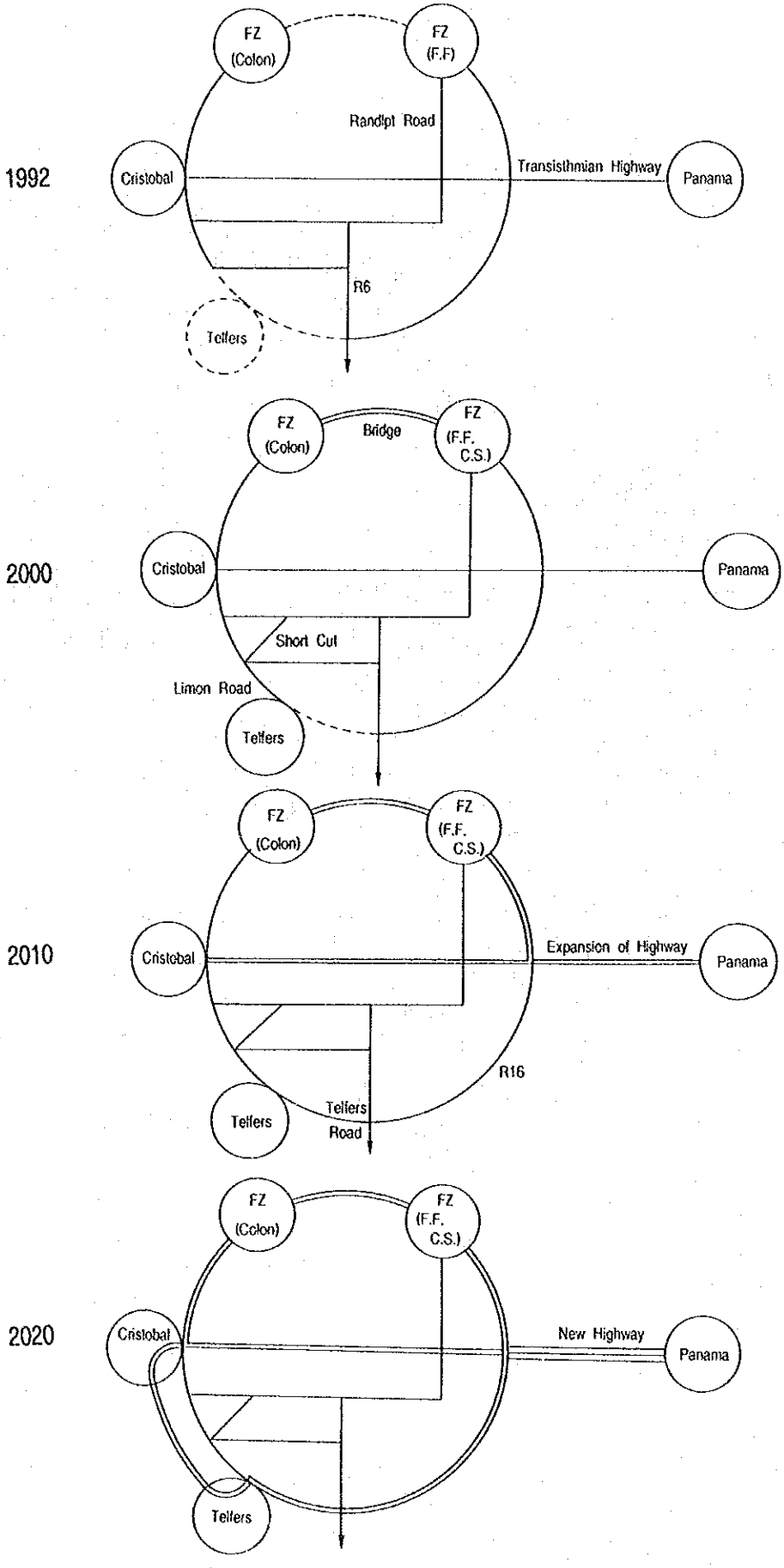


Figure 7-3-2 Scenario for Circle Road Network Formation

on line with Telfers Road which runs along the south side of Mt. Hope Area will be constructed. From the connecting point with Boliver Highway, it is possible to access Randlph Road by this highway and also to access Transisthmian Highway directly by Route 16. Circular road network is formed, however its capacity is still insufficient.

(4) Post Master Plan Stage (2020)

A new highway is constructed between Colon and Panama City and its traffic capacity increases dramatically. Telfers Area and Cristobal Area are united and connected directly by reclamation of French Canal. Full scale improvement of southbound access route from Telfers Area via Route 16 is accomplished. Access route from Cristobal Area to the Colon Free Zone is fully reconstructed. Consequently, a large circular road network is established.

7.3.2 Necessary Measures for Realizing Step-wise Scenario.

Access road from the port of Cristobal to the Colon Free Zone is not in good condition. Access route to and from the Free Zone has been separated to alleviate traffic congestion, however, there is still heavy congestion because the width is narrow and the route travels through the city area. In the expansion plan of the Colon Free Zone by COFRISA, a direct access gate to Transisthmian Highway is planned. It is necessary to secure direct access route from the port of Cristobal without passing through city area.

The bridge between the Colon Free Zone and France Field will serve for the inner traffic of the Free Zone. It is difficult to use as a regional trunk line open to common use at present. Transit capacity is also limited. Increase of transit capacity and operation open to public is preferable in future accordingly.

It is necessary to construct bypass route with four lanes via Telfers Road and Route 16 in the Long Term Plan Stage. Telfers Road is located in the PCC administration area, and transit is not allowed at present. Existing road has two lanes. After reversion of PCC area, necessary area including expansion space should be reserved. Route 16 passes through Fort Gulic and transit is shut down. It is not permitted to transit this road at present. Since this road has only two lanes, it is necessary to expand to four lanes. After reversion of this army base, road area should be reserved including expansion space.

In the Post Master Plan Stage, it is easy to construct inter terminal trunk route in case of French Canal Alternative. In case of Telfers Alternative, trunk route between container terminals will be constructed via Boliver Highway and Telfers Road.

Major trunk line around port area should have four lanes.

7.4 Land Use Plan

7.4.1 Location of Major Project

Location of major development projects proposed within Master Plan Stage is as follows;

Short Term
* Development one new container terminal and construction of access road
* Rehabilitation of existing container terminal
* Demolition of quay shed on Pier No.7

Long Term
* Development of two additional new container terminals and construction of new access route to Boliver Highway
* Modernization of existing container terminal
* Development passenger terminal on Pier No.8 and partial rehabilitation of railway

7.4.2 Land Use Plan of Surrounding Area

The function of port is fulfilled in combination with land transportation system and surrounding area. Port development must be in good coordination with the land use of surrounding area. In order to promote land use of surrounding area in line with the port development policy, the port management body shall have and express basic policy of land use and administrate the area closely related to port activity.

Here, a land use plan of surrounding area of existing port facilities at Cristobal and new container terminal at Telfers Island is explained. This plan is basically for the Long Term Plan (or Post Master Plan) Stage. It is not necessarily based on the detailed demand forecast for future land use.

Corresponding to major projects shown above, preliminary recommendation of land use plan of surrounding area is shown in Figure 7-4-1.

The major issue on land use is explained as follows.

(1) Surrounding Area of Existing Cristobal Port

As experienced with current container terminal operation, wide space for stacking many empty containers will be necessary close to the terminals. Next to the existing terminal, a wide area has already been conceded to private companies to operate container stacking yard. It is recommended to prepare more wide space for container stacking and transportation activities.

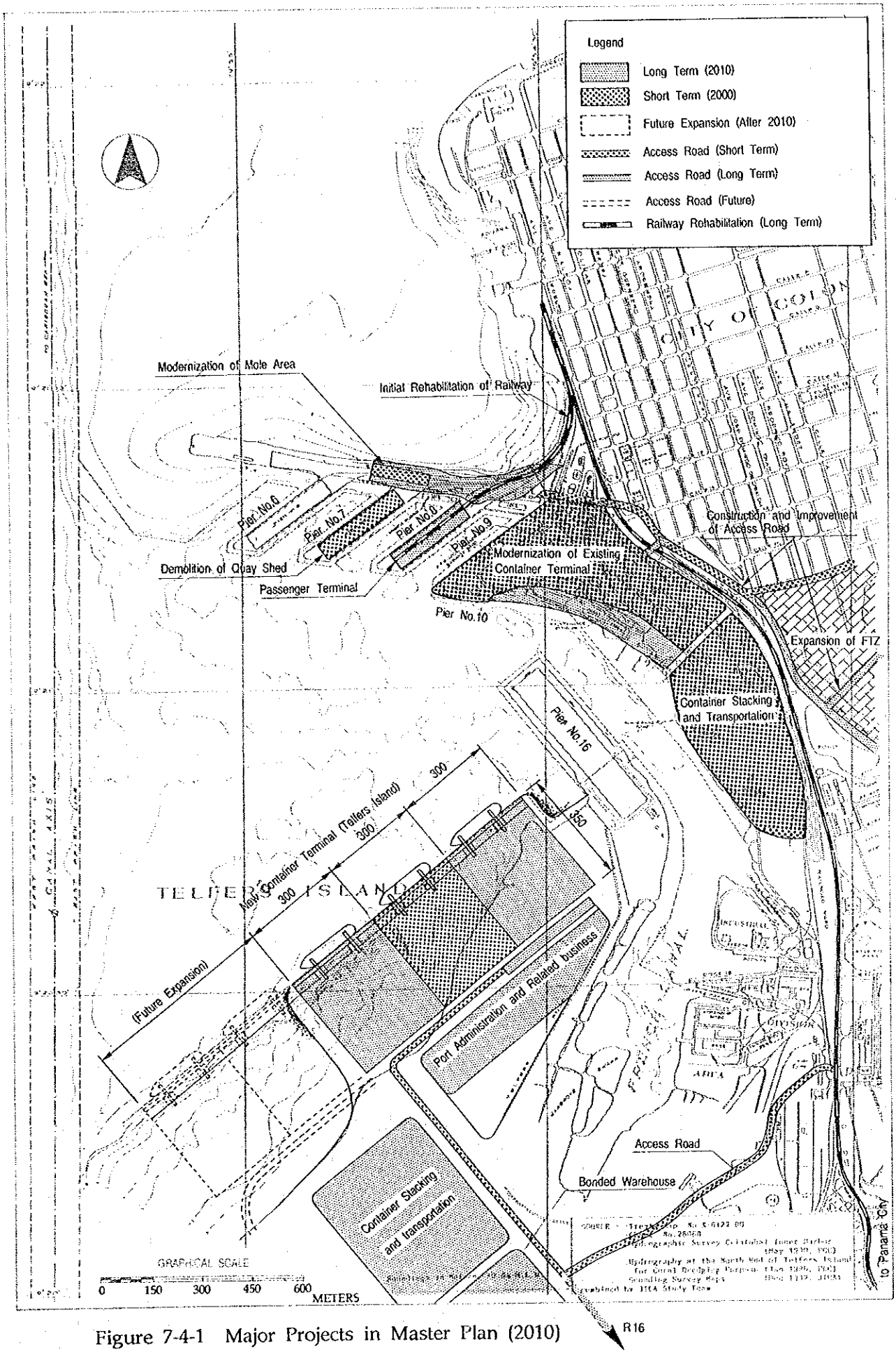


Figure 7-4-1 Major Projects in Master Plan (2010)

(2) Surrounding Area of New Container Terminal in Telfers Island

Since Telfers Island is virgin area, the entire development project should be conducted in a well organized manner. It is recommended to elaborate total development plan of this area. In order to make future container terminal activities smooth and effective, surrounding area shall be reserved for related activities like container stacking or container transportation.

According to increase of container cargo handling, shipping and trading activity will be concentrated in this area. It is also recommended to reserve sufficient space close to the terminals.

There is a possibility that the Panama Railroad will be fully rehabilitated and activated in future. It is recommended to keep the reserved area for construction of access line of Panama Railway along the access road.

Land use of Telfers Island largely depends on the development of new container terminal, and will be different by respective alternative for port development. Major functions introduced in Telfers Island will be cargo handling, land transportation, storage, trade and light industry.

Offices of port related industry are located around the port of Cristobal at present, however, many of them may move to Telfers Island through the shift of port function from Cristobal area.

Telfers Island seems not suitable for residential use. It does not match other functions introduced in Telfers island. There are many other residential areas developed by PCC or US Force. They can be used for residential area after reversion to Panama. There is no need to secure residential area in Telfers Island.

Usual market area for retail trade is not planned at Telfers Island. That function will be located in the Free Port Area at Manzanillo Island.

Construction of new road network is indispensable for the development of Telfers Island. New container terminals will be accessed by two main roads and one subsidiary road.

Railroad will be introduced at back side of the terminals. Facilities for intermodal transportation will be necessary. Railway will not be introduced inside the new container terminals since it might affect terminal operation.

Land use plan at Telfers Island in Post Master Plan Stage is shown in Figure 7-4-2. Major items of land use plan are as follows:

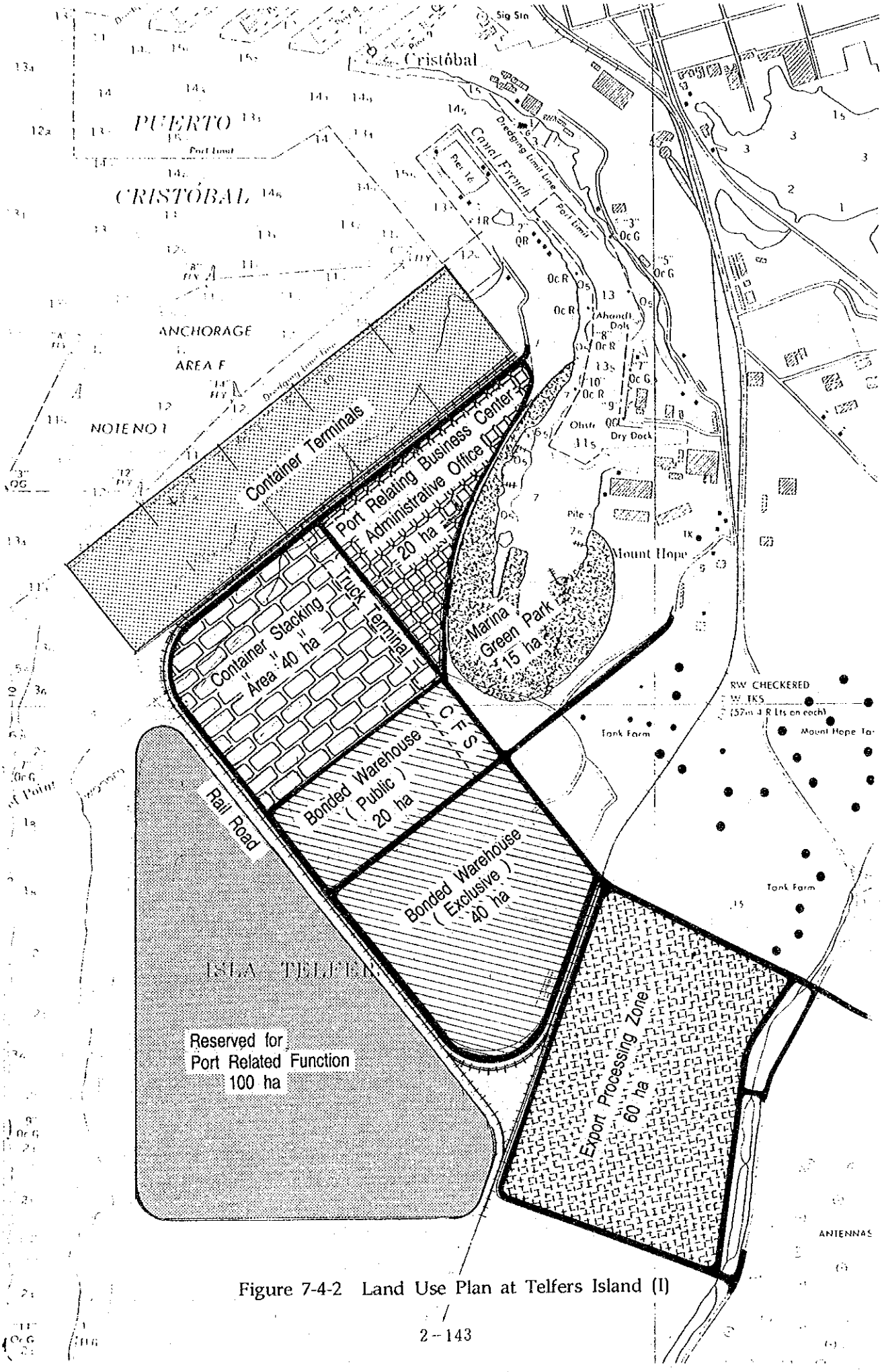


Figure 7-4-2 Land Use Plan at Telfers Island (I)

1) Container Stacking Yard
   40 ha in total for five container terminals
   For empty containers and transhipment containers

2) Bonded Warehouse
   60 ha in total (public use: 20 ha, private use: 40 ha)
   A kind of Free Zone administrated by APN

3) Administration Offices and Port Related Business Center
   20 ha in total
   Including supply and maintenance facilities

   Similar functions at the existing port of Cristobal is located in the area of approx. 4 ha. The scale of these functions increases according to the scale and number of container terminal. At the Post Master Plan Stage, the volume of container cargo handled at Telfers new container terminals will increase to more than four times as much as that is handled at the existing port of Cristobal. Accordingly, area of 20 ha will be needed.

4) Marina and Green Park
   15 ha in total (land area)
   Environmental preservation and amusement

5) Railroad
   3.5 km in total
   Newly constructed branch line for container transportation

6) Export Processing Zone (EPZ)
   60 ha in total
   Light industry, assembly and others
   Almost the same scale with EPZ in Margarita Island

Areas for 1. to 5. shall be under administration of APN.

Besides these areas, northern half of Telfers Island should be reserved for possible future expansion of port related functions.

In case of Alternative F(a), which is the best alternative on Post Master Plan stage in case that PCC's Industrial division can be removed in future, expected land use around container terminals is shown in Figure 7-4-3 as a reference.

The land use plans explained above are not based on the detailed demand forecast and require further detailed study. It is recommended to establish land use plan under arrangement of authorities concerned with active leadership of port sector which will operate major activities expected in Telfers Island.

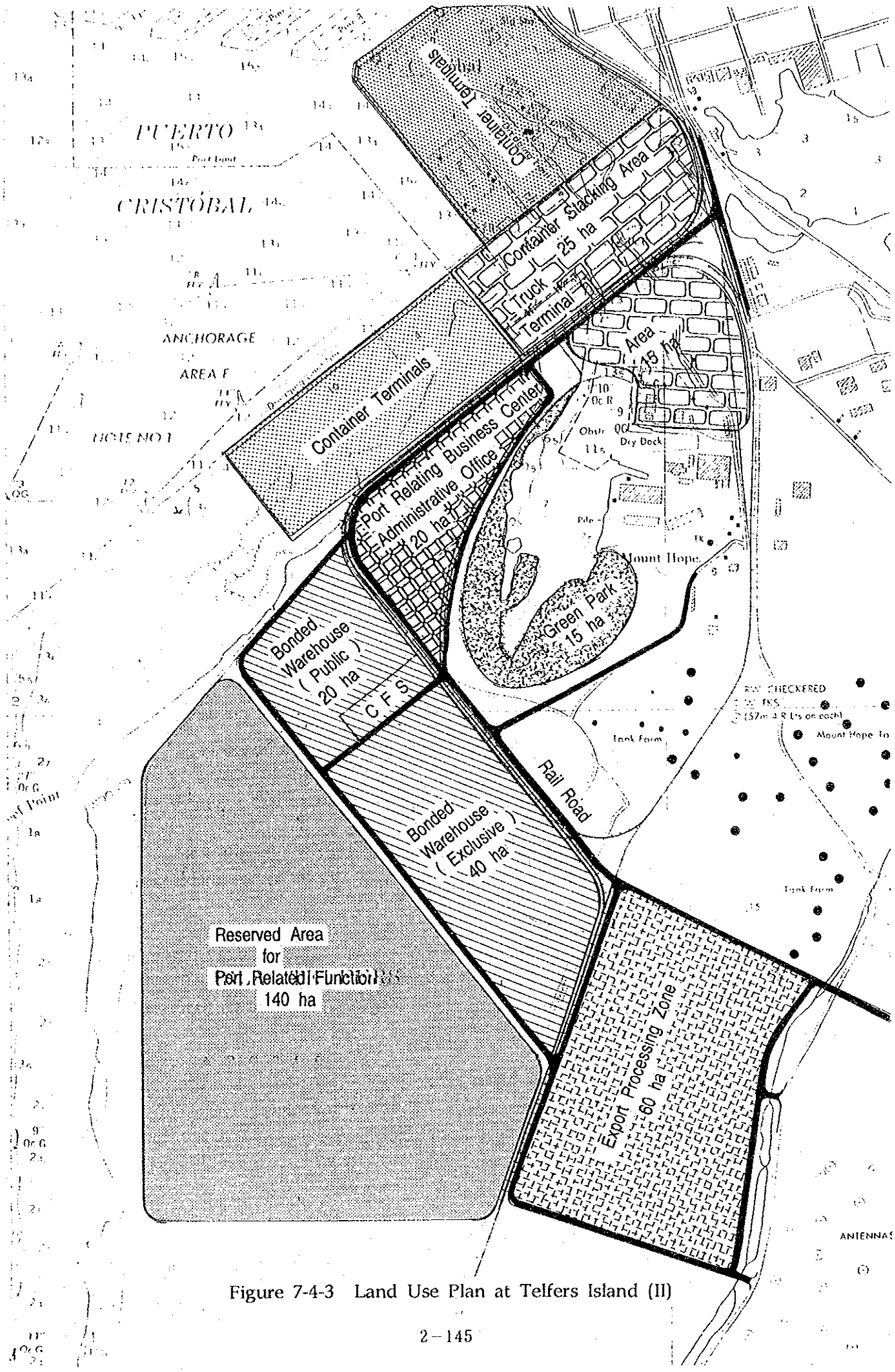


Figure 7-4-3 Land Use Plan at Telfers Island (II)

CHAPTER 8 PRELIMINARY TECHNICAL STUDY OF MAJOR PORT FACILITIES

As shown in Chapter 9 of Part II, approximately 90% of the investment cost will be the initial investment cost for the new terminal at Telfers Island. The remaining cost will be spent for the upgrading of the existing port facilities including piers, mole, and container terminal behind Pier No.9.

Thus, one of the main target of this chapter is to conduct a technical study on the new container terminal together with an alternative study for the best site selection. Preliminary discussions on other facilities than the new terminal will also be made.

8.1 General Description

8.1.1 Background Information

Cristobal, the most prominent port, is located near the Atlantic Panama Canal Entrance. The port of Cristobal is the largest national port with respect to the scale of facilities and cargo traffics. It currently handles more than 50% of the total national traffic by maritime sector.

The port of Balboa is the second largest port, however its recorded traffic is one half of that handled in the port of Cristobal.
The port of Cristobal has various advantages as follows:

a. Well protected by the existing outer breakwater against waves.
b. Wide and deep basin for vessel maneuvering and anchorage. Most of this basin is currently managed by PCC, however there is a strong possibility that the port area be expanded after 2000.
c. Business activities in Colon are accelerated by foreign investors.
d. Well prepared access to the Pacific coast, however some rehabilitation should be given.

Cristobal has railway connections to the city of Panama and a highway network all over the country. It is easy to reach Tocumen International Airport (on the Pacific side, 95 km away) and Enrique A. Jimenez International Airport (also known as France Field at 8 km away from the city of Colon).

