

## Chapter 14: Construction Program



## Chapter 14 Construction Program

### 14.1 Construction Program

#### 14.1.1 Quantity of Works

The major works for the construction of the Short-term Development Plan are reclamation and dredging, the volume of which are 150,000 m<sup>3</sup> and 40,000 m<sup>3</sup> respectively. Thus, 110,000 m<sup>3</sup> of general earth should be collected from the borrow areas. Total rock materials for proposed seawall and breakwaters amounts to 95,000 m<sup>3</sup>.

Total rock materials	95,000 m <sup>3</sup>
- Reuse of the existing breakwaters	16,000 m <sup>3</sup>
- New rock materials	79,000 m <sup>3</sup>

Total concrete volume amounts to 9,300 m<sup>3</sup> breakdown of which is as follows.

#### 14.1.2 Construction Method

The construction program for major construction items is studied for cost estimation and schedule preparation.

Major work items for the Short-term Development Plan includes:

##### In Coastal Protection Work

- a. Seawall (rock riprapping)
- b. Concrete apron
- c. Concrete U-shaped drainage
- d. Asphalt pavement
- e. Temporary berthing jetty (concrete)
- f. Detached breakwater (rock dike)
- g. Leading jetty (rock dike)
- h. Plantation and Landscaping
- i. Car parking (Asphalt pavement)
- j. Dredging of ordinary soil, sand and silty soil
- k. Dredging of coral bed (blasting)
- l. Stream outlet relocation
- m. Others

### In Port Improvement Work

- a. Breakwater (rock mound)
- b. Breakwater (relocate)
- c. Breakwater (wave dispersion concrete unit)
- d. Concrete apron
- e. Asphalt pavement
- f. Building and office, fish market and ice plant
- g. Dredging of ordinary soil, sand and silty soil
- h. Dredging of coral bed
- i. Repairs to the existing quay and wharf (concrete sheet piles)
- j. Repairs to the existing concrete pavement
- k. Navigation aids (a marker buoy)
- l. Ice plant (0.5 t/day)
- m. Cargo handling equipment
  - Forklift, 1 unit 32 tons
  - Forklift, 1 unit 5 ton
  - Forklift, 1 unit 2.5 ton
  - Tractor-trailers, 1 unit
- n. 350 HP tugboat
- o. Others

It can be said that the work should be executed under the following conditions:

- (i) Marine work should be implemented during calm climatic seasons
- (ii) As much as possible, work should be executed landwards. It is recommended to minimize the utilization of floating construction plants.

Accessibility to the construction sites is generally good since they face directly to the existing beach road.

Most of breakwater construction can be carried out using temporary rock dike extending from the beach. Height of dike will be 1.2 ~ 1.5 m since the average lagoon depth and High Water level are MSL -0.3 m and MSL +0.3 m respectively.

Geotechnical condition here are ideal and all the proposed structures are located where soil condition is good. Therefore no soil improvement work, one of the most expensive work items for marine construction, will be required. The preparation of the rock material stockpiles should start as early as possible, since the newly required rock volume amount to 79,000 m<sup>3</sup>.

#### 14.2 Preliminary Construction Schedule

The required construction period is estimated to be about three years including one year for design and contract document preparation. The required period of preparation work before the first year will depend upon financial arrangements.

Table 14-2 Master Construction Schedule

Items	Year				
	1992	① 1993	② 1994	③ 1995	1996
Financial Arrangement	—				
Detailed Design		—			
Contract		—			
Construction			—	—	
Operation					● —→

Table 14-2 shows the schedule when actual construction effort commences at the beginning of 1994. The detailed schedule is shown in Fig. 14-1. It is assumed that the required minimum time for making the financial arrangement is six months. After executing the construction contract, the Contractor will deliver their first team to the site within one month. Mobilization will be completed within two months.

Fig. 14-1 Construction Schedule, Coastal Protection and Port Improvement: Cook Islands/Rarotonga Island  
Short-term Development

No.	Works	Character	Quantity	First Year 1993												Second Year 1994												Third Year 1995												Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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## Chapter 15: Project Cost Estimates





## Chapter 15 Project Cost Estimates

### 15.1 Summary of Project Cost

Total project cost for thirty years operation is 29.32 million Cook dollars; 10.37 and 18.95 million dollars for coastal protection work and port improvement work respectively.

