharf requires the necessary calmness on 95 % (wave height is not more than 50 cm) of the days per year as the same of the existing wharf. The effect of improvement of the breakwater is shown in Table 4.3.3-1 and Appendix 10. The calmness in front of the new wharf is improved to be 95.0 % from 93.4 %.

As a result of breakwater improvement, the transmitting waves can be reduced through the existing breakwater. However, the breakwater improvement can not prevent to cause swell disturbance in Apia Bay by North-Eastern Trade Wind.

Table 4.3.3-1 Calmness in front of the New Wharf

	Working Ratio of Handling (%)	Workable Days of Handling (days)
New wharf at present	93.4	341
New wharf after Improvement	95.0	347
Existing wharf at present	96.3	351

(2) Administration Office

The layout of administration office is shown in Figure 4.3.3-2.

(3) Tug Boat

The general arrangement of a new tug boat is shown in Figure 4.3.3-3.

(4) Ferry Terminal Wharf

The repair works of ferry terminal wharf are shown in Figure 4.3.3-4 and Figure 4.3.3-5.

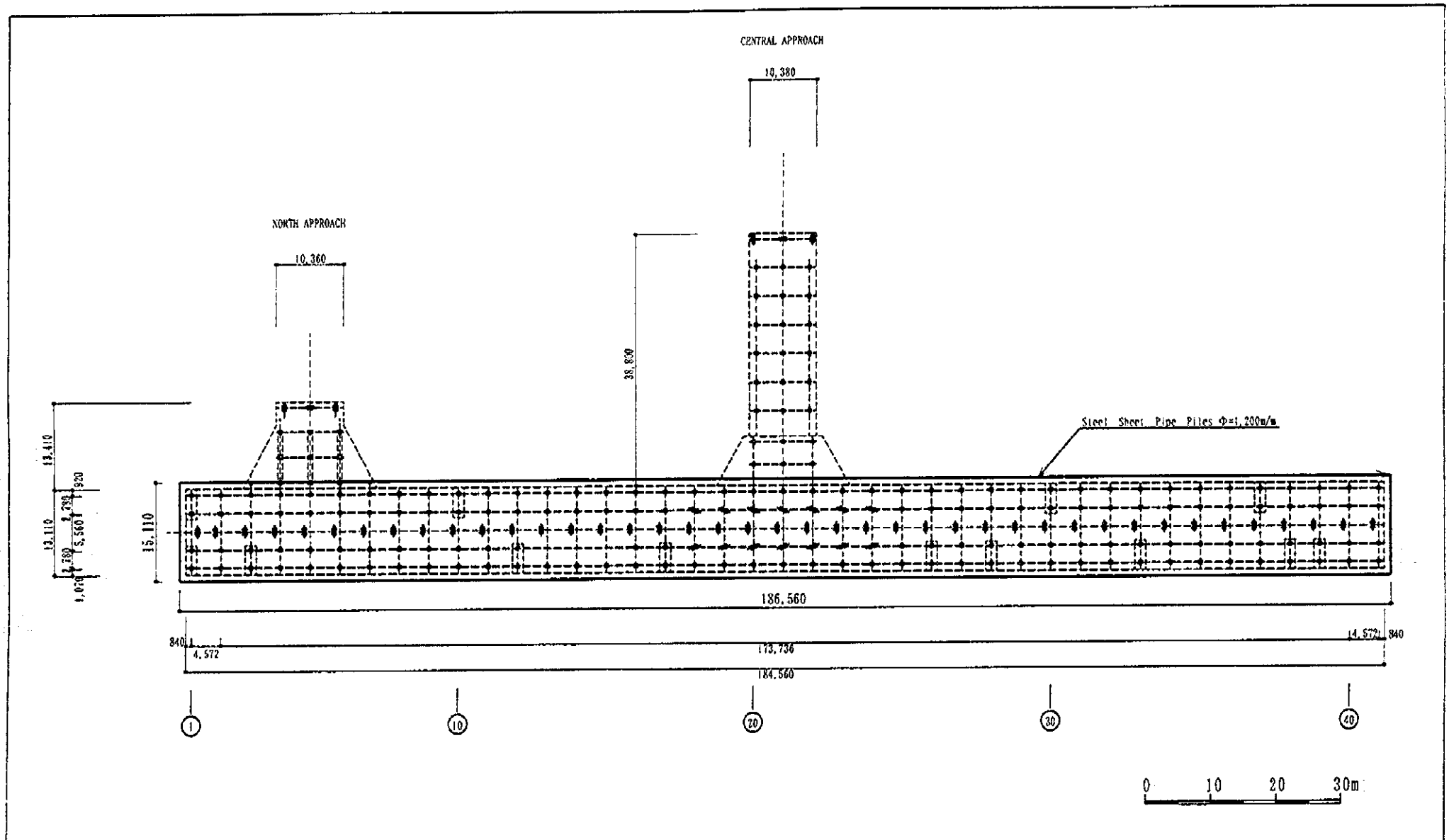


Figure 4.3.2-1 Plan of Reconstruction of Existing Wharf (Alternative Plan 2)