Every year more than 1,000 vessels berth at the port. The port has approx. 4,000 meter long berth. The maximum water depth is 12 meters (40 feet). The main berths are divided into three finger piers, namely piers No. 6, No. 7 and No. 8 and two marginal wharves, namely piers No. 9 and No. 10. Pier No. 16 with U-shaped structure is also providing port services.

Transit sheds are provided on the finger piers. The most recent development is a 7.5 ha container yard behind the Pier No. 9 with two gantry cranes which are capable of

handling 800 TEU daily. A CFS of 6,500 m^2 is also provided.

Rehabilitation works including renewal of fenders and widening of apron were given accordingly.

The area within the port premises are granted for concessions following to the central government policy.
Special operation tariffs are negotiated between the government and private companies based upon the volume of cargoes guaranteed.

The port area is only 2 km from Colon Free Zone which is currently expanding eastward over the Manzanillo Bay. It is expected that the size of this zone will become more than 300 ha. A new bridge construction over the bay has commenced. About a half of the cargo traffics are currently destined to the Free Zone.

The final objective of this study is to prepare both a Long Term Plan for the year 2010 and a Short Term Plan for the year 2000. Traffics to be handled are not only cargoes but also passengers.

The scale of port facilities should be determined generally based on the traffic demands. If the demands exceeds the handling capacity of the existing facilities, a new facility may be required.

8.1.2 Basic Concepts of Technical Study

During the technical study, the following technical concepts should be kept in mind for preparation of a well balanced facility arrangement.

(1) Advantages on Natural Conditions

The port of Cristobal is located at a wide, deep and calm inner basin. Access channel and anchorage are well protected by the existing breakwaters. The water depth is maintained at the minimum depth of MLW -12.0 m by the APN's maintenance dredging. The new container terminal should contain this advantage.

(2) Infrastructure and Port

A port is one of the typical public infrastructures, however construction of port requires a large amount of money and a long duration before starting the operation. Construction cost should be minimum in order to reduce tariff and port charges.

(3) Cost Aspect

According to the visual observation on the existing facilities and the review of the design records though they are so limited, the port facilities are sound in terms

of structural durability.

The existing piers and wharves can be utilized as longer as possible to meet the requirements if APN provides necessary maintenance and repair works. The earlier repair work, the lesser total repair cost. It is also recommended that APN seek the present maximum utilization rate of the facilities.

(4) Maximum Utilization

It seems that the present cargo traffic demands are exceeding or will exceed the cargo handling capacity in Cristobal. Only Pier No. 9 can be classified as the container wharf. This wharf and its back-up yard including CFS will be the sole core of the port before construction of a new terminal.

In this sense, APN should fully use the existing port facilities, not to abandon them.

(5) Port Expansion and Reversion of PCC Areas

Sooner or later, both an extension of existing container yard and construction of a new container terminal will be required. If PCC brings their facilities together systematically and remove them out of the port operation area, APN would easily prepare their future plan for an effective port operation. It is assumed that the proposed project site in Telfers Island will be reverted to Panama from PCC by the year 1997.

(6) Environmental Aspect

Container port facility is basically environmental free. Therefore, a limited pollutant will be discharged from the container terminal. However it is recommended to provide the port with drainage system together with waste water treatment facility. Suspended solid during the drainage work should be monitored.

8.1.3 Project Components

Table 8-1-1 shows the inventory of facilities and related existing structures. Most of the works are for both rehabilitation and upgrading of the existing facilities and upgrading of the present port capacity by means of improvement of the existing facilities and development of a new container terminal. All these works will be implemented in the APN premises including Telfers Island which is scheduled to be reverted to Panama from PCC by the 1997. Addition to these, the minimum investment should be given to the land transportation improvement out of the APN premises.

Each project component has its characteristics in relation with the port capacity.

Rehabilitation of the Existing Facilities and Renewal of the Existing Cargo Handling Equipment : (Prospective-1)

- This investment aims at maintaining the present service level of the existing port facilities.
- Equipment renewal of the existing container terminal will be categorized to this component.

Upgrading of the Existing Facilities and Replacement of the Existing Cargo Handling Equipment (Modernization) : (Prospective-2)

- This investment aims at upgrading the existing port facilities.
- Modification cost of the existing finger piers, mole and container terminal will belong to this component.
- Equipment replacement to advanced ones at the existing container terminal will also belong to this.

Development of the Entirely New Facility (Development) : (Prospective-3)

- This investment will add more cargo handling capacity regarding container transport. It is proposed to conduct a completely new development at a new site.
- The required facilities for this development are wide scope of works including channel/anchorage, wharf, seawall, yard, buildings, utilities and cargo handling equipment.
- This development will take place in two stages, the Short Term development for the year 2000 and the Long Term development for the year 2010.

Table 8-1-2 indicates the relationship between the project components and costing element.

Table 8-1-1 Subdivision of Project Components in Terms of Port Capacity

Facilities	Rehabilitation and Renewal	Upgrading & Replacement	
		Modern.	Develop.
	R (Prospective-1)	M (Prosp-2)	D (Prosp-3)
A. Existing Piers and Mole			
A1 Pier No. 6 (Finger Pier)	-	-	-
A2 Pier No. 7 (")	-	o	-
A3 Pier No. 8 (")	-	o	-
A4 Mole	-	o	-
A5 Pier No. 16	-	-	-
B. Existing Container Terminal (B1)			
B1 Pier No. 9 (Marginal Wharf)	-	-	-
B2 Pier No.10 (")	-	-	-
B3 Yard	-	o	-
B4 Buildings	-	o	-
B5 Utilities	-	o	-
B6 Equipment	o	o	-
C. New Container Terminal (B2)			
C1 Channel/Anchorage	-	-	o
C2 Wharf/Seawall	-	-	o
C3 Yard	-	-	o
C4 Buildings	-	-	o
C5 Utilities	-	-	o
C6 Equipment	-	-	o
D. New Container Terminal (B3/B4)			
D1 Channel/Anchorage	-	-	o
D2 Wharf/Seawall	-	-	o
D3 Yard	-	-	o
D4 Buildings	-	-	o
D5 Utilities	-	-	o
D6 Equipment	-	-	o
E. Facilities out of APN Premises			
E1 For Existing Facilities	-	o	o
E2 For New Terminal	-	o	o

Note: "Rehabilitation" means the works larger than ordinary routine maintenance works.
"Equipment" means cargo handling equipment.

Table 8-1-2 Cost Element Classification

Type of Facilities and Operation		Type of Cost
A.	Facilities within APN Premise	
A1.	Fixed Facilities	
	Existing Fixed Facilities	
a.	Rehabilitation	Initial Cost
	Routine Repair Work	Maintenance Cost of Above
b.	Upgrading/Modernization	Initial Cost
	Routine Repair work	Maintenance Cost of Above
A2.	Equipment	
	Existing Equipment	
a.	Renewal	Initial Cost and Periodical Cost
	Routine Repair Work	Maintenance Cost of Above
b.	Upgrading/Replacement	Initial Cost and Periodical Cost
	Routine Repair work	Maintenance Cost of Above
A3.	Operation	
a.	Existing Facilities/Equipment (including Renewal)	Operation Cost (Fuel and Power) Operation Cost (Manpower)
b.	Upgrading/Replacement	Operation Cost (Fuel and Power) Operation Cost (Manpower)
B.	Facilities Out of APN Premises	
B1.	Fixed Facilities	
a.	Existing Facilities	None
b.	Upgrading/Modernization	Initial Cost
	Routine Repair work	Maintenance Cost of Above
B2.	Equipment	None
B3.	Operation	None

Note: Fixed facilities include the civil works, building and utilities.

8.2 New Container Terminal Development

This section deals with the new container terminal development together with study procedure. An alternative study of the best site selection will also be conducted. Overall evaluation on site selection was carried out in Chapter 4 of Part II. Thus, the major target here is cost comparison study based on the technical justification.

8.2.1 Alternative Study Procedure

The objectives of initial investment cost estimation are the preparation of cost data in order to choose the best site for the new container terminal and fixing the project costs. The former is an input data for overall evaluation with respect of site selection as discussed in Chapter 4 of Part II. The latter is to assume the required initial investment costs for the project.

(1) Technical Data for Site Selection

Pre-conditions of the alternative study for site selection are as follows:

a) Selection of candidate sites as discussed in Chapter 4

SITE-C ..... West Colon
SITE-T ..... Telfers Island
SITE-F ..... French Canal
SITE-CS ..... Coco Solo

These four candidates were chosen and another site (SITE-P) of the existing container terminal is added for total cost estimation.

b) Projection of necessary number of container berths as discussed in Chapter 4

The combination of terminal concluded in Chapter 4 is as follows:

Short Term Plan:
* One berth of existing container terminal
* One new container berth

Long Term Plan:
* One berth of existing container terminal
* Three new container berths including a berth for Short Term Plan

This means that the incremental new berth after the implementation of Short Term Plan is two new container berths.

c) Preparation of modernization plan of existing container terminal as outlined in Chapter 5 (Site-P Upgrading)

This chapter recommends to improve the existing terminal by means of area expansion and introduction of modern equipment.

d) Projection of the scale of major facilities as discussed in Chapter 4

Basic shape of an unit container terminal is 300 m by 350 m. The former is the length of waterfront and the latter is the width of terminal landward.

The proposed initial water depth at berth is MLW -13 m. However, the wharf should structurally be durable for deepening the water depth up to MLW -14 m.

Note: The required cost for cargo handling equipment is excluded, since it is a common cost to all the alternatives. The required cost for upgrading of piers and mole is also excluded by the same reason.

Rising questions for the site selection are:

- How much initial investment should be made for each candidate site?
- How the design water depth influence the initial cost for each candidate site?

In order to know the total initial investment costs, the total cost for four container wharves is estimated. Naming of container berths is as follows:

B1	.....	The existing container terminal at Pier No.9
B2	.....	A new container wharf for the Short Term Plan
B3 and B4	.....	Two new container wharves for the Long Term Plan stage

Thus, the total cost of B1, B2, B3 and B4 is the initial investment cost regarding the container terminal by the completion stage of the Long Term Plan. Among these four wharves, B1 is the common one for all the candidate sites, and rather fixed cost which is not influenced by the design water depth since B1 has the existing marginal wharf Pier No.9, the sole wharf at present.

Thus, the cost estimation of remaining three wharves was carried out for each candidate site by the design water depth. In the marine work cost estimation, soil conditions of each site were taken into consideration of wharf structure design and dredging /reclamation works.

With respect of the design depth, three basic utilization concepts were introduced.

- Concept Minimum
- Concept Flexible
- Concept Deep

Refer to Sub-section 8.3.2.

Table 8-2-1 shows all the cases of initial investment cost study for each development alternatives.

Table 8-2-1 Study Cases of Initial Investment Cost for Each Development Alternative

SITE	Soil Condition	Berth No.	Utilization Concept	Wharf Depth below MLW	Water Depth below MLW
C: West Colon	Soil-C	B2	Minimum	12 m	12 m
"	"	"	Flexible	14 m	12 m
"	"	"	Deep	14 m	14 m
"	"	B3/B4	Minimum	12 m	12 m
"	"	"	Flexible	14 m	12 m
"	"	"	Deep	14 m	14 m
T: Telfers Island	Soil-T	B2	Minimum	12 m	12 m
"	"	"	Flexible	14 m	12 m
"	"	"	Deep	14 m	14 m
"	"	B3/B4	Minimum	12 m	12 m
"	"	"	Flexible	14 m	12 m
"	"	"	Deep	14 m	14 m
F: French Canal	Soil-T	B2	Minimum	12 m	12 m
"	"	"	Flexible	14 m	12 m
"	"	"	Deep	14 m	14 m
"	"	B3/B4	Minimum	12 m	12 m
"	"	"	Flexible	14 m	12 m
"	"	"	Deep	14 m	14 m
CS: Coco Solo	Soil-CT	B2	Minimum	12 m	12 m
"	"	"	Flexible	14 m	12 m
"	"	"	Deep	14 m	14 m
"	"	B3/B4	Minimum	12 m	12 m
"	"	"	Flexible	14 m	12 m
"	"	"	Deep	14 m	14 m

8.2.2 Required Initial Investment Costs for the Project

(1) Combination of Four Container Wharves

After the overall evaluation, Site-T Telfers Island has been finally chosen as shown in Chapter 4 of Part II.

Combination of four container wharves regarding the proposed Site-T is;

B1 ..... Existing container terminal behind the Pier No.9
It is recommended to improve this terminal to be efficient as discussed in Chapter 5 of Part II.

B2 ..... The first container wharf at Site-T
It is recommended to implement this wharf construction in the Short Term Development stage, before year 2000.

B3/B4 ..... The second and third container wharves at Site-T
It is recommended to construct before 2010 as the final stage of Long Term Development.

With respect to the container cargo, the major initial investment cost is for these four wharves.

(2) Construction Work Categories

All the construction works except cargo handling equipment were divided into seven work components, namely;

Item A : General Works

This includes general temporary works which will be necessary for construction efforts and should better be estimated separately from the other items.

- Site common work including the construction site temporary installation, site clearance, site management and test
- Mobilization cost and demobilization cost with respect to major construction machines and dredgers
- Major temporary facilities including temporary jetty installation

Item B : Marine Works

This consists of all the marine construction activities.

- Seabed clearance before the marine works
- Dredging and disposal
- Borrowing and reclamation
- Seawall construction
- Wharf construction including wharf crane foundation
  This work component includes mobilization and demobilization cost of particular construction plants and temporary work yard.
- Others

Item C : On-land Works

This includes on-land civil construction works.

- Soil improvement, if any
- Inner access in the terminal area and port area
- Yard modification at the Cristobal mole
- Apron pavement along the waterfront facilities
- Various pavement works including gravel pavement, light duty pavement, normal duty pavement and heavy duty pavement
- Storm water drainage system
- Open space for future use
- Others

Item D : Building Works

This consists of architectural works and their supplemental works.

- Main gate at the terminal entrance
- Control and management house
- Maintenance shop
- CFS (Container Freight Station)
- Substation and power station houses
- Passenger terminal renovating the existing transit shed at Pier No. 8
- Miscellaneous buildings
- Weigh bridges at the main gate
- Fence and gates
- Park and landscaping
- Others

Item E : Utilities

This item covers all the supporting utilities in the port area.

- Water supply system main and distribution lines
- Fire fighting hydrants
- Sewerage system for the domestic waste water treatment
- Power supply system for receiving and distribution including duct bank and cables
- Power supply system for the power receiving and standby generators with panels
- Power supply system for the wharf crane operation including collector feeds and trolleys
- Road lighting system
- Telecommunication system with fire alarms
- Reefer system

- Bunker system for two lines extension
- Miscellaneous small utilities

Item F : Supplemental Works

This item consists of supplemental works to the project.

- Outer access road to the new terminal including improvement of the existing access and a new approach road to the terminal, if necessary
- Demolishing work of the existing facilities for the new terminal including piers, on-land civil works and buildings
- Environmental protection system to mitigate an adverse effect of the construction activities, if any
- Miscellaneous works

Item G : Others

This item covers the secondary work items to the project.

- Flyover over the existing railway lines, if necessary
- Bunker pier re-installation in case Pier No.16 were replaced
- Bunker main re-installation

The required quantity of works for each alternative is shown in Appendix II-A. All work quantities varies by site conditions. However, the most affected work components by site conditions is the marine works. Dredging and reclamation volumes are severely affected by the existing topographic condition and soil condition. Also seawall and wharf structures will be influenced by the soil condition. The share of marine work in the total terminal construction costs is as follows:

SITE-C	55%
SITE-T	51%
SITE-F	55%
SITE-CS	58%

These figures represent the characters of site conditions. The highest marine work share appears in SITE-CS, Coco Solo, since this site requires 4 km long of an approach channel. The necessary dredging work is so large that it makes the marine work cost share the highest. While, the lowest share is in SITE-T, since this area has the best soil condition and a limited dredging volume due to the fact that the existing seabed depth is about MLW -12.0 m to -14.0 m. Refer to Figures 8-2-3, 8-2-4 and 8-2-5.

The work quantities other than the marine works are rather constant since they are the facilities to be provided commonly to all the terminal.

8.2.3 Comparison by Combined Development Alternatives

(1) Proposed Combination

The construction cost of the project is related to various conditions, important aspects of which are the development site and the depth of wharf.
The following three combination alternatives are studied.

Development Sites

Case-C

B1	Site-P	:	Improvement of the existing terminal Pier No.9
B2	Site-C	:	New terminal at the Site-C utilizing the existing Pier No.7
B3	Site-C	:	New terminal at the Site-C with a new wharf
B4		:	-ditto-

Case-T

B1	Site-P	:	Improvement of the existing terminal Pier No.9
B2	Site-T	:	New terminal at the Site-T with a new wharf
B3		:	-ditto-
B4		:	-ditto-

Case-CS

B1	Site-P	:	Improvement of the existing terminal Pier No.9
B2	Site-CS	:	New terminal at the Site-CS with a new wharf
B3		:	-ditto-
B4		:	-ditto-

(Note: "B" is a container berth number in the construction sequence.)

Wharf Depth Schemes

Five depth development schemes are studied for selection of the best combined development alternatives. Table 8-2-2 shows these alternatives.

Table 8-2-2 Water Depth vs Wharf Depth Scheme for Combined Development Alternatives

Depth: below MLW

Scheme		2000		2010	
		Water Depth (m)	Wharf Depth (m)	Water Depth (m)	Wharf Depth (m)
Scheme 1	B1	as it is	-	as it is	-
	B2	-12	-12	-12	-12
	B3			-12	-12
	B4			-12	-12
Average				-12	-12
Scheme 2	B1	as it is	-	as it is	-
	B2	-12	-12	-12	-12
	B3			-12	-14
	B4			-12	-14
Average				-12	-13.3
Scheme 3	B1	as it is	-	as it is	-
	B2	-12	-12	-12	-12
	B3			-12	-14
	B4			-12	-14
Average				-13.3	-13.3
Scheme 4	B1	as it is	-	as it is	-
	B2	-12	-14	-14	-14
	B3			-14	-14
	B4			-14	-14
Average				-14	-14
Scheme 5	B1	as it is	-	as it is	-
	B2	-14	-14	-14	-14
	B3			-14	-14
	B4			-14	-14
Average				-14	-14

Notes:
1. "Water Depth" means the initial water depth in front of the wharf.
2. "Wharf Depth" means the structural capacity of wharf with respect to the depth. The initial water depth may be shallower than the wharf depth, then the water depth can be deepened upto the wharf depth when so required. This method is widely adopted to achieve the port development by the minimum cost, since it is very difficult to upgrade the structural capacity once constructed. This method will slightly increase the initial cost, however it can save a large amount of cost for improving the shallow water wharf once constructed into the deep water wharf.

(2) Summary and Conclusion

Table 8-2-3 and Figure 8-2-1 show the summary of total development cost comparison respectively.

Table 8-2-3 Summary of Combined Development Cost Comparison by Wharf and Water Depth Scheme

Unit: million $

Schemes	Sites C	T	CS
1	183.44(100%)	149.34(100%)	183.13(100%)
2	187.04(102%)	152.03(102%)	186.31(102%)
3	188.97(103%)	153.69(103%)	195.61(107%)
4	188.97(103%)	157.25(105%)	197.20(108%)
5	188.97(103%)	157.25(105%)	197.20(108%)

Note: Figure in parenthesis indicates a cost index per Scheme 1 for each site.

The most expensive site is the Site-CS, Coco Solo mainly due to the long approach channel and additional cost of utilities. This site is more sensitive to wharf depth increase than the channel depth. Next expensive site is the Site-C, West Colon, mainly due to the existing soft marine clay. This site is not so sensitive to the wharf depth due to the shorter channel than Site-CS.

The most economical site is the Site-T, Telfers Island, mainly due to the reasonable soil condition and deeper water basin in front of the proposed faceline. Scheme 2 and Scheme 3 of Site-T show a slight cost increase than Scheme 1, however, this can be justified by the deeper water wharf (-14m) in two berths after 2010.

Table 8-2-4 shows the construction cost integration details by wharf depth schemes.

Note:

The cost comparison study in this subsection has been roughly made based on preliminary unit costs which differ from those used in the final cost estimation in Chapter 9 of Part II and Chapter 7 of Part III and their Appendices, since the purpose of the comparison is to select the best among the alternatives in a cost-wise mauuer.

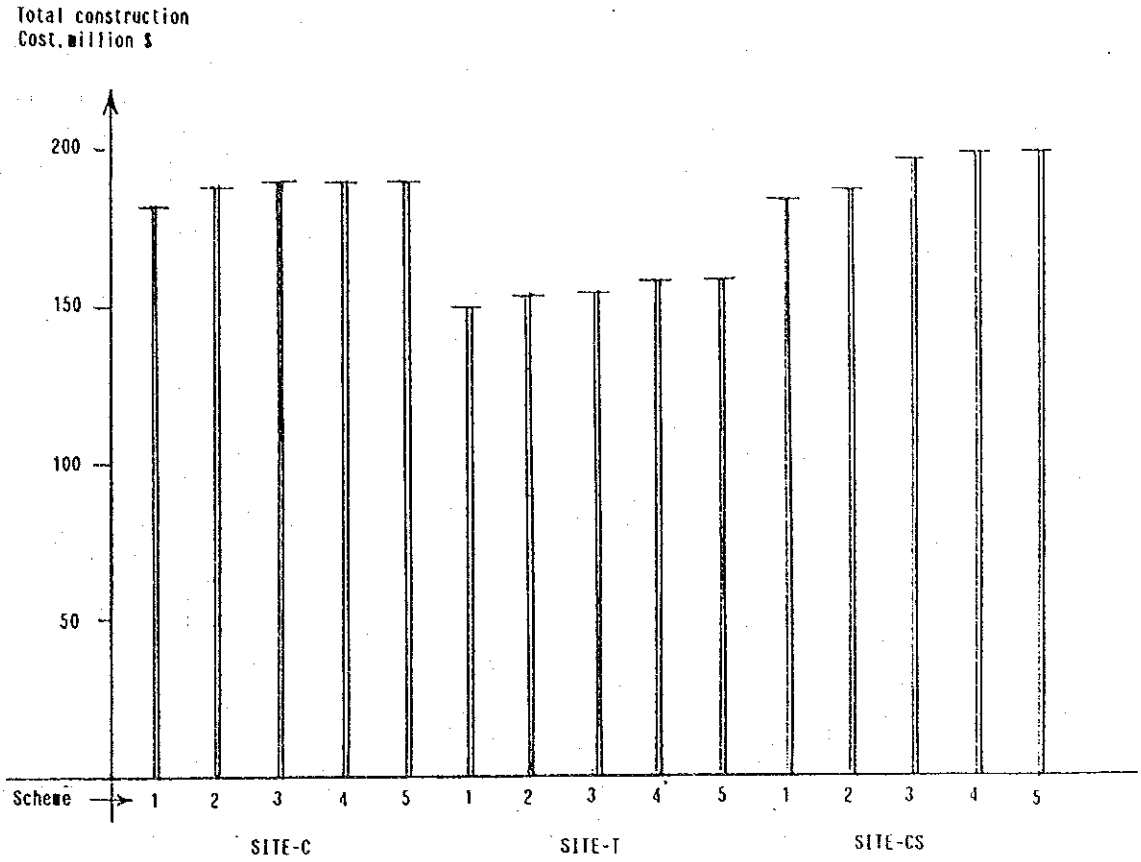


Figure 8-2-1 Cost Comparison by Wharf and Water Depth Scheme

Table 8-2-4 Cost Integration Details by Depth Scheme at Each Site

Unit: million $

Scheme		Site C			Site T			Site CS		
		2000	2010	Total	2000	2010	Total	2000	2010	Total
1.	B1	7.19	0	7.19	7.19	0	7.19	7.19	0	7.19
	B2	49.82	0	49.82	52.11	0	52.11	74.14	0	74.14
	Subtotal	57.01	0	57.01	59.30	0	59.30	81.33	0	81.33
	B3/4	-	126.43	126.43	-	90.04	90.04	-	101.80	101.80
	Total	57.01	126.43	183.44	59.30	90.04	149.34	81.33	101.80	183.13
2.	B1	7.19	0	7.19	7.19	0	7.19	7.19	0	7.19
	B2	49.82	0	49.82	52.11	0	52.11	74.14	0	74.14
	Subtotal	57.01	0	57.01	59.30	0	59.30	81.33	0	81.33
	B3/4	-	130.03	130.03	-	92.73	92.73	-	104.98	104.98
	Total	57.01	130.03	187.04	59.30	92.73	152.03	81.33	104.98	186.31
3.	B1	7.19	0	7.19	7.19	0	7.19	7.19	0	7.19
	B2	49.82	0	49.82	52.11	0	52.11	74.14	9.30	83.44
	Subtotal	57.01	0	57.01	59.30	0	59.30	81.33	9.30	90.63
	B3/4	-	131.96	131.96	-	94.39	94.39	-	104.98	104.98
	Total	57.01	131.96	188.97	59.30	94.39	153.69	81.33	114.28	195.61
4.	B1	7.19	0	7.19	7.19	0	7.19	7.19	0	7.19
	B2	49.82	0	49.82	53.46	2.21	55.67	75.73	9.30	85.03
	Subtotal	57.01	0	57.01	60.65	2.21	62.86	82.92	9.30	92.22
	B3/4	-	131.96	131.96	-	94.39	94.39	-	104.98	104.98
	Total	57.01	131.96	188.97	60.65	96.60	157.25	82.92	114.28	197.20
5.	B1	7.19	0	7.19	7.19	0	7.19	7.19	0	7.19
	B2	49.82	0	49.82	55.67	0	55.67	85.03	0	85.03
	Subtotal	57.01	0	57.01	62.86	0	62.86	92.22	0	92.22
	B3/4	-	131.96	131.96	-	94.39	94.39	-	104.98	104.98
	Total	57.01	131.96	188.97	62.86	94.39	157.25	92.22	104.98	197.20

As shown in Chapter 3 of Part II, SITE-T was selected for the new container terminal construction. The Scheme 4 is chosen as the best development sequence. However the water depth is modified to MLW -13m for all the berths. Thus concluded arrangement is as follows.

