7.3 Standardization of the Hard Countermeasures

7.3.1 Classification of Land Use

To standardize the site, 172 coast units in the entire 31km long shoreline were classified into several zones. Classified land use zones are as follows.

a) Land Use Zone One

Established urban area

b) Land Use Zone Two

Rural area where the beach road runs within 30 meter from the beach top: Rural area "A".

c) Land Use Zone Three

Tourism development areas

d) Land Use Zone Four

Rural area where the beach road runs through a deeper area that is more than 30 meters from the beach top: Rural area "B".

e) Land Use Zone Five

Natural areas having very little artificial development

7.3.2 Classification of Disasters

The hard countermeasures applied per each coast unit should meet the various requirements in terms of protection. In order to standardize, the types of coastal damage in 172 coast units were classified into several grades.

Classification	Grade of Disaster				
	I	II	III	IV	V
"W"	O	O	O		
"EN"	O			O	
"EB"		O			O

Notes:

"W" Shows damage by wave overtopping above beach top. The entire coast was also affected by the wave set-up during cyclones.

"EN" Erosion of both fine particles and coarse particles including coral rock fragments and reclaimed earth.

"EB" Erosion of fine particles, i.e., sand.

a) Grade I for W-EN

The areas most affected by cyclones by means of:

- Wave run-up under the surging of tide.
- Both erosion of fine particles and coarse particles

b) Grade II for W-EB

The areas affected by cyclones by means of:

- Wave run-up under the surging of tide.
- Erosion of fine particles only.

c) Grade III for W

Wave run-up under the surging of tide but causing no significant beach erosion.

d) Grade III for EN

Beach erosion of coarse materials and fine particles, but no significant wave run-up.

e) Grade V for EB

Beach erosion of fine particles only.

7.3.3 Standardization of Countermeasures

Fourteen alternatives were selected as the basic countermeasures by considering the general characteristics of disaster and the coastal condition here. There are seven alternatives for coastal defense work in the micro concept. These are the most popular structures for mitigating possible coastal disasters. Sand nourishment has also been selected as one of the alternatives in the micro concept. Five alternatives were chosen for the macro concept which may apply for improving the existing surrounding conditions to encourage defense work.

The general arrangement and characteristics of these countermeasures are summarized in Table 7-1.

Table 7-1 Summary of Protection Concepts

Type of Protection Works	Function and Evaluation								Remarks
	1. Stable	2. Wave	3. Coast E.	4. Beach E.	5. Access	6. Scenery	7. Wind	8. U. Cost	
a) Micro Concepts									
Coastal Defense Works									
MIC-1; Gravity Seawall	B	B	B	N	P	P	-	5,000	Con. block if required
MIC-2; Rock mound Seawall	G	G	G	N	P	F	-	3,500	
MIC-3; Stepped Slope	G	F	G	F	G	F	-	4,000	
MIC-4; Flexible Hollow Slope	G	F	G	F	F	F	-	2,000	
MIC-5; Flexible Gabion Slope	G	F	F	G	F	F	-	700	
MIC-6; Groin	F	P	F	G	B	F	-	1,200	
MIC-7; Lagoon Breakwater	F	F	F	G	B	F	-	1,200	
Sand Nourishment									
MIC-8; Beach Nourishment	P	P	F	G	B	B	-	500	Cost for ten years
MIC-9; Trap Nourishment	P	P	F	G	B	B	-	400	"
b) Macro Concepts									
On-land Works									
MAC-1; On-land Buffer Zone	B	G	F	-	G	F	F	2,000	For 25 meter wide
MAC-2; Facility Relocation	B	G	F	-	G	G	G	2,500	Beach road 7m wide
MAC-3; Plantation with Dike	B	G	F	-	F	G	G	400	For 20 meter wide
Work near the reef									
MAC-4; Artificial Passage "I"	F	F	F	G	B	B	-	4,000	100m x 30m x 4m
MAC-5; Artificial Passage "Y"	F	N	F	G	B	B	-	8,000	200m x 30m x 4m

Notes 1. Marks,
B: Best, G: Good, F: Fair, P: Poor, N: not Suitable, -: Not applicable
2. Unit cost is estimated cost per shoreline meter, in dollars as 1992 price.
3. "Stable" means grade of structural stability against cyclone wave and surge.

7.4 Application of System to Site

The application of various coastal protection countermeasures are to the 172 coast units under 47 villages.

Each coast unit of the 31 kilometer coastal area has its own particular characteristics. Countermeasure applying to each unit should meet these local condition. An area can be classified from two overall viewpoints: land use of hinterland and estimated disaster grade.

7.4.1 Classification of 31 Km Coastal Line by Land Use

Since a land use development plan for the island in the year 2010 has not yet been provided, this classification has been conducted based on existing land use. A summary of the total area by the length of beach road is as follows:

Zone		Area	Length	Share (%)
- Land use zone one	:	Established urban areas	1,770 m	(5.7)
- Land use zone two	:	Rural areas "A"	6,420 m	(20.7)
- Land use zone three	:	Tourism development Area	1,000 m	(3.2)
- Land use zone four	:	Rural areas "B"	21,600 m	(69.7)
- Land use zone five	:	Natural areas	200 m	(0.7)
		Total length	30,990 m	(100)

Source: Study team

7.4.2 Classification of 31 Km Coastal Line by Disaster Grade

Cyclone disasters are caused by not only waves and surges but also coastal erosion and beach erosion. In order to identify the dominant disaster grade by village, the following three data sources were studied:

i) Cyclone Sally damage map prepared by the Conservation Department.
ii) Perception of villagers concerning damage by waves and surges by Sally
iii) Wave run-up and over-topping calculation against design wave conducted by the study team.

A summary of estimated disaster grades by the existing land use is shown in the following Table.

Table 7-3 Summary of Countermeasures

unit : Length of Beach in meter

Disaster Grade	Present Land Use Classification						Shared (%)	
	Urban	Rural "A"	Tourism	Rural "B"	Nature	Total	Affected	Total
I Wave over-topping and coastal erosion	1,770	-	-	-	-	1,770	11.8	5.7
II Wave over-topping and beach erosion	-	-	-	2,000	-	2,000	13.4	6.5
III Wave over-topping	-	-	-	5,740	-	5,740	38.4	18.5
IV Coastal erosion	-	1,000	400	1,850	100	3,350	22.4	10.8
V Beach erosion	-	1,170	200	720	-	2,090	14.0	6.7
Subtotal	1,770	2,170	600	10,310	100	14,950	100%	-
No damage	-	4,250	400	11,290	100	16,040	-	51.8
Total	1,770	6,420	1,000	21,600	200	30,990	-	100%

Particular in wave over-topping data indicate as follows:

(i) Over-topping is concentrated in the island northern coast.