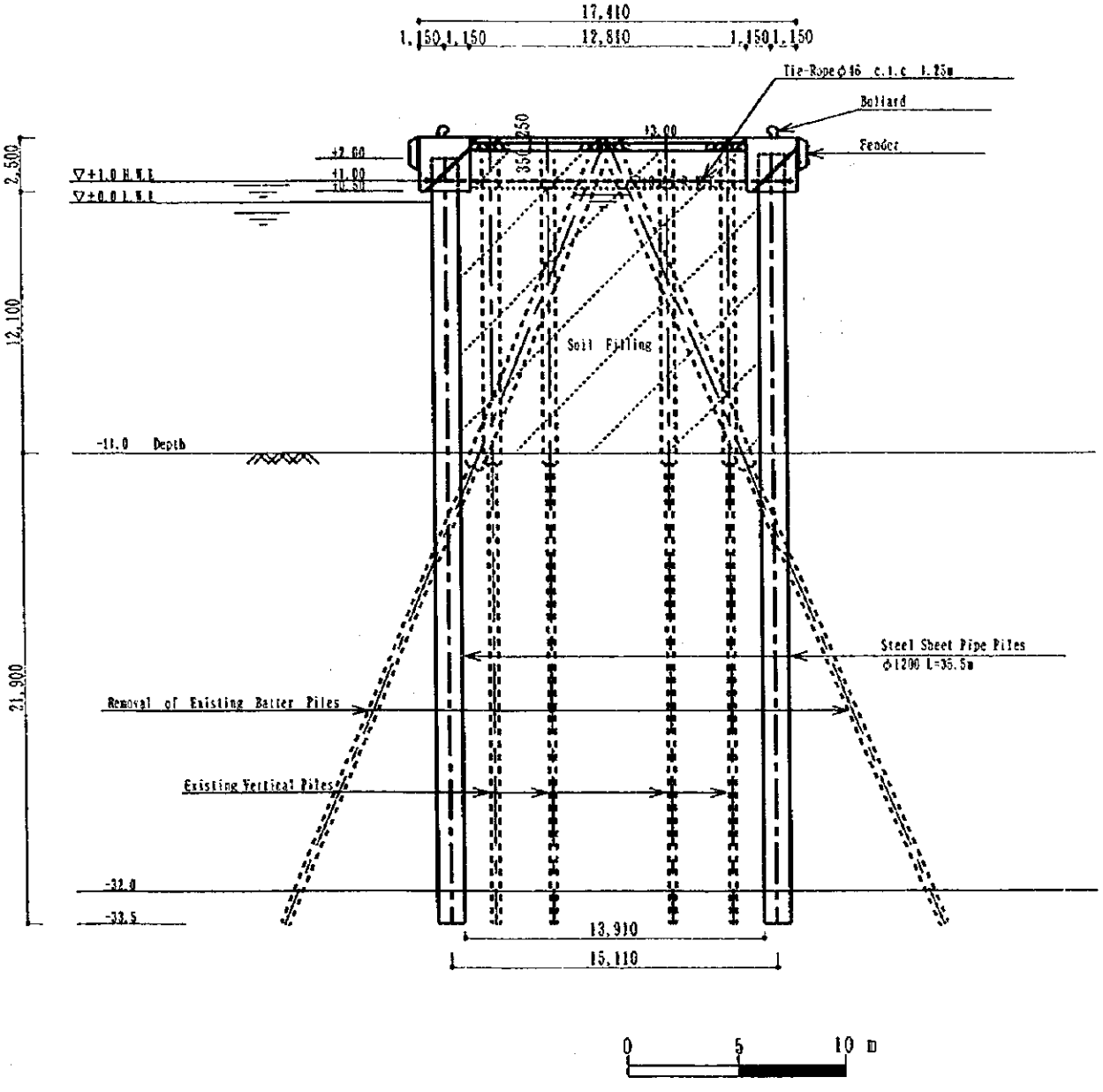


Figure-4.3.2-2 Cross Section of Reconstruction of Existing Wharf (Alternative Plan 2)

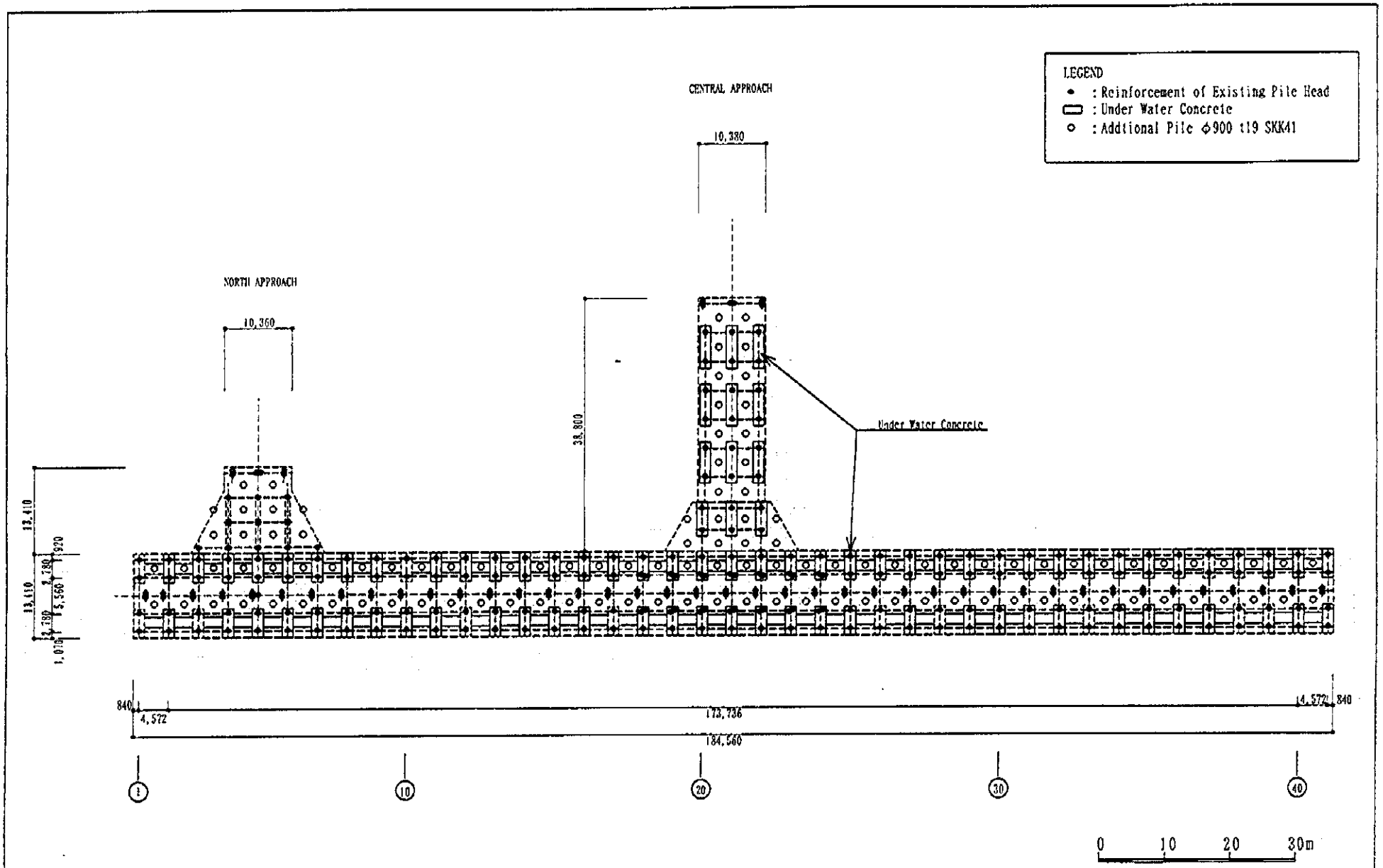


Figure-4.3.2-3 Plan of Reinforcement of Existing Wharf(Alternative Plan 3-1)