Table 15-1 Project Cost Summary

Unit : million Cook Dollars			
Cost Items	Coastal Protection	Port Improvement	Total
Initial Cost	8.46	12.80	21.26
Operation/ Management Cost	-	2.31	2.31
Maintenance Cost	1.91	3.84	5.75
Total	10.37	18.95	29.32

Of these costs, local currency and foreign currency components are 10.01 million dollars and 19.31 million dollars respectively; thus, the local components share only 34 %. Table 15-2 shows the currency components.

Table 15-2 Currency Components

Unit : million Cook Dollars									
Cost Items	Coastal Protection			Port Improvement			Total		
	LC	FC	TC	LC	FC	TC	LC	FC	TC
Initial Cost	3.36	5.10	8.45	3.98	8.82	12.80	7.34	13.92	21.26
Operation Cost	-	-	-	1.19	2.65	3.84	1.19	2.65	3.84
Maintenance Cost	0.76	1.15	1.91	0.72	1.59	2.31	1.48	2.74	4.22
Total	4.12	6.25	10.37	5.89	13.06	18.95	10.01	14.31	29.32



## Chapter 16: Evaluation of the Project



## **Chapter 16    Evaluation of the Project**

### **16.1 Purpose and Methodology of Economic Analysis**

The purpose of the economic analysis is to appraise the economic feasibility of the Short-term Plan from the viewpoint of the national economy. The economic internal rate of return (EIRR) based on a cost-benefit analysis is used to appraise the feasibility of the project.

### **16.2 Benefits**

The economic benefits are obtained from the difference between the "With" case and "Without" case. The following items are identified as benefits of the Short-term Plan.

#### **1) By coastal protection**

- Decrease in land-loss by coastal protection
- Maintaining economic activities
- Protection of residential and public buildings
- Decrease in maintenance cost of transport system (airport/road)
- Increase in land value

#### **2) By port improvement at Avatiu Harbour**

- Savings in waiting time by improvement of breakwater at Avatiu Harbour
- Savings in waiting cost for gangs due to the decrease in the delay of ship arrival
- Savings in interest payments
- Decrease in operating cost by improvement of cargo handling efficiency
- Decrease in working time of labourers
- Decrease of maintenance cost of breakwaters and wharves
- Decrease in offshore handling cost in the event of damage to wharf
- Decrease in damage to port facilities

### **16.3 Costs**

The items that are considered as costs of the project are construction costs, administration costs, operation/maintenance costs and renewal investment costs.

#### 16.4 Results of EIRR Calculation

The results of EIRR calculation including the sensitivity tests are shown below.

Case	EIRR (%)	
Base Case	10.7	
Case A	9.2	(The costs increase by 10%)
Case B	9.0	(The benefits decrease by 10%)
Case C	7.6	(The costs increase by 10% and the benefits decrease by 10%)

Generally, the project is feasible if the EIRR exceeds the opportunity cost of capital. The opportunity cost is estimated to be 12% in developing countries. According to this standard, this project is considered feasible.

#### 16.5 Preliminary Financial Analysis

The purpose of the financial analysis is to appraise the financial feasibility of the Short-term Development Plan. The viability of the project is analyzed using the Discount Cash Flow Method and appraised by the FIRR (financial internal rate of return).

Costs and revenues which are taken into account are summarized as follows.

Cost : initial investment cost, reinvestment cost and operation expenses

Revenues : port operating revenues, residual value of the fixed assets at the end of the project

#### 16.6 Result of Financial Analysis

Assuming that the operation/maintenance cost is decreased by 40%, the FIRR of this project is calculated as follows.

FIRR (%)	Tariff
-	present
1.3	30 % up
3.9	50 % up
6.0	70 % up

Though this project may not seem feasible from the financial point of view if the institutional framework is not improved, this project should not be evaluated merely on the basis of this result because this project should not be considered as profit-oriented one. The fact that significant economic benefits would obviously result should be considered in the evaluation of this project.

Further examination concerning the establishment of a proper port authority and the possibility of raising the port traffic will be required to ensure the economic stability of the Cook Islands.