(ii) Over-topping is observed all the coastlines between village Matavera/Tupara and Village Kaikaveka. Wave over-topping heights vary 1 m to over 6 m averaging about 4 m.

(iii) Over-topping is observed at three coasts except the northern coast.
- Northern end of Village Tokerau/Inava ---------- 1 m
- Near the Ngarangii Passage at Village Avarua ---------- 1 m
- West of the existing airport ---------- 1~5 m

(iv) Damage records of wave action by Conservation Department well meet with the severe wave over-topping coast estimated by the study team.

Based on these data and their evaluation, coasts to be provided with wave over-topping countermeasures should be selected. It is proposed that criteria for selection is the coast which wave cover-topping height is over than 2 m.

The countermeasures against wave over-topping, the most serious disaster to coastal areas are proposed along the following areas.

Coastlines of Wave Over-topping more than 2 meters

a) Shoreline between the northeast corner at Village Matavera/Tupapa to the East end of the airport (8,750 meter long)

b) West of the airport (760 meter long)

Affected coast by erosion can be summarized as follows:

(i) According to the perception study on cyclone damage, erosions here happen over all the coasts.

(ii) According to the damage records by the Conservation Department, erosion is observed all the coastline except northern one. Even in the same village, both erosion and deposit were observed. This may indicate that coastal change is depend also on the local condition.

Based on these data and their evaluation, coasts to be provided with erosion countermeasures should be selected. It is proposed that following condition will be selection criteria.

(i) Coasts recorded as "Active Erosion" and "Exposed Beach Rock" by the Conservation Department.

(ii) Coasts of coastal erosion more than 1.5 m per 5 years or coasts of beach erosion more than 3.0 m per 5 years in the perception study.

Coastline with Active Erosion by Coastal Rep. and Villagers

Countermeasures against erosion is proposed at the following five coastal groups:

a) Northwest shoreline 1,500 meters at Villages Pokoinu I.R. and Tokerau/Inave against coastal erosion. This area is immediately South of the Black Rock where the lagoon width is the narrowest and is exposed to the northern direction from which larger waves approach.

b) Southwest corner (880 meters) at Village Aroa against coastal erosion.

c) Southwest shoreline (200 meters) at Village Vaimaanga against coastal erosion. This area faces Papua Passage.

d) Southeast corner (1,170 meters) at Villages Akapuao and Tikioki against beach erosion.

e) East coast (1,690 meters in total) at Villages Areite, Nukupure, Aroko and Avana. The shoreline (920 meters) at first three villages of requires countermeasures against beach erosion. The remaining 770 m at Avana coast requires countermeasures against coastal erosion.

