4-2 Preliminary Design of the Main Facilities for the First Stage Plan

9. This sub-section describes the outline of the preliminary design of the main facilities under the First Stage Plan. As mentioned in the previous sub-section, higher priorities are given to the breakwater, the repair work for the main wharf, the expansion of the yard and the ferry terminal.

10. Of those items, the repair work for the main wharf, that is the anti-corrosion measure for the H-shaped steel piles using aluminium anodes, is described in Cahpter 1. Therefore, the main facilities described in this sub-section are the breakwater, the revetment for the expansion of the yard, and the dolphin for the ferry terminal.

11. All the facilities are designed based on Japanese standards for the design of port facilities.

1) Breakwater

(1) Design Condition

①	Off-shore design wave	:	(Ho)1/3 = 7.0m, (To)1/3 = 10.0 sec
②	Design wave at breakwater	:	H1/3 = 4.2m, T1/3 = 10.0 sec
③	Design depth	:	D.L. -13.5m
④	Crest height	:	D.L. + 2.8m
			(= H.W.L. 1.0 + 0.6 x 3m)
⑤	Tidal level	:	H.W.L. +1.0m
			L.W.L. ±0.0m
⑥	Unit weight		
	sea water	:	1.03t/m^3
	plain concrete	:	2.3 t/m^3 (above water level)
	quarry stone	:	2.6 t/m^3 (above water level)
	rubble	:	1.0 t/m^3 (below water level)
	foundation soil	:	1.0 t/m^3 (below water level)
⑦	Friction coefficient		
	concrete against concrete	:	0.5
	concrete against rubble	:	0.6

⑧ Angle of internal friction

rubble mound : $\phi = 40^\circ$

foundation soil : $\phi = 30^\circ$

⑨ Allowable safety factor

against sliding : 1.2

against overturning : 1.2

12. 3 types of breakwater are discussed and 'Rubble Mound Type Armoured with Wave Dissipating Concrete Blocks' is recommended. Typical cross section of this breakwater type is shown in Fig. 4.2.1.

2) Expansion of the Container Yard

(1) Design Condition

①	Crown level	:	D.L. +3.0m
②	Design depth	:	D.L. -11.0m
③	Tidal level	:	H.W.L. +1.0m
		:	L.W.L. ±0.0m
④	Residual water level	:	D.L. +0.33m
⑤	Seismic coefficient	:	kh = 0.15
⑥	Surcharge	:	$1.4t/m^2$ (Ordinary)
		:	$0.7t/m^2$ (Earthquake)
⑦	Soil conditions		
	backfilling material	:	$\gamma = 1.8t/m^3, \gamma' = 1.0t/m^3, \phi = 40^\circ$
	rubble		$\gamma = 1.8t/m^3, \gamma' = 1.0t/m^3, \phi = 40^\circ$, $qta = 50t/m^2$
	cohesion	:	$1.0t/m^2$ (-11.0m - -13.0m)
		:	$2.2t/m^2$ (-13.0m - -16.0m)
⑧	Friction coefficient		
	concrete against concrete	:	0.5
	concrete against rubble	:	0.6
⑨	Allowable safety factor		
	against sliding	:	1.2 (Ordinary), 1.0 (Earthquake)
	against overturning	:	1.2 (Ordinary), 1.0 (Earthquake)
	against circular failure	:	1.3 (Ordinary)

(2) Stability of the Retaining Wall and Slope

13. The results of the stability of the retaining wall and slope shown in Fig. 4.2.2 are sufficiently stable.

3) Ferry Terminal

(1) Quaywall

i) Design Condition

①	Crown level	:	D.L. +1.7m
②	Design depth	:	D.L. -3.5m
③	Tidal level	:	H.W.L. +1.0m
		:	L.W.L. ±0.0m
④	Residual water level	:	D.L. +0.33m
⑤	Seismic coefficient	:	kh = 0.15
⑥	Surcharge	:	$1.0t/m^2$ (Ordinary)
		:	$0.5t/m^2$ (Earthquake)
⑦	Objective ship tonnage	:	700 GRT (Queen Salamasina Class)
⑧	Soil conditions		
	backfilling material	:	$\gamma = 1.8t/m^3$, $\gamma' = 1.0t/m^3$, $\phi = 40^\circ$
	rubble	:	$\gamma = 1.8t/m^3$, $\gamma' = 1.0T/m^3$, $\phi = 40^\circ$, $qta = 50t/m^2$
⑨	Friction coefficient		
	concrete against concrete	:	0.5
	concrete against rubble	:	0.6
⑩	Allowable safety factor		
	against sliding	:	1.2 (Ordinary), 1.0 (Earthquake)
	against overturning	:	1.2 (Ordinary), 1.0 (Earthquake)

14. Typical cross section is shown in Fig. 4.2.3.

(2) Dolphin

i) Design Condition

①	Crown level	:	D.L. +2.0m
②	Design depth	:	D.L. -4.0m
③	Tidal level	:	H.W.L. +1.0m
		:	L.W.L. ±0.0m
④	Residual water level	:	D.L. +0.33m
⑤	Objective ship tonnage	:	700GRT (Queen Salamasina Class)
⑥	Soil condition	:	N-value = 30

15. Typical cross section is shown in Fig. 4.2.4.

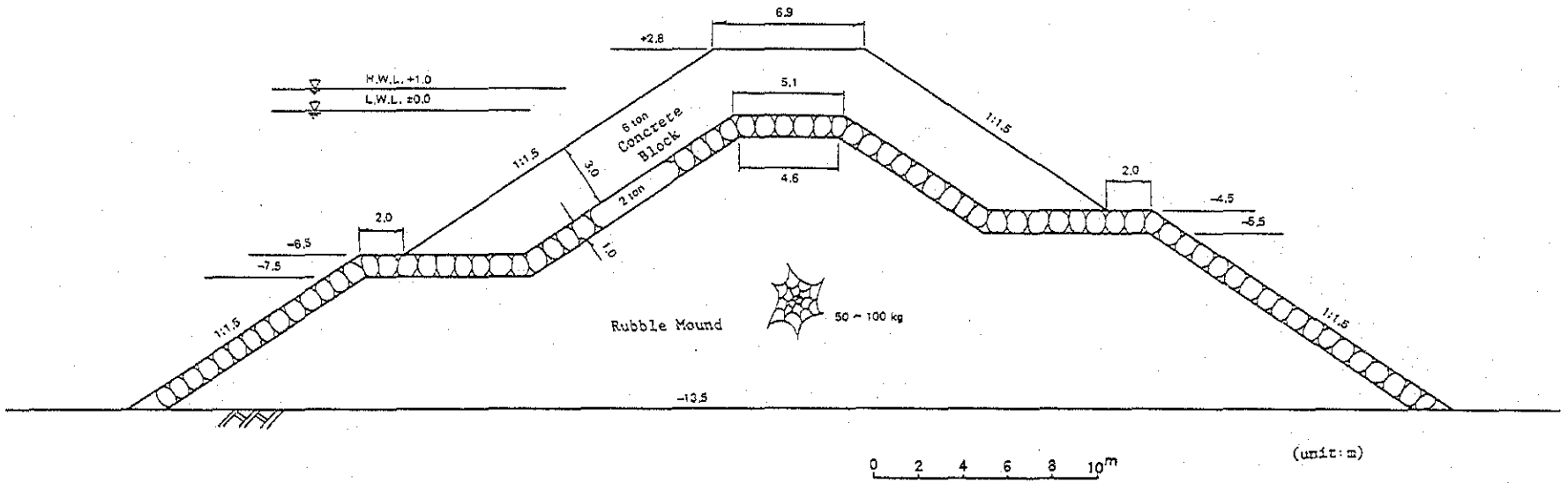


Fig. 4.2.1 Corss Section of Breakwater (Alternative A)

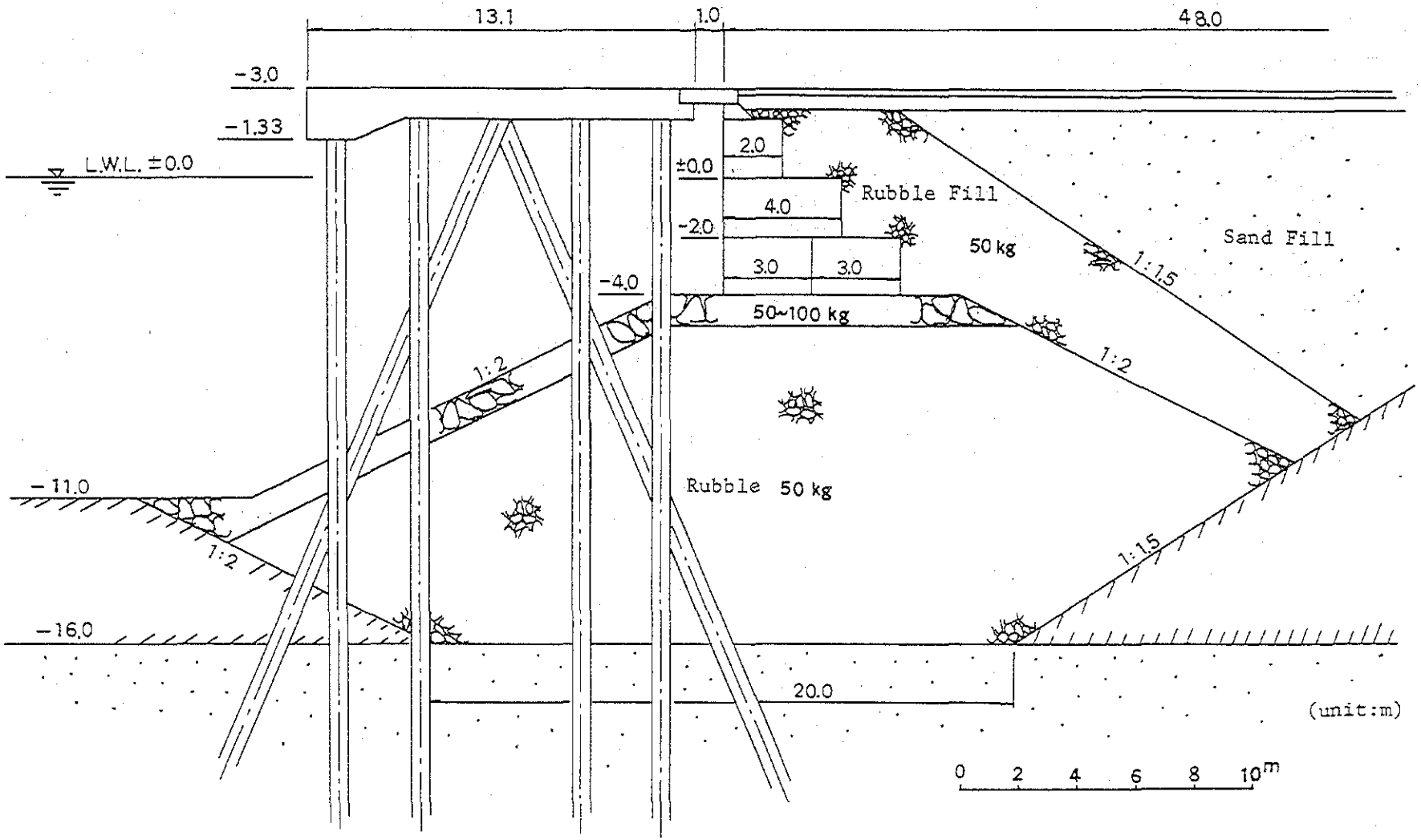


Fig. 4.2.2 Cross Section of Expanded Container Yard

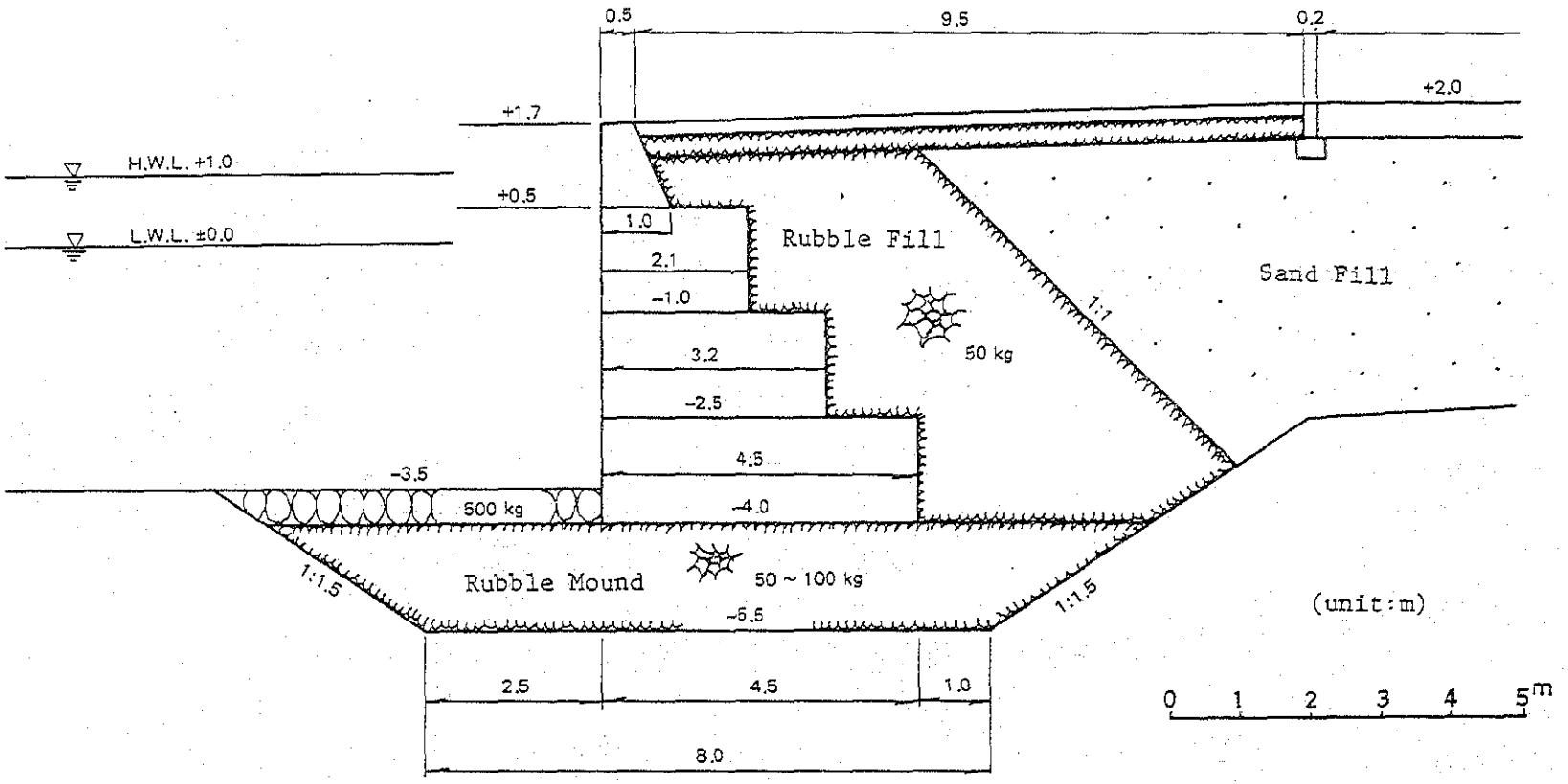


Fig. 4.2.3 Cross Section of Quaywall

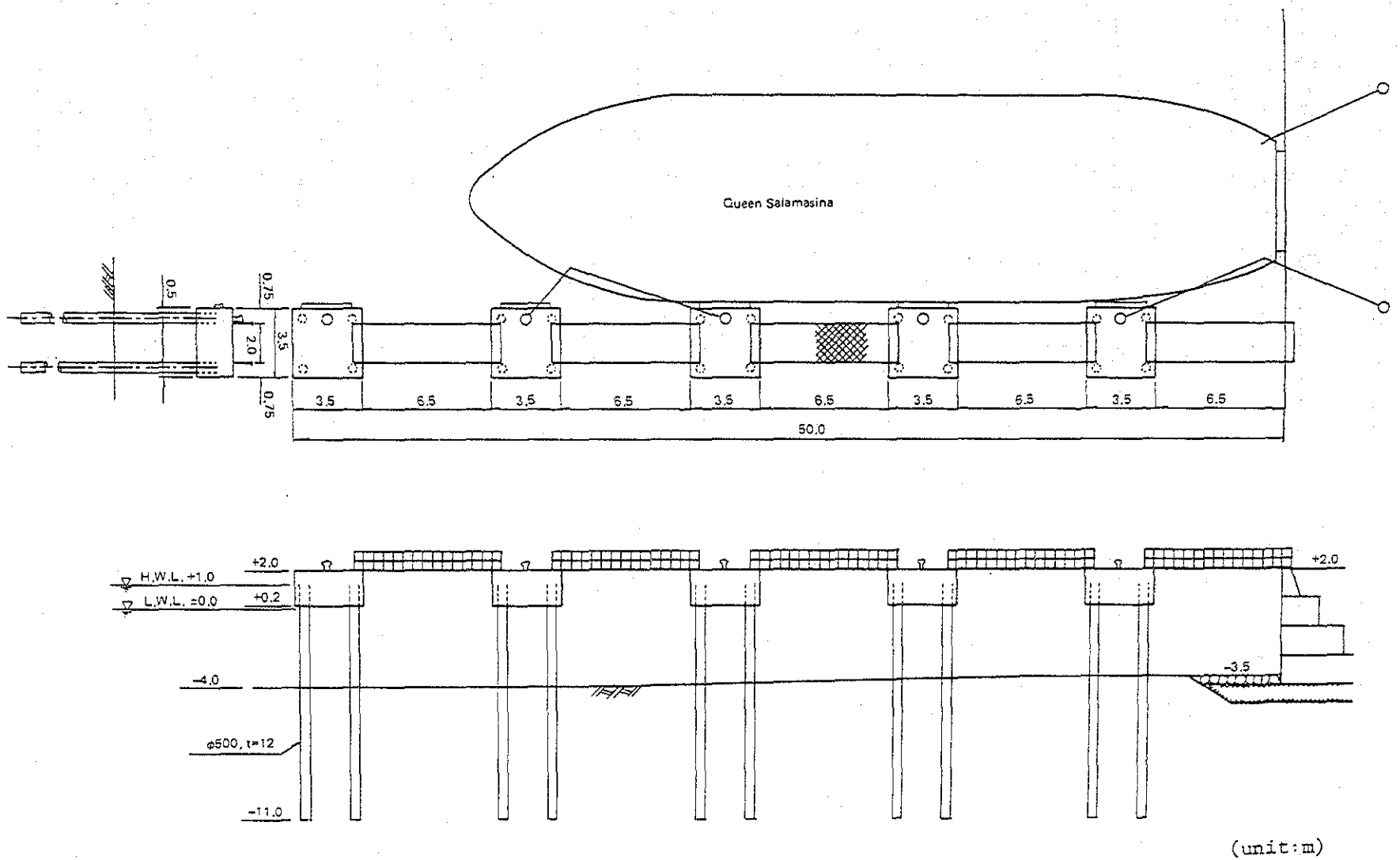


Fig. 4.2.4 Dolphin for Ferry Terminal

4-3 Construction Plan and Cost Estimation

16. This chapter describes the construction plan and the cost estimation of the First Stage Plan.

1) Construction Plan for the First Stage Plan

17. The First Stage Plan of Apia Port includes the following major project items:

① Repair Work of the Main Wharf
② Construction of the Breakwater
③ Construction of the Ferry Terminal
④ Expansion of the Container Yard
⑤ Purchase of a Tugboat
⑥ Lighting of the Existing Mooring Buoys
⑦ Engineering Services

18. In planning, special attention has been paid to minimizing the utilization of foreign materials and equipment and maximizing the use of locally available resources. Further, the construction method has been selected through consideration of the local conditions.

(1) Detailed Design

19. Before the actual construction work begins, the detailed engineering study will be conducted. The detailed engineering services are scheduled to commence in 1988 and will be completed within 7 months from the starting date. In this period, detailed field investigations will be carried out on soil conditions, corrosion of the H-shaped steel piles of the existing main wharf, construction material availability, etc.

20. Since the project will involve large-scale stone works for the construction of the breakwater and the ferry terminal area, special attention should be paid to the investigation on a quarry site, the physical property of the stone, production rate, transportation method/distance and material cost.

21. The soil survey carried out for this study is not detailed enough for the detailed design services and a further boring investigation covering the planned project area should be conducted. Also, a further detailed corrosion survey on the steel piles of the main wharf should be conducted for planning the countermeasure against deterioration of the wharf.

22. The detailed structural design will be prepared for all the structures included in the First Stage Plan. Then the project cost will be estimated in detail based on the bill of quantity and the construction schedule. Special attention will be paid to ensure that the construction work does not interfere with regular port operations.

23. A set of tender documents will be prepared. The tendering procedure is estimated to take about 5 months until the contract is awarded.

(2) Mobilization

24. After the award of the contract, the construction material and equipment will be mobilized to the project site within a period of about 4 months including preparation, transportation and customs clearance of the construction material/equipment.

(3) Repair of the Main Wharf

25. The repair works of the existing main wharf consist of anti-corrosion measures to prolong the remaining life of the wharf and repair/renewal of the curbings and rubber fender to improve safety.

26. According to the underwater survey on the steel piles, the concrete sleeve has spalled off and the steel piles are exposed in some cases. To ensure the stability of the piles in the future, adequate anti-corrosion measures are imperative and an aluminum galvanic method is adopted considering the ease of installation and maintenance. The aluminum section will be welded to the cleaned surface of the steel piles before the formation of the rubble slope.

27. According to the visual survey, ten rubber fenders are damaged and

nine curbings are missing as mentioned former chapter. They will be repaired/renewed in the early stage of the project.

28. The Repair works of the main wharf will take three months.

(4) Construction of the Breakwater

29. The construction of the breakwater is one of the major items of this project. This work involves approximately 60,000m^3 of stone material. The core of the breakwater consists of small size stone weighing 50 - 100 kg, and this mound will be covered by an armour layer of 1 ton rubble. The crown of the breakwater will be protected by wave dissipating concrete blocks weighing 6 tons.

30. These stone materials can be supplied from coconut and cocoa plantations. The quantity of the material available in the plantations is roughly estimated as 100 m^3/hactare. Therefore, the required total area is 6 km^2.

31. The supply capacity of the stone material in the plantations is sufficient. However, the stone is scattered over the ground land area. Therefore, special attention should be paid to the method and equipment for collection and transportation of the stone.

32. The crown of the breakwater will be protected by wave dissipating concrete blocks weighing 6 tons. Special attention should be paid to the method of curing the concrete in hot weather.

(5) Construction of the Ferry Terminal

33. The construction work of the ferry terminal includes five sets of berthing and mooring dolphins, a 45m long gravity type quaywall, a two-story terminal building with a floor area of 710 m^2 and pavement of 3600m^2.

34. The work will be completed within a 13 month period and the terminal will be in service 10 months after the commencement of the project. The construction schedule of the ferry terminal is planned so that it will not

interrupt the present ferry service, i.e. the existing ferry ramp will be demolished at the final stage of the construction of the new terminal after the new ramp and the berthing/mooring dolphins are ready for service.

(6) Expansion of the Container Yard

35. Reclamation of the water area behind the main wharf is scheduled to commence at the initial stage of the construction period. This is so scheduled in order to secure the required settlement period of the reclaimed land area.

36. As mentioned in the former chapter, the top layer of the sea bed behind the main wharf is poor in strength and is planned to be removed to avoid subsidence and to secure stability against a circular slip at the front rubble mound slope. The work will be scheduled in such a way that the interference with regular cargo handling operations on the wharf and the access bridges will be minimized.

37. Demolition of the northern access bridge will be executed at the first stage, and dredging and reclamation works will begin at the northern area enclosed by the wharf, two access bridges and the existing rubble slope. After the completion of the northern revetment for alternative access from the existing container yard to the wharf, the southern access bridge will be demolished and dredging and reclamation works will be continued.

38. A retaining rubble slope mound will be formed under and adjacent to the existing main wharf and in this work special attention should be paid not to damage the steel piles of the existing main wharf. The placing work of stone is planned to be executed by chutes and small flat barges.

39. The pavement of the reclaimed land area will be carried out after settlement of the reclaimed area to avoid nonuniform subsidence of the pavement.

(7) Tugboat

40. The specifications of the tugboat to be purchased are as follows.

Tonnage	180 GT
Engine Power	1,500 HP (750 HP x 2)
Propeller	Twin

41. The tugboat will be ordered immediately after the contract is signed, and the construction work and delivery to the port will take about 6 months.

(8) Lighting of the Existing Mooring Buoys

42. The existing mooring buoys are not lighted, and will be lighted to avoid possible collisions at nighttime.

(9) Construction Equipment

43. For the execution of the project, many kind of construction equipment are required. The major construction equipment to be used is listed below.

	Machinery	Capacity	Number
①	Crawler Crane	50 t	1
②	"	35 t	1
③	Truck Crane	15 t	1
④	Bulldozer	11 t	1
⑤	Tractor Shovel	1.8 m^3	1
⑥	Motor Crawler	3.1 m	1
⑦	Tire Roller	8 - 20 t	1
⑧	Macadam Roller	19 - 20 t	1
⑨	Asphalt Finisher	2.4 - 4.5 m	1
⑩	Dump Truck	8 - 11 t	6 - 10
⑪	Viblo Hammer	40 KW	1
⑫	Concrete Plant	0.5 m^3	1
⑬	Asphalt Plant	20 t	1
⑭	Pontoon	500 t	1
⑮	"	350 t	1
⑯	Soil Barge	300 m^3	2
⑰	Tug Boat	300 ps	1
⑱	Anchor Boat	100 ps	1

⑲	Diving Boat	30 ps	2

(10) Construction Material

44. Major construction material to be used for the project is listed as bellow.

	Material	Quantity
①	Sand/Stone	130,000 m^3
②	Cement	2,400 t
③	Asphalt	150 t
④	Steel Pile	30 t
⑤	Steel Bar	80 t
⑥	Heavy Oil	170 kl
⑦	Light Oil	120 kl

(11) Quarry Site

45. As mentioned before, the project involves large-scale stone works. Major quarry sites on Upolu Island are listed as follows.

	Site	Material	Distance from the Wharf (km)
①	Moamoa	Aggregate and Crusher Run	8
②	Alafua	"	8
③	Olo	"	40
④	Falefa	"	32
⑤	Puipaa	Rubble Mound	10
⑥	Laulii	Scoria for Fill	13
⑦	Solosolo	Sand for Concrete	16
⑧	Vaitele	Sand for Fill	8

(12) Construction Schedule

46. The construction schedule is shown in Table 4.3.1. The total project period is estimated at three years from the detailed engineering study to the completion of the construction work, and actual construction works are

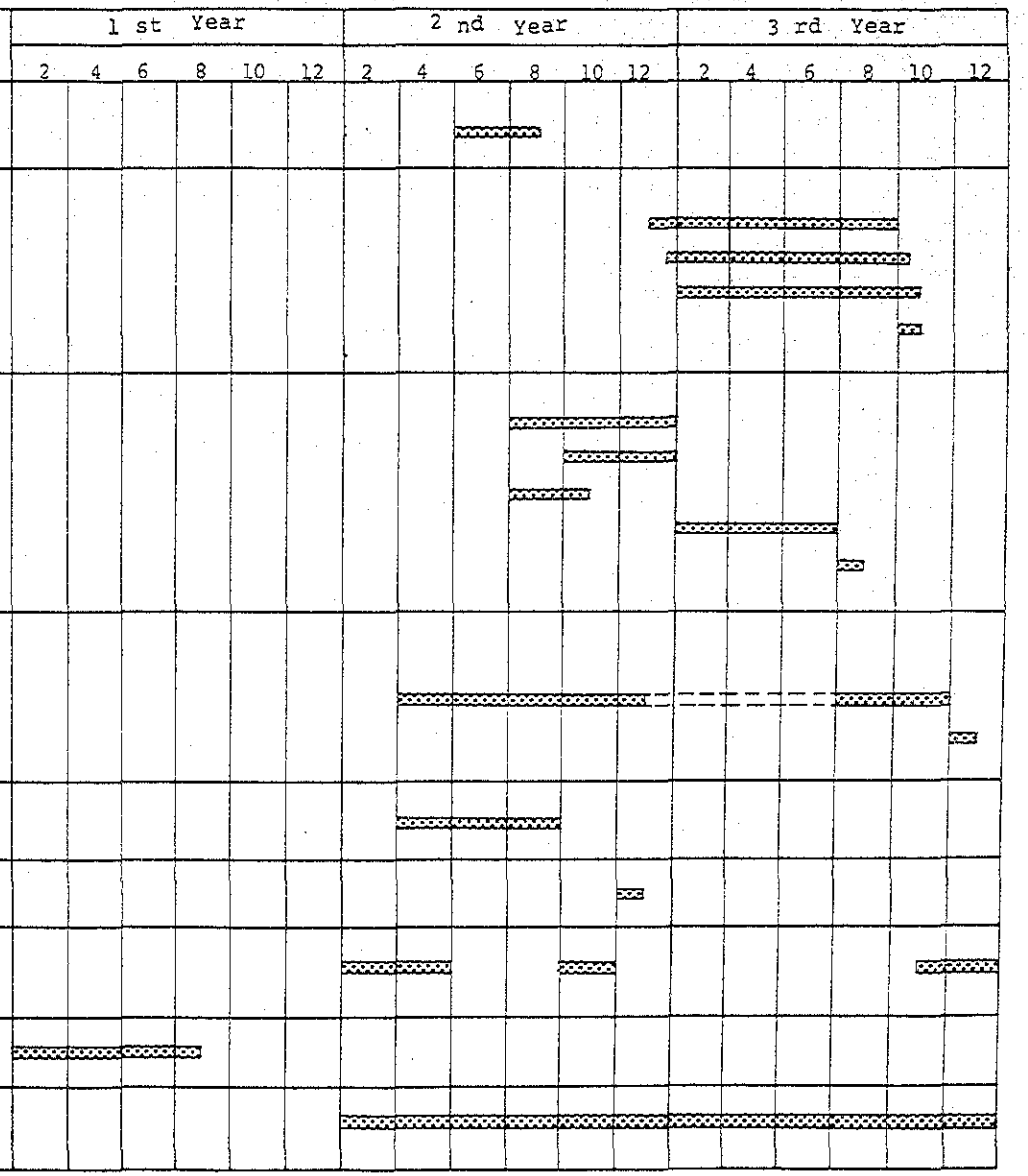
estimated to be completed within a two year period. All the facilities will be in service in 1991.

47. In the above planning, the total number of working days per year is assumed as 250 days, excluding holidays and nonworkable days due to adverse weather. The total construction period is governed by the supply condition of stone material, and in planning the construction schedule special attention has been paid to spreading the project items requiring stone material evenly over the entire construction period.

48. The total project period is estimated at three years from the detailed engineering study to the completion of the construction work, and all the facilities will be in service in 1991.

Table 4.3.1 Construction Schedule for the First Stage Plan of Apia Port

No.	Description	Unit	Quantity
1.	Repair of Main Wharf	L.S.	1
2.	Breakwater		
	(1) Rubble Mound	m^3	50,800
	(2) Armour Stone(1 ton)	m^3	10,500
	(3) Concrete Block(6 ton)	pcs	1,670
	(4) Lighhouse	pcs	1
3.	Ferry Terminal		
	(1) Reclamation	m^3	10,300
	(2) Quaywall	m	45
	(3) Dolphin	m	50
	(4) Terminal Building	m^2	600
	(5) Pavement	m^2	3,600
4.	Expansion of Container Yard		
	(1) Reclamation	m^3	59,000
	(2) Pavement	m^2	6,000
5.	Tugboat (1500 HP)	pcs	1
6.	Buoy Lighting	pcs	4
7.	Mobilization and Demobilization	L.S.	1
8.	Detailed Design	L.S.	1
9.	Construction Supervision	L.S.	1



2) Cost Estimation for the First Stage Plan

49. The project cost for the First Stage Plan is shown in Table 4.3.2 and the total cost is estimated at about 23 million WS$. The prerequisites of the cost estimation are presented below.

(1) Exchange Rates

50. The exchange rates among various currencies are based on the official rates at the time of cost estimation as follows.

1.0 WS$ = 0.48US$
1.0 WS$ = 73 Japanese Yen

All the project costs are indicated in Western Samoa Dollars (WS$).

(2) Tax Exemption

51. It is assumed that no import tax is levied on the construction materials and equipment brought in from overseas.

(3) Physical Contingency

52. The physical contingency is set at 15% for civil works. No contingency is assumed for building works and engineering services, and no contingency is made for inflation.

(4) Project Cost

53. The main construction materials required for the project are various sizes of stone for the breakwater and reclamation work. It is confirmed that the stone material is locally available at a reasonable price and an acceptable daily supply rate. This is also true for the sand and aggregate for concrete work. However, none of the steel materials are locally available, and they must all be imported.