## Chapter 17: Organization for Project Implementation



## **Chapter 17 Organization for Project Implementation**

### **17.1 Executing Agency**

The executing agency of this study is MOPED under which a steering committee forms a supervisory group. The committee consists of various related governmental organizations including:

- (a) Ministry of Planning and Economic Development (MOPED)
- (b) Ministry of Works (MOW)
- (c) Department of Trade, Labour and Transport (TLT)
- (d) Conservation Service Department
- (e) Survey Department

In addition to the above, the following governmental agencies are related to the study:

- (f) Waterfront Commission (WFC)
- (g) Customs Department
- (h) Ministry of Marine Resources
- (i) Tourism Authority
- (j) National Police
- (k) Meteorological Service (MET)
- (l) Treasury

For the next phase of project implementation, it is reported that MOW was nominated by the cabinet in December 1991 to be the executing agency for managing the project.

### **17.2 Cooperative Management**

The project covers various fields including:

- (a) Fisheries Sector
- (b) Commercial Port Sector
- (c) Tourism Sector
- (e) Environmental Sector, and
- (f) Coastal Protection Sector

It is recommended that the project be implemented orderly and systematically. Cooperation in the project by various agencies should be maintained for its economical execution. It is reported that a multi-

discipline taskforce (MDT) will be established for the same purpose as the steering committee, to make decisions concerning project.

MDT may be made up of selected governmental agencies that are directly involved in the project.

The following is a possible project implementation organization:

- (1) Total project management will be conducted by MOW in collaboration with MDT, MOPED and the Treasury
- (2) Coastal protection work will directly be executed by MOW.
- (3) Port improvement work will be executed by TLT and WFC. MOW will act as the liaison office. The Ministry of Marine Resources will cooperate with TLT in respect matters relating to fishery work.

### **17.3 Operation and Maintenance**

After implementation, facilities constructed will be utilized by users. Therefore, the proper operations of facilities should be maintained throughout their service life.

When damages are found, prompt repair work should be provided. To recover initial investment costs, facilities should be utilized for a certain length of time. The average service life assumed here is about thirty years. Facilities may not only be damaged by natural forces such as by waves and surges, but by incidental breakdowns through normal use. It is recommended that appropriate repair work should be accomplished from time to time.

Thus, it is important that responsible agencies observe and monitor the facilities to determine if they are being operated properly. TLT and MOW should be responsible for this post project care.

- (1) TLT will be responsible for covering all of the port facilities. The Ministry of Marine Resources will be responsible for covering the on land fishery facilities.

The Waterfront Commission will be responsible for all onland port facilities other than the fisheries.

- (2) MOW will be responsible for all of the the coastal protection work.

## Chapter 18: Environmental Consideration



## **Chapter 18 Environmental Consideration**

### **18.1 General Description**

Since one of the most valuable and vulnerable resources here is the natural scenery consisting of blue, white and green colours, i.e. the marine ecology together with the blue sea, breaking waves on reef with beach sand and healthy plantation on the hill.

It is also important to remind that tourism industries here are simply based on these natural resources.

Within certain limits, nature has the power to recover from adverse environmental impacts. If the impacts override this natural sustaining capacity, the ecosystem will change gradually. The costs required for maintaining the present ecosystem could be much lower than that for recovering the environment after being severely damaged.

Although there is no actual environmental data available, it seems that the island's urbanized coastal area is affected by pollution although impact is minor.

Additionally, the project may have an impact on the environment, during the construction and after operation.

### **18.2 Environmental Control of Coastal Areas**

This section deals with possible environmental impacts at the coastal areas.

#### **18.2.1 Water Quality**

##### **1) Existing Situations**

Surface water from the hills accumulates once in the swamp and marshy land behind the beach road. Various domestic effluents are also discharge here. When it rains, the water here overflows to the open sea through streams. In the urbanized area, other effluents having high organic loads enter the streams. In rural areas, households treat their effluents by means of primitive septic tanks. Thus, concentrations of effluents in the underground water appears not to have happened, since the households are scattered throughout the area.

Although sample tests have not been conducted, the sea water quality at the rural site generally seems good. This may be due to following reasons.

- a. Load intensity in rural areas is rather low.
- b. Water circulation in lagoon is maintaining by tidal current, thus discharged water to lagoon can easily propagate to the offshore.
- c. Natural sandy beach may have self-purification effect to discharged loads.

To be discussed here is the seawater quality at the inner port basin that is covered by the existing breakwater. Although the seawater circulation through the armour rock dike may take place to some extent, the rate of dilution here is lower than that of the lagoon.

## 2) Necessity of Control

The rate of urbanization is currently moderate; it is not anticipated that rapid urbanization will occur by year 2000. Thus, rapid increase of load discharge by villagers will not happen.