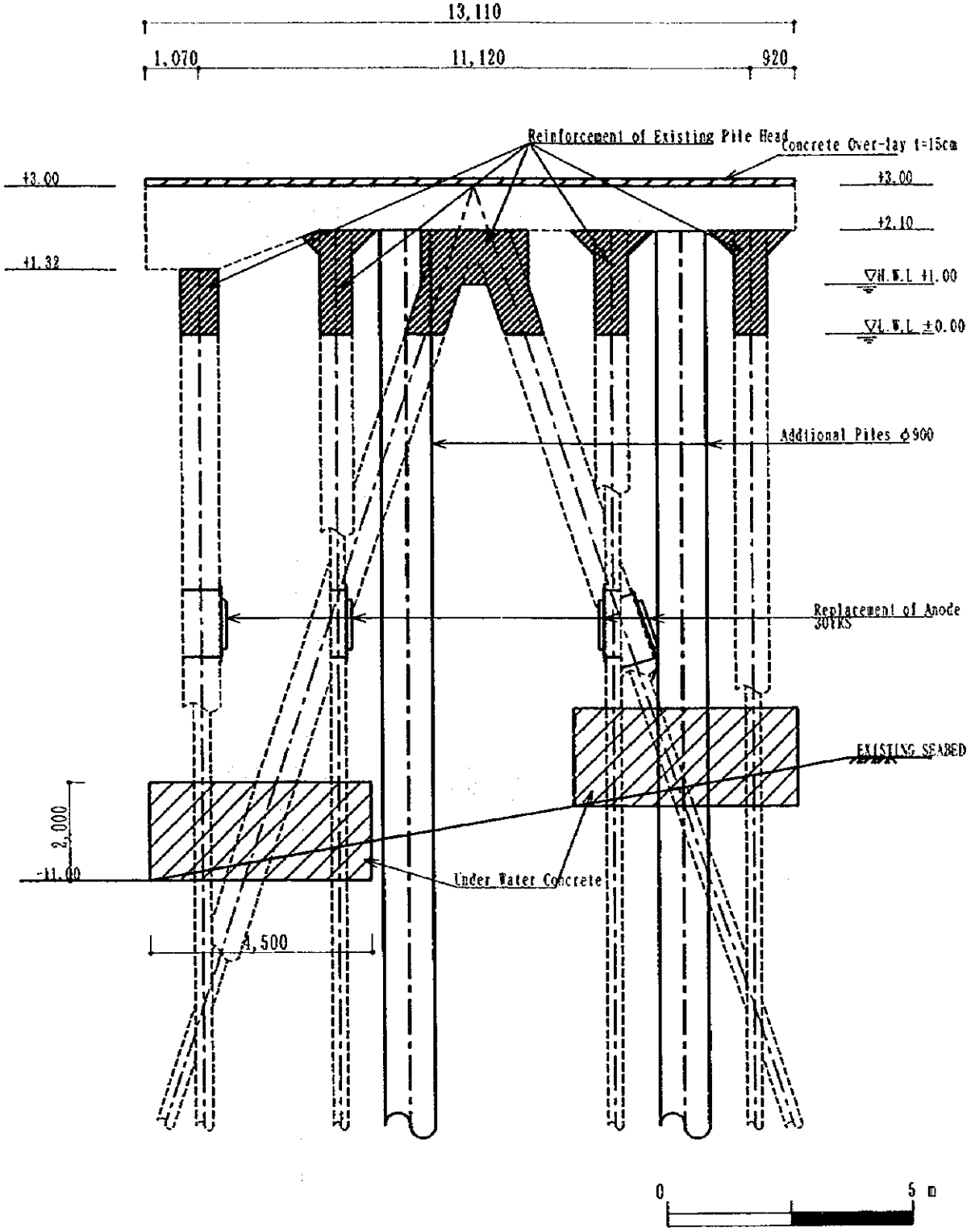


Figure 4.3.2-4 Cross Section of Reinforcement of Existing Wharf
(Alternative Plan 3-1)

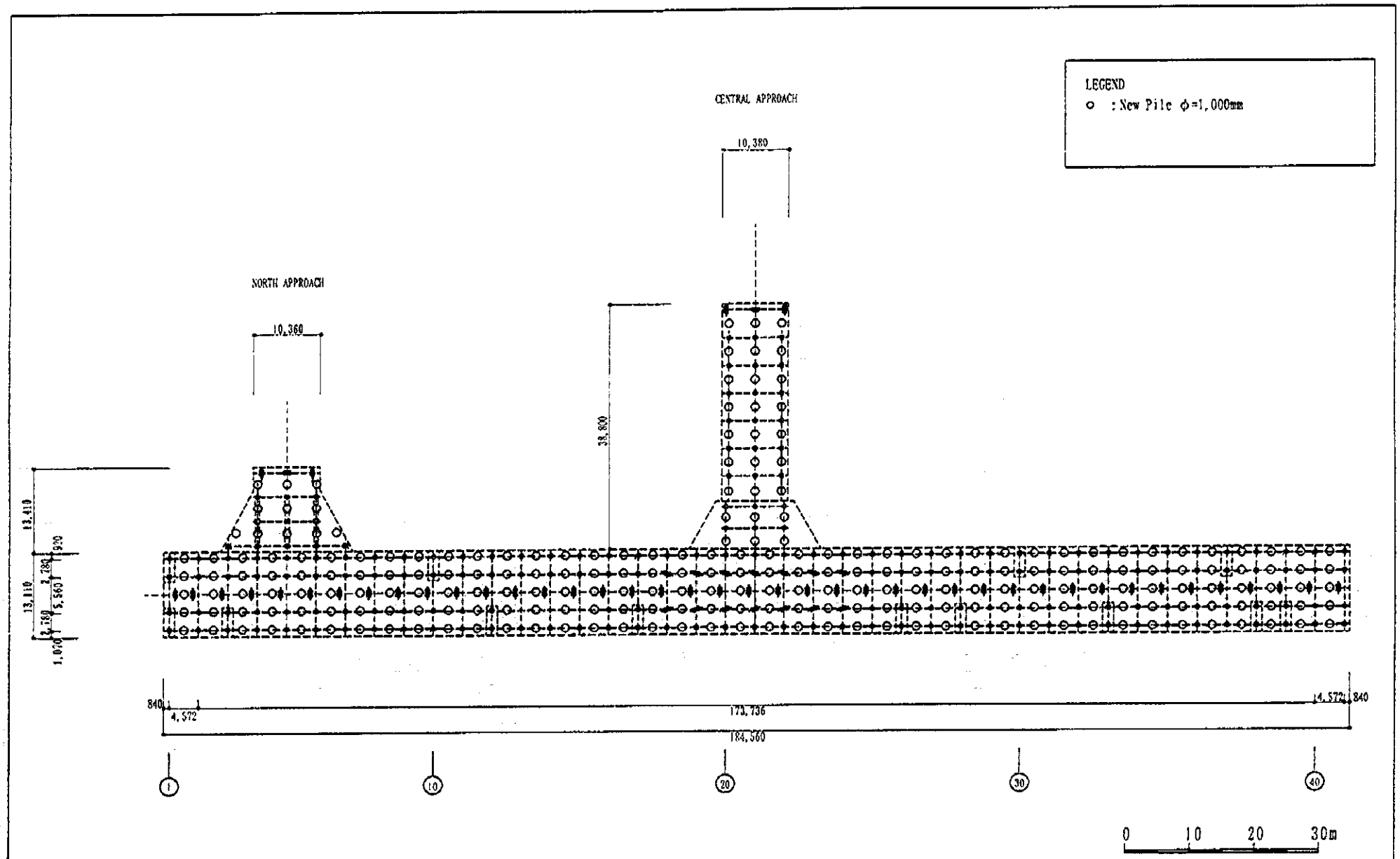


Figure-4.3.2-5 Plan of Reinforcement of Existing Wharf (Alternative Plan 3-2)