SITE-T : Telfers Island Terminal

Water depth is MLW -13m.

Wharf depth is MLW -14m.

The required construction cost at SITE-T will be as follows:

Table 8-2-5 Required Combined Construction Cost at Proposed SITE-T (Preliminary)

Berth	Required Cost	
B1	7.19	Million US $
B2	54.57	"
B3/4	93.56	"
Total	155.32	"

Note: This figure excludes both equipment cost and upgrading cost of piers and mole.

The required additional construction cost to Scheme 5 for the water depth of MLW -14m is 1.93 million US $ which is 1.2% of the total construction cost proposed. Figure 8-2-2 shows the changes in the combined construction cost (B1 - B4) by water depth and wharf depth at SITE-T.

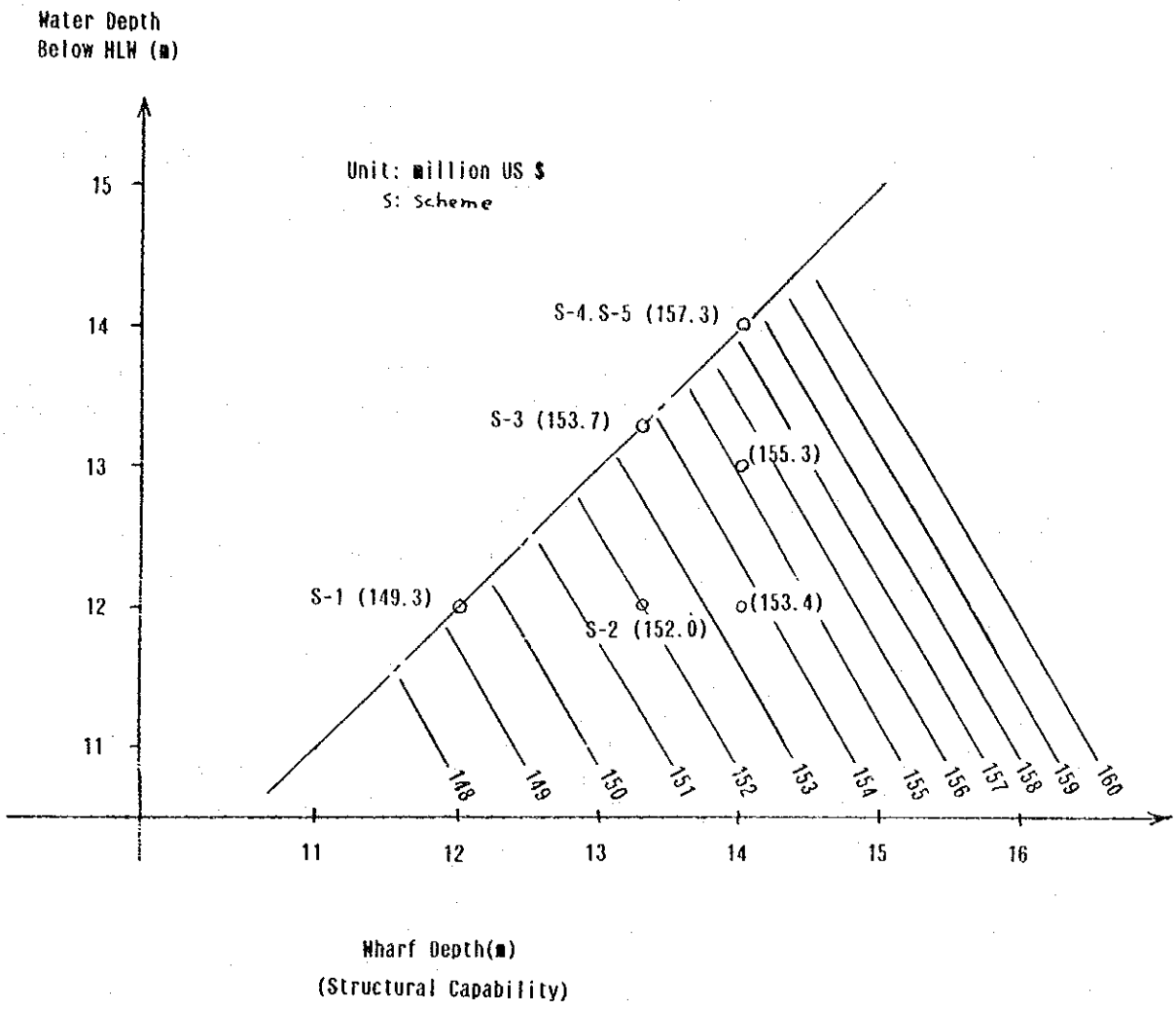


Figure 8-2-2 Changes in Combined Construction Cost (B1~B4) by Water Depth and Wharf Depth at SITE-T

8.2.4 Detailed Study of Each Alternative

(1) Summary

Table 8-2-6 shows a summary of construction cost estimated for each terminal alternative for four sites, namely the Site-C, Site-T, Site-F and Site-CS. Each alternative has three basic waterfront utilization concepts as follows:

Concept Minimum

This aims at providing the lowest possible cost. Thus both the water depth in front of wharf and channel depth is MLW -12m which is suitable for the following container vessels.

- All the first generation vessels, up to 20.000 DWT
- 95% loading ratio of second generation vessels, up to 30,000 DWT
- 85% loading ratio of third generation vessels, up to 40,000 DWT
- 80% loading ratio of fourth generation vessels, up to 60,000 DWT

Wharf design depth is also MLW-12m, thus the water depth in front of the wharf should theoretically be MLW-12m or shallower. This idea can provide the project with the lowest cost, however, there is little flexibility to meet the larger container vessel as shown above.

Concept Flexible

This plan slightly increases the project cost than Concept Minimum, however it may provide more flexibility for the future changes of vessel size. The water depth in front of wharf and channel will initially be MLW-12m, then it can be deepen up to MLW -14m by seabed dredging. Of course, wharf design depth has to be MLW-14m at the initial stage.

Concept Deep

This idea is to provide the project with a deeper wharf and channel at the beginning in order to stimulate the port users and better port sales. Thus, the design water depth and channel depth should initially be MLW -14m. This water depth is suitable for the following container vessels.

- All the vessels up to the third generation vessels, up to 40,000 DWT.
- 95% loading ratio of the fourth generation vessels, up to 60,000 DWT.

Water depth should basically be decided by the largest vessel calling to the new terminal. However, this comparison study may provide the decision maker with a useful information.

Table 8-2-6 Container Terminal Construction Cost Summary of Each Alternative Site (Preliminary)

Unit: Million $

Sites	Wharf (terminal)	Concepts		
		Minimum	Flexible	Deep
P. Existing Terminal	B1	7.19	7.19	7.19
C. West Colon	B2	49.82	49.82	49.82
	B3/4	126.43	130.03	131.96
T. Telfers Island	B2	52.11	53.46	55.67
	B3/4	90.04	92.73	94.39*
F. French Canal	B5/6	133.48	136.18	148.65
CS. Coco Solo	B2	74.14	75.73	85.03
	B3/4	101.80	104.98	104.98**

Notes:
1. * The deepening cost of $2.21 million should be added to $94.39 million in case that the wharf B2 is designed for MLW-12m.
2. ** Similarly the deepening cost of $9.30 million should be added to $104.98 million.
3. These costs do not include equipment cost.
4. Since there is no wharf development in French Canal Site during the Long Term Plan stage, cost for Berth 5 and Berth 6 is shown for reference.

Table 8-2-7 shows the construction cost breakdown of each alternative site.

Figures 8-2-3, 8-2-4 and 8-2-5 indicate the required dredging works by the water depth at each alternative site, except SITE-F. By these figures the basic site character can be summarized as follows:

- SITE-C : The West Colon Terminal

The average water depth of existing seabed between the faceline and Canal is about MLW -9.0 m and relatively flat up to the Canal, thus the required average dredging depth is 3m and 5m to the dredging level MLW -12 m and MLW -14 m respectively. The required dredging volume at this site is smaller than SITE-CS but larger than SITE-T.

- SITE-T : The Telfers Island Terminal

The average water depth is about MLW -13.5 m and shallower water area than MLW -14 m is limited only 500 meter in front of the wharf faceline.

- SITE-CS : The Coco Solo Terminal

The average water depth is about MLW -9.5 m and gradually changes from the wharf area to the Canal. The water depth in all the 4 km long approach channel to this site is shallower than MLW -14.0 m.

Table 8-2-7 Container Terminal Construction Cost Breakdown of Each Alternative Site

Unit: million $

	Works	P14	C14		T14		F14		CS14	
		B1	B2	B3/4	B2	B3/4	-	B5/6	B2	B3/4
A.	General Works	1.39	4.50	7.31	4.50	5.68	-	5.68	6.13	7.31
B.	Marine Works	1.04	20.32	71.99	28.00	47.97	-	81.82	49.21	57.08
C.	On-land Works	3.48	12.07	26.11	7.80	15.60	-	18.54	7.80	15.60
D.	Building	0.42	6.51	13.61	6.45	13.65	-	12.41	6.45	13.65
E.	Utilities	0.49	4.82	10.38	5.32	10.23	-	11.64	10.82	10.23
F.	Supplemental Works	0.37	1.60	2.56	3.60	1.26	-	4.12	4.62	1.11
G.	Others	0	0	0	0	0	-	14.44	0	0
H.	Subtotal	7.19	49.82	131.96	55.67	94.39 (+2.21)*	-	148.65	85.03	104.98 (+9.30)*
I.	Contingency	-	-	-	-	-	-	-	-	-
J.	Engineering	-	-	-	-	-	-	-	-	-
K.	Total 14	7.19	49.82	131.96	55.67	94.39	-	148.65	85.03	104.98
L.	Reduction, 14/12	0	0	-1.93	-2.21	-1.66	-	-12.47	-9.30	0
M.	Cost, 14/12	7.19	49.82	130.03	53.46	92.73	-	136.18	75.73	104.98
N.	Reduction, 12	0	0	-5.53	-3.56	-4.35	-	-15.17	-10.89	-3.18
P.	Cost, 12	7..19	49.82	126.43	52.11	90.04	-	133.48	74.14	101.80

Notes: 1. These costs do not include the equipment cost.
2. Reduction 14/12 and Reduction 12 are against total (k).
K - L = M, K - N = P
3. Figure with asterisk indicates an additional cost if the initial water depth of B2 is MLW−12m
4. Since there is no wharf in French canal site during master plan stage, cost for Berth 5 and Berth 6 is shown for reference.

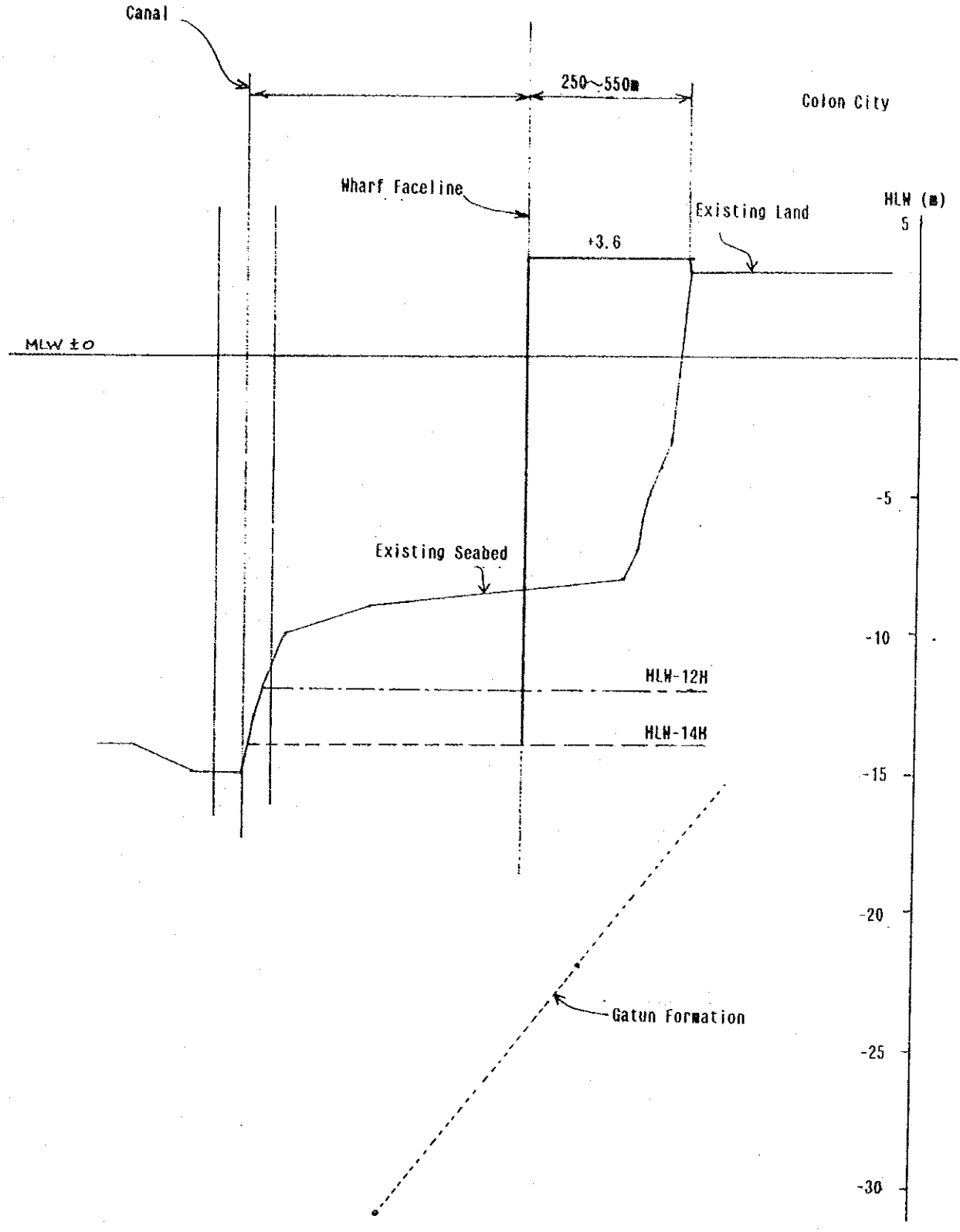


Figure 8-2-3 Dredging Work for West Colon Terminal

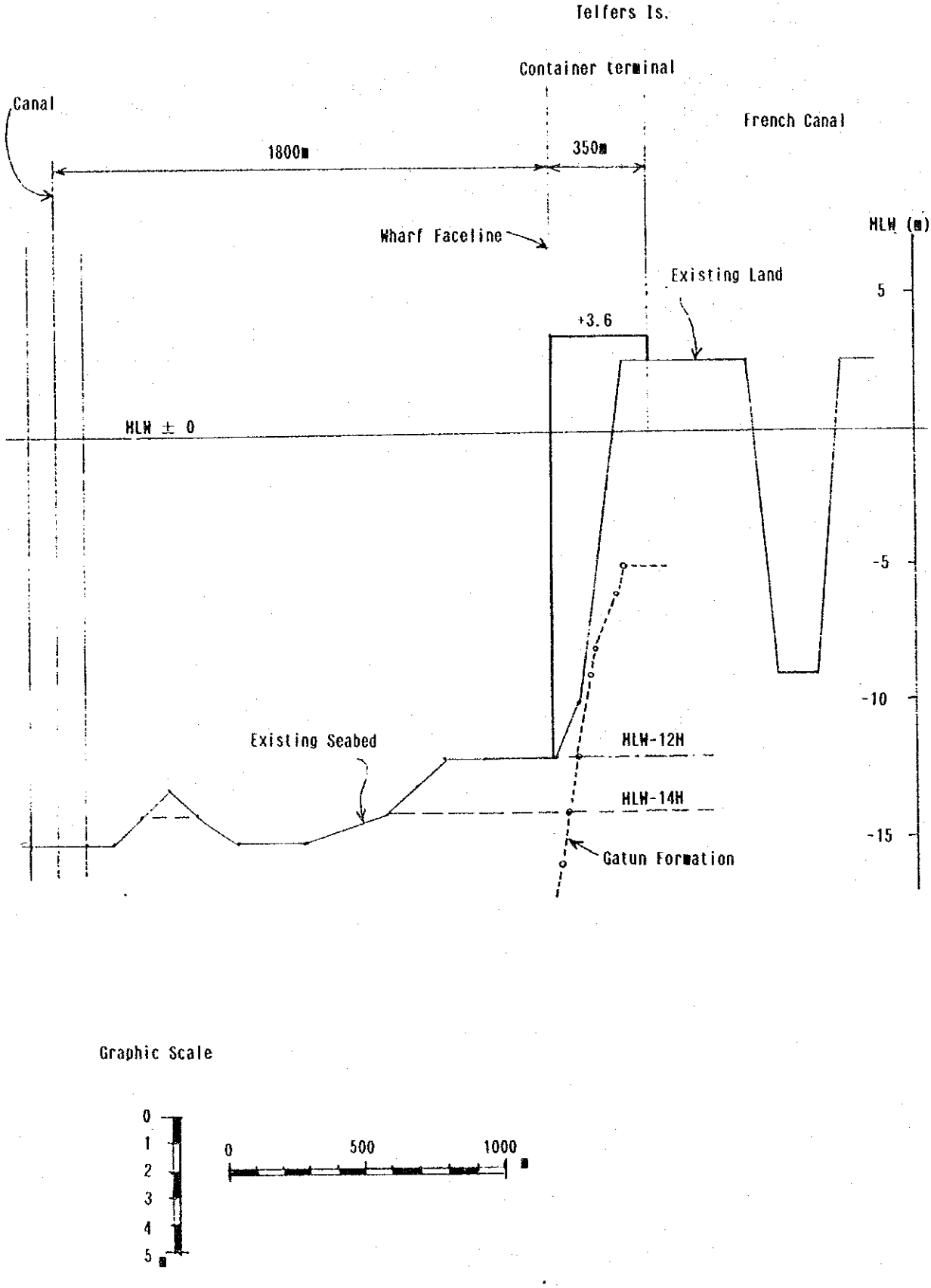


Figure 8-2-4 Dredging Work for Telfers Island Terminal

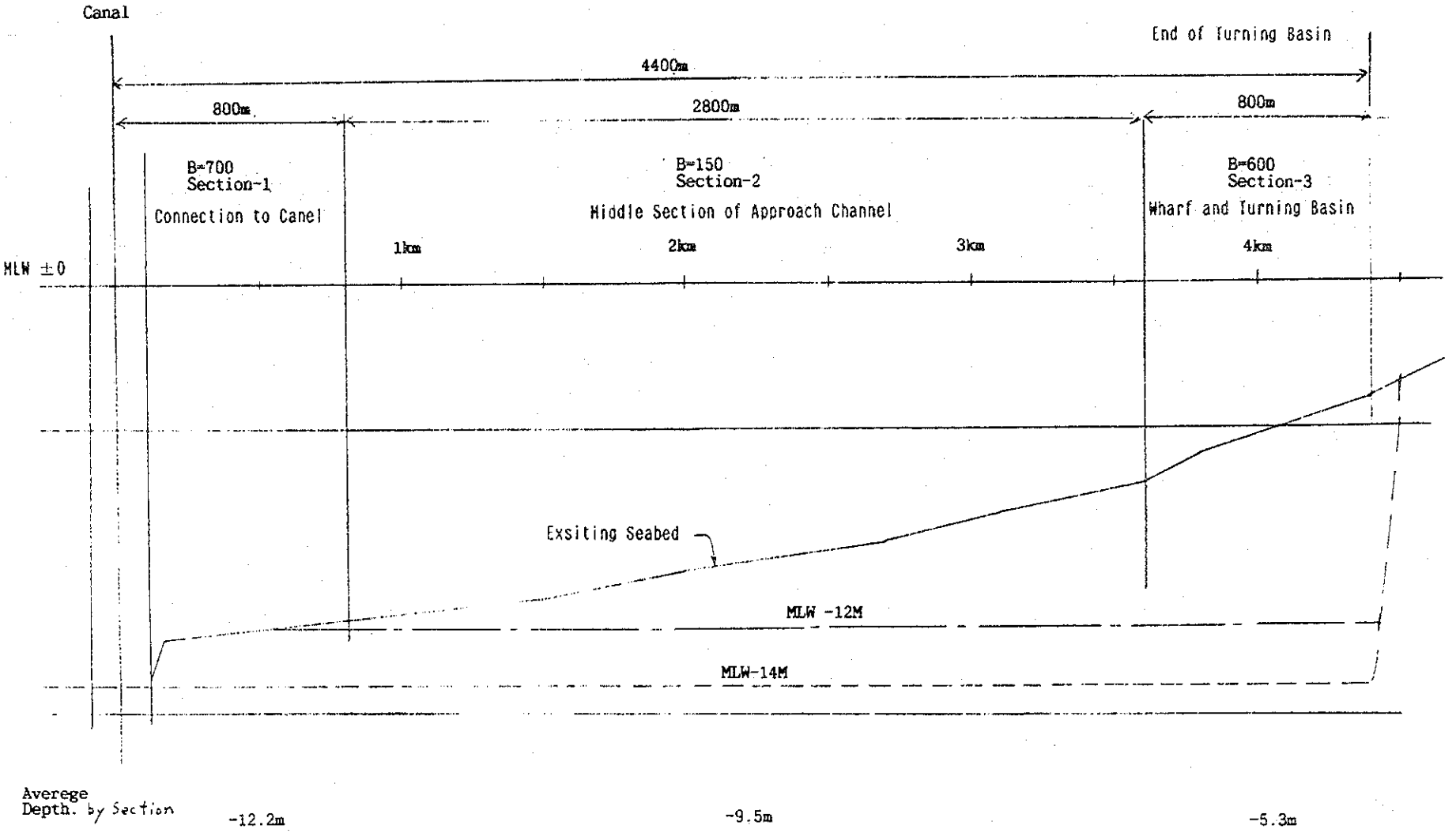


Figure 8-2-5 Dredging Work for Approach Channel for Coco Solo Terminal

(2) Waterfront Utilization Concepts

The purpose of construction cost estimation is two holds, namely;

- How much initial investment should be made for each candidate site?
- How the design water depth and wharf depth influence the initial cost?