54. The heavy construction equipment required for this type of large-scale marine work is not locally available and must be mobilized from overseas. A limited number of construction machines such as dump trucks and mobile cranes are locally available.

55. The project cost has been estimated on the basis of the unit prices and quantities of each project item according to the construction schedule. The cost has been estimated for the foreign and local currency portions separately with a further breakdown into material and labor costs. The local portion includes the cost of stone material, fuel, and minor construction equipment.

56. The total project cost is estimated at about 23 million WS$ consisting of about 16 million WS$ for the foreign portion (70%) and about 7 million WS$ for the local portion (30%). The four major items of the project comprise about 70% of the total project cost, i.e. 22% for the breakwater, 14% for the ferry terminal, 22% for the expansion of container yard and 12% for the tugboat.

Table 4.3.2 Construction Cost for the First Stage Plan

(Unit: 1,000 WS$)

Item	1st Year						2nd Year						3rd Year						Total					
	For-eign	Local				Total	For-eign	Local				Total	For-eign	Local				Total	For-eign	Local				Total
		Other	U.S.L	S.L.	Total			Other	U.S.L	S.L.	Total			Other	U.S.L	S.L.	Total			Other	U.S.L	S.L.	Total	
1 Wharf repair	0	0	0	0	0	0	477	11	0	8	19	496	0	0	0	0	0	0	477	11	0	8	19	496
2 Breakwater	0	0	0	0	0	0	259	215	10	13	238	497	2,331	1,931	94	119	2,144	4,475	2,590	2,146	104	132	2,382	4,972
3 Ferry terminal	0	0	0	0	0	0	1,152	296	49	87	432	1,584	1,152	296	49	87	432	1,584	2,304	592	98	174	864	3,168
4 Yard expansion	0	0	0	0	0	0	1,235	1,161	60	84	1,305	2,540	1,235	1,161	60	84	1,305	2,540	2,470	2,322	120	168	2,610	5,080
5 Tug boat	0	0	0	0	0	0	2,740	0	0	0	0	2,740	0	0	0	0	0	0	2,740	0	0	0	0	2,740
6 Buoy lightings	0	0	0	0	0	0	16	0	0	0	0	16	0	0	0	0	0	0	16	0	0	0	0	16
7 Mobilization	0	0	0	0	0	0	2,877	0	0	0	0	2,877	0	0	0	0	0	0	2,877	0	0	0	0	2,877
S. Total	0	0	0	0	0	0	8,756	1,683	119	192	1,994	10,750	4,718	3,388	203	290	3,881	8,599	13,474	5,071	322	482	5,875	19,349
8 Detailed design	678	0	0	34	34	712	0	0	0	0	0	0	0	0	0	0	0	0	678	0	0	34	34	712
9 Supervision	0	0	0	0	0	0	315	0	0	0	0	315	315	0	0	0	0	315	630	0	0	0	0	630
10 Contingency	0	0	0	0	0	0	468	252	18	29	299	767	708	508	30	44	582	1,290	1,176	760	48	73	881	2,057
S. Total	678	0	0	34	34	712	783	252	18	29	299	1,082	1,023	508	30	44	582	1,605	2,484	760	48	107	915	3,399
G. Total	678	0	0	34	34	712	9,539	1,935	137	221	0 2,293	0 11,832	5,741	3,896	233	334	4,463	10,204	15,958	5,831	370	589	6,790	22,748

Abbreviation: U.S.L: Un-skilled Labor S.L.: Skilled Labor

CHAPTER 5
ECONOMIC ANALYSIS

Chapter 5 Economic Analysis

5-1 General

1. In this chapter, the feasibility of the First Stage Plan of the project is analyzed from the economic point of view, considering the economic costs and benefits.

The goal of the analysis is to determine whether the net benefits of the project exceed those which could be derived from other investment opportunities in Western Samoa.

2. The economic internal rate of return (EIRR) based on cost-benefit analysis is used in order to appraise the feasibility of the project. In estimating the economic cost and benefit of the First Stage Plan, shadow pricing is applied.

3. Shadow pricing here refers to the appraisal of benefits and costs in terms of international prices (border prices). Fig. 5.1.1 shows the flow chart of the economic analysis procedure.

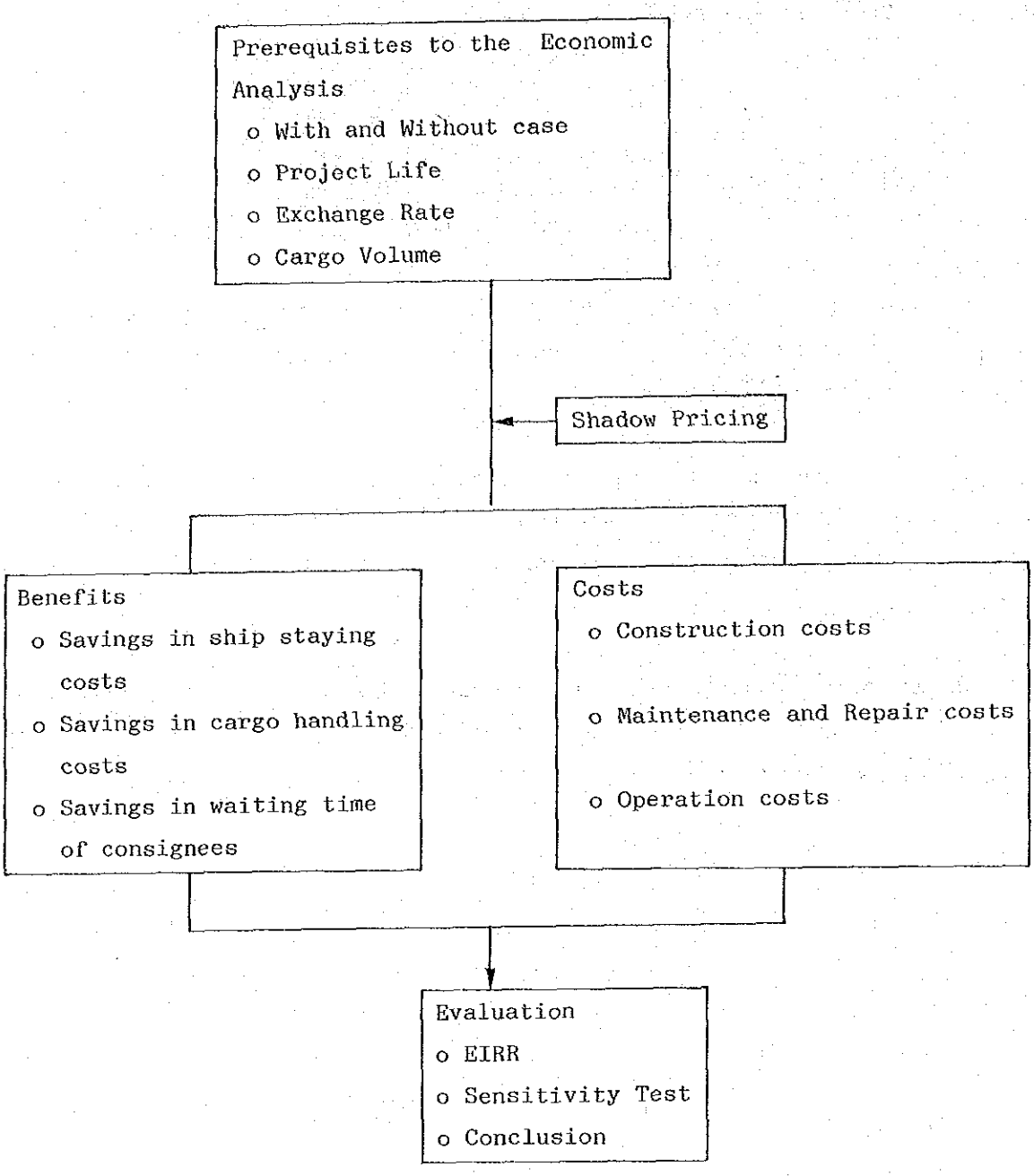


Fig. 5.1.1 Flow Chart of the Economic Analysis Procedure

5-2 Prerequisites to the Economic Analysis

1) "Without" case

4. The cost-benefit analysis is conducted on the difference between the "With" and "Without" investment cases. Therefore, determing the "Without" case is a very important part of the economic analysis.

5. The "With" case is presented in Chapters III and IV, above.

After considering various possibilities, the following conditions are adopted as the "Without" case.

① The main wharf at Apia port is not rehabilitated. So, the cargoes excluding mineral oil and coconut oil are handled offshore at Apia port.

② For container ships with Ro/Ro facilities, the container cargo is handled utilizing ship gear as in the port.

③ The container handling time between the apron and the container storage yard is not reduced because the containers can not be stored directly behind the main wharf.

④ The number of available days for container cargo handling does not increase because the breakwater is not constructed under the without case.

⑤ The waiting time for consignees at the customs gate of the ferry terminal at Apia port is not reduced because the condition of the ferry terminal is not improved under the without case.

2) Cargo Volume

6. The general cargo volume each year at Apia port is calculated based on the cargo forecast presented in Chapter 2. Table 5.2.1 shows the general cargo handling volume from 1990 to 2005 at Apia port.

Table 5.2.1 General Cargo Handling Volume at Apia Port

(Unit: '000 tons)

Year	Cargo Volume
1990	159.0 (10.9)
91	165.7 (11.5)
92	172.8 (12.0)
93	180.2 (12.5)
94	187.9 (13.0)
95	195.9 (13.5)
96	204.2 (14.1)
97	212.9 (14.7)
98	222.2 (15.4)
99	231.5 (16.0)
2000	241.0 (16.7)
01	251.6 (17.4)
02	262.4 (18.2)
03	273.6 (18.9)
04	285.2 (19.8)
05	297.4 (20.6)

( ) : Ferry cargo at Apia port, outside the general cargo handling volume

7. The project life of the First Stage Plan is assumed to be 18 years from the beginning of the construction (from 1988).

8. The exchange rate adopted for this study is the following rate from early in 1987.

1 WS$ = 73 Japanese Yen = 0.48 US$

5-3 Shadow Pricing

1) Methodology

9. Most of the data used to calculate the benefits and costs are expressed in market prices. The labor cost at market prices is often influenced by a minimum wage system. The local currency portion of the goods and materials at market prices often include customs duties. So, market prices often do not express the true costs from the economic point of view.

10. In this study, the labor cost in the local currency portion is changed to the economic cost using the Shadow Wage Rate. The economic value of goods and materials which include imported materials is calculated by subtracting the customs duty from the market prices.

2) Calculation of the Conversion Factors

(1) Conversion Factor for Consumption (CFC)

11. The conversion factor for consumption is usually used for changing the market price of consumer goods to economic prices. However, this factor is mainly used for calculating the shadow wage rate in this report.

12. The conversion factor for consumption is calculated by the following formula.

$$CFC = \frac{Ic + Ec}{(Ic + Dic) + (Ec - Dec)}$$

Ic : Total amount of imports of consumer goods

Ec : Total amount of exports of consumer goods

Dic: Total amount of import duty on consumer goods

Dec: Total amount of export duty on consumer goods

13. However in this study, due to a lack of the required data for calculating the conversion factor for consumption, the conversion factor for consumption can not be calculated directly, so, the standard conversion factor (SCF) is used to substitute for the conversion factor for

consumption (CFC) because the SCF is not so different from the CFC.
The standard conversion factor is calculated by the following formula.

$$SCF = \frac{I + E}{(I + Di) + (E + De)}$$

where

I : Total amount of imports

E : Total amount of exports

Di : Total amount of import duty

De : Total amount of export duty

The SCF is calculated as shown in Table 5.3.1

Table 5.3.1 SCF Calculation from 1981 to 1983

(Unit: 1000 WS$)

Year	1981	1982	1983
Import Value (CIF)*1	70,622	61,463	75,328
Export Value (FOB)*1	11,668	15,664	26,998
Import Duties *2	10,148	12,292	17,187
Export Duties *2	218	167	257
(Export Surcharge)			
SCF (each year)	0.89	0.86	0.86

Source:*1 Return of the Trade, Commerce and Shipping of Western Samoa for the Calender Year 1983

*2 The 1985 Budget Statment

$$SCF = \frac{089 + 0.86 + 0.86}{3} = 0.87$$

SCF = CFC

then

CFC = 0.87

(2) Shadow Wage Rate

14. The economic value of labor cost is generally measured by its opportunity cost (the value of lost marginal production for other purposes arising from the additional employment of a laborer for this project).

15. In general, the conversion factor for labor in developing countries is calculated using the following formula.

$$\text{The Conversion Factor for Labor} = \frac{\text{The Opportunity Cost of Labor}}{\text{Market Wage}} \times \text{Conversion Factor for Consumption}$$

16. In this project, the cost of skilled labor is calculated based on actual market wages, assuming that the market mechanism is functioning properly. So, the opportunity cost for skilled labor is equal to the market wage. Thus, the conversion factor for skilled labour is calculated by multiplying the nominal wage rate by the conversion factor for consumption.

$$\text{Conversion factor for skilled labour} = \text{Nominal wage rate} \times \text{CFC} = 1 \times 0.87 = 0.87$$

17. The economic cost of unskilled labour can be calculated based on a simplified measure of the opportunity cost considering the productivity of the agricultural sector. As the wages paid to unskilled laborers usually exceed the opportunity cost, these market wages should not be used for calculating the economic value of the unskilled labor. So, the conversion factor for unskilled labor is calculated by multiplying by the ratio between the shadow wage rate and the market wage.

18. The shadow wage rate is obtained by the following formula.

$$SWR = C - \frac{1}{S}(C - m)$$

SWR : Shadow wage rate

C : Market wage

m : Opportunity cost

S : Premium for saving

Here, it is assumed that the premium for saving does not influence the project. So then S = 1, and thus SWR = m.

19. The number of working days for agricultural laburers is assumed to be 22 days per month. The opportunity cost (m) is obtained by the following formula.

$$m = \frac{GDPa}{Pa \times 12 \times 22}$$

where

GDPa : Total GDP of Agriculture, Forestry and Fishery

Pa : Total number of Agriculture, Forestry and Fishery Workers

20. Thus, the conversion factor of unskilled labor (CFLu) is obtained by the following formula.

$$CFLu = \frac{SWR}{Wn} \times SCF$$

where

CFLu : Conversion factor of unskilled labor

Wn : Nominal wage

21. The conversion factor of unskilled labor is calculated in Table 5.3.2.

Table 5.3.2 Caluculation of Conversion Factor for Unskilled Labor

(1980 prices)

Year	Unit	1981	1982	1983
Total number of Agriculture, Forestry and Fishery Workers	Persons	25,050	25,385	25,715
Total GDP of Agriculture, Forestry and Fishery Sector	'000W$	11,659	13,621	13,313
SWR = Opportunity Cost	W$/day	1.76	2.03	1.96
Nominal wage	W$/day	2.90	0.86	0.86
Standard Conversion Factor	-	0.89	0.86	0.86
Conversion Factor for Unskilled Labor	-	0.54	0.58	0.50

$$CFLu = \frac{0.54 + 0.58 + 0.50}{3} = 0.54$$

5-4 Benefits

1) Benefit Items

22. Considering the current situation presented in Chapter 1, the cargo volume forecast in Chapter 2, the port planning in Chapter 3, and the First Stage Plan presented in Chapter 4, the following items are identified as benefits of the First Stage Plan.

① Tangible Benefits

- o Savings in ship staying costs from the construction of the breakwater and from the rehabilitation of the Main Wharf.
- o Saving in cargo handling costs.
- o Saving in the waiting time of consignees at the customs gate at the ferry boat terminal.

② Intangible Benefits

- o Reduction in damages and pilferage of cargoes.
- o Reduction in damages and accidents of ships.
- o Improvement of cargo handling safety.
- o Increase in employment opportunities.
- o The multiplier effect of the investment of the First Stage Plan

2) Benefits from Savings in Ship Staying Costs

23. Benefits from savings in ship staying costs originate from the difference of ship staying costs between the with case and the without case. In other words, the benefits from savings in ship staying costs originates from the difference between the ship staying costs for cargo handling at berth under the with case and the ship staying costs for offshore cargo handling under the without case.

24. If the main wharf is not rehabilitated and the breakwater is not constructed, a pontoon will have to be used for offshore handling in relatively unsheltered seas. The sheltering efficiency of the proposed breakwater is shown in Table 5.4.1.

Table 5.4.1 Sheltering Efficency of the Proposed Breakwater

(Unit: days/year)

Wave Height (In front of the berth)	Without case (1)	With case (2)	(1) - (2)
0.5m - 0.7m	9.0	4.0	5.0
0.7m or more	13.0	1.0	12.0

It is assumed that the working efficiencies of cargo handling between ships and quay, ships and pontoon, and pontoon and quay are as follows:

$h < 0.5m$ ⟶ Eco = 16.5 units/hour
Ecv = 17.0 tons/hour (Good condition)

$0.5m \leqq h \leqq 0.7m$ ⟶ Eco = 10.0 units/hour
Ecv = 10.0 tons/hour (Bad condition)

$h > 0.7m$ ⟶ Eco = Ecv = 0 (Impossible condition)

Where h : Wave height in front of the main wharf
Ec : The working efficiency of container cargo handling (Except Ro/Ro system)
Ecv: The working efficiency of conventional cargo handling (Except liquid bulk cargo)

25. The estimate of these working efficiencies is based on a survey of shipping companies and shipping agents. The saving in vessels' staying cost is primarily realized by shipping companies. For foreign vessels, the benefit accrues to foreign countries. However, some portion of the benefits should be returned to Western Samoa. In this study, the study team assumes that 50% of the benefits attributed to foreign vessel operators will be transferred to the Western Samoan economy. The avarage share of Western Samoan vessels in the country's foreign trade is about 20%. Therefore, the total benefit to the Western Samoan economy from the reduced staying costs is the sum of the direct benefits (100%) from Western Samoan vessels and the indirect benefits (50%) from foreign vessels.

26. The benefits from the savings in ship staying costs are obtained using the following formulas.

Total savings in vessel staying costs per ton = Saving in vessel costs from rehabilitaion of the main wharf per ton + Saving in vessel staying from construction of the breakwater per ton

$$\text{Savings in vessel staying cost from rehablitation of the main wharf per ton} = \frac{\left(\text{Staying time per ship for offshore cargo handling} - \text{Staying time per ship for cargo handling at berth}\right) \times \text{Vessel staying cost per unit time} \times \text{Number of Vessels per year}}{\text{Annual cargo handling volume}}$$

$$\text{Savings in vessels staying cost from construction of the breakwater per ton} = \Big\{\Big(\big(\text{Number of impossible days for cargo handling under the without case} - \text{Number of impossible days for cargo handling under the with case}\big) \times \text{Berth occupancy rate under the without case}\Big) + \big(\text{Number of bad days for cargo handling under the without case} \times \text{Berth occupancy rate under the without case}\big) - \big(\text{Number of bad days for cargo handling under the with case} \times \text{Berth occupancy rate under the with case}\big)\Big\} \times \text{Vessel staying cost per day} \div \text{Annual general cargo volume}$$

27. The result of the calculation is shown in Table 5.4.2. (Refer to Appendix 2.).

Table 5.4.2 Benefits from Savings in Ship Staying Costs

(Unit: 1000 ws$)

Year	92	93	94	95	96	97	98	99	2000	2001	2002	2003	2004	2005
Benefit	93	1793	1835	1924	1954	2087	2138	2198	2273	2341	2408	2393	2456	2524

3) Benefits from Savings in Cargo Handling Costs

28. The benefits from the savings in cargo handling costs originate from three items. One is the difference between the cargo handling cost at berth under the with case and the offshore cargo handling cost under the without case, another is the increase of good condition days for cargo handling from the construction of the breakwater under the with case and the third is the reduced cargo handling cost from reclamation behind the main wharf under the with case.

29. If the area behind the main wharf is reclaimed, Ro-Ro vessels will be able to use their equipment efficiently.

30. The benefits from the savings in cargo handling cost are obtained using the following formulas.

Savings in cargo handling costs = Savings in cargo handling costs from rehabilitaion of the main wharf + Savings in cargo handling costs from construction of the break-water + Savings in cargo handling cost from centralized container storage + Savings in cargo handling cost from use of the Ro/Ro system

Per ton savings in cargo handling costs from rehabilitation of the Main Wharf = (Cargo handling cost per ton between vessel and pontoon + Cargo transport cost per ton between vessel and apron + Cargo handling cost per ton between pontoon and apron) - cargo handling cost per ton between vessel and apron under the with case

Savings in cargo handling costs from construction of the breakwater per ton = (Number of hours in a year in good condition for cargo handling under the with case - Number hours in a year in good condition for cargo handling under the withoust case) x (Number of actual cargo handling hours per year / Number of hours per year) x Cargo handling cost per in good condition under the with case / Annual general cargo handling volume

Per TEU savings in cargo handling costs = (Carrying time of contaners between apron and container yard under the without case per TEU x Carrying cost of cargo per unit time)

- (Carrying time of containers betweem apron and container yard under the with case x Carrying cost of cargo per unit time)

Per ton savings in cargo handling from use of the Ro/Ro system = (Cargo handling time per ton for Lo/Lo system x Cargo handling cost per hour for Lo/Lo system) - (Cargo handling time per ton for Ro/Ro system x Cargo handling cost per hour for Ro/Ro system)

31. The results of the calculation are shown in Table 5.4.3 (Refer to Appendix 4).

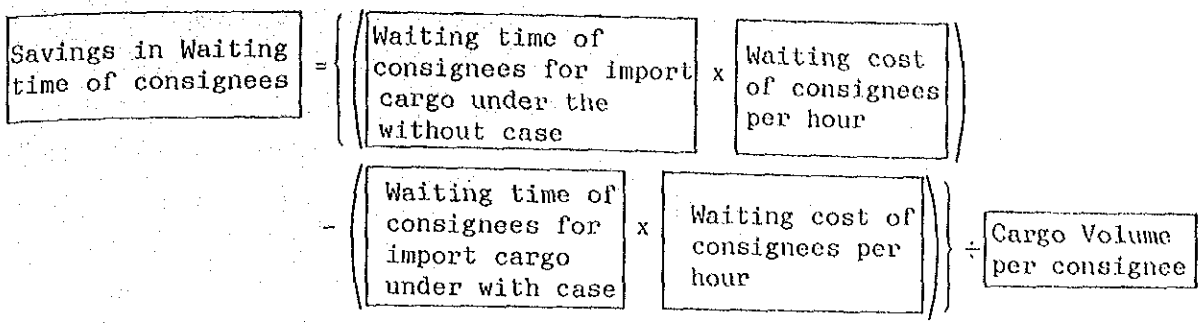
Table 5.4.3 Benefits from Savings in Cargo Handling Costs

(Unit: 1000 ws$)

Year	92	93	94	95	96	97	98	99	2000	2001	2002	2003	2004	2005
Benefit	124	2855	2870	2862	2843	2847	2866	2827	2830	2832	3062	3060	3105	3161

4) Benefits from Savings in Waiting Time of Consignees

32. The benefits from the savings in the waiting time of consignees is the difference of the customs gate at the ferry boat terminal between the "With" case and the "Without" case. It is calculated based on the difference of the waiting time under the cases and the per unit time cost of waiting. The number of gates will be 3 under the "With" case and only 1 under the "Without" case. So, the waiting cost of consignees under the "With" case will be reduced in comparison with the cost under the "Without" case. The waiting time of the consignees will be reduced by about 30 percent under the "With" case. The benefits from the saving in the waiting time of consignees are obtained using the following formula.



33. The result of the calculation is shown in Table 5.4.4.

Table 5.4.4 Benefits from Reconstruction of the Ferry Terminal

(Unit: 1000 ws$)

Year	92	93	94	95	96	97	98	99	2000	2001	2002	2003	2004	2005
Benefit	7	7	7	8	8	8	9	9	9	10	10	11	11	11

5) Intangible Benefits

34. The First Stage Plan of this project shall produce various intangible benefits including:

① Reduction in damage and accidents of ships and in damage of cargoes from the improved calmness.

② Improvement of ships' operating safety at Apia port from the use of the new tug boat.

③ Reduction in the pilferage of cargoes at Apia port from the construction of the fence between the ferry terminal and other port facilities.

④ Increase in employment opportunities from the construction works of the First Stage Plan.

⑤ Multiplier effect from the investment of the First Stage Plan.

6) Benefit between 1990 and 2005

35. The total benefit of the First Stage Plan is calculated as the total of the tangible benefits calculated above.

Table 5.4.5 shows the total benefit of the First Stage Plan from 1990 to 2005.

Table 5.4.5 Total Benefit at Economic Prices

(Unit: 1000 WS$)

Year	Savings in ship Staying Costs	Savings in Cargo Handling Costs	Savings in Waiting Cost of Consignees	Total Benefit
1992	93	124	7	224
1993	1,793	2,855	7	4,655
1994	1,835	2,870	7	4,712
1995	1,924	2,862	8	4,794
1996	1,954	2,843	8	4,805
1997	2,087	2,847	8	4,942
1998	2,138	2,866	9	5,013
1999	2,198	2,827	9	5,034
2000	2,273	2,830	9	5,112
2001	2,341	2,832	10	5,182
2002	2,408	3,062	10	5,480
2003	2,393	3,060	11	5,464
2004	2,456	3,105	11	5,572
2005	2,524	3,161	11	5,696

5-5 Cost

1) Construction Cost

36. The total investment which is estimated at market prices for the First Stage Plan in 4-2 has to be converted to economic prices for the economic apprisal.

37. The labor cost in the local currency portion in the First Stage Plan is changed to economic prices using the shadow wage rate. In the local currency portion in the First Stage Plan, the cost of goods and materials which are imported from foreign countries is changed to economic prices by subtracting the customs duty from the market prices.

38. Table 5.5.1 shows the market prices and the economic prices of goods and materials by work for the local currency portion of the First Stage Plan. Table 5.5.2 shows the market prices and the economic prices of labor for the local currency portion of the First Stage Plan. Table 5.5.3 shows the market prices and the economic prices of the total construction cost of the First Stage Plan.

39. The market prices of gasoline and light oil which are controlled by the government are changed to economic prices taking the price controls into consideration.

Table 5.5.1 Market Pirces and Economic Prices of Goods and Materials in Local Currency Portion by Work

(Unti: 000 WS$)

Year	1988		1989		1990		Total	
	Market Prices	Economic Prices	Market Prices	Economic Prices	Market Prices	Enocomic Prices	Market Prices	Economic Prices
Main Wharf	-	-	3.0	1.5	-	-	3.0	1.5
Breakwater	-	-	206.0	186.2	1859.0	1678.6	2065.0	1864.8
Reclamation	-	-	1121.0	959.0	1121.0	959.0	2242.0	1918.0
Ferry Terminal	-	-	271.0	225.6	271.0	225.6	542.0	451.2
Total	-	-	1601.0	1372.3	3251.0	2863.2	4852.0	4235.5

Table 5.5.2 Market Prices and Economic Prices of Labor in Local Currency Portion by Work

(Unit: 000 WS$)

		1988		1989		1990		Total	
		Market Prices	Economic Prices	Market Prices	Economic Prices	Market Prices	Economic Prices	Market Prices	Economic Prices
Main Wharf	Skilled Labor	-	-	-	-	-	-	-	-
	Unskilled Labor	-	-	-	-	-	-	-	-
Breakwater	Skilled Labor	-	-	5.0	4.4	48.0	41.8	53.0	46.2
	Unskilled Labor	-	-	10.0	5.4	94.0	50.8	104.0	56.2
Ferry Terminal	Skilled Labor	-	-	62.0	53.9	62.0	53.9	124.0	107.8
	Unskilled Labor	-	-	49.0	26.5	49.0	26.5	98.0	53.0
Reclamation	Skilled Labor	-	-	44.0	38.3	44.0	38.3	88.0	76.6
	Unskilled Labor	-	-	60.0	32.4	60.0	32.4	120.0	64.8
Detailed Design	Skilled Labor	34.0	29.6	-	-	-	-	34.0	29.6
	Unskilled Labor	-	-	-	-	-	-	-	-
Supervision	Skilled Labor	-	-	-	-	-	-	-	-
	Unskilled Labor	-	-	-	-	-	-	-	-
Total	Skilled Labor	34.0	29.6	111.0	96.9	154.0	134.0	299.0	260.2
	Unskilled Labor	-	-	119.0	64.3	203.0	109.7	322.0	174.0

Table 5.5.3 Market Prices and Economic Prices of the Total Construction Cost
(Excluding Physical Contingency)

(Unit: 000 WSS)

Year	1988			1989			1990			Total			Grand Total
Foreign/Local Currency Portion	Foreign	Local		Foreign	Local		Foreign	Local		Foreign	Local		of
		Market Prices	Economic Prices		Market Prices	Economic Prices		Market Prices	Economic Prices		Market Prices	Economic Prices	Economic Prices
Main Wharf	-	-	-	477.0	19.0	15.4	-	-	-	477.0	19.0	15.4	492.4
Breakwater	-	-	-	259.0	238.0	210.7	2,331.0	2,144.0	1,895.6	2,590.0	2,382.0	2,106.3	4,696.3
Ferry Terminal	-	-	-	1,152.0	432.0	349.5	1,152.0	432.0	349.5	2,304.0	864.0	699.0	3,003.0
Reclamation	-	-	-	1,235.0	1,305.0	1,099.3	1,235.0	1,305.0	1,099.3	2,470.0	2,610.0	2,198.6	4,668.6
Tag Boat	-	-	-	2,740.0	-	-	-	-	-	2,740.0	-	-	2,740.0
Navigation Aids	-	-	-	16.0	-	-	-	-	-	16.0	-	-	16.0
Mobilization	-	-	-	2,877.0	-	-	-	-	-	2,877.0	-	-	2,877.0
Detailed Design	678.0	34.0	29.6	-	-	-	-	-	-	678.0	34.0	29.6	707.6
Supervision	-	-	-	315.0	-	-	315.0	-	-	630.0	-	-	630.0
Total	678.0	34.0	29.6	9,071.0	1,994.0	1,674.9	5,033.0	3,881.0	3,344.4	14,782.0	5,909.0	5,048.9	19,830.9

2) Maintenance and Repair Costs

40. The maintenace and repair costs per year for the facilities of the First Stage Plan are assumed to be 10 percent of the depreciation cost. These prices must also be converted to economic prices for the economic appraisal using the standard conversion factor. Table 5.5.4 shows the maintenance and the repair costs of the facilities in the First Stage Plan.

Table 5.5.4 Maintenance and Repair Costs

(Unit: 1000 WS$)

	Market Price	Economic Price
1990	33	29
1991	68	59
1992	68	59
1993	100	87
1994	100	87
1995	100	87
1996	100	87
1997	100	87
1998	100	87
1999	100	87
2000	100	87
2001	100	87
2002	100	87
2003	100	87
2004	100	87
2005	100	87
Total	1,469	1,278

3) Operation Cost

41. The incremental operation costs from the First Stage Plan are the personnel and fuel cost for the tugboat. These prices must be converted to economic prices for the economic analysis. The cost which is calculated at market prisces has to be converted to economic prices using the conversion factor for skilled labour and heavy oil because most of this cost assumed to be crew and fuel for the tugboat. Table 5.5.5 shows the operationcost from 1989 to 2005.

Table 5.5.5 Operation Cost

(Unit: 1000 WS$)

	Market Price	Economic Price
1990	45	30
1991	46	30
1992	46	30
1993	47	31
1994	48	31
1995	49	32
1996	49	32
1997	50	32
1998	52	33
1999	53	33
2000	53	33
2001	54	34
2002	55	34
2003	56	35
2004	57	35
2005	58	36
Total	818	521

4) Total Cost

42. Table 5.5.6 shows the total economic cost of the First Stage Plan.

Table 5.5.6 Cost at Economic Prices

(Unit: th. WS$)

Year	Construction Cost	Maintenance & Repair Cost	Operation Cost	Total
1988	708	-	-	708
1989	11,414	-	-	11,414
1990	9,500	29	30	9,559
1991	-	59	30	89
1992	-	59	30	89
1993	-	87	31	118
1994	-	87	31	118
1995	-	87	32	119
1996	-	87	32	119
1997	-	87	32	119
1998	-	87	33	120
1999	-	87	33	120
2000	-	87	33	120
2001	-	87	34	121
2002	-	87	34	121
2003	-	87	35	122
2004	-	87	35	122
2005	-	87	36	123

5-6 Evaluation

43. The EIRR of the project is calculated to be 13.40 percent for the base case in Table 5.6.1. In general, the opportunity cost of capital in developing countries ranges from 8 percent to 15 percent as shown in Table 5.6.2. Furthermore, it is generally considered that a project with an EIRR of more than 10 percent is economically feasible. Thus, the base case can be judged as feasible.

