2.4 Redevelopment of Bandaranaike Quay

51. Bandaranaike Quay (BQ) was developed in the early 1950s to serve conventional cargo ships. Facilities of BQ are five berths and four warehouses for break-bulk cargo as follows:

Facilities in Bandaranaike Quay

Berth	Depth	Warehouse
BQ1	6.5m/8.5m	4,905 m2
BQ2	9.5m	5,518 m2
BQ2A		-
BQ3	10.0m	5,518 m2
BQ4	9.0m	4,905 m2
	8.5m	

52. Breakbulk cargo has shown a decrease for the last 10 years so that warehouses in the Bandaranaike Quay are not used for breakbulk but used for unstuffing LCL containers, which are mainly transported from Jaya Container Terminal. Open storage yards for timber, steel, vehicles and containers have a shortage in the port in spite of warehouses.

53. As Bandaranaike Quay is located in the centre of the port, redevelopment as a passenger berth is an appropriate way to utilize the quay. In the long-term development, BQ No.1-2 berths shall be redeveloped as a Ro/Ro terminal and BQ No.3-4 as a passenger berth with a depth of minus 12 meters. However, in the short-term development, BQ shall be rehabilitated for Ro/Ro and conventional berths with a view to catering to car carriers, semi-container and conventional cargo vessels.

54. Development plans for the short-term and long-term are shown in Figures 2.4.1 -2.4.2 respectively and rehabilitation works are listed in Table 2.4.1.

TABLE 2.4.1 Bandaranaike Quay Short-term Redevelopment

Rehabilitation Works	Quantity	Est.Cost
Demolition of Warehouses	4	Total Cost: US$ 16.8 million
Paving	53,000 m2	
Rubber Fenders and Cap Concrete	1,080 m	
Yard Lighting	53,000 m2	

FIGURE 2.4.1 Bandaranaike Quay Short-Term Redevelopment Plan

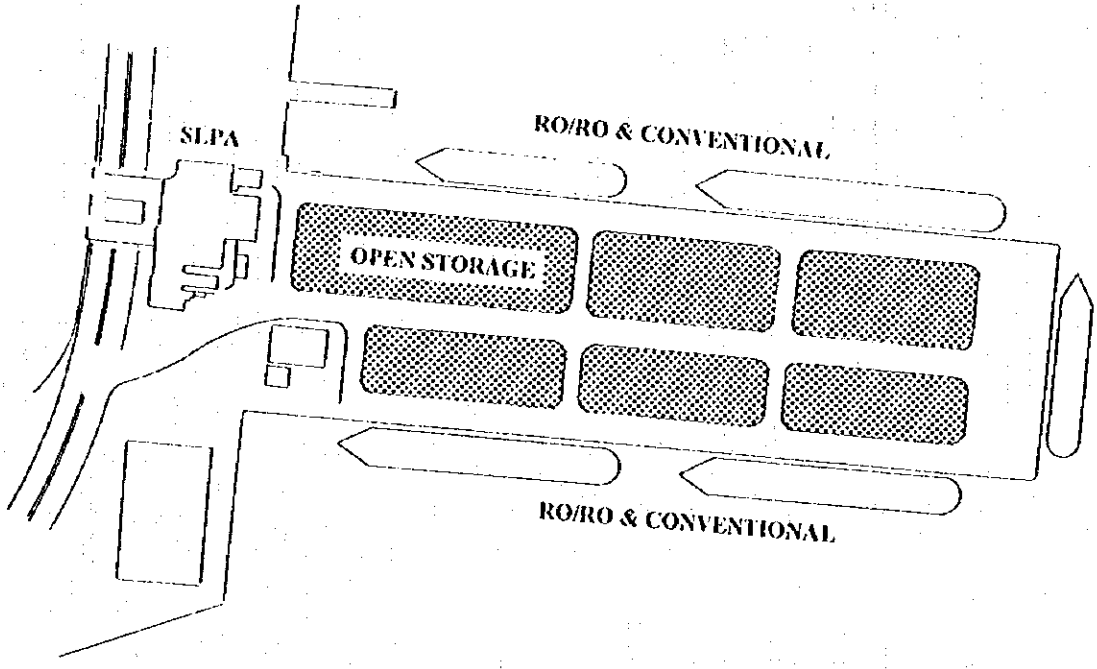
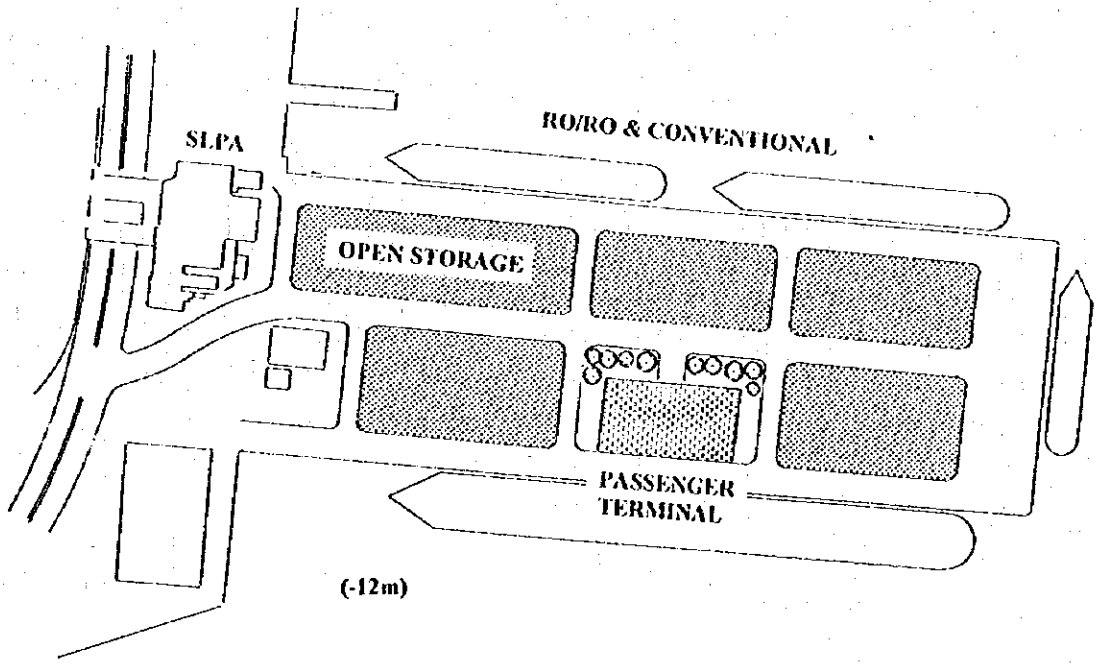


FIGURE 2.4.2 Bandaranaike Quay Long-Term Redevelopment Plan



2.5 Navigation Safety Measures

55. The aim of the short-term plan is to cope with the high potential for growth of the port. With the realization of the plan, its resultant benefits bring the expansion of QEQ outer yard capacity to accommodate Post-panamax vessels. However, the bottleneck of W entrance still remains in question because the widening of the W entrance is not undertaken.

56. This probably requires a lot of expense and a long period for the completion of the new N breakwater, widening the W entrance and then full utilization of the JCT/QEQ berths. Before these conditions are ready, the necessary measures for navigation safety are as follows:

1) additional pilots and simulator training
2) reinforcing tug fleet
3) developing the N channel and adopting traffic separation scheme, and
4) providing navigational aids.

Furthermore, to control traffic safety of the entire port area:

5) introducing VTS, and
6) updating sailing regulations in the port.

2.5.1 Additional Pilots and Simulator Training

57. In 2005, the forecasted number of calling vessels reaches 5,689(low case), 6,291(middle case) and 8,333(high case) against 3,220 of 1994, increases of 177%, 215% and 259%, respectively.

58. It is necessary to continue the existing compulsory pilotage service. Moreover, the present 15 members, four pilots on duty for one day followed by stand-by for two days at Colombo and one pilot on duty at Galle by one month shift, should be increased to 24(low case), 29(middle case) and 34(high case) to manage the forecasted increase in vessels.

59. The selection of a capable new pilot should be prudent on his qualification and gift, further, it requires some months for training to give him practical experience. In this connection, the Authority may commence a solution to the said problem, on the basis of a-pre-estimated need for the pilots.

60. Although the maneuvering skill of the port's pilots have been highly assessed among incoming captains, a program of simulator training would be necessary to cope with the great changes to come into the channels, berths, vessel type/size, traffic volume, tugs, nav. aids, sailing regulations and etc.

61. The scheme is aimed at giving pilots a certain preparatory experience for the maneuvering of such vessels in the coming situation prior to their actual onboard service at the site. Accordingly, the most effective method would be simulator training specially programmed for the port of Colombo, by which practice of vessel maneuver using " virtual reality" such as the landform, port layout, other vessels movements, natural phenomena in most realistic

visual/acoustic mode would be conducted.

62. For the said training, preparing the scenario based on the port dimensions and the vessels' data must be done first. The practice could be carried out for a period of two to three weeks by groups of several trainees.

63. The simulator should be applied for the new situation of the port and for the new pilot candidates of the future.

2.5.2 Reinforcing Tug Fleet

64. The ocean going vessel that reduces her speed under several knots in a port, normally loses almost all of her rudder function, therefore the assistance of tug boats is indispensable for turning/berthing the vessel. In the congested port of Colombo, where turning space is insufficient, the role of the tug fleet will be especially important for the smooth flow of vessels, and its resultant promotion of the port productivity.

65. The authority, accordingly, will need to have on-hand a proper number of capable tug boats for the forecasted increase of calling vessels at the appropriate time.

(1) Required Number of Tug Boat

66. The number of tug boats to meet the forecasted calling vessel as mentioned in 2.5.1 will be estimated by following calculations.

No : total objective calling vessels per one year
do : total days of vessel in/out per year
no : average required no. of tug boats per operation
No : average required no. of tug boats per day
do : *average total operation days per year per tug boat*
no : average total operation per year per tug boat
r : average operation per day per tug boat
w : average operation hours per tug boat

Required total operations of tug boats per year : No x no = No x no = No x r x do

Required average tug boat per day : No = No x no/ r x do = No x no / r x do

no : required tug boats per operation for per mother vessel maneuver, based on calling vessels in 2005 by weighted average is three point seven(3.7).

do : average operation days per tug boat per year is assumed 330 days with the exception of docking/cruising for Galle, Trincomalle

Average operations per tug boat per day in 2005,

Low case : 5,689 x 3.7 / 330 = 63.8
Middle case : 6,921 x 3.7 / 330 = 77.6
High case : 8,333 x 3.7 / 330 = 93.4

The necessary tug boats at Colombo in 2005 is derived from the above figures by dividing the value of r(average operation per day per tug boat).

67. The value of r depends upon the conditions and circumstances of each port. The major points to be considered from the technical side are the required time per operation, daily maintenance, fuel filling and the working system of the crew. The present r at Colombo is estimated about eight(8) or more, and examples of r in major ports in Japan are as follows : Tokyo(4.2), Yokohama(3.2), Shimizu(2.8), Nagoya(3.7), Yokkaichi(4.2), Osaka(2.7), Kobe(2.7), kitakyushu(1.5).

* objective vessels : foreign trader over 3,000grt, domestic over 6,000grt, as of 1991)

68. The desired tug boats should hence-forth have sufficient power to conduct quick and precise movements to assist the increasing large incoming mother vessels..
A tug boat equipped with a total of 3,000 ps engines and two Z rudder propellers is recommended as one of the models.

69. To compensate the high expense for such a high quality tug boat, a possible solution is the raising of the value of r, through which the number of tug boats procured could be reduced by adopting a work system of day and night shift basis. This would in turn satisfy the authority's policy of a 24 h open port.

70. Considering the above, if the value of r is assumed to be 10, the necessary tug boats at Colombo will be as follows,

(low case) : 63.8 / 10 = 7
(middle case) : 76.9 / 10 = 8
(high case) : 93.1 / 10 = 10

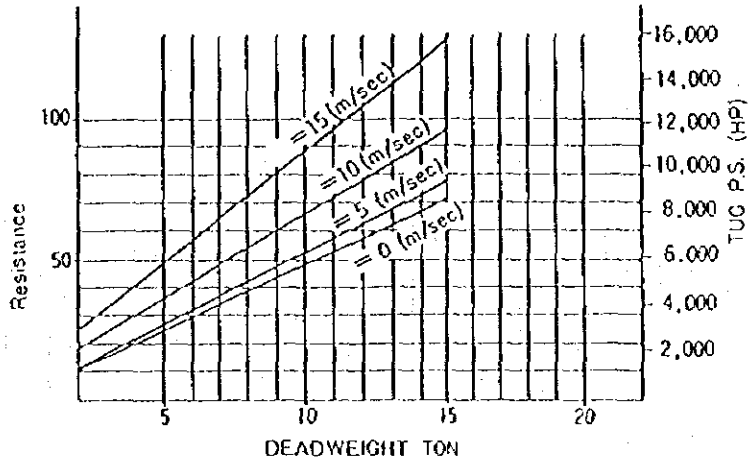
In addition to the above, it is necessary to provide three tug boats for Galle and Trincomalee, and the replacement of the aged ones of over 30 years could be considered, then, the final number of new tug boats to be provided is presumed as follows.

(low case) : 7(CMB) + 3(Galle,Trincomalee) + 4(replacement) - 9(presence) = 5
(middle case) : 8 + 3 + 4 - 9 = 6
(high case) : 10 + 3 + 4 - 9 = 8

(2) Required Output of Tug Boats and Type of Propellers

71. The maximum thrust required when moving a mother vessel athwart direction, and an empirical formula on the required thrust based on vessels' deadweight tonnage and external force(mainly by wind force) is shown in Fig. 2.5.1.

FIGURE 2.5.1 Necessary Tug Boats' Thrust against Wind and Vessels' Deadweight



72. According to the above Fig.2.5.1, as an example, the assisting maneuver for a 60,000 dwt mother vessel under headwind of 10 m/s requires a total of 6,000 ps tug power(2 tugs each 3,000 ps). Another formula which require eight to ten (8 - 10) % of an objective vessel's dwt is in practical use. The objective vessels which require tug boats assistance are not only large vessels but are inclusive of some medium or small vessels as 10,000 to 3,000 grt, therefore powerful tug boats are not needed at all times. With reference to this, an example of the tug fleet composition in major Japanese ports is as follows,

ps	no.	%
200 - 1,200	16	5.9
1,200 - 2,200	36	13.2
2,200 - 3,200	120	44.1
3,200 over	100	36.8
total	272	100.0

73. From the above data 80% of the tug fleet in Japan can be said to be 3,000 ps while 20% is medium power of 2,000 ps and under.

Composition of Japan's tug fleet by type of propeller is as follows,

propeller type	no.	%
FOP	11	2.4
CAP	7	1.5
VIP	12	2.6
ZAP	433	93.5
total	463	100.0

74. From the above data the CAP or VIP tugs which were popular in the past have been steadily replaced by ZAP type, and the new one is being widely employed as harbor tug boats for

her high maneuverability, reliability and powerful performance.

75. Summing up, the desired fleet composition hereinafter is 80% of 3,000 ps ones as main force and 20% of 2,000 ps ones as supplement, with equipped ZAP propeller for them all. Those tug boats should be practically used whenever pilot boats cannot sail far off harbor due to rough sea condition, for they are much more sea worthy than small pilot boats.

2.5.3 Providing Navigational Aids

76. Installing a certain number of navigational aids which involves some shifting of the existing aids and replacing deteriorated ones is required to follow the changes of channels and to conform to the international standards of IALA.

77. The new arrangement of navigational aids in the targeted year of 2005 is shown in Table 2.5.1.

78. According to the promotion of port activities , the new N channel, in particular, will be necessary in the near future.

TABLE 2.5.1 List of Nav. Aids

Items	Type	Quantity	Site
Lateral Mark (starboard)	Lighted Buoy	5	W channel 2, N channel 3
Lateral Mark (port)	Lighted Buoy	5	W channel 2, N channel 3
Lateral Mark (starboard)	Lighted Beacon	3	New BW 1,SW Arm BW 1
Lateral Mark (port)	Lighted Beacon	2	NW BW 1, NE BW 1
Safety Water Mark	Lighted Buoy	2	Off channel entrances each 1

* *The five lighted buoys that will be installed on the existing West Channel can be shifted to the new West Channel.*

2.5.4 Introducing VTS

(1) General

79. Without having Vessel Traffic System, the risk of accidents or navigational errors would be high at ports where have a heavy traffic or ship calls carrying hazardous cargoes. The IMO Regulation A.578(14) "Guidelines for Vessel Traffic Services(VTS)" recommends port authorities to use a radar-based vessel traffic system in order to improve safety and efficiency of marine traffic, and safeguard the protection of the environment.

- To improve the safety and to reduce the risk of vessel traffic accidents in port areas and approaches;
- To enhance the enforcement of port regulations;
- To improve efficiency and operational activities;

- To alert vessels in order to prevent accidents, such as collision, grounding or damage of underwater structures;
- To monitor the position of navigation aids such as buoys.

80. It is recently recognized that the need for VTS is diversifying not only for safety of traffic and environmental protection at port waters and channels, but also for fishing rights protection, security of coastal and off-shore construction works, meteorological/hydrographic monitoring, and regulation of illegal activities.

81. Vessel Traffic Systems have been put into the practical use since 1960 or so. The basic system detects vessel echoes by radar and displays the targets on a CRT screen. The courses and speeds of the moving targets are also calculated, processed and displayed in a superimposed mode on the same screen.

82. The present VTS is capable of simultaneously detecting, tracking and displaying about 50 to 250 traffic targets on the CRT screen. Target acquisition and tracking can be assigned in an automatic or manual mode, and processing is made by its internal processors.

(2) The System Configuration and Basic Functions

83. To perform the above functions the desired VTS for the Port of Colombo should be operated by qualified operators and consist of a CONTROL CENTER with a RADAR SITE, a VHF RADIOTELEPHONE SYSTEM for communication with vessels, VHF/DIRECTION FINDER sub- system to identify vessels approaching the surveillance area, CCTV sub-system to cover the dead spot of radar system and COMMUNICATIONS LINK among the Harbor Master office, the Pilots, the Chief Operation Manager and each Terminal Operation Manager.

84. Port Management Information sub-system is also effective for implementation of VTS. Vessel and port facilities information can be stored as a database in a computer system for easy access from port users. Its functions are retrieval of detailed vessel information for traffic control, retrieval of ship movement schedule for berth management, efficient port facilities management and service, and port information service.

85. The CONTROL CENTER carries out for 24-hour radar surveillance throughout the port area and VHF communications with the pilot station, the vessels and the terminals. VTS functions may include data collection, data evaluation, information service, navigation assistance service, traffic organization service, and support of allied activities.

86. By integrating all information concerning vessel movements and terminal activities, various forecasts could be made, e.g.;
- future position of vessels,
- estimated times of arrival(ETA) of vessels,
- vessels' crossing of checkpoints such as port boundary, anchorage, fairway entrance,
- closest point of approach (CPA) and time to CPA,

- collision survey or analysis,
- grounding prediction,
- appropriate berth appointment to vessels for the most effective use of each terminal.

2.5.5 Traffic Separation Scheme

87. In recent years, the West Entrance/West Fairway has become saturated even with annual traffic of about 7,000 vessels, causing complaints among shipping companies who are forced to wait for berthing.

88. The North Entrance/North Fairway should be improved accordingly, and full use should be made of the two fairways to control increasing vessels movements which is supposed to reach more than 12,000 in the target year.

89. However, the width of each fairway is being planned at 300 m to maintain the calmness of the inside port and thus the two fairways should still be used for one way traffic.

90. Under the said conditions, the most effective solution should be exclusive use of each fairway by vessels' draft as far as practical, and the North Fairway will be able to use for vessels drawing up to 10.5 m whose dimension of approximately 22,000 GRT, 200 m length, 27 m breadth and drawing 10.5 m in full loaded condition.

91. To execute the above scheme, dredging work off the North Entrance and installing certain navigational aids for the North Fairway, in particular, are indispensable. (mention later)

2.5.6 Updating Traffic Regulations

92. The revisions of the existing port traffic regulations should set new standards to cope with the coming situation in the following points, in particular:

- definition of the Port Area, the West Fairway, the North Fairway, the Tanker Berth, the Anchorage, the Large Vessel(Deep Draft Vessel) and the Other Vessel,
- prior notification of entry/departure at specified time with certain information relting a vessel,
- designation of the sailing Fairway, and the Berth,
- priority of vessels to proceed in the Fairways,
- restrictions to cross, overtake, parallel proceed and anchor in the Fairways,
- restriction on the Maximum Proceeding Speed in the Fairways and specified port areas,
- priority of departing vessels in possible meeting at the entrance of the Fairways
- other necessary sailing regulations than the INTERNATIONAL REGULATIONS FOR PREVENTING COLLISION AT SEA,
- preservation of the environment of the port area.