In order to answer to the latter question, the construction cost was estimated by several design water depths.

The required water depth depends on the size of ship. The required depth for each size of ship is estimated by following formula.

$$Dw = a*Dr + \text{allowance (1 m)}$$
$$= a*Dr + 1.0 \text{ m}$$

Where, Dw = Required water depth, below MLW (m)
a = Loading ratio,
When 75% loading, a = 0.75
a = 80%, 85%, 90%, 95% and 100% (full loading)

Dr = Draft at the full loading
First - Generation, DWT 20,000 (1,000 TEUs) Dr = 10.5 m
Second - Generation, DWT 30,000 (1,500 TEUs) Dr = 11.5 m
Third - Generation, DWT 40,000 (2,750 TEUs) Dr = 12.5 m
Fourth - Generation, DWT 60,000 (5,300 TEUs) Dr = 13.5 m

The required water depth by loading condition is shown in Table 8-2-8. Two water depths, MLW -12 m and MLW -14 m were selected in order to verify the change of initial construction cost due to the water depth.

Table 8-2-8 Required Water Depth by Ship Loading Conditions

Unit: Depth(m) below MLW

Loading Ratio	Generation of Container Vessel			
	First 20,000 DWT	Second 30,000 DWT	Third 40,000 DWT	Fourth 60,000 DWT
100% (Full Load)	11.5	12.5	13.5	14.5 (15)
95%	11.0	11.9	12.9	13.8 (14)
90%	10.5	11.4	12.3	13.2 (13)
85%	9.9	10.8	11.6	12.5 (12)
80%	9.4	10.2	11.0	11.8 (11)
			Panamax Type	Post-Panamax Type

8.2.5 French Canal Development Alternatives

(1) Study Purpose

As discussed in the beginning of this section, there are five sites for the container terminal namely,

Site P Existing terminal behind the Pier No.9 which currently has a land of 8.4 ha for 150,000 TEUs annual operation. This site is expected to play a continuous role even after the new terminal development.

Site C West Colon
This locates at the north of the existing mole and contacting the west of Colon City. This area is currently an open sea of MLW -9 m depth.

Site T Telfers Island
This is not an island but a headland separating the Site P with the existing inner basin for the dock yard, the French Canal. The northern coast of this area remained just as a natural beach facing the center of Limon Bay of MLW -13.5m water depth. This coastline shapes a straight line along the dredging limits specified by PCC.

Site F French Canal
The Canal of 1,300 m long leads vessels from the bay to the dock facilities in PCC's industrial division area. The water depth is about MLW -12 m. The width of this waterway is about 120 m. At the canal entrance, there is a bunker pier, Pier No.16, which physically separates Site P and Site T.

Site CS Coco Solo
This site locates along the west coast of mother land leading to Folk River Bay. Distance between the existing Site P and this site is about 7 km. There is a 500 m long flat land of 20 ha which is waiting for a new role to play. The water depth in front of this site is about MLW -5.5 and the distance from this site to the core of the bay is about 4,000 m.

All the sites except Site F have a simple shape of coastline with respect to reasonable location of terminal faceline. (Note: The faceline means a line where a new marginal wharf may be located.)

While Site F has a complicated shape representing the canal itself and the existing Pier No.16. The canal is for a waterway to the PCC's dock yard for ship repairing and Pier No.16 is utilizing for unloading fuels from the tankers. It is assumed that both functions should be maintained as they are or elsewhere. As seen in the map, however, this site locates in the strategic area with respect to the cargo handling function in commercial port.

Thus, it was proposed that more detailed study should be made how this site fits into the cargo handling area.

(2) Long Term Prospective

Other aspects to be considered in the comparison study are the total costs for terminal development based on the required number of container wharf. Rough implementation schedule for each development stage is assumed as follows:

Prospective 1
Continuous maintenance efforts of existing facilities.

Prospective 2
Upgrading or improvement of the existing container terminal behind Pier No.9 should be made as soon as possible.

Prospective 3 Short Term Development (STD)
The construction of a new two terminal for STD should be carried out by 2000, probably by 1999.

Prospective 3 Long Term Development (LTD)
The construction of new two terminals for LTD should be conducted before 2010.

Addition to these prospectives, the post-Long Term Plan development should be envisaged assuming two wharf developments after 2000.
For the cost comparison purpose, the required number of container wharf is roughly estimated as follows:

Prospective 2: The existing container terminal should be used.

Prospective 3: In the STD stage (1998/1999), one container wharf will be constructed.

Prospective 3: In the LTD stage (2003/2009), two wharves will be added

Prospective 3: Post LTD stage, two more wharves will be added.

Thus, the total new container wharf by the end of LTD stage and Post-LTD stage are three wharves and five wharves respectively.

It should be noted that neither site except Site T has enough space required for five wharves. Site F has also a limited space availability that the maximum number of wharf in this site is three. However, it has various advantages than Site C and Site CS that it locates in close proximity not only to the existing container terminal but also the Telfers Island which is the most prominent site for other wharf development.

(3) Results of Alternative Study

Four alternative arrangements were evaluated by the cost aspect. Table 8-2-10 shows a summary of this cost evaluation. In order to compare them from an economical point of view, the discounted costs were introduced.

Note: Discounted cost means the net present value (NPV) of the total construction cost. All the alternatives have the same cargo handling capacity. Thus, if the investment cost spends late stage, such alternative has an economical advantage. The cost with discount rate of zero means the construction cost at present price.

Figure 8-2-6 shows the changes of discounted costs by index.

It is clear that the alternative Site T is the most economical case comparing to all the French Canal Terminal Schemes. Among the French Canal Alternatives, F(a) to F(d), F(d) is the lowest cost case, since only one wharf out of five new terminals will be located along Site F and the remaining four wharves are allotted at Site T. Thus cost character is very similar to those of Site T development, in which all new wharves will be constructed at Site T. F(b) is selected as the best alternative with respect to French Canal Development.

Table 8-2-9 shows the wharf arrangement and discount rates. Table 8-2-10 indicates the construction cost by French Canal Alternative.

Refer to Figures 3-2-2, 3-2-3, 3-2-4 and 3-2-5 for each French canal altertative.

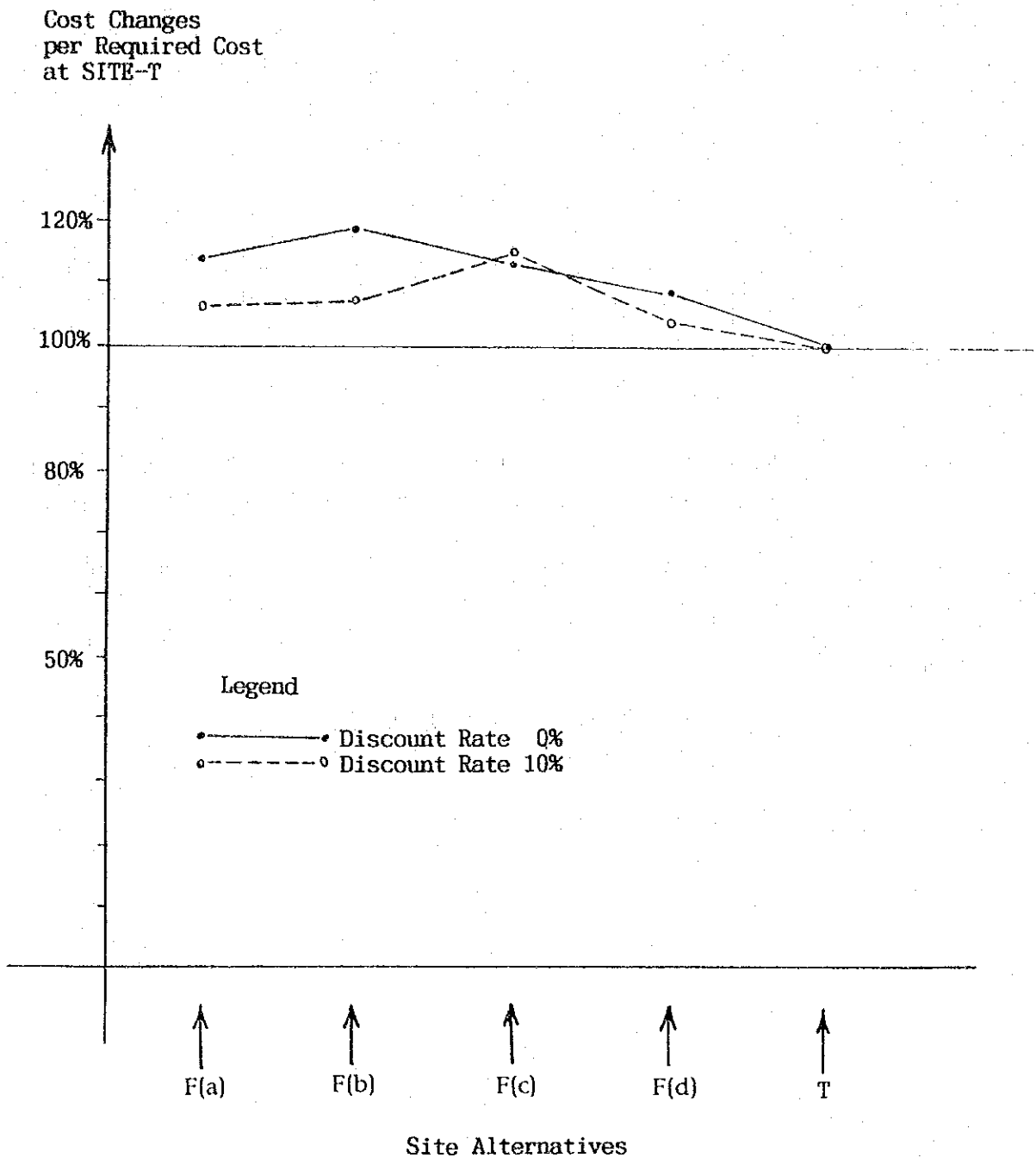


Figure 8-2-6 Cost Changes for French Canal Terminal Alternatives (6 wharves including 2 post-LTD wharves)

Table 8-2-9 Wharf Arrangement and Discount Rate

Prospectives	Wharf No.	Site	Time * Year	Discount Rate 0%	5%	10%	15%
2	B1	P	3	1.00	0.86	0.75	0.66
3-STD	B2	T	4	1.00	0.82	0.68	0.57
3-LTD	B3 and B4	depend	9	1.00	0.64	0.42	0.28
3-Post LTD	B5 and B6	depend	19	1.00	0.40	0.16	0.07

Note: Time means length of period between the year of construction commencement and present.

Table 8-2-10 Summary of Cost for French Canal Development Alternatives

	F(a)		F(b)		F(c)		F(d)		T*	
Wharf	0%	10%	0%	10%	0%	10%	0%	10%	0%	10%
B1-B4	153.4 (100)	80.7 (100)	153.4 (100)	80.7 (100)	186.6 (121)	94.7 (117)	153.4 (100)	80.7 (100)	153.4 (100)	80.7 (100)
B1-B6	279.1 (113)	100.8 (100)	289.6 (118)	102.5 (107)	275.6 (112)	108.9 (114)	267.7 (109)	98.9 (104)	246.1 (100)	95.5 (100)

Note: 1. B1 is the upgraded existing container terminal at Pier No.9. This wharf cost is common one to all alternatives.
2. T is Site T, Telfers, where five wharves will be constructed, B2 - B6. The estimated cost of this site shows the lowest one, thus it is also shown in the table for reference.
3. Figure in parenthesis is an index per figure for Site T, each discount rate 0% and 10% respectively.
4. All the costs do not include any equipment cost.

Tables 8-2-11, 8-2-12, 8-2-13 and 8-2-14 show the total development cost at French Canal Terminal. The basic costs in these tables are in case "14/12", the wharf is designed for MLW -14 m depth, however, the initial water depth remains MLW -12 m.

Table 8-2-11 French Canal Terminal (a) : SITE F (a)

Unit: million US$

Wharf	Site	Discount Rate 0%	5%	10%	15%
B1	Site P	7.2	6.2	5.4	4.8
B2	Site T	53.5	43.9	36.4	30.5
B3/B4	"	92.7	59.3	38.9	26.0
Subtotal		153.4	109.4	80.7	61.3
B5/B6	Site F	125.7	50.3	20.1	8.8
Total		279.1	159.7	100.8	72.8

Table 8-2-12 French Canal Terminal (b): SITE F (b)

Unit: million US$

Wharf	Site	Discount Rate 0%	5%	10%	15%
B1	Site P	7.2	6.2	5.4	4.8
B2	Site T	53.5	43.9	36.4	30.5
B3/B4	"	92.7	59.3	38.9	26.0
Subtotal		153.4	109.4	80.7	61.3
B5/B6	Site F	136.2	54.4	21.8	9.5
Total		289.6	163.8	102.5	73.5

Table 8-2-13 French Canal Terminal (c) : SITE F (c)

Unit: million US$

Wharf	Site	Discount Rate 0%	5%	10%	15%
B1	Site P	7.2	6.2	5.4	4.8
B2	Site T	53.5	43.9	36.4	30.5
B3/B4	"	125.9	80.6	52.9	35.3
Subtotal		186.6	130.7	94.7	70.6
B5/B6	Site F/T	89.0	35.6	14.2	6.3
Total		275.6	166.3	108.9	76.9

Table 8-2-14 French Canal Terminal (d): SITE F (d)

Unit: million US$

Wharf	Site	Discount Rate 0%	5%	10%	15%
B1	Site P	7.2	6.2	5.4	4.8
B2	Site T	53.5	43.9	36.4	30.5
B3/B4	"	92.7	59.3	38.9	26.0
Subtotal		153.4	109.4	80.7	61.3
B5/B6	Site F/T	114.3	45.7	18.2	8.0
Total		267.7	155.1	98.9	69.3

Note: Site F/T = Cost B5 + Cost B6 = 66.1 + 47.8 = 113.9

Table 8-2-15 Telfers Island Terminal: SITE T

Unit: million US$

Wharf	Site	Discount Rate 0%	5%	10%	15%
B1	Site P	7.2	6.2	5.3	4.8
B2	Site T	53.5	43.9	36.4	30.5
B3/B4	"	92.7	59.3	38.9	26.0
Subtotal		153.4	109.4	80.7	61.3
B5/B6	Site F/T	92.7	37.1	14.8	6.4
Total		246.1	146.5	95.5	67.7

(4) Cost Changes by Wharf Depth at Site F

All the alternatives show very similar changes. The cost increase from the 12 m wharf to 14 m wharf is about 10% of those of 12 m wharf. However, it remains only three % increase if 14 m wharf construction by initial dredging up to -12 m.

Table 8-2-16 shows the construction cost changes by the wharf design depth.

Table 8-2-16 Construction Cost Change of French Canal Alternatives by Water Depth and Wharf Depth

Unit : Million US$

	Alternative														
	F(a)			F(b)			F(c)			F(d)			T		
Wharf	14	14/12	12	14	14/12	12	14	14/12	12	14	14/12	12	14	14/12	12
B1	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
B2	55.7	53.5	52.1	55.7	53.5	52.1	55.7	53.5	52.1	55.7	53.5	52.1	55.7	53.5	52.1
B3/B4	94.4	92.7	90.0	94.4	92.7	90.0	140.3	125.9	123.2	94.4	92.7	90.0	94.4	92.7	90.0
Subtotal	157.3 (105)	153.4 (103)	149.3 (100)	157.3 (105)	153.4 (103)	149.3 (100)	203.2 (111)	186.6 (102)	182.5 (100)	157.3 (105)	153.4 (103)	149.3 (100)	157.3 (105)	153.7 (103)	149.3 (100)
B5	*	*	*	*	*	*	41.0	41.0	39.6	66.3	66.3	65.0	*	*	*
B6	125.7	125.7	123.0	148.7	136.2	133.5	50.2	48.0	46.7	50.2	48.0	46.7	94.4	92.7	90.0
Subtotal	125.7 (102)	125.7 (102)	123.0 (100)	148.7 (111)	136.2 (102)	133.5 (100)	91.2 (106)	89.0 (103)	86.3 (100)	116.5 (104)	114.3 (102)	111.7 (100)	94.4 (105)	92.7 (103)	90.0 (100)
Total	283.0 (104)	279.1 (102)	272.3 (100)	306.0 (108)	289.6 (102)	282.8 (100)	294.4 (110)	275.6 (103)	268.8 (100)	273.8 (105)	267.7 (103)	261.0 (100)	251.7 (105)	246.1 (103)	239.3 (100)

Notes:
1. The required costs for B5 in F(a), F(b) and T are included in the costs for B6.
2. Legend
   14 ---------- Wharf of MLW -14 m, Water depth of MLW - 14 m.
   14/12 ---------- Wharf is MLW -14 m design, however the water depth may remain MLW -12 m until the real necessity of deepening to -14 m.
   12 ---------- Wharf of MLW -12 m, Water depth of MLW - 12 m.
3. Figure in parenthesis indicates a cost increase index to the required cost of -12 m wharf case in the same site.
4. All the costs do not include any equipment cost.

8.3 Required Upgrading of Existing Container Terminal

In Chapter 5, necessary discussions on the modernization of the existing container terminal were conducted. This terminal is only one in the port of Cristobal until the completion of the new terminal construction. One of the main subjects studied in Chapter 5 is how to plan the most efficient terminal land use with a safe traffic circulation, since it's land shape is prolonged one.

This section deals with the design aspects of facilities based on the conclusion drawn in the said chapter.

8.3.1 Land Use

The scale of land at present and in the future are estimated as follows:

- Present	8.36 ha	
- Expansion area by 1995	1.87 ha	(Areas A plus B)
Total area by the end of 1995	10.23 ha	
- Further expansion by 2002	3.32 ha	(Area C)
- Total area by the end of 2002	13.55 ha	

Note: This area was calculated using the available maps. Further expansion means to modify the surrounding PCC areas for the container terminal.

Figure 8-3-1 shows the outline of this land availability.

It is assumed that this land of 13.6 ha is the target to develop the Long Term Plan. According to chapter 5, this land will be utilized as follows:

Area Use	Area	Share
- Wharf apron	1.50 ha	11.1%
- Inner access	4.22 ha	31.1%
- Transfer points	0.04 ha	0.3%
- Multi-purpose area	1.19 ha	8.8%
- Building space	0.78 ha	5.8%
- Container yard	4.66 ha	34.4%
- Park and landscaping	0.43 ha	3.2%
- Reserves	0.73 ha	5.3%
Total	13.55 ha	100.0%

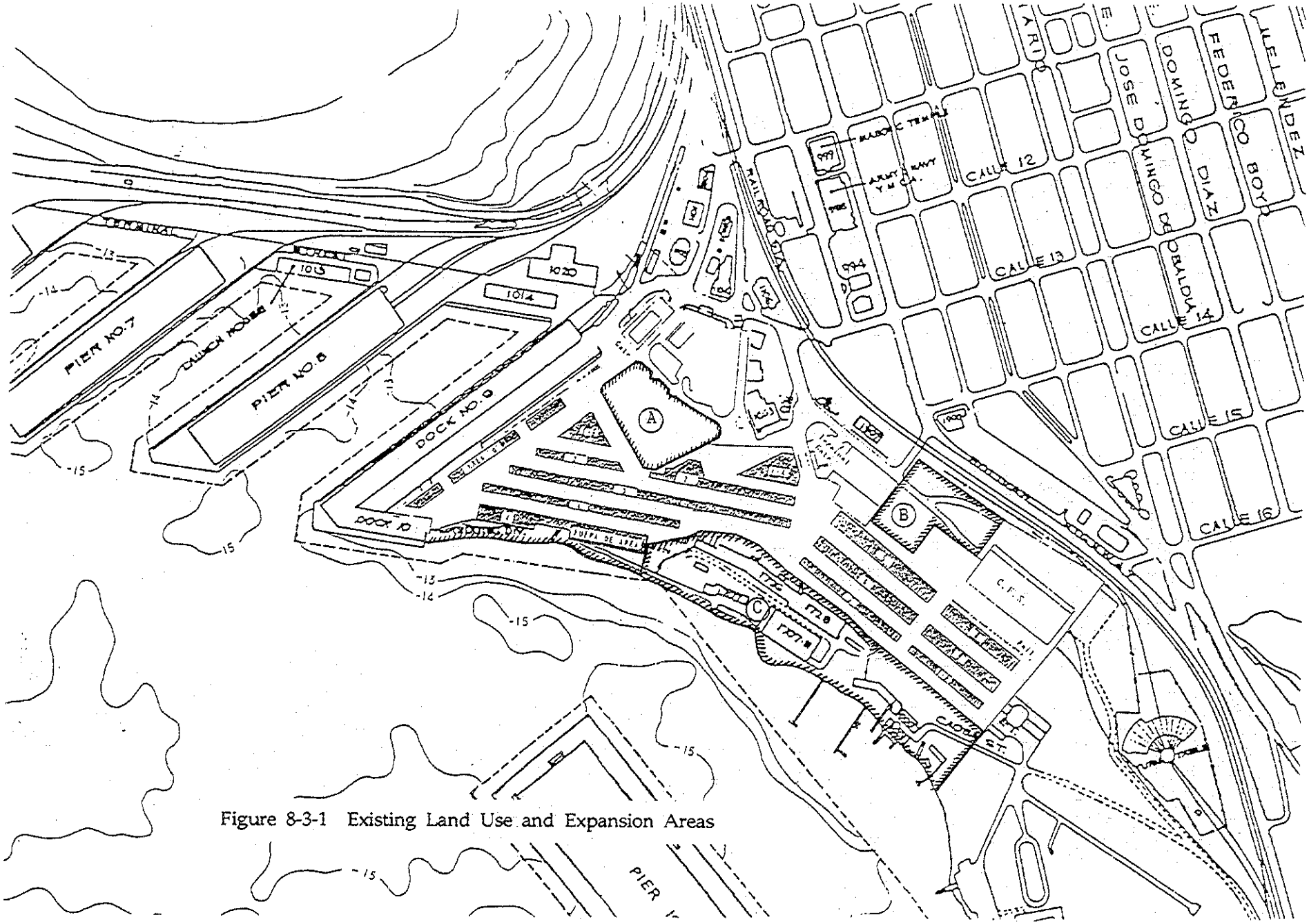


Figure 8-3-1 Existing Land Use and Expansion Areas

8.3.2 Upgrading Policies

As mentioned above, this terminal currently handles most of the container cargo which is about 110,000 TEUs in 1991. This shares about 65% of the total containers in the port of Cristobal. APN made their best efforts to widen the area mainly by concrete pavement. APN intends to widen the area by two main reasons.

- To maintain a smooth and safe traffic circulation in the terminal
- To re-shape the yard by means of expanding the terminal to adjacent areas which are presently not utilized for the container operation

Proportionally to increasing container cargoes, it is reported that the traffic congestion happens so often that the port traffic disturbs the city traffic mainly near the port main entrance and the railway crossing point. The design of existing terminal improvement and its implementation should take these aspects into account. Thus basic design policies of improvement and upgrading this terminal should be as follows:

a. The nearest area should be modified into the terminal area, thus the available lands for the terminal should be incorporated in the design.
b. A safe inner traffic circulation should be achieved.
c. Cargo handling equipment should be renewed and/or replaced in accordance with the recommendation made in Chapter 5 of Part II. It is assumed that the transfer crane system will gradually be the main yard equipment.
d. Existing facilities should fully be used in order to minimize the initial cost.
e. The present traffic congestion near the terminal entrance should be mitigated.
f. Disturbance of the present terminal operation due to the required improvement works should be minimized.