Fig. 7– 1 Classification of Disaster and Countermeasures by Village

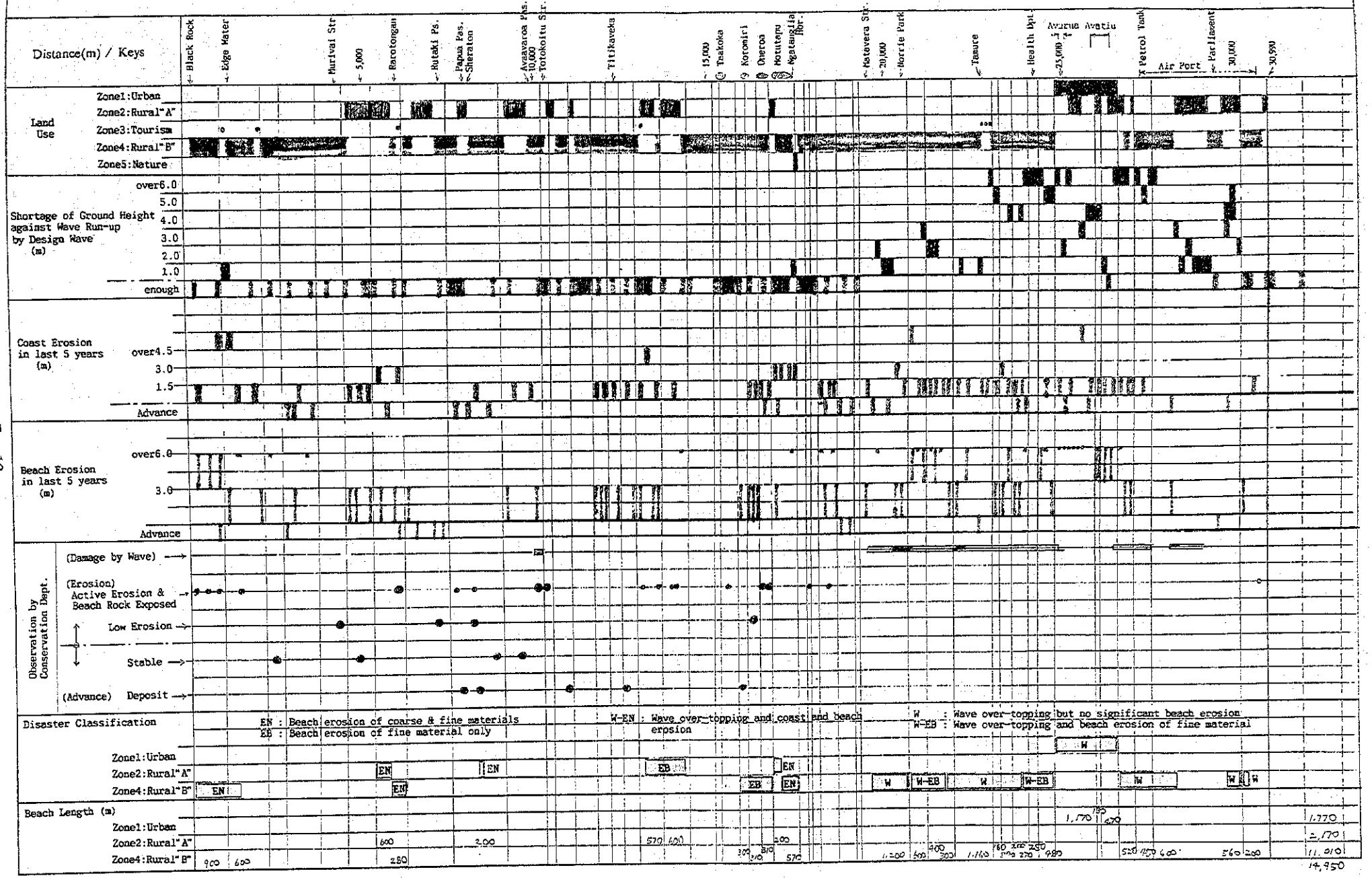


Table 7-4 List of Coasts to be protected

No.	Village	Coast Unit* (200 m each)	Length (m)	Land Use		Disaster Grade	
101	Pokoinu I.R.	1011 - 1015	900	Rural "B"	III	Coastal	Erosion
102	Tokerau/Inave	1012 - 1023	600	"	"		"
-	-	-	-	-	-		-
107	Aroa	1071 - 1073	600	Rural "A"	IV	Coastal	Erosion
"	"	1074 - 1075	280	Rural "B"	"		"
-	-	-	-	-	-		-
201	Vaimaanga	2014	200	Rural "A"	IV	Coastal	Erosion
-	-	-	-	-	-		-
209	Akapuao	2092 - 2094	570	Rural "A"	V	Beach	Erosion
210	Tikioki	2101 - 2103	600	"	"		"
-	-	-	-	-	-		-
303	Areite	3031 - 3032	300	Rural "B"	V	Beach	Erosion
304	Nukupure	3041 - 3042	310	"	"		"
305	Aroko	3051 - 3052	310	"	"		"
306	Avana	3061	200	Rural "A"	IV	Coastal	Erosion
"	"	3062 - 3064	570	Rural "B"	"		"
-	-	-	-	-	-		-
403	Matevera/Tupapa	4032 - 4037	1200	Rural "B"	III	Wave	Over-topping
404	Titama	4041 - 4043	600	"	II	Wave	Over-topping and Beach Erosion
501	Araitetonga	5011 - 5012	400	"	"		"
"	"	5013 - 5014	300	"	III	Wave	Over-topping
502	Kiikii	5021 - 5026	1,160	"	"		"
503	Punataia	5031	160	"	"		"
504	Tapae	5041 - 5042	390	"	"		"
506	Pue	5061	200	"	"		"
"	"	5062 - 5063	270	"	II	Wave	Over-topping and Beach Erosion
507	Vaikai	5071 - 5072	250	"	"		"
601	Ngatipa	6011 - 6013	480	"	"		"
603	Avarua	6031 - 6036	1,170	Urban	III	Wave	Over-topping
604	Ruatonga	6041	130	"	"		"
605	Avatiu	6051 - 6053	470	"	"		"
701	Atupa	7011 - 7013	520	Rural "B"	"		"
702	Kaikaveka	7021 - 7023	450	"	"		"
703	"Airport"	7031 - 7033	600	"	"		"
-	-	-	-	-	-		-
703	"Airport"	70311 - 70313	560	Rural "B"	III	Wave	Over-topping
706	Pokoinu	7061	200	"	"		"
	Total		14,950 m				

Note, For the Coast Units, see Appendix C-1. "Coastal File"

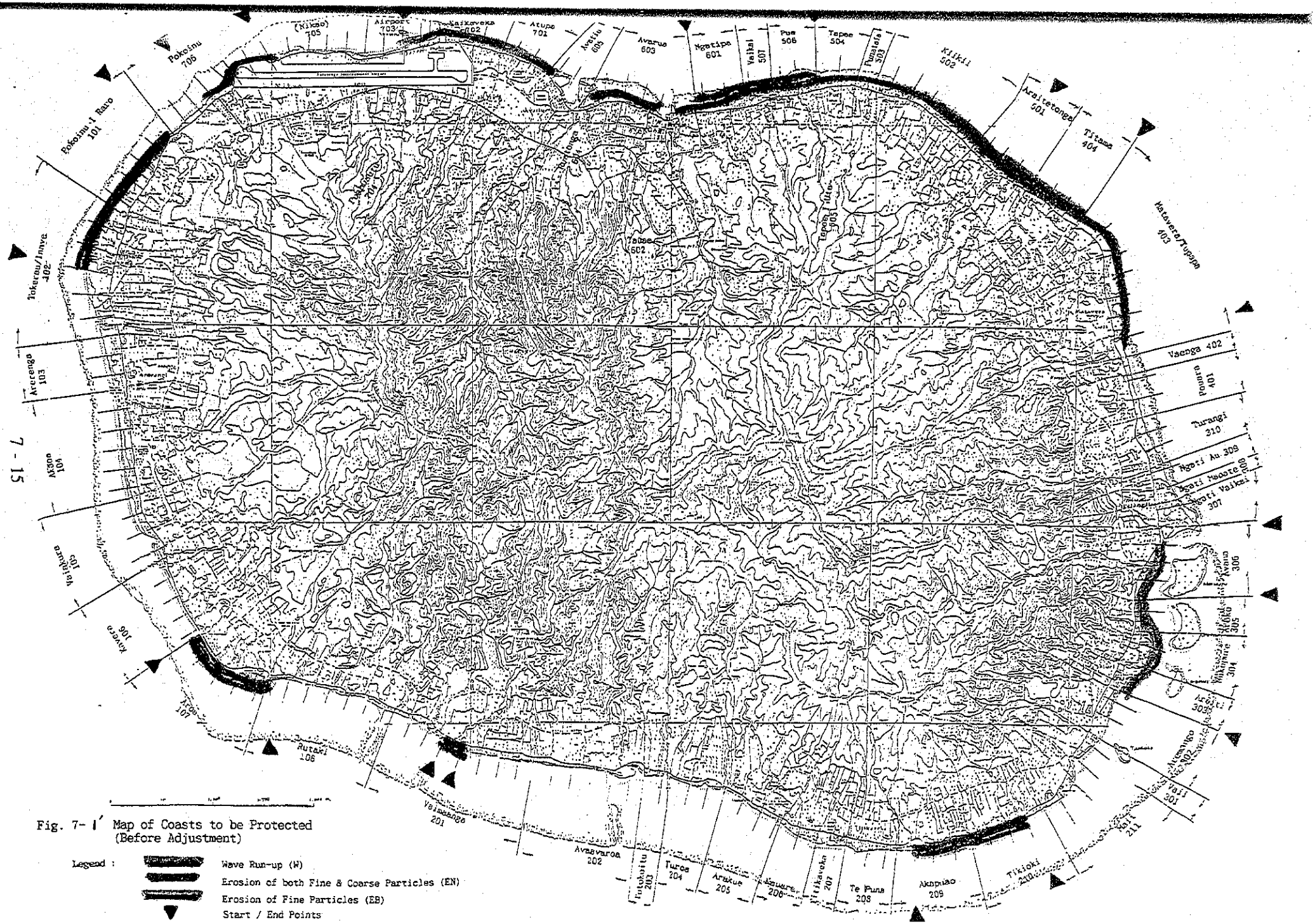


Fig. 7-1′ Map of Coasts to be Protected (Before Adjustment)

Legend :

- Wave Run-up (W)
- Erosion of both Fine & Coarse Particles (EN)
- Erosion of Fine Particles (EB)
- Start / End Points

7.5 Avarua Coastal Protection Master Plan

7.5.1 Planning Criteria

There are two harbours and most developed urban areas along the Avarua Coast. Coastal protection plan should cover these functions.