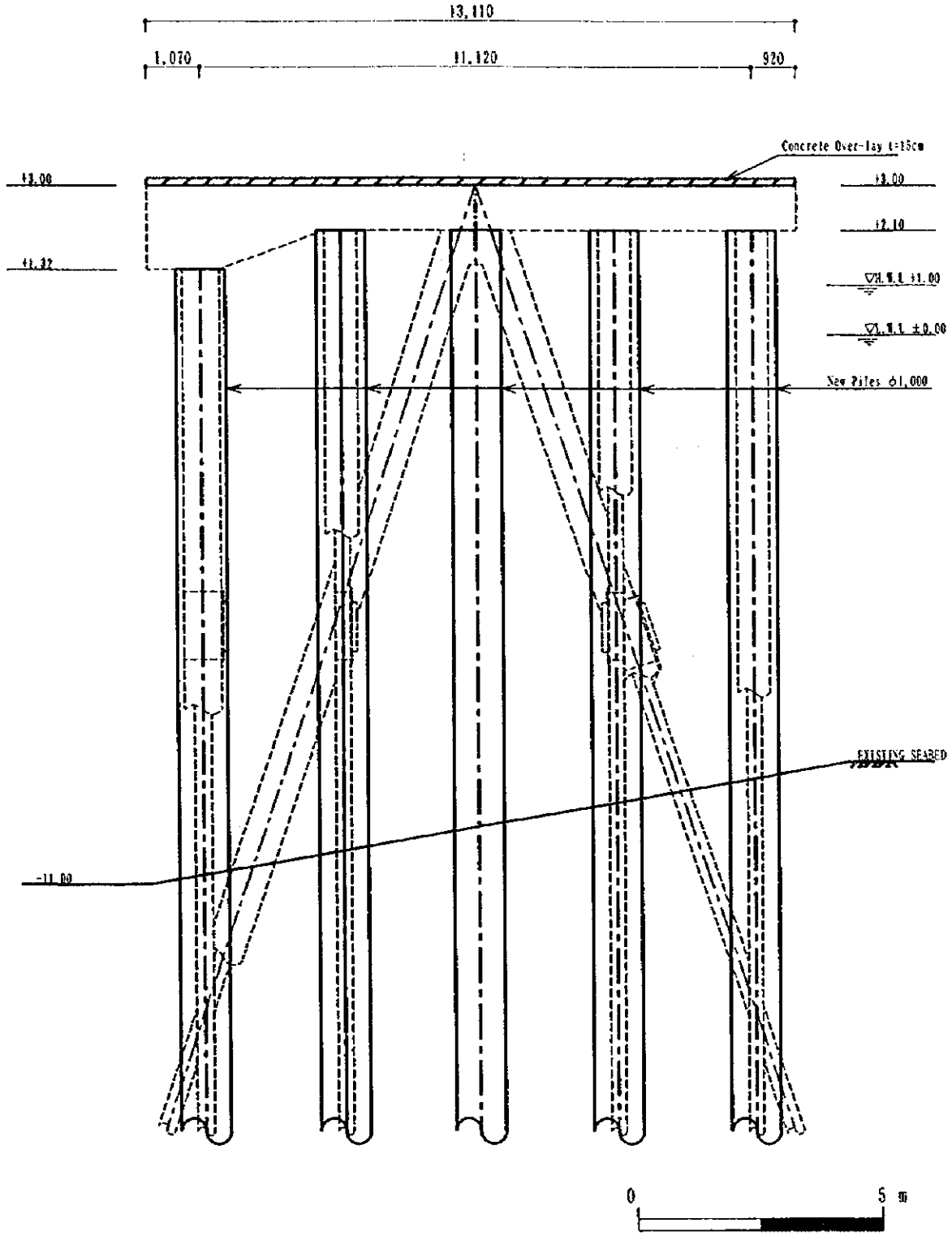


Figure-4.3.2-6 Cross Section of Reinforcement of Existing Wharf (Alternative Plan 3-2)