2.6 Widening the West Entrance

2.6.1 Bottleneck of West Entrance and Maximum Size of Calling Vessel

93. A continued increase of calling vessels in terms of both number and size has been forecast through the period targeted by the year 2005. However, incoming vessels must negotiate shallow and narrow bottleneck in close proximity to the W entrance, thus large vessel such as Panamax vessels have difficulty in calling the port. At present, Evergreen R class (4,300 TEU capacity) is the largest vessel that can call the port.

94. In other words, under the existing channel condition, the port can not accommodate vessels over 300 m long, 32 m beam and drawing 13 m, with the exception of extra favourable weather in which sea is calm, visibility is good and there is no current or stream. (see Fig. 5.6.1) The narrowest navigable width between NW and SW breakwaters as of 1995. 12 is shown in Table 5.6.1.

TABLE 2.6.1 Narrowest Navigable Width between Breakwaters

Depth	Navigable W.	Vessel's Breadth	against	Channel Width
		32m(3000-4300TEU)	40m(4500-5000TEU)	est.43m(6000TEU+)
-10 m	178 m	5.6B	4,5B	4.1B
-11 m	171 m	5.3B	4.3B	4.0B
-12 m	151 m	4.7B	3.8B	3.5B
-13 m	137 m	4.3B	3.4B	3.2B
-14 m	131 m	4.1B	3.3B	3.0B
-15 m	125 m	3.9B	3.1B	2.9B

Source: Depth/Navigable Width as of 1995.12 by JPC

95. The basic aim in the design of the approach channel is the safe passage of all calling vessels from the sea to the berthing area. A major consideration will be whether the channel should be wide enough to allow ships to pass in opposite directions or if sailing will be limited to a single direction. A secondary consideration depends on the size of vessel to be catered for and the physical conditions of the site.

96. A representative technical standard which is widely accepted in maritime engineering circle is found in "Port Development Handbook for planners in developing countries" issued by UNCTAD:

In a well marked channel, the total width of the full-depth channel required for two-way traffic may be taken to comprise, on straight reaches, maneuvering lanes of about twice the vessel beam

for each direction, plus about 30 m between vessels and up to one-and-a half times the beam for bank clearance at each side. At bends in the channel, greater widths are required than on straight reaches because of the tendency of ships to drift on turning. An additional width, depending upon the radius of curvature of the bend but approximately equal to the beam of each vessel, will be required in order to allow for the projected width of vessels negotiating the bend, that is,

W : total width of full-depth channel required
W_b : bank clearance
W_m : maneuvering lane
W_s : ships clearance
$W = W_b + W_m + W_s = 3B + 2B = 5B$ (on straight reaches)
$3B + 3B = 6B$ (at bends)

The Japan Maritime Safety Agency has its own criteria.
Japan Maritime Safety Agency criteria:

$W_b = 1.8B \times 2 = 3.6B$
$W_m = 1.7B$
$W_s = 1L(6\text{-}7B)$
$\therefore W = 3.6B + 1.7B = 5.3B$ (on straight stretches)
$3.6B + 2.7B = 6.3B$ (at bends)

97. Applying the above standards to the W channel, of which conditions are under one-way-traffic, winding about 15° and without enough shelter from open sea force, the required width for the supposed vessel would be not less than 5.3B on straight stretches and 6B or more at the bend.

98. In this regard, the channel near the W entrance should be considered a substandard for larger vessels over 30 m beam and drawing 10 m. Given the remarkable tendency of incoming vessels to grow larger in recent years, the fact that no serious accident has occurred in this channel is probably due to the excellent performance of the pilots, whose exploits could be likened to the passing of a thread through the eye of a needle, together with great good fortune.

99. However, the repeated apprehensions on the part of captains when passing the entrance is cause for concern and inherent hazard of the channel should be recognized by SLPA officials and personnel concerned..

2.6.2 Steps towards W entrance widening

100. Selecting the ports of call is one of the important management policies for container carriers who place top priority on maintaining schedules.. Trunk route operators in particular, have a tendency to limit the ports of call from the points of view of safety and estimated earnings. Accordingly, some ports where weather/sea conditions are less than favourable may eventually lose their position as hub ports.

101. Naturally, operators would deploy the vessels of appropriate size on a specified route to maintain continued service throughout the year. In this regard, the above trend in world shipping will create a serious obstacle to the port of Colombo's aim to be a hub of Asia, because of the bottleneck at the W entrance for passing Post-panamax vessels who will be the leading vessels of the world trunk routes in near future.

102. Improving the W entrance for the safe traffic of Post-panamax vessels e.g. 4,800-5,000 teu requires widening of the narrowest part to 240 m at -15 m with removing about 100m of the southern end of the Island breakwater. However, due to the deterioration of calmness at the inner port, which would result, the said works, should not be executed before adequate measures preventing waves/swells invasion have been implemented.

103. To solve the problematic situation, a possible measure is to develop the QEQ outside area in line with the short term plan as early as possible to accept the rapid increase of vessel traffic, i.e. :
1) constructing berths for Post-panamax vessels at the outside of QEQ,
2) constructing/extending new SW breakwater at the outside of QEQ, and new NW breakwater off the island breakwater, with systematic, practical basis to cope with the promotion of port activity,
3) after ensuring inner port calmness remove the S end of NW breakwater, and dredge the narrow part of the channel,
4) constructing new yards, berths, channel and facilities for the new N port.

104. In line with the above steps, following measures should be taken to promote the navigation safety:
1) developing the N channel and adopting traffic separation scheme,
2) introducing VTS
3) setting new sailing regulations in the port,
4) expanding navigational aids and tug fleet,
5) supplementing and retraining the port pilots.

< An example of KAOHSIUNG PORT>

105. There are two approach channels in KAOHSIUNG PORT(Container throughput over 500 million teu,1994) and the second channel is mostly used by large container vessels. The width of second channel inner entrance is 170 m and distance from the entrance to the center of turning circle is 600 m, which is equivalent to 5.3B and 2L for an Evergreen R class vessel, respectively. Although the above dimensions slightly exceed those of the W entrance of Colombo, both ports can be said to share two common problems: narrowness of entrance and
limited space of turning basin.

106. However, in KAOHSIUNG, the approach channel in between the outer and the inner ports is well sheltered from the open sea force by two breakwaters(N 1,500 m, S 2,000 m long, respectively). Incoming vessels, those are becalmed after passing the outer entrance proceed on

a 1,700 m leg at moderately reduced speed and then could go into the smoothed inner entrance. Accordingly, ship handlers are reduced of their burden to negotiate the narrow pass.

107. In summing up, it may be said that although the difference of the maneuvering conditions between the two ports is apparently small, a fairly large contrast exists in each approach channel condition. (see Figure 2.6.2)

FIGURE 2.6.1 Narrowest Part of West Entrance

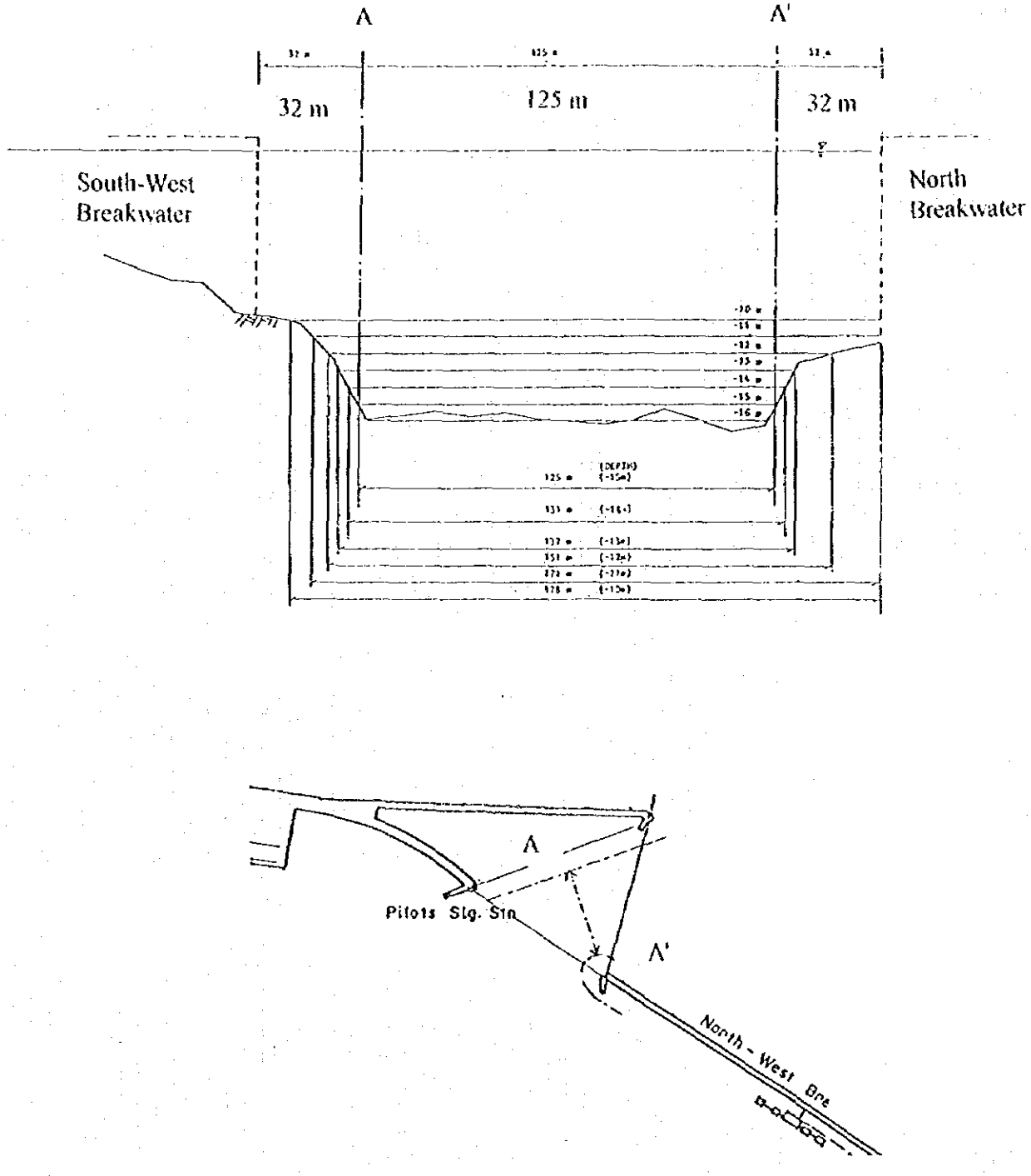
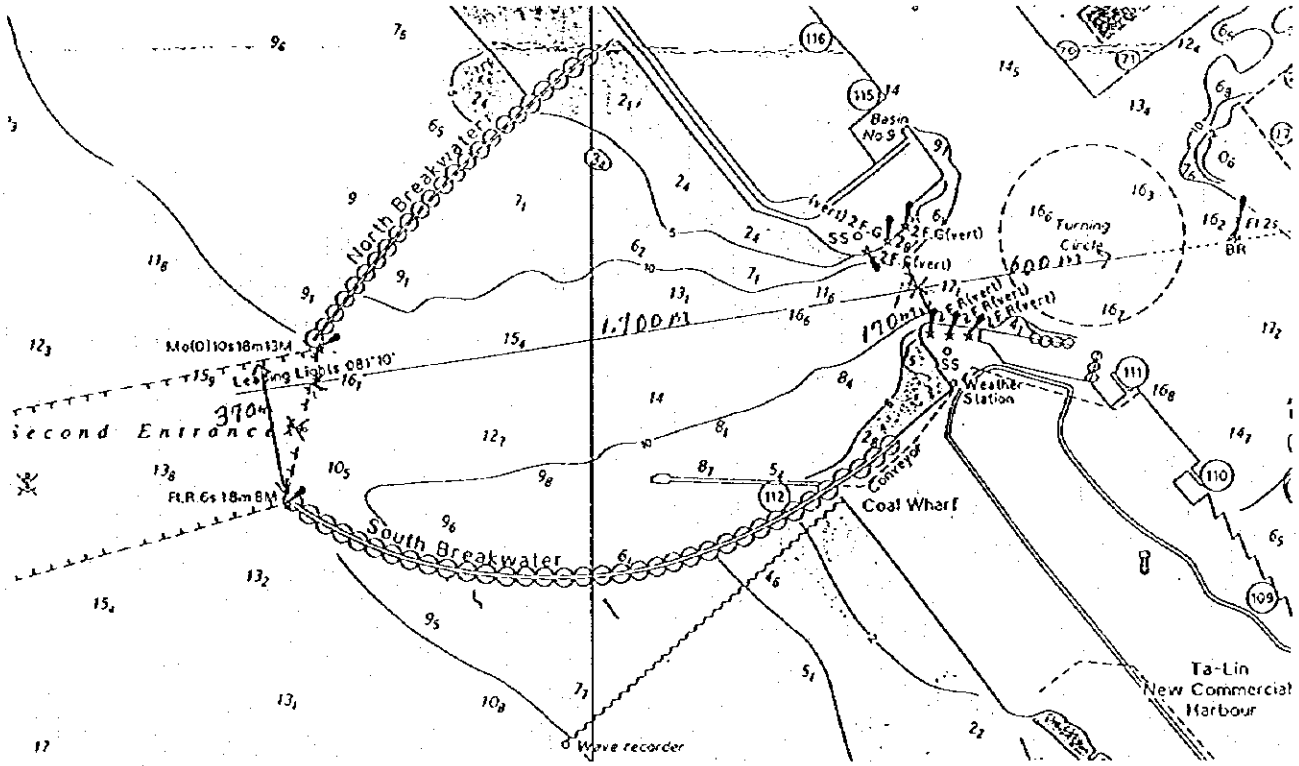


FIGURE 2.6.2 The Second Channel of KAOSHUNG PORT



2.7 North Channel

108. Ship waiting queue for entering the port sometimes caused by leaving ships as leaving ships sometimes have to wait due to the operation of another ship. Ship traffic will become a bottleneck to increase the capacity of cargo handling. North Channel will play a key role to reduce the waiting time of leaving vessels, which will result in reducing the waiting time of approaching vessels. However, the present depth of North Channel is about 10.7 meters, which allows ships with a draft up to 9 meters, approximately ships up to 12,000 DWT in full load.

109. The number of calling vessels in 1994 was 3,220, average in/out traffic was 17.6/day, which will increase over 1.75 times in 2005. As a result, the daily in/out traffic will reach 31.2 (low case), 37.9 (middle case) and 45.6 (high case), respectively. West channel serves almost all vessels so that it will become congested sooner or later due to the heavy traffic anticipated in the near future. It is therefore indispensable to develop another channel to accommodate future ship traffic.

(1) Layout of New North Channel and Dimensions

110. The major problems related to the new channel alignment are the hard rock formation existing in close proximity off the North Entrance, a submerged oil pipe crossing 400 m off the channel, a submerged sewage pipe extending NW direction off 1,400 N of the channel and some ranges of shoal 2.5 km NW off the port. (See Figure 2.7.1)

111. Owing to those obstructions, dredging is limited to minus 12 m and the channel should be curved from the entrance to 60 degree port side with a 1,500 m radius. The outline of the channel dimensions is as follows:

1) depth of the water ; - 12 m
2) width of the channel ; 300 m (near the entrance is 160 m)
3) radius of curved channel ; 1,500 m
4) total length of the channel ; about 3,000 m

(2) Ship Traffic through Each Channel

112. The N channel (depth: 12 m, width: 300 m) is navigable for vessels with a draft under 10.5 m and is able to function as a normal passage for conventional cargo boats, dry bulkers, middle sized box carriers, semi-containers, Ro/Ro and passenger ships. Forecast number of calling vessels of those types is over 3,000 out of the total 8,062 at high growth case in 2005. The new channel, accordingly, could manage nearly the same volume as the present West Channel.

113. After completion of the QEQ Outer Harbour, the available berths increase to five for the mother vessel, to six for the feeder at the inner port, and to three for the mother vessel at the outer port. Even with the success of the said separation scheme, the West Channel will have to manage 5,000 vessels per year or more in the high growth case in 2005. Daily ship moves are

estimated at about 19-27 through the West Channel and at about 12-18 through the North Channel. If the North Channel is not available, an average of daily ship traffic through West Channel will be 31-45 per day, of which 31-39 moves are through the present West Entrance.

114. Assuming that peak hour traffic will be 150-200 % of average hourly traffic, West entrance will have to cater to 3-4 moves per hour. In order to cope with these ship moves, navigational aids should be improved in terms of radio control, radar system, pilot services, and tug boats. Introduction of VTS will help efficient control of ship traffic through the narrow West Entrance. Efforts should be made to ensure the safety in ship manoeuvring.

TABLE 2.7.1 Channel Traffic in 2005

Year	Ship Calls per Year	Average Daily Moves
West Channel	3,400-5,000	19-27
North Channel	2,200-3,200	12-18
Total	5,600-8,200	31-45

(3) North Channel Dredging

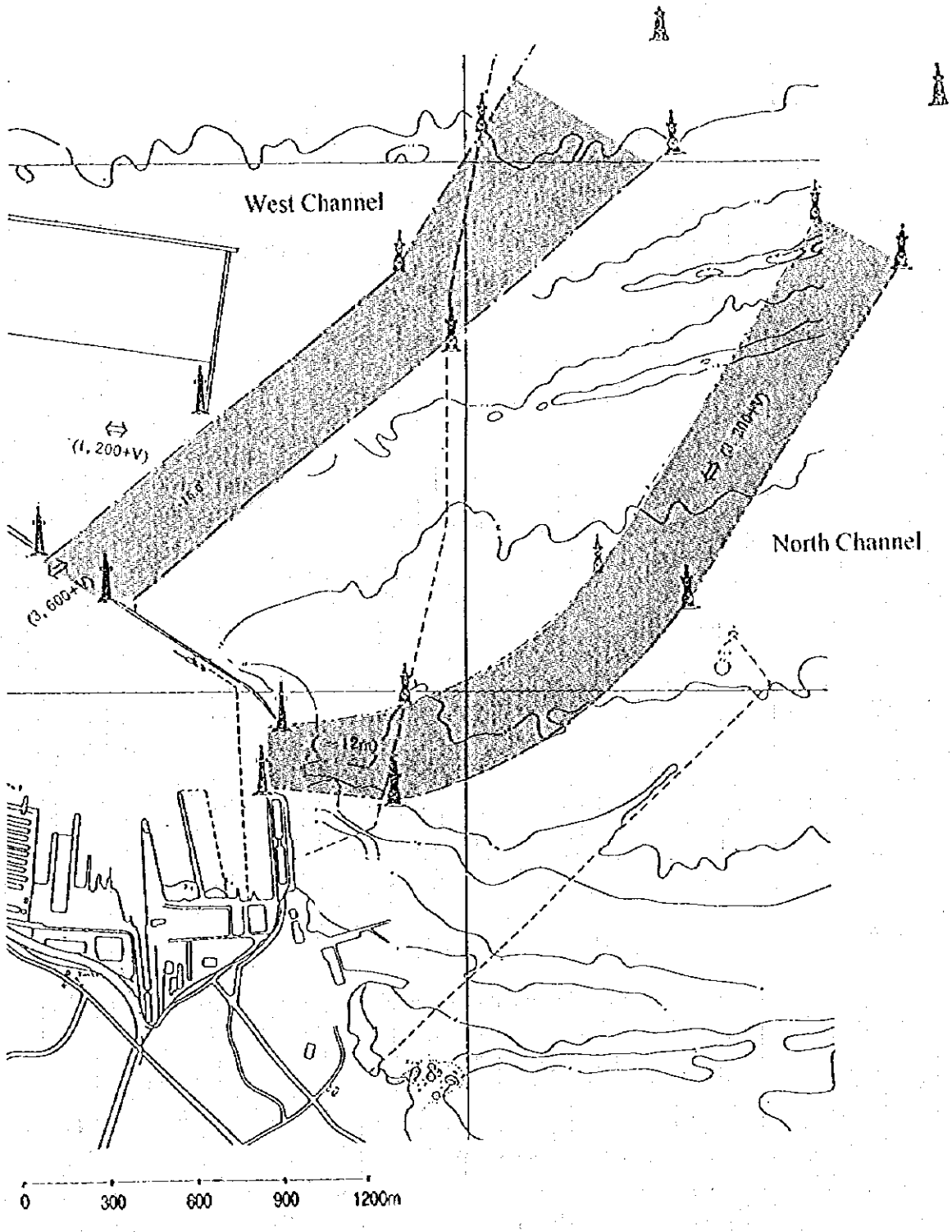
115. The crude oil pipeline was laid across the North Channel in 1987. The elevation of pipeline is :

- 14.0 m : at the west side of the North Channel
- 14.25 m : at the centre
- 13.25 m : at the east side of the North Channel

116. In this regard, North Channel can be dredged to minus 12 meters without replacing the oil pipeline. Estimated volume of dredging is about 250,000 m3, of which 20,000 m3 will be a hard material. Total cost of North Channel dredging is estimated at about US$ 6 million.