1) Requirement in respect to Coastal Protection

Protection work consists of land reclamation in about 50~80 m width and seawall construction similar to the works by MOW. Width of new land at the Avarua Central Coast is 50 m. This defense line is similar alignment to "Line-B" and shapes a straight line connecting corners of two breakwaters. Average land width in the Avarua East Coast is also 50 m.

2) Requirements in respect to Port Improvement

According to the port improvement study both Avatiu and Avarua Harbours will be provided with various arrangements as follows:

<u>Avatiu Harbour</u>

a. Major function here is both the commercial port and the fisheries port.
b. East breakwater should be extended by 150 m for both calm inner basin and approach channel.
c. New port area of 1.5 Ha should be given along the west part of new reclaimed land.
d. Higher development priority will be given than Avarua Harbour.

<u>Avatiu Harbour</u>

a. Major function here is a marine tourism center as marina.
b. Both breakwaters, West and East, will be constructed. East breakwater will be extended by 100 m seawards.
c. Works to be implemented in the Short-term Development will be the minimal improvement in order to concentrate to Avatiu Harbour improvement.

3) Requirements from the Avarua Urban Areas

New land should be gained for the provision of public land which is currently in short of supply and for future Avatiu Harbour expansion. According to land use estimation, new land should be 5 Ha or more. In the new land long the seawall, cyclone buffer zone will be provided in emergency case. New reclamation will be conducted both in Avarua Central Coast and Avarua East Coast. These new land are called hereinafter as "Port Park Complex".

Port Park Complex

New land reclamation of 6 Ha will be carried out as follows:

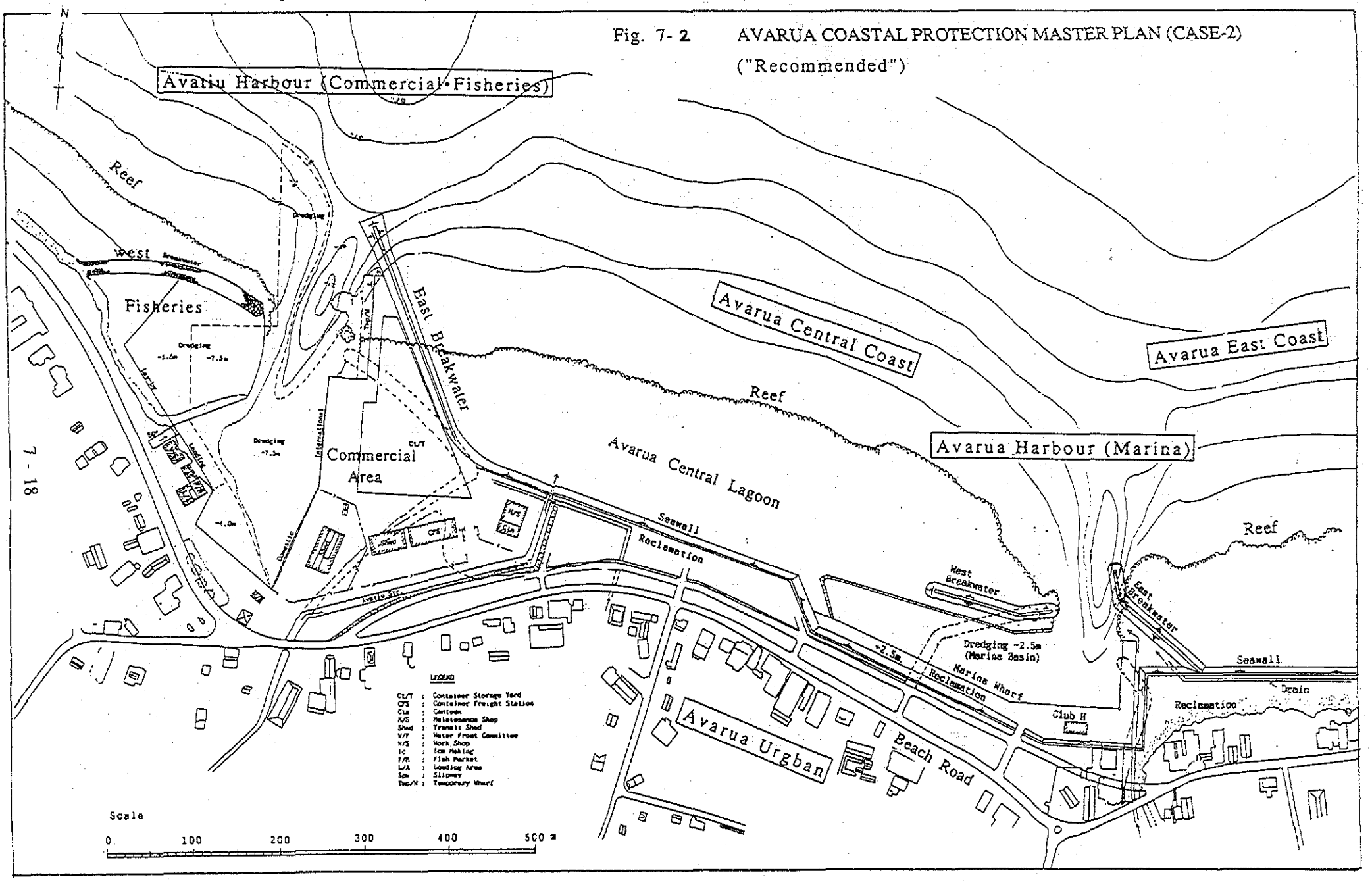
Avarua Central Coast ----------	4 Ha	500 m x 80 m
Avarua East Coast ----------	2 Ha	300 m x 50 m

Port park complex will be an open space for the public use, including roads, parking area, bus terminal, park etc,. The complex will be constructed in the reclaimed areas between the existing shoreline and the new seawall to be constructed in the lagoon. The primary purpose of the complex during a cyclone is to maintain the buffer zone in order to absorb cyclone energy before it arrives such dense urban areas as Ngatipa, Avarua, Ruatonga and Avatiu.

7.5.2 Avarua Coastal Protection Master Plan

Fig. 7-2 shows the coastal protection layout together with recommended port improvements.