Cargo volume to be handled in the harbour is also moderate and the number of vessel calls is limited. It is assumed that the present load level will continue for foreseeable future. Therefore, an expensive centralized sewerage treatment plant will not be required. Thus, minimum treatment countermeasures should be scheduled in order to maintain the present environmental level.

## 3) Scope of Protection Measures

It is proposed that the following water quality improvements be taken into consideration.

- Enforcement of an individual sewerage treatment facility if the load source is located within a certain distance from the beach front.
- Enforcement of effluent control by vessels.



### 18.2.2 Scenery

#### 1) Existing Situation

The most beautiful sight in the coastal region is that of waves breaking on the reef. The contrast between the light blue sea water and the white waves can be seen all along the coast.

#### 2) Necessity of Control

To maintain this spectacular sight, high wall structures along the coastline should not be constructed. Plantations with rural fragment dike along the coast harmonizes with the blue sea. These will be barriers against cyclone wave and wind.

Character of artificial structures along the coastline should carefully be controlled so as not to disturb the existing landscape.

### 18.3 Environmental Consideration to the Project

#### 1) Seawater Quality in the Harbour Basin

It is recommended that regulations be issued prohibiting the discharge of domestic organic material into the inner port basin. Incinerators will be provided in the port area to cope with the solid wastes generated there. Septic tanks will be provided for handling the polluted water in the fisheries sector.

#### 2) Crown Top of the Coastal Protection Wall

Where an open view is required, the crown top of the seawall parapet should be limited in height so that people can see the horizon and the breaking waves from the beach road. Minimum access from the existing roadway to the new coastal protection line will be provided for villagers and tourists.

#### 3) Material of Artificial Structures

Where a natural landscape is required, the surface material and its finish should harmonize with nature.

#### 4) Recovery of Nature in the Reclamation Area

Plantations and lawns will be provided on the areas to be reclaimed for cyclone buffer zones.

#### 18.4 Future Prospect

To maintain sustainable environmental conditions, it is recommended that continuous efforts be made to provide coastal area with a better future environment. This section deals with necessary actions to be taken by now.

##### 1) Investigation and Monitoring

It is recommended that periodical investigations be made of the seawater quality including, BOD, COD, HP and coliform bacteria. It is also recommended to establish environmental standards by which surveyed data can be evaluated.

##### 2) Enforcement

It is reported that Conservation Department is preparing water quality regulations that will require the private sector to provide their own septic tanks if they are located within thirty meters of the high water mark.

It is also recommended that large-scale coastal developments be assessed to minimize environmental impacts that may severely damage the existing environmental conditions and that measures to mitigate the impacts be instituted.

##### 3) Advertising

At present, the island scenery is good. It is, however, recommended that necessary environmental information be passed on to the villagers for better understanding of the island to sustainable living.

## Chapter 19: Preparation for Project Implementation



## **Chapter 19 Preparation for Project Implementation**

The aim of this report is not only to generate the project's technical work but to pave the way for construction. The necessary preparatory arrangements prior to the construction are given herewith.

### **19.1 Administrative Aspects**

As described in Chapter 17, it is recommended that an organization for project implementation be established. Since the project covers various technical fields, participation in the project by related governmental agencies will be needed.

The project will be managed by a project executing agency under the multi-discipline taskforce (MDT) which consists of representatives from related agencies.

### **19.2 Technical Aspects**

The executing agency should manage the detailed design of project components together with the preparation of Tender Documents.

#### **(1) Detailed Design**

In any case, the detailed design should be completed before construction begins.

#### **(2) Preparation of Coastal Land Use Master Plan**

At present, there is no firm city master plan for the Avarua Urbanized Area. The utilization of the new reclamation area should meet the concepts of city planning. MOW may be the leading ministry for this task. The newly reclaimed area is not only used as a cyclone buffer zone against wave over-topping but is for improving land resources that face the open sea. Maximum utilization of this land should be performed accordingly.

### **19.3 Financial Aspects**

The proposed Short-term Development Plan costs about 21.26 million Cook dollars, 8.46 million for coastal protection and 12.80 million for port improvements. It will take about three years to complete the construction work. Thus, approximately seven million Cook dollars should be paid to the contractor every year. If the government intends to obtain financial assistance from an external monetary source, necessary arrangements should be made to meet the construction schedule. Since the project components in the proposed Short-term Development Plan covers work that is urgently required for coastal protection and port improvement, it is recommended that the government contacts with such source as soon as possible.