117. The channel with a depth of minus 12 meters is able to cater to ships up to a draft of 10.5 meters, approximately 24,000 DWT in full load. This vessel size covers 70 % of the calling vessels in full load so that a large percentage of vessels can use the North Channel in case of half load.

FIGURE 2.7.1 NORTH CHANNEL



2.8 Road Development

118. The traffic on the inter-terminal road will increase considerably following the redevelopment of QEQ and the development of QEQ outside. The present inter-terminal road has four lanes partly, however, it shall be expanded to full four lane road with two side lanes.

119. Assuming that only Gate No. 11 serves heavy lorry traffic, Gates No. 7, 11, 13 serve small lorries, and all gates available serve passenger cars and other port-related traffic except cargo transportation, future gate traffic and inter-terminal road traffic are assessed as follows:

TABLE 2.8.1 Gate Traffic in 2005

(Traffic/Day)

Gates\Year	1996	2005
1	2,068	2,200-2,900
2	442	370-490
4	1,887	2,300-3,100
7	1,921	2,400-3,200
11	2,440	7,500-10,100
13	1,553	1,000-1,400
Total	10,311	15,800-21,200

Range of traffic in 2005 is based on Low Growth Case and High Growth Case

TABLE 2.8.2 Inter-terminal Road Traffic after QEQ Outer Development

(Traffic/Day)

Section	1996	After QEQ Dev.
QEQ South End (L1)	3,156	6,100
BQ Entrance (L2)	6,361	10,400
Dock Yard West End (L3)	4,510	9,600

See PART 2, TABLE 2.6.3 for the location

120. Taking into consideration that the inter-terminal road shall have full four lanes with two side lanes, areas for the road have to be precisely determined and all buildings in the road area be replaced when they will have need for rehabilitation.

121. Improvement plan for the present inter-terminal road is shown in Figure 2.8.1. Within a short-term development period, widening shall be carried out where buildings or rail road are demolished. The bridge over the canal has two lanes and can be a bottleneck as the traffic increases. New bridge over the canal shall be planned to cope with traffic congestion anticipated.

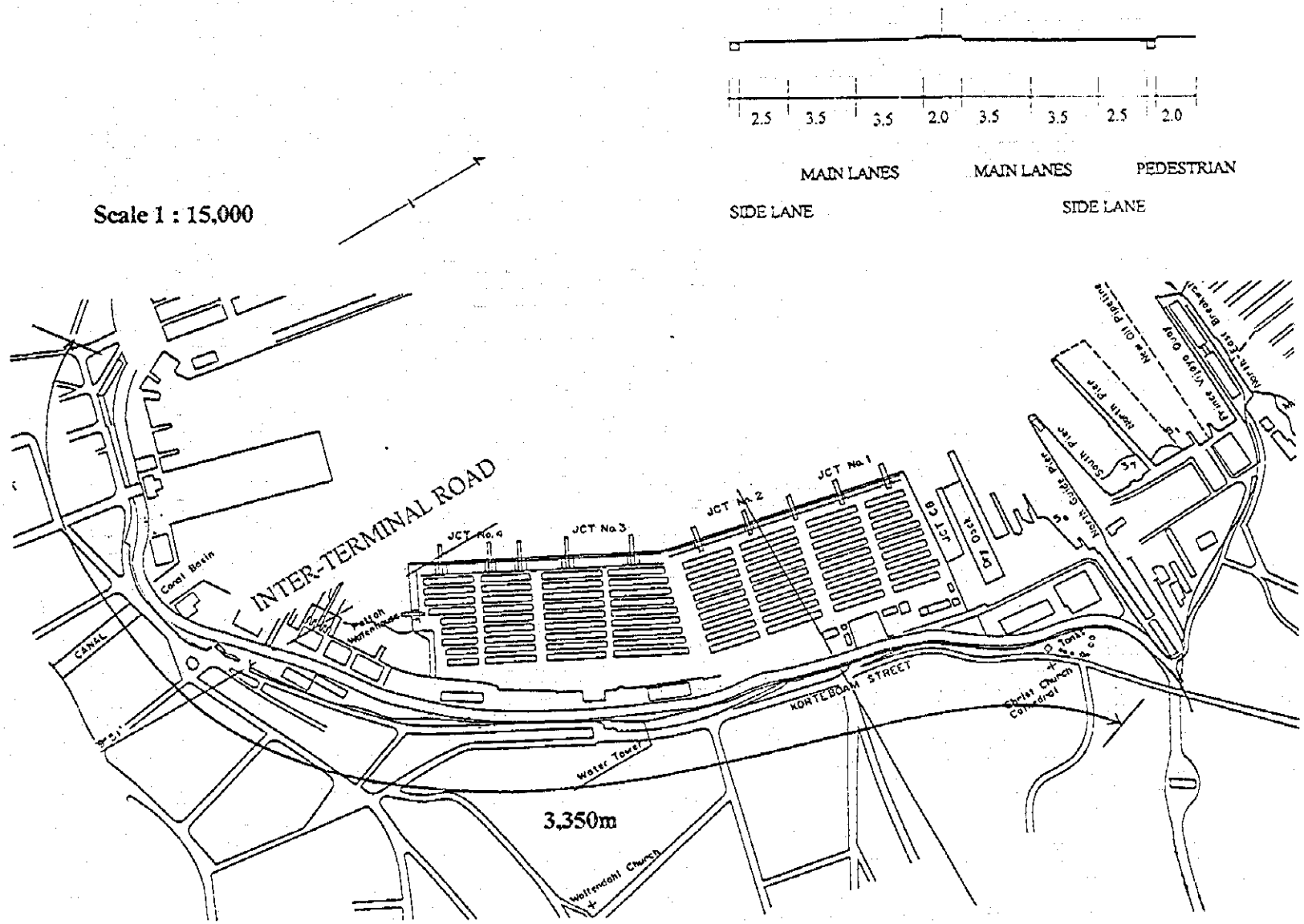


FIGURE 2.8.1 INTER-TERMINAL ROAD IMPROVEMENT

2.9 Ancillary Services

122. Development of the new port requires more tug boat services, pilotage services, bunkering water supply, ship's chandlers and other supporting activities. Number of tug boats required in 2005 is assessed at 7 in the low growth case and at 10 in the high growth case (see Part 4, Section 2.5.2).

123. An average of 14,000 tons of bunkering water was supplied per month during the first half of 1996. Since the Port of Colombo is not a terminal port of liner services, 37% of full container ships replenished water in the same period. Ratios of replenishing ships are estimated at 86% of semi-container ships, 94% of conventional ships and 80% of dry bulk ships. (see details in Appendix Table A2.9.2)

124. Demand for bunkering water is assessed at about 290,000-370,000 m^3 in 2005 and 390,000-520,000 m^3 in 2015. The low estimate is based on the present pattern of bunkering water supply and the high estimate is on the assumption that ratio of replenishing ships will be increased by 50% in case of full container ships and Ro/Ro ships.

TABLE 2.9.1 Supply of Fresh Water for Ships
Port of Colombo –July, 1996

Ship Type	Total No. of Ships	Water Supply (ton)
Container (fully)	55	4,740
Semi Container	14	1,025
Conventional	53	3,533
Dry Bulk	13	1,185
Oil Tanker	6	544
Ro/Ro	1	100
Other	3	32
Sub-total	145	11,159
Tugs/Barges/Dredger	42	3,405
Total	**187**	**14,564**

Source: SLPA

TABLE 2.9.2 Bunker Water (Medium Growth Case)

Case	1994	2005	2015
Present Pattern	174,768	292,928	394,263
High Demand	-	373,585	517,126

3. Urgent Development Plan

3.1 QEQ Redevelopment and Outer Expansion

125. Recalling ship congestion in 1992 and 1993, there is an urgent necessity for the early implementation of small projects to increase the capacity of cargo handling and ship accommodation. In connection with container transhipment, it is important to accommodate feeder ships without delay, so that the redevelopment of QEQ will be of great help to reduce ship waiting time.

126. Urgent plan for the QEQ redevelopment and outer expansion is shown in Figure 3.1.1. This plan is the first stage of the South Port Development, and will increase capacity by 0.5 million TEUs, raising the total capacity of the port to 2.4 million TEUs. The plan will cover the demand estimated in 2005 in the low growth case and the demand in 2001 in the high growth case. Project cost of the urgent plan for QEQ redevelopment and partial expansion to the outside is estimated at about US$ 470 million. (See Figure 3.1.1)

127. Apart from the QEQ No.6 extension with a length of 380 meters and a depth of minus 14 meters, funding arrangements for the rehabilitation of QEQ NO. 2 & 3 were confirmed in July 1995 between the Sri Lankan Government and OECF Japan, including civil works for improvement of the entire QEQ area and the procurement of two units of 35.5 ton quay side cranes, 12 units of transfer cranes and other necessary equipment.

3.2 Projects for Urgent Implementation

3.2.1 Redevelopment of Bandaranaike Quay

128. Utilization of Bandaranaike Quay will be another way to increase the container handling capacity. BQ will have a total terminal area of 5.4 ha with an open storage yard of 2.6 ha, which can be used as a container yard until QEQ has enough capacity. At the first stage of the redevelopment, the south side of the quay, No.1-2 Berths, can be modified to a Ro/Ro and feeder berth.

3.2.2 North Channel Dredging

129. Increasing ship calls will bring a long ship waiting queue in the near future and ship traffic will become a bottleneck of port operations. Driven by an increase in ship traffic, the North Channel will be utilized as an exit from the port so as to introduce the separation of in/out ships. Dredging shall be carried out in the short term.

TABLE 3.1.1 QEQ Outer Terminal Development Urgent Plan

Facilities	Quantity	Est. Cost
Seawall Future Quaywall Total=	1,780 m 760 m 2,540 m	Civil Work Total: US$ 320 million
Reclamation	3,495,000 m3	
Berths	Main: 1 Feeder: QEQ No.2-4	
Terminal Area	40 ha	
Capacity	0.9 million TEUs (Port Total: 2.4 million)	
Completion Milestone	5 years	
Equipment	Container Cranes: 3 (No.6 Extension) 3 (Additional for No.2-4) Transfer Cranes: 21 Trailer Chassis: 84 Tug Boats: 2 (Additional)	Equipment Total: US$ 80 million
Others	CFS, Gates, Maintenance Shop, Administration Buildings, etc.	G.Total: US$ 470 million

3.2.3 Navigation Assistance

130. Increasing ship calls also bring further requirements for powerful tug boats and pilotage services. By the year 2000, two more tug boats will be necessary to cope with the anticipated cargo increase. Radar control of ship traffic is also indispensable for increasing the capacity and safety of ship traffic.

3.2.4 JCT Container Handling Equipment

131. In order to meet the urgent demand, reinforcement of JCT is a practical way to improve the capacity of the port. Given that container throughput will increase to 1.9 million TEUs around the year 2000, an additional quay crane should be installed at JCT No.1-2 terminal and JCT Cross Berth. It is also recommended to add transfer cranes and trailer chassis in connection with the quay crane. Recommended equipment is as folloes:

Container crane: 2 (One for JCT No.1-2, One for JCT Cross Berth)

Transfer crane: 3
Trailer Chassis: 12

3.2.5 North Pier Development

132. The development plan of the North Pier has been already finalized and is in the process of implementation. Development work includes the improvement of existing quay structure (380 m), area reclamation (90 m × 390 m), construction of revetment (480 m), pavement of yard (46,000 m²), building work and other necessary work and is scheduled to be completed before the end of March 1999. In addition, two units of multi purpose cranes (200-ton per hour) with other ancillary equipment will be installed for the handling of fertilizer and container. Details of the development plan are shown in Figure 3.2.5.

3.3 Ancillary Development

Truck Pool

133. Truck queue on the inter-terminal road occupies a lane and is an obstacle to port traffic. Although waiting queue of trucks is mainly caused by their chartering system[1], truck pool in the port area or nearby the port access road will help clear the inter-terminal road. Rail yard behind JCT or SLPA property along the port access road can be utilized as a truck pool.

Inland Container Depot

134. At present, there are more than thirteen inland container depots (ICD) in the vicinity of the Colombo container terminal. Except Orugodawatte Depot, all these ICDs are operated by private shipping companies or forwarders. Storage and maintenance of empty containers, container delivery service for shipper and stuffing service of export LCL cargoes into containers are main activities of these ICDs. Unstuffing of import containers is conducted at the CFSs in the port by SLPA. (see Table 3.1.2 in Part 2)

135. Efforts should be made to encourage private sectors to build ICDs and to reduce container dwelling time in the port. SLPA should also operate ICDs around the port so as to increase the capacity of the container yard.

Yard Operations and Communications

136. A computer system to control cargo flow will play a key role in cargo handling productivity. Computer system should be updated periodically to cope with increasing cargo. Communications with shipping lines and agents are also upgraded to EDI, by which port users will be encouraged to bring more transhipment.

137. Wide review and recommendations for improving computer management information system in the Port of Colombo have been made in the report of "Study for Enhancement of Management(Stage 1, February 1995)" The main items of the proposal are as follows;

---

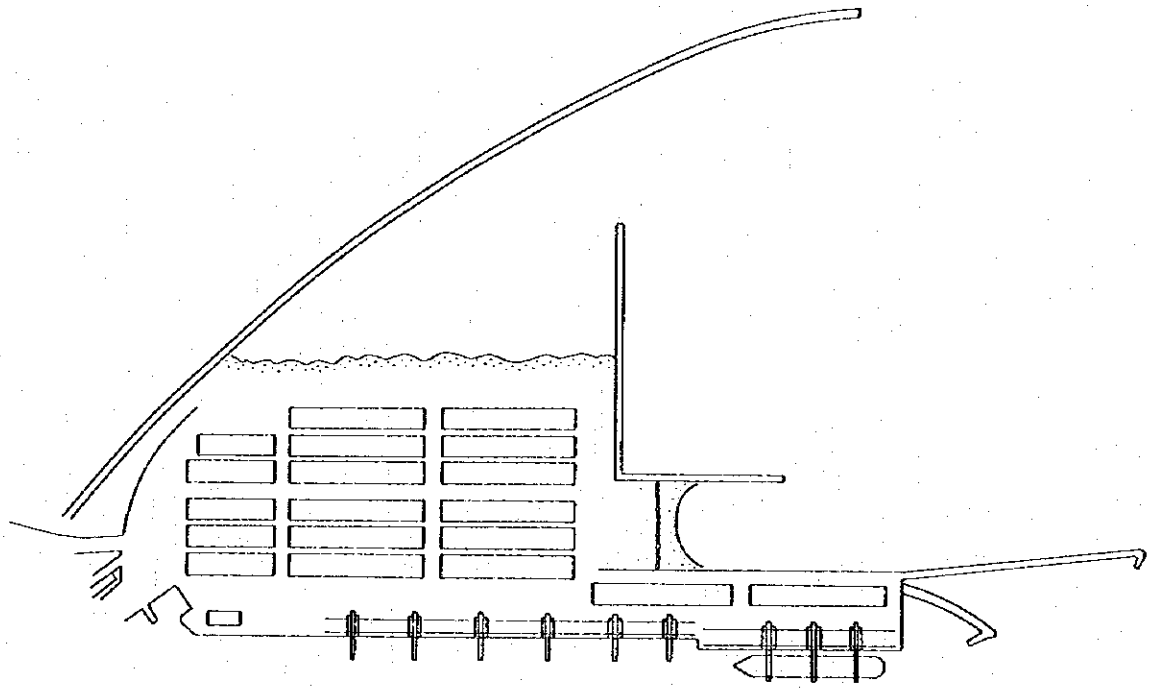
[1] Trucks are mainly queuing in the hope of contracting business, not to pick up a particular box designated.

(a) Strengthening of Computerizing Planning Section and committee
(b) Enhancement of Computer Facilities
(c) Development of Application Systems such as Warehouse Control, Maintenance Engineering and Personal Management Systems
(d) Effectuation of Computerization and Application Development
(e) Improvement of Statistics and Management Information System

138. It is observed that many sections in SLPA input the same information and data into their own computer systems, some are main frame and some PC, without coordination. This is a waste of huge human resources, damages the accuracy of data and delays processing of the output information for management control.

139. Another point is that while container operation control system in JCT is modernized (e.g. YOCS) and much information is stored in the system, this information is applied only to operation control, not utilized for planning or engineering activities in SLPA. In the near future, computer system for QEQ/QCT will be installed in the rehabilitation project, and related computer system for container handling will be integrated. Therefore, it would be practical to build up a total management information system in SLPA based on a core system.

FIGURE 3.1.1 URGENT DEVELOPMENT PLAN QEQ OUTER TERMINAL



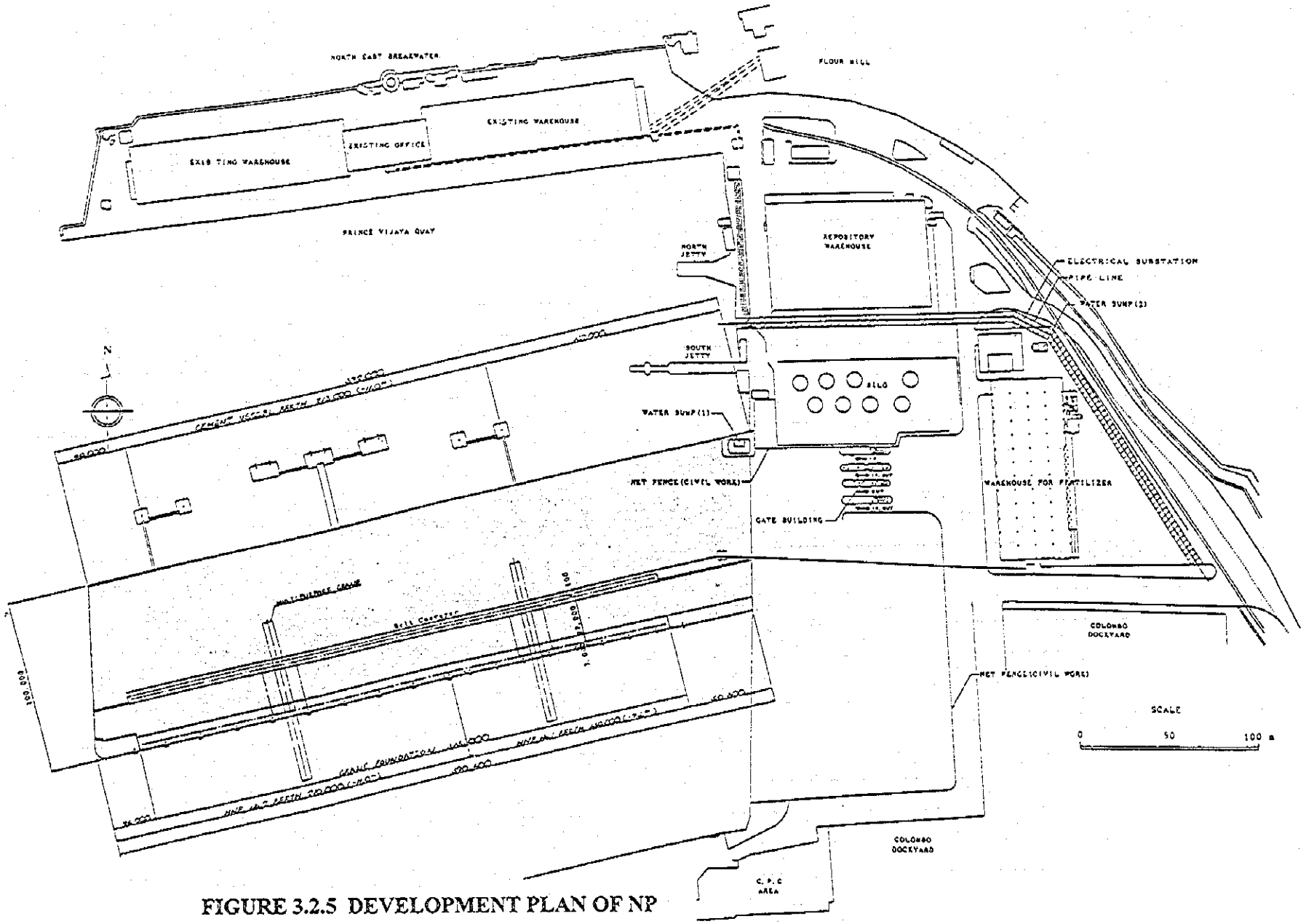


FIGURE 3.2.5 DEVELOPMENT PLAN OF NP

4. Structural Design of Port Infrastructure

4.1 General

140. In consequence of the detailed study and analysis of several type structure, the concrete caisson supported structure has been selected as the best choice for the breakwater, seawall and quaywalls proposed for the New Port of Colombo except QEQ No. 6 Extension Quaywall, despite some relative disadvantages inherent in the selected type, such as requirements for skilled labour for the maintenance of concrete caissons installed in place and the need for provision of large-capacity floating plants for caisson fabrication and installation. The selection was based on careful comparative evaluation of alternative types considered for the three distinct structures.