8.3.3 Design of Existing Terminal Upgrading

This subsection deals with the possible countermeasures for each design policy shown in the previous subsection.

(1) Land Expansion

The existing land space and possible expansion area are assumed as below:

- Present (Dec. 1992) 8.36 ha

- Area"A" near the existing main gate 1.00 ha
  The expansion of this area is currently implemented by APN.
  It is assumed this will be completed by the end of 1995.

- Area"B" west of existing CFS 0.87 ha
  It is assumed that this piece of land will also be modified to

the terminal area by the end of 1995.

- Area"C" south of existing area 3.32 ha
  This area faces to French Canal and currently occupied by PCC maintenance area and marina.
  It is assumed this land will be available to the terminal by the end of 2002.

  Total additional areas 5.19 ha
  Total area by the fully developed stage will be 13.55 ha.

This additional area will be redeveloped in accordance with the priority requirements. As discussed in Chapter 5, priority will be given in order as shown below.

Priority 1: Land use for reasonable allotment of container stacking slots to meet the yard equipment and cargo demands.
Priority 2: Land use for safe and economical traffic circulation pattern and improvement of the main gate itself.
Priority 3: Land use of providing additional areas for the systematic operation including the parking space, transfer points, empty container depot, trailer pool, etc.

As discussed in Chapter 5, the pier-ward area will be an open area for container stacking while the landward area will be a service area for CFS, car park and empty container depot, container repairing space, fumigation space, etc.

Figure 8-3-2 shows the sequence of yard development in three stages.

Scheme-1 indicates the present land use at the end of 1992 although APN is commencing to enlarge the Area "A" of northern corner into the container marshalling yard. The terminal main gate is as it is.

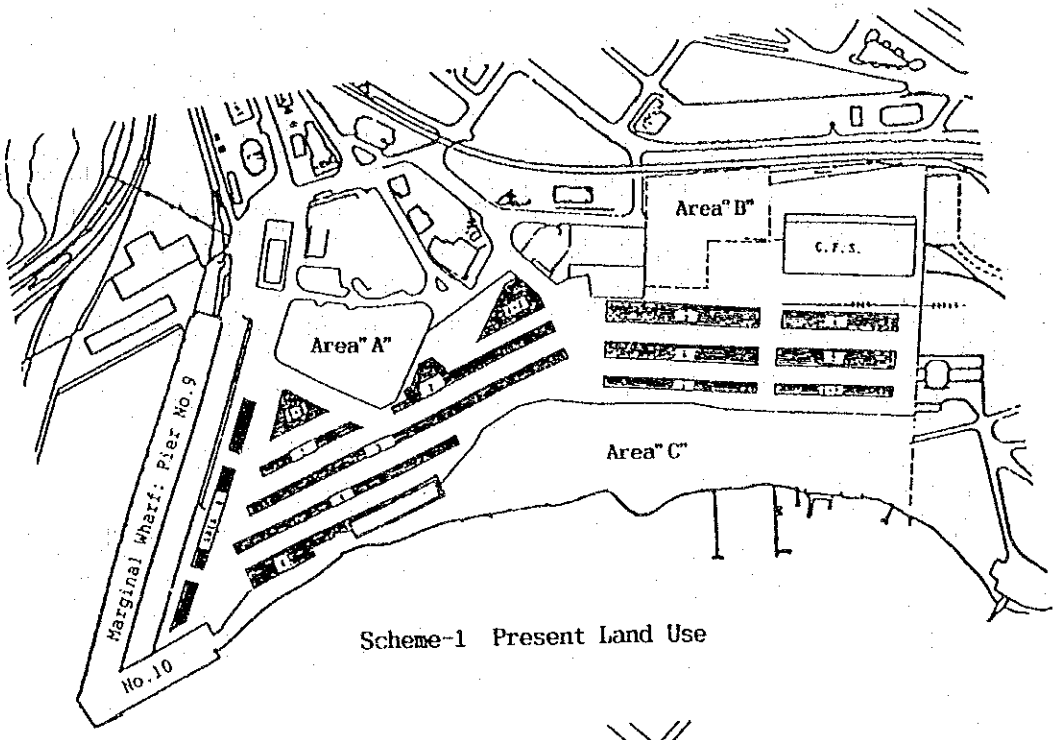
Scheme-2 shows the interim condition before the full development. Both Areas "A" and "B" have been included in the terminal. Although the yard behind the wharf and the open space near the CFS are improved, the land width around the exit gate is only 100m, where is one of the most congesting places.

Scheme-3 demonstrates the final stage of modernization when Area "C" has been occupied by the container terminal. The main gate is relocated in order to mitigate the present traffic congestion.

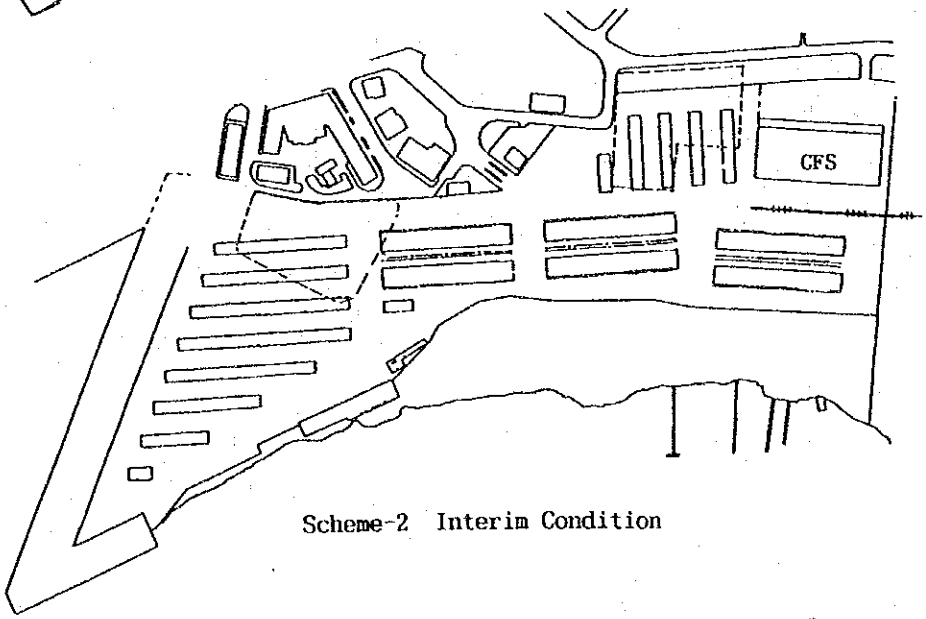
Table 8-3-1 shows the land use breakdown for Scheme-3 including the application of three expansion areas.

The first expansion Area "A" provides a new container marshalling yard of 3,200m2 in M1 zone and the remaining 6,800m2 will be the inner access space. The second

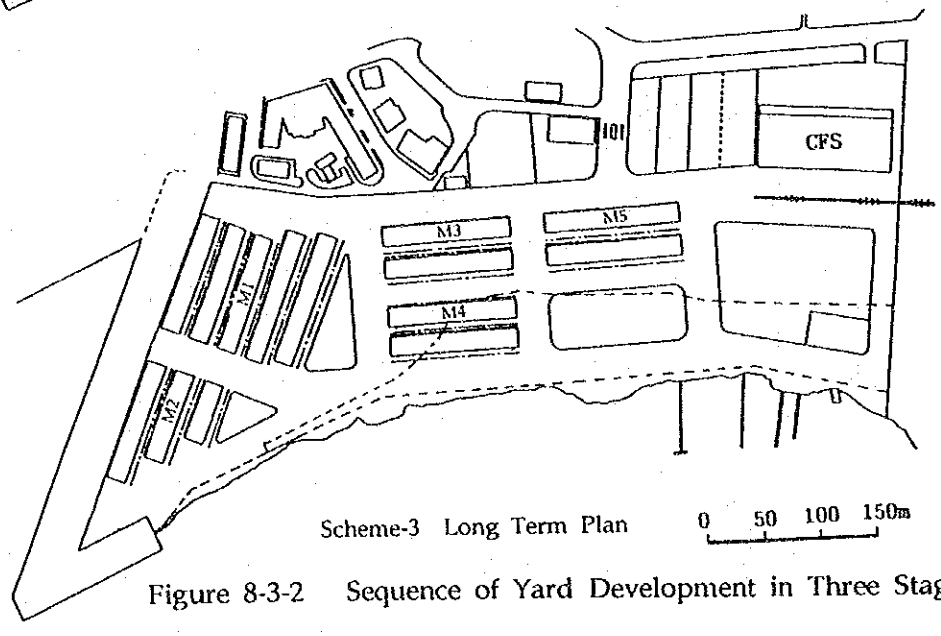
expansion Area "B" aims at provision of the multi-purpose area including the customs space, car parking area (1) and cleaning/repairing yards of containers. The landscaping will also be provided at the northern boundary. The last expansion Area "C" will be implemented during the Long Term Plan stage and provide the empty container depots at the southern zone. The south coastal access will also be provided.



Scheme-1 Present Land Use



Scheme-2 Interim Condition



Scheme-3 Long Term Plan 0 50 100 150m

Figure 8-3-2 Sequence of Yard Development in Three Stages

Table 8-3-1 Land Use in the Final Stage of Existing Container Terminal

Land Use	Total	Use of Expansion Areas		
		Area "A"	Area "B"	Area "C"
(i) Container Marshalling Yead				
- M1 = 130m x 135m	=17,550m2	3,000m2	-	-
- M2 = 1/2(140 + 70) x 80	= 8,400m2	-	-	-
- M3 = 55m x 125m	= 6,875m2	200m2	-	-
- M4 = 55m x 125m	= 6,875m2	-	-	5,000m2
- M5 = 55m x 125m	= 6,875m2	-	-	-
Sub-total	46,575m2	3,200m2	0m2	5,000m2
(ii) Buildings				
- CFS (Existing) 115m x 55m	= 6,325m2	-	-	-
- Terminal Office 20m x 40m	= 800m2	-	-	-
(two stories)	-	-	-	-
- Electric Station	= 180m2	-	-	-
(Power House)	-	-	-	-
- Main Gate	= 18m2	-	-	-
- Others	= 500m2	-	-	-
Sub-total	7,825m2	0m2	0m2	0m2
(iii) Multi-Purpose Area				
- Customs Space		-	2,300m2	-
- Parking Area (1)		-	2,300m2	-
- Container Cleaning Space (80 x 115)	= 9,200m2	-	1,500m2	-
- Container Repairing Space (80 x 115)		-	1,500m2	-
- Parking Area (2) 45m x 60m	= 2,700m2	-	-	-
Sub-total	11,900m2	0m2	7,600m2	0m2
(iv) Park and Landscaping 285m x 15m	= 4,275m2	0m2	1,100m2	0m2
(v) Apron 375m x 40m	=15,000m2	0m2	0m2	0m2

(Table 8-3-1)

Land Use	Total	Use of Expansion Areas		
		Area "A"	Area "B"	Area "C"
(vi) Reserved Area				
- Pier No.10 1/2(55 + 80)x 25	= 1,688m2	-	-	-
- Trailer Pool(1) 1/2 x 40 x 40	= 800m2	-	-	-
- Trailer Pool(2) 1/2 x 40 x 90	= 1,800m2	-	-	-
- Coastal Area 5m x 600m	= 3,000m2	-	-	3,000m2
Sub-total	= 7,288m2	0m2	0m2	3,000m2
(vii) Empty Container Depot and Inner Access				
- Fumigation Sapce	= 1,500m2	-	-	1,500m2
- Depot(1) 125 x 110 - 1,500	=12,250m2	-	-	2,400m2
- Depot(2) 115 x 50	= 5,750m2	-	-	5,750m2
- Inner Access	=23,100m2	6,800m2	-	15,550m2
Sub-total	42,600m2	6,800m2	0m2	25,200m2
Total Area	135,463m2	10,000m2	8,700m2	33,200m2
	100%	7.4%	6.4%	24.5%

(2) Pavement Upgrading

Chapter 5 provides various alternative layouts of traffic circulation and stacking area allotment per type of yard equipment. In this paragraph, the required pavement allotment was studied based on that land use plan.

Design loads for the inner access is a tractor chassis of 40' container.
It is recommended that these access roads have reasonable width by traffic conditions.

- Main access 25 m
- Two-way access 25 m
- Minor access 15 m

As shown in the figures in Chapter 5, the recommended traffic pattern is regulated in order to provide its circulation with a systematic flow.

The required pavement upgrading will be performed in the two basic stages, namely the Short Term Plan and Long Term Plan. The pavement works together with supplemental works in the Short Term Plan will be as follows.

- Additional works to Area "A" pavement
  Area 10,000 m2
- Additional works to Area "B" pavement
  Area 7,600 m2
- Road sign and bay marking
  Area 38,100 m2
- Storm water drainage
  Area 18,700 m2

The pavement works together with supplemental works in the Long Term Plan will be as follows.

- Pavement
  Area 29,020 m2
- Storm water drainage
  Area 33,200 m2

Table 8-3-2 indicates the typical section of pavement.

Table 8-3-2 Typical Section of Concrete Pavement

Classification	Surface		Subbase	Subgrade CBR
Pavement (1) Light	Crushed rock	t=0.2m	t=0.3m	10
Pavement (2) Normal-AS	Asphalt	t=0.1m	t=0.5m	7
Pavement (2) Normal-C	Concrete	t=0.25m	t=0.35m	5
Pavement (2) Normal-CB	Concrete Block	t=0.12m	t=0.5m	7
Pavement (3) Heavy-C1	Concrete	t=0.3m	t=0.45m	5
Pavement (4) Heavy-C2	Concrete	t=0.35m	t=0.5m	5
Pavement (5) Yard Heavy	Concrete	t=1.2m	t=0.3m	5

It is assumed that the existing concrete pavement in the terminal can be remained as they are except particular heavy loading points. It is also assumed that new pavement will be of 25cm thick concrete or more.

(3) Yard Equipment Upgrading

Refer to the related section in Chapter 5 of Part II.

(4) Maximum Use of Existing Facilities

As mentioned above, most of the existing concrete pavement of 25cm thickness will be used except any location which requires heavy loads than expected.

(5) Improvement of Outer Access around the Entrance

It is assumed that the external roads are out of APN control. However, the required improvement cost for existing roads of 1,250 m2 was included in the design. This road improvement will be of asphalt type. According to the direct interview to roads users, they requested the Study Team to provide a wide road with traffic signals. Other comments were to provide more lighting system and traffic control. It is assumed that these improvement should be performed by the city of Colon or other related government organization.
Refer to Chapter 7 of Part II.

(6) Minimum Disturbance to Terminal Operation

The construction works for upgrading may disturb the terminal operation. This situation should be minimized as possible. It is recommended that the area expansion should be carried out at first, then such area will be modified to terminal area as required. Modification of the existing areas should be executed at last.

In addition to above mentioned considerations, the following works should be included in the upgrading efforts:

- Seawall improvement along the French Canal
- Improvement of stormwater drainage
- Provision of terminal office
- Improvement of existing maintenance shop
- Provision of powerplants
- Weighbridge
- Yard lighting improvement
- Access roads lighting improvement

8.3.4 Development Phasing

Upgrading of the existing container terminal will be conducted in four phases. The major works to be performed in each phase are as follows:

Phase 1 (1994/1999)

This period is the construction period of the Short Term Development.
- Ordinary construction works for yard expansion
- Introduction of such modern instrument as small scale computers and minor related works to equipment
- Introduction of a transfer crane

Phase 2 (2000/2002)

This phase is the construction period of the Long Term Development.

- Ordinary construction works for upgrading of various works
- Related works
  Total computer system
  Container repair facilities
  Buildings
  Power supply and emergency generator

Phase 3 (2003/2009)

This phase does not contain any upgrading works. Only equipment renewal for retired ones will be made, however it does not mean upgrading of equipment.

Phase 4 (2010 and after)

- Equipment renewal as scheduled.

Note: Equipment renewal which means purchase of same type of equipment for retired one will be discussed separately.
It is also recommended to improve lighting facilities.

8.4 Required Upgrading of Existing Finger Piers

8.4.1 Basic Functions

According to the future use of the existing finger piers proposed in Chapter 6 of Part II, there are three functions.

i) Function 1 : General cargo handling

Three finger piers No.6, No.7 and No.8 structurally have enough capacity. Each pier has a transit shed. The apron width is rather narrow except pier No.7 whose apron was recently widened for more space for equipment operation. It is recommended that pier No.6 and pier No.7 should be utilized for conventional handling. If an open storage area are provided near pier No.7, systematical general cargo operation for vehicle imported can be carried out.

ii) Function 2 : Supplemental container handling

When necessary, the piers should provide container handling services. Chapter 5 proposes that pier No.7 will be utilized for container cargo handling in the Short Term Development. It is also proposed that the container handling will be carried out by the ship's gears.

iii) Function 3 : Passenger terminal

Passenger terminal office will be provided in the port of existing shed of pier No.8

during the Long Term Development stage.

8.4.2 Development Phasing

Upgrading of the existing finger piers will be performed in four phases. The major works to be conducted in each phase are as follows:

Phase 1 (1994/1999)

This period is the construction period of the Short Term Development.
- Demolishing the existing shed at Pier No.7
- Upgrading of deck pavement after the shed demolition
- Upgrading of mole pavement
- Introduction of a mobile crane

Phase 2 (2000/2002)

This phase is the construction period of the Long Term Plan Development.
- Partial modification of the existing shed at Pier No.8 for new passenger terminal
- Upgrading of the mole pavement and access

Phase 3 (2003/2009) Nothing to be noted.

Phase 4 (2010 and after) Nothing to be noted.

8.4.3 Existing Finger Pier Improvement for Wharf Crane (Tentative)

Chapter 7 of Part I concluded that all the finger piers are stable enough for normal port operation, even against large berthing forces or seismic forces. However, a special container handling equipment as a gantry crane is quite heavy and gives large vertical loads on the pier deck. Therefore a stress check should be carried out in case that a gantry crane is equipped on the pier.

This section deals with the evaluation of the existing deck structure (beams including piles) when a gantry crane is equipped on the finger pier No.7.

Note: It is concluded that finger piers will not be equipped with a heavy crane.

(1) Basic Conditions

Type of Gantry Crane

The type of a gantry crane which might be equipped on the pier is not known yet. However, the following dimensions of the crane will be applied for this study.

- Crane type : Panamax type
- Rail span : 24.2 m (3 x pile pitch 8.08m)
  Note: The crane span should be same as where the piles locate.
- Wheel Base : 16 m
- Crane Weight : 750 ton
- Nos. of Wheels : 4 x 8 wheels = 32
- Vertical Load : 50 ton/wheel

Dimension of Beams

Dimension of the existing longitudinal concrete beams are as follows:

- Beam Type : Concrete beam reinforced by steel girder
- Dimensions of the beam : A (Area of section) = 0.660 m2
  I (Moment of inertia) = 0.525 m4
  Z (Modulus of section) = 0.457 m3
- Beam Span : 13.7 m per beam

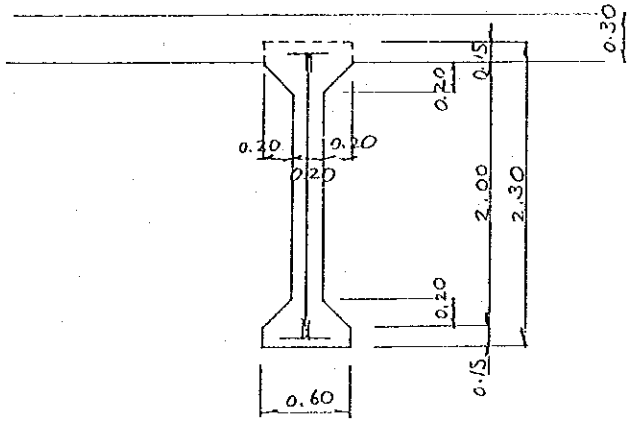


Figure 8-4-1 Dimension of Beam (Pier No.7)

Loading Case

The following figure shows the condition of crane wheels loading on the beams.

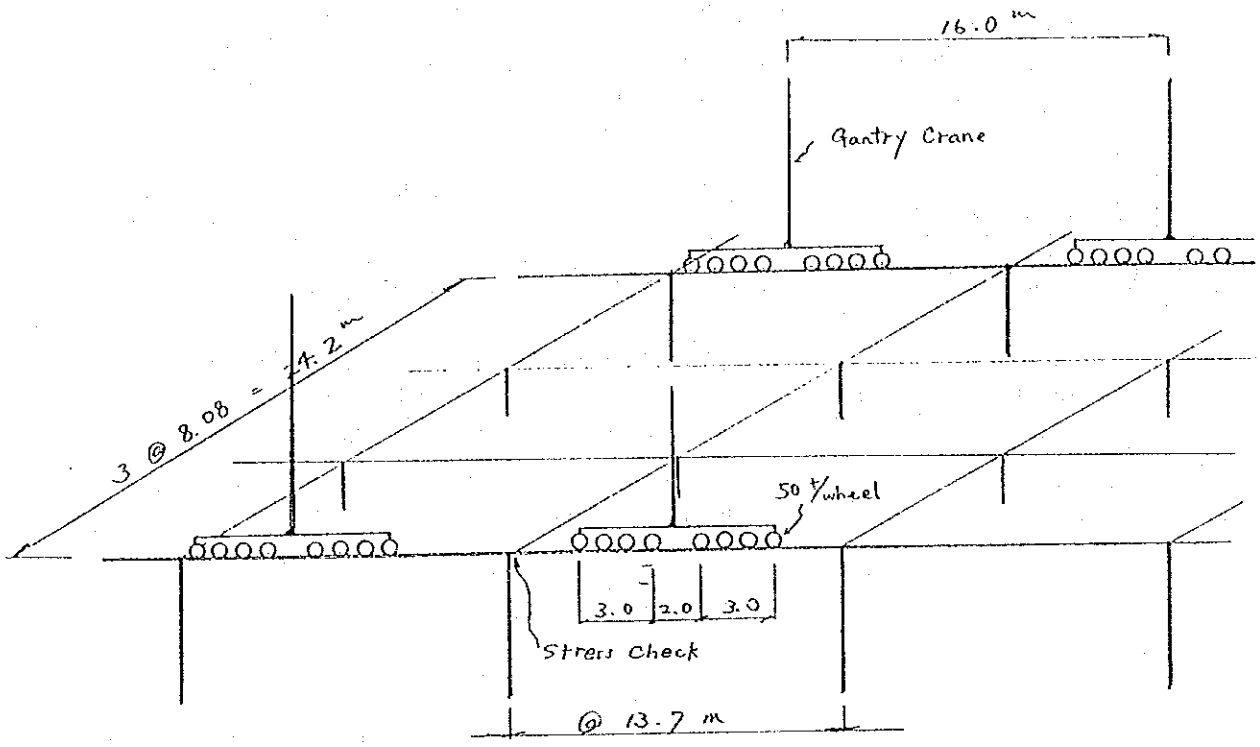


Figure 8-4-2 Loading Case for Stress Calculation

Concrete Quality

Concrete strength of the beams was obtained by concrete core sampling as mentioned in Chapter 8 of Part I. The standard concrete quality of Fc'=240kg/cm2 shall be applied in this study. The allowable stress of the reinforced concrete is assumed as follows:

	Long-term	Short-term
Sc (Axial compressive stress)	72 kg/cm2	108 kg/cm2
Sb (Bending compressive stress)	90 kg/cm2	135 kg/cm2
Ss (Shearing stress)	4.5 kg/cm2	6.8 kg/cm2

On such a condition that the crane is loaded on the beam, a long-term allowable stress shall be applied.