Fig. 7- 2 AVARUA COASTAL PROTECTION MASTER PLAN (CASE-2)
("Recommended")



7.6 Summary of Coastal Protection Master Plan

7.6.1 Cost Ceiling

Actual investment cost for coastal protection can be obtained as follows:

$$Cc = Co \times R$$

Where, Cc : Cost after ceiling
Co : Original total cost before the ceiling
R : Implementation rate (%)

The implementation rate should be decided upon consideration of the land use priority and the disaster grades. Zone One, the urban developed area, should be top priority. Zone three, the tourism area, will also have top priority due to the need of maintaining the largest industry here for the purpose of increasing employment opportunities. Zones Two and Four, the rural areas, will be assigned a lower priority. Considering this, the proposed the implementation rates for each zone will be;

Zone		Land Use	Implementation Rate
Zone One	:	Urbanized Areas	100 %
Zone Two	:	Rural Areas "A"	50 %
Zone Three	:	Tourism Areas	70 %
Zone Four	:	Rural Areas "B"	30 %

Thus the total cost after ceiling will be:

Table 7-6 Total Coastal Protection Cost in Master Plan (After Ceiling)

Zone	R	Original Cost	Cost after ceiling	Share
Zone One	100 %	8,178,000	8,178,000	(35.5 %)
Zone Two	50 %	2,819,000	1,410,000	(6.1 %)
Zone Three	70 %	4,360,000	3,052,000	(13.3 %)
Zone Four	30 %	34,750,000	10,425,000	(45.2 %)
A. Total Direct Cost		50,107,000	23,065,000	(100 %)
B. Management Cost (20.5 % of A.)			4,725,000	
C. Grand Total Cost after Ceiling			27,790,000	

7.6.2 Protected Area

Protected coastal area will be as follows:

Table 7-7 Protected Coast Length in Master Plan (After Ceiling)

Zone	Coastal Length (m)			Remarks
	Before Ceiling	After Ceiling		
Zone One	870	870	(15.9%)	Urban
Zone Two	2,170	1,085	(19.8%)	Rural "A"
Zone Three	600	420	(7.7%)	Tourism
Zone Four	10,310	3,093	(56.6%)	Rural "B"
Zone Five	0	0		Nature
Total	13,950	5,468	(100%)	

Note, Both Avarua Harbour and Avatiu Harbour areas are excluded.

Thus, coverage by the Master Plan is 39% of all the coastal protection required (13,950 meters). Table 7-8 shows the list of typical countermeasures for each land use category.

Table 7-8 List of Typical Countermeasures per Land Use

Land Use	Disaster Grade		Countermeasure	Damaged Coast(m) x R		Coastline to be protected (m)
Zone One	GI.	MIC-1	Gravity Seawall	870 x 100 %	=	870 m
Urban Area		MAC-1	On-land Buffer Zone			
		MAC-3	Plantation with Dike			
Zone Two	GIV	MIC-4	Flexible Hollow Slope	1,000 x 50 %	=	500
Rural "A"	GV	MIC-5	Flexible Gagion Slope	1,170 x 50 %	=	585
Zone Three	GIV	MIC-3	Stepped Slope	400 x 70 %	=	280
Tourism Area		MIC-6	Groin			
		MIC-8	Beach Nourishment			
		MAC 4	Artificial Passenge "I"			
	GV	MIC-5	Flexible Gabion Slope	200 x 70 %	=	140
		MIC-6	Groin			
		MIC-8	Beach Nourishment			
Zone Four	GI.II	MIC-2	Rock Mound Seawall	7,740 x 30 %	=	2,322
Rural "B"		MAC-3	Plantation with Dike			
	GIV	MIC-4	Flexible Hollow Slope	1,850 x 30 %	=	555
	GV	MIC-6	Groin	720 x 30 %	=	216
			Total	13,950 x 39 %	=	5,468 meter

Chapter 8: Master Plan of Port Improvement

Chapter 8 Master Plan of Port Improvement

8.1 Proposed Ideas of Improvement of Avatiu and Avarua Harbours

a. To provide a container storage area to accommodate the increase in container cargoes,
b. To expand the east breakwater, the width of the entrance channel, turning basin and depth of the quay wall at Avatiu Harbour to ensure the safety of large vessels,
c. To repair the existing quay wall,
d. To prepare the facilities of the fishery port for the increase in both number and size of fishing boats to realize more fish catches,
e. To construct a marina for the increase in the number of pleasure boats, especially large yachts to enhance tourism industry development,
f. To protect small fishing boats from high waved during a cyclone.

8.2 Results of Demand Forecast

1) Population

The nominal growth rate of population is 0.53% annually taking into consideration the equivalent number of tourists. The annual growth rate without consideration of the equivalent number of tourists is 0.3%.

2) Gross Domestic Product (GDP)

The estimate of GDP complies with a simple linear regression analysis based on the data of GDP from 1982 to 1990.

3) Forecast of Cargo Volume

Year	Overseas Cargo ('000 freight ton)	Domestic Cargo ('000 freight ton)
1997	46.1	2.4
2010	53.1	2.8

When forecasting the ratio of containerization, conditions of the mother port and other ports where a vessel calls have to be considered. The ratio of containerization in Avatiu Harbour will become 64% in 1997 and 70% in 2010.

Size of container ships in the south Pacific area will not radically change in the future.

Numbers of ship calls at Avatiu Harbour are as follows.

Year	General Cargo Ship	Tanker	Total
1997	40	14	54
2010	50	16	66

4) Fishery

The growth rate of fish catches correlates to the growth rate of population; when including equivalent number of tourists, the rate from 1990 to 2010 becomes approx. 10%. Fish catches of approx. 200 tons are expected in 2010 considering that the Ministry of Marine Resources intends to vigorously develop the fishery industry in the future.

The number of fishing boats are summarized as follows.

Year	Type of Boat	Number of Boats
1997	L = 4 - 6 m (existing)	35
2010	L = 4 - 6 m L = max. 10 m	40 10 : Total 50

When a simple linear regression analysis is applied for forecasting the number of calls for pleasure boats using the above time series data, the annual number of calls is 190 in 1997 and 340 in 2010. A concentration degree of 17% will be applied for estimating the maximum number in the future; so it is expected that approx. 33 in 1997 and 60 boats in 2010 will be moored simultaneously at a marina.

5) Parking Area in Port Park Complex

According to the field observation, the total number of parked cars including large vehicles is 200.

8.3. Projection of Port Facilities in Master Plan

1) General

The east breakwater in Avatiu Harbour will be relocated and extended to ensure a calm water space.

The required number of deep-sea berths for foreign trade is determined using the berth occupancy rate based on the demand forecast; the number remains unchanged. The depth of the berths at present is 6.2 m below MSL and because this is insufficient for large vessels the basin for foreign trade vessels has to be dredged to 7.5 m below MSL. The width of the basin will be expanded to 140 m in case of using a tug boat taking into consideration the safe turning of large vessels.