4.2 Natural Conditions for the Structural Design

141. Listed below are the design conditions for the project facilities. These conditions have been established on the basis of the Study Team's review of the existing relevant data and the outcome of a series of field surveys performed during the September 1995 - February 1996 period.

(1) Winds

142. Wind velocities of 30-year and 50-year return periods are 81 miles/hr (36 m/sec) and 85 miles/hr (38 m/sec), respectively.

(2) Waves

(1) South Container Terminal Development

143. From the calculation results of probability waves, the design waves with a 50-year return period and a 15-year return period have been taken respectively for the seawalls types A, B, C & D and the breakwater type A with due regard for the ease of construction, structural stability and economy. The design wave parameters determined for the two structures at their proposed sites are as tabulated below.

TABLE 4.2.1 Design Wave Parameters for Breakwater and Seawalls under South Port Development

Type of structure	Return period of wave (yr)	Water depth Alongside (m)	H 1/3 (m)	H max (m)	Period (sec)
Breakwater (type A)	50	-15	5.2	9.4	10.0
Seawall (types A & B)	15	0 to -12	3.7	6.1	8.7
Seawall (type C)	15	-12 to -15	4.0	7.2	8.7

144. For the Short Term Development Plan, a seawall running from Points B to D in a length of 390 m and an inner breakwater from Points D to E in a length of 180 m has been designed

under the wave conditions indicated in TABLE 4.2.2.

TABLE 4.2.2 Design Wave Parameters for Seawall and Inner Breakwater

Type of structure	Return period of wave (yr)	Water depth alongside (m)	H 1/3 (m)	H max (m)	Period (sec)
Seawall type D	50	-15	5.2	9.4	10.0
Inner Breakwater (Type B)	50	-13.5	2.8	5.0	7.0

(2) North Container Terminal Development

145. Insofar as the North Container Terminal Development is concerned, the New West Breakwater, New North-West Breakwater and New North Seawall (in Alternative (1)) are the structures whose stability against wave action needs to be studied. In consideration of the proposed alignment and orientation of the three proposed structures, it is presumed that the prevailing waves will be SW for the New West Breakwater and NW for the New North-West Breakwater and the New North Seawall. Tabulated below are the design wave parameters for the proposed structure sites as determined from the corresponding deepwater wave conditions.

TABLE 4.2.3 Design Wave Parameters for Breakwaters and Seawall under North Development Plan

Type of Structure	Return Period of Wave (Yr)	Water Depth Alongside (m)	H 1/3 (m)	H max (m)	Period (sec)
South Breakwater	50	-15	5.2	9.4	10.0
North Breakwater	50	-13.5	2.8	5.0	7.0
Seawall (Case 2)	50	-13.5	2.8	5.0	7.0

(3) Tide Level

146. From the latest tide observation data, the following tide levels have been taken for planning and design purposes.

HHWL : +1.14 m
HWL : +0.97 m
LWL : +0.16 m

(4) Water Depth Alongside

Breakwater : -15.0 m
Seawall : 0.0 m to -15.0 m
Quaywall : -11.0 m, -13.0 m, -15.0 m

(5) Crown Level

Breakwater	:	+4.5 m (Some overtopping inevitable)
Seawall	:	+7.0 m (Allowable overtopping against land facilities)
Quaywall	:	+2.7 m (Existing level: +2.7 m)

(6) Soil Conditions

147. TABLE 4.2.4 shows Soil Conditions in the Short Term Development Plan.

(7) Earthquake

148. Seismic coefficients are not used in the structural design for reasons that the project area is in an aseismatic region, and that all available data collected by the Study Team indicate the absence of earthquake records covering the project area.

4.3 South Port Development

4.3.1 Seawall

149. A seawall is a barrier built along the shoreline to prevent the encroachment of the shore by direct wave action. Normally, the area behind the seawall is filled up and unlike a breakwater, the seawall is not slid backward by wave force. Thus the cross section of a seawall may often be reduced as compared with a breakwater which is typically flanked on the seaward side and the harbour side by waters.

150. In this project, it is planned to build three different types of the seawalls northwestward from Point A (Battenburg Point) to Point B in a total length of 2,530 m and a seawall type D from Points B to D in a length of 390 m. (see FIGURE 4.3.1 Layout Plan under Short Term Development Plan) The water depth alongside the proposed seawall alignment ranges from 0 to -15 m. The cross sections of the seawall type A (0 to -7.0 m), type B (-7.0 m to -12.0 m), type C (-12.0 m to -15.0 m) and type D (-15.0 m) are appended hereto.

151. The rubble mound covered with concrete armour blocks is recommendable for the depth shallower than around -7.0 m, for it can be steadily constructed by reclamation starting at Battenburg Point.

152. For the depth range of -7.0 to -14.0 m, the concrete caisson is most appropriate for the reasons given on pages 9-6 and 9-7 of the Interim Report.

153. The receding parapet type structure has been chosen for the seawall to reduce wave overtopping onto the reclaimed area behind and to reduce its crown height to the maximum extent possible.

154. FIGURES A.4.3.1, A.4.3.2, A.4.3.3 and A.4.3.4 illustrate the standard cross sections of the seawall.

4.3.2 Breakwater and Inner Breakwater

155. FIGURE A.4.3.5 illustrates the standard cross section of breakwater. FIGURE A.4.3.6 illustrates the standard cross section of inner breakwater.

4.3.3 Quaywall

156. FIGURE A.4.3.7 illustrates the standard cross section of -14 m Quaywall as QEQ No. 6 Extension and FIGURE A.4.3.8 illustrates the standard cross section of the -16 m Quaywall facing QEQ Outer Harbour.

4.4 North Development

157. For development of the sea area on the west of the coastline running from the northern shores of the existing Port of Colombo to the Kelani River, two alternative plans have been considered:

158. Alternative (1) for Crow Island offshore development which envisages the construction of 3,270 m of seawall ranging in depth alongside from -12.0 to -15.0 m and 2,280 m of breakwater with -12.0 to 15.0 m alongside as shown in FIGURE 1.1.2 and Alternative (2) for northward development of the PVQ which envisages the construction of 3,690 m of breakwater with -12.0 to -15.0 m alongside as shown in FIGURE 1.1.3.

159. The North Port Development of the existing Port of Colombo is likely to prove economically less feasible than South Port Development Plan discussed in Section 4.4, for the primary reason that the proposed seawall and breakwater have substantial lengths as indicated in the table below.

TABLE 4.4.1 Length of Breakwater and Seawall

Structure	South Container Terminal (m)	North Container Terminal Alternative (1) (m)	North Container Terminal Alternative (2) (m)
Seawall	2,920	3,120	600
Breakwater	210	3,110	3,560
Total	3,130	6,210	4,160

160. Nevertheless, the cross sections of the seawall and breakwaters proposed in Alternative (1) and (2) under the North Development Plan have been studied for the purpose of cost comparison between this development plan and South Port Development Plan.

161. In view of the similarity in the marine and geotechnical conditions between the two proposed project sites, the conclusion was drawn that the cross sections of the proposed seawalls and breakwaters under the South Port Development Plan can safely be applied to those cross sections of the corresponding structures under the North Port Development Plan as described below.

(1) The cross section of the concrete caisson type seawall structure under the South Port Development Plan with a design depth alongside of -15.0 m as illustrated in FIGURE A.4.3.4 is applicable to the cross section of the seawall in Case II.

(2) The cross section of the concrete caisson type breakwater with a design depth alongside of -15.0 m and a length of 30 m under the South Port Development Plan as illustrated in FIGURE A.4.3.5 is applicable to the cross sections of the breakwaters proposed in Alternative (1) & (2) with a length of 1,550 m.

(3) The cross section of the concrete caisson type inner breakwater with a design depth alongside of -13.0 m and a length of 180 m under the South Port Development Plan as illustrated in FIGURE A.4.3.6 is applicable to the breakwater 1,250 m long in Alternative (1) and another breakwater 2,010 m long in Alternative (2).

In the same view of the similarity in the marine and geotechnical condition between the two proposed sites, the standard cross section of quaywalls of South Port Development Plan are also safely applied to those standard cross section of the corresponding structure under the North Port Development Plan except the FIGURE A.4.4.1 -11 m quaywall which is newly designed for Short Term North Development Plan Alternative (1) and (2) as enclosed.

4.5 Relocation of Offshore Pipeline and Sewer Outfall

4.5.1 Offshore pipeline

(1) Present Conditions

162. A single point buoy mooring (SPBM) is provided 9 km offshore in the west direction of the Port of Colombo as shown in FIGURE A.4.5.1 to serve mainly for discharging of crude oil. The crude oil discharged at the SPBM is transported through a submerged oil pipeline which rises up at the intermediate position of the North East Breakwater.

163. These SPBM and submerged oil pipeline were completed in 1987, and the annual ship calls and handling volume at the SPBM in 1994 reached the number of 21 and 1,920,000 tons respectively. The SPBM, constructed at the elevation of -28 m with the shallowest depth of swinging area of 20 m, is capable of accommodating a tanker up to 200,000 DWT class.

164. The submerged oil pipeline with pipe diameter of 36' is laid directly on the seabed at the section up to a depth of -10 m and buried with cover of 1.2 m at the deeper section. The pipeline is applied with a coal tar enamel coating and concrete coating of 100 mm to 113 mm thick thereon.

(2) Necessity of Relocation

165. It is foreseen from the new port general layout that the proposed face line of reclaimed area and breakwater will cross the existing oil pipeline route and the deepening work will be

executed on and around the route. Relocation of the oil pipeline will be necessitated in case that : 1) extra load of reclaimed area and breakwater is expected to be imposed on the pipeline (the pipe strength will become insufficient), 2) deepening of access channel and port basin is expected on the pipeline, (the pipeline laying depth should also be altered).

(3) Relocation Policy

166. When the relocation of the existing oil pipeline is necessitated, study in every respect should be conducted to establish the relocation policy. The prerequisite conditions for such study include 1) maximum allowable period of suspended operation of the SPBM, 2) availability of the substitute facilities for the SPBM at the other oil berths during the suspension, and 3) sufficiency of substitute import products for crude oil.

167. After examination of these prerequisite conditions, one of the following alternatives should be selected: 1) Construction of additional SPBM and pipeline on other route and 2) Relocation of the existing pipeline for the required section.

(4) Basic Concept of Relocation

168. When the relocation of the existing oil pipeline is necessitated, new route of the pipeline starting from the intermediate position of the North East Breakwater should be selected taking into consideration the following basic concept : 1) The distance between the rising point of pipeline and new SPBM or joint pipe should be minimized, 2) The pipeline should be directly laid on the ground of reclaimed land, 3) The pipeline route should be kept away from the anchorage as much as possible or sufficient covered thickness should be designed, 4) Sufficient structural strength should be secured when the pipeline route crosses the breakwater, 5) Such routing as crossing the access channel should be avoided as much as possible, but when such crossing is inevitable the routing should be designed to cross the access channel at right angle, and 6) The water area where the pipe is replaced should be such area which does not give any hindrance to safe and smooth ship navigation.

(5) General Method of Relocation

1) Earth Cover

169. The pipeline will be buried to prevent the damage thereto which will be caused by anchor cast from the ships. Earth cover thickness has to be determined depend on the ship size, anchor weight and soil characteristics of the earth cover. FIGURE A.4.5.2 shows the data on ship size, anchor weight and laying depth of submerged pipeline.

309. Supposing that the ship be of 60,000 DWT class, the anchor will weigh about 10 tons and the earth cover of 2 to 3 m will be required when the seabed is of ordinary sand. The trench bottom in the basin will be calculated by adding covered thickness and pipe diameter to the required water depth. Assuming that the required water depth be -16 m, the trench bottom will be -19 to -20 m.

2) Relocation

170. In general, the pipeline will be laid from the shore or by use of barge after trench excavation. The pipe replacement works at the intermediate section of the submerged water pipeline was reportedly experienced in Japan, however, a difficulty was observed in welding the pipe to secure the watertightness for prevention of the oil leakage from the pipe at the seabed. Accordingly, it is common practice to cut the submerged oil pipeline at the relevant section and to join with the new pipe on a barge as shown in FIGURE 4.5.3

171. TABLE 4.5.1 shows the work sequence and schedule of pipe replacement for the 1,000 m-section of the submerged oil pipeline. Key point in execution of each work is as stated in the table. The respective works are very difficult to be executed and the work period required for completion of the relocation works will be at least 1 year.

(6) Selection of Method of Relocation

172. As stated above, the relocation of submerged oil pipeline at its intermediate section will involve many difficulties and possibly require longer period than in the case of new construction. Further study on the relocation method will be done taking into consideration the availability of the substitute facilities for the SPBM at the other oil berths during the suspension of operation of the SPBM.

4.5.2 Sewer Outlet

(1) Present Conditions

173. The location of sewer outlet is as shown in FIGURE A.4.5.1 City sewage is discharged into the sea at the depth of -12 m through sewer pipe with diameter of 1.5 m and length of 2.9 km. No further data on the sewer pipe are available, but it is said that the pipe is of Hume concrete of cast iron. Relocation of the sewer pipe should be determined in relation to the facility layout plan for the new port, based upon the results of site survey.

(2) Method of Relocation

174. It seems that no problem may be encountered if the sewer pipe is directly laid on the seabed as the pipe discharges non-dangerous liquid, but this direct laying has some fear for possible damage to or destroy of the laid pipe by sunken ship. As for the new sewer pipe, steel pipe will be fixed to the seabed with flanges with due consideration to the easiness of underwater work. In some cases it will be better to bury the sewer pipe with the same thickness as the pipe diameter. Final decision on the method of relocation of the sewer pipe will be made in due course of time.

TABLE 4.2.4 Soil Conditions in Short Term Development Plan

(1) Short Term Development Plan

Breakwater Site		Seawall Site	Quaywall Site
Existing Seabed		Existing Seabed	Existing Seabed
(-12.0 m to -14.0 m)		(-10.0 m to -15.0 m)	(-10.0 m to -14.0 m)
N = 10		N = 10	N = 15
Coarse sand r = 1.8 t/m³		Sand, Clayey sand	Coarse sand
		r = 1.8 t/m³	
-17.0 m	⌀ = 30°	-20.0 m ⌀ = 30°	r = 1.8 t/m³
-24.0 m	sand	22.0 ~ 25.0 m sand	17.0 m ⌀ = 30°
Rock	N > 50	Rock N > 50	
			Rock
			N > 50

(2) Short Term Development Plan (Alternative (1))

Breakwater Site			Existing Site	Quaywall Site
New West Existing Seabed		New North West Seabed	Existing Seabed	Existing Seabed
(-10.0 m to -15.0 m)		(-12.0 m to -14.0 m)	(-10.00 m to -12.0 m)	(-9.00 m to -12.0 m)
N = 10		N = 10	N = 5	N = 2 ~ 10
Sand	y = 1.8 t/m³	Sand y = 1.8 t/m³	Sand y = 1.8 t/m³	Clayey sand
Clayey sand		Clayey sand	Clayey sand	y = 1.8 t/m³
	⌀ = 30°	⌀ 30°	⌀ = 27°	Clay ⌀ = 25° ~ 30°
-22.0 m		-18.0 m sand	-16.00 m	-13 m ~ -19 m
-26.0 m	sand	-24.0 m	-24.00 m sand, clay	
Rock	N > 50	Rock N > 50	Rock N > 50	Rock N > 50

(3) Short Term Development Plan (Alternative (2))

Breakwter Site			Exisitng Site	Quaywall Site
New West Existing Seabed		New North West Existing Seabed	Existing Seabed	Existing Seabed
(-10.0 m to -15.0 m)		(-12.0 m to -14.0 m)	(-10.00 m to -12.0 m)	(-11.00 m to -12.0 m)
N = 10		N = 10	N = 5	N = 2
Sand	y = 1.8 t/m³	Sand y = 1.8 t/m³	Sand y = 1.8 t/m³	Sand y = 1.8 t/m³
Clayey sand		Clayey sand	Clayey sand	Clay ⌀ = 0.25°
	⌀ = 30°	⌀ = 30°	⌀ = 0.27°	
-22.0 m		-18.0 m	-16.0 m	-15.0 m
-26.0 m	sand	-24.0 m sand	-24.0 m sand,	-15.0 m ~ -19.0 m
Rock	N > 50	Rock N > 50	clay ⌀ = 30°	Sand ⌀ = 30°
			Rock N > 50	Rock N > 50

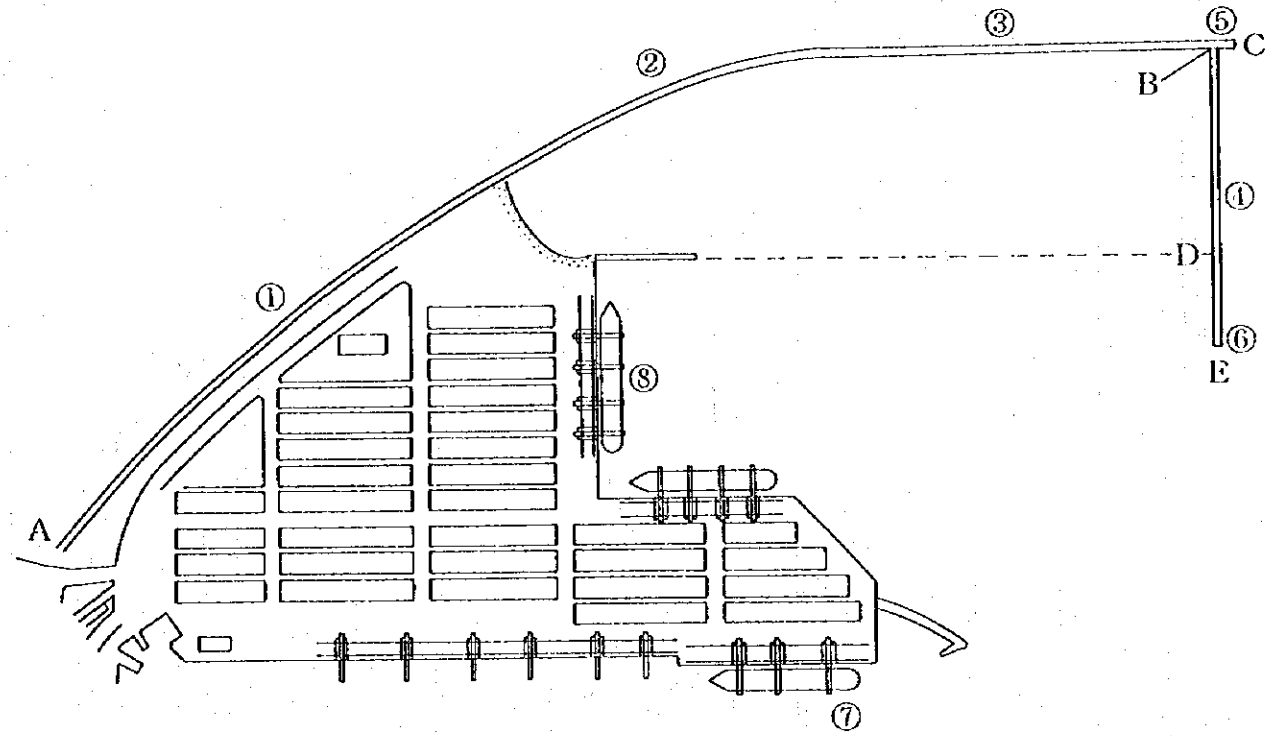


FIGURE 4.3.1 Layout Plan (Seawall, Breakwater and Quaywall) under Short Term Development