Table 5.6.1 EIRR Calculation

EIRR = 13.40%

(Unit: 1,000 WS$)

Year	Cost	Benefit	Bnft. - Cost
1988	708	0	-708
1989	11,414	0	-11,414
1990	9,559	0	-9,559
1991	89	0	-89
1992	89	245	156
1993	118	4,679	4,561
1994	118	4,737	4,619
1995	119	4,825	4,706
1996	119	4,831	4,712
1997	119	4,970	4,851
1998	120	5,042	4,922
1999	120	5,065	4,945
2000	120	5,145	5,025
2001	121	5,217	5,096
2002	121	5,517	5,396
2003	122	5,502	5,380
2004	122	5,612	5,490
2005	123	5,739	5,616
Residual Value	0	3,819	3,819
Total	23,421	70,945	47,524

Table 5.6.2 Opportunity Cost of Capital

Nation	Sector	EIRR (%)
India	Manufacturing	10 - 12
Pakistan	Agriculture	10
	Manufacturing	10
Bangladesh	Manufacturing	15
Nepal	Transport	8
Egypt	Manufacturing	8
Sudan	Agriculture	8
Gambia	Transport	10
Solomon Is.	Forestry	8
Indonesia	Power	6
Jordan	Water Supply	8

Source: O.D.M., U.K., 1975

44. Sensitivity tests are conducted to analyze changes in the EIRR based on two major factors: construction cost and cargo volume.

Table 5.6.3 Results of Sensitivity Tests

Assumption		EIRR
Case A : Construction cost	10% increase	10.93 %
Case B : Cargo volume	10% decrease	12.02 %

45. In general, the opportunity cost of capital in developing countries ranges from 8 percent to 15 percent. So, the First Stage Plan can be judged as feasible from the economic point of view because the EIRR under all cases exceeds 10%.

CHAPTER 6
FINANCIAL ANALYSIS

Chapter 6 Financial Analysis

6-1 Purpose and Methodology

1. The purpose of this chapter is to appraise the financial profitability of the First Stage Plan itself.

2. The profitability of the project itself is analysed by the financial internal rate of return (FIRR) using the discount cash flow method. The FIRR is a discount rate which makes the net present value of the cash flow (revenues minus expenditures) equal to zero. For the calculation of the FIRR, constant 1987 prices are used.

6-2 Prerequisites

1) Period of Financial Analysis

3. The financial analysis covers the 18 years from the beginning of the construction in 1988 to 2005.

2) Revenues and Expenditures

4. Incremental revenues and expenditures reflect the comparison of the "with" and "without" project cases.

(1) Revenues

5. Incremental port revenues from the First Stage Plan are calculated based on the current port tariff rate and the fundamental conditions such as the number of vessels using the tugboat, the cargo volume and the number of vessels using berth at Apia (c.f. Appendix 4). Table 6.2.1 shows the incremental port revenue.

6. Further, the revenues for the calculation of the FIRR include the residual value of port facilities in 2005, as shown in Table 6.2.2. This value originates from the fact that the depereciation period of port facilities constructed under the First Stage Plan such as the ferry

Table 6.2.1 Incremental Port Revenue

(Unit: 1,000 WS$)

Item \ Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1. Pilotage	0	0	91	97	97	101	106	110	112	116	120	126	126	130	136	141	147	151
2. Wharfage	0	0	0	0	0	362	377	393	409	426	444	463	482	502	523	545	568	592
3. Storage of Containers	0	0	0	5	5	6	6	6	7	7	7	8	8	8	9	9	10	10
4. Berthage	0	0	0	0	0	11	12	12	13	13	14	14	14	15	15	16	16	17
5. Dockage	0	0	0	0	0	50	53	53	55	58	60	62	62	65	67	70	72	74
6. Wharf Cleaning	0	0	0	0	0	12	12	12	13	13	14	14	14	15	15	16	17	17
7. Tug Service	0	0	61	63	63	66	69	71	71	74	77	79	79	82	85	87	90	92
Total	0	0	152	165	165	608	635	657	680	707	736	766	785	817	850	884	920	953

terminal and breakwater are longer than the period of the financial analysis (c.f. Appendix 4).

Table 6.2.2 Residual Value of Port Facilities in 2005

(Unit: 1,000 WS$)

Facility	Residual Value
1. Ferry Terminal	2,416
2. Breakwater	4,893
Total	7,309

(2) Expenditures

7. Expenditures for the calculation of the FIRR consist of incremental operation cost, incremental maintenance and repair cost and the construction cost of the First Stage Plan. Each cost is calculated by the same method presented in the Economic Analysis in Chapter 5.

① Operation Cost

The incremental operation cost from the First Stage Plan is the personnel and fuel cost for the tugboat.

② Maintenance and Repair Costs

The maintenance and repair costs per year for the facilities of the First Stage Plan are assumed to be 10 percent of the depreciation cost (c.f. Appendix 5).

③ Construction Cost

The construction cost of the First Stage Plan is estimated in Chapter 4.

8. Table 6.2.3 shows the expenditure for the calculation of the FIRR.

Table 6.2.3 Expenditure

(Unit: 1,000 WS$)

Item / Year	Incremental Operation Cost	Incremental Maintenance and Repair Cost	Construction Cost	Total
1988	0	0	712	712
1989	0	0	11,832	11,832
1990	45	33	10,204	10,282
1991	46	68	0	114
1992	46	68	0	114
1993	47	100	0	147
1994	48	100	0	148
1995	49	100	0	149
1996	49	100	0	149
1997	50	100	0	150
1998	52	100	0	152
1999	53	100	0	153
2000	53	100	0	153
2001	54	100	0	154
2002	55	100	0	155
2003	56	100	0	156
2004	57	100	0	157
2005	58	100	0	158
Total	818	1,469	22,748	25,035

6-3 Evaluation

9. The result of the FIRR calculation is shown in Table 6.3.1. The FIRR is -2.7 percent. As the FIRR of the First Stage Plan is negative, it is difficult to execute the project using a loan.

Table 6.3.1 FIRR Calculation

FIRR = -2.7%

(Unit: 1,000 WS$)

Year	Revenue	Expenditure
1988	0	712
1989	0	10,282
1990	152	114
1991	165	114
1992	165	114
1993	608	147
1994	635	148
1995	657	149
1996	680	149
1997	707	150
1998	736	152
1999	766	153
2000	785	153
2001	817	154
2002	850	155
2003	884	156
2004	920	157
2005	8,262	158
Total	17,789	25,035

CHAPTER 7
PORT ADMINISTRATION AND OPERATION

Chapter 7 Port Administration and Operation

7-1 Present Problems

1. As mentioned in Chpater 1, the ports in Western Samoa are presently managed primarily by M.O.T. However, there are various problems with the present management system as follows:

① The present budget is insufficient.
② The Customs Department has statutory authority to control port activities considerably.
③ Comprehensive, long-term port development plans are not being prepared, and the maintenance of facilities and equipment is insufficient due to a lack of port engineers.
④ The present port statistics are insufficient for proper port planning and management.

7-2 Establishment of a Port Authority

1) Proposed Measures

(1) Buget

2. In Western Samoa, all port revenues are presently paid into the general account of the State. Under this situation, the ports cannot guarantee the funds necessary for efficient administration and appropriate maintenance. So the port sector should maintain its own buget.

(2) Organization of New Sections

3. It is necessary to organize new sections responsible for port planning, maintenance and port statistics.

i) Port Planning

4. Comprehensive, long-term development and improvement plans are

essential for the orderly development of port areas. Without long-range plans and clearly enunciated policy, haphazard construction is likely to take place which may disturb the future development of the ports.

5. For making good port plans, surveys of the present conditions such as depth and wave height are necessary. Many surveys have been carried out by foreign study teams, but the Port Administration should carry out additional surveys whenever the existing data are insufficient for comprehensive planning and development.

ii) Maintenance Work

6. Adequate maintenance is necessary not only to increase the working life of port facilities, but also to provide good service to port users. If the container yards are poorly maintained, handling equipment such as forklifts may be damaged. Similarly, leaks in the roofs of storage sheds may result in damage of the stored cargo. So the Port Administration should have a well-equipped maintenance section including trained civil engineers.

iii) Port Statistics

7. Statistical service is often rather neglected at many developing ports. A substantial increase of handling cargo may require urgent improvements, additional storage space or more mechanical equipment. So if a port is to be opreated with efficiency and foresight, the Port Administrator requires timely and accurate information about port traffic and port operations.

8. In Western Samoa, cargo traffic statistics are prepared by Customs and by the Department of Statistics, but these data are mostly expressed in value terms rather than in weight. So most of these data cannot be used for port planning and port management.

9. At least the following statistical data are necessary for efficient port administration. These data must be recorded for each vessel which calls at port.

(Example of Data Collection Form)

Form 1

1. Name of Ship: _____
2. Type of Ship: General, Container, Ro/Ro, Tanker, Other (_____)
3. Date & Time of Arrival: _____
4. Date & Time of Departure: _____
5. Last Port: _____
6. Destination: _____
7. Shipowner/Agent: _____
8. Stevedore: _____
9. Ship Demensions
   (1) G.R.T: _____ tons (2) D.W.T: _____ tons
   (3) Length: _____ m (4) Draft: _____ m
10. Total Cargo Discharged: _____ revenue tons
11. Total Cargo Loaded: _____ revenue tons
12. Number of Containers
   (1) Loaded in: _____ TEU (2) Loaded out: _____ TEU
   (3) Empty in: _____ TEU (4) Empty out: _____ TEU
   (F.C.L: _____ TEU, L.C.L: _____ TEU)

Form 2

Cargo Details

1. Import Cargo

Customs Tariff Code *1	Revenue Tons	Package Code *2
Total		

2. Export Cargo

Commodity Code *3	Revenue Tons	Package Code *2
Total		

*1 It is necessary to convert the "customs tariff codes" to the "port statistic codes" before totaling the cargo volume by commodity. (cf. Table A.2.1 in Appendix 2)

*2 Package Code

01 --- Container
02 --- Liquid in bulk
03 --- Solid in bulk
04 --- Others

*3 Commodity Code (Export Cargo)

01 --- Coconut oil
02 --- Cocoa
03 --- Copra meal
04 --- Copra
05 --- Taro
06 --- Timber
07 --- Veneer
08 --- Bananas
09 --- Beer
10 --- Cigarettes
11 --- Coconut cream
12 --- Fruit juice
13 --- Others

(3) Establishment of a Unified Administrative Body

10. At present, the ports in Western Samoa are administered by both M.O.T. and Customs. This is an uneconomical and inappropriate system. The ports should make every effort to assist the Customs in performing their duties. But the administrative purview of the Customs should be limited to their proper responsibilities, that is prevention of smuggling, collection of dues and enforcement of various Customs regulations.

11. So it is necessary to establish an organization to unify all the port-related functions which are presently being carried out by various bodies.

2) Establishment of a Port Authority

12. Generally speaking, port authorities are necessary for the following reasons.

① Financial independence

Ports finances should be entirely separated from the finances of the State. The port sector should have its own budget, and should function as an independent financial center. Port dues and other receipts of ports should be used exclusively for port administration, maintenance and improvement. Port tariffs should be set at a reasonable level, but must be sufficient for covering normal current expenses, including the depreciation costs of tugboats, sheds, etc. Only funds for major port expansion schemes or for major dredging should be supplied by the State, either in the form of direct subsidies or as loans.

② Workers' Morale

The port authority must maintain a high morale among port workers. This is very important to carry out efficient operations and to provide high quality port services.

③ Freedom from political pressures

A port can never be managed efficiently under rules and regulations established for quite different purposes and for different kinds of

activities. A much more flexible, businesslike system of management is required, free from political pressures and fluctuations.

13. On the other hand, as mentioned in Chpater 1, the Government of Western Samoa would like to establish the Western Samoa Port Authority to provide a coordinated and integrated system of port facilities and port services connected therewith and other matters relating thereto.

14. For all of the above reasons, it is would be desirable to establish the Port Authority, but further consideration of the financial viability is necessary after determining the management policy including the ownership of port facilities and the extent of the authority's responsiblities and duties.

15. We estimate future port revenue and expenditure such as personnel cost, operation cost and maintenance cost to serve as basic data for a financial analysis of the proposed Port Authority in Appendix 5.

3) Port Authority and Private Activities

(1) Cargo Handling

16. Generaly speaking, it is better that activities of a predominantly commercial character, such as cargo handling, be carried out by private companies under the overall supervision of a public administrative body. Private companies are, actually, more efficient and more economic than public bodies because of the profit incentive, their natural eagerness to avoid losses and their flexibility.

17. In Western Samoa, cargo handling is presently carried out by private companies. Each shipping agent undertakes cargo handling directly or exclusively, so they can cope flexibly with various changes in cargo flow.

18. If the proposed Port Authority undertakes handling directly, the control over the various phases of port operations will be more centralized, but port charges will become more expensive and less efficient due to a lack of competition. For example, in Fiji port handling charges tripled

after the port authority took over cargo handling.

19. Thus, it is better to continue the present cargo handling system by private companies. Further, if the stevedoring companies make a committee to carry out their cargo handling more systematically and more safely, cargo handling efficiency may improve.

(2) Operation of Ferry Services

20. Ferry services between Mulifanua and Salelologa and between Apia and Pago Pago of American Samoa are operated by Western Samoa Shipping Corporation (W.S.S.C.) which is wholly owned by the Government of Western Samoa.

21. As mentioned in Chapter 1, the sailing schedule is fixed but vessels do not operate on schedule and there is no reservation system. So W.S.S.C. has to improve its operation system. However, we feel that W.S.S.C. should continue as the operating body to ensure the financial soundness of the ferry operation.

4) Organization and Functions of the Port Authority

(1) Scope of Functions

22. The Port Authority shall coordinate and administer port facilities, port services and other matters relating thereto except for cargo handling and ferry service.

(2) Advisory Port Committee

23. An Advisroy Port Committee including representatives of the Government and the private sector should be established to oversee the activities of the Port Authority. However, Ministers involved or the Cabinet itself may from time to time give the Authority directions of a special or general character concerning the policy to be followed within the framework of the overall social and economic development of Western Samoa.

24. Suitable members of the Committee would include the following:

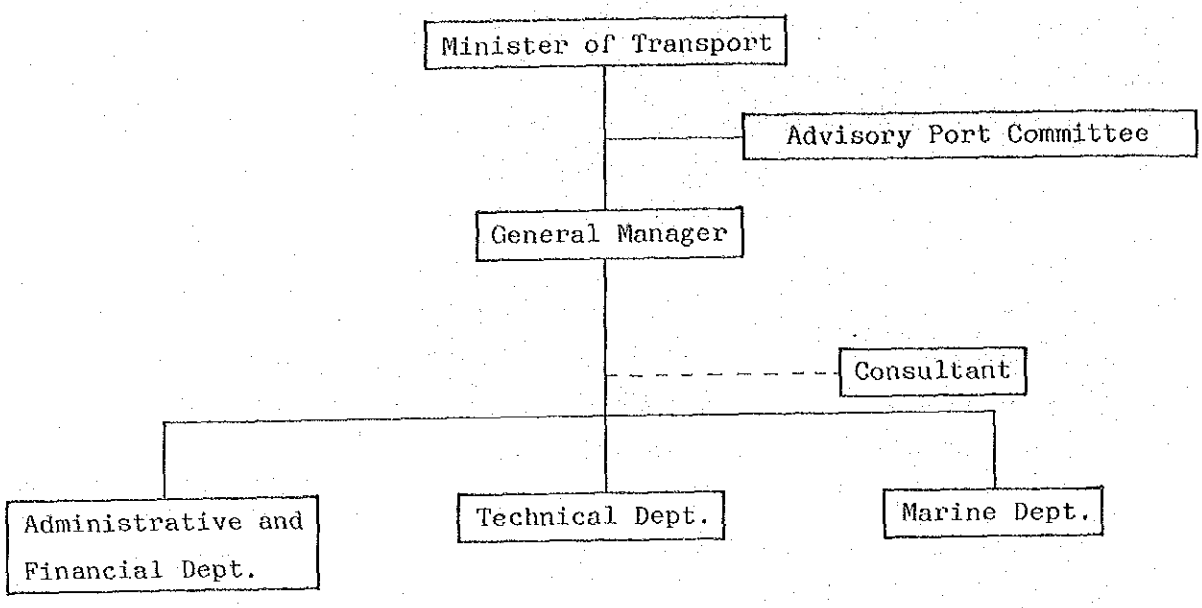
(example)

- government --- Comptroller of Customs
  Financial Secretary
  Director of P.W.D.
  Director of D.E.D.
  General Manager of W.S.S.C.
  General Manager of the Port Authority
- private sector --- Representatives of shipping agents
  Well informed persons

(3) Organization and Functions

25. As mentioned above, M.O.T. has no sections responsible for port planning, port statistics and maintenance, so the present organization is not sufficient. It is necessary to organize new sections for new works and to unify all the functions which are being carried out by various bodies. Fig. 7.2.1 shows an idea of the organization and functions of the proposed Port Authority.

26. "Registration of vessels" and "registration of seamen" do not seem to be within the regular duties of the Port Authority. However, presently there are no other bodies which can take responsibility for registering vessels and seamen, so we have included these works as part of the duties of the proposed Port Authority.



① Administration of Port Facilities
② Licenses to Use Port Facilities
③ Allocation of Berths
④ Collecting Dues and Charges
⑤ Development Control in the Port Area
⑥ Reclamation Control in the Port Area
⑦ Supervision of W.S.S.C.
*⑧ Registration of Vessels
*⑨ Registration of Seamen

① Port Planning
② Port Statistics
③ Port Surveys
④ All Harbour Works
⑤ Repair and Maintenance
⑥ Mechanical Plant

① Navigation Control
② Light Services
③ Towage Services
④ Pilotage Services
⑤ Line Handling Services
⑥ Water and Bunkering Services
⑦ Cleaning Wharfs
⑧ Port Security
⑨ Other Services

Fig. 7.2.1 Idea of the Organization and Functions of the Proposed Port Authority

* Work on behalf of the Government.

5) Training

27. At the present time there is little know-how concerning port planning, port statistics and maintenance in Western Samoa. It will be necessary to engage outside advisers such as port planning statistics experts and port construction experts, for a while to assist the proposed Port Authority.

28. It is also useful to dispatch promising young workers to foreign ports for further training. A few months of actual work at an advanced port, preferably in more than one department, can provide valuable insights into the administrative machinery and operating methods of highly developed ports.

29. The Government of Western Samoa should spare no efforts in recruiting suitable young staff, providing adequate training opportunities and offering reasonable conditions of employment.

APPENDIX

Appendix 1 Idea of a New Port in Vaiusu Bay

We have judged, as mentioned in Chapter 3, that the idea of a new port in Vaiusu Bay will still be premature in the target year.

But we present the result of our consideration about this idea here to serve as reference material for the Government of Western Samoa.

1-1 Background

1) Review of the Raudkivi Report

In 1975, A.J. Raudkivi, professor of Auckland University, prepared the "Report on Apia Harbour Study". In his report he proposed the resiting of Apia Port to Vaiusu Bay for the following reasons.

① The problem of surging in Apia Harbour which endangers ships moored at the wharf and interferes with cargo handling.

② The problem of future expansion of Apia Port.

③ The problem of traffic congestion in downtown Apia caused by the heavy traffic associated with the operation of Apia Port.

The site proposed by Professor Raudkivi lies just to the west of the Mulinuu Peninsula at the western limits of Apia. There is a natural opening through the reef and, with the exception of a shallow entrance bar, an extensive deepwater inlet within the natural protection of the reef flats (See Fig. A.1.1).

2) Idea of P.W.D.

The Government of Western Samoa has shown an active interest in the idea of a new port.

The reasons are as follows.

① The new port will promote industrial development at Vaitele by providing direct access from the industrial area to the wharf.

② It is possible to prepare an industrial area adjacent to the port through reclamation using the excavated material.

In 1985, the Public Works Department of the Government of Western Samoa prepared "Proposal Report for New Seaport". Fig. A.1.2 and Fig.

A.1.3 show the location and the layout plan proposed by this report.

The proposed site was located a little west of Raudkivi's site.

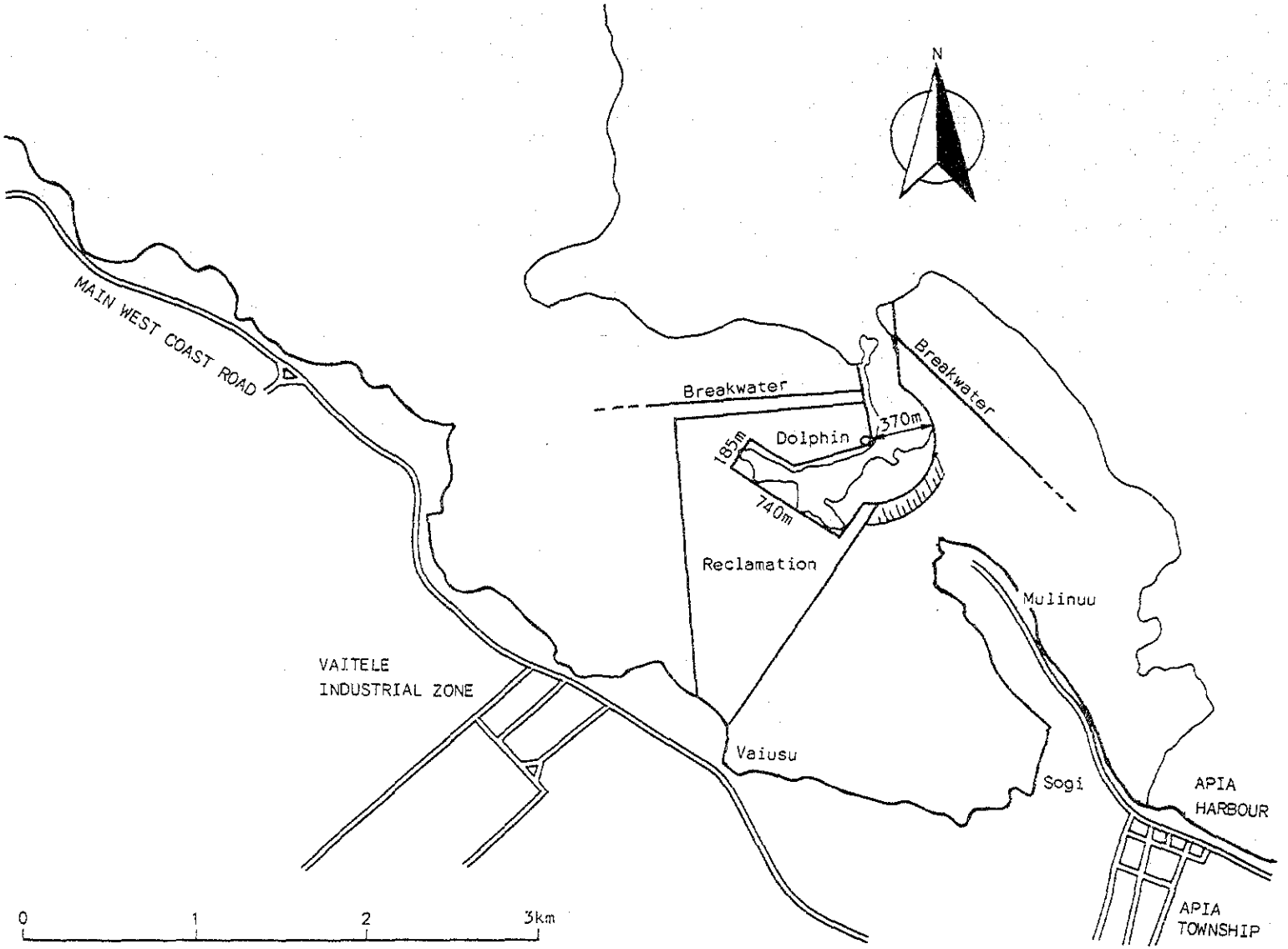


Fig. A.1.1 Professor Raudkivi's Plan

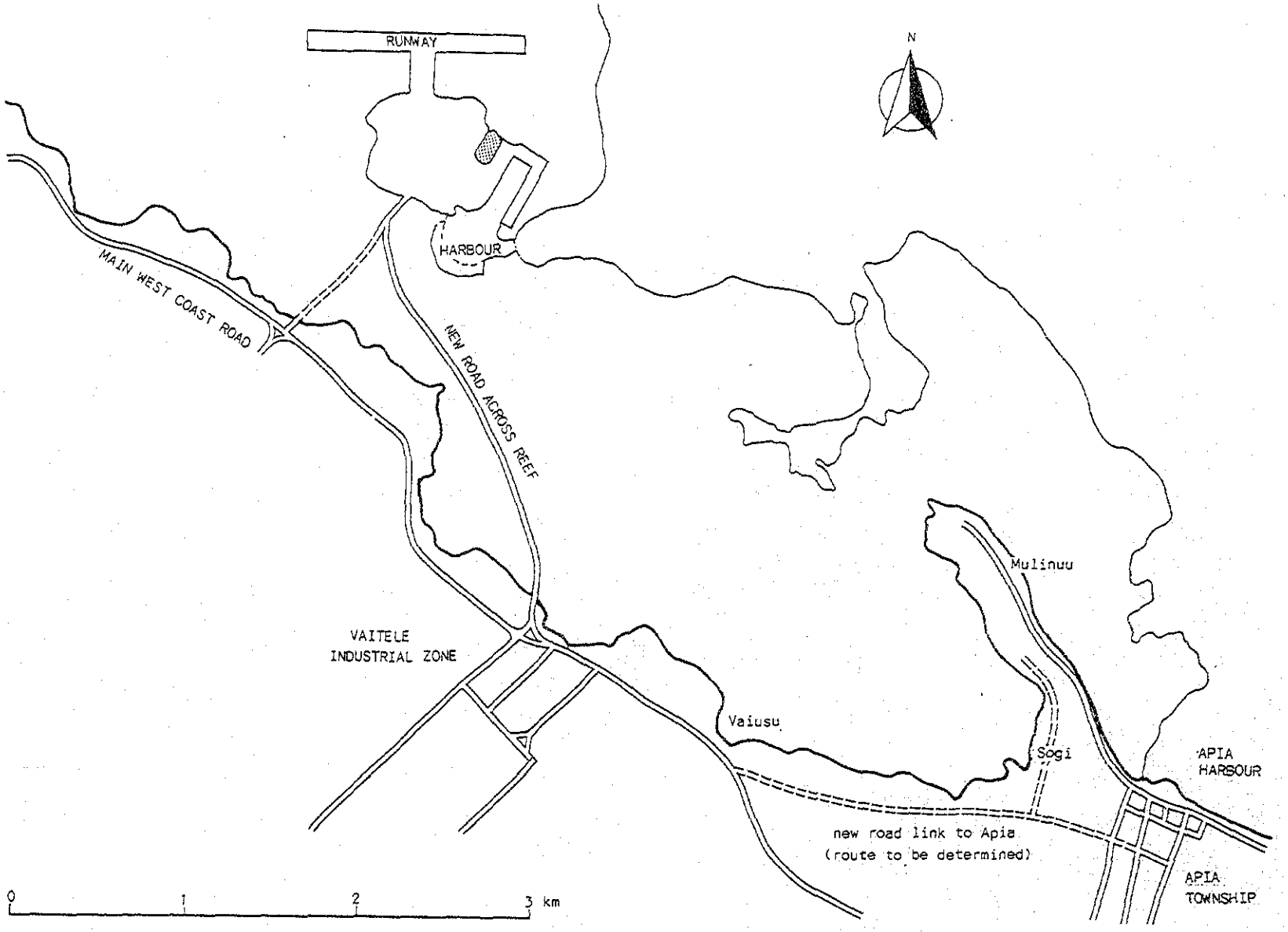


Fig. A.1.2 Layout Plan of the New Port Project

Source: "Proposal Report for New Seaport" Oct. 1985 Govt. of Westerm Samoa

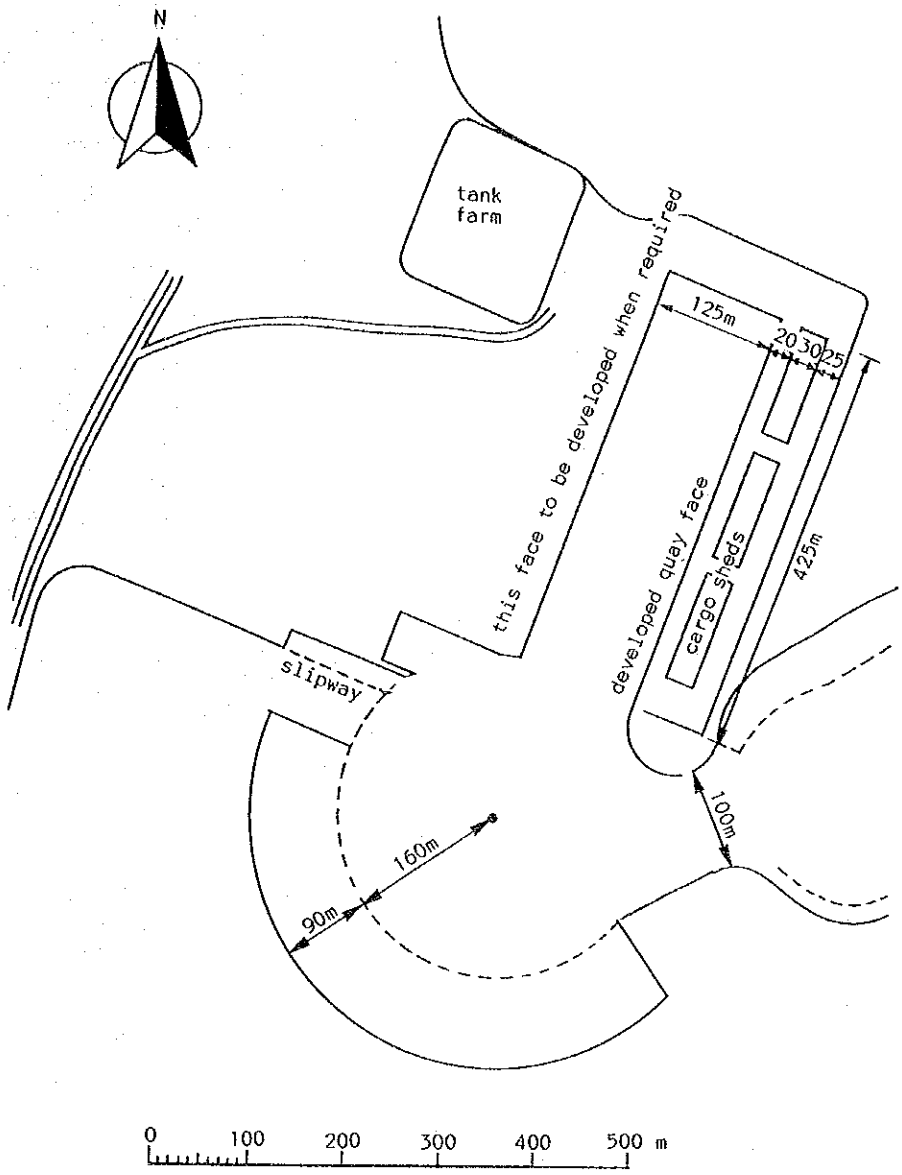


Fig. A.1.3 Harbour Layout Plan of the New Port

Source: "Proposal Report for New Seaport" Oct. 1985
Govt. of Westerm Samoa

1-2 Result of Our Consideration

1) Problems with the Previous Plans

There are various problems with the previous plans as noted below.

(1) Raudkivi's Plan

① Roughness at the entrance of the channel
② Environmental problem in the closed bay surrounded by the Mulinuu Peninsula and the new road across the reef.
③ High cost for excavation of the edge of the coral reef.
④ Insufficient width and length of the entrance channel and turning basin.

(2) P.W.D's Plan

① Roughness at the entrance of the channel
② Difficulty of ensuring calmness in the basin because of the seas and swells from the northeast.
③ Insufficient width and length of the entrance channel and turning basin.
④ Possibility of using "dry excavation" technique.
Technically it would be very difficult to use the dry excavation technique. Thus, the actual cost of the project would be much higher than the 36 million WS$ estimated in the report.

2) Basic Designs of the New Port

As mentioned above, there are some problems with the previous plans. So we have tried to improve each plan, and made two basic designs of the new port.

(1) Premises of the basic designs

The premises of the basic designs are as follows;

① Vessel Size

L.O.A. 200 m

Draft 10 m

② Entrance Channel

Width 200 m (vessel length)

Length 1,000 m (5 times vessel length = stopping distance)

③ Turning Basin

D = 400 m (2 times vessel length)

④ Mooring Facilities

Wharf : 2 berths for the design vessels (L = 420 m, D = -11 m)

Dolphin: for tankers (D = -11 m)

Berth for small vessels: (L = 100 m)

⑤ Future Expansion Area

To reserve an expansion area for the future development of the port.