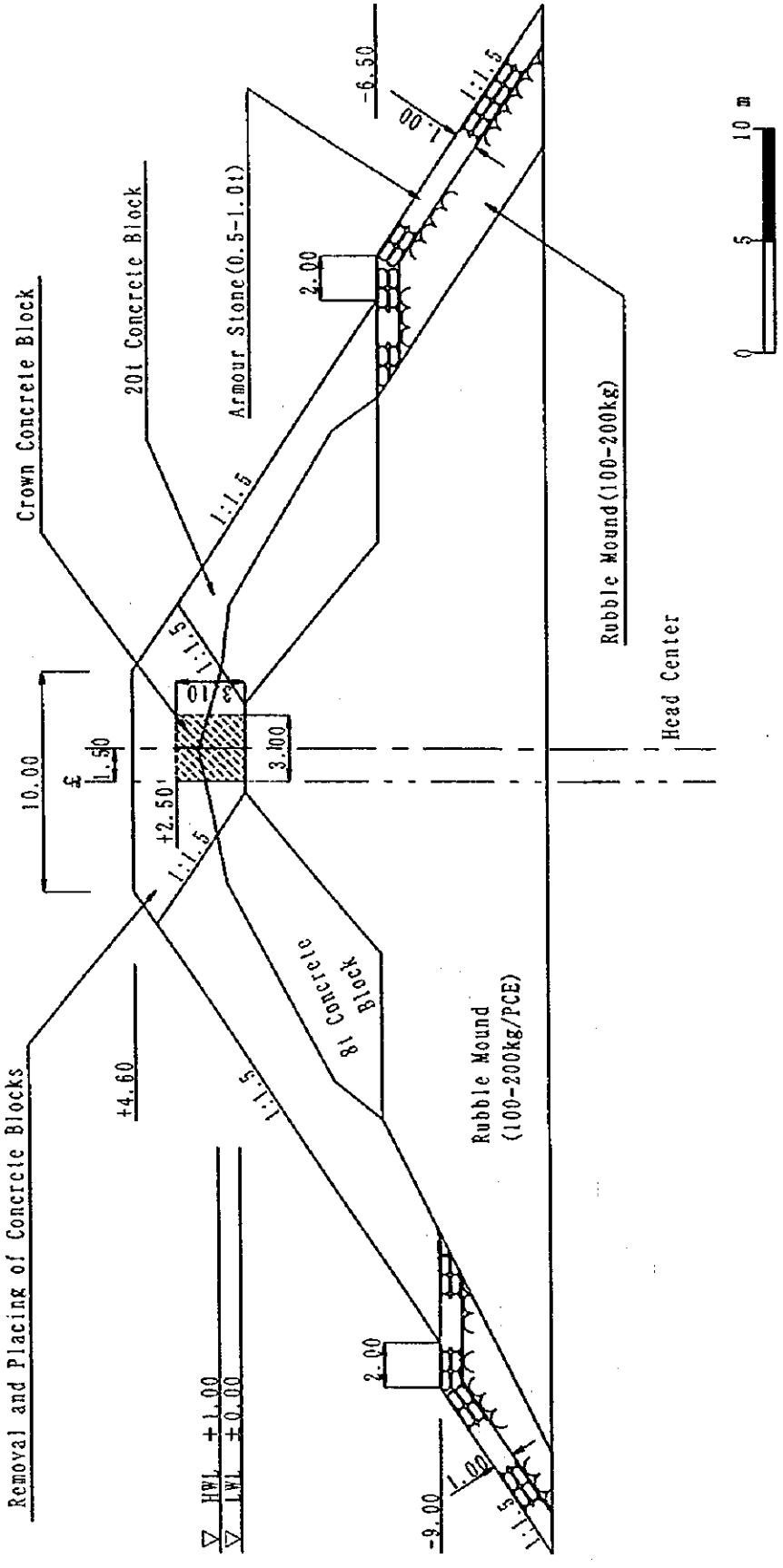


Figure 4.3.3-1 Cross Section of Improvement of Existing Breakwater

Figure 3.3.3-2 Layout of Administration Office Building

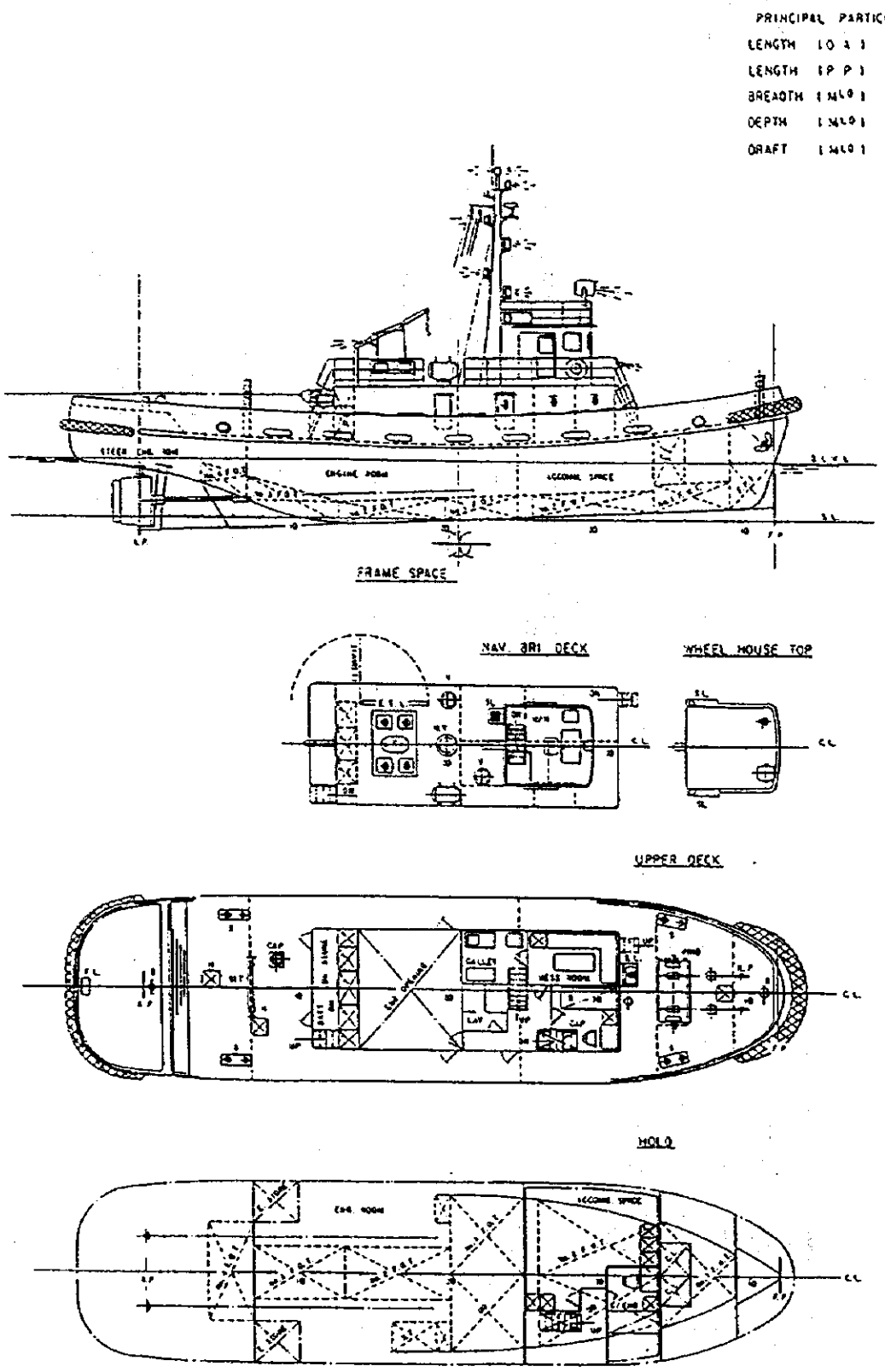
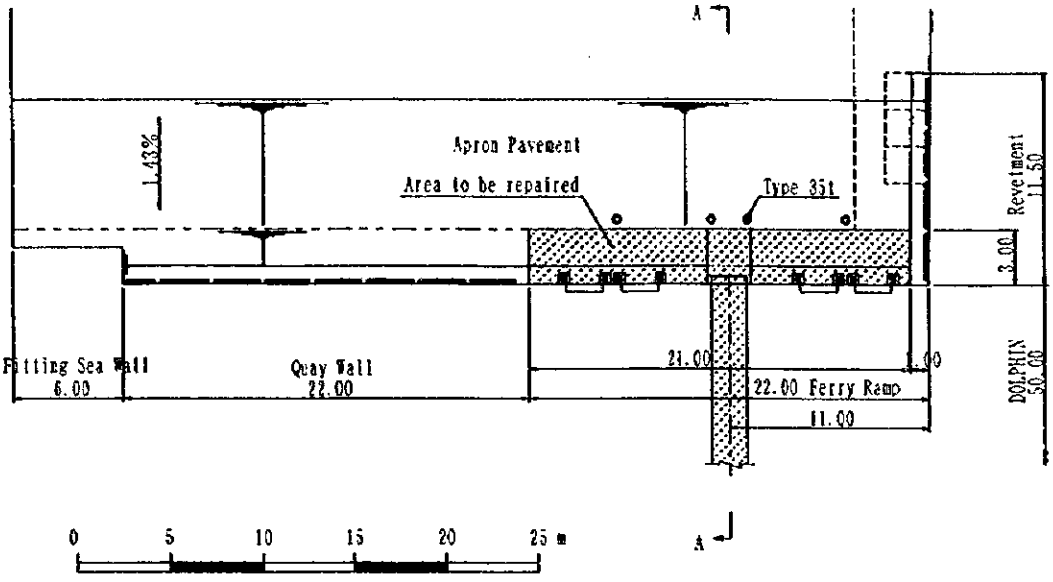