FIGURE 4.3.2 Standard Cross Section of Concrete Caisson Type C Seawall ③
(-12.0 m to -15.0 m deep alongside)

Unit: meter

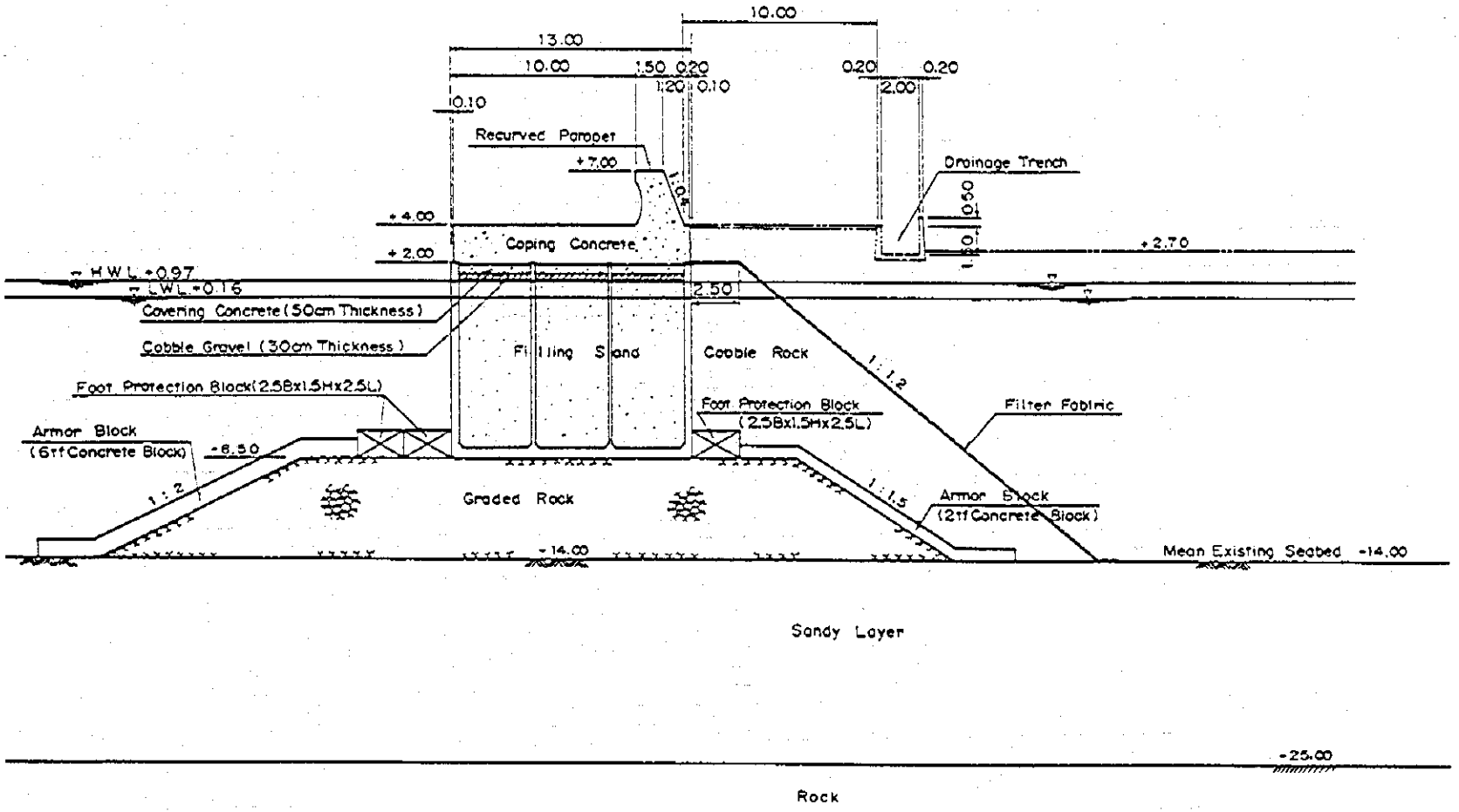


FIGURE 4.3.3 Standard Cross Section of -16.0 m Quaywall ⑧
(Concrete Caisson type)

Unit: meter

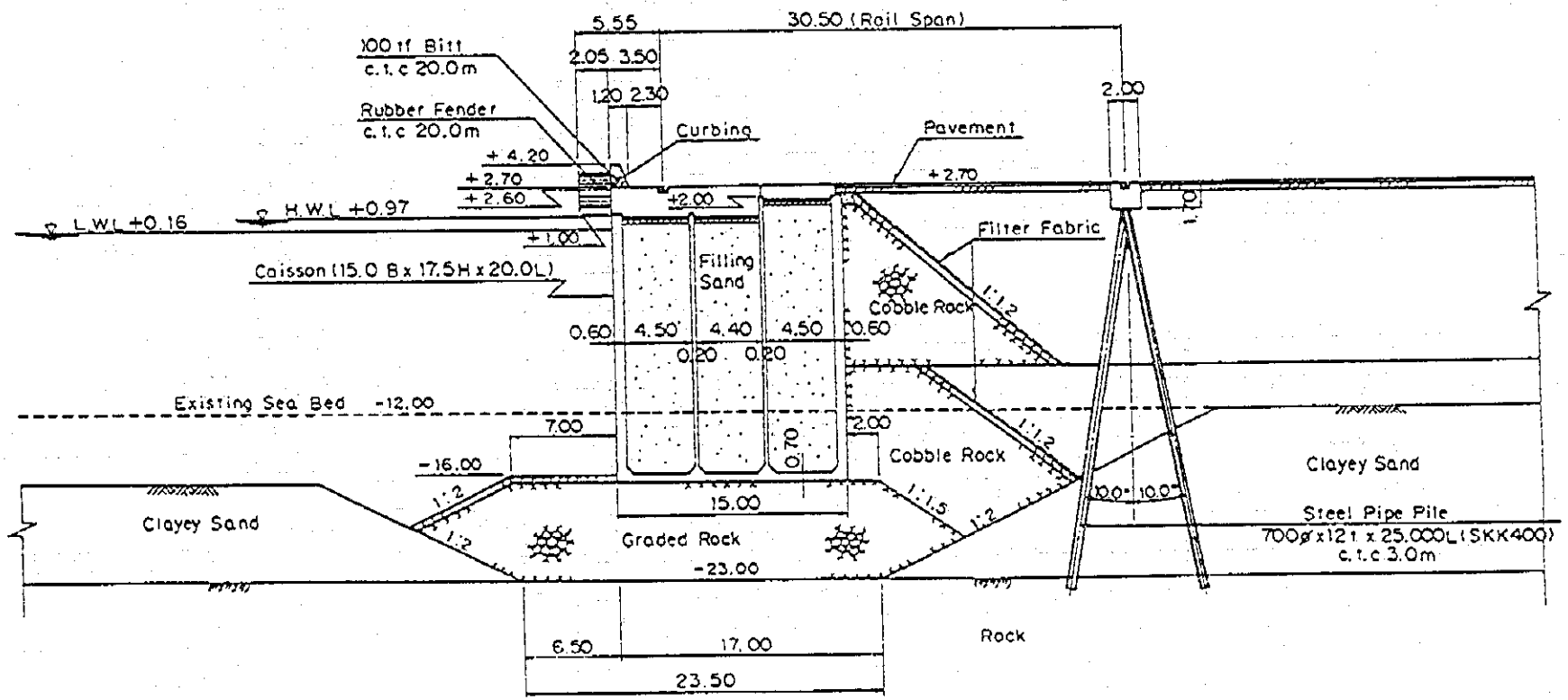
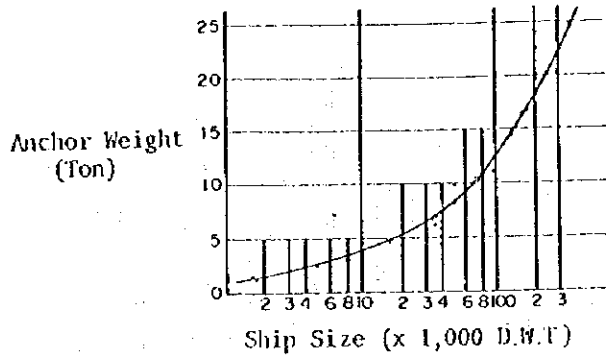


FIGURE 4.5.1 Data on Ship Size, Anchor Weight and Laying Depth of Pipeline



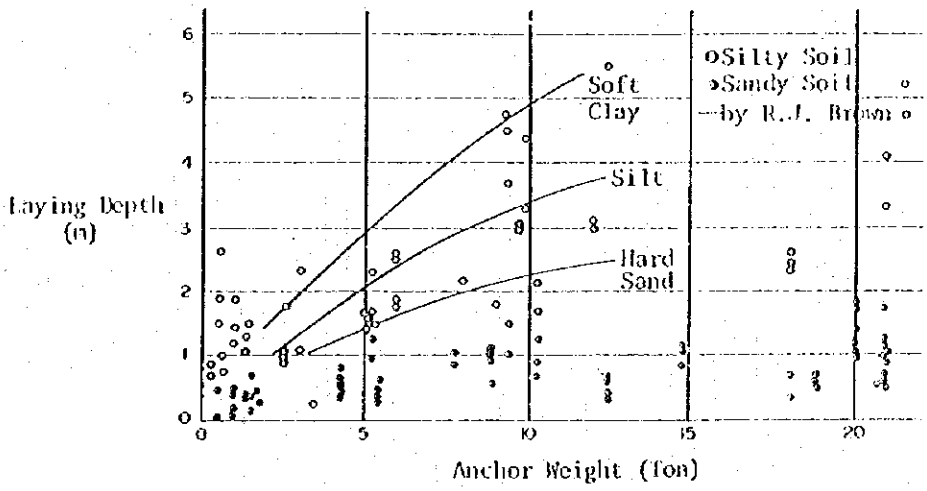


TABLE 4.5.1 Major Submerged Pipeline in Japan

Location	Pipe Diameter (inch)	Laying Distance (m)	Maximum Water Depth of Pipe Laid (m)	Maximum Depth of Pipe Laid (m)
Tomakomai	48	3,200	24.0	2.0
Niigata	14	11,200		(Planned)
Chiba	48	9,950	27.0	4.0
Nagoya	56	8,700	29.0	3.0
Ube	48	11,300	23.0	2.0
Okinawa	42	4,400	21.0	2.0
Okinawa	56	2,700	40.0	3.0 (Planned)

FIGURE 4.5.2 Pipeline Replacement Work Sequence

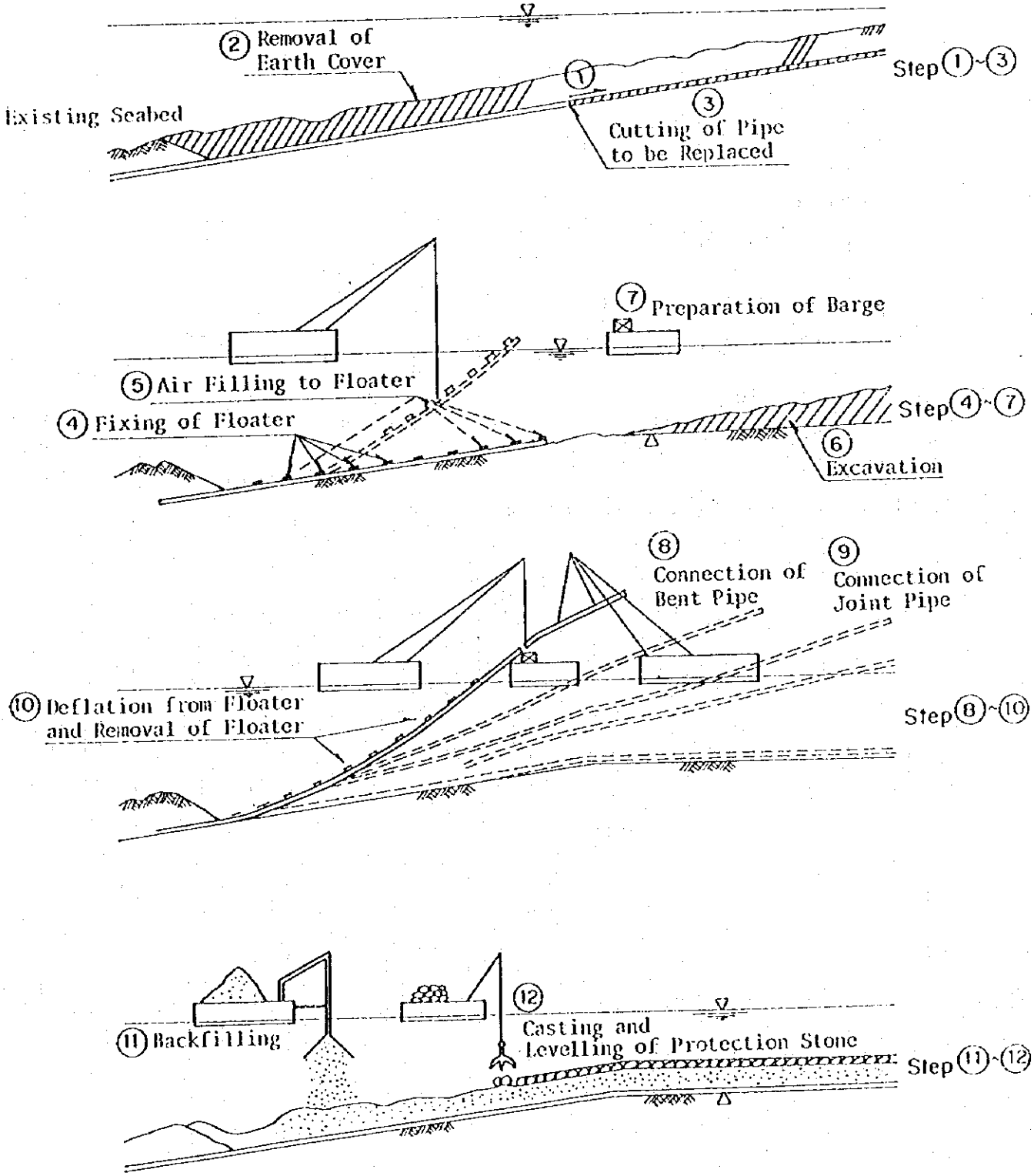
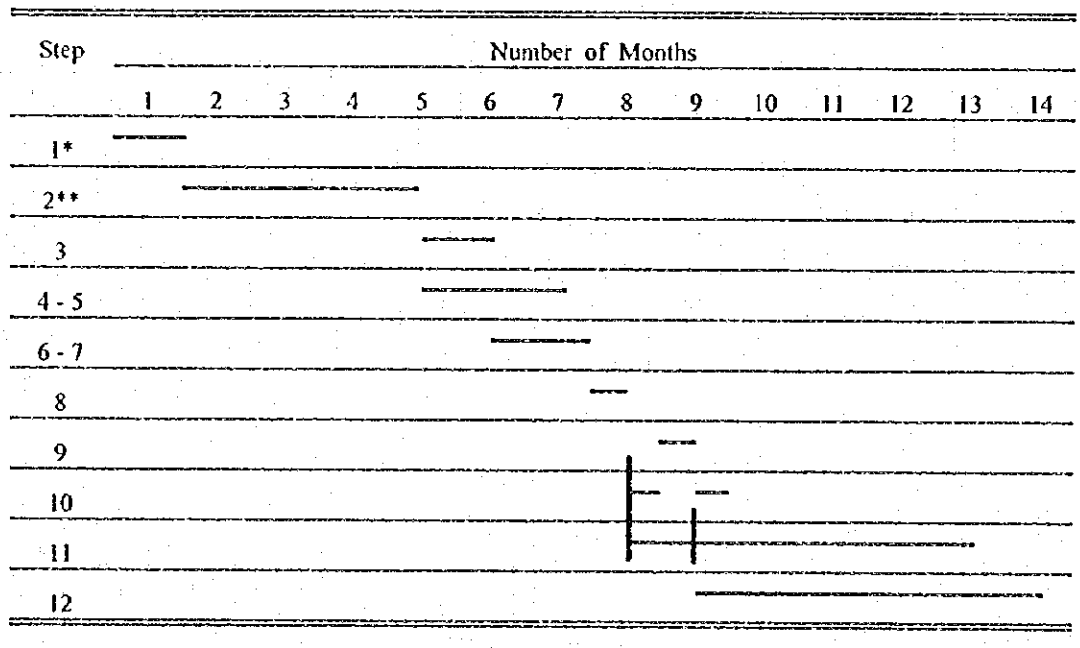


TABLE 4.5.2 Pipe Replacement Work Sequence and Schedule

Pipe Replacement Work Sequence

Step	Work Item	Description	Key Point in Execution
1	Purge of oil in pipeline	Pipe diameter 36'	Separation capacity of oil from water.
2	Removal of earth cover	50 m³/m	Pump dredger is preferable to prevent damage to the pipeline.
3	Cutting of pipe	Underwater cutting	Protection of cut end for re-connection.
4	Fixing of floater		Fixing method.
5	Filling air into floater		Automatic control/adjustment of buoyancy
6	Seabed dredging	Trench bottom : -19 m to -20 m	Capability of dredging rock layer to
7	Mobilization of barge		Connection of pipe on barge.
8	Connection of bent pipe	Single pipe of 25 m long	Bent pipe in line with seabed.
9	Connection of joint pipe		Continuous connection while moving back.
10	Deflation from floater		Deflation in step with single pipe connection, lowering of pipe.
11	Backfilling	100 kg to 500 kg/piece	Sand of good quality.
12	Casting of protection stone material		Casting without impact on seabed and levelling.

Pipe Replacement Work Schedule (for 1,000 m Section)



Legend : * *Preparatory period after purge.*
** *about 50,000 m³*

5. Construction Procedures

5.1 Construction Schedule

175. As detailed TABLE 5.1.1 the construction of the short-term project will be carried out in the sequence indicated below.

(1) Construction of QEQ No.6 Container Berth, 380 m in length, will be started in the first year of the project period and completed in mid of third year from the commencement of the project.

(2) Offshore works on the seawall out side QEQ will be started from southern end and proceed towards north-west direction in the first year of the project. The construction period for the seawall is considered to be about 8 years.

(3) When the above seawall is completed about 600 m or more in length, it may be the third year of the project period, and the offshore work -16.0 m container berth is scheduled to commence during this time.

176. This wharf structure, which is of concrete caisson type, will be provided as the revetment structure and will be utilized for the retaining wall of the land reclamation in the first stage of the project.

(4) The reclamation work outside QEQ will be started at the same time as the completion of -16.0 m revetment, and a part of the new container yard will be opened to the container marshaling operation after 5 years of commencement of the project.

(5) Main civil structures of the project such as long seawall, -16.0 m container wharf, revetment, reclamation work will be completed in the eighth year of the project period.

(6) Entire container yard, all container facilities, handling equipment and electric power supply will be completed in the ninth year from the commencement of the project.

5.2 Construction Condition

5.2.1 General Information on Construction Works in Colombo

177. Amid a continuing rush for construction projects in Colombo and neighboring areas in recent periods, there have come into the picture those contractors equipped with relatively large heavy-duty construction machinery and those construction firms offering an acceptable level of construction technologies.

178. Suppliers of quarry-run material, cement, ready-mix concrete and other construction materials have also made such a growth that they are now in a position to serve the needs of the domestic construction industry on a stable and continuous basis. As a result, it now seems that

general onshore construction works can be carried out by local contractors with a passable level of workmanship if they are given technical guidance by engineers from advanced nations.

179. In Sri Lanka, construction workers in general and construction equipment operators, many of whom have gained an acceptable level of skills through their temporary jobs in the Middle East and other parts of Asia, can be recruited in the local labour market.