The area of CFS will be unchanged in the Master Plan since the calculated area of 420 m^2 is less than the present area. The area of the container storage yard in case of the forklift system in combination with tractor-trailers is 6,800 m^2, and the area of the marshaling yard is 5,100 m^2.

The length of the landing wharf will be set at 50 m to allow for future expansion since the required landing wharf length is approx. 30 m based on the demand. The length of the lay-by wharf is 180 m. Marketing hall including areas for sorting, weighing packing etc. is determined to be approx. 200 m^2. The area of the ice making plant is 75 m^2. The existing repair shop is sufficient for future use.

A fixed fork-shaped type is adopted for the mooring facilities of the marina. According to the estimation, the number of calling yachts mooring simultaneously at Rarotonga in 2010 is approx. 60 and the length of the wharf for the yachts is 380 m.

Consequently, the fishery port is established at Avatiu Harbour and the marina at Avarua Harbour.

2) Basic Layout of Avatiu Harbour

The container cargo volume in 2010 will reach about 26 thousand tons. Therefore, the container storage yard should be expanded and CFS should be relocated behind the deep-sea wharfs. The dangerous LPG tanks should be moved outside of the port. The fishery port facilities consisting of the

landing wharf, the lay-by wharf, the market hall, the ice making plant etc. will be established at the western side of Avatiu Harbour.

3) Basic Layout of Avarua Harbour

The marina with mooring facilities of 380 m in length will be established.

4) Basic Layout of Port Park Complex

A green belt with a park and facilities for inland public transportation such as bus terminals and a parking area will be established.

5) Summary of Facilities

Items	Quantity	Note
Avatiu Harbour		
Deep-sea Area		
Quay Wall (-7.5 m)	139 m	
(-6.2 m)	125 m	
(-4.0 m)	115 m	
CFS	880 sq.m	
Cargo shed (No.1)	640 sq.m	
(No.3)	920 sq.m	
Container yard	11,900 sq.m	
Maintenance shop	250 sq.m	including canteen
Fishing Port Area		
Landing wharf (-1.5 m)	50 m	
Lay-by wharf (-1.5 m)	180 m	
Facility of Ice maker	75 sq.m	
Sorting area, Market Hall	200 sq.m	
Maintenance shop	380 sq.m	as it is.
Slipway	1	
Eastern breakwater	310 m	
Western breakwater	240 m	
(Equipment)		
Tractor-trailer	2 sets	
Forklift 32 tons	3	
2.5 tons	6	
5 tons	4	
Avarua Harbour		
Marina (Yacht harbour)		
Quay Wall (-2.5 m)	380 m	
Club house	200 sq.m	
Easter breakwater	110 m	
Western breakwater	140 m	
Port Park Complex		
Bus terminal at Avatiu	1,800 sq.m	
Bus terminal at Avarua	1,800 sq.m	
Parking Area	11,000 sq.m	

Chapter 9: Cost Summary for Master Plan Stage

Chapter 9 Cost Summary for Master Plan Stage

9.1 Construction Cost Summary

The total cost is an accumulated construction cost for the coastal protection and the port improvements. The required investment for the year 2010 will be 60.9 million dollars at 1992 current prices.

Sectorial breakdown of the costs is shown in table below.

Table 9-1 Total Construction Cost: Master Plan 2010

Sectors	Cost
Coastal Protection	27.8 million Dollars
Port Improvement	33.1 million Dollars
Total	60.9 million Dollars

The coastal protection cost here will cover about 39% of the coastal areas to be protected, while the port improvement will involve the existing two ports, Avatiu and Avarua.

9.2 Construction Period Required

It is estimated that the total period required to complete this work whole the works in Master Plan is four years if they are implemented during one stage.

Table 9-2 Construction and Disbursement Schedule

Sectors	Year				Total
	1	2	3	4	
1. Coastal Protection	7.0	7.0	7.0	6.8	27.8
2. Avatiu Harbour Improvement	9.0	9.0	6.6		24.6
3. Avarua Harbour Improvement				8.5	8.5
Annual expenditure in million dollars	16.0	16.0	13.6	15.3	60.9

Chapter 10: Phased Development Plan

Chapter 10 Phased Development Plan

10.1 General Description

According to the Master Plan cost estimates, it is proposed that an investment amounting to 60.9 million dollars should be made by the year 2010, 33.1 million dollars for port improvements and 27.8 million dollars for coastal protection. All of the port improvements will be made at two harbours, Avatiu and Avarua. The share of these two ports is 74 % and 26 % for Avatiu and Avarua respectively. Amount of the protection work for both the Avarua urban area and other rural areas will share 35.5 % and 64.5 % respectively.

All the recommended works in the Master Plan are not necessarily given the same priority. Some work should be implemented urgently; however, other elements can be constructed later stage. The proposed work is combined with various components of different priorities.

In order to invest the limited resources effectively and to prevent the works from concentration in a short period, phasing of the work with proper arrangements should be scheduled.

10.2 Priority

The scope to be included in the short-term development plan is as follows:

a) Of the places where excessive wave overtopping by a Sally class cyclone is expected, the existing facilities properties are important and can not be substituted by others

- Private facilities along the beach road in Avarua Urbanized Areas
- Government offices and facilities along the beach road in the same
- Port facilities in Avatiu Harbour
- Fuel storage facilities near the airport
- Other the same

b) Of the places where excessive coastal erosion by a Sally class cyclone is expected, the existing facilities are important and can not be substituted by others

- Private and public facilities located immediately eastward of Avarua Harbour
- Airport runway at the westward end constructed on the reclaimed land
- Other the same

c) Of the existing port facilities, those that should be provided with urgent repair work:

- Repair work to the damaged quaywall at Avatiu Harbour
- Widening of the turning basin in Avatiu Harbour
- Fishery facilities in Avatiu Harbour
- Port facilities in Avarua Harbour
- Other the same

It is recommended that these works should be urgently implemented for sustaining the development of island.

10.3 Phased Development

The phased development plan has been prepared in order to implement gradually the Master Plan. Work components in the Master Plan have been classified into two phases.

Fig. 10-1 and 10-2 show the phased development plans for the coastal protection and port improvement respectively.

Coastal protection work in Phase One will concentrate on the northern coast from the eastern boundary at Village Pue to the west end of the existing airport. Among them, the Port Park Complex (defined as the Avarua coastal area between Villages Ngatipa and Avatiu) will be provided with continuous protection work. However, areas other than the Complex will partly be protected where required.