⑥ Access road to hinterland

To ensure access to Apia and Vaitele

⑦ Countermeasures against swells

To ensure sufficient calmness in front of the berth.

(2) Layout of the Port Facilities

Figs. A.1.4 and A.1.5 show the proposed layouts of the port facilities at each location.

(3) Construction Cost

Table A.1.1 shows the rough cost estimation of the new port at each site.

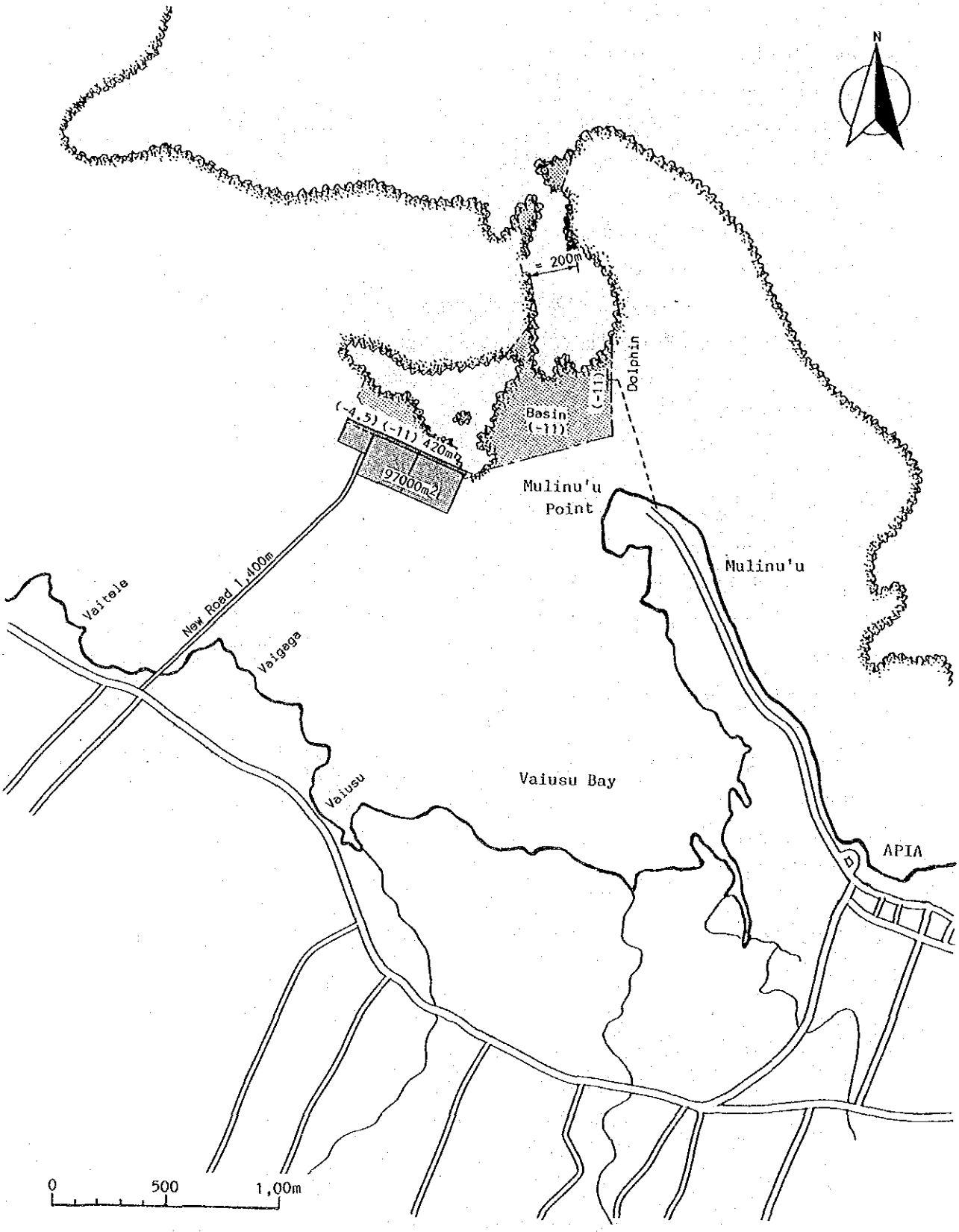


Fig. A.1.4 Layout of the Port Facilities (Alternative 1)

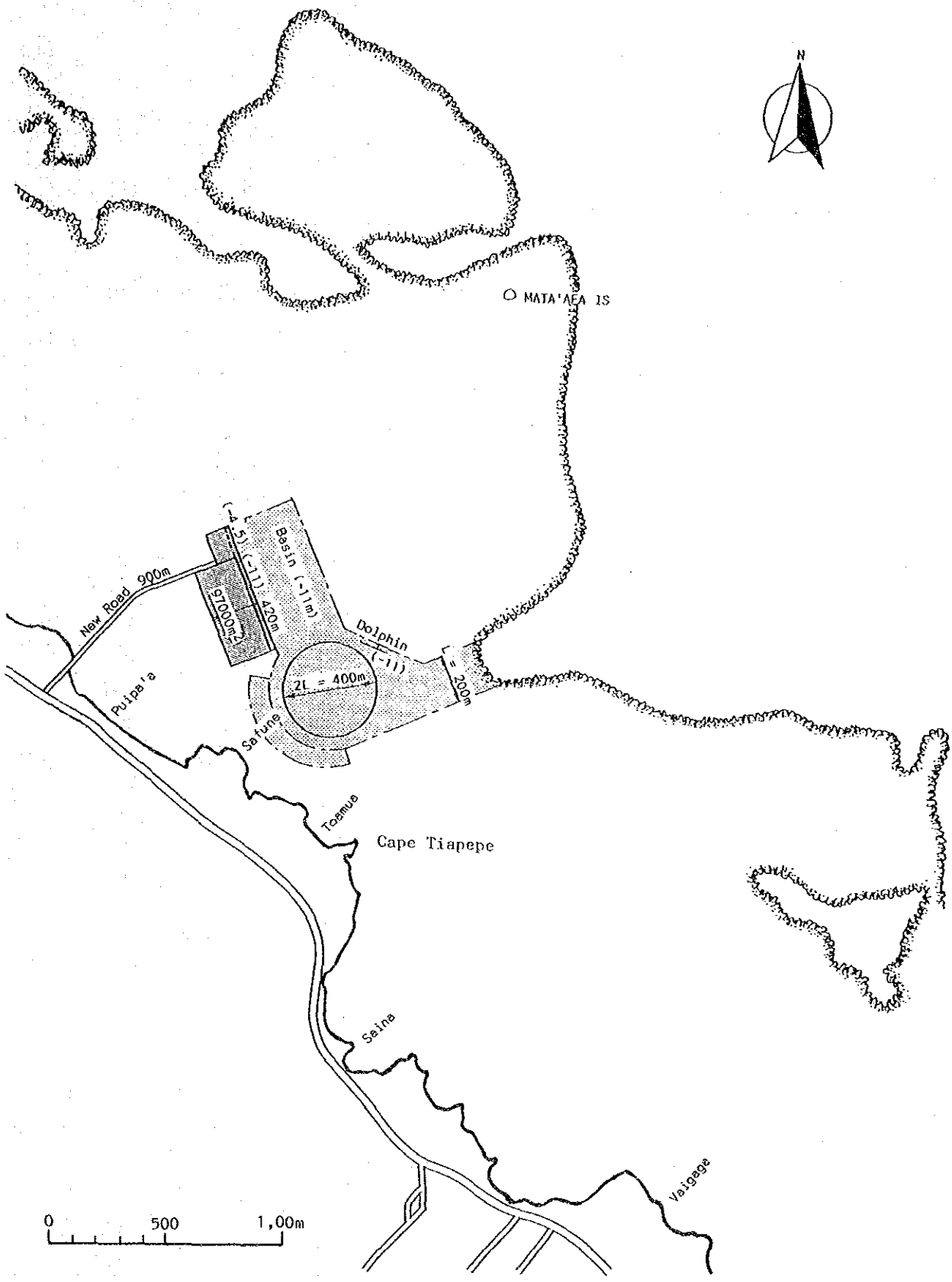


Fig. A.1.5 Layout of the Port Facilities (Alternative 2)

Table A.1.1 Rough Cost Estimation of the New Port

No.	Item	Unit	Quantity		Unit Cost (WS$)	Cost (1,000 WS$)	
			Alternative 1	Alternative 2		Alternative 1	Alternative 2
1	Dredging						
	-11m Coral	m^3	690,000	40,000	35	24,150	1,400
	-11m Sand	m^3	2,610,000	5,290,000	10	26,100	52,900
	-4.5m Sand	m^3	20,000	20,000	10	200	200
	Slope	m^3	0	280,000	10	0	2,800
2	Access Road	m	1,400	900	3,400	4,760	3,060
3	Quay						
	-11m	m	420		51,400	21,588	21,588
	Transitional	m	60		41,100	2,466	2,466
	-4.5m	m	100		30,800	3,080	3,080
4	Dolphin Berth -11m	m	200		103,000	20,600	20,600
5	Container Yard						
	Heavy Duty	m^2	40,000		105	4,200	4,200
	Light Duty	m^2	10,000		60	600	600
6	Container Freight St.	m^2	1,200		1,700	2,040	2,040
7	Maintenance Shop	m^2	200		1,400	280	280
8	Transit Shed	m^2	5,000		1,100	5,500	5,500
9	Main Office	m^2	1,500		2,700	4,050	4,050
10	Pilot Office	m^2	200		2,400	480	480
11	Tug Boat	pc	2		2,740,000	5,480	5,480
12	Mobilization	ls	1		6,850,000	6,850	6,850
	S. Total					132,424	137,574
13	Engineering Services	ls	(1-10)x0.05			6,005	6,262
14	Contingency	ls	(1-5)x0.15			16,162	16,934
	S. Total					22,166	23,196
	G. Total					154,590	160,770

(4) Problems

Even under the improved designs, the following fundamental problems still remain.

① Construction cost is very high.
② Roughness at the entrance of the channel.
③ Environmental problems in the Bay (especially Alternative 1).
④ Increase of the road transportation distance to downtown Apia (especially Alternative 2).
⑤ Effective usage of the present port facilities at Apia Port must be maximized.

Appendix 2 Conversion Table for the Port Statistics

As mentioned in Chapter 7, it is necessary to convert the "customs tariff code" to the "port statistics code" before totaling the cargo volume by commodity.

Table A.2.1 shows an example conversion table for the port statistics.

Table A.2.1 Example Conversion Table for the Port Statistics

Port Statistics Code		Customs Tariff Code
Agricultural & Aquatic Products	01 Wheat	1001-1004
	02 Rice, Minor Cereals, Beans	0705, 1005-1007
	03 Vegetables, Fruits	0701-0704, 0706, 0801-0807 0809-0813
	04 Raw Cotton	5501, 5502
	05 Other Agricultural Products	0601-0604, 1203, 1204, 1206, 1207, 1209, 1303, 1401-1403, 1405, 1801, 2401
	06 Other Livestock Products	0101, 0105, 0106, 0201-0206, 0401, 0405-0407, 0504, 0508, 4101
	07 Aquatic Products	0301-0303, 0512, 0513, 1208
Forest Products	08 Logs, Lumber	4403-4405, 4409
	09 Resin	1301, 1302, 4001
	10 Firewood, Charcoal	4402
Mineral Products	11 Coal	2701
	12 Gravel, Sand, Stone	2505, 6801, 6802, 6806, 6901
	13 Other Nonmetallic Minerals	2506-2508, 2510-2513, 2520, 2522, 2524, 3801, 3803
Metalworking and Machine Industrial Products	14 Iron and Steel	7301, 7302, 7304-7319
	15 Nonferrous Metals	7401, 7403-7407, 7409, 7414, 7502, 7503, 7602-7606, 7801, 7804, 7901, 7904, 8001, 8002, 8004, 8006, 8101, 8104, 8315, 8523,

Port Statistics Code		Customs Tariff Code
Metalworking and Machine Industrial Products	16 Metallic Products	7210, 7320-7322, 7324-7328, 7329-7333, 7334, 7335, 7339, 7340, 7410, 7415, 7419, 7608, 7609, 7611-7613, 7616, 7802, 7803, 7805, 7905, 7906, 8201-8207, 8209, 8211-8213, 8301, 8302, 8308, 8309, 8311 8313, 8314
	17 Transportation Machinery	8702, 8703, 8705-8714, 8801-8803, 8901
	18 Other Machinery	7014, 7337, 7408, 7607, 8208, 8307, 8401-8465, 8501-8522, 8526-8528, 8601, 8701, 8903, 9002, 9005-9029, 9101, 9102, 9104-9111, 9211, 9213, 9306, 9307, 9402
Chemical Industrial Products	19 Ceramic Ware	6903, 6907, 6908, 6910-6912, 6914
	20 Cement	2523
	21 Glass Products	7002-7009, 7011-7013, 7015-7021, 9001
	22 Other Ceramic Products	6803, 6804, 6806-6808, 6810-6816, 6902, 6904-6906, 8524, 8525
	23 Petroleum Products	2710-2716, 3608
	24 Coke	2704
	25 Other Coal Products	2705, 2706
	26 Chemicals	2707, 2801, 2804-2808, 2810, 2813-2825, 2827-2832, 2835-2840, 2842-2858, 2901-2917, 2923-2929, 2943, 2945
	27 Chemical Fertilizers	3101-3105

Port Statistics Code		Customs Tariff Code
Chemical Industrial Products	28 Dyestuff, Paints, Synthetic Resins and Other Chemical Products	1109, 1502-1508, 1511, 1512, 2938, 3002, 3003, 3202-3213, 3302, 3304, 3306, 3401-3407, 3501-3506, 3605-3607, 3701-3706, 3708, 3806-3809, 3811-3819, 3901-3907, 4002
Light Industrial Products	29 Paper, Pulp	4701, 4801-4813, 4815, 4817, 4820, 4907
	30 Yarn, Half-finished Spinning Products	5102, 5103, 5307, 5310, 5505-5508, 5605, 5606, 5705, 5706
	31 Other Textile Industrial Products	5007, 5009, 5104, 5202, 5509, 5607, 5710, 5804-5810, 5901-5908, 5911, 5913-5917, 6001, 6204, 6205, 6501
	32 Sugar	1701
	33 Other Industrial Products	0206, 0402-0404, 0901-0910, 1101-1103, 1108, 1513, 1601-1605, 1702-1705, 1802, 1805, 1806, 1901-1908, 2001-2007, 2101-2107, 2201-2210, 2402, 2501
Miscellaneous Industrial Products	34 Toys	9702, 9704
	35 Daily Necessities	3707, 4013, 4202, 4203, 4420, 4424, 4427, 4603, 4814, 4818, 4819, 4821, 4901-4906, 4908-4911, 5801-5803, 5910, 5912, 6003-6006, 6101-6107, 6109-6111, 6201, 6202, 6401-6406, 6503-6507, 6602, 6603, 6809, 6913, 7112, 7114, 7116, 7336, 7338, 7417, 7418, 7615, 7806, 8210, 8214,

Port Statistics Code		Customs Tariff Code
Miscellaneous Industrial Products	35 Daily Necessities	8303-8306, 8310, 9003, 9004, 9201-9210, 9212, 9403, 9404, 9601-9605, 9606, 9703, 9705-9708, 9801-9812, 9814, 9815, 9904, 9906
	36 Rubber Products	4003, 4005-4012, 4014-4016
	37 Wooden Goods	4410, 4411, 4413-4419, 4421-4423, 4425, 4426, 4428, 4502-4504
	38 Other Manufacutured Industiral Products	3004, 3005, 4106, 4201, 4204, 4205, 4304, 4602, 6702, 6703, 6705, 8215, 9302, 9304, 9305
Special Items	39 Odds and Ends	4004, 4702, 5503, 5603, 6301, 6302
Special Items	40 Animal and Vegitable Foodstuffs and Manure	1210, 2301-2307
	41 Transportation Containers	4816, 6203, 7010, 7323, 7610
Unclassied Goods	42 Unclassifiable Goods	

Appendix 3. Economic Analysis

3-1 Vessels for the analysis

Almost all container cargo and conventional cargo are actually handled by different types of vessels in Apia port. However, for the economic analysis, all general cargoes are assumed to be transported by the same vessel. The ratio of each type of cargo per vessel is determined based on the ratio of container cargoes to conventional cargoes in Apia port.

1) Cargo handling volume per vessel

Table A.3.1 Cargo Handling Volume per Vessel

No	Year	Cargo handling volume	Number of vessels	Cargo handling volume per vessel	Percentage of containerization	Container cargo per vessel	Conventional cargo per vessel
		(thousand tons)	(vessels)	(tons)	(%)	(tons)	(tons)
1	1990	1590(109)	194	820	7231	593	227
2	91	1657(115)	201	824	7289	601	223
3	92	1728(120)	207	835	7347	613	222
4	93	1802(125)	214	842	7406	624	218
5	94	1879(130)	220	854	7466	638	216
6	95	1959(135)	227	863	7525	649	214
7	96	2042(141)	235	869	7586	659	210
8	97	2129(147)	242	880	7646	673	207
9	98	2222(154)	250	889	7708	685	204
10	99	2315(160)	257	901	7769	700	201
11	2000	2410(167)	265	909	7832	712	197
12	1	2516(174)	274	918	7894	725	193
13	2	2624(182)	282	930	7958	740	190
14	3	2736(189)	291	940	8022	754	186
15	4	2852(198)	301	948	8086	767	181
16	5	2974(206)	310	959	8151	782	177

* ( ): Cargo handling volume at Ferry Terminal

Table A.3.2 Cargo Handling volume per vessel by Import and Export

No	Year	Container Cargo			Conventional Cargo			Number of vessels
		Total	Import	Export	Total	Import	Export	
		(tons)	(tons)	(tons)	(tons)	(tons)	(tons)	(vessels)
1	1990	593 (40)	464 (31)	129 (9)	227	145	82	194
2	91	601 (41)	472 (32)	129 (9)	224	142	82	201
3	92	613 (42)	482 (33)	131 (9)	222	141	81	207
4	93	624 (42)	491 (34)	133 (9)	218	139	79	214
5	94	638 (43)	503 (34)	135 (9)	216	138	78	220
6	95	649 (45)	512 (35)	137 (10)	214	136	78	227
7	96	659 (45)	521 (35)	138 (10)	210	133	77	235
8	97	673 (46)	533 (36)	140 (10)	207	131	76	242
9	98	685 (47)	543 (37)	142 (10)	204	129	75	250
10	99	700 (47)	556 (37)	144 (10)	201	127	74	257
11	2000	712 (48)	566 (38)	146 (10)	197	125	72	265
12	1	725 (49)	577 (39)	148 (10)	193	122	71	274
13	2	740 (50)	591 (40)	149 (10)	190	120	70	282
14	3	754 (51)	603 (41)	151 (10)	186	116	70	291
15	4	767 (52)	613 (41)	154 (11)	181	113	68	301
16	5	782 (53)	626 (42)	156 (11)	177	110	67	310

*:( ):Number of loadrd containers by TEU

Table A.3.3 Number of Handling Containers Vessel

Year	Import			Export		
	Loaded	Empty	Total	Loaded	Empty	Total
	(TEU)	(TEU)	(TEU)	(TEU)	(TEU)	(TEU)
1990	31	-	31	9	22	31
91	32	-	32	9	23	32
92	33	-	33	9	24	33
93	33	-	33	9	24	33
94	34	-	34	9	25	34
95	35	-	35	10	25	35
96	35	-	35	10	25	35
97	36	-	36	10	26	36
98	37	-	37	10	27	37
99	37	-	37	10	27	37
2000	38	-	38	10	28	38
1	39	-	39	10	29	39
2	40	-	40	10	30	40
3	41	-	41	10	31	41
4	41	-	41	11	30	41
5	42	-	42	11	31	42

3-2 Working Efficiency of Cargo Handling per Gang

1) Container Cargo Handling

- o Using ship gear or crawler crane: 16.3 units/hour
- o Using Ro/Ro system with forklifts: 25 units/hour

2) Conventional Cargo Handling

- o Using ship gear or crawler crane: 16.8 tons/hour

3-3 Depreciation, Repayment and Fuel Expenses

Table A. 3.4 Depreciation, Repayment and Fuel Expenses

	Depreciation Period (Years)	New Worth (th.WS$)	Residual Value (% of New Worth)	Depreciation Expenses per Year (th. WS$)	Interest Repayment (% per Year)	Repayment per Year (WS$)	Fuel Expenses (WS$/h)
Truck(10tons)	5	960	10	172	4.5	21,800	
Vessel(4000 G/T)	15	15,000.0	10	900.0	8.0	1,752,000	43.5
Crawler Crane	5	466.0	10	85.8	8.0	116,713	3.8
Pontoon(200t)	12	236.0	10	17.7	8.0	31,000	-
Tugboat(D-350)	10	918.0	10	82.6	4.5	116,000	53.2
Forklift(25t)	5	685.0	10	123.4	8.0	172,563	3.0
Forklift(3.5t)	5	68.5	10	12.3	8.0	17,000	1.4

Note: The study team assumed the above values based on the values in Japan.

3-4 Standard Labor Cost for Cargo Handling per Gang per Hour

Table A. 3.5 Labor Cost for Cargo Handling (Container Cargo)

K	Kind of Worker	N	Unit Price	Price
S	Crane Operater	2	1.8	3.6
U	Watcher for cargo handling	2	0.5	1.0
U	Wharf laborer	2	0.5	1.0
U	Lasher	6	0.5	3.0
S	Driver of cargo handling equipment	3	1.8	5.4
S	Supervisor	1	2.7	2.7
	Total	16		16.7

Note
N: Number of Workers K: Kind of Laborers
S: Skilled Labor U: Unskilled Labor

Table A.3.6 Labor Cost for Cargo Handling (Conventional)

K	Kind of Worker	N	Unit Price	Price
S	Crane Operater	2(2)	1.8	3.6
U	Stevedore	6(10)	0.5	3.0
U	Longshoreman	4(8)	0.5	2.0
U	Watcher for cargo handling	2(2)	0.5	1.0
S	Driver of cargo handling equipment	2(2)	1.8	3.6
S	Supervisor	1(1)	2.7	2.7
U	Transit shed or open storage laborer	3(6)	0.5	1.5
Total		20(31)		17.4

Note

N: Number of Workers
K: Kind of Laborers
S: Skilled Labor
U: Unskilled Labor

3-5 Calculation of Benefit from Rehabilitation of the Main Wharf

1) Prerequisites for offshore handling

- o The offshore cargo handling position is 100 m from the main wharf.
- o A 200 ton pontoon is used between the vessel and the land stage.
- o The pontoon is moved by a tugboat (D-350).
- o The cargo handling between the vessels and the pontoon uses ship gear.
- o The cargo handling between the pontoon and the land stage uses a crawler crane.
- o The one way transfer time between the vessel and the land stage is assumed to be about 30 minutes including preparation for towing.
- o The capacity of the pontoon is as follows:

Container: 7 TEU
Conventional cargo: 120 tons

2) Cost Estimate

(1) Cost of cargo handling at berth.

- o Cargo handling capacity per gang
- o Number of laborers per gang
- o Labor cost per gang per hour

} Using the standard. (See Table A.3.4 and A.3.5.)

o Cargo handling time per vessel

For container cargo:

$$\text{cargo handling time} = \frac{\left(\begin{array}{c}\text{Number of}\\ \text{loading containers}\end{array}\right) + \left(\begin{array}{c}\text{Number of}\\ \text{unloading containers}\end{array}\right)}{16.8\ \text{TEU/hour}} \qquad \text{(A)}$$

For conventional cargo:

$$\text{Cargo handling time} = \frac{\text{Conventional cargo handling volume per vessel}}{16.8\ \text{tons/hour}} \qquad \text{(B)}$$

Cargo handling time per vessel = (A) + (B)

Table A.37 Total Cargo Handling Time under the With Case

No	Year	(A) Container cargo handling time per vessel	(A') Conventional cargo handling time per vessel	(B) Number of vessels	(C)=(A)×(B) Total cargo handling time for container cargo	(D)=(A')×(B) Total cargo handling time for conventional cargo
		(hours)	(hours)	(vessels)	(hours)	(hours)
1	1990	3.8	13.5	194	737.2	2,619.0
2	91	3.9	13.3	201	783.9	2,673.3
3	92	4.0	13.2	207	828.0	2,732.4
4	93	4.0	13.0	214	856.0	2,782.0
5	94	4.2	12.9	220	924.0	2,838.0
6	95	4.3	12.7	227	976.1	2,882.9
7	96	4.3	12.5	235	1,010.5	2,937.5
8	97	4.4	12.3	242	1,064.8	2,976.6
9	98	4.5	12.1	250	1,125.0	3,025.0
10	99	4.5	12.0	257	1,156.5	3,084.0
11	2000	4.7	11.7	265	1,245.5	3,100.5
12	1	4.8	11.5	274	1,315.2	3,151.0
13	2	4.9	11.3	282	1,381.8	3,186.6
14	3	5.0	11.1	291	1,455.0	3,230.1
15	4	5.0	10.8	301	1,505.0	3,250.8
16	5	5.2	10.5	310	1,612.0	3,255.0

o Labor cost per ton

$$\text{Labor cost perton} = \left\{\left\{\left(\begin{array}{c}\text{Cargo handling}\\ \text{time for}\\ \text{container}\\ \text{cargo}\end{array}\right) \times 16.7\ \text{WS\$/hour}\right\} + \left\{\left(\begin{array}{c}\text{Cargo handling}\\ \text{time for}\\ \text{container}\\ \text{cargo}\end{array}\right) \times 17.4\ \text{WS\$/hour}\right\}\right\} \div \left(\begin{array}{c}\text{Cargo handling}\\ \text{volume per}\\ \text{vessel}\end{array}\right)$$

Table A.3.8 Labor Cost per Ton under the With Case

Year	Cargo handling time per vessel			Labour Cost per Ton			
	(A) Container cargo	(B) Conventional	(A) + (B) Total	(C) (A)×16.7WS$/hour	(D) (B)×17.4WS$/hour	(E) Volume per vessel	(F)=[(C)+(D)]/(E) Labor cost per ton
1990	3.8(hours/vessel)	13.5(hours/vessel)	17.3(hours/vessel)	63.5(WS$/vessel)	234.9(WS$/vessel)	820(tons/vessel)	0.36(WS$/ton)
91	3.9	13.3	17.2	65.1	231.4	825	0.36
92	4.0	13.2	17.2	66.8	229.7	835	0.36
93	4.0	13.0	17.0	66.8	226.2	842	0.35
94	4.2	12.9	17.1	70.1	224.5	854	0.34
95	4.3	12.7	17.0	71.8	221.0	863	0.34
96	4.3	12.5	16.8	71.8	217.5	869	0.33
97	4.4	12.3	16.7	73.5	214.2	880	0.33
98	4.5	12.1	16.6	75.2	210.5	889	0.32
99	4.5	12.0	16.5	75.2	208.8	901	0.32
2000	4.7	11.7	16.4	78.5	203.6	909	0.31
1	4.8	11.5	16.3	80.2	200.1	918	0.31
2	4.9	11.3	16.1	81.8	196.6	930	0.30
3	5.0	11.1	16.1	83.5	193.1	940	0.29
4	5.0	10.8	15.8	83.5	187.9	948	0.29
5	5.2	10.5	15.7	86.8	182.7	959	0.28

Table A.3.9 Labor Cost for Cargo Handling under the With Case

Year	Labor cost per ton for cargo handling (1)	Cago handling volume per year (2)	Labor cost per year for cargo handling (1)×(2)
1990	0.36(WS$/ton)	159,000tons/year)	57,240(WS$/year)
91	0.36	165,700	59,652
92	0.36	172,800	62,208
93	0.35	180,200	63,070
94	0.34	187,900	63,886
95	0.34	195,900	66,606
96	0.33	204,200	67,386
97	0.33	212,900	70,257
98	0.32	222,200	71,104
99	0.32	231,500	74,080
2000	0.31	241,000	74,710
1	0.31	251,600	77,996
2	0.30	262,400	78,720
3	0.29	273,600	79,344
4	0.29	285,200	82,708
5	0.28	297,400	83,272

o Kinds of handling equipment at the apron and the marshalling yard

For container cargo: 25 ton forklift (2 units)
For conventional cargo: 3.5 ton forklift (2 units)

o Cargo handling equipment cost (depreciation expenses, repayment and fuel expenses) at the apron and the marshalling yard.

Depreciation expenses, repayment and fuel expenses: Refer to Table

A.3.4

The cargo handling equipment costs are obtained using the following formula.

$$\left\{\left\{\begin{pmatrix}\text{Depreciation}\\ \text{Expense per}\\ \text{year}\end{pmatrix} + \begin{pmatrix}\text{Repayment}\\ \text{per year}\end{pmatrix}\right\} \Big/ \begin{pmatrix}\text{Working}\\ \text{times}\\ \text{per year}\end{pmatrix}\right\} + \begin{pmatrix}\text{Fuel}\\ \text{expenses}\\ \text{per hour}\end{pmatrix} \times \begin{pmatrix}\text{Number}\\ \text{of units}\end{pmatrix}$$

= (Cargo handling equipment cost per hour)

Table A.3.10 Cargo Handling Equipment Cost per Hour

(Unit:WS$)

Year	3.5tons forklift	25tons forklift
1990	25.2	417.1
91	24.7	417.1
92	24.2	417.1
93	23.9	417.1
94	23.4	417.1
95	23.1	417.1
96	22.7	417.1
97	22.5	417.1
98	22.2	417.1
99	21.8	417.1
2000	21.7	417.1
1	21.4	417.1
2	21.2	417.1
3	20.9	412.9
4	20.8	399.4
5	20.8	373.2

Table A.3.10 shows the cargo handling equipment cost per hour in each year.