(2) Stress Calculation

Stress check will be conducted at the beam-pile connection point where a largest sectional force occurs. The result of calculation of sectional force and stress is shown below.

Check on Longitudinal Beam

- Sectional Force due to Dead Load (incl. beams & slabs)
  Md (Bending moment) = 278 tm
  Sd (Shearing force) = 122 t

- Sectional Force due to Crane Wheel Load
  Mc = 548 tm
  Sc = 200 t

- Total Sectional Force
  M = 826 tm
  S = 322 t

- Stress
  Sb = 181 kg/cm2 > Allowable 90 kg/cm2
  Ss = 49 kg/cm2 > Allowable 4.5 kg/cm2

Thus, the existing longitudinal beams of pier No.7 are not durable for heavy gantry crane loads. Therefore a necessary countermeasure to reinforce the beams should be required in case that a gantry crane be equipped on the pier.

Method for reinforcing the beams will be discussed later.

Check on Foundation Piles

- Axial Force acting on Piles
  N = 322 + (Np: Self weight of pile)
  where the self weight of the pile is calculated as;
  Np = 6.1 t/m x 37 m
  = 226 t/pile
  Thus, N = 322 + 226 = 548 t/pile

- Allowable Bearing Capacity of the Pile
  Ra = 30 x N value x Ap/ SF
  where, N value = 50 (Gatun Rock's N value is more than 50)

Ap : Sectional area of pile = 2.545 m2
SF : Safety factor at long-term condition = 2.5
Thus, Ra = 30 x 50 x 2.545 / 2.5
= 1,527 t/pile > 548 t/pile

Therefore the existing foundation piles have enough bearing capacity against heavy crane loads.

(3) Improvement Alternatives

In order to reinforce the existing longitudinal beams, an additional section should be constructed nearby the existing beams. The required sectional area for reinforcing will be determined from the result of stress check as appeared in the previous sub-section.
The required sectional area is calculated as follows:

A = 0.660m2 x (49 - 6.8)/6.8
= 4.10 m2

The additional beams should better be built as close to the existing beam as possible. However, in order not to destroy the sound foundation piles' top, the new beams will be built a little away from the existing beam and they should all band together by lateral beams as shown in Figure 8-4-3.
The beam height will be as same as the existing from an anti-corrosion point of view.

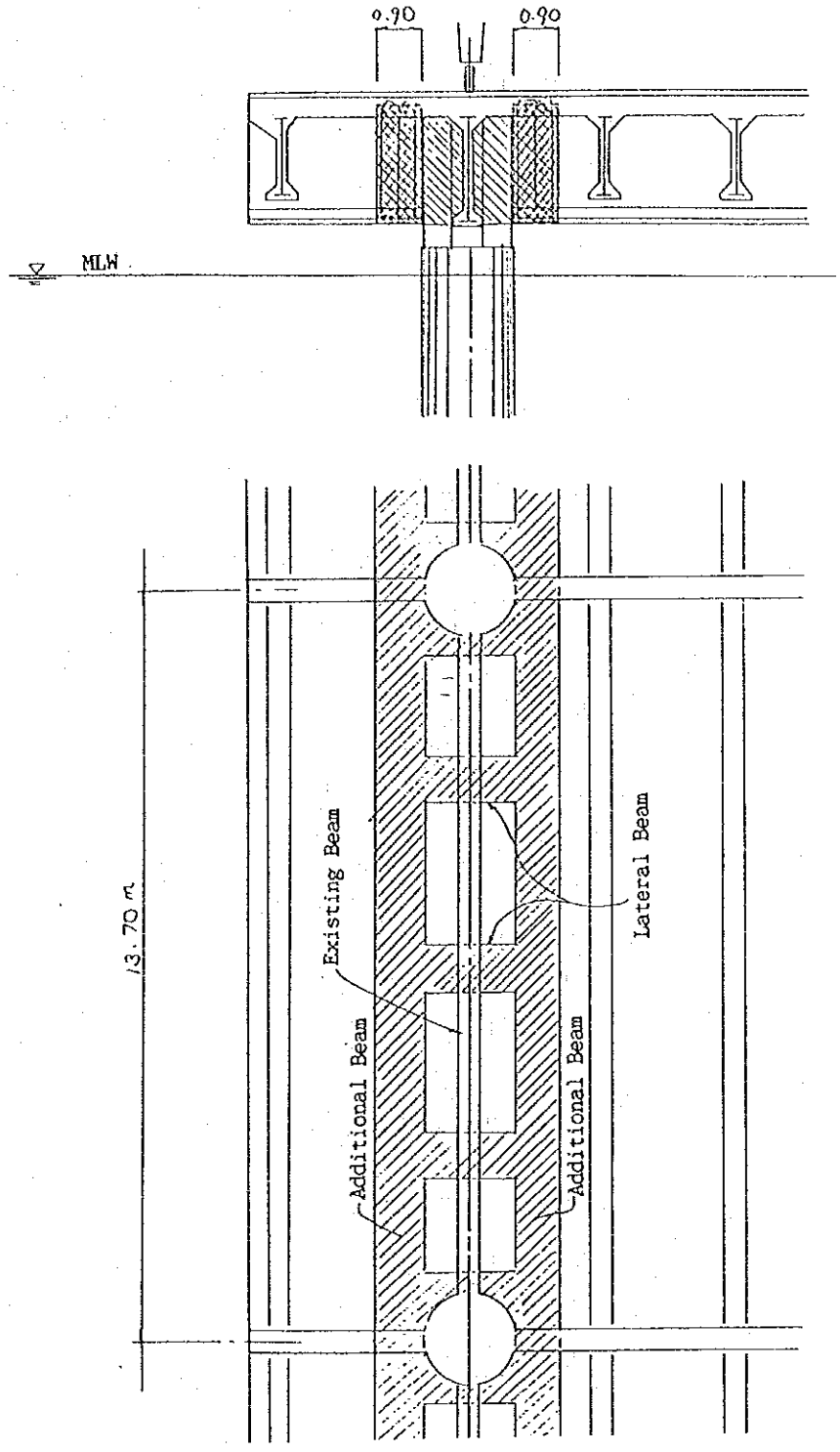


Figure 8-4-3 Improvement Alternative : Longitudinal Beam

8.5 Required Upgrading of Existing Pier No.16.

For the time being, there is no requirement for upgrading the Pier No.16. Important action to be made by APN will be to carry out the ordinary routine maintenance works.

8.6 Required Upgrading Works for Mole

(1) Basic Consideration

The existing mole project takes place in the eastern part of the APN management area in Cristobal. It provides the finger piers with both access area and shelter against north-eastern waves. It should also provide port users with an emergency storage yard.

Recommendations on routine maintenance works to the mole are as follows:

a. Railway system should be maintained as proposed in Chapter 3 of Part II. Some part of them should be replaced by flat pavement in order to increase both areas for access and storage.
b. Existing road access should be rearranged and maintained for smooth traffic circulation.
c. Some area should be allocated to the emergency open storage area.
d. A separate access to the PCC area which locates at the head of mole should be arranged in order to secure safety of cargo and its traffic.
e. Utility embedded in the mole should be maintained by required repair works. Necessary protection on them should be provided against heavy traffic in future.
f. Existing riprapping work of mole's side slopes should be repaired in order to protect the mole itself.

Among the above, items (e) and (f) are discussed with more details in Chapter 6 of Part III as a part of project components for repairing of the existing facilities.

(2) Development Phasing

Upgrading of the existing mole will be performed in four phases. The major works to be executed in each phase are as follows:

Phase 1 (1994/1999)

This period is the construction period of the Short Term Development.
- Partial demolition of existing rail track
- Grading of mole surface for smooth area
- Yard pavement for open storage
- Additional access pavement

Phase 2 (2000/2002)

This phase is the construction period of the Long Term Development.
- Yard pavement for open storage
- Access pavement of mole

Phase 3 (2003/2009) Nothing to be noted.

Phase 4 (2010 and after) Nothing to be noted.

8.7 Facilities out of APN Premises

This section deals with the required works for upgrading of on-land transport system which locates out of the APN premises.

(1) Road Network Improvement to Existing Port Area

In order to improve the onland transport system, the existing road network should be upgraded. Figure 8-7-1 shows the recommended scope of work.

(2) Road Network Improvement to New Terminal at Telfers Island

It is recommended to construct a new road network between the new terminal at Telfers Island and the major routes. Figure 8-7-2 shows the recommended alignment of road system. The longest access will be a by-path road between the new terminal site and the Free Zone area through the France Field. This access requires to arrange five bridges.

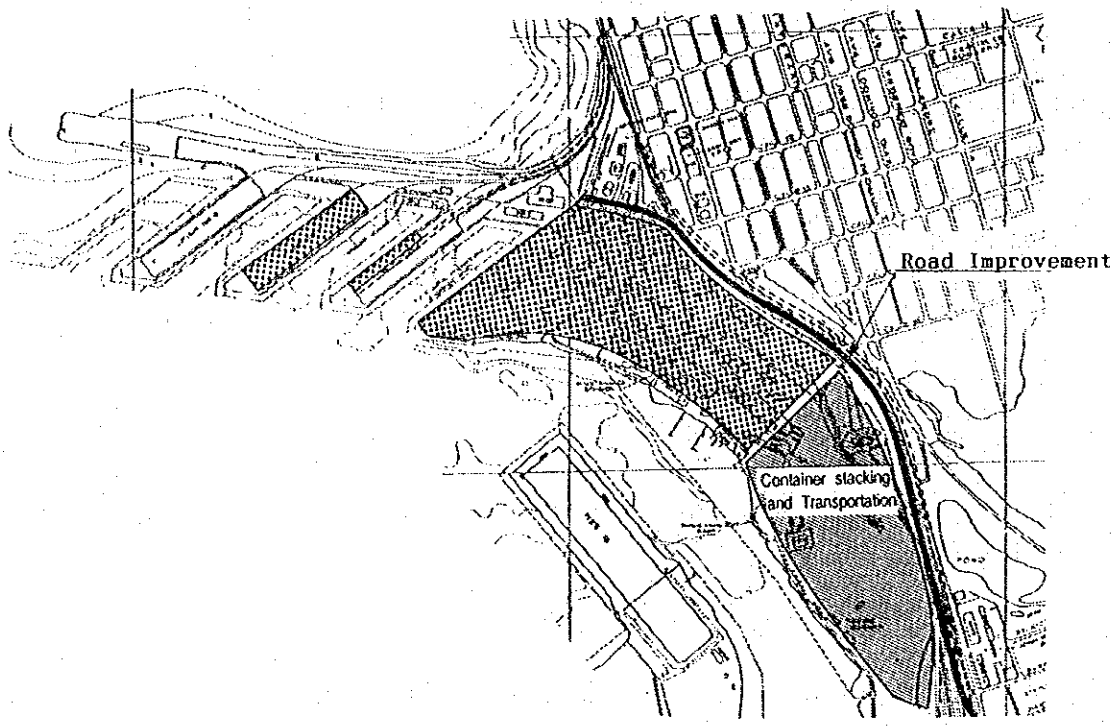


Figure 8-7-1 Recommended Road Improvement to Existing Port Area

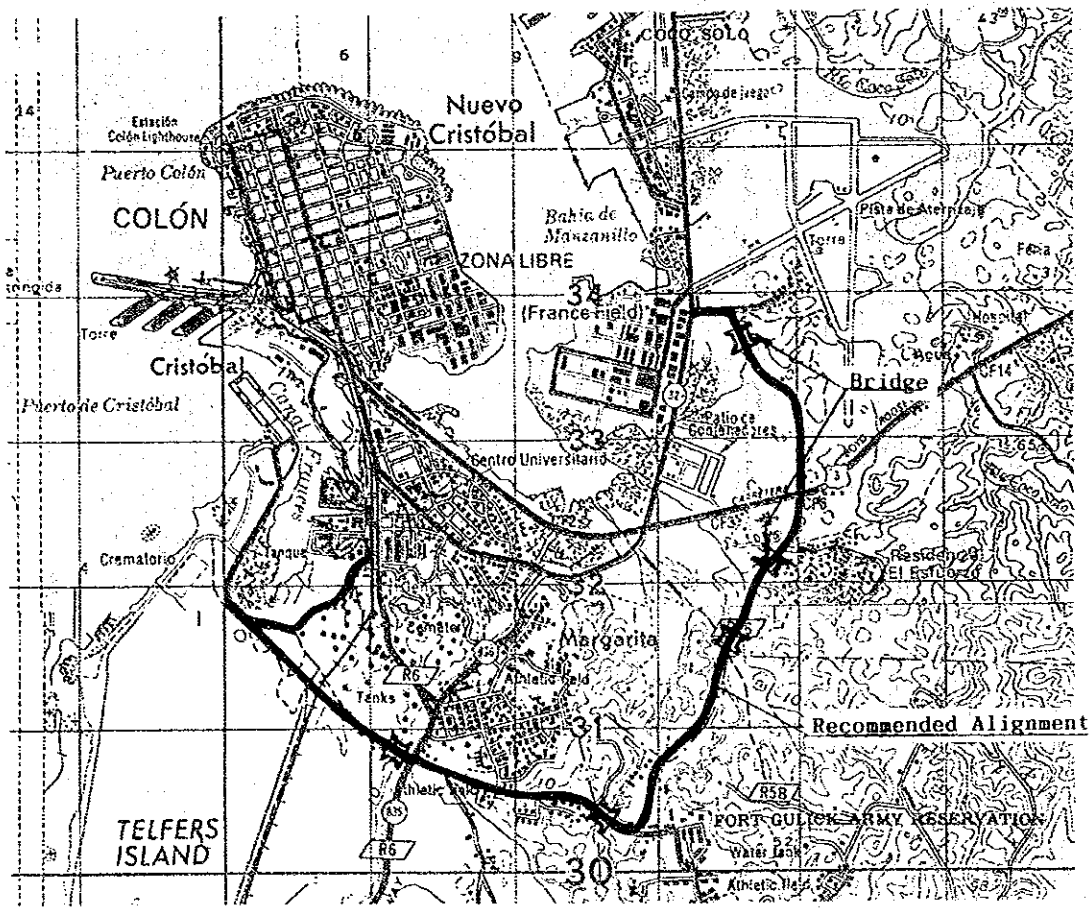


Figure 8-7-2 Recommended Road Improvement to New Terminal

CHAPTER 9 PROJECT COST ESTIMATION AND LONG TERM IMPLEMENTATION SCHEDULE

This chapter deals with both the cost aspect and construction program of the Master Plan project. Quantity of works are basically based on the Master Plan facility planning concepts as shown in Chapter 4, Chapter 5, Chapter 6 and Chapter 7 of Part II.

The cost aspect and construction program of the short term project among the Master Plan project will be discussed in Chapter 7 of Part III. Required costs are estimated based on the quantities of work and unit prices for each work component. The same unit prices are applied for both the long term project and short term project. Detailed information regarding the unit prices are provided in Appendix II-A, and Appendix III-A indicates refined project cost by which the required cost study in this chapter is conducted.

Highlight of the project components is the new container terminal since its required initial cost may share about 93 % of the total initial cost.

> Note : The Short Term Development and the Long Term Development are the proposed works for 1994/1999 and 2000/2009 respectively. Both development schemes constitute the Master Plan Development.

9.1 Basic Composition of Project Cost

The project cost is one of the most important aspects to be evaluated. An economical terminal construction and easy maintenance will make the port charges low and maximize the operation profits. Other than these points of view, there are three prospectives with respect to the required costs since this study is for preparation of a Master Plan of the port of Cristobal for the year 2010.

Port Development Cost

- Prospective 1 : Renewal of Existing Facilities

  How much routine investment should be made for maintaining the existing port facilities? This category of works includes the required renewal of cargo handling equipment and large scale renewal of the existing fixed facilities. This should be based on the study results of Chapter 5 and Chapter 6 of Part II.

- Prospective 2 : Upgrading and Replacement of Existing Facilities

  How much additional investment should be made for upgrading the existing port facilities including container terminal at Pier No.9 ? Improvement works required for the existing piers and mole will also be added. This work includes replacement of the existing equipment with advanced ones. This should also relate to the study

results of Chapter 5 and Chapter 6 of Part II.

- Prospective 3 : New Terminal Development

  Which site is the best selection for a new container terminal? This alternative study has been discussed in Chapter 4 of Part II. Cost estimation of a new terminal at each candidate site should be performed based on the terminal facility scale as discussed in Chapter 4. This category includes not only an initial construction cost but also an initial equipment cost. The required cost for periodical purchase of cargo handling equipment are also included.

  Note : Cost components categorized in Prospective 1 are for maintaining the present port capacity of the existing facilities, while those in Prospective 2 and 3 are for increasing port capacity by adding new functions on the existing facilities and developing a new terminal.

Another important aspect is the time table ensuring the most feasible investment. This time schedule was fixed for the Master Plan (Long Term Development and Short Term Development) based on the port demands supported by the traffic demands forecast. For demands forecast refer to chapter 2 of Part II.

Phasing of Project Implementation

Cost subdivision between the Short Term Development stage and the Long Term Development stage should be mode based on this time schedule.

Cost should consist of an initial investment cost and maintenance and operation costs. The required cost integration by a selected management system will be performed based on the recommendations in Chapter 9 of Part III.
The unit prices adopted here are basically following to the current prices in Panama 1993 and the similar project experience in other developing countries.
However, the cost estimation in this study is neither for construction purpose nor detailed design. Thus, an appropriate contingency amount should be considered.

In addition to the above, a cost comparison study on the cost difference between the wharf depth of -12 m and -14 m should be conducted. The deeper water depth can provide port users with preferable conditions in term of vessel size. However, the deeper water, the higher cost. For the selection of best wharf depth, this study should be performed. Chapter 8 of Part II provides detailed discussions on this matter. Based on the results of Chapter 4 of Part II, it is concluded that the new terminal wharf should be structurally designed for MLW -14 m, however the initial water depth should be -13 m for minimizing the initial investment cost.

9.2 Initial Investment Cost and Operation/Maintenance Cost

This subsection deals with the definition of cost components.

(1) Existing Facility Improvement and New Development

The major existing port facilities to be improved in the port of Cristobal are as follows:

- Finger Piers No.6, No.7 and No.8
- Cristobal mole
- Marginal wharves, Piers No.9 and No.10
- Container terminal behind the marginal wharves
- Pier No. 16.
- Access road

These facilities except roads are currently utilized for cargo handling and storage. Besides these, it is proposed to construct a new container terminal at Site-T, Telfers Island.

As discussed in the previous subsection, there are three different types of required costs.

- The required costs for Prospective 1, renewal of existing facilities.

  These include works for the existing port facilities namely, the finger piers (Piers No.6, No.7 and No.8) including the mole, the marginal wharves (Piers No.9 and No.10) including container terminal and Pier No.16.

- The required costs for Prospective 2, upgrading and replacement of existing facilities.

  These are composed of works for upgrading of the existing port facilities and access roads as specified in Prospective 2.

- The required costs for Prospective 3, the new terminal development.

  This consists of works for completely new terminal development to handle the cargo exceeding the capacity of existing facilities even after conducting Prospective 2. Three container berths will be constructed, a berth during the Short Term Development (STD) and two berths during the Long Term Development (LTD).

(2) Initial Investment, Periodical Purchase and Operation/Maintenance

Some cost may be used relatively in a short period, however, another cost may be spent continuously during its project life. The former is named as the initial

investment cost and the latter is called as the periodical purchase cost and the maintenance and operation cost.

Existing facility:

Initial Investment Cost

The required initial investment costs for the existing facilities are limited to the necessary costs for maintaining or upgrading of them, since they are already constructed.

In this project, the upgrading of the existing container terminal is categorized as a major item to this. Other than this, the existing piers and mole will be upgraded as required.

Periodical Purchase Cost

Necessary investment for the cargo handling equipment should be made. There are two types of investments regarding the time of introduction, namely the initial investment and periodical investment. The former consists of a required initial cost which will be spent in a short period generally with initial construction works. In this project, this type of investment will be conducted as follows:

Term	Existing Facility	New Terminal
Short Term	1994/1995	1998/1999
Long Term	2001/2002	2003/2004 and 2008/2009

However, the latter will be spent periodically for renewal and replacement after the initial investment.

Note : All the equipment cost for the existing terminal is classified to the periodical cost.

There are basically two types of investments regarding periodical equipment cost, namely, the equipment renewal and equipment replacement. In the cost estimation, the former means ordinary equipment purchase of the same type of machines as before. The latter is for upgrading of existing equipment by means of purchasing advanced one.

For the detailed classification of equipment cost, the following definitions are used:

a. "Initial"
b. "Renewal for initial"
c. "Replacement"
d. "Renewal"

Item (a) is as explained previously. Item (b) is renewal of equipment of initially

invested. Item (c) is replacement of previous equipment by advanced one. Item (d) is just ordinary renewal of previous equipment by same but new one. Last three items belong to the periodical investment.

Operation and Maintenance Cost

Of course, the existing facilities need to be taken care of for providing services to the port users. This is the operation and maintenance cost. The operation cost includes the necessary cost for equipment handling and facility use. The required manpower costs are also included. The maintenance cost consists of routine repair works for maintaining all the facilities in order.

The scale of operation cost depends on both the cargo handling method and the cargo volume, while, the maintenance cost is based on the port facility itself. Thus all the existing port facilities requires appropriate operation and maintenance works. Refer to section 9.11.

New Development:

Initial Investment Cost

The initial investment will consist of both the required costs for fixed facilities and cargo handling equipment. Necessary investment for the access improvement will be estimated based on both schemes of existing access upgrading and development of new access. Of course, the largest investment will be undertaken for the construction of a new container terminal at Telfers Island.

Periodical Purchase Cost

Necessary investment for periodical purchase of equipment should be conducted based on the scheduled life of each equipment.

Operation and Maintenance Cost

The new terminal will require the necessary cost for its operation and maintenance.

(3) Application to the Project Components

Prospective 1:

The prospective 1 includes required works for maintaining the existing facilities. Thus, this does not include any initial investment costs. The required renewal cost of existing cargo handling equipment belongs to this. The operation cost for this component is the required cost for operation as APN currently uses. The maintenance cost is the routine maintenance work cost which is required for

keeping the existing facility in orderly condition by means of periodical repair works.

Prospective 2:

The prospective 2 is for upgrading and replacement of existing facilities not only to meet the new function allocated but also for increasing the present capacity for future cargo demands. This can be applied not only to the existing container terminal but also to the other existing facilities. Thus, this includes the initial investment cost for upgrading of the existing fixed facilities and replacement of cargo handling equipment. The operation cost also should be considered.

The routine maintenance work is to be provided also for ensuring the improved facilities in orderly condition by means of periodical repair works.

Prospective 3:

The prospective 3 is for the development of a new container terminal. The initial investment cost includes the fixed facilities and cargo handling equipment. The required cost for the renewal of initially purchased equipment should be added. Operation and maintenance cost should also be included.

9.3 Basic Condition for Cost Estimation

This subsection deals with the basic conditions with respect to the construction and cost estimation.

9.3.1 Pricing Policies

The costs consist of all the necessary direct expenses including material, transportation, manufacturing and installation. Direct costs should include tax and customs duty. Each cost includes not only such direct costs but also management cost, reasonable over-head and profit. Unit cost of each work component was estimated by the Study Team considering the past experiences on similar type of project together with the cost information provided by APN.

Among the various port facilities, both wharf structure and seawall were roughly designed. However the size of structure may be changed subject to modifications during the detailed design.