Figure 4.3.3-3 General Arrangement of Tug Boat

PLAN



SECTION A-A

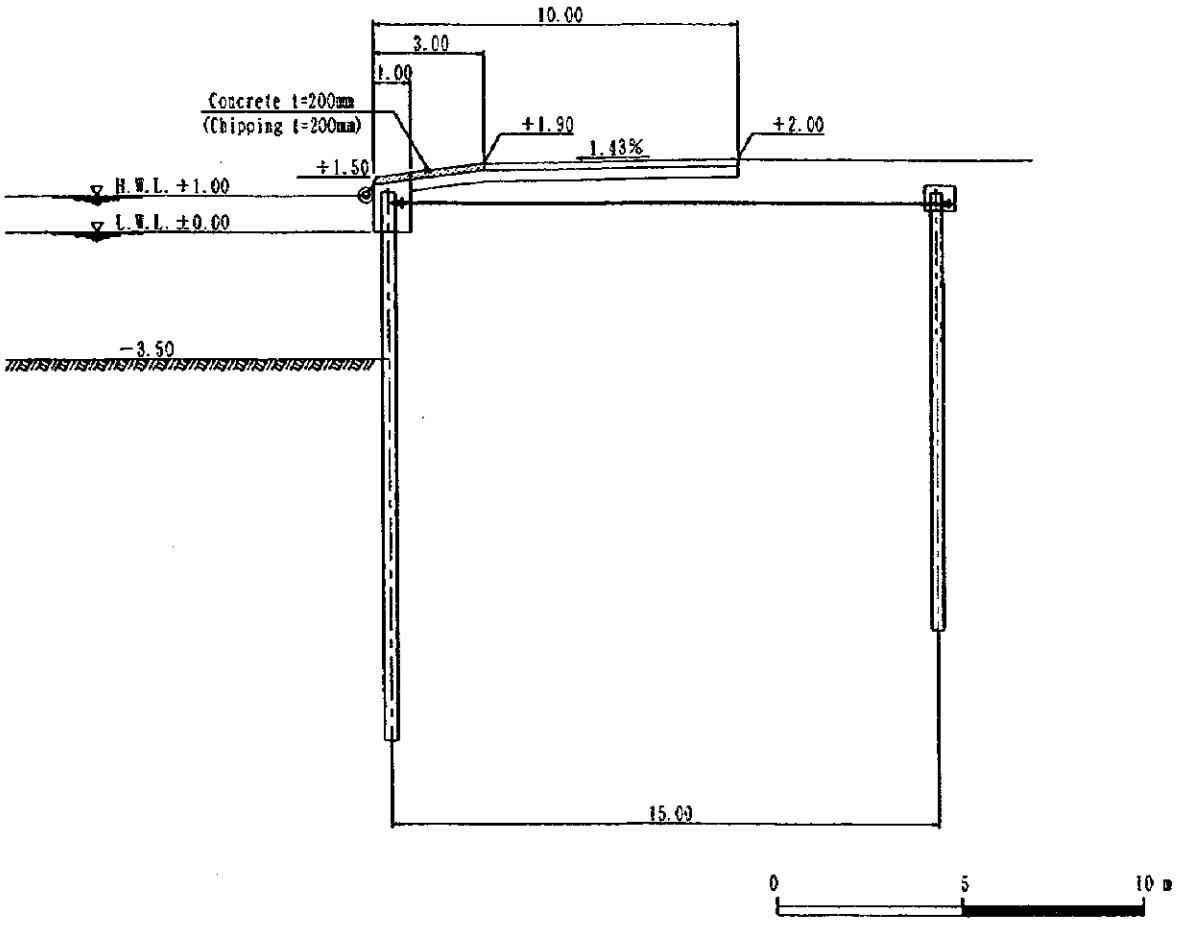


Figure 4.3.3-4 Repair of Ferry Terminal Wharf

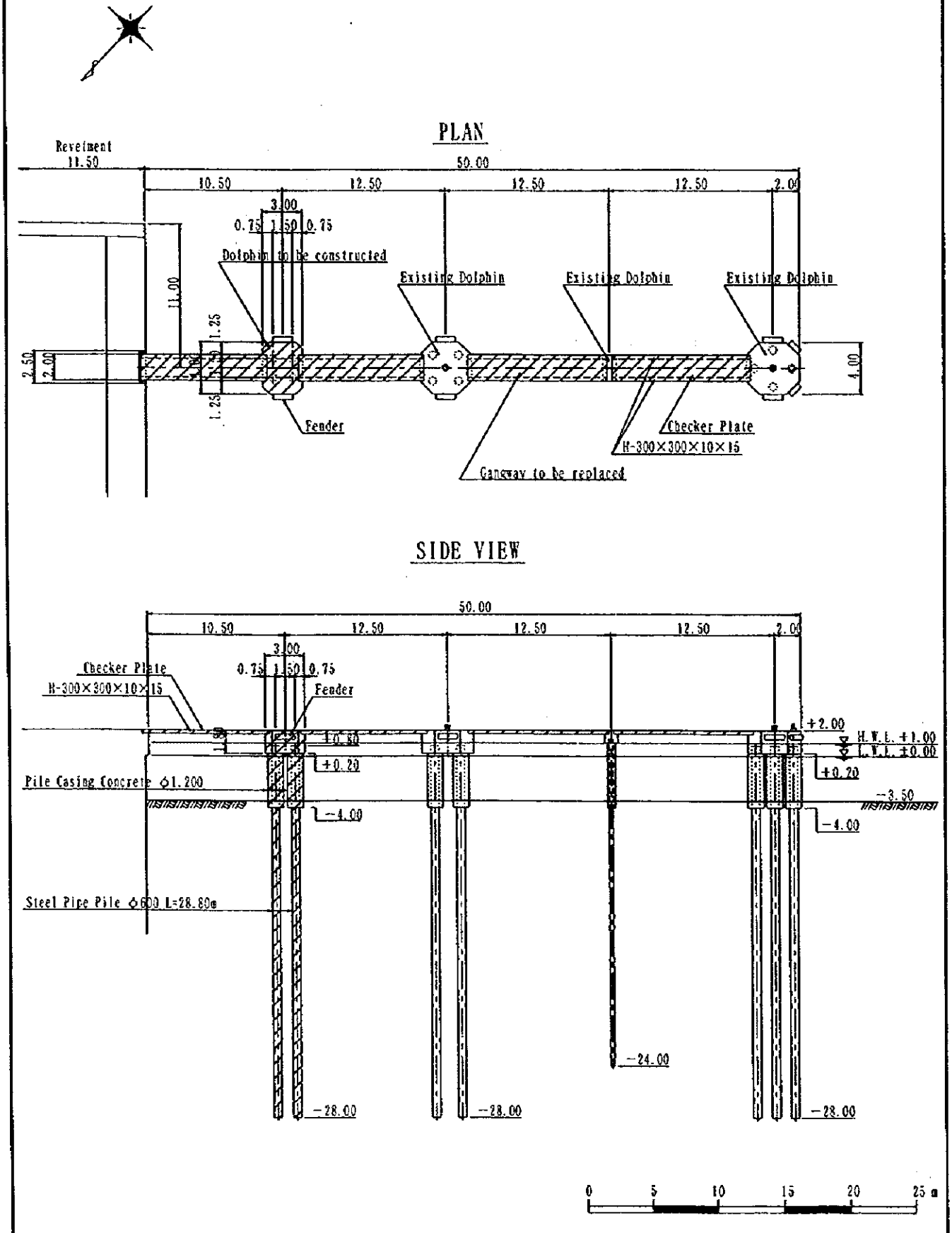


Figure 4.3.3-5 Repair of Ferry Dolphin

4.4 Construction Plan and Cost Estimation

This section presents the construction plan and the cost estimation for the phased improvement plan.

4.4.1 Construction Plan

(1) Construction Quantities

The construction quantities of facilities on each alternative plan of the phased improvement plan are shown in Table 4.4.1-1 1)~4). Administration office, tug boat and minor repair works are commonly included in all the alternative plans.

Table 4.4.1-1 Facilities and Construction Quantities

1) Alternative Plan 1

Facility	Unit	Quantity	Remarks
1. Construction of New Wharf	m	190	155m quay (-11m) and 35m seawall
2. Improvement of Breakwater	m	70	Placing of concrete crown blocks
3. Pavement of Staging Area	m^2	4,500	Concrete pavement
4. Repair of Existing Wharf	m	185	Anti-corrosion works to existing 307 piles
5. Minor Repair Works	Ls	1	Ferry terminal wharf and dolphin
6. Administration Office	m^2	450	2 story office building
7. Tug Boat	No	1	1600 HP

2) Alternative Plan 2

Facility	Unit	Quantity	Remarks
1. Reconstruction of Existing Wharf	m	189	Enclosing existing wharf by steel sheet pipe pile wall and filling with soil
2. Minor Repair Works	Ls	1	Ferry terminal wharf and dolphin
3. Administration Office	m^2	450	2 story office building
4. Tug Boat	No	1	1600 HP

3) Alternative Plan 3-1

Facility	Unit	Quantity	Remarks
1. Reinforcement of Existing Wharf	m	185	Reinforcing of existing 307 piles Driving of 112 additional piles
2. Minor Repair Works	Ls	1	Ferry terminal wharf and dolphin
3. Administration Office	m^2	450	2 story office building
4. Tug Boat	No	1	1600 HP

4) Alternative Plan 3-2

Facility	Unit	Quantity	Remarks
1. Reinforcement of Existing Wharf	m	185	Replacing all the existing piles with new piles. Driving of 248 new piles
2. Minor Repair Works	Ls	1	Ferry terminal wharf and dolphin
3. Administration Office	m^2	450	2 story office building
4. Tug Boat	No	1	1600 HP

(2) Construction Materials

Construction materials which are procurable in Samoa are ready mixed concrete, stones, backfilling soil and building materials. Evaluating the prices and quantities of materials in adjacent countries, Japan and New Zealand, the following procurement is preferable:

a) Steel materials be procured from Japan.
b) Ready mixed concrete be procured in Samoa.