Table A.3.11 Cargo Handling Equipment Cost of 25ton Forklift per Ton under the With Case

Year	Cost of 25ton forklift per hour (1)	Cargo handling time per Vessel for container cargo (2)	Cargo handling volume per vessel for container cargo (3)	Cargo handling equipment cost of 25ton fork lift per ton {(1)×(2)}/(3)
1990	417.1 (WS$/hour)	38 (hours/vessel)	593 (tons/vessel)	27 (WS$/ton)
91	417.1	39	601	27
92	417.1	40	613	27
93	417.1	40	624	27
94	417.1	42	638	27
95	417.1	43	649	28
96	417.1	43	659	27
97	417.1	44	673	27
98	417.1	45	685	27
99	417.1	45	700	27
2000	417.1	47	712	28
1	417.1	48	725	28
2	417.1	49	740	28
3	412.9	50	754	27
4	399.4	50	767	26
5	373.2	52	782	25

Table A. 3.12 Cargo Handling Equipment Cost of 35ton Forklift per Ton under the With Case

Year	Cost of 35ton forklift per hour	Cargo handling time per vessel for conventional cargo (2)	Cargo handling volume per vessel for conventional cargo (3)	Cost of 35ton forklift per ton {(1)×(2)} / 3
1990	25.2 (WS$/hour)	13.5(hours/vessel)	227 (tons/vessel)	1.5 (WS$/ton)
91	24.7	13.3	223	1.5
92	24.2	13.2	222	1.4
93	23.9	13.0	218	1.4
94	23.4	12.9	216	1.4
95	23.1	12.7	214	1.4
96	22.7	12.5	210	1.4
97	22.5	12.3	207	1.3
98	22.2	12.1	204	1.3
99	21.8	12.0	201	1.3
2000	21.7	11.7	197	1.3
1	21.4	11.5	193	1.3
2	21.2	11.3	190	1.3
3	20.9	11.1	186	1.2
4	20.8	10.8	181	1.2
5	20.8	10.5	177	1.2

Table 3.13 Cargo Handling Equipment Cost at Apron and Marshalling Yard under the With Case

Year	Cost of 25 ton forklift (1)	Cargo handling volume for container cargo (2)	Cost of 35ton forklift (3)	Cargo handling volume for conventional cargo (4)	Cargo handling equipment cost {(1)×(2)} + {(3)×(4)}
1990	27(WS$/ton)	115,000(tons)	1.5(WS$/ton)	44,000(tons)	376,500(WS$)
91	27	120,800	1.5	44,900	393,510
92	27	127,000	1.4	45,800	407,020
93	27	133,500	1.4	46,700	425,830
94	27	140,300	1.4	47,600	445,450
95	28	147,400	1.4	48,500	480,620
96	27	154,900	1.4	49,300	487,250
97	27	162,800	1.3	50,100	504,690
98	27	171,300	1.3	50,900	528,680
99	27	179,900	1.3	51,600	552,810
2000	28	188,800	1.3	52,200	596,500
1	28	198,600	1.3	53,000	624,980
2	28	208,800	1.3	53,600	654,320
3	27	219,500	1.2	54,100	657,570
4	26	230,600	1.2	54,600	665,080
5	25	242,400	1.2	55,000	672,000

(2) Vessel staying cost at berth

a) Prerequisites

o Standard vessel for calculation: 4000 G.T
(From average of container vessels and conventional general cargo vessels in 1985)

- o New worth
- o Depreciation expenses
- o Repayment
- o Fuel expense at anchorage

} Refer to Table A.3.4

- o Working days per year: 300 days
- o Number of crew: 20 persons/vessel
- o Average wage: 56,000 WS$/person per year

b) Calculation

- o Capital cost:

  (900 th.WS$ + 1,752 th.WS$)/(300 days x 2.4 hours/day)

  = 368 WS$/hour

Table A.3.14 Capital Cost per Ton

Year	Capital cost per hour	Cargo handling time per vessel	Cargo handling volume per vessel	Capital cost per ton
1990	368 (WS$/hour)	17.3(hours/vessel)	820(ton/vessel)	7.8 (WS$/ton)
91	368	17.2	824	7.7
92	368	17.2	835	7.6
93	368	17.0	842	7.4
94	368	17.1	854	7.4
95	368	17.0	863	7.2
96	368	16.8	869	7.1
97	368	16.7	880	7.0
98	368	16.6	889	6.9
99	368	16.5	901	6.7
2000	368	16.4	909	6.6
1	368	16.3	918	6.5
2	368	16.1	930	6.4
3	368	16.1	940	6.3
4	368	15.8	948	6.1
5	368	15.7	959	6.0

- o Voyage cost

  Fuel expense at berth: 43.5 WS$/hour

  Crew cost: (5,600 WS$/person x 20 persons)/300 days

  = 3,700 WS$/hour

  3,700 - 24 hours = 154.2 WS$/hour

  Other voyage costs: 11 WS$/hour

  Total (Voyage costs): 208.7 WS$/hour

Table A.3.15 Voyage Cost at Berth per Ton

Year	Voyage cost per hour	Cargo handling time per vessel	Cargo handling volume per vessel	Voyage cost at berth per ton
1990	2087 (WS$/hour)	17.3 (hours/vessel)	820 (tons/vessel)	4.4 (WS$/ton)
91	2087	17.2	824	4.4
92	2087	17.2	835	4.3
93	2087	17.0	842	4.2
94	2087	17.1	854	4.2
95	2087	17.0	863	4.1
96	2087	16.8	869	4.0
97	2087	16.7	880	4.0
98	2087	16.6	889	3.9
99	2087	16.5	901	3.8
2000	2087	16.4	909	3.8
1	2087	16.3	918	3.7
2	2087	16.1	930	3.6
3	2087	16.1	940	3.6
4	2087	15.8	948	3.5
5	2087	15.7	959	3.4

o Port charges (at Apia Port) per vessel

Port Dues

0.05 WS$/GRT x 4,000 GRT = 200 WS$

Cargo Dues

Table A.3.16 Cargo Dues

Year	Cargo dues per ton	Cargo handling volume per vessel	Cargo dues per vssel
1990	0.1 (WS$/ton)	820 (tons/vessel)	82 (WS$/vessel)
91	0.1	824	82
92	0.1	835	84
93	0.1	842	84
94	0.1	854	85
95	0.1	863	86
96	0.1	869	87
97	0.1	880	88
98	0.1	889	89
99	0.1	901	90
2000	0.1	909	91
1	0.1	918	92
2	0.1	930	93
3	0.1	940	94
4	0.1	948	95
5	0.1	959	96

Berthage

Working dues 60 WS$/time x 2 = 120 WS$

Watching dues 15 WS$/h x 2 h = 30 WS$

Dockage

0.05 WS$/GRT per day x 4,000 GRT x 1 day = 200 WS$

Light Dues 40 WS$

Pilotage

0.1 WS$/GRT x 4,000 GRT = 400 WS$

Cleaning Dues 50 WS$

Table A. 3.17 Port Charge per Vessel under the With Case

Unit :WS$/Vessel

Year	Port dues	Cargo dues	Berthage	Dockage	Light dues	Pilotage	Cleaning does	Total
1990	200	82	150	200	40	400	50	1,122
91	200	82	150	200	40	400	50	1,122
92	200	84	150	200	40	400	50	1,124
93	200	84	150	200	40	400	50	1,124
94	200	85	150	200	40	400	50	1,125
95	200	86	150	200	40	400	50	1,126
96	200	87	150	200	40	400	50	1,127
97	200	88	150	200	40	400	50	1,128
98	200	89	150	200	40	400	50	1,129
99	200	90	150	200	40	400	50	1,130
2000	200	91	150	200	40	400	50	1,131
1	200	92	150	200	40	400	50	1,132
2	200	93	150	200	40	400	50	1,133
3	200	94	150	200	40	400	50	1,134
4	200	95	150	200	40	400	50	1,135
5	200	96	150	200	40	400	50	1,136

Table A. 3.18 Port Charge per Ton

Year	Port Charge per vessel	Cargo handling volume per vessel	Port charge per ton
1990	1,122 (WS$)	820 (tons)	1.4 (WS$)
91	1,122	824	1.4
92	1,124	835	1.3
93	1,124	842	1.3
94	1,125	854	1.3
95	1,126	863	1.3
96	1,127	869	1.3
97	1,128	880	1.3
98	1,129	889	1.3
99	1,130	901	1.3
2000	1,131	909	1.2
1	1,132	918	1.2
2	1,133	930	1.2
3	1,134	940	1.2
4	1,135	948	1.2
5	1,136	959	1.2

o Vessels' staying cost at berth per ton

The staying cost of vessels at berth per ton is calculated using the following formulas.

Staying cost of vessels at berth per ton	=	Capital cost per ton	+	Voyage cost at berth per ton	+	Port charge per ton

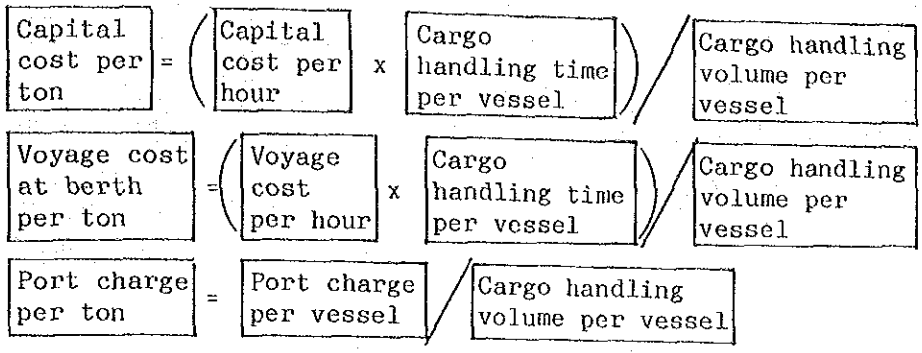


Table A.3.19 Staying cost of Vessels at Berth per Ton

Year	Capital cost per ton	Voyage cost at berth per ton	Port charge per ton	Staying cost of vessels at berth per ton
1990	7.8 (WS$/ton)	4.4 (WS$/ton)	1.4 (WS$/ton)	13.6 (WS$/ton)
91	7.7	4.4	1.4	13.5
92	7.6	4.3	1.3	13.2
93	7.4	4.2	1.3	12.9
94	7.4	4.2	1.3	12.9
95	7.2	4.1	1.3	12.6
96	7.1	4.0	1.3	12.4
97	7.0	4.0	1.3	12.3
98	6.9	3.9	1.3	12.1
99	6.7	3.8	1.3	11.8
2000	6.6	3.8	1.2	11.6
1	6.5	3.7	1.2	11.4
2	6.4	3.6	1.2	11.2
3	6.3	3.6	1.2	11.1
4	6.1	3.5	1.2	10.8
5	6.0	3.4	1.2	10.6

Table A.3.20 Staying Cost of Vessels per Year under the With Case

Year	Staying cost of vessels per ton (1)	Cargo handling volume per year (2)	Staying cost of vessels per year (1)×(2)
1990	13.6 (WS$/ton)	159,000 (tons)	2,162,400 (WS$)
91	13.5	165,700	2,236,950
92	13.2	172,800	2,280,960
93	12.9	180,200	2,324,580
94	12.9	187,900	2,423,910
95	12.6	195,900	2,468,340
96	12.4	204,200	2,532,080
97	12.3	212,900	2,618,670
98	12.1	222,200	2,688,620
99	11.8	231,500	2,731,700
2000	11.6	241,000	2,795,600
1	11.4	251,600	2,868,240
2	11.2	262,400	2,938,880
3	11.1	273,600	3,036,960
4	10.8	285,200	3,080,160
5	10.6	297,400	3,152,440

(3) Offshore Cargo Handling Cost

a) Labor cost per hour

(a) Number of laborers per gang

o Cargo handling between vessel and pontoon

Container cargo handling: 13 persons

Conventional cargo handling: 15 persons

o Cargo handling between pontoon and land stage

Container cargo handling: 12 persons

Conventional cargo handling: 18 persons

(b) Labor cost per gang per hour

o Cargo handling between vessel and pontoon

Container cargo handling: 11.3 (WS$/hour)

Conventional cargo handling: 12.3 (WS$/hour)

o Cargo handling between pontoon and land stage

Container cargo handling: 14.7 (WS$/hour)

Conventional cargo handling: 16.4 (WS$/hour)

(c) Cargo handling equipment cost between vessel and the marshalling yard

o Type of cargo handling equipment at the apron and the marshalling yard.

Cargo handling between pontoon and land stage:

Crawler crane (35t) --- 3 unit

Cargo handling between the apron of land stage and the marshalling yard

For container cargo ----- 25 ton forklift x 2 units

For conventional cargo --- 3.5 ton forklift x 4 units

o Type of cargo handling equipment between vessel and the apron.

Tugboat (D-350)------- 1 unit

Pontoon (200 tons)--- 2 units (From 1990 to 1999)

3 units (From 2000 to 2005)

Table A. 3.21 Cargo Handling Time per Vessel under the Without Case

Year	Cargo Handling time per vessel between vessel and pontoon		Cargo handling time per vessel between pontoon and wharf		Cargo transfer time per vessel between vessel and wharf		Cargo handling and transfer time per vessel between vessel and wharf		
	Container (A)	Conventional (B)	Container (C)	Conventional (D)	Container (E)	Conventional (F)	(A) + (C) + (E)	(B) + (D) + (F)	Total
	(hours)	(hours)	(hours)	(hours)	(hours)	(hours)	(hours)	(hours)	(hours)
1990	3.8	13.5	3.8	13.5	5.0	1.5	12.6	28.5	41.1
91	3.9	13.3	3.9	13.3	5.0	1.5	12.8	28.1	40.9
92	4.0	13.2	4.0	13.2	5.0	1.5	13.0	27.9	40.9
93	4.0	13.0	4.0	13.0	5.0	1.5	13.0	27.5	40.5
94	4.2	12.9	4.2	12.9	5.0	1.5	13.4	27.3	40.7
95	4.3	12.9	4.2	12.7	5.0	1.5	13.6	27.1	40.7
96	4.3	12.5	4.3	12.5	5.0	1.5	13.6	26.5	40.1
97	4.4	12.3	4.4	12.3	6.0	1.5	14.8	26.1	40.9
98	4.5	12.1	4.5	12.1	6.0	1.5	15.0	25.7	40.7
99	4.5	12.0	4.5	12.0	6.0	1.5	15.0	25.5	40.5
2000	4.7	11.7	4.7	11.7	6.0	1.5	15.4	24.9	40.3
1	4.8	11.5	4.8	11.5	6.0	1.5	15.6	24.5	40.1
2	4.9	11.3	4.9	11.3	6.0	1.5	15.8	24.1	39.9
3	5.0	11.1	5.0	11.1	6.0	1.0	16.0	23.2	39.2
4	5.0	10.8	5.0	10.8	6.0	1.0	16.0	22.6	38.6
5	5.2	10.5	5.2	10.5	6.0	1.0	16.4	22.0	38.4

Table A. 3.22 Cargo Handling Equipment Cost per Hour for Crawler Crane

(Unit)

Year	Depreciation Expense per year (1)	Repayment per year (2)	Working time per year (3)	Hire per hour (4)=((1)+(2))/(3)	Fuel expense per hour (5)	Cost of handling time per hour (4)+(5)
	(WS$)	(WS$)	(hours)	(WS$/hour)	(WS$/hour)	(WS$/hour)
1990	85,800.0	116,713.0	2,657.8	76.2	3.8	80.0
91	85,800.0	116,713.0	2,740.3	73.9	3.8	77.7
92	85,800.0	116,713.0	2,822.1	71.8	3.8	75.6
93	85,800.0	116,713.0	2,889.0	70.1	3.8	73.9
94	85,800.0	116,713.0	2,984.7	67.9	3.8	71.7
95	85,800.0	116,713.0	3,079.6	65.8	3.8	69.6
96	85,800.0	116,713.0	3,144.2	64.5	3.8	68.3
97	85,800.0	116,713.0	3,299.3	61.4	3.8	65.2
98	85,800.0	116,713.0	3,391.7	59.7	3.8	63.5
99	85,800.0	116,713.0	3,469.5	58.4	3.8	62.2
2000	85,800.0	116,713.0	3,559.8	56.9	3.8	60.7
1	85,800.0	116,713.0	3,662.5	55.3	3.8	59.1
2	85,800.0	116,713.0	3,750.6	54.0	3.8	57.8
3	85,800.0	116,713.0	3,802.1	53.3	3.8	57.1
4	85,800.0	116,713.0	3,872.9	52.3	3.8	56.1
5	85,800.0	116,713.0	3,968.0	51.0	3.8	54.8

Table A. 3.23 Cargo Handling Equipment Cost of Crawler Crane per Ton

Year	Hire per hour (1)	Cargo handling and transfer time per vessel (2)	Fuel expense per hour (3)	Cargo handling time per vessel between pontoon and wharf (4)	Cargo handling volume per vessel (5)	Number of Units (6)	Cargo handling equipment cost of crawler crane per ton {(1)×(2)} + {(3)×(4)})×(6)/(5)
1990	76.2 (WS$/hour)	41.1 (hours/vessel)	3.8 (WS$/hour)	17.3 (hours/vessel)	820 (tons/vessel)	3	11.7 (WS$/ton)
91	73.9	40.9	3.8	17.2	824	3	11.1
92	71.8	40.9	3.8	17.2	835	3	10.8
93	70.1	40.5	3.8	17.0	842	3	10.2
94	67.9	40.7	3.8	17.1	854	3	9.9
95	65.8	40.7	3.8	16.9	863	3	9.6
96	64.5	40.1	3.8	16.8	869	3	9.0
97	61.4	40.9	3.8	16.7	880	3	8.7
98	59.7	40.7	3.8	16.6	889	3	8.4
99	58.4	40.5	3.8	16.5	901	3	8.1
2000	56.9	40.3	3.8	16.4	909	3	7.8
1	55.3	40.1	3.8	16.3	918	3	7.5
2	54.0	39.9	3.8	16.2	930	3	7.2
3	53.3	39.2	3.8	16.1	940	3	6.9
4	52.3	38.6	3.8	15.8	948	3	6.6
5	51.0	38.4	3.8	15.7	959	3	6.3

Table A.3.24 Cargo Handling Equipment Cost of 25 ton Forklift per Hour

Year	Depreciation expense per year (1)	Repayment expense per year (2)	Working time per year (3)	Number of units (4)	Hire per hour (5)={(1)+(2)}/(4)/(3)	Fuel expense per hour (6)	Cargo handling equipment cost of 25ton forklift (5)+{(6)×(4)}
1990	123,400 (WS$)	172,563 (WS$)	2,444.4 (hours)	2	242.2 (WS$/hour)	3.0 (WS$/hour)	248.2 (WS$/hour)
91	123,400	172,563	2,572.8	2	230.1	3.0	236.1
92	123,400	172,563	2,691.0	2	220.0	3.0	226.0
93	123,400	172,563	2,782.0	2	212.8	3.0	218.8
94	123,400	172,563	2,948.0	2	200.8	3.0	206.8
95	123,400	172,563	3,087.0	2	191.7	3.0	197.7
96	123,400	172,563	3,196.0	2	185.2	3.0	191.2
97	123,400	172,563	3,581.5	2	165.3	3.0	171.3
98	123,400	172,563	3,750.0	2	157.8	3.0	163.8
99	123,400	172,563	3,855.0	2	153.5	3.0	159.5
2000	123,400	172,563	4,081.0	2	145.0	3.0	151.0
1	123,400	172,563	4,274.4	2	138.5	3.0	144.5
2	123,400	172,563	4,455.6	2	132.8	3.0	138.8
3	123,400	172,563	4,656.0	2	127.1	3.0	133.1
4	123,400	172,563	4,816.0	2	122.9	3.0	128.9
5	123,400	172,563	5,084.0	2	116.4	3.0	122.4

Table A. 3.25 Cargo Handling Equipment Cost of 25ton Forklift per Ton

Year	Hire per hour (1)	Cargo handling and transfer time for container per vessel (2)	Fuel expense per hour (3)	Cargo handling time per vessel between pontoon and wharf (4)	Cargo handling volume per vessel (5)	Number of units (6)	Cargo handling equipments cost of 25 tons forklift per ton ((1)×(2))+((3)×(4)×(6))/(5)
1990	2422 (WS$/hour)	126 (hours/vessel)	30 (WS$/hour)	38 (hours/vessel)	593 (tons/vessel)	2	5.2 (WS$/ton)
91	2301	128	3.0	3.9	601	2	4.9
92	2200	130	3.0	4.0	613	2	4.7
93	2128	130	3.0	4.0	624	2	4.5
94	2008	134	3.0	4.2	638	2	4.3
95	1917	136	3.0	4.2	649	2	4.1
96	1852	136	3.0	4.3	659	2	3.9
97	1653	148	3.0	4.4	673	2	3.7
98	1578	150	3.0	4.5	685	2	3.5
99	1535	150	3.0	4.5	700	2	3.3
2000	1450	154	3.0	4.7	712	2	3.2
1	1385	156	3.0	4.8	725	2	3.0
2	1328	158	3.0	4.9	740	2	2.9
3	1271	160	3.0	5.0	754	2	2.7
4	1229	169	3.0	5.0	767	2	2.6
5	1164	164	3.0	5.2	782	2	2.5

o Cargo handling equipment cost at the apron and the marshalling yard for container cargo.

Table A. 3.26 Cargo Handling Equipment Cost per Ton
under the Without Case for Container Cargo

Year	Crawler Crane (1)	25ton forklift (2)	Cargo handling equipment cost per ton for container cargo (1)+(2)
1990	11.7 (WS$/ton)	5.2 (WS$/ton)	16.9 (WS$/ton)
91	11.1	4.9	16.0
92	10.8	4.7	15.5
93	10.2	4.5	14.7
94	9.9	4.3	14.2
95	9.6	4.1	13.7
96	9.0	3.9	12.9
97	8.7	3.7	12.4
98	8.4	3.5	11.9
99	8.1	3.3	11.4
2000	7.8	3.2	11.0
1	7.5	3.0	10.5
2	7.2	2.9	10.1
3	6.9	2.7	9.6
4	6.6	2.6	9.2
5	6.3	2.5	8.8

Table A. 3.27 Cargo Handling Equipment Cost of 3.5 ton Forklift per Hour

Year	Depreciation expense per year (1)	Repayment expense per year (2)	Working time per year (3)	Number of units (4)	Hire per hour (5)=[{(1)+(2)}×(4)]/(3)	Fuel expense per hour (6)	Cargo handling equipment cost per hour of 3.5 ton forklift(4units) (5)+[(6)×(4)]
1990	12,300 (WS$)	17,000 (WS$)	2,764.5 (WS$)	4	42.4 (WS$)	1.4 (WS$)	48.0 (WS$)
91	12,300	17,000	2,824.1	4	41.5	1.4	47.9
92	12,300	17,000	2,887.7	4	40.6	1.4	47.0
93	12,300	17,000	2,942.5	4	39.8	1.4	46.2
94	12,300	17,000	3,003.0	4	39.0	1.4	45.4
95	12,300	17,000	3,075.9	4	38.1	1.4	44.5
96	12,300	17,000	3,113.8	4	37.6	1.4	44.0
97	12,300	17,000	3,158.1	4	37.1	1.4	43.5
98	12,300	17,000	3,212.5	4	36.5	1.4	42.9
99	12,300	17,000	3,276.8	4	35.8	1.4	42.2
2000	12,300	17,000	3,299.3	4	35.5	1.4	41.9
1	12,300	17,000	3,356.5	4	34.9	1.4	41.3
2	12,300	17,000	3,398.1	4	34.5	1.4	40.9
3	12,300	17,000	3,375.6	4	34.7	1.4	41.1
4	12,300	17,000	3,401.3	4	34.5	1.4	40.9
5	12,300	17,000	3,410.0	4	34.4	1.4	40.8

Table A. 3.28 Cargo Handling Equipment Cost of 3.5 ton Forklift per Ton

Year	Hire per hour (1)	Cargo handling and transfer time for conventional cargo per vessel (2)	Fuel expense per hour (3)	Cargo handling time per vessel between pontoon and wharf (4)	Number of units (5)	Cargo handling volume per vessel (6)	Cost of cargo handling equipment per ton of 3.5 ton forklift {[(1)×(2)]+[(3)×(4)×(5)]}/(6)
1990	42.4 (WS$/hour)	28.5 (hours/vessel)	1.4 (WS$/hour)	13.5 (hours/vessel)	4	227 (tons/vessel)	5.7 (WS$/ton)
91	41.5	28.1	1.4	13.3	4	223	5.6
92	40.6	27.9	1.4	13.2	4	222	5.5
93	39.8	27.5	1.4	13.0	4	218	5.4
94	39.0	27.3	1.4	12.9	4	216	5.3
95	38.1	27.1	1.4	12.7	4	214	5.2
96	37.6	26.5	1.4	12.5	4	210	5.1
97	37.1	26.1	1.4	12.3	4	207	5.1
98	36.5	25.7	1.4	12.1	4	204	5.0
99	35.8	25.5	1.4	12.0	4	201	4.9
2000	35.5	24.9	1.4	11.7	4	197	4.9
1	34.9	24.5	1.4	11.5	4	193	4.8
2	34.5	24.1	1.4	11.3	4	190	4.8
3	34.7	23.2	1.4	11.1	4	186	4.7
4	34.5	22.6	1.4	10.8	4	181	4.7
5	34.4	22.0	1.4	10.5	4	177	4.7

o Cargo handling equipment cost at the apron and the marshalling yard for conventional cargo.

Table A.3.29 Cargo Handling Equipment Cost per Ton for Conventional Cargo under the Without Case

Year	Crawler crane (1)	35ton forklift (2)	Cargo handling equipment cost per ton for conventional cago (1)+(2)
1990	11.7 (WS$/ton)	5.7 (WS$/ton)	17.4 (WS$/ton)
91	11.1	5.6	16.7
92	10.8	5.5	16.3
93	10.2	5.4	15.6
94	9.9	5.3	15.2
95	9.6	5.2	14.8
96	9.0	5.1	14.1
97	8.7	5.1	13.8
98	8.4	5.0	13.4
99	8.1	4.9	13.0
2000	7.8	4.9	12.7
1	7.5	4.8	12.3
2	7.2	4.8	12.0
3	6.9	4.7	11.6
4	6.6	4.7	11.3
5	6.3	4.7	11.0

O Cargo handling equipment cost at the apron and the maschalling yard under the without case.

Table A-3-30 Cargo Handling Equipment Cost at Apron and Marshalling Yard under the Without Case

Year	Cargo handling equipment cost per ton of container cargos (1)	Cargo handling volume of container cargo (2)	Cargo handling equipment cost per ton for conventional cargo (3)	Cargo handling volume for conventional (4)	Cargo handling equipment cost ((1)×(2))+((3)×(4))
	(WS$/ton)	(tons)	(WS$/ton)	(tons)	(WS$)
1990	16.9	115,000	17.4	44,000	2,709,100
1991	16.0	120,800	16.7	44,900	2,682,630
1992	15.5	127,000	16.3	45,800	2,715,040
1993	14.7	133,500	15.6	46,700	2,690,970
1994	14.2	140,300	15.2	47,600	2,715,780
1995	13.7	147,400	14.8	48,500	2,733,180
1996	12.9	154,900	14.1	49,300	2,693,340
1997	12.4	162,800	13.8	50,100	2,710,100
1998	11.9	171,300	13.4	50,900	2,720,530
1999	11.4	179,900	13.0	51,600	2,721,660
2000	11.0	188,800	12.7	52,200	2,739,740
2001	10.5	198,600	12.3	53,000	2,737,200
2002	10.1	208,800	12.0	53,600	2,752,080
2003	9.6	219,500	11.6	54,100	2,734,760
2004	9.2	230,600	11.3	54,600	2,738,500
2005	8.8	242,400	11.0	55,000	2,738,120

o Use time of pontoon and tugboat per vessel.

Table A.3.31 Use Time of Pontoon and Tugboat per Vessel under the Without Case

Year	Pontoon			Tugboat		
	Container	Conventional	Total	Cantainer	Conventional	Total
	(hours)	(hours)	(hours)	(hours)	(hours)	(hours)
1990	12.6	28.5	41.1	5.0	1.5	6.5
1991	12.8	28.1	40.9	5.0	1.5	6.5
1992	13.0	27.9	40.9	5.0	1.5	6.5
1993	13.0	27.5	40.5	5.0	1.5	6.5
1994	13.4	27.3	40.7	5.0	1.5	6.5
1995	13.6	27.1	40.7	5.0	1.5	6.5
1996	13.6	26.5	40.1	5.0	1.5	6.5
1997	14.8	26.1	40.9	6.0	1.5	7.5
1998	15.0	25.7	40.7	6.0	1.5	7.5
1999	15.0	25.5	40.5	6.0	1.5	7.5
2000	15.4	24.9	40.3	6.0	1.5	7.5
2001	15.6	24.5	40.1	6.0	1.5	7.5
2002	15.8	24.1	39.9	6.0	1.5	7.5
2003	16.0	23.2	39.2	6.0	1.0	7.0
2004	16.0	22.6	38.6	6.0	1.0	7.0
2005	16.4	22.0	38.4	6.0	1.0	7.0

Table A.3.32 Cost of Tugboat per Ton

Year	Depreciation expense per year (1)	Repayment expense per year (2)	Working time per year (3)	Hire per hour (4)={(1)+(2)}/(3)	Fuel expense per hour (5)	Cost of tugboat per hour (6)=(4)+(5)	Working time per vessel (7)	Cargo handling volume per vessel (8)	Cost of tugboat per ton {(6)×(7)} / (8)
	(WS$)	(WS$)	(hours)	(WS$)	(WS$)	(WS$)	(hours)	(tons)	(WS$)
1990	82,600	116,000	1,358	146.2	53.2	199.4	6.5	820	1.6
1991	82,600	116,000	1,407	141.2	53.2	194.4	6.5	824	1.5
1992	82,600	116,000	1,449	137.1	53.2	190.3	6.5	835	1.5
1993	82,600	116,000	1,498	132.6	53.2	185.8	6.5	842	1.4
1994	82,600	116,000	1,540	129.0	53.2	182.2	6.5	854	1.4
1995	82,600	116,000	1,589	125.0	53.2	178.2	6.5	863	1.3
1996	82,600	116,000	1,695	117.2	53.2	170.4	6.5	869	1.3
1997	82,600	116,000	1,936	102.6	53.2	155.8	7.5	880	1.3
1998	82,600	116,000	2,000	99.3	53.2	152.5	7.5	889	1.3
1999	82,600	116,000	2,056	96.6	53.2	149.8	7.5	901	1.2
2000	82,600	116,000	2,120	93.7	53.2	146.9	7.5	909	1.2
2001	82,600	116,000	2,192	90.6	53.2	143.8	7.5	918	1.2
2002	82,600	116,000	2,256	88.0	53.2	141.2	7.5	930	1.1
2003	82,600	116,000	2,037	97.5	53.2	150.7	7.0	940	1.1
2004	82,600	116,000	2,107	94.3	53.2	147.5	7.0	948	1.1
2005	82,600	116,000	2,170	91.5	53.2	144.7	7.0	959	1.1

Table A.3.33 Cost of Pontoon per Ton

Year	Depreciation expense per year (1)	Repayment expense per year (2)	Working time per year (3)	Number of units (4)	Hire per hour (5)=[(1)+(2)]/(3)	Working time per vessel (6)	Cargo handling volume per vessel (7)	Cost of pontoon per ton [(5)×(6)×(4)]/(7)
	(WS$)	(WS$)	(hours)	(units)	(WS$)	(hours)	(tons)	(WS$)
1990	17,700	31,000	3,986.7	2	12.2	41.1	820	1.2
1991	17,700	31,000	4,110.6	2	11.8	40.9	824	1.2
1992	17,700	31,000	4,233.2	2	11.5	40.9	835	1.1
1993	17,700	31,000	4,333.5	2	11.2	40.5	842	1.1
1994	17,700	31,000	4,477.0	2	10.9	40.7	854	1.0
1995	17,700	31,000	4,619.5	2	10.5	40.7	863	1.0
1996	17,700	31,000	4,711.8	2	10.3	40.1	869	1.0
1997	17,700	31,000	4,934.9	2	9.8	40.9	880	0.9
1998	17,700	31,000	5,087.5	2	9.6	40.7	889	0.9
1999	17,700	31,000	5,204.3	2	9.4	40.5	901	0.8
2000	17,700	31,000	5,339.8	2	9.1	40.3	909	0.8
2001	17,700	31,000	5,493.5	2	8.9	40.1	918	0.8
2002	17,700	31,000	3,750.6	3	13.0	30.9	930	1.7
2003	17,700	31,000	3,802.4	3	12.8	39.2	940	1.6
2004	17,700	31,000	3,872.9	3	12.6	38.6	948	1.5
2005	17,700	31,000	3,968.0	3	12.3	38.4	959	1.5

Table A.3.34 Cost of Tugboat and Pontoon per Year

Year	Cost of tugboat per ton (1)	Cost of pontoon per ton (2)	Cargo handling volume per year (3)	Cost of tugboat and pontoon per year [(1)+(2)] × (3)
	(WS$/ton)	(WS$/ton)	(tons)	(WS$)
1990	1.6	1.2	159,000	445,200
1991	1.5	1.2	165,700	447,390
1992	1.5	1.1	172,800	449,280
1993	1.4	1.1	180,200	450,500
1994	1.4	1.0	187,900	450,960
1995	1.3	1.0	195,900	450,570
1996	1.3	1.0	204,200	469,660
1997	1.3	0.9	212,900	468,380
1998	1.3	0.9	222,200	488,840
1999	1.2	0.8	231,500	463,000
2000	1.2	0.8	241,000	482,000
2001	1.2	0.8	251,600	503,200
2002	1.1	1.7	262,400	734,720
2003	1.1	1.6	273,600	738,720
2004	1.1	1.5	285,200	741,520
2005	1.1	1.5	297,400	773,240

(d) Labor cost of cargo handling and tugboat per ton

Table A.3.35 Labor Cost for Container Cargo Handling per Vessel

Year	Between vessel and pontoon			Between pontoon and land stage			Labor cost for cargo handling per vessel (7) = (3) + (6)
	Labor cost per gang per hour (1)	Cargo handling time per vessel (2)	Labor cost per vessel (3) = (1) × (2)	Labor cost per gang per hour (4)	Cargo handling time per vessel (5)	Labor cost per vessel (6) = (4) × (5)	
	(WS$)	(hours)	(WS$)	(WS$)	(hours)	(WS$)	(WS$)
1990	11.3	3.6	42.9	14.7	3.8	55.9	98.8
1991	11.3	3.9	44.1	14.7	3.9	57.3	101.4
1992	11.3	4.0	45.2	14.7	4.0	58.8	104.0
1993	11.3	4.0	45.2	14.7	4.0	58.8	104.0
1994	11.3	4.2	47.5	14.7	4.2	61.7	109.2
1995	11.3	4.3	48.6	14.7	4.3	63.2	111.8
1996	11.3	4.3	48.6	14.7	4.3	63.2	111.8
1997	11.3	4.4	49.7	14.7	4.4	64.7	114.4
1998	11.3	4.5	50.9	14.7	4.5	66.2	117.1
1999	11.3	4.5	50.9	14.7	4.5	66.2	117.1
2000	11.3	4.7	53.1	14.7	4.7	69.1	122.2
2001	11.3	4.8	54.2	14.7	4.8	70.6	124.8
2002	11.3	4.9	55.4	14.7	4.9	72.0	127.4
2003	11.3	5.0	56.5	14.7	5.0	73.5	130.0
2004	11.3	5.0	56.5	14.7	5.0	73.5	130.0
2005	11.3	5.2	58.8	14.7	5.2	76.4	135.2