9.3.2 Costing Criteria

The cost estimation made herein are based on the following conditions:

1) Construction efforts for the Short Term Plan is tentatively scheduled to commence at the beginning of 1994 and to complete by the end of 1999.
   It is also assumed that the construction efforts for the Long Term Plan will commence at the beginning of 2000 and complete by the end of 2009.
2) Estimation is based on the market price as of January 1993.
3) Tax for the material purchase, ITBM is contained in the unit price in construction cost except equipment. However, municipal tax which is about 1.5% of the fixed facilities costs is excluded.
4) Customs duty on imported construction materials for permanent works except equipment are included.
5) Engineering fee is 10% of the construction cost.
6) Physical contingency is 15% of the construction cost.
7) Price escalation is not considered.

Any cost for land purchase or rental otherwise is excluded in the cost estimation. It is proposed that a part of Telfers Island can be utilized for free of charge by the contractor as a temporary construction site. It is also proposed, at the tender stage, the possibility that a half of the southern faceline of Pier No.16 could be provided to the contractor for construction purpose.

The typical unit price and major construction plants especially for floating equipment are provided in Appendix II-A and Appendix III-A respectively.

9.4 Phasing of Project Implementation

Upgrading of the existing port facilities will be conducted as early as possible. New container terminals will be constructed to cope with the increase of demands.

Construction/procurement schedule of each project facility and equipment and timing of commencement of their services are shown below.

Table 9-4-1 Outline Schedule

Facility	Construction/ Procurement	Commencement of Service
Existing Port Facility inducing Container Terminal (Cristobal) B1		
Short Term	1994 - 1995	1996
Long Term	2001 - 2002	2003
Container Terminals (Telfers) B2, B3/4		
Short Term *	1998 - 1999	2000
Long Term I	2003 - 2004	2005
Long Term II	2008 - 2009	2010

Note : Assuming that the project site in Telfers Island will be reverted from PCC by 1997. Instrument and equipment works at the existing container terminal will also be undertaken in 1999 and 2009.

Implementation schedule of the Master Plan will be further refined based on this outline schedule. Detailed basic investment schedule is shown in Table 9-4-2.

Table 9-4-2 Basic Investment Schedule

Ph.	Clnd. Year	Project Components: New Container Terminal — One Berth(300m) Telfers B2	New Container Terminal — Two Berths(600m) Telfers B3	New Container Terminal — Two Berths(600m) Telfers B4	Existing Facilities — Container Terminal Pier 9,B1	Existing Facilities — Mole and Piers
1a	1994				Execution	Execution
1a	1995	Finance*			do	do
1a	1996	Design*				
1a	1997	Contract				
1b	1998	Construction				
1b	1999	Construction	Cargo Review		Equipment *	
2	2000	Operation	Finance			
2	2001		Design		Execution	Execution
2	2002		Contract		do	do
3	2003		Construction			
3	2004		Construction	Cargo Review		
3	2005		Operation	Finance		
3	2006			Design		
3	2007			Contract		
3	2008			Construction		
3	2009			Construction	Equipment *	
4	2010			Operation		
4	2011					
4	2012					
4	2013					
4	2014					
4	2015					
4	2016					
4	2017					
4	2018					
4	2019					
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4	2021					
4	2022					
4	2023					
4	2024					
4	2025					
4	2026					
4	2027					
4	2028					
4	2029					
4	2028					
4	2029					

Legend: [ ] Short Term Plan

[ ] Long Term Plan

Notes. 1. Cargo handling equipment renewal and replacement are excluded.
2. "Finance" means preparation and arrangement of finance.
3. "Design" means both the required detailed investigation and design.

The project cost expenditure can be divided into five phases.

- Phase 1a : During the undertaking of the urgent plan in the Short Term Development Plan
- Phase lb : During the undertaking of the Short Term Development Plan
- Phase 2 : After the Short Term Development Plan stage but during the Long Term Development of the existing facilities
- Phase 3 : During the undertaking of Long Term Development for new terminals
- Phase 4 : After the completion of Long Term Development

Phase 1 and Phase 3 should be implemented by the year 1999 and 2009 respectively. Three major project components of Prospective 1, Prospective 2 and Prospective 3 will be implemented based on this phasing diagram at an appropriate time. The required cost for these components can be divided into three categories, namely;

- Initial investment costs consisting the construction cost and initial equipment purchase cost
- Required cargo handling equipment cost for their renewal and replacement
- Maintenance and operation costs

These facilities will be utilized not only for container cargoes but also other type of cargoes as well as passengers. Project cost to be estimated here includes the required cost for various port services.

Table 9-4-3 demonstrates an entire expenditure plan.

Table 9-4-3 Entire Expenditure Plan

Prospective	Phasing				
	1a STD (Urgent)	1b STD	2 After STD but before LTD	3 LTD	4 After LTD
Prospective1					
Equipment Renewal	(1)	(1)	(1)	(1)	(1)
Maintenance & Operation	(2)	(2)	(2)	(2)	(2)
Prospective 2					
Initial Const.	(3)	-	(3)	-	-
Equipment Replacement	-	(4)	(4)	(4)	(4)
Maintenance & Operation	(5)	(5)	(5)	(5)	(5)
Prospective 3 (STD)					
Initial Investment	-	(6)	-	-	-
Equipment Renewal	-	-	-	(7)	(7)
Maintenance & Operation	-	-	(8)	(8)	(8)
Prospective 3 (LTD)					
Initial Investment	-	-	-	(9)	-
Equipment Renewal	-	-	-	-	(10)
Maintenance & Operation	-	-	-	(11)	(11)

Note:
1. STD = Short Term Development for the year 2000
2. LTD = Long Term Development for the year 2010
3. Initial Investment includes not only construction work but also initial equipment purchase.
4. Figure in parenthesis is the work components to be conducted. Refer to Figure 9-6-1.

9.5 Selected New Terminal Site

As discussed in Chapter 4 of Part II, SITE-T, the northern coast of Telfers Island was selected as the site for the new container terminal construction.

In the minutes of meeting signed by both government in Dec. 1991, a map is attached for the project site selection. Figure 9-5-1 is the attached map showing three alternative sites.

SITE-C : West Colon
SITE-T : Telfers Island
SITE-CS : Coco Solo

In addition to these, an alternative site at the French Canal, SITE-F was generated for more realistic study.
An overall evaluation on these four alternatives is conducted by six major views as follows:

- Reliability
- Space utilization
- Water area utilization
- Accessibility
- Effect on Existing Function, and
- Construction Cost (Initial Investment Costs)

For this evaluation, cost estimation of eight alternative sites were conducted as shown in Chapter 8 of Part II.

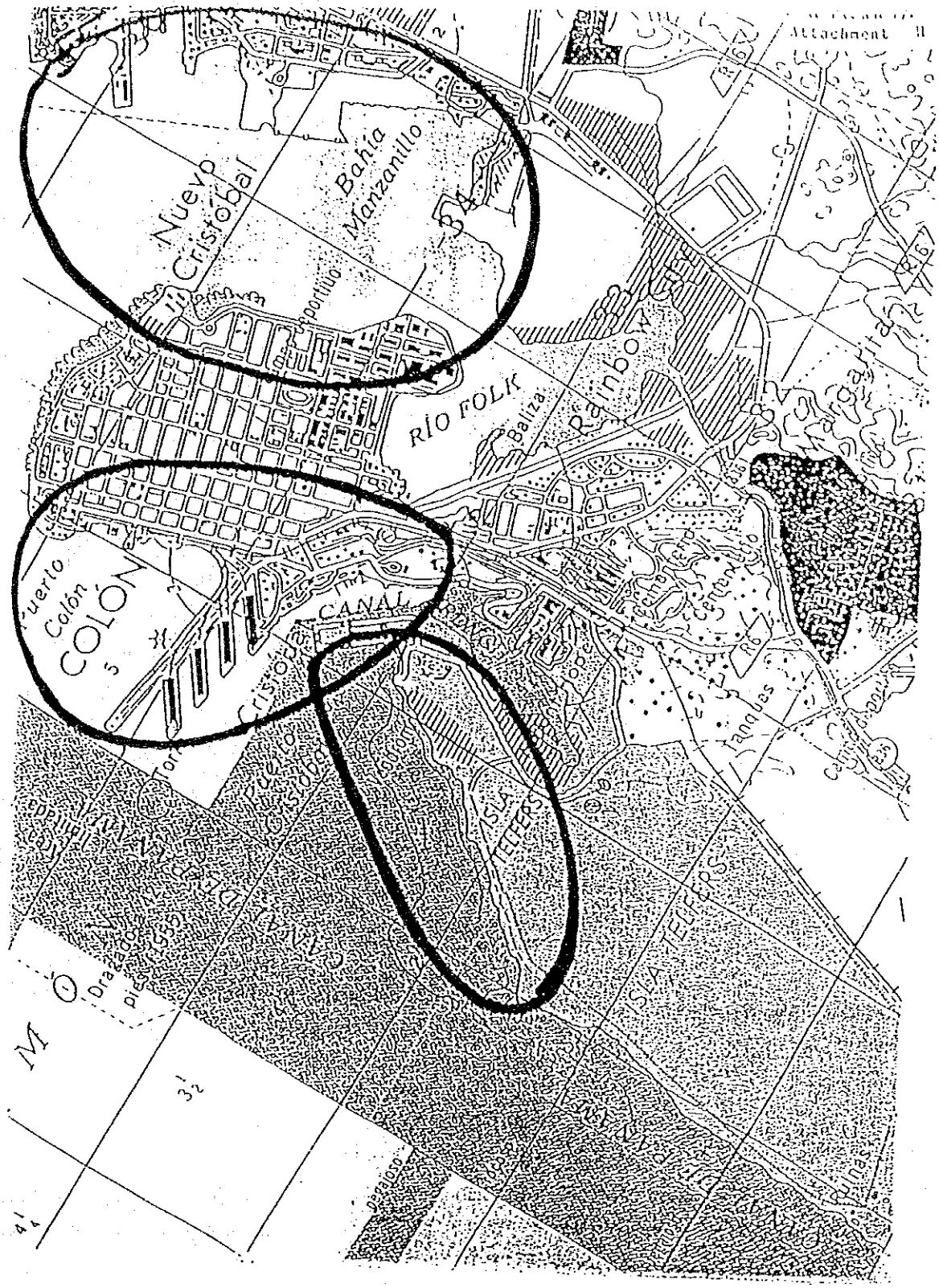

Figure 9-5-1 Attached Map in the Minutes of Meeting (Dec.1991)

9.6 Project Cost Summary

9.6.1 Project Cost

The total investment costs by the year 2029 except maintenance and operation M/O costs will amount to $574.4 million. An amount of $423.6 million will be invested for the entirely new container terminal including periodical equipment renewal, three berths at Telfers Island. The balance of $150.8 million can be divided into $67.7 million and $83.1 million. The former is the required cost of renewal of the existing container terminal, piers and mole. The latter is the required cost for upgrading and replacement of the said facilities.

The Required M/O are also roughly estimated. It is assumed that an unit M/O costs per TEU is about $40. Total M/O cost by year 2029 will amount to $738 million. The total cost including M/O cost for 36 years between 1994 and 2029 will amount to $1,312.4 million.

Figure 9-6-1 shows the total expenditure outlook including the periodical equipment renewal and replacement cost. Table 9-6-1 shows the total expenditure plan to meet the entire expenditure plan as shown in Figure 9-6-1. Among the total investment costs of $574.4 million, the equipment costs share about 61% amounting to $348.4 million. All these equipment costs are for cargo handling machines including their renewal and replacement. Figure 9-6-2 shows the cost balance between the construction cost of the fixed facilities and equipment cost for the cargo handling machines.

In the phase 1 stage, the Short Term Development, $110.9 million will initially be invested, amounts of $78.3 million and $32.6 million for the construction cost and initial equipment cost respectively. Other than this initial investment, the required cost for periodical equipment renewal and replacement will amount to $16.8 million.

All these costs include a physical contingency to allow an additional cost due to unknown natural conditions. The engineering costs for the detailed design and construction supervision are also included. Table 9-6-2a shows the total initial investment cost detailing with the required physical contingency and engineering costs for design and construction supervision.

9.6.2 Required Investment Cost by Area

Table 9-6-2b indicates the initial investment cost and periodical equipment renewal and replacement cost by area. Table 9-6-2c shows the annual expenditure schedule for initial investment.

As shown in Table 9-6-2b, the total initial investment cost within the project site amounts to $331.0 million for construction works and equipment purchase. This cost will be spent during the period from 1994 to 2009. The required initial cost for the new

container terminal at Telfers Island will amount to $292.7 million which shares 88.4% of the initial cost. The initial cost for the existing container terminal and piers are $31.5 million and $6.8 million respectively. Other than this cost, an amount of $243.5 million should be spent for the periodical equipment renewal and replacement by 2029.
Since the estimate cargo throughput in 2010 is 4.2 million tons, unit initial investment cost per cargo is 78.8 $/ton.

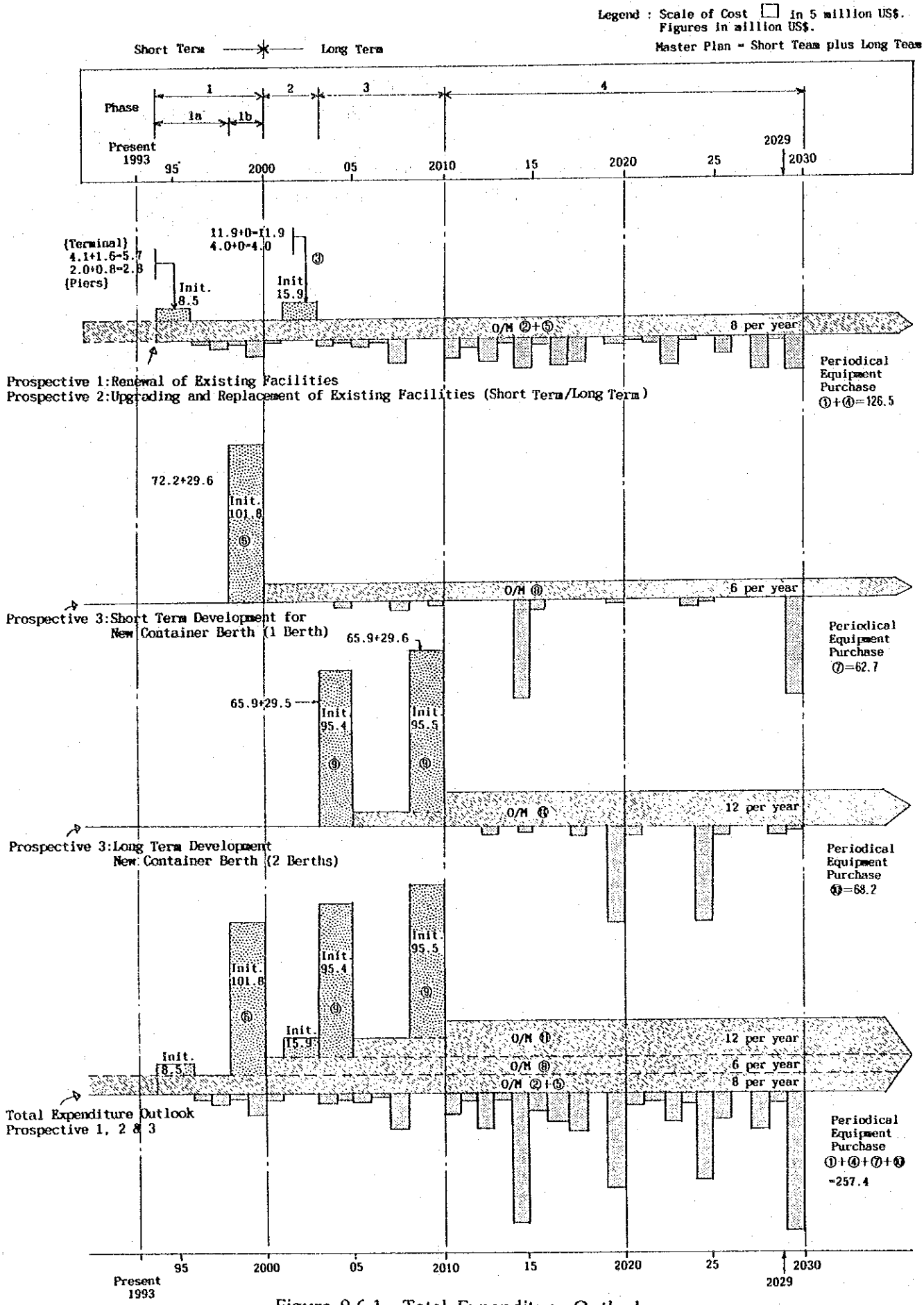

Figure 9-6-1 Total Expenditure Outlook

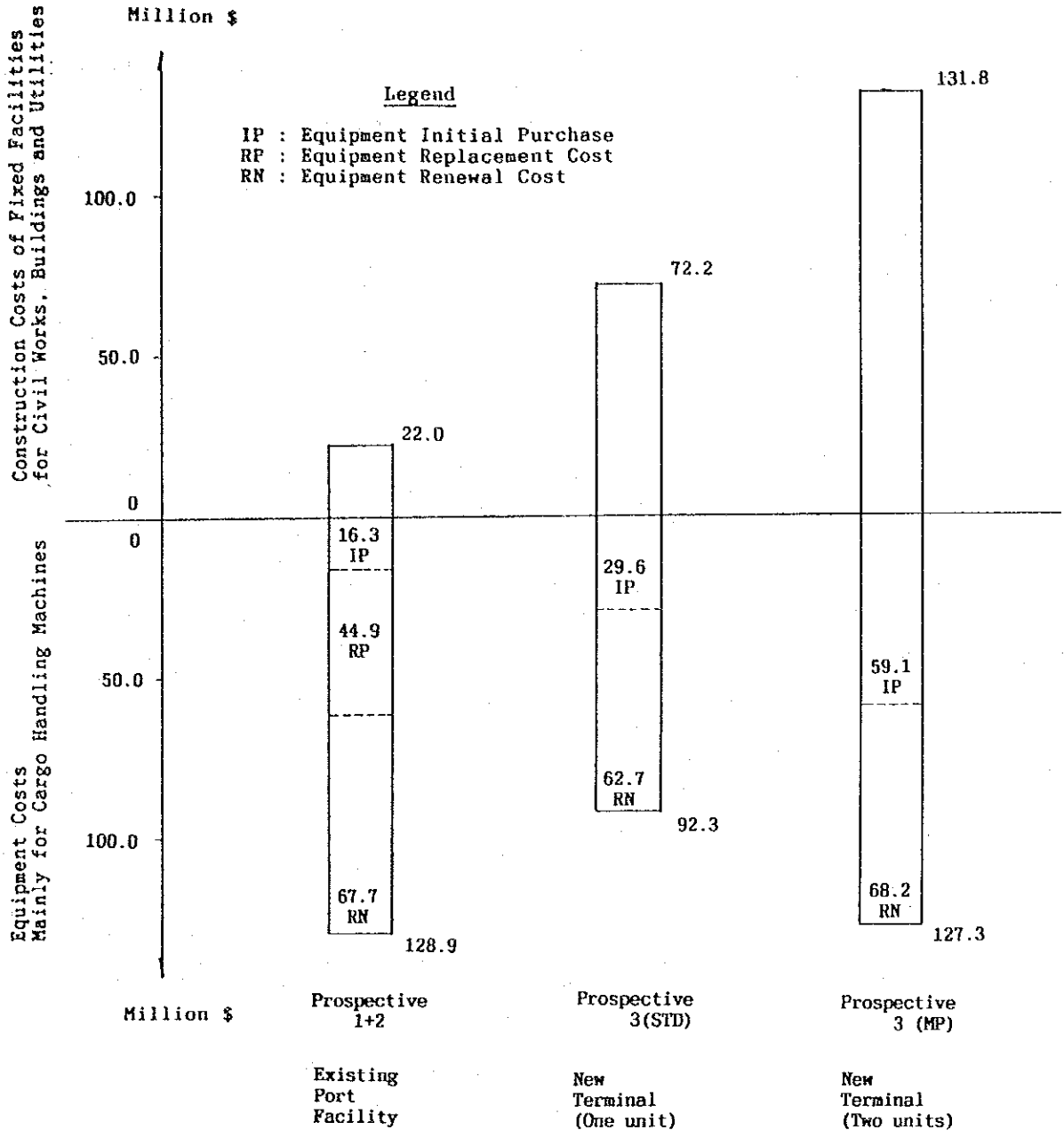

Figure 9-6-2 Balance between Construction Costs and Equipment Costs for 36 years 1994 to 2029

Table 9-6-1 Total Expenditure Plan

Unit: Million US$

Project Components	Phase 1a 4 years 1994/1997	1b 2 years 1998/1999	2 3 years 2000/2002	3 7 years 2003/2009	4 20 years 2010/2029	Total
Prospective 1	-	-	-	-	-	-
a.Initial Const	-	-	-	-	-	0
b.Initial Equipment	-	-	-	-	-	0
Sub-total (a+b)	-	-	-	-	-	0
c.Equipmt Renewal	5.7+0.9	9.8+0.4	9.0+0.1	1.1+1.6	35.3+3.8	60.9+6.8
d.Equipmt Replacement	-	-	-	-	-	0
Sub-total (c+d)	6.6	10.2	9.1	2.7	39.1	67.7
Total (a~d)	6.6	10.2	9.1	2.7	39.1	67.7
e.M/O (2.0 m$/yr)	8.0	4.0	6.0	14.0	40.0	72.0
Group Total (a~e)	14.6	14.2	15.1	16.7	79.1	139.7
Prospective 2	-	-	-	-	-	-
a.Initial Const	4.1+2.0	-	11.9+4.0	-	-	16.0+6.0
b.Initial Equipment	1.6+0.8	0.6+0	0+0	13.3+0	-	15.5+0.8
Sub-total (a+b)	5.7+2.8	0.6+0	11.9+4.0	13.3+0	-	31.5+6.8
c.Equipmt Renewal	-	-	-	-	-	0
d.Equipmt Replacement	0	0	0.2+0	0.8+0.8	40.7+2.4	41.7+3.2
Sub-total (c+d)	0	0	0.2	1.6	43.1	44.9
Total (a~d)	8.5	0.6	16.1	14.9	43.1	83.2
e.M/O (6.0 m$/yr)	24.0	12.0	18.0	42.0	120.0	216.0
Group Total (a~e)	32.5	12.6	34.1	56.9	163.1	299.2
Prospective 3: STD	-	-	-	-	-	-
a.Initial Const	-	72.2	-	-	-	72.2
b.Initial Equipment	-	29.6	-	-	-	29.6
Sub-total (a+b)	-	101.8	-	-	-	101.8
c.Equipmt Renewal	-	0	0	2.9	59.8	62.7
d.Equipmt Replacement	-	-	-	-	-	0
Sub-total (c+d)	-	0	0	2.9	59.8	62.7
Total (a~d)	-	101.8	0	2.9	59.8	164.5
e.M/O (6.0 m$/yr)	-	-	18.0	42.0	120.0	180.0
Group Total (a~e)	-	101.8	18.0	44.9	179.8	344.5
Prospective 3: LTD	-	-	-	-	-	-
a.Initial Const	-	-	-	131.8	-	131.8
b.Initial Equipment	-	-	-	59.1	-	59.1
Sub-total (a+b)	-	-	-	190.9	-	190.9
c.Equipmt Renewal	-	-	-	0.3	67.9	68.2
d.Equipmt Replacement	-	-	-	-	-	0
Sub-total (c+d)	-	-	-	0.3	67.9	68.2
Total (a~d)	-	-	-	191.2	67.9	259.1
e.M/O (12.0 m$/yr)	-	-	-	30.0	240.0	270.0
Group Total (a~e)	-	-	-	221.2	307.9	529.1
Total Project	-	-	-	-	-	-
a.Initial Const	6.1	72.2	15.9	131.8	-	226.0
b.Initial Equipment	2.4	30.2	0	72.4	-	105.0
Sub-total (a+b)	8.5	102.4	15.9	204.2	-	331.0
c.Equipmt Renewal	6.6	10.2	9.1	5.8	166.8	198.5
d.Equipmt Replacement	0	0	0.2	1.6	43.1	44.9
Sub-total (c+d)	6.6	10.2	9.3	7.4	209.9	243.4
Total (a~d)	15.1	112.6	25.2	211.6	209.9	574.4
e.M/O	32.0	16.0	42.0	128.0	520.0	738.0
Total (a~e)	47.1	128.6	67.2	339.6	729.9	1,312.4

Notes: 1. M/O cost is estimated $40 per TEU. Refer to Section 9.11.
2. Contingency (15%) and engineering fee (10%) are included.