180. On the other hand, however, all construction plants and equipment required for offshore works must be procured from overseas supply sources. Further, a construction yard of adequate size can hardly be obtained in Colombo Port where various brisk port activities are carried on in limited spaces. In this respect, the Study Team has suggested the provision of a construction yard outside the port area for the purpose of the Project implementation. Such construction materials as graded rocks, sand, asphalt, fuels and cement can be obtained from local sources, while steel and chemical products required for the Project construction would have to be imported.

5.2.2 Sea Condition of Offshore QEQ

181. It is difficult to execute the offshore civil work outside the Colombo Port during the South West monsoon season due to the rough sea conditions. The study team has analyzed wave observation records obtained by SLPA in 1993 and 1994 and their results are summarized in the FIGURE 5.2.1.

182. These results show that the significant wave height of more than one meter is recorded continuously through out the entire period of about 6 months from May to October, and, as such, it is not expected to carry out any offshore civil work during this time.

183. The offshore civil work shall be planned to concentrate during the North East monsoon season from November to April as indicated the FIGURE 5.2.1.

5.2.3 Construction Work Site

(1) Construction of the seawall and -16.0 meter container wharf will be performed simultaneously, and a large quantity of rubble stone will be required for the foundations of concrete caissons.

(2) The requirement of rubble stones estimated at a monthly volume of about 27,000 m^3, will need an open storage space of nearly 10,000 m^2 at a shoreline location convenient for loading the stones to floating craft.

(3) Construction of the seawall will require more than 58,000 numbers of concrete blocks for foundations. It will be necessary to secure space for fabrication and storage of this concrete blocks in large quantities.

(4) A floating dock of about 10,000 ton capacity will be required for the construction of the concrete caissons which shall be the main body of the seawall structure and also the quaywall

structure. A caisson fabrication yard will be necessary and it will consist of an open yard and a wharf of about 50 m in length in a well sheltered water area for the temporary anchorage of manufactured concrete caissons.

(5) Floating pile driver, barges, tugboats, diver boats and other construction crafts will be moored at the construction site.

(6) The yard will need approximately 70,000 m^2 of space with a shoreline of 200 m in length in order to stockpile the rubble stones and storage of the concrete products manufactured during South West monsoon season.

As the redevelopment of the port area progresses, it will be increasingly difficult to secure the necessary space for the construction work site. In this connection, it is suggested that a new site for construction operations be provided in the water area behind the Prince Vijaya Quay by filling.

(7) FIGURE 5.2.2 illustrates the proposed construction yard (referred to in subsection 5.2.1) for production and storage of construction materials.

5.2.4 Construction Materials

(1) Steel

184. In Sri Lanka, steel and steel products for construction purposes are produced by the state-owned Ceylon Steel Corporation, Ltd. at its steel mill located at Athurugiriya about 20 km east of Colombo. This steel mill produces nearly 50,000 tons of steel and steel products through electric furnaces using imported ingots. The principal products of CSC are as listed below.

Rolled Products

TOR steel, 10, 12, 16, 20 and 25 mm in thickness
Deformed steel, 10, 12, 16, 20 and 25 mm in diameter
Mild steel round bar, 10, 12, 16, 20 and 25 mm in diameter
Mild steel flats, 12 × 6, 16 × 6, 20 × 6, 25 × 6, 30 × 6 and 40 × 6 m
Mild steel angles, 25 × 25 × 3, 30 × 30 × 3, 40 × 40 × 5 and 50 × 50 × 6 mm

Wire Products

Nail wire, G.I. welded mesh, barbed wire, etc.

Other steel products are imported on an as-needed basis. For major construction projects, in particular, systematic procurement of necessary steel products is hardly possible and this makes it inevitable for the country to depend almost entirely on imports to meet steel product requirements.

(2) Cement

185. Sri Lanka's domestic demand for cement amounts to over 1,500,000 tons annually and the production capacity combined of cement factories in the country can hardly fill the annual needs, thus making it necessary to depend on imports to meet the shortage.

186. Cement factories are located in Trincomalee, Kankesanturai, Puttalam and Galle and they produce cement using imported clinker. The current production situations of the four cement factories are outlined below.

a) The Trincomalee factory, operated by Tokyo Cement of Japan, turns out about 250,000 tons annually.

b) The factory at Kankesanturai has suspended production under the influence of protracted ethnic conflicts.

c) Nearly 400,000 tons are manufactured by the Puttalam factory.

d) The Galle factory has an annual output of 170,000 tons.

187. The bulk of imported cement is imported by Mahaweli Cement Co., Ltd. which owns silos at the Port of Colombo. This cement manufacturer imports approximately 400,000 tons annually from such countries as Kenya, India, Persian Gulf states, and Indonesia. The company has strongly requested permission from the Sri Lanka Authority to install four additional silos at the port where it currently operates nine units.

(3) Stone

188. In the vicinity of Colombo, there are a large number of small quarries producing various types and sizes of stone needed for building works, road construction, and concrete aggregates. At some of these minor quarries manual labour is still used for crushing stones, but in recent years there has been a tendency among the larger quarries to use breakers, crushing plants and other mechanical means for producing various sizes of stone. Near the quarries located within a distance of about 30 km from Colombo, more than 10 hills are found where production of stones in an estimated quantity of some 400,000 m^3 is presumably possible. It seems, therefore, that there is hardly any cause for worries as far as the sources of stone supply are concerned.

189. In recent years, however, the trend for residential quarters to spread to the suburbs of Colombo and increased restraints on quarry developments in the suburban areas for environmental considerations have combined to drive quarry production activities to locations at increasingly greater distances from the urban areas. Moreover, a recent construction boom in the Colombo area has contributed to higher stone prices, thus giving rise to the possibility of pushing up construction costs as a whole.

190. In the series of Port of Colombo Extension Projects during the last 10 years, the

contractors procured about 400 m^3 of rubble stones for foundations each day on a continuous basis. This quantity was equivalent to about 100 truck loads per day. This level of contractor performance may be expected in future port construction projects in Sri Lanka. For increased stone deliveries, however, it may be necessary to implement such measures as the provision of primary storage areas having a wider entrance for trucks and other vehicles and the introduction of new high-powered mechanical equipment for quarries.

(4) Fill Sand

191. Typically, laterite is used in reclamation and site preparation works in Colombo. This material, however, cannot be used for reclaiming land from the sea. Sandy soils from borrow pits are obtainable only in limited quantities in the neighborhood of Colombo. Supply of fill material from rivers, estuaries or coastal areas is largely restricted. For these reasons, sand required for reclamation works in the series of Colombo Port Extension Projects had to be obtained from the seabed of offshore areas. Bottom sand in these areas seems to be moving from south to north. Approximately 4,000,000 cu.m. of submarine sand has been procured in connection with the Colombo Port Extension Projects and the use of sand from this source will be considered for the purpose of constructing the New Port of Colombo.

(5) Ready-Mixed Concrete

192. Of some five ready-mixed concrete producers operating in Colombo, two are major firms receiving assistance from Japanese manufacturers. The combined annual production capacity of the two producers is approximately 200,000 m^3, which may add up to nearly 300,000 m^3 annually when the output of the remaining manufacturers is combined. One of the two major producers has reported a maximum annual shipment of 58,000 m^3 to the local construction industry.

(6) Construction Material Prices

193. The information on the basic material prices and labour casts related to the construction works are investigated and results of survey are summarized in the four tables shown in TABLE A.5.2 (1) ~ (3).

194. The changes in these unit prices in past years, 1988 and 1990 are also shown in the above tables for the purpose of comparison, and the rise in prices are indicated on a percentage basis under the different currencies, namely, in Japanese Yen, and US Dollar.

195. According to these survey data, the prices of graded rock, filling materials and labour has increased nearly four times in Sri Lanka Rupees (Rs.) from 1988 to 1995. The prices increases in other materials, such as steel products, oil products and concrete show an increase of about two times from 1998 to 1995 in Rs.

5.2.5 Import Duties and Relevant Taxation for Construction Projects

(1) Taxes on Construction Industry

196. In Sri Lanka, contractors undertaking construction works are required to pay Corporation Tax and Business Turnover Tax. A stamp duty is also payable when a construction contract is concluded.

a) Corporation Tax

197. This tax is assessed on 35% of a profit realized. The tax office seems to experience much difficulty in grasping the exact corporate profits. In addition, a 15% Surcharge Tax and a 4.5% Defence Levy are also added to the Corporation Tax. Business corporations typically file with the competent authorities tax returns duly certified by their own auditors.

b) Business Turnover Tax

198. This tax is assessed at 6% of the value of contracts or prices of materials and services purchased.

b) Business Turnover Tax

199. This tax is assessed at 6% of the values of contracts or prices of materials and services purchased.

c) Stamp Duty

200. A revenue stamp for a sum equivalent to one-thousandth of the contract value must be affixed to the duly executed contract form.

(2) Import Duties

201. Taxes and duties listed below are imposed on contractors when importing construction equipment and materials. The tax rates vary with items imported. TABLE 5.2.1 gives the existing rates of the above-named taxes and duties applicable to major items of construction equipment and materials.

TABLE 5.2.1 Import Duties of Construction Equipment and Material

Unit: Percent

Description	Customs Duty	Turnover Tax	Defence Levy	Excise Duty
Equipments				
Crawler Crane	10	free	4.5	free
Truck	35	20	4.5	free
Back Hoe	10	free	4.5	free
Flat Barge	10	20	4.5	free
Materials				
Steel Bar	35	10	4.5	free
Steel Pipe Piles	10	10	4.5	free
Structural Steel	35	10	4.5	free
Cement	10	free	4.5	5% per kg
Fender	35	20	4.5	free
Bitt	35	20	4.5	free
Timber	35	10	4.5	free
Plywood	35	10	4.5	free

(3) Tax Exemptions

202. In construction projects executed with financial aid or investments from foreign nations, applicable taxes or duties may sometimes be payable by the executing agencies in Sri Lanka when entering into the contracts. In this case, the contract prices do not include the Corporation Tax, the Business Turnover Tax and import duties. As a result, the construction costs may appear to be relatively low and careful consideration should, therefore, be given to this point in financial analysis.

5.3 Work Procedures

203. The present Project consists of such major types of work as offshore civil engineering works, container yard preparation, building works, telecommunications installations and container handling equipment works. The construction works of the Project are characterized by (1) very short construction time, (2) difficulty in obtaining spaces for a construction yard in the port area, and (3) considerable difficulty expected in carrying our offshore construction activities during six months of the year due to monsoons. Of particular importance would be the planned production and storage of graded rocks for riprap foundations, concrete caissons and blocks.

204. The construction procedures including the production and storage planning for the vital construction materials noted above are outlined in Part 5, Section 2 Project Outline.

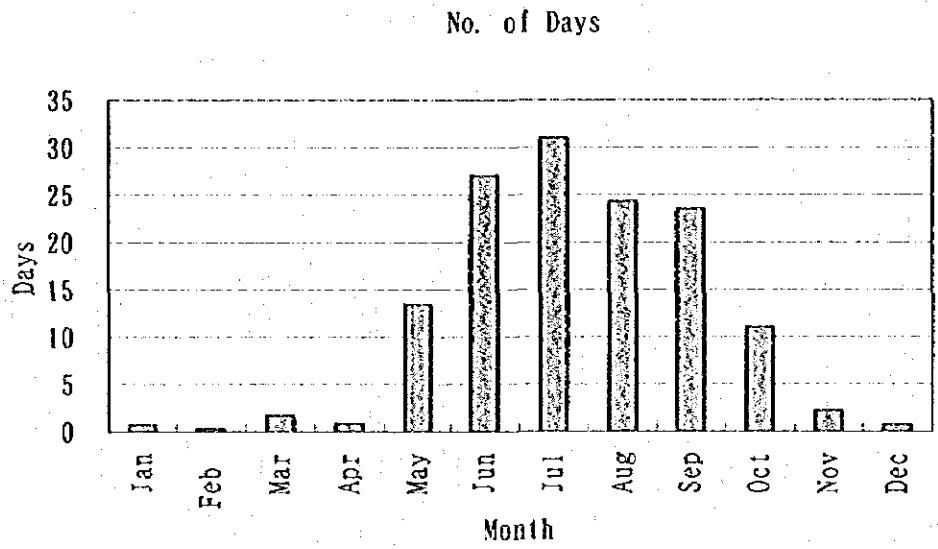
Table 5.1.1 Construction Schedule of Short Term Project 2005

No.	Description	Quantity	1997	1998	1999	2000	2001	2002	2003	2004	2005
			1	2	3	4	5	6	7	8	9
	Project Scheme	Urgent Plan									
		Short Term Plan									
I	**South Port Development**										
I-1	Preparatory Work	Work Site (4.5 ha)									
I-2	QEQ No.6 Quaywall -14m	380m+170m									
I-3	Outer QEQ										
	(a) Seawall and North Revetment	2,560m+390m									
	(b) Quaywall -16m	380m+460m									
	(c) Revetment	250m+260m									
	(d) Breakwater	180m									
	(e) Demolition of SW Breakwater	450m									
I-4	Dredging of Turning Basin	3,800,000m3									
I-5	Reclamation	5,100,000m3									
I-6	Paving Yard and Road	713,00m2									
I-7	Building Work and Electric										
I-8	Cargo Handling Equipment			QEQ2,3,4,5,6			Outer QEQ				
II	**Renovation of Existing Port Facility**										
II-1	Additional Crane to JCT	03 Container Crane									
II-2	Renovation of Bandaranike Quay										
II-3	Navigation Assistance										
II-4	Widening West Entrance	1,460,000m3				Dump to Reclamation Area					
II-5	Port Road Rehabilitation	3,350m									
II-6	North Channel Dredging	250,000m3		Dump to North PVQ Work Site							

FIGURE 5.2.1 Occurrence of Rough Wave -- more than one meter

($H_{1/3}$ > 1.0 m, from Apr. 1993 to Mar. 1994)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
No. of Days	0.7	0.3	1.7	0.8	13.4	27.0	31.0	24.3	23.5	11.0	2.2	0.7	11.4



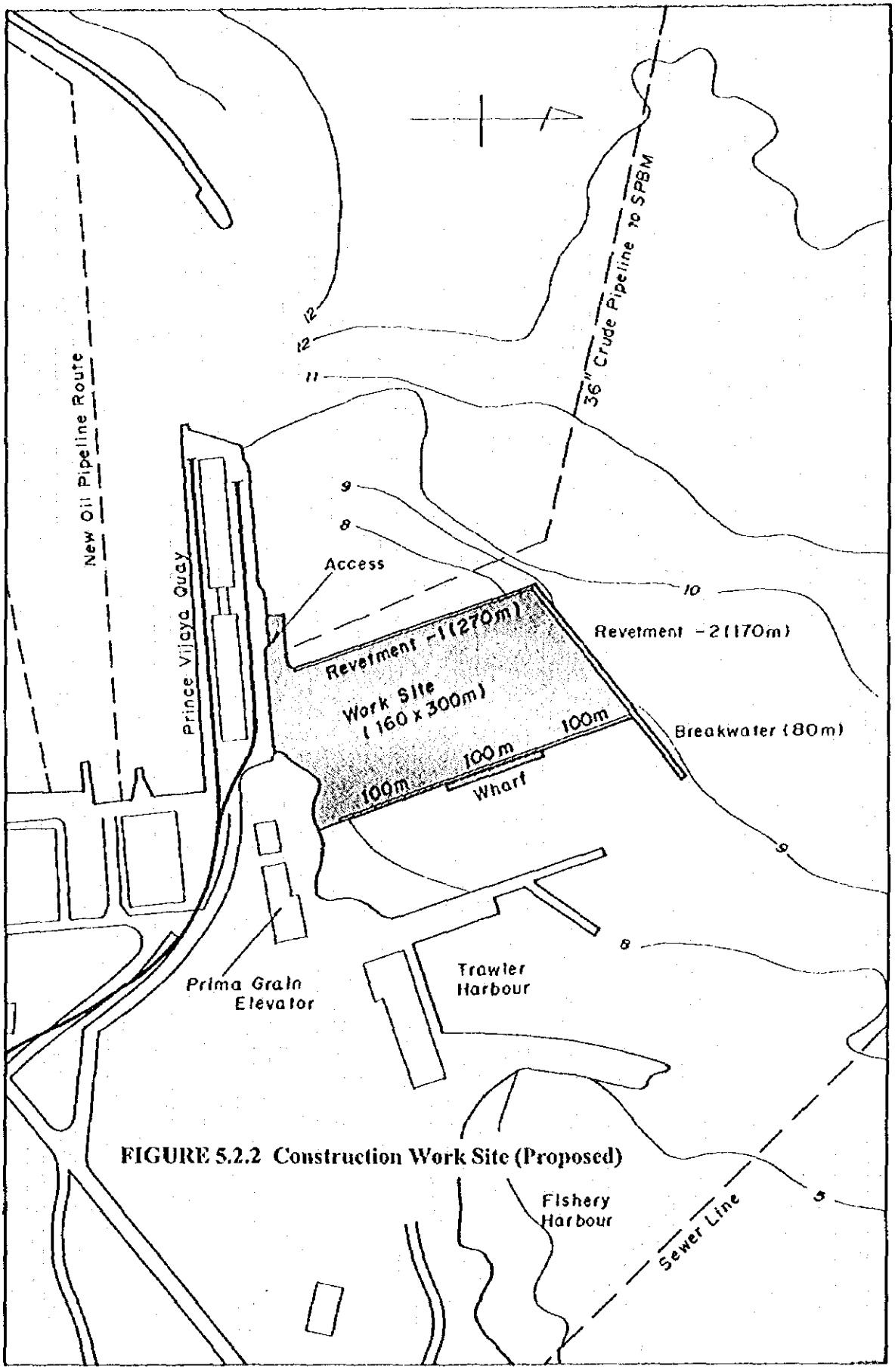


FIGURE 5.2.2 Construction Work Site (Proposed)

6. Cost Estimates

6.1 Basic Conditions of Cost Estimation

205. The cost estimates for the project have been prepared by applying the basic prices and rates obtained through our study from November 1995 to February 1996 and pertaining to the various construction plant, equipment, material and labor required for the project.

206. The cost estimation is also checked based on a comparative evaluation of the unit costs of comparable major items of work in the project and similar projects executed in neighboring Asian countries.

(1) The estimated construction cost consists of foreign and local currency components. The exchange rates used in the cost estimation are:

US$ 1.00 = Rs. 53.36 = ¥ 104.4 (as of January 1996)

(2) All prices and rates inputted into the cost estimates are as of January 1996.

(3) No allowance is made for the import duties applicable to imported materials, equipment construction plants to be brought into Sri Lanka from other countries.

(4) No allowance is made for the business turnover tax (BTT) assessable on materials and fuels obtainable from local sources.

(5) The contract tax applicable to construction contracts is not included in the const estimates.

(6) Nor is any price escalation allowed for in the cost estimates for construction, container handling equipment and engineering services.

(7) The direct cost of construction is classified into the foreign and local currency components. The percentage distribution of the major items of construction materials, equipment and labor between the foreign and local currency components is shown below.

Item	Foreign (%)	Local (%)
Rubble and other stones	0	100
Ready-mixed concrete	0	100
Concrete products from local sources	0	100
Worker and Labor	0	100
Fuel and asphalt	0	100
Steel and reinforcing bars	100	0
Formwork for concreting	60	40
Floating equipment	100	0
Construction equipment for land (ordinary)	0	100
Construction equipment for land (special)	100	0

6.2 South Port Development

207. TABLE 6.2.1 summarizes the project cost of the Short Term Development Plan targeted for the year 2005, and the project cost breakdown for the South Port Development which will constitute the pivotal project in the Short Term Development Plan is given in TABLE 6.2.2.

208. The project cost of the South Port Development amounts to US$ 838.66 million which is broken down into the foreign currency component of US$ 662.62 millions and the domestic currency component of US$ 176,04 million. TABLE 6.2.3 gives the disbursement schedule for the Short Term Development Plan spanning the 9-year period 1997-2005.

209. TABLE 6.2.4 summarizes the project cost estimates for the Urgent Development Plan 2000 and TABLE 6.2.5 gives the project cost breakdown for South Port Development which will constitute the pivotal project under the Urgent Development Plan.

210. As is evident from the two tables, the total project cost of the Urgent Development Plan is roughly US$ 499.44 million, of which approximately US$ 465.63 million will go for the implementation of the South Port Development Project.