Table A.3.36 Labor Cost for Conventional Cargo Handling per Vessel

Year	Between vessel and pontoon			Between pontoon and land stage			Labor cost for cargo handling per vessel (7) = (3) + (6)
	Labor cost per gang per hour (1)	Cargo handling time per vessel (2)	Labor cost per vessel (3) = (1) × (2)	Labor cost per gang per hour (4)	Cargo handling time per vessel (5)	Labor cost per vessel (6) = (4) × (5)	
	(WS$)	(hours)	(WS$)	(WS$)	(hours)	(WS$)	(WS$)
1990	12.3	13.5	166.1	16.4	13.5	18.9	185.0
1991	12.3	13.3	163.6	16.4	13.3	18.6	182.2
1992	12.3	13.2	162.4	16.4	13.2	18.5	180.9
1993	12.3	13.0	159.9	16.4	13.0	18.2	178.1
1994	12.3	12.9	158.7	16.4	12.9	18.1	176.8
1995	12.3	12.9	158.7	16.4	12.9	18.1	176.8
1996	12.3	12.5	153.8	16.4	12.5	17.5	171.3
1997	12.3	12.3	151.3	16.4	12.3	17.2	168.5
1998	12.3	12.1	148.8	16.4	12.1	16.9	165.7
1999	12.3	12.0	147.6	16.4	12.0	16.8	164.4
2000	12.3	11.7	143.9	16.4	11.7	16.4	160.3
2001	12.3	11.5	141.5	16.4	11.5	16.1	157.6
2002	12.3	11.3	140.0	16.4	11.3	15.8	155.8
2003	12.3	11.1	136.5	16.4	11.1	15.5	152.0
2004	12.3	10.8	132.8	16.4	10.8	15.1	147.9
2005	12.3	10.5	129.2	16.4	10.5	14.7	143.9

Table A-3-37 Labor Cost for Cargo Handling per Ton under the Without Case

Year	Labor cost for cargo handling per vessel			Labor cost for cargo handling per ton	
	Container (1)	Conventional (2)	Total (3) = (1) + (2)	Cargo handling volume per vessel (4)	Labor cost per ton (3) / (4)
	(WS$)	(WS$)	(WS$)	(tons)	(WS$)
1990	98.8	185.0	283.8	820	0.3
1991	101.4	182.2	283.6	824	0.3
1992	104.0	180.9	284.9	835	0.3
1993	104.0	178.1	282.1	842	0.3
1994	109.2	176.8	286.0	854	0.3
1995	111.8	176.8	288.6	863	0.3
1996	111.8	171.3	283.1	869	0.3
1997	114.4	168.5	282.9	880	0.3
1998	117.1	165.7	282.8	889	0.3
1999	117.1	164.4	281.5	901	0.3
2000	122.2	160.3	282.5	909	0.3
2001	124.8	157.6	282.4	918	0.3
2002	127.4	155.8	283.2	930	0.3
2003	130.0	152.0	282.0	940	0.3
2004	130.0	147.9	277.9	948	0.3
2005	135.2	143.9	279.1	959	0.3

Table A-3-38 Crew Cost of Tugboat per Ton

Year	Crew cost per hour (1)	Use time of tugboat per vessel (2)	Cargo handling volume per vessel (3)	Crew cost per ton [(1)×(2)] / (3)
	(WS$)	(hours)	(tons)	(WS$)
1990	16.3	6.5	820	0.1
1991	16.3	6.5	824	0.1
1992	16.3	6.5	835	0.1
1993	16.3	6.5	842	0.1
1994	16.3	6.5	854	0.1
1995	16.3	6.5	863	0.1
1996	16.3	6.5	869	0.1
1997	16.3	7.5	880	0.1
1998	16.3	7.5	889	0.1
1999	16.3	7.5	901	0.1
2000	16.3	7.5	909	0.1
2001	16.3	7.5	918	0.1
2002	16.3	7.5	930	0.1
2003	16.3	7.0	940	0.1
2004	16.3	7.0	948	0.1
2005	16.3	7.0	959	0.1

Table A.3.39 Labor Cost of Cargo Handling and Tugboat per Ton

Year	Labor cost for cargo handling per ton (1)	Crew cost of tugboat per ton (2)	Labor cost of cargo handling and tugboat per ton (1) + (2)
	(WS$)	(WS$)	(WS$)
1990	0.3	0.1	0.4
1991	0.3	0.1	0.4
1992	0.3	0.1	0.4
1993	0.3	0.1	0.4
1994	0.3	0.1	0.4
1995	0.3	0.1	0.4
1996	0.3	0.1	0.4
1997	0.3	0.1	0.4
1998	0.3	0.1	0.4
1999	0.3	0.1	0.4
2000	0.3	0.1	0.4
2001	0.3	0.1	0.4
2002	0.3	0.1	0.4
2003	0.3	0.1	0.4
2004	0.3	0.1	0.4
2005	0.3	0.1	0.4

Table A.3.40 Labor Cost for Cargo Handling under the Without Case

Year	Labor cost per ton for cargo handling (1)	Cargo handling volume per year (2)	Labor cost per year for cargo handling (1) × (2)
	(WS$/ton)	(ton/year)	(WS$/year)
1990	0.4	159,000	63,600
1991	0.4	165,700	66,280
1992	0.4	172,800	69,120
1993	0.4	180,200	72,080
1994	0.4	187,900	75,160
1995	0.4	195,900	78,360
1996	0.4	204,200	81,680
1997	0.4	212,900	85,160
1998	0.4	222,200	88,880
1999	0.4	231,500	92,600
2000	0.4	241,000	96,400
2001	0.4	251,600	100,640
2002	0.4	262,400	104,960
2003	0.4	273,600	109,440
2004	0.4	285,200	114,080
2005	0.4	297,400	118,960

(4) Vessel staying cost for offshore handling

The Prerequisites of the cost calculation are presented in (2), above. Also, please refer to Appendix 3-5,2),(2).

a) Calculation

- o Capital cost per hour
- o Voyage cost per hour
- o Port charges per vessel

} Refer to Appendix 3-5,2),(2)

Table A.3.41 Capital Cost per Ton under the Without Case

Year	Capital cost per hour (1)	Cargo handling time per vessel (2)	Cargo handling volume per vessel (3)	Capital cost per ton {(1) × (2)} / (3)
	(WS$)	(hours)	(tons)	(WS$)
1990	368	41.1	820	18.4
1991	368	40.9	824	18.3
1992	368	40.9	835	18.0
1993	368	40.5	842	17.7
1994	368	40.7	854	17.5
1995	368	40.7	863	17.4
1996	368	40.1	869	17.0
1997	368	40.9	880	17.1
1998	368	40.7	889	16.8
1999	368	40.5	901	16.5
2000	368	40.3	909	16.3
2001	368	40.1	918	16.1
2002	368	39.9	930	15.8
2003	368	39.2	940	15.3
2004	368	38.6	948	15.0
2005	368	38.4	959	14.7

Table A.3-42 Voyage Cost under the Without Case

Year	Voyage cost per hour (1)	Cargo handling time per vessel (2)	Cargo handling volume per vessel (3)	Voyage cost per ton [(1) × (2)] / (3)
	(WS$)	(hours)	(tons)	(WS$)
1990	208.7	41.1	820	10.5
1991	208.7	40.9	824	10.5
1992	208.7	40.9	835	10.2
1993	208.7	40.5	842	10.0
1994	208.7	40.7	854	9.9
1995	208.7	40.7	863	9.8
1996	208.7	40.1	869	9.6
1997	208.7	40.9	880	9.7
1998	208.7	40.7	889	9.6
1999	208.7	40.5	901	9.4
2000	208.7	40.3	909	9.3
2001	208.7	40.1	918	9.1
2002	208.7	39.9	930	9.0
2003	208.7	39.2	940	8.7
2004	208.7	38.6	948	8.5
2005	208.7	38.4	959	8.4

Table A.3-43 Port Charge per Ton under the Without Case

Year	Port due per vessel	Cargo due per vessel	Light due per vessel	Pilotage per vessel	Cleaning due per vessel	Port charge per vessel	Cargohandling volume per vessel	Port charge per ton
	(WS$)	(WS$)	(WS$)	(WS$)	(WS$)	(WS$)	(tons)	(WS$)
1990	200	82	40	400	50	772	820	0.9
1991	200	82	40	400	50	772	824	0.9
1992	200	84	40	400	50	774	835	0.9
1993	200	84	40	400	50	774	842	0.9
1994	200	85	40	400	50	775	854	0.9
1995	200	86	40	400	50	776	863	0.9
1996	200	87	40	400	50	777	869	0.9
1997	200	88	40	400	50	778	880	0.9
1998	200	89	40	400	50	779	889	0.9
1999	200	90	40	400	50	780	901	0.9
2000	200	91	40	400	50	781	909	0.9
2001	200	92	40	400	50	782	918	0.9
2002	200	93	40	400	50	783	930	0.8
2003	200	94	40	400	50	784	940	0.8
2004	200	95	40	400	50	785	948	0.8
2005	200	96	40	400	50	786	959	0.8

* Calculated from existing Tariff

o Vessel staying cost

Table A.3.44 Vessel Staying Cost per Ton under the Without Case

Year	Capital cost per ton (1)	Voyage cost per ton (2)	Port charge per ton (3)	Vessel staying cost per ton (4) = (1) + (2) + (3)
	(WS$)	(WS$)	(WS$)	(WS$)
1990	18.4	10.5	0.9	29.8
1991	18.3	10.5	0.9	29.7
1992	18.0	10.2	0.9	29.1
1993	17.7	10.0	0.9	28.6
1994	17.5	9.9	0.9	28.3
1995	17.4	9.8	0.9	28.1
1996	17.0	9.6	0.9	27.5
1997	17.1	9.7	0.9	27.7
1998	16.8	9.6	0.9	27.3
1999	16.5	9.4	0.9	26.8
2000	16.3	9.3	0.9	26.5
2001	16.1	9.1	0.9	26.1
2002	15.8	9.0	0.8	25.7
2003	15.3	8.7	0.8	24.9
2004	15.0	8.5	0.8	24.4
2005	14.7	8.4	0.8	24.0

Table A.3.45 Vessel Staying Cost per Year under the Without Case

Year	Vessel staying cost per ton (1)	Cargo handling volume per year (2)	Vessel staying cost per year (1) × (2)
	(WS$/ton)	(tons)	(WS$)
1990	29.8	159,000	4,738,200
1991	29.7	165,700	4,921,290
1992	29.1	172,800	5,028,480
1993	28.6	180,200	5,153,720
1994	28.3	187,900	5,317,570
1995	28.1	195,900	5,504,790
1996	27.5	204,200	5,615,500
1997	27.7	212,900	5,897,330
1998	27.3	222,200	6,066,060
1999	26.8	231,500	6,204,200
2000	26.5	241,000	6,386,500
2001	26.1	251,500	6,566,760
2002	25.7	262,400	6,743,680
2003	24.9	273,500	6,812,640
2004	24.4	285,200	6,958,880
2005	24.0	297,400	7,137,600

3) Benefit from Rehabilitation of the Main Wharf

Table A.3.46 Benefit from Rehabilitation of Main Wharf

Year	Cargo handling at berth- (With case)				Offshore cargo handling (Without case)				Benefit		
	Cargo handling cost			Vessel staying cost	Cargo handling cost			Vessel staying cost	Saving in cargo handling cost	Saving in vessel staying cost	Benefit from Rehabilitation of Main Wharf
	Labour cost of cargo handling	Cargo handling equipment cost of forklift.	Cost of tugboat and pontoon		Labour cost of cargo handling	Cargo handling equipment cost of crawler crane and forklift	Cost of tugboat and pontoon				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)= {(5)+(6)+(7)} − {(1)+(2)+(3)}	(10)=0.6(8)−(4)	(9) + (10)
	(th.WS$)	(th.WS$)		(th.WS$)	(th.WS$)	(th.WS$)	(th.WS$)	(th.WS$)	(th.WS$)	(th.WS$)	(th.WS$)
1990	57	377	–	2,162	64	2,709	445	4,738	2,784	1,546	4,330
1991	60	394	–	2,231	66	2,683	447	4,981	2,742	1,589	4,331
1992	62	407	–	2,281	69	2,715	449	5,028	2,764	1,648	4,412
1993	63	425	–	2,335	72	2,691	451	5,154	2,725	1,697	4,422
1994	64	445	–	2,424	75	2,716	451	5,318	2,733	1,736	4,469
1995	67	481	–	2,488	79	2,737	451	5,505	2,718	1,822	4,540
1996	67	487	–	2,532	82	2,693	470	5,616	2,691	1,850	4,541
1997	70	505	–	2,619	85	2,710	488	5,897	2,658	1,961	4,619
1998	71	529	–	2,699	89	2,721	489	6,066	2,699	2,026	4,725
1999	74	555	–	2,797	93	2,722	463	6,204	2,631	2,083	4,734
2000	75	597	–	2,796	96	2,740	482	6,387	2,646	2,155	4,801
2001	78	625	–	2,888	101	2,737	503	6,567	2,638	2,219	4,857
2002	79	654	–	2,939	105	2,752	735	6,744	2,859	2,283	5,142
2003	79	658	–	3,037	109	2,735	739	6,813	2,846	2,266	5,112
2004	83	665	–	3,080	114	2,739	742	6,959	2,847	2,327	5,174
2005	83	672	–	3,152	119	2,738	773	7,138	2,875	2,392	5,267
Total	1,132	8,475	–	42,341	1,417	43,538	8,558	95,055	43,906	31,606	75,512

* (1) The ratio of Samoan vessels to all calling vessels at Apia Port : 20%

(2) The ratio of the return to the Western Samoan economy for the benefit from the saving in vessel staying cost is assumed as follows.

Samoan vessels : 100%

Foreign vessels : 50%

3-6 Calculation of Benefit from Reclamation

1) Prerequisites of the calculation

- o Under the without case, containers are stowed in area A to F in Figure A.3.1, and the figures in parenthesis show the percentage of the share of the slots in each area.

- o Figure A.3.2 shows the container stowage area in the First Stage Plan and the figures in parenthesis show the percentage of the slots in each area.

- o The cargo handling equipment for containers in the marshalling yard is two forklifts with an average forward speed and an average reverse speed of 10 km per hour and 5 km per hour respectively.

- o Average cycle time of the container crane is assumed to be 3.7 minutes based on observation at Apia Port. (Working efficiency: 16.3 units/hour).

- o If there are enough forklifts for Ro/Ro operation, the working efficiency of cargo handling using the Ro/Ro system is 25 units per hour (2.4 minutes per unit).

- o In the Lo/Lo system, the preparation time of the forklifts on the apron and the marshalling yard are 0.5 minutes per unit and 1.5 minutes per unit respectively.

- o The other prerequisites are the same as those presented in 3-5,2),(1)(2).

2) Calculation of Benefit from concentration of containers behind the Main Wharf.

(1) Carrying cost of containers between the apron and the marshalling yard under the without case.

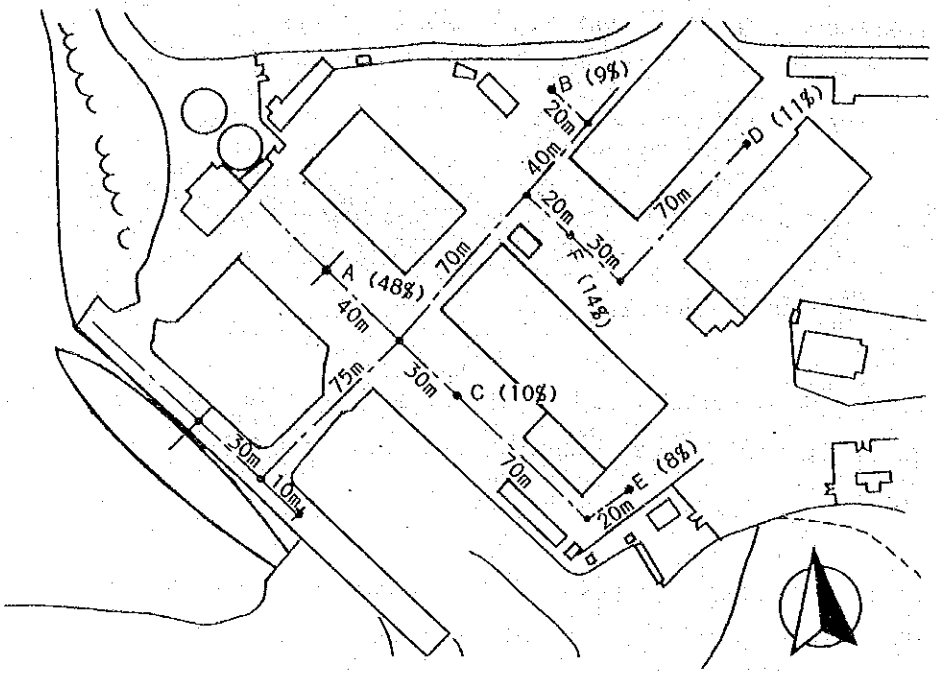


Fig. A.3.1 Container Stowage Yard under the Without Case

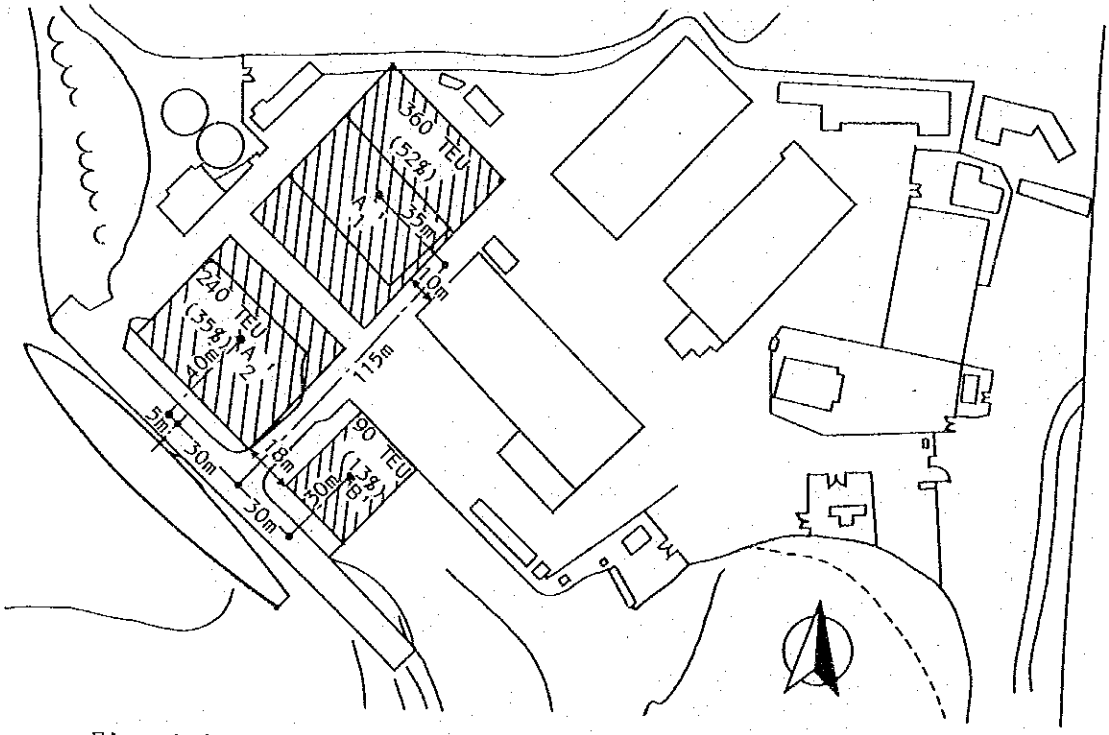


Fig. A.3.2 Container Stowage Yard under the With Case

Table A.3.47 Number of Handling Containers at Each Stowage Area per Vessel under the Without Case

Year	Number of handling containers per vessel at each stowage area					
	Area A	Area B	Area C	Area D	Area E	Area F
	(TEU) (TEU)	(TEU) (TEU)	(TEU) (TEU)	(TEU) (TEU)	(TEU) (TEU)	(TEU) (TEU)
1990	62 × 0.48 = 29.8	62 × 0.09 = 5.6	62 × 0.10 = 6.2	62 × 0.11 = 6.8	62 × 0.08 = 5.0	62 × 0.14 = 8.6
1991	64 × 0.48 = 30.7	64 × 0.09 = 5.8	64 × 0.10 = 6.4	64 × 0.11 = 7.0	64 × 0.08 = 5.1	64 × 0.14 = 9.0
1992	66 × 0.48 = 31.7	66 × 0.09 = 5.9	66 × 0.10 = 6.6	66 × 0.11 = 7.3	66 × 0.08 = 5.3	66 × 0.14 = 9.2
1993	66 × 0.48 = 31.7	66 × 0.09 = 5.9	66 × 0.10 = 6.6	66 × 0.11 = 7.3	66 × 0.08 = 5.3	66 × 0.14 = 9.2
1994	68 × 0.48 = 32.6	68 × 0.09 = 6.1	68 × 0.10 = 6.8	68 × 0.11 = 7.5	68 × 0.08 = 5.4	68 × 0.14 = 9.6
1995	70 × 0.48 = 33.6	70 × 0.09 = 6.3	70 × 0.10 = 7.0	70 × 0.11 = 7.7	70 × 0.08 = 5.6	70 × 0.14 = 9.8
1996	70 × 0.48 = 33.6	70 × 0.09 = 6.3	70 × 0.10 = 7.0	70 × 0.11 = 7.7	70 × 0.08 = 5.6	70 × 0.14 = 9.8
1997	72 × 0.48 = 34.6	72 × 0.09 = 6.5	72 × 0.10 = 7.2	72 × 0.11 = 7.9	72 × 0.08 = 5.8	72 × 0.14 = 10.0
1998	74 × 0.48 = 35.5	74 × 0.09 = 6.7	74 × 0.10 = 7.4	74 × 0.11 = 8.1	74 × 0.08 = 5.9	74 × 0.14 = 10.4
1999	74 × 0.48 = 35.5	74 × 0.09 = 6.7	74 × 0.10 = 7.4	74 × 0.11 = 8.1	74 × 0.08 = 5.9	74 × 0.14 = 10.4
2000	76 × 0.48 = 36.5	76 × 0.09 = 6.8	76 × 0.10 = 7.6	76 × 0.11 = 8.4	76 × 0.08 = 6.1	76 × 0.14 = 10.6
2001	78 × 0.48 = 37.4	78 × 0.09 = 7.0	78 × 0.10 = 7.8	78 × 0.11 = 8.6	78 × 0.08 = 6.2	78 × 0.14 = 11.0
2002	80 × 0.48 = 38.4	80 × 0.09 = 7.2	80 × 0.10 = 8.0	80 × 0.11 = 8.8	80 × 0.08 = 6.4	80 × 0.14 = 11.2
2003	82 × 0.48 = 39.4	82 × 0.09 = 7.4	82 × 0.10 = 8.2	82 × 0.11 = 9.0	82 × 0.08 = 6.6	82 × 0.14 = 11.4
2004	82 × 0.48 = 39.4	82 × 0.09 = 7.4	82 × 0.10 = 8.2	82 × 0.11 = 9.0	82 × 0.08 = 6.6	82 × 0.14 = 11.4
2005	84 × 0.48 = 40.3	84 × 0.09 = 7.6	84 × 0.10 = 8.4	84 × 0.11 = 9.2	84 × 0.08 = 6.7	84 × 0.14 = 11.8

Table A.3.48 Handling Distance between the Apron and Each Stowage Area under the Without Case

Stowage area	Round trip Distance between the apron and stowage areas	
	Forward or reverse	Round trip Distance
A	Forward	{(75m+40m)×2}+30m = 260m
	Reverse	30m+10m = 40m
B	Forward	{(75m+70m+40m+20m)×2}+30m = 440m
	Reverse	30m+10m = 40m
C	Forward	{(75m+30m)×2}+30m = 240m
	Reverse	30m+10m = 40m
D	Forward	{(75m+70m+20m+30m+70m)×2}+30m = 560m
	Reverse	30m+10m = 40m
E	Forward	{(75m+30m+70m+20m)×2}+30m = 420m
	Reverse	30m+10m = 40m
F	Forward	{(75m+70m+20m)×2}+30m = 360m
	Reverse	30m+10m = 40m

Table A.3.49 Round Trip Forklift Time between Apron and Each Stowage Area under the Without Case

Stowage area	transfer time by forklift
A	(0.006minutes/m × 260m)+(0.012minutes/m × 40m)+2.04minutes
B	(0.006 × 440)+(0.012 × 40)=3.12
C	(0.006 × 240)+(0.012 × 40)=1.92
D	(0.006 × 560)+(0.012 × 40)=3.84
E	(0.006 × 420)+(0.012 × 40)=3.00
F	(0.006 × 360)+(0.012 × 40)=2.64

Table A.3.50 Transfer Time by Forklift between Apron and Each Stowage Area per Vessel
Excluding Preparation Time of Forklifts under the Without Case

Year	Transfer time by forklift between apron and stowage area per vessel						
	Area A	Area B	Area C	Area D	Area E	Area F	Total
	(TEU×minutes/TEU)(minutes)	(TEU×minutes/TEU)(minutes)	(TEU×minutes/TEU)(minutes)	(TEU×minutes/TEU)(minutes)	(TEU×minutes/TEU)(minutes)	(TEU×minutes/TEU)(minutes)	(minutes)
1990	29.8 × 2.04 = 60.79	5.6 × 3.12 = 17.41	6.2 × 1.92 = 11.90	6.8 × 3.84 = 26.11	5.0 × 3.00 = 15.00	8.6 × 2.64 = 22.70	153.97
1991	30.7 × 2.04 = 62.63	5.8 × 3.12 = 18.10	6.4 × 1.92 = 12.29	7.0 × 3.84 = 26.88	5.1 × 3.00 = 15.30	9.0 × 2.64 = 23.76	158.96
1992	31.7 × 2.04 = 64.67	5.9 × 3.12 = 18.41	6.6 × 1.92 = 12.67	7.3 × 3.84 = 28.03	5.3 × 3.00 = 15.90	9.2 × 2.64 = 24.29	163.97
1993	31.7 × 2.04 = 64.67	5.9 × 3.12 = 18.41	6.6 × 1.92 = 12.67	7.3 × 3.84 = 28.03	5.3 × 3.00 = 15.90	9.2 × 2.64 = 24.29	163.97
1994	32.6 × 2.04 = 66.50	6.1 × 3.12 = 19.03	6.8 × 1.92 = 13.06	7.5 × 3.84 = 28.80	5.4 × 3.00 = 16.20	9.6 × 2.64 = 25.34	168.93
1995	33.6 × 2.04 = 68.54	6.3 × 3.12 = 19.66	7.0 × 1.92 = 13.44	7.7 × 3.84 = 29.57	5.6 × 3.00 = 16.80	9.8 × 2.64 = 25.87	173.88
1996	33.6 × 2.04 = 68.54	6.3 × 3.12 = 19.66	7.0 × 1.92 = 13.44	7.7 × 3.84 = 29.57	5.6 × 3.00 = 16.80	9.8 × 2.64 = 25.87	173.88
1997	34.6 × 2.04 = 70.58	6.5 × 3.12 = 20.28	7.2 × 1.92 = 13.82	7.9 × 3.84 = 30.34	5.8 × 3.00 = 17.40	10.0 × 2.64 = 26.40	178.82
1998	35.5 × 2.04 = 72.42	6.7 × 3.12 = 20.90	7.4 × 1.92 = 14.21	8.1 × 3.84 = 31.10	5.9 × 3.00 = 17.70	10.4 × 2.64 = 27.46	183.79
1999	35.5 × 2.04 = 72.42	6.7 × 3.12 = 20.90	7.4 × 1.92 = 14.21	8.1 × 3.84 = 31.10	5.9 × 3.00 = 17.70	10.4 × 2.64 = 27.46	183.79
2000	36.5 × 2.04 = 74.46	6.8 × 3.12 = 21.22	7.6 × 1.92 = 14.59	8.4 × 3.84 = 32.26	6.1 × 3.00 = 18.30	10.6 × 2.64 = 27.98	188.81
2001	37.4 × 2.04 = 76.30	7.0 × 3.12 = 21.84	7.8 × 1.92 = 14.98	8.6 × 3.84 = 33.02	6.2 × 3.00 = 18.60	11.0 × 2.64 = 29.04	193.78
2002	38.4 × 2.04 = 78.34	7.2 × 3.13 = 22.46	8.0 × 1.92 = 15.36	8.8 × 3.84 = 33.79	6.4 × 3.00 = 19.20	11.2 × 2.64 = 29.57	198.72
2003	39.4 × 2.04 = 80.38	7.4 × 3.12 = 23.09	8.2 × 1.92 = 15.74	9.0 × 3.84 = 34.56	6.6 × 3.00 = 19.80	11.4 × 2.64 = 30.10	203.67
2004	39.4 × 2.04 = 80.38	7.4 × 3.12 = 23.09	8.2 × 1.92 = 15.74	9.0 × 3.84 = 34.56	6.6 × 3.00 = 19.80	11.4 × 2.64 = 30.10	203.67
2005	40.3 × 2.04 = 82.21	7.6 × 3.12 = 23.71	8.4 × 1.92 = 16.13	9.2 × 3.84 = 35.33	6.7 × 3.00 = 20.10	11.8 × 2.64 = 30.15	207.63

o From Table A.3.50, the average container transfer time by Forklift between the apron and the stowage area per unit excluding preparation time:

Table A.3.51 Transfer time by Forklift between Apron and
Stowage Area per TEU under the Without case

Year	Total transfer time by forklift per vessel	Number of containers per vessel	Transfer time per TEU
	(minutes/vessel)	(TEU/vessel)	(minutes/TEU)
1990	153.97	62	2.5
1991	158.96	64	2.5
1992	163.97	66	2.5
1993	163.97	66	2.5
1994	168.93	68	2.5
1995	173.88	70	2.5
1996	173.88	70	2.5
1997	178.82	72	2.5
1998	183.79	74	2.5
1999	183.79	74	2.5
2000	188.81	76	2.5
2001	193.78	78	2.5
2002	198.72	80	2.5
2003	203.67	82	2.5
2004	203.67	82	2.5
2005	207.63	84	2.5

o Considering preparation time of the forklifts, the interval of forklifts for container cargo handling under the without case is shown Table A.3.5.2.

Table A-3.52 Interval of Forklifts for Container Cargo Handling under the Without case

Year	Transfer time between Apron and Stowage Area per TEU (1)	Handling time by forklift at Apron and Stowage Area (2)	Number of forklifts (3)	Interval of forklifts for container cargo handling [(1) + (2)] / (3)
	(minutes)	(minutes)	(units)	(minutes/unit)
1990	2.5	2.0	2	2.3
1991	2.5	2.0	2	2.3
1992	2.5	2.0	2	2.3
1993	2.5	2.0	2	2.3
1994	2.5	2.0	2	2.3
1995	2.5	2.0	2	2.3
1996	2.5	2.0	2	2.3
1997	2.5	2.0	2	2.3
1998	2.5	2.0	2	2.3
1999	2.5	2.0	2	2.3
2000	2.5	2.0	2	2.3
2001	2.5	2.0	2	2.3
2002	2.5	2.0	2	2.3
2003	2.5	2.0	2	2.3
2004	2.5	2.0	2	2.3
2005	2.5	2.0	2	2.3

The difference of the cost between the with case and the without case is only the fuel expense because the container crane doesn't wait for the forklifts as the value of the intervals from 1990 to 2005 is smoller than 3.7 minutes.

So, it is not necessary to calculate the carrying cost of the containers between the apron and the stowage yard.

o Fuel expense of the forklifts per ton

Table A-3-53 Fuel Expense of the Forklifts for Container Cargo Handling per Ton under the Without Case

Year	Fuel expense of the forklift per hour per unit	Number of forklift	Total transfer time by forklifts per vessel	Handling time by forklift at apron and stowage area per TEU	Number of handling containers per vessel	Container cargo handling volume per vessel	Fuel expense of the forklifts per ton (2 units)
	(WS$/hour/unit)	(units)	(minuts/vessel)	(minutes/TEU)	(TEU/vessel)	(tons/vessel)	(WS$/ton)
1990	0.9	2	153.97	2.0	62	593	0.8
1991	0.9	2	158.96	2.0	64	601	0.9
1992	0.9	2	163.97	2.0	66	613	0.9
1993	0.9	2	163.97	2.0	66	624	0.9
1994	0.9	2	168.93	2.0	68	638	0.9
1995	0.9	2	173.88	2.0	70	649	0.9
1996	0.9	2	173.88	2.0	70	659	0.9
1997	0.9	2	178.82	2.0	72	673	0.9
1998	0.9	2	183.79	2.0	74	685	0.9
1999	0.9	2	183.79	2.0	74	700	0.9
2000	0.9	2	188.81	2.0	76	712	0.9
2001	0.9	2	193.78	2.0	78	725	0.9
2002	0.9	2	198.72	2.0	80	740	0.9
2003	0.9	2	203.67	2.0	82	754	0.9
2004	0.9	2	203.67	2.0	82	767	0.9
2005	0.9	2	207.63	2.0	84	782	0.9

(2) Fuel expense of the forklifts per ton for container cargo handling between vessel and stowage yards under the with case.