Table 9-6-2a Total Initial Investment Cost

Unit: million $

Items	Phase 1a	1b	2	3	4	Total
a.Construction Works	4.9	57.8	12.7	105.4	0	180.8
b.Conti*/Eng**	1.2	14.4	3.2	26.4	0	45.2
Sub-total (a+b)	6.1	72.2	15.9	131.8	0	226.0
c.Mechanical Works	2.4	30.2	0	72.4	0	105.0
Total (c+d)	8.5	102.4	15.9	204.2	0	331.0

Notes: 1. * The rate of contingency is 15% of the construction works.
2. ** The rate of engineering fees is 10% of the construction works.

Table 9-6-2b Initial Investment Cost and Periodical Equipment Purchase Cost

Unit: million $

Cost Category	Project Site				Access Road
	New Container Terminal	Existing Container Terminal	Piers and Mole	Total	Refer to Section 9.10
a.Initial Const. Works	204.0	16.0	6.0	226.0	11.4
b.Initial Equip. Purchase	88.7	15.5	0.8	105.0	0
Sub-total (a+b)	292.7	31.5	6.8	331.0	11.4
	(88.4%)	(9.5%)	(2.1%)	(100%)	
c.Periodical Equip. Purchase	130.9	102.6	10.0	243.5	0
Total (a+b+c)	423.6	134.1	16.8	574.5	11.4

Notes: 1. "Equipment Renewal/Replace includes the required cost by 2029.
2. Contingency and engineering costs are included.
3. Ordinary routine maintenance cost is excluded.

Table 9-6-2c Annual Expenditure Schedule for Initial Investment

Unit: million $

Year	Initial Const. Works	Initial Equipmt. Purchase	Annual Expenditure	Project Area
1994	3.0	0	3.0	B1 and Piers
6	3.1	2.4	5.5	"
6	-	-	0	
7	-	-	0	
8	36.1	0	36.1	B2
9	36.1	30.2	66.3	B2
2000	-	-	0	
1	7.9	0	7.9	B1 and Piers
2	8.0	0	8.0	"
3	32.9	5.4	38.3	B3
4	33.0	29.5	62.5	B3
2005	-	-	0	
6	-	-	0	
7	-	-	0	
8	32.9	0	32.9	B4
9	33.0	37.5	70.5	B4
2010	-	-	0	
Total	226.0	105.0	331.0	

Note: B1, B2, B3 and B4 show the wharf number.
B1: Existing container terminal at Pier No.9
B2: New container wharf : 1st wharf at Telfers
B3: " : 2nd wharf at Telfers
B4: " : 3rd wharf at Telfers
Piers: Existing piers and mole
Contingency and engineering costs are included.

9.6.3 Preliminary Disbursement Schedule

Preliminary disbursement schedule was developed for the initial investment costs. Table 9-6-3 shows the study results.

Table 9-6-3 Preliminary Disbursement Schedule (Initial Construction and Initial Equipment Purchase)

Unit: Million $

Year	Phase	1.New Container Terminal					2.Existing Container Terminal					3.Piers and Mole (Others)					Total				
		Const. Works	Conti. Eng.	Sub-total	Mech. Works	Total	Const. Works	Conti. Eng.	Sub-total	Mech. Works	Total	Const. Works	Conti. Eng.	Sub-total	Mech. Works	Total	Const. Works	Conti. Eng.	Sub-total	Mech. Works	Total
1994	1a	-	-	-	-	0	1.6	0.4	2.0	0	2.0	0.8	0.2	1.0	-	1.0	2.4	0.6	3.0	0	3.0
1995	1a	-	-	-	-	0	1.7	0.4	2.1	1.6	3.7	0.8	0.2	1.0	0.8	1.8	2.5	0.6	3.1	2.4	5.5
1996	1a	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
1997	1a	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
1998	1b	28.9	7.2	36.1	0	36.1	-	-	-	-	0	-	-	-	-	0	28.9	7.2	36.1	0	36.1
1999	1b	28.9	7.2	36.1	29.6	65.7	-	-	-	0.6	0.6	-	-	-	-	0	28.9	7.2	36.1	30.2	66.3
2000	2	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
2001	2	-	-	-	-	0	4.7	1.2	5.9	0	5.9	1.6	0.4	2.0	0	2.0	6.3	1.6	7.9	0	7.9
2002	2	-	-	-	-	0	4.8	1.2	6.0	0	6.0	1.6	0.4	2.0	0	2.0	6.4	1.6	8.0	0	8.0
2003	3	26.3	6.6	32.9	0	32.9	-	-	-	5.4	5.4	-	-	-	-	0	26.3	6.6	32.9	5.4	38.3
2004	3	26.4	6.6	33.0	29.5	52.5	-	-	-	-	0	-	-	-	-	0	26.4	6.6	33.0	29.5	62.5
2005	3	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
2006	3	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
2007	3	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
2008	3	26.3	6.6	32.9	0	32.9	-	-	-	-	0	-	-	-	-	0	26.3	6.6	32.9	0	32.9
2009	3	26.4	6.6	33.0	29.6	62.6	-	-	-	7.9	7.9	-	-	-	-	0	26.4	6.6	33.0	37.5	70.5
2010	4	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0
Total		163.2	40.8	204.0	88.7	282.7	12.8	3.2	16.0	15.5	31.5	4.8	1.2	6.0	0.8	6.8	180.8	45.2	226.0	105.0	331.0

Note: Cargo Handling renewal/replacement cost is excluded. Refer to sections 9.7 and 9.8 for this matter.

Legend: Const. Works = Construction Works,

Conti. Eng. = Contingency (15 %) and Engineering Cost (10 %)

Mech. Works = Cargo handling equipment initial purchas cost including instrument.

Table 9-6-4 Preliminary Disbursement Schedule (Periodical Equipment Purchase for Existing Facility)

Unit: 1,000 US$

Clndr. Year	Existing Container Terminal				Piers and Mole		Aunual Total			Phase Total		
	Instrument		Equipment		Equipment		Initial/	Renewal	Total	Intial/	Replace	Renewal
	STD	LTD	Replace	Renew	Replace	Renew	Replace			Purchase		
93												
94	0		0	0	0	0	0	0	0			
1995	0		1,590	4,602	800	112	2,390	4,714	7,104			
96				480		0	0	480	480			
97				645		744	0	1,389	1,389	(2,390)	0	6,583
98				0		403	0	403	403			
99	598			9,760		0	598	9,760	10,358	(598)	0	10,163
2000			246	202		112	246	314	560			
01	0	0		8,800	0	0	0	8,800	8,800			
02	0	0		0	0	0	0	0	0	0	246	9,114
03			(5,376)	439	800	358	6,176	797	6,973			
04	598			0		0	598	0	598			
2005			246	690		856	246	1,546	1,792			
06				0		403	0	403	403			
07				0		0	0	0	0			
08				0		0	0	0	0			
09		(7,898)		0		0	7,898	0	7,898	(13,274)	1,644	2,746
2010			1,590	2,778		112	1,590	2,890	4,480			
11				439	800	358	800	797	1,597			
12				0		0	0	0	0			
13				600		744	0	1,344	1,344			
14		7,898		8,800		403	7,898	9,203	17,101			
2015			246	90		112	246	202	448			
16				8,800		0	0	8,800	8,800			
17				0		0	0	0	0			
18			5,376	0		0	5,376	0	5,376			
19		7,898		439	800	358	8,698	797	9,495			
2020			246	90		112	246	202	448			
21				600		744	0	1,344	1,344			
22				0		403	0	403	403			
23				0		0	0	0	0			
24		7,898		0		0	7,898	0	7,898			
2025			1,590	2,778		112	1,590	2,890	4,480			
26				0		0	0	0	0			
27				439	800	358	800	797	1,597			
28				0		0	0	0	0			
29		7,898		9,400		0	7,898	9,400	17,298	0	43,040	39,069
Initial	(598)	(7,898)	(6,966)	(0)	(800)	(0)	(16,262)	(0)	(800)	(16,262)	-	-
Periodical	598	31,592	9,540	60,871	3,200	6,804	44,930	67,675	128,067	-	44,930	-
Total	1,196	39,490	16,506	60,871	4,000	6,804	61,192	67,657	128,867	-	-	67,675

Note: Figures in parenthesis indicate initial purchase.
STD: Short Term Development
LTD: Long Term Development

9.7 Required Cost for New Container Terminal Development

This section deals with the cost estimation for new container terminal development at Telfers Island. Necessary discussions will be conducted both on the initial construction works and initial cargo handling equipment purchase together with those renewal.

9.7.1 Summary of Required Cost

The required total costs including equipment renewal by 2029 amounts to 382.8 million US$ which consists of the initial construction costs together with initial equipment purchase costs and equipment renewal costs by 2029 of 251.9 million US$ and 130.9 million US$ respectively. Among the initial costs, construction cost amounts to 163.2 million US$ which shares 64.8% of the required initial ones. During the Short Term Development in 1998/1999, 87.4 million US$ will be used for the first container berth in Telfers Island, and another 164.5 million US$ will be spent for the next two berths. Refer to Table 9-7-1 below.

Table 9-7-1 Summary of Required Cost for New Container Terminal

Unit: Million $

Category	Total	Short Term 1998/1999	Long Term 2003/2004 and 2008/2009
A. Initial Cost			
Construction	163.2(64.8%)	57.8	105.4
Cargo Handling E.	88.7(35.2%)	29.6	59.1
Total	251.9(100%)	87.4	164.5
-	(100%)	(34.7%)	(65.3%)
B. Periodical Cost			
Cargo Handling E. Renewal by 2029	130.9	62.7	68.2
Grand Total	382.8	150.1	232.7

Note : Figures shown above do not include contingency and engineering cost.

9.7.2 Initial Construction Cost

The required total initial construction cost amounts to 163.2 million US$, among which the marine work cost shares 51.8%, followed by the on-land work cost at 18.9% and building work cost at 13.5%.

During the Short Term Development stage, an amount of 57.8 million US$ will be spent for the construction of first container berth, and another 105.4 million US$ will be spent for construction of the next two berths in Long Term stage.

Table 9-7-2 shows the summary of initial construction cost for the new container terminal.

Table 9-7-2 Summary of Initial Construction Cost for New Container Terminal

Unit: US$

Work Category	Total	Short Term 1998/1999	Long Term 2003/2004 and 2008/2009	
A.General Works	11,687,500(7.4%)	5,250,000	3,218,750	3,218,750
B.Marine Works	81,424,140(51.8%)	29,403,020	26,010,560	26,010,560
C.On-land Works	29,739,420(18.9%)	9,913,140	9,913.140	9,913,140
D.Building	21,251,950(13.5%)	6,172,650	7,539,650	7,539,650
E.Utilities	10,797,500(6.9%)	3,732,500	3,532,500	3,532,500
F.Supplemental Works	8,288,140(1.5%)	3,296,140	2,496,000	2,496,000
G.Others	0(0%)	0	0	0
Total	163,188,560(100%)	57,767,450	52,710,600	52,710,600
	(100%)	(35.4%)	(32.3%)	(32.3%)

Notes: 1. For cost estimation of Long Term stage, the following items in Appendix III-A are separated from other categories.

a. Passenger Terminal at Pier No.8	1,350,000	US$
b. Mole yard pavement	1,670,400	US$
c. Mole road pavement	189,540	US$
Total	3,209,940	US$

2. In the Long Term stage, two new berths will be constructed in 2003/2004 and 2008/2009. Required cost for each is simply obtained by dividing the cost for two berth simultaneous construction into two parts.

9.7.3 Equipment Cost for New Container Terminal

As discussed in the previous chapters, specifications of the required equipment are proposed for the new container terminal. An annual container cargo by an unit terminal is almost 150,000 TEUs. Two wharf cranes of rating capacity of 41 ton will be provided for each wharf. The container handling method proposed at the marshaling yard is the transfer crane system.

Total numbers of these machines for each wharf are 48 units, breakdown of which are shown in the table below.

Table 9-7-3 Breakdown of Equipment Cost for Unit Container Terminal

Unit: US$

Type of Equipment		Unit Rate Unit		Required Unit	Cost
Equipment					
	Wharf Crane	$/ea	8,800,000	2	17,600,000
	Yard Crane	"	1,344,000	7	9,408,000
	Tractor	"	62,710	16	1,003,360
	Chassis	"	22,400	16	358,400
	Top-Loader	"	480,000	2	960,000
	Forklift(CFS)	"	44,800	1	446,240
Total					29,553,760

The proposed wharf crane is for the Panamax type container vessels which is the largest one calling at the port of Cristobal at present. When the post-Panamax vessels are expecting to arrive at the new terminal, this should be replaced by a large crane.

All the equipment indicated in the table is required for operating of one container terminal unit. Thus, when two terminal units are constructed simultaneously, the required equipment will be double.

Total equipment cost for the Short Term Development:
29.6 million US$

Total equipment cost for the Long Term stage:
Additional 59.1 million US$

These costs include all the required expenses for equipment, transport, installation and testing. Customs duty and ITBM are not included.

Tables 9-7-5 and 9-7-6 show the cost breakdown of equipment renewal both for the Short Term and Long Term stage. These costs can be summarized as follows:

Table 9-7-4 Summary of Equipment Cost : New Terminal

Unit: 1000 US$

Type of Cost	Short Term 1998/1999	Long Term 2003/2004 and 2008/2009	Total
Initial purchase	(48) 29,553.76	(96) 59,107.52	(144) 88,661.28
Periodical Purch.	(183) 62,728.48	(277) 68,178.40	(460)130,906.88
Total	(231) 92,282.24	(373)127;285.92	(604)219,568.16
	(42%)	(58.0%)	(100%)

Notes: 1. Renewal indicates the required cost by 2029.
2. Figures in parenthesis show the total number of machine units.

Table 9-7-5 Cost Breakdown of Cargo Handling Equipment Initial Requirement and Renewal for New Container Terminal B2-1998/1999

Unit: 1000 US$

Year	Wharf Crane 8,800 $	Yard Crane 1,344$	Top-loader 480$	Folk-lift 44.8$	Tractor 62.71$	Chassis 22.4$	Annual Total
1999	(2)17,600	(7)9,408	(2)960	(5)224	(16)1,003.36	(16)358.4	(48)29,553.76
2000							0
2001							0
2002							0
2003							0
2004						(16)358.4	(16)358.40
2005							0
2006							0
2007			(2)960	(5)224	(16)1,003.36		(23)2,187.36
2008							0
2009						(16)358.4	(16)358.40
2010							0
2011							0
2012							0
2013							0
2014	(2)17,600	(9)9,408				(16)358.4	(25)27,366.40
2015			(2)960	(5)224	(16)1,003.36		(23)2,187.36
2016							0
2017							0
2018							0
2019						(16)358.4	(16)358.40
2020							0
2021							0
2022							0
2023			(2)960	(5)224	(16)1,003.36		(23)2,187.36
2024						(16)358.4	(16)358.40
2025							0
2026							0
2027							0
2028							0
2029	(2)17,600	(7)9,408				(16)358.4	(25)27,366.40
Init. Purchase	(2)17,600	(7)9,408	(2)960	(5)224	(16)1,003.36	(16)358.4	(48)29,553.76
Renw. Cost	(4)35,200	(14)18,816	(6)2,880	(15)672	(48)3,010.08	(96)2,150.4	(183)62,728.48
G. Total	(6)52,800	(21)28,224	(8)3,840	(20)896	(64)4,013.44	(112)2,508.8	(231)92,282.24

Table 9-7-6 Cost Breakdown of Cargo Handling Equipment
Initial Requirement and Renewal for New Container Terminal
B3/B4 - 2003/2004, 2008/2009

Unit: 1000 US$

Year	B3 Berth 2003/2004 Annual Total	B4 Berth 2008/2009 Annual Total	Annual Total
1999	-	-	-
2000	-	-	-
2001	-	-	-
2002	-	-	-
2003	Construction	-	-
2004	(48)29,553.76	-	(48) 29,553.76
2005	0	-	0
2006	0	-	0
2007	0	-	0
2008	0	Construction	0
2009	(16) 358.40	(48)29,553.76	(64) 29,912.16
2010	0	0	0
2011	0	0	0
2012	(23) 2,187.36	0	(23) 2,187.36
2013	0	0	0
2014	(16) 358.40	(16) 358.40	(32) 716.80
2015	0	0	0
2016	0	0	0
2017	0	(23) 2,187.36	(23) 2,187.36
2018	0	0	0
2019	(25)27,366.40	(16) 358.40	(41) 27,724.80
2020	(23) 2,187.36	0	(23) 2,187.36
2021	0	0	0
2022	0	0	0
2023	0	0	0
2024	(16) 358.40	(25)27,366.40	(41) 27,724.80
2025	0	(23) 2,187.36	(23) 2,187.36
2026	0	0	0
2027	0	0	0
2028	(32) 2,187.36	0	(32) 2,187.36
2029	(16) 358.40	(16) 358.40	(32) 716.80
Initial Purchase	(48)29,553.76	(48)29,553.76	(96) 59,107.52
Renewal Cost	(158)35,362.08	(119)32,816.32	(277) 68,178.40
Grand Total	(206)64,915.84	(167)62,370.08	(373)127,285.92

9.7.4 Disbursement Schedule for New Container Terminal Development

Based on the development phasing as shown in Section 9.4, the estimated annual expenditure plan of the new container terminal development at Telfers Island is shown in Table 9-7-7.

Table 9-7-7 Development Cost Disbursement Schedule for New Container Terminal

Unit: 1,000US$

Year	Phase	Total Initial Cost			Short Term 1998/1999			Long Term 2003/2004 2008/2009			Equipment Renewal Cost		
		Const.	Equip.	Total	Const.	Equip.	Total	Const.	Equip.	Total	Short Term	Long Term	Total
1998	1b	28,884	0	28,884	28,884	0	28,884	-	-	-	-	-	-
1999	1b	28,884	29,554	58,438	28,884	29,554	58,438	-	-	-	-	-	-
2000	2	-	-	-				-	-	-	0	-	0
2001	2	-	-	-				-	-	-	0	-	0
2002	2	-	-	-				-	-	-	0	-	0
2003	3	26,355	0	26,355				26,355	0	26,355	0	-	0
2004	3	26,335	29,554	55,909				26,355	29,554	55,909	358	-	358
2005	3	-	-	-				-	-	-	0	0	0
2006	3	-	-	-				-	-	-	0	0	0
2007	3	-	-	-				-	-	-	2,187	0	2,187
2008	3	26,355	0	26,355				26,355	0	26,355	0	0	0
2009	3	26,355	29,554	55,909				26,355	29,554	55,909	358	358	716
2010	4										0	0	0
2011	4										0	0	0
2012	4										0	2,187	2,187
2013	4										0	0	0
2014	4										27,366	717	28,083
2015	4										2,187	0	2,187
2016	4										0	0	0
2017	4										0	2,187	2,187
2018	4										0	0	0
2019	4										358	27,725	28,083
2020	4										0	2,187	2,187
2021	4										0	0	0
2022	4										0	0	0
2023	4										2,187	0	2,187
2024	4										358	27,725	28,083
2025	4										0	2,187	2,187
2026	4										0	0	0
2027	4										0	0	0
2028	4										0	2,187	2,187
2029	4										27,366	717	28,083
Total		163,188	88,662	251,850	57,768	29,554	57,768	105,420	59,108	164,528	62,725	68,177	130,902

9.8 Required Cost for Upgrading of Existing Container Terminal

This section deals with the cost estimation for the upgrading of the existing container terminal. The scope of works are mainly modernization of the facilities.

9.8.1 Summary of Required Cost

The required total costs including equipment renewal by 2029 amounts to 130.9 million US$ which consists of the initial cost and periodical cost by 2029 of 28.3 million US$ and 102.6 million US$ respectively. Among the initial costs, construction cost amounts to 12.8 million US$ which shares 45.2% of the required cost. During the Short Term development, 3.3 million US$ will be spent, and another 9.5 million US$ will be spent for the Long Term Development. Refer to Table 9-8-1 below.

Table 9-8-1 Summary of Required Cost for Existing Container Terminal

Unit : million $

Category	Total	Short Term 1994/1999	Long Term 2000/2029
A. Initial Cost			
a) Ordinary Construction	12.8(45.2%)	3.3	9.5
b) Related Instrument Works*	8.5(30.0%)	0.6	7.9
c) Cargo Handling Equipment	7.0(24.8%)	1.6	5.4
Sub-total	28.3(100%)	5.5	22.8
	(100%)	(19.4%)	(80.6%)
B. Periodical Cost			
a) Related Instrument Works	32.2	0.6	31.6
b) Cargo Handling Equipment	70.4	15.5	54.9
Sub-total	102.6	16.1	86.5
Total	130.9	21.6	109.3

Note: 1. Figures shown above do not include contingency and engineering costs.
2. Refer to Table 9-8-5 for equipment renewal and replacement by 2029.
3. Related Instrument Works; Short Term in 1999, Long Term in 2009.

The ordinary construction works are for the improvement of the existing facilities by means of the general construction works, which will be required for the area expansion and rearrangement of facilities. The related works mean the proposed works for the modernization of operating system by introduction of new instruments. These items include not only provision of emergency power supply system but also introduction of computer system.

Addition to the above items, the required cost for existing cargo handling equipment renewal should be taken into consideration. The required total cost for cargo handling equipment renewal and replacement between 1995 and 2029 amounts to 77.4 million US$. Among this cost, the renewal cost will amount to 60.9 million US$ which shares 78.7% of the total cost. An annual average cost of them is 1.8 million US$. Refer to Table 9-8-5.

9.8.2 Ordinary Construction Works : Initial Construction

The details of these costs are shown in Table 9-8-2 and the Table of Cristobal Port Cost Estimation : Summary "Case: SITE-P14 B1" in Appendix III-A.

The required cost for ordinary construction works amounts to 12.8 million US$. All the required costs are categorized into the Short Term Development stage 1994/1995 and Long Term stage 2001/2002.

Ordinary Construction Works	Total (Master Plan)	Short Term 1994/1995	Long Term 2001/2002
a. General Works	$1,387,500	$693,750	$693,750
b. Marine Works	1,732,540	0	1,732,540
c. On-land Works	5,605,870	2,039,250	3,566,620
d. Building	423,300	91,000	332,300
e. Utilities	2,970,720	342,240	2,628,480
f. Supplemental Works	731,000	143,000	588,000
g. Others	0	0	0
Total	$12,850,930	$3,309,240	$9,541,690

As shown in the table, marine works and onland works amount to 7.3 million US$ sharing about 57.0% of this category. The former is mainly for the strengthening of the existing seawall along French Canal ensuring the terminal pavement against the failure of coastal slope. The latter is mainly for the yard expansion, lighting and other access pavement. More cost details of the on-land works are as follows. Other breakdown is shown in Table 9-8-2.

(1) Short Term Development

i) Additional cost for the Area "A"

Area "A" = 10,000 m2
Renovation of this area is conducting by APN since 1992. It is assumed that one-third of unit pavement cost will required.

10,000 m2 x 105.3 $/m2 = 1,053,000 US$