6.3 North Port Development

211. TABLE 6.3.1 gives the project cost of the North Port Development, Alternative 1, and TABLE 6.3.2 shows the project cost of the PVQ North Development, Alternative 2. TABLE 6.3.3 and 6.3.4 show the breakdown of summarize the project costs of Alternative 1 and Alternative 2, respectively, for the Short Term Development Plan targeted for the year 2005.

212. TABLE 6.3.5 summarized the costs of the major work items under the Base Plan, Alternative 1 and Alternative 2 for the Short Term Development Plan.

TABLE 6.2.1 Summary of Project Cost

SHORT TERM DEVELOPMENT PLAN 2005

Thousand US$

No.	Description	Construction Cost			Remarks
		Foreign	Local	Total	
I	**South Port Development**				
I-1	Civil Work	360,491	143,764	504,255	
I-2	Building, Electric and Water Supply	44,935	8,655	53,590	
I-3	Cargo Handling Equipment	176,280	0	176,280	
I-4	Engineering Service	31,553	8,383	39,936	
I-5	Physical Contingency	49,357	15,242	64,599	
I-6	Sub Total	662,616	176,044	838,660	
II	**Renovation of Bandaranaike Quay**				
II-1	Construction Cost	10,378	3,628	14,006	
II-2	Engineering Service	1,038	363	1,401	
II-3	Physical Contingency	1,038	363	1,401	
II-4	Total	12,454	4,354	16,808	
III	**Navigation Assistance**				
III-1	Construction Cost	28,600	0	28,600	
III-2	Engineering Service	1,702	300	2,002	
III-3	Physical Contingency	2,860	0	2,860	
III-4	Total	33,162	300	33,462	
IV	**Widening Main Channel**				
IV-1	Construction Cost	19,147	3,648	22,795	
IV-2	Engineering Service	1,340	256	1,596	
IV-3	Physical Contingency	1,915	365	2,280	
IV-4	Total	22,402	4,269	26,671	
V	**Road Development**				
V-1	Fort Road	11,697	3,687	15,384	
V-2	Engineering Service	1,170	368	1,538	
V-3	Physical Contingency	1,170	368	1,538	
V-4	Total	14,037	4,423	18,460	
VI	**North Channel Dredging**				
VI-1	Construction Cost	4,485	520	5,005	
VI-2	Engineering Service	449	52	501	
VI-3	Physical Contingency	449	52	501	
VI-4	Total	5,383	624	6,007	
VII	**Grand Total**	750,054	190,014	940,068	

TABLE 6.2.2 Breakdown of Project Cost

SOUTH PORT DEVELOPMENT 2005

Thousand US$

No.	Work Item		Remarks	Unit	Quantity	Construction Cost		
						Foreign	Local	Total
I	SOUTH PORT DEVELOPMENT							
I-1	Civil Work							
I-1-1	QEQ No.6 Extension	Quaywall	-14.0 m	m	380	19,533	8,371	27,904
I-1-2		Revetment	-14m to -8m	m	170	6,269	2,686	8,955
I-1-3	South Container Terminal	Quaywall	-16.0 m	m	840	55,415	23,749	79,164
I-1-4		Revetment in Basin	-16.0 m	m	510	26,721	11,452	38,173
I-1-5		New S-W Seawall Type-A	upto -7m	m	240	7,363	3,155	10,518
I-1-6		New S-W Seawall Type-B	-7m to-12m	m	300	12,097	5,184	17,281
I-1-7		New S-W Seawall Type-C	-12m or more	m	2,020	99,583	42,678	142,261
I-1-8		North Revetment	-15.0 m	m	390	13,738	5,888	19,626
I-1-10	Breakwater	Inner Breakwater	-15.0 m	m	180	6,270	2,687	8,957
I-1-11		Breakwater Demolition	Existing	m	450	12,249	5,250	17,499
I-1-12	Dredging of Turning Basin		-16.0 m	m3	3,800,000	21,318	3,762	25,080
I-1-13	Reclamation		+2.7 m	m3	5,100,000	21,242	3,748	24,990
I-1-14	Paving of Container Yard	PC slab, stacking plate, Electric conduit		m2	428,000	47,187	20,223	67,410
I-1-15	Paving of Terminal Area and Road			m2	285,000	5,766	2,471	8,237
I-1-16	Surface Drainage			m2	713,000	5,740	2,460	8,200
I-1-17	Sub Total					360,491	143,764	504,255
I-1-18	Contingency	10% of sub total				36,049	14,377	50,426
I-1-19	Total					396,540	158,141	554,681
I-2	Building, Electric and Water Supply							
I-2-1	CFS	40m by 150m		Bldg.	2	7,084	2,361	9,445
I-2-2	Gate Building	20m by 45m		Bldg.	1	720	240	960
I-2-3	Administration Building	32m by 32m		Bldg.	1	5,397	1,799	7,196
I-2-4	Maintenance Shop	30m by 70m		Bldg.	1	1,574	525	2,099
I-2-5	Facilities Building	18m by 32m		Bldg.	2	540	180	720
I-2-6	Power Station Building	40m by 40m		Bldg.	1	787	262	1,049
I-2-7	Sump and Pump House			sum	1	383	127	510
I-2-8	Sub Total of Building					16,485	5,494	21,979
I-2-9	Electric Supply, Reefer, Yard Illumination etc. in Yard			sum	0.7	15,496	1,722	17,218
I-2-10	Generator		2,500 KVA	No.	3.0	5,693	632	6,325
I-2-11	Sub Station Equipment		10,000KVA	sum	0.7	6,198	689	6,887
I-2-12	Water Supply and drainage			sum	0.7	1,063	118	1,181
I-2-13	Sub-Total of Services					28,450	3,161	31,611
I-2-14	Sub Total of No.8and No.13					44,935	8,655	53,590
I-2-15	Contingency	10% of No.14 above				4,494	865	5,359
I-2-16	Total					49,429	9,520	58,949
I-3	Cargo Handling Equipment							
I-3-1	Container Crane	Post Panmanx		No.	11	81,634	0	81,634
I-3-2	Container Crane	Panamax to QEQ No.2,3		No.	3	17,316	0	17,316
I-3-3	Transfer Crane		(11+3)*3+3=45	No.	45	57,144	0	57,144
I-3-4	Trailer Chassis		45*4=180	No.	180	20,186	0	20,186
I-3-5	Sub Total					176,280	0	176,280
I-3-6	Contingency	5% of Sub Total				8,814	0	8,814
I-3-7	Total					185,094	0	185,094
I-4	Total	I-1, I-2, I-3				631,063	167,661	798,724
I-5	Engineering Service	5 % of Total				31,553	8,383	39,936
I-6	Grand Total					662,616	176,044	838,660

TABLE 6.2.3 Disbursement Schedule for Short Term Project

Unit : '000US$

No.	Description	Remarks	Amount Total Construction Cost			1997 1st Year			1998 2nd Year			1999 3rd Year			2000 4th Year			2001 5th Year			2002 6th Year			2003 7th Year			2004 8th Year			2005 9th Year		
			Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total	Forign	Local	Total
I	South Port Development																														
I-1	Preparatory Work																														
I-2	QEQ No 6 Quaywall -14m	380+170m	25,802	11,057	36,859	10,321	4,423	0.4 14,744	12,901	5,529	0.5 18,430	2,580	1,106	0.1 3,686																	
I-3	Outer QEQ																														
	(a) Seawall	2,950m	132,781	56,905	189,686	15,933	6,829	0.12 22,762	15,933	6,829	0.12 22,762	15,933	6,829	0.12 22,762	15,933	6,829	0.12 22,762	15,933	6,829	0.12 22,762	15,933	6,829	0.12 22,762	15,933	6,829	0.12 22,762	15,933	6,829	0.12 22,762	5,311	2,276	0.04 7,587
	(b) Quaywall -16m	380+460m	55,415	23,749	79,164							11,083	4,750	0.20 15,833	11,083	4,750	0.20 15,833	11,083	4,750	0.20 15,833	11,083	4,750	0.20 15,833	11,083	4,750	0.20 15,833						
	(c) Revetment	300+260m	26,721	11,452	38,173																8,016	3,436	0.3 11,452	8,016	3,436	0.3 11,452	2,672	1,145	0.1 3,817			
	(d) Inner Breakwater	180m	6,270	2,687	8,957																						2,508	1,075	0.4 3,583	3,762	1,612	0.6 5,374
	(e) Demolition Breakwater	450m	12,249	5,250	17,499																			6,125	2,625	0.5 8,750	6,125	2,625	0.5 8,750			
I-4	Dredging	3,800,000m3	21,318	3,762	25,080							6,395	1,129	0.3 7,524							8,527	1,505	0.4 10,032	6,395	1,129	0.3 7,524						
I-5	Reclamation	5,100,000m3	21,242	3,748	24,990							4,248	750	0.2 4,998	4,248	750	0.2 4,998				2,124	375	0.1 2,499	2,124	375	0.1 2,499	4,248	750	0.2 4,998	4,248	750	0.2 4,998
I-6	Paving Yard and Road	713,000m2	58,693	25,154	83,847										14,673	6,289	0.25 20,962							14,673	6,289	0.25 20,962	14,673	6,289	0.25 20,962	14,673	6,289	0.25 20,962
I-7	Building Work and Electric		44,935	8,655	53,590				6,742	1,297	0.15 8,039	6,742	1,297	0.15 8,039	6,742	1,297	0.15 8,039							11,237	2,161	0.25 13,398	6,742	1,297	0.15 8,039	6,742	1,297	0.15 8,039
I-8	Cargo Handling Equipment		176,280	0	176,280							35,256	0	0.2 35,256	35,256	0	0.2 35,256							35,256	0	0.2 35,256	35,256	0	0.2 35,256	35,256	0	0.2 35,256
I-9	Engineering Service		31,553	8,383	39,936	6,310	1,677	7,987	3,155	839	3,994	3,155	839	3,994	3,155	839	3,994	3,155	839	3,994	3,155	839	3,994	3,155	839	3,994	3,155	839	3,994	3,155	839	3,994
I-10	Total of I		613,259	160,802	774,061	32,564	12,929	45,493	38,731	14,491	53,225	85,392	16,700	102,092	91,090	20,754	111,844	30,171	12,418	42,589	48,838	17,734	66,572	113,997	28,433	142,430	96,656	23,140	119,796	75,819	14,208	90,027
II	Renovation of Existing Port Facility																														
II-1	BQ Renovation		10,378	3,628	14,006							#REF!	#REF!	0.6 #REF!	#REF!	#REF!	0.4 #REF!															
II-2	Navigation Assistance		28,600	0	28,600							5,720	0	0.2 5,720	5,720	0	0.2 5,720							5,720	0	0.2 5,720	5,720	0	0.2 5,720	5,720	0	0.2 5,720
II-3	Widening Main Entrance		19,147	3,648	22,795				4,787	912	0.25 5,699	4,787	912	0.25 5,699	4,787	912	0.25 5,699													4,787	912	0.25 5,699
II-4	Road Development		11,697	3,687	15,384																			4,677	1,477	0.4 6,154	4,677	1,477	0.4 6,154	2,339	738	0.2 3,077
II-5	North Channel Dredging		4,485	520	5,005				4,484	521	1.0 5,005																					
II-6	Engineering Service		5,699	1,339	7,038	1,211	197	1,408	1,211	197	1,408	605	99	704	605	99	704				605	99	704	605	99	704	605	99	704	605	99	704
II-7	Total of II		80,006	12,822	92,828	1,211	197	1,408	10,482	1,630	12,112	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	0	0	0	605	99	704	11,002	1,576	12,578	11,002	1,576	12,578	13,451	1,749	15,200
III	Total of Construction Cost	I + II	693,265	173,624	866,889	33,775	13,126	46,901	49,213	16,124	65,337	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	30,171	12,418	42,589	49,443	17,833	67,276	124,999	30,009	155,008	107,658	24,716	132,374	89,270	15,957	105,227
IV	Contingency		56,789	16,390	73,179																										
	(a) Outer QEQ Development		49,357	15,242	64,599																										
	(b) Renovation of Existing Port Facility		7,432	1,148	8,580																										
V	Grand Total	III + VI	750,054	190,014	940,068																										

TABLE 6.2.4 Summary of Project Cost
URGENT DEVELOPMENT PLAN 2000

Thousand US$

No.	Description	Amount	Remarks
I	**South Port Development**		
I-1	Civil Work	291,377	01 Main Berth, 53 ha Container Yard, etc.
I-2	Building, Electric and Water Supply	39,535	CFS, Gate, Office, Reefer, Generator, Light
I-3	Cargo Handling Equipment	75,667	07 Container Crane, 21 Transfer Crane, etc.
I-4	Engineering Service	22,173	
I-5	Physical Contingency	36,875	
I-6	Total	465,627	See detail in TABLE 4.3.5.2
II	**Renovation of Bandaranaike Quay**		
II-1	Construction Cost	14,006	06 ha Open Yard, Lighting, etc
II-2	Engineering Service	1,401	
II-3	Physical Contingency	1,401	
II-4	Total	16,808	See details in Figure A 3.3.2.1
III	**Navigation Assistance**		
III-1	Construction Cost	9,400	Communications, Tug Boat, Navigation aids
III-2	Contingency	940	
III-3	Engineering	658	
III-4	Total	10,998	See details in Figure A 3.3.2.2
IV	**North Channel Dredging**		
IV-1	Construction Cost	5,005	Dredging -12.0 m
IV-2	Contingency	501	
IV-3	Engineering	501	
IV-4	Total	6,007	See details in Figure A 3.3.2.3
V	**Grand Total**	499,440	

TABLE 6.2.5 Breakdown of Project Cost
URGENT PLAN 2000

Thousand US$

No.	Work Item		Remarks	Unit	Quantity	Unit Cost (US$)	Amount ('000US$)
1	**South Port Development**						
I-1	**Civil Work**						
I-1-1	QEQ No.6 Extension	Quaywall	-14.0 m	m	380	73,431	27,904
I-1-2		Revetment	-14m to -8m	m	170	52,675	8,955
I-1-3	South Container Terminal	Revetment in Basin	-16.0 m	m	760	74,849	56,885
I-1-4		New S-W Seawall Type-A	upto -7m	m	240	43,827	10,518
I-1-5		New S-W Seawall Type-B	-7m to-12m	m	300	57,602	17,281
I-1-6		New S-W Seawall Type-C	-12m or more	m	1,270	70,426	89,441
I-1-7	Dredging of Turning Basin		-16.0 m	m2	760,000	6.6	5,016
I-1-8	Reclamation		+2.7 m	m3	3,495,000	4.9	25,970
I-1-9	Paving of Container Yard	PC slab, stacking plate, Electric conduit		m2	218,000	157.5	34,335
I-1-10	Paving of Terminal Area and Road			m2	311,000	28.9	8,988
I-1-11	Surface Drainage			m2	529,000	11.5	6,084
I-1-12	Sub Total						291,377
I-1-13	Contingency	10% of sub total					29,138
I-1-14	Total						320,515
I-2	**Building, Electric and Water Supply**						
I-2-1	CFS	40m by 150m		Bldg.	1.0	4,722,639	4,723
I-2-2	Gate Building	20m by 45m		Bldg.	1.0	959,520	960
I-2-3	Administration Building	32m by 32m		Bldg.	1.0	7,196,402	7,196
I-2-4	Maintenance Shop	30m by 70m		Bldg.	1.0	2,098,951	2,099
I-2-5	Facilities Building	18m by 32m		Bldg.	2.0	359,820	720
I-2-6	Power Station Building	40m by 40m		Bldg.	1.0	1,049,475	1,049
I-2-7	Sump and Pump House			sum	1.0	509,745	510
I-2-8	Sub Total of Building						17,257
I-2-9	Electric Supply, Reefer, Yard Illumination etc. in Yard			sum	0.5	24,597,076	12,299
I-2-10	Generator		2,500 KVA	No.	2.0	2,108,321	4,217
I-2-11	Sub Station Equipment		10,000KVA	sum	0.5	9,838,831	4,919
I-2-12	Water Supply and drainage			sum	0.5	1,686,657	843
I-2-13	Sub-Total of Services						22,278
I-2-14	Sub Total of No.8and No.13						39,535
I-2-15	Contingency	10% of No.14 above					3,954
I-2-16	Total						43,489
I-3	**Cargo Handling Equipment**						
I-3-1	Container Crane	Post Panmanx	3No.×1Berth	No.	3	7,421,289	22,264
I-3-2	Container Crane	Panamax to QEQ No.2,3		No.	3	5,772,114	17,316
I-3-3	Transfer Crane		(3+3)*3+3=21	No.	21	1,269,865	26,667
I-3-4	Trailer Chassis		21*4=84	No.	84	112,144	9,420
I-3-5	Sub Total						75,667
I-3-6	Contingency	5% of Sub Total					3,783
I-3-7	Total						79,450
I-4	**Total**	I-1, I-2, I-3					443,454
I-5	**Engineering Service**	5 % of Total					22,173
I-6	**Grand Total**						465,627

TABLE 6.3.1 Summary of Project Cost
SHORT TERM DEVELOPMENT PLAN 2005 (Crow Island Offshore Dev.)

Thousand US$

No.	Description	Amount	Remarks
I	***Crow Island Offshore Development***		
I-1	Civil Work	614,187	02 Main Berth, 68 ha Container Yard, etc.
I-2	Building and Electric Works	57,202	CFS, Gate, Office, Reefer, Generator, Light
I-3	Cargo Handling Equipment	155,250	13 Container Crane, 39 Transfer Crane, etc.
I-4	Engineering Service	45,077	
I-5	Physical Contingency	74,902	
I-6	Sub Total	946,618	See detail in TABLE 4.6.3.3
II	**Renovation of Bandaranaike Quay**		
II-1	Construction Cost	14,006	06 ha Open Yard, Lighting, etc
II-2	Engineering Service	1,401	
II-3	Physical Contingency	1,401	
II-4	Total	16,808	See details in Figure A 3.3.2.1
III	**Navigation Assistance**		
III-1	Construction Cost	28,600	Communications, Tug Boat, Navigation aids
III-2	Contingency	2,860	
III-3	Engineering	2,002	
III-4	Total	33,462	See details in Figure A 3.3.2.2
IV	**Widening Main Channel**		
IV-1	Construction Cost	22,795	Dredging -16.5m, Demolition Breakwater
IV-2	Contingency	2,280	
IV-3	Engineering	1,596	
IV-4	Total	26,671	See details in Figure A 3.3.2.3
V	**Road Development**		
V-1	Muteal Road	1,867	22m width roar, L=900 m
V-2	Crow Island Road	16,816	22m width roar, L=1,600 m
V-3	Physical Contingency	1,869	
V-4	Engineering Service	1,869	
V-5	Total	22,421	See details in Figure A 3.3.2.4
VI	**Relocation of Submarine Pipeline**		
VI-1	SPBM Pipeline	32,421	Relocation of 7,750 m 36" Pipeline, Tie-in
VI-2	Sewerage Line	38,456	Relocation of 5,700 m 1500 mm dia Pipeline
VI-3	Physical Contingency	7,088	
VI-4	Engineering Service	7,088	
VI-5	Total	85,053	See details in Figure A 3.3.2.5
VII	**Grand Total**	1,131,033	

TABLE 6.3.2 Summary of Project Cost
SHORT TERM DEVELOPMENT PLAN 2005 (PVQ North Dev.)

Thousand US$

No.	Description	Amount	Remarks
I	**PVQ North Development**		
I-1	Civil Work	603,378	02 Main Berth, 60 ha Container Yard, etc.
I-2	Building and Electric Works	48,868	CFS, Gate, Office, Reefer, Generator, Light
I-3	Cargo Handling Equipment	144,322	12 Container Crane, 36 Transfer Crane, etc.
I-4	Engineering Service	43,450	
I-5	Physical Contingency	72,441	
I-6	Sub Total	912,459	See detail in TABLE 4.6.4.3
II	**Renovation of Bandaranaike Quay**		
II-1	Construction Cost	14,006	06 ha Open Yard, Lighting, etc
II-2	Engineering Service	1,401	
II-3	Physical Contingency	1,401	
II-4	Total	16,808	See details in Figure A 3.3.2.1
III	**Navigation Assistance**		
III-1	Construction Cost	28,600	Communications, Tug Boat, Navigation aids
III-2	Contingency	2,860	
III-3	Engineering	2,002	
III-4	Total	33,462	See details in Figure A 3.3.2.2
IV	**Widening Main Channel**		
IV-1	Construction Cost	22,795	Dredging -16.5m, Demolition Breakwater
IV-2	Contingency	2,280	
IV-3	Engineering	1,596	
IV-4	Total	26,671	See details in Figure A 3.3.2.3
V	**Road Development**		
V-1	Mutwal Road	1,867	22m width roar, L=900 m
V-2	Physical Contingency	187	
V-3	Engineering Service	187	
V-4	Total	2,241	See details in 3.3.2.4
VI	**Relocation of Submarine Pipeline**		
VI-1	SPBM Pipeline	32,421	Relocation of 7,750 m 36" Pipeline, Tie-in
VI-2	Sewerage Line	38,456	Relocation of 5,700 m 1500 mm dia Pipeline
VI-3	Physical Contingency	7,088	
VI-4	Engineering Service	7,088	
VI-5	Total	85,053	See details in Figure A 3.3.2.5
VII	**Grand Total**	1,076,694	

TABLE 6.3.3 *Breakdown of Project Cost*
SHORT TERM PLAN (Crow Island Offshore Dev.)