The port improvement work classified in Phase One will mainly be performed at Avatiu Harbour. Avarua Harbour will partly be improved as of the Phase One work.

Fig. 10-1 Phased Development Plan : Coastal Projection, Phase One

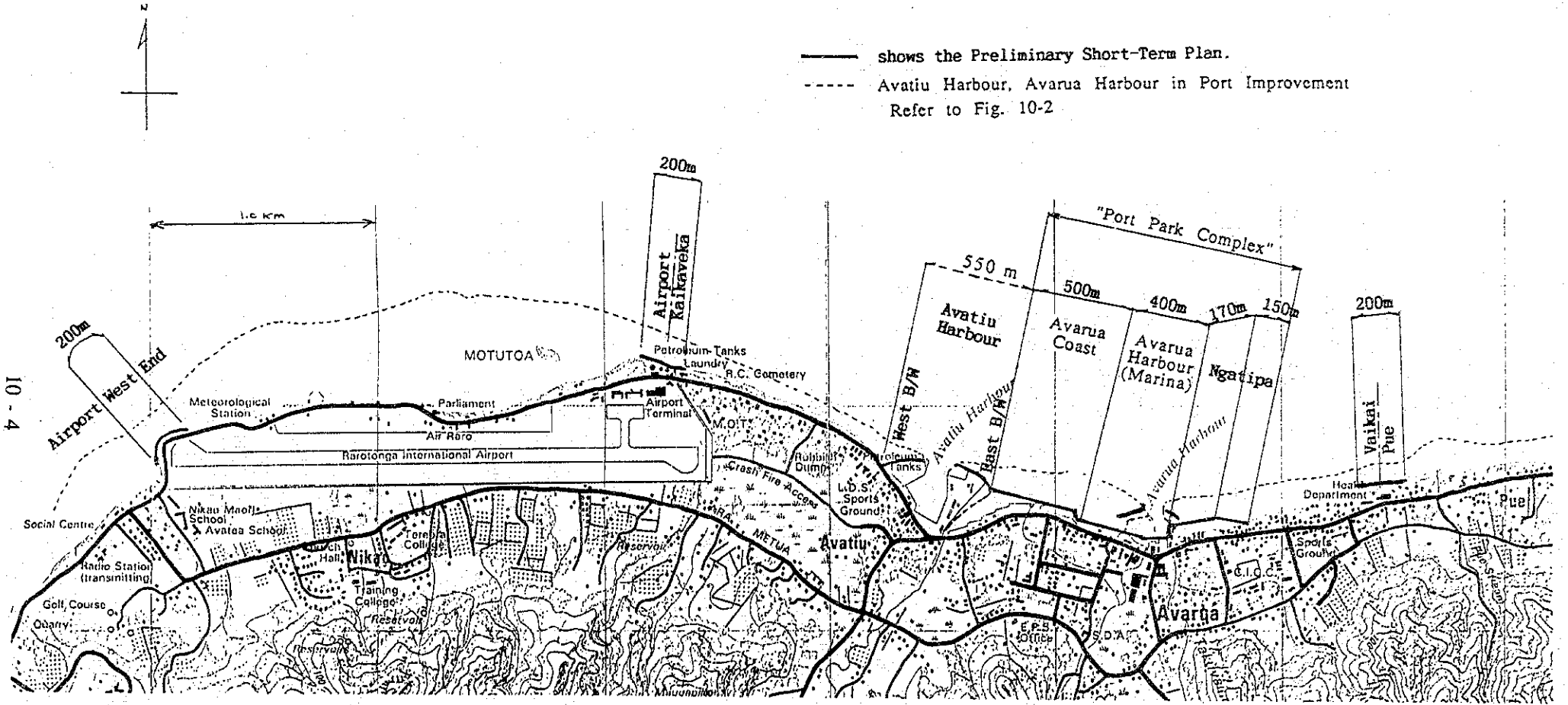


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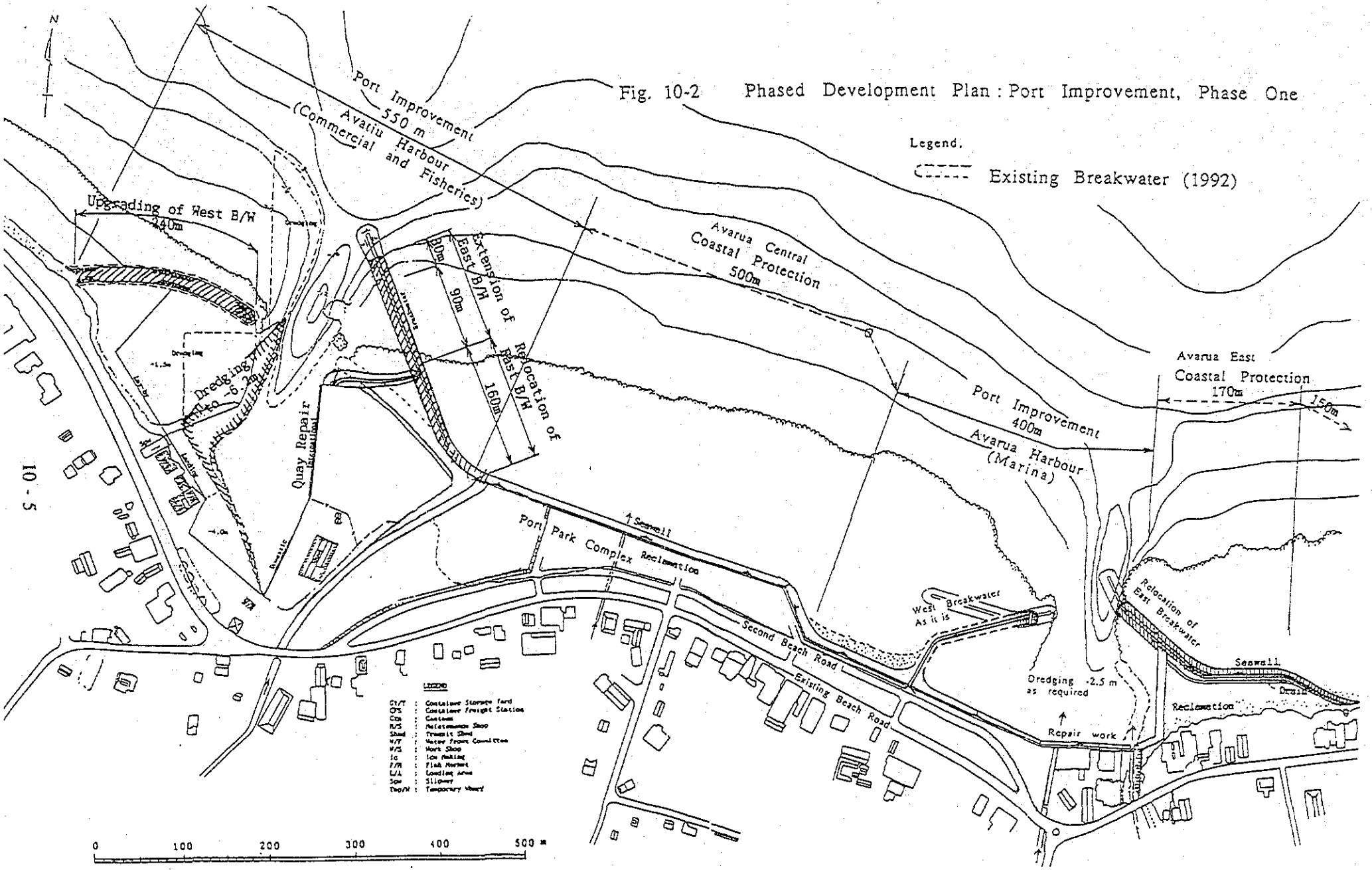
Fig. 10-2 Phased Development Plan : Port Improvement, Phase One