Table A-3-54 Number of Handling Containers at Each Stowage Area per Vessel under the With Case

Year	Number of Handling Containers at each stowage area per vessel		
	Area A_1	Area A_2	Area B
	(TEU/vessel) (TEU/vessel)	(TEU/vessel) (TEU/vessel)	(TEU/vessel) (TEU/vessel)
1990	62 × 0.52 = 32.2	62 × 0.35 = 21.7	65 × 0.13 = 8.1
1991	64 × 0.52 = 33.3	64 × 0.35 = 22.4	64 × 0.13 = 8.3
1992	66 × 0.52 = 34.3	66 × 0.35 = 23.1	66 × 0.13 = 8.6
1993	66 × 0.52 = 34.3	66 × 0.35 = 23.1	66 × 0.13 = 8.6
1994	68 × 0.52 = 35.3	68 × 0.35 = 23.8	68 × 0.13 = 8.8
1995	70 × 0.52 = 36.4	70 × 0.35 = 24.5	70 × 0.13 = 9.1
1996	70 × 0.52 = 36.4	70 × 0.35 = 24.5	70 × 0.13 = 9.1
1997	72 × 0.52 = 37.4	72 × 0.35 = 25.2	72 × 0.13 = 9.4
1998	74 × 0.52 = 38.5	74 × 0.35 = 25.9	74 × 0.13 = 9.6
1999	74 × 0.52 = 38.5	74 × 0.35 = 25.9	74 × 0.13 = 9.6
2000	76 × 0.52 = 39.5	76 × 0.35 = 26.6	76 × 0.13 = 9.9
2001	78 × 0.52 = 40.6	78 × 0.35 = 27.3	78 × 0.13 = 10.1
2002	80 × 0.52 = 41.6	80 × 0.35 = 28.0	80 × 0.13 = 10.4
2003	82 × 0.52 = 42.6	82 × 0.35 = 28.7	82 × 0.13 = 10.7
2004	82 × 0.52 = 42.6	82 × 0.35 = 28.7	82 × 0.13 = 10.7
2005	84 × 0.52 = 43.7	84 × 0.35 = 29.4	84 × 0.13 = 10.9

Table A.3.55 Handling Distance between the Apron and Each Stowage Area under the With Case

Stowage area	Round-trip distance between apron and stowage areas	
	Forward or reverse	Round-trip distance
A_1'	Forward	(30m + 115m + 35m) × 2 = 360m
	Reverse	–
A_2'	Forward	(5m + 40m) × 2 = 90m
	Reverse	–
B'	Forward	(30m + 30m + 30m) × 2 = 180m
	Reverse	–

Table A.3.56 Round-trip Forklift Time between Apron and Each Stowage Area under the With Case

Stowage area	Transfer time by forklift
A_1'	0.006 minutes/m × 360 m = 2.16 minutes
A_2'	0.006 × 90 = 0.54
B'	0.006 × 180 = 1.08

Table A.3.57 Transfer Time by Forklift between Apron and each Stowage Area per Vessel excluding Preparation Time of Forklift under the With Case

Year	Transfer time by forklift between apron and each stowage area per vessel															
	Area A_1' (1)					Area A_2' (2)					Area B' (3)					Total (1) + (2) + (3)
	(minuts/TEU)		(TEU/vessel)		(minuts/vessel)	(minuts/TEU)		(TEU/vessel)		(minuts/vessel)	(minuts/TEU)		(TEU/vessel)		(minuts/vessel)	(minutes/vessel)
1990	2.16	×	32.2	=	69.6	0.54	×	21.7	=	11.7	1.08	×	8.1	=	8.7	90.0
1991	2.16	×	33.3	=	71.7	0.54	×	22.4	=	12.1	1.08	×	8.3	=	9.0	92.8
1992	2.16	×	34.3	=	74.1	0.54	×	23.1	=	12.5	1.08	×	8.6	=	9.3	95.9
1993	2.16	×	34.3	=	74.1	0.54	×	23.1	=	12.5	1.08	×	8.6	=	9.3	95.9
1994	2.16	×	35.3	=	76.2	0.54	×	23.8	=	12.9	1.08	×	8.8	=	9.5	98.6
1995	2.16	×	36.4	=	78.6	0.54	×	24.5	=	13.2	1.08	×	9.1	=	9.8	101.6
1996	2.16	×	36.4	=	78.6	0.54	×	24.5	=	13.2	1.08	×	9.1	=	9.8	101.6
1997	2.16	×	37.4	=	80.8	0.54	×	25.2	=	13.6	1.08	×	9.4	=	10.2	104.6
1998	2.16	×	38.5	=	83.2	0.54	×	25.9	=	14.0	1.08	×	9.5	=	10.3	107.5
1999	2.16	×	38.5	=	83.2	0.54	×	25.9	=	14.0	1.08	×	9.6	=	10.4	107.6
2000	2.16	×	39.5	=	85.3	0.54	×	25.6	=	14.4	1.08	×	9.9	=	10.7	110.4
2001	2.16	×	40.6	=	87.7	0.54	×	27.3	=	14.7	1.08	×	10.1	=	10.9	113.3
2002	2.16	×	41.6	=	89.9	0.54	×	28.0	=	15.1	1.08	×	10.4	=	11.2	116.2
2003	2.16	×	42.6	=	92.0	0.54	×	28.7	=	15.5	1.08	×	10.7	=	11.6	119.1
2004	2.16	×	42.6	=	92.0	0.54	×	28.7	=	15.5	1.08	×	10.7	=	11.6	119.1
2005	2.16	×	43.7	=	94.4	0.54	×	29.4	=	15.9	1.08	×	10.9	=	11.8	122.1

o From Table A.3.57, the forklift fuel expense per ton is as follows:

Table A.3.58 Fuel Expense of the Forklifts for Container Cargo Handling per Ton under the With Case

Year	Fuel expense per forklift per hour	Number of forklifts	Total transfer time by forklifts per vessel	Handling time by forklifts at apron and stowage area per TEU	Number of handling containers per vessel	Container cargo handling volume per vessel	Fuel expense of the forklifts per ton (2 units)
	(WS$/hour/unit)	(units)	(minuts/vessel)	(minutes/TEU)	(TEU/vessel)	(tons/vessel)	(WS$/ton)
1990	0.9	2	90.0	2.0	62	593	0.7
1991	0.9	2	92.8	2.0	64	601	0.7
1992	0.9	2	95.9	2.0	66	613	0.7
1993	0.9	2	95.9	2.0	66	624	0.7
1994	0.9	2	98.6	2.0	68	638	0.7
1995	0.9	2	101.6	2.0	70	649	0.7
1996	0.9	2	101.6	2.0	70	659	0.7
1997	0.9	2	104.6	2.0	72	673	0.7
1998	0.9	2	107.6	2.0	74	685	0.7
1999	0.9	2	107.6	2.0	74	700	0.7
2000	0.9	2	110.4	2.0	76	712	0.7
2001	0.9	2	113.3	2.0	78	725	0.7
2002	0.9	2	116.2	2.0	80	740	0.7
2003	0.9	2	119.1	2.0	82	754	0.7
2004	0.9	2	119.1	2.0	82	767	0.7
2005	0.9	2	122.1	2.0	84	782	0.7

(3) Calculation of Benefit from concentration of containers behind the Main Wharf.

Table A.3.59 Benefit per Ton from Concentration of Containers behind the Main Wharf

Year	Fuel expense of the forklifts per ton		Benefit per ton
	Without cose (1)	With case (2)	(1) − (2)
	(WS$/ton)	(WS$/ton)	(WS$/ton)
1990	0.8	0.7	0.1
1991	0.9	0.7	0.2
1992	0.9	0.7	0.2
1993	0.9	0.7	0.2
1994	0.9	0.7	0.2
1995	0.9	0.7	0.2
1996	0.9	0.7	0.2
1997	0.9	0.7	0.2
1998	0.9	0.7	0.2
1999	0.9	0.7	0.2
2000	0.9	0.7	0.2
2001	0.9	0.7	0.2
2002	0.9	0.7	0.2
2003	0.9	0.7	0.2
2004	0.9	0.7	0.2
2005	0.9	0.7	0.2

Table A.3.60 Benefit from Concentration of Containers behind the Main Wharf from Reclamation

Year	Benefit per ton (1) (WS$/ton)	Container cargo Volume (2) (tons/year)	Benefit per year (1) × (2) (WS$/year)
1990	0.1	115,000	11,500
1991	0.2	120,800	24,166
1992	0.2	127,000	25,400
1993	0.2	133,500	26,700
1994	0.2	140,300	28,060
1995	0.2	147,400	34,880
1996	0.2	154,900	30,980
1997	0.2	162,800	32,560
1998	0.2	171,300	34,260
1999	0.2	179,900	35,980
2000	0.2	188,800	37,760
2001	0.2	198,600	39,720
2002	0.2	208,800	41,760
2003	0.2	219,500	43,900
2004	0.2	230,600	46,120
2005	0.2	242,400	48,480

3) Calculation of Benefit from Saving in Cargo handling Costs for Ro/Ro System

o The average interval of forklifts for container cargo handling is as follows.

With case = 1.7 minutes/unit (Refer to Table A.3.61.)

Without case = 2.3 minutes/unit (Refer to Table A.3.5.2) < 2.4 minutes/unit (Cargo handling efficency of Ro/Ro system.)

Table A-3.6 Interval of Forklifts for Container Cargo Handling under the With Case.

year	Transfer time between apron and stowage area per TEU (1)	Handling time by forklift at apron and stowage area (2)	Number of forklifts (3)	Interval of forklifts for container cargo handling ((1)+(2))/(3)
	(minutes)	(minutes)	(units)	(minutes)
1990	900/62=1.45	2.0	2	1.7
1991	928/64=1.45	2.0	2	1.7
1992	959/66=1.45	2.0	2	1.7
1993	959/66=1.45	2.0	2	1.7
1994	986/68=1.45	2.0	2	1.7
1995	1016/70=1.45	2.0	2	1.7
1996	1016/70=1.45	2.0	2	1.7
1997	1046/72=1.45	2.0	2	1.7
1998	1076/74=1.45	2.0	2	1.7
1999	1076/74=1.45	2.0	2	1.7
2000	1104/76=1.45	2.0	2	1.7
2001	1133/78=1.45	2.0	2	1.7
2002	1162/80=1.45	2.0	2	1.7
2003	1191/82=1.45	2.0	2	1.7
2004	1191/82=1.45	2.0	2	1.7
2005	1221/84=1.45	2.0	2	1.7

o The working efficiency of the cargo handling for the Ro/Ro system is 25 units/hour (2.4 minutes/unit) because the cargo handling efficency of the Ro/Ro system which is 2.4 minutes/unit is longer than the average inerval of forklifts.

(1) Labor Cost

o Prerequisites of labor cost for Lo/Lo system

. Number of laborers per gang } Refer to Table A.3.5 and
. Labor cost per gang per hour } Table A.3.6.
. Working time of container cargo handling per vessel for Lo/Lo system: (Refer to Table A.3.8.)

o Prerequisites of labor cost for Ro/Ro System

. Number of laborers per gong : 12 persons/gang
. Labor cost per gong per hour: 12.1 WS$/hour

o Labor cost per ton

Table A.3. 62 Labor Cost per ton for Container Cargo Handling

year	Container cargo handling volume per vessel (1)	Lo/Lo System: Labor cost per vessel (From Table A. 3.8) (2)	Lo/Lo System: Labor cost per ton (2)/(1)	Ro/Ro System: Labor cost per hour (3)	Ro/Ro System: Number of containers per vessel (4)	Ro/Ro System: Cargo handling efficiency (5)	Ro/Ro System: Cargo handling time per vessel (6)=(4)/(5)	Ro/Ro System: Labor cost per ton [(3)×(6)]/(1)
	(tons/vessel)	(WS$/vessel)	(WS$/ton)	(WS$/hour)	(TEU/vessel)	(TEU/hour)	(hours/vessel)	(WS$/ton)
1990	593	63.5	0.11	12.1	62	25	2.48	0.05
1991	601	65.1	0.11	12.1	64	25	2.56	0.05
1992	613	66.8	0.11	12.1	66	25	2.64	0.05
1993	624	66.8	0.11	12.1	66	25	2.64	0.05
1994	638	70.1	0.11	12.1	68	25	2.72	0.05
1995	649	71.8	0.11	12.1	70	25	2.80	0.05
1996	659	71.8	0.11	12.1	70	25	2.80	0.05
1997	673	73.5	0.11	12.1	72	25	2.88	0.05
1998	685	75.2	0.11	12.1	74	25	2.96	0.05
1999	700	75.2	0.11	12.1	74	25	2.96	0.05
2000	712	78.5	0.11	12.1	76	25	3.04	0.05
2001	725	80.2	0.11	12.1	78	25	3.12	0.05
2002	740	81.8	0.11	12.1	80	25	3.20	0.05
2003	754	83.5	0.11	12.1	82	25	3.28	0.05
2004	767	83.5	0.11	12.1	82	25	3.28	0.05
2005	782	86.8	0.11	12.1	84	25	3.36	0.05

(2) Cargo handling equipment cost (depreciation expenses, repayment and fuel expenses) between the apron and the stowage yard for container cargo.

o Kind of cargo handling equipment: 25 tons forklift (2 units)

o Cargo handling equipment cost of forklifts per hour:
Refer to Table A.3.10.

o Cargo handling equipment cost per ton

Table A.3 63 Cargo Handling Equipment Cost for Container Cargo

year	Lo/Lo System	Ro/Ro System			
	Cargo handling equipment cost per ton (From Table A.3.11)	Cargo handling equipment cost per hour * (1)	Container cago handling time per vessel ** (2)	Container cargo handling volume per vessel (3)	Cargo handling equipment cost per ton {(1)×(2)} /(3)
	(WS$/ton)	(WS$/hour)	(hours/vessel)	(tons/vessel)	(WS$/ton)
1990	2.7	417.1	2.48	593	1.7
1991	2.7	417.1	2.56	601	1.8
1992	2.7	417.1	2.64	613	1.8
1993	2.7	417.1	2.64	624	1.8
1994	2.7	417.1	2.72	638	1.8
1995	2.8	417.1	2.80	649	1.8
1996	2.7	417.1	2.80	659	1.8
1997	2.7	417.1	2.88	673	1.8
1998	2.7	417.1	2.96	685	1.8
1999	2.7	417.1	2.96	700	1.8
2000	2.8	417.1	3.04	712	1.8
2001	2.8	417.1	3.12	725	1.8
2002	2.8	417.1	3.20	740	1.8
2003	2.7	412.9	3.28	754	1.8
2004	2.6	399.4	3.28	767	1.7
2005	2.5	373.2	3.36	782	1.6

* Refer to Table A.3.10

** Container cargo handling time per Vessel = Number of containers per vessel / Cargo handling efficiency

(3) Calculation of Benefit per ton from Ro/Ro system.

Table A.3 64 Benefit from Saving in Cargo Handling Cost from Using Ro/Ro System

year	Container cargo handling volume (1)	Without Case (Lo/Lo)		With Case (Ro/Ro)		Benefit
		Labor cost per ton (2)	Cargo handling equipment cose per ton (3)	Labor cost per ton (4)	Cargo handling equipment cost per ton (5)	{(2)+(3)−(4)−(5)} ×(1)
	(tons/year)	(WS$/ton)	(WS$/ton)	(WS$/ton)	(WS$/ton)	(WS$/year)
1990	115,000	0.11	2.70	0.05	1.70	121,900
1991	120,800	0.11	2.70	0.05	1.80	115,968
1992	127,000	0.11	2.70	0.05	1.80	121,920
1993	133,500	0.11	2.70	0.05	1.80	128,160
1994	140,300	0.11	2.70	0.05	1.80	134,688
1995	147,400	0.11	2.70	0.05	1.80	141,504
1996	154,900	0.11	2.70	0.05	1.80	148,704
1997	162,800	0.11	2.70	0.05	1.80	156,288
1998	171,300	0.11	2.70	0.05	1.80	164,448
1999	179,900	0.11	2.70	0.05	1.80	172,704
2000	188,800	0.11	2.70	0.05	1.80	181,248
2001	198,600	0.11	2.70	0.05	1.80	190,656
2002	208,800	0.11	2.70	0.05	1.80	200,448
2003	219,500	0.11	2.70	0.05	1.80	210,720
2004	230,600	0.11	2.70	0.05	1.70	244,436
2005	242,400	0.11	2.70	0.05	1.60	281,184

4) Benefits from Saving in Cargo Handling Cost for Reclamation

Table A.3.65 Benefits from in Cargo Handling Costs from Reclamation

year	Benefits from Saving in Cargo Handling Costs from Reclamation		
	Benefit from concentration of containers	Benefit from using Ro/Ro system	Total
	(th.WS$/year)	(th.WS$/year)	(th.WS$/year)
1990	11.5	121.9	133.4
1991	24.2	116.0	140.2
1992	25.4	121.9	147.3
1993	26.7	128.2	154.9
1994	28.1	134.7	162.8
1995	34.9	141.5	176.4
1996	31.0	148.7	179.7
1997	32.6	156.3	188.9
1998	34.3	164.4	198.7
1999	36.0	172.7	208.7
2000	37.8	181.2	219.0
2001	39.7	190.7	230.4
2002	41.8	200.4	242.2
2003	43.9	210.7	254.6
2004	46.1	244.4	290.5
2005	48.5	281.2	329.7

3-7 Benefit from the Breakwater

1) Prerequisites of the calculation

o Sheltering efficiency of the breakwater:
o Working efficiency of cargo handling:

} Refer to 5-4, 2) in Chapter 5

o Other prerequisites: Refer to Appendix 3-1, 3-2, 3-3, 3-4, 3-5.

2) Calculation of the Benefits

o Cargo handling time per vessel under the with case

Table A.3.66 Cargo Handling Time per Vessel under the With Case

year	For Container Cargo	(hour/vessel)	(hour/vessel)	For Conventional Cargo	(hours/vessel)	(hours/vessel)
1990	$10T_{CB}+16.5T_{CG}=62$ (TEU/Vessel) $T_{CB}/T_{CG}=4$days/(365days−5days)	*-1 $T_{CB}=0.04$ *-2 $T_{CG}=3.73$	Total 3.8	$10T_{VB}+17T_{VG}=227$ (tons/vessel) $T_{VB}/T_{VG}=4$days/(365days−5days)	*-3 $T_{VB}=0.15$ *-4 $T_{VG}=13.27$	Total 13.4
1991	$10T_{CB}+16.5T_{CG}=64$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.04$ $T_{CG}=3.85$	Total 3.9	$10T_{VB}+17T_{VG}=223$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.14$ $T_{VG}=13.03$	Total 13.2
1992	$10T_{CB}+16.5T_{CG}=66$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.04$ $T_{CG}=3.97$	Total 4.0	$10T_{VB}+17T_{VG}=222$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.14$ $T_{VG}=12.97$	Total 13.1
1993	$10T_{CB}+16.5T_{CG}=66$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.04$ $T_{CG}=3.97$	Total 4.0	$10T_{VB}+17T_{VG}=218$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.14$ $T_{VG}=12.74$	Total 12.9
1994	$10T_{CB}+16.5T_{CG}=68$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.10$	Total 4.2	$10T_{VB}+17T_{VG}=216$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.14$ $T_{VG}=12.62$	Total 12.8
1995	$10T_{CB}+16.5T_{CG}=70$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.21$	Total 4.3	$10T_{VB}+17T_{VG}=214$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.14$ $T_{VG}=12.50$	Total 12.6
1996	$10T_{CB}+16.5T_{CG}=70$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.21$	Total 4.3	$10T_{VB}+17T_{VG}=210$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.14$ $T_{VG}=12.27$	Total 12.4
1997	$10T_{CB}+16.5T_{CG}=72$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.33$	Total 4.4	$10T_{VB}+17T_{VG}=207$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.13$ $T_{VG}=12.10$	Total 12.2
1998	$10T_{CB}+16.5T_{CG}=74$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.45$	Total 4.5	$10T_{VB}+17T_{VG}=204$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.13$ $T_{VG}=11.91$	Total 12.0
1999	$10T_{CB}+16.5T_{CG}=74$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.45$	Total 4.5	$10T_{VB}+17T_{VG}=201$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.13$ $T_{VG}=11.75$	Total 11.9
2000	$10T_{CB}+16.5T_{CG}=76$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.60$	Total 4.7	$10T_{VB}+17T_{VG}=197$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.13$ $T_{VG}=11.51$	Total 11.6
2001	$10T_{CB}+16.5T_{CG}=78$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.70$	Total 4.8	$10T_{VB}+17T_{VG}=193$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.13$ $T_{VG}=11.28$	Total 11.4
2002	$10T_{CB}+16.5T_{CG}=80$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.79$	Total 4.8	$10T_{VB}+17T_{VG}=190$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.12$ $T_{VG}=11.10$	Total 11.2
2003	$10T_{CB}+16.5T_{CG}=82$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.05$ $T_{CG}=4.94$	Total 5.0	$10T_{VB}+17T_{VG}=188$ $T_{VB}/T_{VG}=0.0111$	$T_{VB}=0.12$ $T_{VG}=10.87$	Total 11.0
2004	$10T_{CB}+16.5T_{CG}=82$ $T_{CB}/T_{CG}=4$	$T_{CB}=0.05$ $T_{CG}=4.94$	Total 5.0	$10T_{VB}+16.5T_{VG}=181$ $T_{VB}/T_{VG}=0.0111$	$T_{CB}=0.12$ $T_{VG}=10.58$	Total 10.7
2005	$10T_{CB}+16.5T_{CG}=84$ $T_{CB}/T_{CG}=0.0111$	$T_{CB}=0.06$ $T_{CG}=5.06$	Total 5.1	$10T_{VB}+16.5T_{VG}=177$ $T_{VB}/T_{VG}=0.0111$	$T_{CB}=0.11$ $T_{VG}=10.34$	Total 10.5

*-1 T_{cs} : Container cargo handling time in bad weather conditions
*-2 T_{vs} : Conventional cargo handling time in bad weather conditions
*-3 T_{cs} : Container cargo handling time in good weather conditions
*-4 T_{vs} : Conventional cargo handling time in good weather conditions

o Impossible time for cargo handling considering the vessel occupancy ratio.

Table A.3.67 Impossible Time for Cargo Handling Considering the Berth Occupsney Ratio under the Without Case

year	Impossible time for Cargo handling in a year. (13days×24hours/day) (1)	Berthing time per vessel. (Cargo handling time) (2)	Number of vessels. per year (3)	Number of berths. (buoy berths) (4)	Berth occupancy rate (5)=[(2)×(3)]/[365 (dorys) × 24 (hours) ×(4)]	Impossible time for cargo handling considering the berth occupancy ratio. (6)=(1)×(5)
	(hours/year)	(hours/vessel)	(Vessel/year)	(Berths)		(hours/year)
1990	3120	41.1	194	2	0.455	1420
1991	3120	40.9	201	2	0.470	1466
1992	3120	40.9	207	2	0.483	1507
1993	3120	40.5	214	2	0.495	1544
1994	3120	40.7	220	2	0.511	1594
1995	3120	40.7	227	2	0.527	1644
1996	3120	40.1	235	2	0.538	1679
1997	3120	40.9	242	2	0.565	1763
1998	3120	40.7	250	2	0.581	1813
1999	3120	40.5	257	2	0.594	1853
2000	3120	40.3	265	2	0.610	1903
2001	3120	40.1	274	2	0.627	1956
2002	3120	39.9	283	2	0.642	2003
2003	3120	39.2	291	2	0.651	2031
2004	3120	38.6	301	2	0.663	2069
2005	3120	38.4	310	2	0.679	2118

Table A.3.68 Impossible Time for Cargo Handling Considering the Berth Occupancy Ratio under the With Case

year	Impossible time for cargo handling in a year (1days×24hours/day) (1)	Berthing time per vessel (Cargo handling time) (2)	Number of vessels per year (3)	Berth Occupancy rate (4)= {(2)×(3)}/{365days ×24hours}	Impossible time for cargo handling considering the berth occupancy ratio (5)=(1)×(4)
	(hours/year)	(hours/vessel)	(vessels/year)		(hours/year)
1990	24.0	17.2	194	0.381	9.1
1991	24.0	17.1	201	0.392	9.4
1992	24.0	17.1	207	0.404	9.7
1993	24.0	16.9	214	0.412	9.9
1994	24.0	17.0	220	0.427	10.2
1995	24.0	16.9	227	0.438	10.5
1996	24.0	16.7	235	0.448	10.8
1997	24.0	16.6	242	0.459	11.0
1998	24.0	16.5	250	0.471	11.3
1999	24.0	16.4	257	0.481	11.5
2000	24.0	16.3	265	0.493	11.8
2001	24.0	16.2	274	0.507	12.2
2002	24.0	16.0	282	0.515	12.4
2003	24.0	16.0	291	0.532	12.8
2004	24.0	15.7	301	0.539	12.9
2005	24.0	15.6	310	0.552	13.2

o Benefit from reduction in labor cost

Table A.3.69 Benefit from Reduction in Labor Cost

Year	Container cargo handling			Conventional cargo handling			Benefit from reduction in labor cost (7)={(1)×((2)-(3))}+{(4)×((5)-(6))}
	Labor cost per hour (1)	Cargo handling time under the without case (2)	Cargo handling time under the with case (3)	Labor cost per hour (4)	Cargo handling time under the without case (5)	Cargo handling time under the with case (6)	
1990	16.7 (WS$/hour)	3.8 (hours/vessel)	3.8 (hours/vessel)	17.3 (WS$/hour)	13.5 (hours/vessel)	13.4 (hours/vessel)	1.7 (WS$/vessel)
1991	16.7	3.9	3.9	17.2	13.3	13.2	1.7
1992	16.7	4.0	4.0	17.2	13.2	13.1	1.7
1993	16.7	4.0	4.0	17.0	13.0	12.9	1.7
1994	16.7	4.2	4.2	17.1	12.9	12.8	1.7
1995	16.7	4.3	4.3	17.0	12.7	12.6	1.7
1996	16.7	4.3	4.3	16.8	12.5	12.4	1.7
1997	16.7	4.4	4.4	16.7	12.3	12.2	1.7
1998	16.7	4.5	4.5	16.6	12.1	12.0	1.7
1999	16.7	4.5	4.5	16.5	12.0	11.9	1.7
2000	16.7	4.7	4.7	16.4	11.7	11.6	1.6
2001	16.7	4.8	4.8	16.3	11.5	11.4	1.6
2002	16.7	4.9	4.9	16.1	11.3	11.2	1.6
2003	16.7	5.0	5.0	16.1	11.1	11.0	1.6
2004	16.7	5.0	5.0	15.8	10.8	10.7	1.6
2005	16.7	5.2	5.1	15.7	10.6	10.5	1.7

o Benefit from saving in cargo handling equipment cost

Table A. 3.70 Benefit from Reduction in Cargo Handling Equipment Cost

Year	25 ton forklift			3.5 ton forklift			Benefit from reduction in cargo handling equipment cost (7)=[{(1)×((2)-(3))}+{(4)×((5)-(6))}]
	Cargo handling equipment cost (1)	Cargo handling time under the without case (2)	Cargo handling time under the with case (3)	Cargo handling equipment cost (4)	Cargo handling time under the without case (5)	Cargo handling time under the with case (6)	
1990	417.1 (WS$/hour)	3.8 (hours/Vessel)	3.8 (hours/Vessel)	25.2 (WS$/hour)	13.5 (hours/Vessel)	13.4 (hours/Vessel)	2.5 (WS$/Vessel)
1991	417.1	3.9	3.9	24.7	13.3	13.2	2.5
1992	417.1	4.0	4.0	24.2	13.2	13.1	2.4
1993	417.1	4.0	4.0	23.9	13.0	12.9	2.4
1994	417.1	4.2	4.2	23.4	12.9	12.8	2.3
1995	417.1	4.3	4.3	23.1	12.7	12.6	2.3
1996	417.1	4.3	4.3	22.7	12.5	12.4	2.3
1997	417.1	4.4	4.4	22.5	12.3	12.2	2.3
1998	417.1	4.5	4.5	22.5	12.1	12.0	2.3
1999	417.1	4.5	4.5	21.8	12.0	11.9	2.2
2000	417.1	4.7	4.7	21.7	11.7	11.6	2.2
2001	417.1	4.8	4.8	21.4	11.5	11.4	2.1
2002	417.1	4.9	4.9	21.2	11.3	11.2	2.1
2003	412.9	5.0	5.0	20.9	11.1	11.0	2.1
2004	399.4	5.0	5.0	20.8	10.8	10.7	2.1
2005	373.2	5.2	5.1	20.8	10.5	10.5	37.3

o Benefit from saving in vessel staying cost

Table A.3.7.1 shows the saving in vessel staying cost from the reduction of the number of bad weather days (Wave height 0.7m - 0.5m) by the breakwater:

Table A. 3.71 Benefit from Sauing in Vessel Staying Cost from the Reduction in the Number of Bad Weather Condition Days

Year	Ship staying cost per hour (1)	Ship staying time under the without case (2)	Ship staying time under the with case			Benefit from reduction of ship staying cost (1)×((2)-(5))
			For container cargo (3)	For conventional cargo (4)	Total (5)=(3)+(4)	
1990	576.7 (WS$/hour)	17.3 (hours/Vessel)	3.8 (hours/Vessel)	13.4 (hours/Vessel)	17.2 (hours/Vessel)	57.7 (WS$/Vessel)
1991	576.7	17.2	3.9	13.2	17.1	57.7
1992	576.7	17.2	4.0	13.1	17.1	57.7
1993	576.7	17.0	4.0	12.9	16.9	57.7
1994	576.7	17.1	4.2	12.8	17.0	57.7
1995	576.7	17.0	4.3	12.6	16.9	57.7
1996	576.7	16.8	4.3	12.4	16.7	57.7
1997	576.7	16.7	4.4	12.2	16.6	57.7
1998	576.7	16.6	4.5	12.0	16.5	57.7
1999	576.7	16.5	4.5	11.9	16.4	57.7
2000	576.7	16.4	4.7	11.6	16.3	57.7
2001	576.7	16.3	4.8	11.4	16.2	57.7
2002	576.7	16.1	4.8	11.2	16.0	57.7
2003	576.7	16.1	5.0	11.0	16.0	57.7
2004	576.7	15.8	5.0	10.7	15.7	57.7
2005	576.7	15.7	5.1	10.5	15.6	57.7

Table A.3.7.2 shows saving in vessel staying cost from the reduction in the number of impossible days (wave height 0.7m) by the breakwater:

Table A.3.72 Benfit from Saving in Vessel Staying Cost from the Reduction in the Number of Impossible Days.

Year	Impossible time for cargo handling considering the berth occupancy ratio under the without case. (1)	Impossible time for cargo handling considering the berth occupancy ratio under the with case. (2)	Ship staying cost per hour (3)	Number of vessel per year. (4)	Reduction in vessel staying cost from the reduction in the number of impossible days ((1)-(2))×(3))/(4)
1990	142.0 (hours/year)	9.1 (hours/year)	576.7 (WS$/hour)	194 (Vessels/year)	395.5 (WS$/Vessel)
1991	146.6	9.4	576.7	201	393.6
1992	150.7	9.7	576.7	207	392.8
1993	154.4	9.9	576.7	214	392.1
1994	159.4	10.2	576.7	220	391.1
1995	164.4	10.5	576.7	227	391.0
1996	167.9	10.8	576.7	235	385.5
1997	176.3	11.0	576.7	242	393.9
1998	181.3	11.3	576.7	250	392.2
1999	185.3	11.5	576.7	257	390.0
2000	190.3	11.8	576.7	265	388.5
2001	195.6	12.2	576.7	274	386.0
2002	200.3	12.4	576.7	282	384.3
2003	203.1	12.8	576.7	291	377.1
2004	206.9	12.9	576.7	301	371.7
2005	211.8	13.2	576.7	310	369.5

3) Benefit from the Breakwater

Table A. 3.73 Benefit from the Construction of Breakwater

Year	Benefit from reduction in vessel staying cost			Number of vessels per year	Benefit from reduction in cargo handling cost			Benefit from the construction of the breakwater
	Reduction in the number of impossible days (1)	Reduction in the number of bad days (2)	Total per year (3)=((1)+(2))×(4)	(4)	Reduction in labor cost (5)	Reduction in cargo handling equipment cost (6)	Total per year. (7)=((5)+(6))×(4)	(8)=(3)+(7)
1990	395.5 (WS$/vessel)	57.7 (WS$/vessel)	87,9208 (WS$/year)	194 (vessels/year)	1.7 (WS$/vessel)	2.5 (WS$/year)	814.8 (WS$/year)	88,735.6 (WS$/year)
1991	393.6	57.7	90,711.3	201	1.7	2.5	844.2	91,555.5
1992	392.8	57.7	93,253.5	207	1.7	2.4	848.7	94,102.2
1993	392.1	57.7	95,257.2	214	1.7	2.4	877.4	97,134.6
1994	391.1	57.7	98,736.0	220	1.7	2.3	885.6	99,621.6
1995	391.0	57.7	101,854.9	227	1.7	2.3	903.0	102,757.9
1996	385.5	57.7	104,152.0	235	1.7	2.3	940.0	105,092.0
1997	393.9	57.7	109,987.2	242	1.7	2.3	963.9	110,951.2
1998	392.2	57.7	112,475.0	250	1.7	2.3	1,000.0	113,475.0
1999	390.0	57.7	115,058.9	257	1.7	2.2	1,002.3	116,061.2
2000	388.5	57.7	118,243.0	265	1.6	2.2	1,007.0	119,250.0
2001	386.0	57.7	121,573.8	274	1.6	2.1	1,013.8	122,587.6
2002	384.3	57.7	124,644.0	282	1.6	2.1	1,043.4	125,687.4
2003	377.1	57.7	126,526.8	291	1.6	2.1	1,078.7	127,605.5
2004	371.7	57.7	129,249.4	301	1.6	2.1	1,113.7	130,363.1
2005	369.5	57.7	132,432.0	310	1.7	37.3	12,099.0	144,522.9

3-8 Benefits from Reconstruction of Ferry Terminal

1) Prerequisites of calculation

- o We assumed 90% of consignees will be waiting from the beginning time of customs' clearance. the remainder will recive the cargoes after they have been cleared.