c) Stones and backfilling soil be procured in Samoa.
d) Building materials which imported from New Zealand be procured in Samoa.

(3) Construction Plan

1) Basic Concept

In Samoa, construction works such as dredging, pile driving and other port facilities have been executed with the introduction of a foreign engineering. Large scale construction equipment such as a dredger, pile driving crane, a floating crane, etc. will be mobilized from Japan, considering the prices and availability of those in the adjacent countries, Fiji and New Zealand. Small scale construction equipment for road construction and small mobile crane will be locally available. Common labours for the construction works will be locally procurable.

2) Construction Plans of Main Facilities

Construction plan of the new wharf and rehabilitation of the existing wharf of each alternative plan are as follows:

(a) Alternative Plan 1

a) Construction of New Wharf

A steel sheet pipe pile bulk head type is adopted. Flow of the construction works is shown in Figure 4.4.1-1.

(i) The area for driving steel sheet pipe piles is dredged up to the design depth in advance.

(ii) After dredging, steel sheet pipe piles of the front wall are installed at the designed position with assistance piles of guide waling and then is driven by a large floating crane. The top of driven steel piles are arranged straight by waling channel steels using a floating crane.

(iii) Anchor piles of steel pipe piles are driven by a crane on land.

(iv) backfilled up to the water surface using a floating crane.

(v) The front wall and the anchor piles are connected by tie ropes.

(vi) The coping concrete of the front wall is cast using a concrete pump.

(vii) Backfilling is finalized adjusting the tension of the tie ropes in order to arrange the face line of the front wall.

(viii) Apron concrete is cast and accessories such as fenders and bollards are installed.

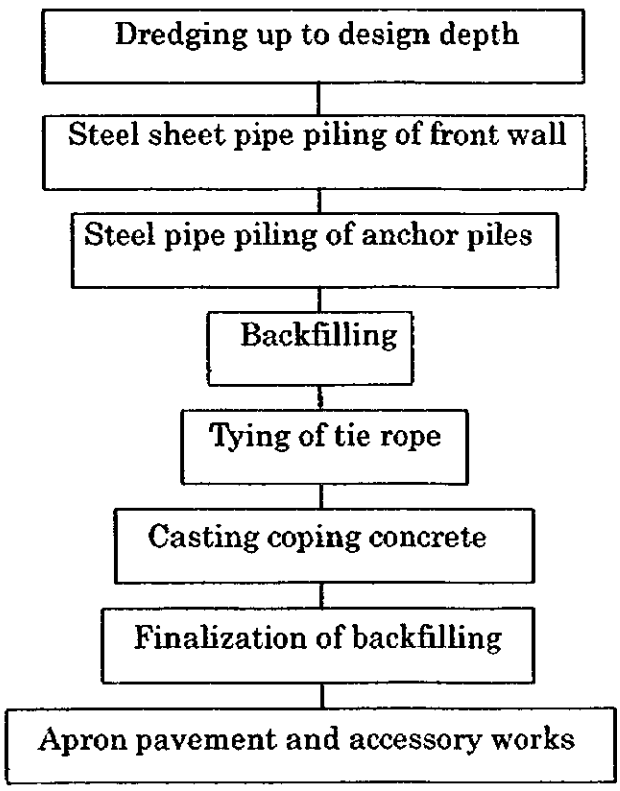


Figure 4.4.1-1 Flow of Construction Procedure of New Wharf

b) Anti-corrosion Work to Existing Wharf

Anti-corrosion work to the existing wharf is executed as follows:

(i) Piles above Water

All spalled concrete and loose materials are removed and all the concrete surface are to be sand blasted. Then the surface would be primed with epoxy resin and epoxy resin mortar applied in layers until original profile obtained. Following curing a top coat of epoxy resin is applied. In cracked area, all concrete surface are cleaned by sand blast and epoxy resin coatings are executed.