Chapter 11: Definition of Short-Term Development Plan

Chapter 11 Definition of Short-term Development Plan

11.1 Necessity of the Project

11.1.1 Policy Objectives

The project is proposed based on the following policy objectives of the Government of Cook Islands.

i) Protection of the national land and the security of the nation against natural disasters.

ii) Maintaining a supply of items essential for human life and related fundamental materials.

iii) Promotion of Industries

iv) Increase Employment Opportunities and Prevent of Population Outflow

11.1.2 Possible Countermeasures (Contents of the Project)

Countermeasures to achieve the said policy objectives can be summarized as follows:

i) To protect the national land and to ensure the nation's safety, appropriate coastal projection will be undertaken in the project.
The area to be protected is the coastline since public utilities such as the airport and port as well as the city environs are in close proximity to the coast.

ii) To provide coastal protection works in respect to natural disasters by wave over-topping and coastal erosion. Location to be protected will be selected based on the paset damage and land use requirement at its hinterland.

iii) To cover the damaged areas by coastal protection works.

- Coastal area near the Health Department and its surroundings
- Coastal area in front of the Avarua urbanized area
- Coastal area in front of the fuel storage yards at the Eastern end of existing airport
- Beach road near the MET
- Beach road at the North-West corner of airport
- Beach road at the West end of airport

Not only Cyclone Sally but also Val/Wase and Gene should be taken into consideration of protection plan.

iv) To maintain an adequate supply of items essential for life and related fundamental materials.
The improvement of breakwaters, basin and wharfs, and the procurement of a tugboat in Avatiu Harbour will be undertaken to minimize damage to the port caused by cyclones, and to ensure the safety of ships maneuvering.
Additionally, to enhance physical distribution, the procurement of necessary cargo handling equipment is also considered in the project.

v) To establish and promote industries such as tourism, the improvement of breakwaters, basin and the wharf in Avarua Harbour which is used for usual mooring and emergency evacuation of small fishing crafts.

vi) To create both comfortable and safety circumstances, a port-park complex in the Avarua central coast that will function not only as a green zone and parking area but also as a cyclone buffer zone, will be established.

vii) To supply food to the nation and tourists, fishery related facilities in Avatiu Harbour will be established.

viii) By promoting industries and, through the implementation of the project, employment opportunities and the number of permanent residents will increase.

ix) The aim of the above measures is towards the realization of land protection, the safety of the nation, and a stabilized national economy.

Based on the above, the project can be considered to be in harmony with the policy objectives of the Cook Islands Government.

Furthermore, if the current situation remains unchanged, there is a strong likelihood that heavy damage will be inflicted in the near future. Therefore, given that the primary aim of the project is to protect the national land and to defend it against natural disasters, the urgency of the project should be recognized.

11.2 Definition

The Master Plan is a final objective which is a target to be attained over a long time span. The Short-term Development Plan is a milestone that must be accomplished first.

Work components proposed in the Master Plan include the various work categories and large scale investments required to meet the demands of target year 2010. Some of the work can be implemented around the year 2010. However, other specified work should be executed promptly to meet urgent requirements. Thus, all the works recommended in the Master Plan are not necessarily assigned the same priority.

It is understood that the Short-term Development Plan should only include the urgently required work. Thus, the objective of the Short-term Development Plan is to draw up a scheme outlining the urgently required components of the Master Plan.

Character of Short-term Development Plan

As discussed in Chapter 10, the basic criteria of the high priority work can be summarized as follows:

i) Protection work having a high investment efficiency compared to the necessary costs that might require for restoration of the expected damage in the case of no investment.

ii) Any existing facility that can not be substituted by others.

iii) Any existing facility already being damaged that requires urgent repairs as the only alternative.

iv) Any existing facilities which can not ensure the safety of its users.

If these criteria are applied to the project, the scope of urgently required work can be categorized as follows:

Category "A"

Among the places where wave overtopping by a Sally class cyclone is expected and the existing facilities are important and can not be substituted by others.

This category may include the following work:

i) Urbanized area along the beach road in Avarua.

ii) Government offices and public facilities along the beach road in Avarua.

iii) Port facility in Avatiu Harbour

iv) Fuel storage facilities on the coastal bank near the existing airport

v) Government offices and public facilities near the Health Department

Category "B"

Among the places where coastal erosion by a Sally class cyclone is foreseen and the existing facilities are important and can not be substituted by others.

This category may include the following works.

i) Facilities located immediately eastward of Avarua Harbour.

ii) Runway westward end on the reclaimed land.

Category "C"

Among the existing waterfront facilities, those that should be provided with urgent repair work or improvements.

This category may include the following works.

i) Repair work to the Avatiu Harbour quaywall

ii) Widening of the turning basin and the provision of a tug boat for the safety of vessels maneuvering in Avatiu Harbour

iii) Longer calm approach channel of Avatiu Harbour

iv) Fisheries facilities in Avatiu Harbour

v) Repair work to the berthing facilities at Avarua Harbour

vi) Repair work to the breakwaters at Avatiu and Avarua Harbour

As seen above, the coastal protection work in the Short-term Plan will be concentrated on the northern coast from the eastern boundary at Village Pue to the west end of airport as the western limit. Among them, the Port Park Complex, defined as an area between Villages Ngatipa and Avatiu, will be provided with continuous protection work. However, areas other than the Complex will be partly protected where required.

The port improvement work classified in the Short-term Plan will mainly be performed at Avatiu Harbour. Avarua Harbour will also be improved as a part of the marina development.