- o Customs' clearance time of import cargo per unit: about 3.1 minutes (From observation)

- o Average cargo volume per unit: 200 kg

- o Employees of consignees
  - . Average number of employees for receiving cargoes: 2 persons/unit
  - . Average labor cost at economic prices of the employees:
    - Driver (Skilled labor): 1.8 WS$/hour
    - Assistant (Unskilled labor): 0.5 WS$/hour

- o Standard new worth of consignees truck
- o Depreciation period of consignees' truck

} Refer to Table A.3.4

- o Number of customs gates for import cargoes
  - Without case: 1 gate
  - With case: 3 gates

- o Number of inspectors at the receiving gate of the ferry terminal:
  1 person/gate (customs' inspector)

2) Calculation of the cost per minute

- o Labor cost:
  (1.8WS$/hour + 0.5 WS$/hour)/60minutes/hour = 0.04 WS$/minutes
- o Truck cost:
  (21,800WS$/year + 17,200 WS$/year)/(240days/year x 12hours/year x 60 minutes/hour) = 0.23 WS$/minute

3) Calculation of Benefits

o Number of consignees per ferry boat.

Table A. 3.74 Number of Consignees per Ferry Boat

Year	Cargo handling volume per year (1)	Number of ferry boats per year (2)	Cargo volume per consignee (3)	Number of consignees per ferry boat (4) = (1) / (2)) / (3)
1990	10, 900 (tons/years)	100 (boats/year)	0. 7 (tons/consignee)	156 (consignees/boat)
1991	11, 500	100	0. 7	164
1992	12, 000	100	0. 7	171
1993	12, 500	100	0. 7	179
1994	13, 000	100	0. 7	186
1995	13, 500	100	0. 7	193
1996	14, 100	100	0. 7	201
1997	14, 700	100	0. 7	210
1998	15, 400	100	0. 7	220
1999	16, 000	100	0. 7	229
2000	16, 700	100	0. 7	239
2001	17, 400	100	0. 7	249
2002	18, 200	100	0. 7	260
2003	18, 900	100	0. 7	270
2004	19, 800	100	0. 7	283
2005	20, 600	100	0. 7	294

o Benefit from saving in waiting cost of consignee per boat.

Table A. 3.75 Saving in Waiting Cost of Consignees per Boat

	Number of consigees per ferrey boat (1)	Waiting ratio of consignees (2)	Customs' clearance time per consignee (3)	Number of gates for import cargo: Without case (4)	Number of gates for import cargo: With case (5)	Waiting cost of consignees per hour (6)	Saving in Waiting cost of consignees per boat $(7)=((1)\times(2)\times(3))\times\{\frac{1}{(5)}-\frac{1}{(4)}\}\times(6)\times\frac{1}{2}$
1990	156 (consignees/boat)	0. 9	3. 1 (minuts /consignee-gates)	1	3	0. 27 (WS$/minut)	39. 4 (WS$/boat)
1991	164	0. 9	3. 1	1	3	0. 27	41. 4
1992	171	0. 9	3. 1	1	3	0. 27	43. 2
1993	179	0. 9	3. 1	1	3	0. 27	45. 2
1994	186	0. 9	3. 1	1	3	0. 27	46. 9
1995	193	0. 9	3. 1	1	3	0. 27	48. 7
1996	201	0. 9	3. 1	1	3	0. 27	50. 7
1997	210	0. 9	3. 1	1	3	0. 27	53. 0
1998	220	0. 9	3. 1	1	3	0. 27	55. 5
1999	229	0. 9	3. 1	1	3	0. 27	57. 8
2000	239	0. 9	3. 1	1	3	0. 27	60. 3
2001	249	0. 9	3. 1	1	3	0. 27	62. 8
2002	260	0. 9	3. 1	1	3	0. 27	65. 6
2003	270	0. 9	3. 1	1	3	0. 27	68. 1
2004	283	0. 9	3. 1	1	3	0. 27	71. 4
2005	294	0. 9	3. 1	1	3	0. 27	74. 2

o Benefit from saving in waiting cost of consignee per year.

Table A. 3.76 Benefit from Saving in Waiting Cost of Consignees

Year	Saving in waiting cost of consignee per boat (1)	Number of ferry boats per year (2)	Benefit from saving in waiting cost of consignees (1)×(2)
1990	39.4 (WS$/boat)	100 (boats/year)	3,940 (WS$/year)
1991	41.4	100	4,140
1992	43.2	100	4,320
1993	45.2	100	4,520
1994	46.9	100	4,690
1995	48.7	100	4,870
1996	50.7	100	5,070
1997	53.0	100	5,300
1998	55.5	100	5,550
1999	57.8	100	5,780
2000	60.3	100	6,030
2001	62.8	100	6,280
2002	65.6	100	6,560
2003	68.1	100	6,810
2004	71.4	100	7,140
2005	74.2	100	7,420

Appendix 4 Revenue for the Calculation of the FIRR

4-1 Incremental Port Revenue

The conditions for the calculation of the incremental port revenue are as follows. Basic data of the future port revenue is presented in Appendix 5.

1) Pilotage

All revenue originates from the First Stage Plan.

2) Wharfage

Revenue from Apia wharf after 1993 excluding the buoy berth originates from the First Stage Plan.

3) Storage of Containers

Revenue from the container yard constructed under the First Stage Plan excluding revenue from other agencies originated from the First Stage Plan.

First Stage Plan	6,000 m^2
Others	15,200 m^2

4) Berthage

same as 2)

5) Dockage

same as 2)

6) Wharf Cleaning

same as 2)

7) Tug Service

All revenue originates from the First Stage Plan.

4-2 Residual Value of Port Facilities in 2005

1) Ferry Terminal

- o Price 4,227,000 WS$ (excluding pavement cost)
- o Depreciation Period 35 years
- o Depreciation Cost 4,227,000WS$ ÷ 35 years = 120,800WS$
- o Residual Years 35 years - 15 years = 20 years
- o Residual Value in 2005 120,800WS$ x 20 years = 2,416,000WS$

2) Breakwater

- o Price 6,992,000 WS$
- o Depreciation Period 50 years
- o Depreciation Cost 6,992,000WS$ ÷ 50 years = 139,800WS$
- o Residual Years 50 years - 15 years = 35 years
- o Residual Value in 2005 139,800WS$ x 35 years = 4,893,000WS$

Appendix 5 Calculation of the Revenue and Expenditure of the Port Authority

As mentioned in Chapter 7, further consideratin about financial viability is necessary before the establishment of a Port Authority. In this section, we estimate future port revenue and expenditure such as personnel cost, operation cost and maintenance cost to serve as basic data for a financial analysis of the proposed Port Authority.

5-1 Fundamental Conditions

1) Number of Vessels

Port	Type of Vesseles	1986	2005
Apia	General Cargo	172 vessels	310 vessels
	Oil Tanker	24 vessels	24 vessels
Asau	General Cargo	5 vessels	10 vessels
	Oil Tanker	6 vessels	6 vessels
Total		207 vessels	350 vessels

Note 1) Figures in 1986 are data of Register of Ships

Note 2) Excluding the Ferry "Apia/Pagp Pago", Yachts, Warships, Search Vessels, etc.

2) Average Tonnages of the Calling Vessels

(1) 1986 --- 4,200 GRT/vessel (actual results)

(2) 2005 --- 4,900 GRT/vessel

Note) The size of oil tankers will increase in the future.

3) Cargo Volume for Storaga Charges

(1) 1986

Total General Cargo - Container Cargo x Ratio of FCL

= 134,500 tons - 94,200 tons x 0.60 = 78,000 tons

(2) 2005

297,400 tons - 242,400 tons x 0.60 = 152,000 tons

4) Conversion Factor for Storage Charges of Empty Containers

(1) 1986 --- 1,600 TEU

(2) 2005 --- 1,600 x 2.64 = 4,200 TEU

Note) 12,900 TEU/4,890 TEU = 2.64

5) Ration of Pilot Use

60 %

Note) Vessels of 1,500 GRT or more use pilots.

6) Ratio of Tug Use

60%

Note) Vessels of 3,000 GRT or more use tugs.

7) Average Tonnages of Vessels which Use Pilots

(1) 1986 --- 6,500 GRT (actual results)

(2) 2005 --- 7,200 GRT

Note) The size of oil tankers will increase in the future.

5-2 Calculation of Port Revenue

1) Pilotage

$$0.1\ \text{WS\$/GRT} \times \frac{\text{Number of Calling Vessels}}{②} \times \frac{\text{Ratio of Pilot Use}}{①} \times \frac{\text{Average Tonnage of Vessels which Use Pilots}}{⑭}$$

2) Light Dues

$$40\ \text{WS\$/vessel} \times \frac{\text{Number of Calling Vessels}}{②}$$

3) Port Dues

(1) Sea-going vessels

$$0.05 \text{ WS\$/GRT} \times \frac{\text{Number of Calling Vessels}}{②} \times \frac{\text{Average Tonnage of the Calling Vessels}}{③}$$

(2) Home-trade vessels

$$5 \text{ WS\$/GRT} \times \frac{\text{Total Tonnage of Home-trade Vessels}}{④}$$

4) Cargo Dues

$$0.1 \text{ WS\$/ton} \times \frac{\text{Total Cargo Volume}}{⑧}$$

5) Wharfage

(1) Import Cargo other than Bulk Petroleum

$$2.0 \text{ WS\$/ton} \times \frac{\text{Import Cargo Volume}}{⑤}$$

(2) Export Cargo

$$1.5 \text{ WS\$/ton} \times \frac{\text{Export Cargo Volume}}{⑥}$$

(3) Import Bulk Petroleum

$$1.0 \text{ WS\$/ton} \times \frac{\text{Import Bulk Petroleum Volume}}{⑦}$$

6) Storage of Cargoes

$$6.0 \text{ WS\$/ton} \times \frac{\text{Stored Cargo Volume}}{⑨}$$

Note) Average dwell time is 8 days.

7) Storage of Containers

$$2 \text{ WS\$/TEU} \times (19\text{-}7\text{-}7) \times \frac{\text{Conversion Factor for Storage Charges of Empty Containers}}{⑩}$$

Note) Average dwell time is 19 days, but does not apply for the first and last 7 days

8) Berthage

(1) Up to 1,500 GRT

$$40 \text{ WS\$/vessel} \times \frac{\text{Number of Vessels using Berths}}{⑪} \times 0.3$$

(2) In Excess of 1,500 GRT

$$60 \text{ WS\$/vessel} \times \frac{\text{Number of Vessels using Berths}}{⑪} \times 0.7$$

9) Dockage

$$0.05 \text{ WS\$/GRT} \times 4{,}800 \text{ GRT/vessel} \times \frac{\text{Number of Vessels using Berths}}{⑪}$$

Note) Average tonnage of vessels using berths is 4,800 GRT, and will not change in the future.

10) Fee for Shed Use

$$2 \text{ WS\$/foot}^2 \times \frac{\text{Area of Shed Use}}{⑫}$$

11) Miscellaneous

(1) Wharf Cleaning

i) Tallow, Cement or Bitumen or like Commodities

$$100 \text{ WS\$/vessel} \times \frac{\text{Number of Vessel using Berths}}{⑪} \times 0.1$$

ii) Other Commodities

$$50 \text{ WS\$/vessel} \times \frac{\text{Number of Vessels using Berths}}{⑪} \times 0.9$$

(2) Tug Service

$$220 \text{ WS\$/hour} \times \frac{\text{Number of Calling Vessels}}{②} \times \frac{\text{Ratio of Tug Use}}{⑬} \times 2 \text{ hours}$$

Note) Tariff Rate of Tug Service (1,500HP) is set at 220WS$/hour with reference to the present tariff.

(3) Others

i) Hire of Ministry Staff 20,000 WS$

ii) Fresh Water Supply

20,000 WS$ ÷ 170 vessels x $\frac{\text{Number of Vessels using Berths}}{\text{⑪}}$

iii) Others 10,000 WS$

5-3 Calcultaion of Port Expenditure

1) Personnel Expenses

(1) Salaries

i) 1987

162,100 WS$ (Government Budget)

ii) The amount of increase after the establishment of the Port Authority

73,000 WS$ ~ 93,000 WS$

(General Manager, Consultant, New Staff)

(2) Allowance for Committee Members

6,000 WS$

(3) Wages

83,000 WS$ (Government Budget)

(4) Local Travel

i) 1987

2,700 WS$ (Government Budget)

ii) The amount of increase after the establishment of the Port Authority

(in proportion to salaries)

1,200 WS$ ~ 1,500 WS$

(5) Overseas Travel

i) 1987

3,000 WS$ (Government Budget)

ii) The amount of increase after the establishment of the Port Authority.

9,000 WS$

2) Office Expenses

(1) 1987

28,100 WS$ (Government Budget)

(2) The amount of increase after the establishment of the Port Authority (in proportion to salaries)

12,700 WS$ ~ 16,100 WS$

3) Office Operation Cost

(1) 1987

22,500 WS$ (Government Budget)

(2) The amount of increase after the establishment of the Port Authority

10,000 WS$

4) Electric Charges

. Apia Wharf ----------	30,000 WS$
. Beacon----------	2,000 WS$
. Mulifanua Wharf ---------	6,000 WS$
. Salelologa Wharf --------	6,000 WS$
. Asau Wharf----------	3,000 WS$
Total	47,000 WS$

(no change in the future)

5) Water Charges

(1) 1987

20,000 WS$ (Government Budget)

(2) In the future, Water Charges will increase in proportion to the number of vessels using berths.

$$20{,}000 \text{ WS\$} \div 170 \text{ vessels} \times \frac{\text{Number of Vessels using Berths}}{⑪}$$

6) Running Cost of Tugboats (1,500 HP)

$$\frac{\text{Number of Calling Vessels}}{②} \times \frac{\text{Ratio of Tug Use}}{⑬} \times 2 \text{ hours}$$

x 130 l/hour x 0.58 WS$/l x (1+0.2)

Note) Maintenance Cost is 20 percent of fuel cost.

7) Repair and Maintenance Cost

10 % of the Depreciation Cost will be appropriated for Repair and Maintenance.

(1) Yard Pavement

Price	First Stage Plan	909,000 WS$
	Other Agencies	2,106,000 WS$
	Total	3,015,000 WS$
Depreciation Period		10 years
Maintenance Cost	3,015,000 WS$ ÷ 10 years x 0.1 = 30,200 WS$/year	

(2) Sheds

Price	9,500,000 WS$
Depreciation Period	35 years
Maintenance Cost	9,500,000 WS$ ÷ 35 years x 0.1 = 27,100 WS$/year

(3) Ferry Terminal

Price	4,227,000 WS$ (excluding pavement cost)
Depreciation Period	35 years
Maintenance Cost	4,227,000 WS$ ÷ 35 years x 0.1 = 12,100 WS$/year

(4) Tugboat

Price	3,442,000 WS$
Depreciation Period	10 years
Salvage Value	10 %

Maintenance Cost

3,442,000 WS$ x 0.9 ÷ 10 years x 0.1 = 31,000 WS$/year

(5) Wharf at Apia

Price	12,671,000 WS$
Depreciation Period	40 years (1966-2005)

Maintenance Cost 12,671,000 WS$ ÷ 40 years x 0.1 = 31,700 WS$/year

(6) Wharf at Asau

Price	8,219,000 WS$
Depreciation Period	40 years

Maintenance Cost 8,219,000 WS$ ÷ 40 years x 0.1 = 20,600 WS$/year

(7) Breakwater

Price	6,992,000 WS$
Depreciation Period	50 years

Maintenance Cost 6,992,000 WS$ ÷ 50 years x 0.1 = 14,000 WS$/year

(8) Beacons and Buoys

8,000 WS$ (Government Budget in 1987)
2,000 WS$ (New Beacons)
10,000 WS$

(9) Maintenance Dredging Costs

Dredging Volume up to 2005

$220{,}000 m^3$

$220{,}000 m^3$ x 13 WS$/$m^3$ ÷ 17 years = 168,200 WS$/year

Table A.5.1 Fundamental Conditions

Unit: 100WS$

Item \ Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
① Ratio of Pilot Use (%)	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
② Number of Calling Vessels (Vessels)	220	230	240	240	250	260	270	270	280	290	300	300	310	320	330	340	350
③ Average Tonnages of the Calling Vessels (CRT/vessel)	4,300	4,300	4,400	4,400	4,400	4,500	4,500	4,600	4,600	4,600	4,700	4,700	4,700	4,800	4,800	4,900	4,900
④ Total Tonnage of Home-trade Vessels (GRT)	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
⑤ Import Cargo Volume (Ton)	113,000	118,100	123,400	128,900	134,700	140,800	147,100	153,800	160,700	167,900	175,500	183,400	191,600	200,200	209,200	218,700	228,500
⑥ Export Cargo Volume (Ton)	58,800	61,100	63,600	66,100	68,800	71,500	74,300	77,300	80,400	83,600	86,900	90,400	94,000	97,700	101,600	105,700	109,900
⑦ Import Bulk Petroleum Volume (Ton)	27,900	28,700	29,500	30,400	31,300	32,300	33,200	34,200	35,200	36,300	37,400	38,500	39,600	40,800	42,100	43,300	44,600
⑧ Total Cargo Volume (Ton)	199,700	207,900	216,500	225,400	234,800	244,600	254,600	265,300	276,300	287,800	299,800	312,300	325,200	338,700	352,900	367,700	383,000
⑨ Stored Cargo Volume (Ton)	86,700	89,800	93,000	96,300	99,700	103,300	107,000	110,800	114,800	118,900	123,100	127,500	132,100	136,800	141,700	146,800	152,000
⑩ Conversion Factor for Storage Charges of Empty Containers (TEU)	1,500	1,600	1,700	1,800	1,900	1,900	2,000	2,200	2,300	2,400	2,500	2,600	2,800	2,900	3,100	3,200	3,400
⑪ Number of Vessel Using Berths (Vessel)	190	190	200	210	210	220	230	230	240	250	260	270	270	280	290	300	310
⑫ Area of Shed Use ($foot^2$)	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000
⑬ Ratio of Tug Use (%)	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
⑭ Average Tonnage of Vessels which Use Pilots (GRT/vessel)	6,600	6,600	6,700	6,700	6,700	6,800	6,800	6,900	6,900	6,900	7,000	7,000	7,000	7,100	7,100	7,200	7,200

Table A.5.2 Port Revenue (Present Rate)

Unit : 100 WS $

Item \ Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Pilotage	871	911	965	965	1,005	1,061	1,102	1,118	1,159	1,201	1,260	1,260	1,302	1,363	1,406	1,469	1,512
Light Dues	88	92	96	96	100	104	108	108	112	116	120	120	124	128	132	136	140
Port Dues	528	550	583	583	605	640	663	676	699	722	760	760	784	823	847	888	913
i) Sea-going vessels	(473)	(495)	(528)	(528)	(550)	(585)	(608)	(621)	(644)	(667)	(705)	(705)	(729)	(768)	(792)	(833)	(858)
ii) Home-trade vessels	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)	(55)
Cargo Dues	193	200	208	216	225	234	243	253	263	273	284	296	307	320	333	346	360
Wharfage	3,421	3,566	3,717	3,874	4,039	4,212	4,389	4,578	4,772	4,975	5,188	5,409	5,638	5,878	6,129	6,393	6,665
i) Import cargo other than bulk petroleum	(2,260)	(2,362)	(2,468)	(2,578)	(2,694)	(2,816)	(2,942)	(3,076)	(3,214)	(3,358)	(3,510)	(3,668)	(3,832)	(4,004)	(4,184)	(4,374)	(4,570)
ii) Export cargo	(882)	(917)	(954)	(992)	(1,032)	(1,073)	(1,115)	(1,160)	(1,206)	(1,254)	(1,304)	(1,356)	(1,410)	(1,466)	(1,524)	(1,586)	(1,649)
iii) Import bulk petroleum	(279)	(287)	(295)	(304)	(313)	(323)	(332)	(342)	(352)	(363)	(374)	(385)	(396)	(408)	(421)	(433)	(446)
Storage of Cargoes	5,202	5,388	5,580	5,778	5,982	6,198	6,420	6,648	6,888	7,134	7,386	7,650	7,926	8,208	8,502	8,808	9,120
Storage of Containers	150	160	170	180	190	190	200	220	230	240	250	260	280	290	310	320	340
Berthage	103	103	108	113	113	118	125	125	130	135	140	145	145	152	157	162	167
i) Up to 1,500 GRT	(23)	(23)	(24)	(25)	(25)	(26)	(28)	(28)	(29)	(30)	(31)	(32)	(32)	(34)	(35)	(36)	(37)
ii) In excess of 1,500 GRT	(80)	(80)	(84)	(88)	(88)	(92)	(97)	(97)	(101)	(105)	(109)	(113)	(113)	(118)	(122)	(126)	(130)
Dockage	456	456	480	504	504	528	552	552	576	600	624	648	648	672	696	720	744
Fees for Shed Use	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Miscellaneous	629	1,236	1,279	1,297	1,323	1,366	1,411	1,411	1,453	1,498	1,541	1,559	1,585	1,628	1,672	1,716	1,760
i) Wharf Cleaning	(105)	(105)	(110)	(116)	(116)	(121)	(127)	(127)	(132)	(138)	(143)	(149)	(149)	(154)	(160)	(165)	(171)
ii) Tug Service	(0)	(607)	(634)	(634)	(660)	(686)	(713)	(713)	(739)	(766)	(792)	(792)	(818)	(845)	(871)	(898)	(924)
iii) Fresh Water Supply	(524)	(524)	(535)	(547)	(547)	(559)	(571)	(571)	(582)	(594)	(606)	(618)	(618)	(629)	(641)	(653)	(665)
Total	13,041	14,062	14,586	14,977	15,486	16,051	16,582	17,089	17,682	18,294	18,953	19,478	20,139	20,862	21,584	22,358	23,121

Table A.5.3 Port Expenditure

Unit : 100WS$

Item \ Yrar	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Personnel Expenses	3,400	3,603	3,603	3,603	3,603	3,502	3,502	3,502	3,502	3,502	3,502	3,502	3,502	3,502	3,502	3,502	3,502
(1) Salaries	(2,351)	(2,551)	(2,551)	(2,551)	(2,551)	(2,451)	(2,451)	(2,451)	(2,451)	(2,451)	(2,451)	(2,451)	(2,451)	(2,451)	(2,451)	(2,451)	(2,451)
(2) Allowance for Committee Members	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)	(60)
(3) Wages	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)	(830)
(4) Local Travel	(39)	(42)	(42)	(42)	(42)	(41)	(41)	(41)	(41)	(41)	(41)	(41)	(41)	(41)	(41)	(41)	(41)
(5) Overseas Travel	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)	(120)
Office Expenses	408	442	442	442	442	425	425	425	425	425	425	425	425	425	425	425	425
Office Operation Cost	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325
Electric Charges	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470
Water Charges	224	224	235	235	247	259	259	271	282	294	306	306	318	329	341	353	365
Fuel for Tugboat	0	250	261	261	271	282	293	293	304	315	326	326	337	347	358	369	380
Repair and Maintenance Cost	2,556	2,886	3,449	3,449	3,449	3,449	3,449	3,449	3,449	3,449	3,449	3,449	3,449	3,449	3,449	3,449	3,449
(1) Yard Pavement	(0)	(0)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)
(2) Sheds	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)	(271)
(3) Ferry Terminal	(0)	(0)	(121)	(121)	(121)	(121)	(121)	(121)	(121)	(121)	(121)	(121)	(121)	(121)	(121)	(121)	(121)
(4) Tugboat	(0)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)	(310)
(5) Wharf at Apia	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)	(317)
(6) Wharf at Asau	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)	(206)
(7) Breakwater	(0)	(0)	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(140)	(140)
(8) Beacons and Buoys	(80)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
(9) Maintenance Dredging Cost	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)	(1,682)
Total	7,383	8,200	8,785	8,785	8,807	8,712	8,723	8,735	8,757	8,780	8,803	8,803	8,826	8,847	8,870	8,893	8,916

Appendix 6 Comparison of Port Charges with Neighboring Countries

6-1 Port Tariff in Western Samoa

The present port tariff in Western Samoa was revised in 1984 as shown in Table A.6.1.

Table A.6.1 Port Tariff in Western Samoa

No.	Item	Present Tariff	Note
1.	Pilotage	0.1 WS$/GRT	Vessel Charge
2.	Light Dues	40 WS$/vessel	Vessel Charge
3.	Port Dues		
	i) Sea-going vessels	0.05 WS$/GRT	Vessel Carghe
	ii) Home-trade vessels	5 WS$/GRT year	
4.	Cargo Dues	0.1 WS$/ton	Vessel Charge
5.	Wharfage		Cargo Charge
	i) Import cargo other than bulk petroleum	2.0 WS$/ton	
	ii) Export cargo	1.5 WS$/ton	
	iii) Import bulk petroleum	1.0 WS$/ton	
6.	Storage of Cargoes		Cargo Charge
	i) 1st day	nil	
	ii) 2nd day	nil	
	iii) 3rd day	nil	
	iv) 4th day or part thereof	1.5 WS$/ton	
	v) 5th day or part thereof	2.0 WS$/ton	
	vi) 6th day or part thereof	2.5 WS$/ton	
	vii) 7th day or part thereof	3.0 WS$/ton	
	viii) 8th day or part thereof	6.0 WS$/ton	
	ix) Each succeeding day or part thereof after the 8th day	6.0 WS$/ton	

No.	Item	Present Tariff	Note
7.	Storage of Empty Containers	2 WS$/TEU · day	Vessel Charge
8.	Berthage		Vessel Charge
	i) Up to 1,500 GRT	40 WS$/vessel	
	ii) In excess of 1,500 GRT	60 WS$/vessel	
9.	Dockage	0.05 WS$/GRT	Vessel Charge
10.	Fee for Shed Use	2 WS$/foot^2	Cargo Charge
11.	Micellaneous		Vessel Charge
	i) Wharf Cleaning		
	(a) tallow, cement or bitumen or like commodities	100 WS$/vessel	
	(b) other commodities	50 WS$/vessel	
	ii) Tug Service		
	Up to 200 HP	30 WS$/hour	
	201 to 400 HP	40 WS$/hour	
	401 to 600 HP	60 WS$/hour	
	601 to 800 HP	80 WS$/hour	
	801 to 1,000 HP	130 WS$/hour	
	1,001 to 1,200 HP	(160 WS$/hour)*	
	1,201 to 1,400 HP	(190 WS$/hour)	
	1,401 to 1,600 HP	(220 WS$/hour)	
	iii) Fresh Water Supply	0.03 WS$/gallon	

* Tariff rate of tug service over 1,000HP is set with reference to the present tariff.

6-2 Comparison of Port Charges with Neighboring Countries

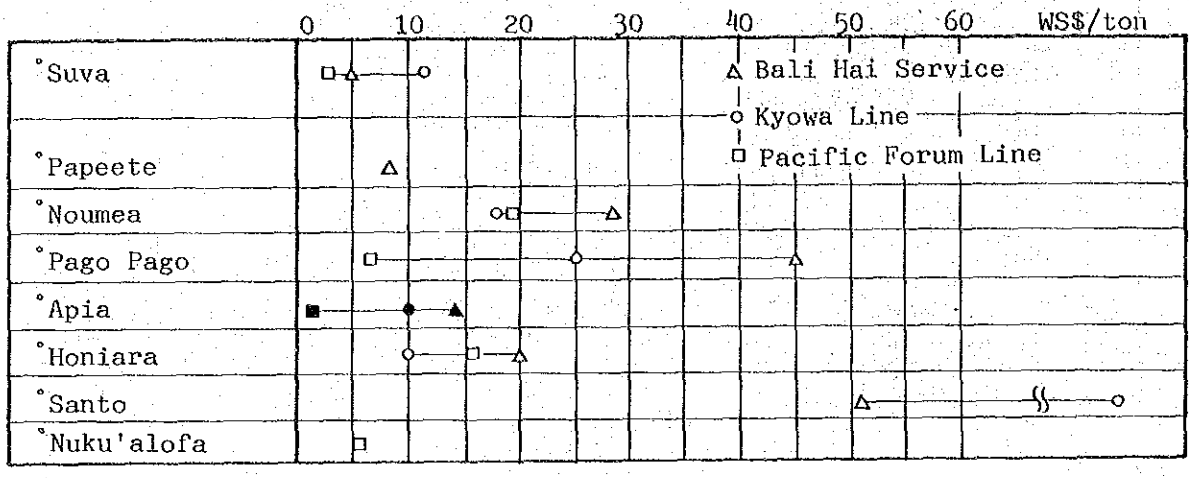


Fig. A.6.1 Comparison of Port Charges per Revenue Ton

Note) Tarawa Port is excluded because of offshore cargo handling.

Table A.6.2 Comparison of Port Charges with Neighboring Countries (from New Zealand)

No.	Name of Port	Total Port Charges per Vessel	Handling Cargo Volume per Vessel (P.F.L.)	Port Charges per Revenue Ton (P.F.L.)	Freight from New Zealand
1.	Apia (Western Samoa)	1,500 WS$ (1.0)	860 ton	2 WSS/ton (1.0)	220 WSS/ton
2.	Suva (Fiji)	4,700 (3.1)	1,400	3 (1.5)	230
3.	Pago Pago (American Samoa)	6,100 (4.1)	900	7 (3.5)	270
4.	Honiara (Solomon Islands)	4,700 (3.1)	300	16 (8.0)	320
5.	Noumea (New Caledonia)	5,700 (3.8)	300	19 (9.5)	320
6.	Nuku'alofa (Tonga)	2,300 (1.5)	400	6 (3.0)	220

Note 1) Size of vessel is about 3,700 GRT.
2) Freight is calculated by the general cargo rate and includes banker surcharges and currency surcharges.

Table A.6.3 Comparison of Port Charges with Neighboring Countries (from Japan)

No.	Name of Port	Total Port Charges per Vessel	Handling Cargo Volume per Vessel		Port Charges per Revenue Ton		Freight from Japan
			(Bali Hai Service)	(Kyowa Line)	(Bali Hai Service)	(Kyowa Line)	
1.	Apia (Western Samoa)	2,100 WS$ (1.0)	150 ton	210 ton	14 WS$/ton (1.0)	10 WS$/ton (1.0)	580 WS$/ton
2.	Suva (Fiji)	9,800 (4.7)	2,030	920	5 (0.4)	11 (1.1)	550
3.	Pago Pago (American Samoa)	6,300 (3.0)	140	250	45 (3.2)	25 (2.5)	610
4.	Santo (Vanuatu)	4,600 (2.2)	90	10	51 (3.6)	460 (46.0)	570
5.	Honiara (Solomon Islands)	2,400 (1.1)	120	230	20 (1.4)	10 (1.0)	570
6.	Noumea (New Caledonia)	10,800 (5.1)	380	590	28 (2.0)	18 (1.8)	570
7.	Papeete (Tahiti)	13,100 (6.2)	1,730	-	8 (0.6)	-	660
8.	Tarawa (Kiribati)	1,600 (0.8)	390	-	4 (0.3)	-	680

Note 1) Size of vessel is about 8,000 GRT.
2) Freight is calculated by the general cargo rate and includes banker surcharges and currency surcharges.