(ii) Piles below Water

Cathodic protection by galvanic anode is installed by divers.

(iii) Damaged Beam

The same method of Piles above Water is adopted.

(b) Alternative Plan 2

This plan is to enclose the existing wharf with a steel sheet pipe wall. To minimize interference the construction work with port operation, firstly a half of the wharf is reconstructed and the other half of the wharf is used for cargo handling. Secondly the construction work of the other half is commenced.

(i) Steel sheet pipe piles all along the edge of the existing concrete deck are driven by a large crane on the existing wharf. Since the existing batter piles obstruct new piles, the existing batter piles are pulled out by vibrohammer.

(ii) The existing concrete deck and part of beams are demolished and inside of the wall is filled with soil.

(iii) After filling of soil, coping concrete and concrete pavement are executed.

(iv) The existing fenders and bollard are taken out and are reinstalled on the steel sheet pipe wharf.

(c) Alternative Plan 3-1

This plan consists of reinforcement of the existing piles and driving of additional piles. As the same of Plan 2, firstly a half of the wharf is reconstructed and the other half of the wharf is used for cargo handling. Secondly the construction work of the other half is commenced.

a) Reinforcement of Existing Piles

The existing piles are reinforced as follows. These pile reinforcement works involve lot of works under concrete deck and under water affected by berthing ship and tide.

(i) Piles above Water

The casing concrete and tremie concrete around H steel pile are drilled and chipped away and the surface of H steel pile is cleaned by sand blasting. Reinforcement bars are arranged around H pile and new concrete is poured into place. On the surface of the concrete epoxy coating is executed.

(ii) Piles below Water

Cathodic protection by galvanic anode is installed by divers.

(iii) Piles above Seabed

The piles at lower portion are reinforced by underwater concrete.

b) Driving of Additional Piles

A part of the existing concrete is removed and then the additional piles are driven by a large crane on the concrete deck. The new concrete beams for additional piles are executed.

(d) Alternative Plan 3-2

This plan is to replace all the existing piles with new pile. A part of the existing concrete deck and beam are removed and the new piles are driven by a large floating crane. The new concrete beams for new piles are executed.

(4) Construction Schedule

Construction Schedule of the alternative plans are presented in Figure 4.4.1-2.

Figure 4.4.1-2 Construction Schedule

1)Alternative Plan1

Facility	Unit	Quantity	Construction Year	
			1st Year	2nd Year
1. Construction of New Wharf	m	190		
2. Improvement of Breakwater	m	70		
3. Pavement of Staging area	m²	4,500		
4. Repair of Existing Wharf	m	185		
5. Minor Repair Works	Ls	1		
6. Administration Office	m²	450		
7. Tug Boat	No	1		

2) Alternative Plan 2 and 3

Facility	Unit	Quantity	Construction Year	
			1st Year	2nd Year
1. Reconstruction of Reinforcement of Existing Wharf	m	190		
2. Minor Repair Works	Ls	1		
6. Administration Office	m²	450		
7. Tug Boat	No	1		

4.4.2 Cost Estimation

The Construction cost of each alternative plan of the phased improvement plan is estimated as follows:

(1) Estimate Conditions

1) Estimation Limit

Some limits for the estimation are as follows:

a) Taxes locally imposed on materials and labours are included in the estimation.
b) Customs duties imposed on import goods are excluded from the estimation.
c) Land rents, compensations and insurance costs are excluded from the estimation.

2) Foreign and Local Portion

In general, the cost of the foreign portion includes:

a) Articles and goods which have not been produced domestically,
b) Articles and goods which are seldom produced domestically,
c) And articles and goods which cannot be procured locally because of low domestic production or high domestic consumption.

Based on the above criteria, the foreign portion comprises:

a) Labor cost of the foreigners who work for foreign contractors, and the rental fee of construction equipment which belong to foreign contractors,
b) Imported materials and goods such as steel materials, bollards, and fenders, etc.,
c) Imported a tug boat.

3) Exchange Rate

The following exchange rate among Tala, US$ and Japanese Yen issued at the end of September, 1998 are applied:

1 Tala = 0.3280 US$ = 44.95 Japanese Yen

4) Physical Contingency

a) 0 %: Imported a tug boat and construction costs of buildings
b) 10% : Construction costs of civil works

(2) Estimation Procedure

The estimation procedures are as follows:

a) As for the prices of imported materials and goods, lower prices between Japan and New Zealand are adopted.
b) As for the rental fees of construction equipment, those in Japan are lower than the other adjacent country, New Zealand, are adopted.
c) Overhead for construction works is fixed as 10 % of the sum of the direct construction costs and expenses for expatriates, and engineering services fee as 9 % of the total construction cost.
d) Overhead for a tug boat is fixed as 3 % of the total prices.
e) 10 % Government Tax have been applied in Samoa.

(3) Construction Cost

The construction costs of each alternative plan for the phased improvement plan are presented in Table 4.4.2-1.

Table 4.4.2-1 Comparison of Construction Costs of Alternative Plans

Facility	Unit	Quantity	Construction Cost (Tala thousand)			
			Plan 1	Plan 2	Plan 3-1	Plan 3-2
1. Construction of New Wharf	m	190	30,822	0	0	0
2. Improvement of Breakwater	m	70	1,511	0	0	0
3. Pavement of Staging Area	m^2	4,500	1,307	0	0	0
4.Repair or Reinforcement of Existing Wharf	m	185	2,858	41,723	32,742	30,904
5. Administration Office	m^2	450	1,553	1,553	1,553	1,553
6. Tug Boat	No	1	7,063	7,063	7,063	7,063
7. Minor Repair Works	Ls	1	409	409	409	409
Sub-total (1 to 7)			45,523	50,748	41,767	39,929
8. Engineering Services	Ls	1	4,086	4,558	3,749	3,586
Sub-total (1 to 8)			49,609	55,306	45,516	43,515
9. Physical Contingency	Ls	1	3,707	4,230	3,332	3,148
Grand Total			53,316	59,536	48,848	46,663

1 Tala = 0.3280 US Dollar = 44.95 Japanese Yen