Thousand US$

No.	Work Item		Remarks	Unit	Quantity	Unit Cost	Amount
I	**CROW ISLAND OFFSHORE DEV.**						
I-1	**Civil Work**						
I-1-1	North Container Terminal	Quaywall NT 3,4,5	-16.0 m	m	700	94,243	65,970
I-1-2		Quaywall NT 2	-11.0 m	m	350	58,704	20,546
I-1-3		Quaywall NT 1	-9.0 m	m	220	41,288	9,083
I-1-4		South Revetment	-16.0 m	m	380	74,849	28,443
I-1-5		West Seawall	-13.0 m	m	520	50,323	26,168
I-1-6		North Seawall Type-1	-12.0 m to -13.0 m	m	350	44,126	15,444
I-1-7		North Seawall Type-2	-10.0 m to -12.0 m	m	850	40,542	34,461
I-1-8		North Seawall Type-3	-8.0 m to -10.0 m	m	450	36,174	16,278
I-1-9		North Revetment	-3.0 m to -8.0 m	m	970	18,666	18,106
I-1-10		Inner Revetment	-3.0 m to -8.0 m	m	840	18,666	15,679
I-1-11	Breakwater	New North West	-12m to -15m	m	1,250	60,607	75,759
I-1-12		New South West	-12m to -15m	m	1,550	60,607	93,941
I-1-13	Dredging of Turning Basin		-16.0 m	m3	8,000,000	6.6	52,800
I-1-14	Reclamation		+2.7 m	m3	9,000,000	4.9	44,100
I-1-15	Paving of Container Yard	PC slab, stacking plate, Electric conduit		m2	458,000	157.5	72,135
I-1-16	Paving of Terminal Area and Road			m2	218,000	28.9	6,300
I-1-17	Surface Drainage			m2	676,000	11.5	7,774
I-1-18	Groin at Estuary			m	600	18,666	11,200
I-1-19	Sub Total						614,187
I-1-20	Contingency	10% of sub total					61,419
I-1-21	Total						675,606
I-2	**Building, Electric and Water Supply**						
I-2-1	CFS	40m by 150m		Bldg.	2.0	4,722,639	9,445
I-2-2	Gate Building	20m by 45m		Bldg.	1.0	959,520	960
I-2-3	Administration Building	32m by 32m		Bldg.	1.0	7,196,402	7,196
I-2-4	Maintenance Shop	30m by 70m		Bldg.	1.0	2,098,951	2,099
I-2-5	Facilities Building	18m by 32m		Bldg.	2.0	359,820	720
I-2-6	Power Station Building	40m by 40m		Bldg.	1.0	1,049,475	1,049
I-2-7	Sump and Pump House			sum	1.0	509,745	510
I-2-8	Sub Total of Building						21,979
I-2-9	Electric Supply, Reefer, Yard Illumination etc. in Yard			sum	0.8	24,597,076	19,678
I-2-10	Generator		2,500 KVA	No.	3.0	2,108,321	6,325
I-2-11	Sub Station Equipment		10,000KVA	sum	0.8	9,838,831	7,871
I-2-12	Water Supply and drainage			sum	0.8	1,686,657	1,349
I-2-13	Sub-Total of Services						35,223
I-2-14	Sub Total of No.8and No.13						57,202
I-2-15	Contingency	10% of No.14 above					5,720
I-2-16	Total						62,922
I-3	**Cargo Handling Equipment**						
I-3-1	Container Crane	Post Panamax	4 No. * 2Berth	No.	8	7,421,289	59,370
I-3-2	Container Crane	Panamax	3+2=5	No.	5	5,772,114	28,861
I-3-3	Transfer Crane		(8+5) * 3 = 39	No.	39	1,269,865	49,525
I-3-4	Trailer Chassis		39*4=156	No.	156	112,144	17,491
I-3-5	Sub Total						155,250
I-3-6	Contingency	5% of Sub Total					7,763
I-3-7	Total						163,013
I-4	**Total**	I-1, I-2, I-3					901,541
I-5	**Engineering Service**	5 % of Total					45,077
I-6	**Grand Total**						946,618

TABLE 6.3.4 Breakdown of Project Cost
SHORT TERM PLAN (PVQ North Dev.)

Thousand US$

No.	Work Item		Remarks	Unit	Quantity	Unit Cost	Amount
I	**PVQ NORTH DEVELOPMENT**						
I-1	**Civil Work**						
I-1-1	NCT West Quay	Quaywall	-16.0 m	m	700	94,243	65,970
I-1-2		Quaywall	-11.0 m	m	380	58,704	22,308
I-1-3		Revetment	-16.0 m	m	730	74,849	54,640
I-1-4	NCT East Quay	Revetment	-9.0 m	m	700	41,288	28,902
I-1-5		Quaywall	-8.0 m	m	470	36,790	17,291
I-1-6		Quaywall	-5.0 m	m	370	22,473	8,315
I-1-7	New North Seawall	Revetment	-10m to-12m	m	600	50,323	30,194
I-1-8	Breakwater	New North	-10.0 m	m	130	49,763	6,469
I-1-9		New North West	-12m to -15m	m	2,010	60,607	121,820
I-1-10		New South West	-12m to -15m	m	1,550	60,607	93,941
I-1-11	Dredging of Turning Basin		-16.0 m	m3	7,200,000	6.6	47,520
I-1-12	Reclamation		+2.7 m	m3	7,500,000	4.9	36,750
I-1-13	Paving of Container Yard	PC slab, stacking plate, Electric conduit		m2	351,000	157.5	55,283
I-1-14	Paving of Terminal Area and Road			m2	246,000	28.9	7,109
I-1-15	Surface Drainage			m2	597,000	11.5	6,866
I-1-16	Sub Total						603,378
I-1-17	Contingency	10% of sub total					60,338
I-1-18	Total						663,716
I-2	**Building, Electric and Water Supply**						
I-2-1	CFS	40m by 150m		Bldg.	1	4,722,639	4,723
I-2-2	Gate Building	20m by 45m		Bldg.	1	959,520	960
I-2-3	Administration Building	32m by 32m		Bldg.	1	7,196,402	7,196
I-2-4	Maintenance Shop	30m by 70m		Bldg.	1	2,098,951	2,099
I-2-5	Facilities Building	18m by 32m		Bldg.	2	359,820	720
I-2-6	Power Station Building	40m by 40m		Bldg.	1	1,049,475	1,049
I-2-7	Sump and Pump House			sum	1	509,745	510
I-2-8	Sub Total of Building						17,257
I-2-9	Electric Supply, Reefer, Yard Illumination etc. in Yard			sum	0.7	24,597,076	17,218
I-2-10	Generator		2,500 KVA	No.	3.0	2,108,321	6,325
I-2-11	Sub Station Equipment		10,000KVA	sum	0.7	9,838,831	6,887
I-2-12	Water Supply and drainage			sum	0.7	1,686,657	1,181
I-2-13	Sub-Total of Services						31,611
I-2-14	Sub Total of No.8and No.13						48,868
I-2-15	Contingency	10% of No.14 above					4,887
I-2-16	Total						53,755
I-3	**Cargo Handling Equipment**						
I-3-1	Container Crane	Post Panamax	4 No.×2Berth	No.	8	7,421,289	59,370
I-3-2	Container Crane	Panamax	2 No.×2Berth	No.	4	5,772,114	23,088
I-3-3	Transfer Crane		(8+4)*3 =36	No.	36	1,269,865	45,715
I-3-4	Trailer Chassis		36*4=144	No.	144	112,144	16,149
I-3-5	Sub Total						144,322
I-3-6	Contingency	5% of Sub Total					7,216
I-3-7	Total						151,538
I-4	**Total**	I-1, I-2, I-3					869,009
I-5	**Engineering Service**	5 % of Total					43,450
I-6	**Grand Total**						912,459

TABLE 6.3.5 Cost Comparison of Project Alternatives for Short Term Plan

Thousand US$

No.	Various Works Involved	Short Term Development Plan		
		Base Plan	Alternative 1	Alternative 2
1	Port Expansion - Civil Work	578,675	653,166	629,597
2	Port Expansion - Building Works and Electric Works	58,706	66,263	63,872
3	Port Expansion - Container Handling Equipment	201,278	227,189	218,990
4	Renovation of Bandaranaike Quay	16,808	16,808	16,808
5	Navigation Assistance	33,462	33,462	33,462
6	Widening Main Channel	26,671	26,671	26,671
7	Road Development	18,460	22,421	2,241
8	Relocation of Submarine Pipeline	-	85,053	85,053
9	North Channel Dredging	6,007	-	-
10	Grand Total	940,067	1,131,033	1,076,694

Alternative 1: Crow Island Offshore Development
Alternative 2: PVQ North Development

7. Economic Analysis

7.1 Methodology

213. The purpose of this chapter is to appraise the economic feasibility of the Short-term Development Plan from the viewpoint of the national economy. This chapter focuses on whether the benefits of this project exceed those which could be derived from other investment opportunities in this country.

214. All benefits and costs in the economic analysis are evaluated using economic prices based on the border price concept.

215. There are various methods to evaluate the feasibility of this type of development project. In this study, the Economic Internal Rate of Return (EIRR) based on a cost-benefit analysis is used to appraise the feasibility of the Short-term Development Plan.

The procedure of the economic appraisal is summarized in FIGURE 7.1.1.

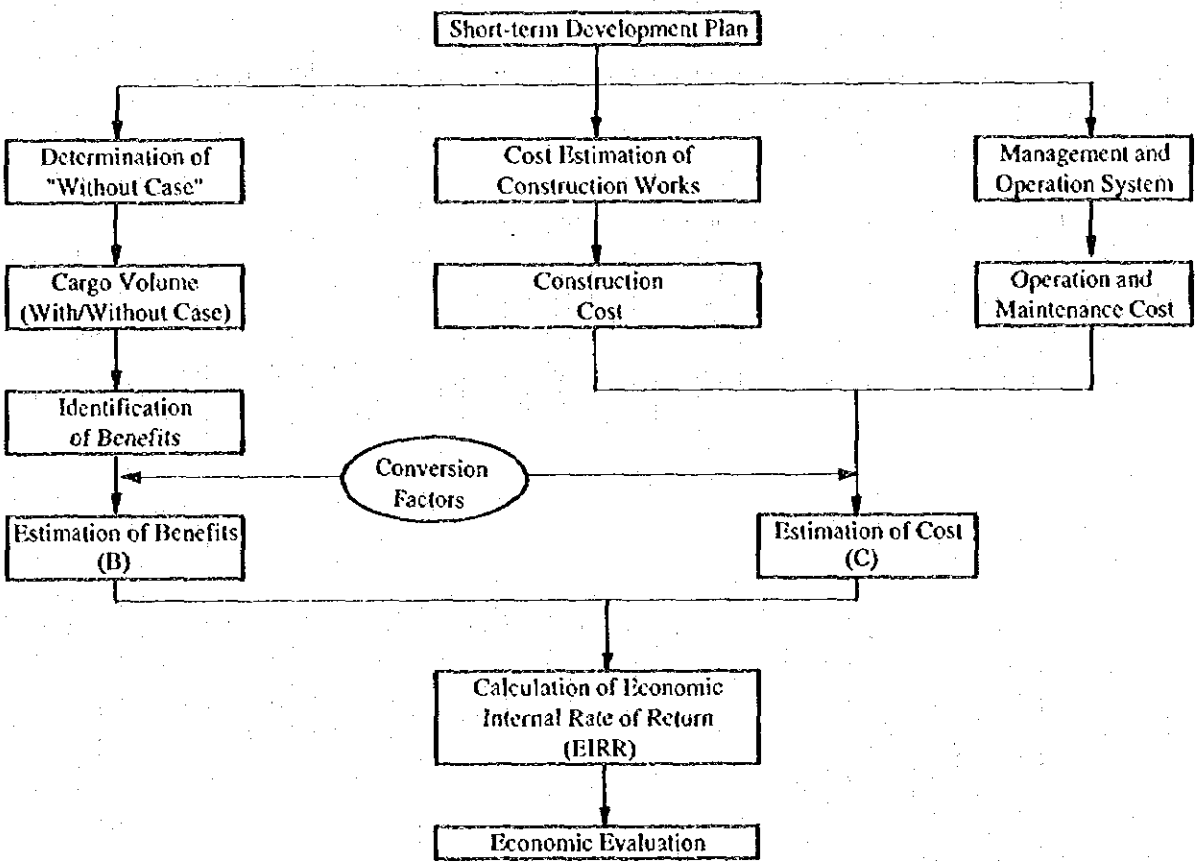


FIGURE 7.1.1 Process of Economic Analysis

7.2 Prerequisites of Analysis

(1) Base Year

216. The "Base Year" here means the standard year in the estimation of costs and benefits. The target year of the Short-term Development Plan is 2005 and starting year of construction is assumed 9 years prior to the target year.

(2) Project Life

217. Taking into consideration the depreciation period of the main facilities of 30 years and the construction period of 9 years, the period of calculation (Project Life) in the economic analysis is assumed to be 39 years from the beginning of construction.

(3) Foreign Exchange Rate

218. The exchange rate adopted for this analysis is US$ 1.00 = Rs.53.36=104.4Yen, that is, the same rate as used in the cost estimation.(see Chapter 6, Part 4)

(4) "Without" Case

219. A cost-benefit analysis is conducted on the difference between the "With" case in which an investment is made and the "Without" case in which no investment is made, that is, the benefits and costs arising from the proposed investment are compared.

220. The "Without" case is set as follows:

1) No investment is made for the Short-term Development Plan.
2) There will be no increase in the number of transhipment containers at the Port of Colombo after it reaches the capacity of implementation of JCT#4, QEQ#2-3 and North Pier rehabilitation.

(5) Cargo Throughput

1) "With" Case

221. The cargo volume (high case, medium case and low case) under the with case at the Port of Colombo during the planning period is forecast in Chapter 1, Part 3.

2) "Without" Case

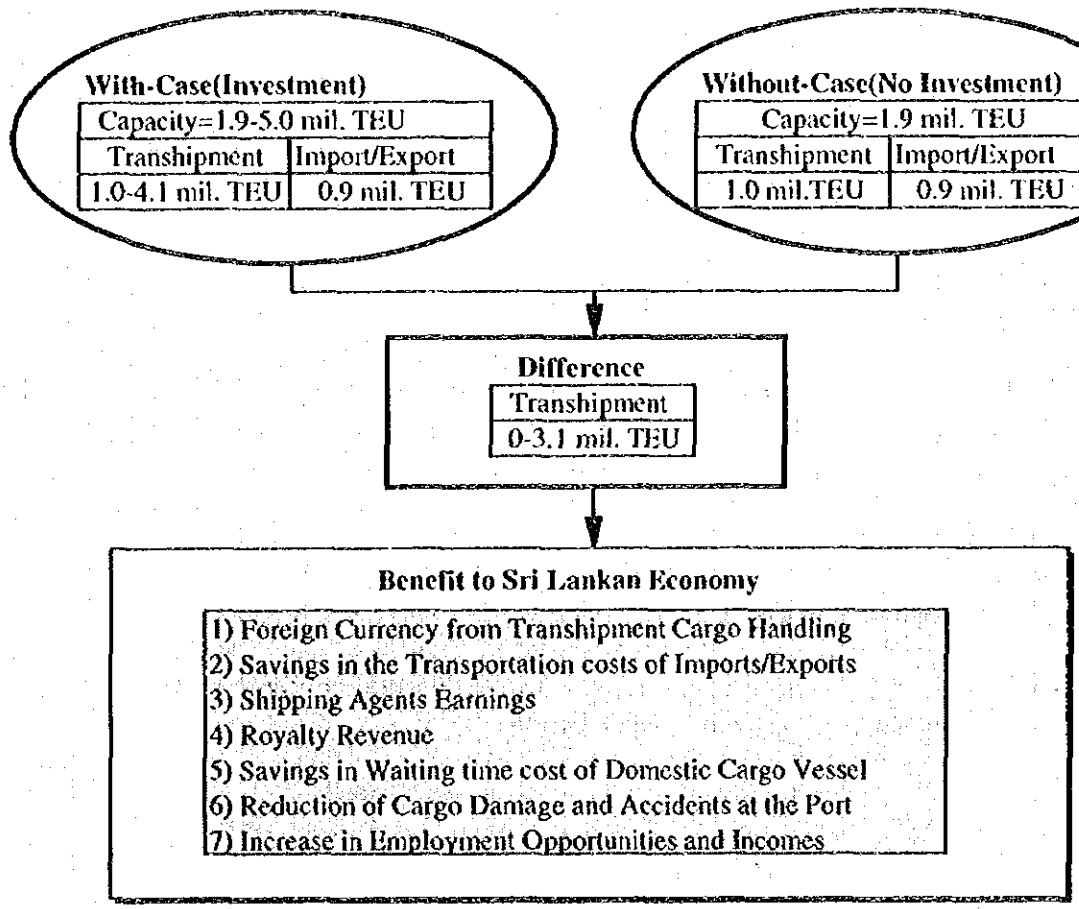
222. The volume of container transhipment cargo will not increase after it reaches the capacity of implementation of JCT#4, QEQ#2-3 and North Pier rehabilitation.

223. The foreign trade container cargo will be increased irrespective of the capacity. Priority will be given to the foreign trade containers, so the limited capacity will be appropriated for the

foreign containers. Thus, the number of transhipment containers will decrease as the number of the foreign trade containers increases.

224. The cargo throughput under the "With" case and "Without" case is shown in TABLE 7.2.1.

TABLE 7.2.1 Cargo Throughput under the "With" Case and "Without" Case



7.3 Economic Prices

(1) General

225. For the economic analysis, all prices must be expressed as economic prices. In general, the construction cost, the operation cost and the repair cost are estimated at market prices. But in this study, for the estimation of these costs, import duties and turnover tax are excluded from traded goods, viz., the prices of traded goods are expressed as CIF prices. For non-traded goods, turnover tax, stamp duty and other duties are excluded. Therefore, these prices exclusive of personnel expenses are already expressed as economic prices, and thus require on conversion.

226. Labor is divided into skilled and unskilled labor. Skilled labor costs are estimated based on local market wages, and unskilled labor costs are estimated based on the value of the gross marginal product.

227. Economic prices for the labor costs are calculated by multiplying these costs by the conversion factor for consumption. Since all the benefits are estimated at market prices, it is necessary to re-evaluate them from the economic point of view.

228. In this study, the conversion of benefits to economic prices is made using the Standard Conversion Factor (SCF) and the Conversion Factor for Consumption (CFC).

(2) Standard Conversion Factor (SCF)

229. Import duties and export subsidies create a price differential between the domestic market and the international market.

230. The Standard Conversion Factor makes up for this price difference. The Standard Conversion Factor is obtained by the following formula.

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

where, I : Total value of imports
E : Total value of exports
Di: Total value of import duties
De: Total value of export duties and subsidies

231. In this report, the average SCF form 1991 to 1994 is adopted for the analysis. The Standard Conversion Factor is calculated as 0.887. (See TABLE 7.3.1).

TABLE 7.3.1 Standard Conversion Factor

Year	Total Exports Rs.Million	Total Imports Rs.Million	Total Export Duty Rs.Million	Total Import Duty Rs.Million	Standard Conversion Factor
1991	82,225	127,843	1,633	31,009	0.87732
1992	107,509	149,837	1,280	36,119	0.88076
1993	137,994	181,381	642	41,139	0.88747
1994	158,660	221,527	755	42,650	0.90074
Average					0.88657 (0.887)

Source: " Facts and Figures", Sri Lanka Customs

(3) Conversion Factor for Consumption (CFC)

232. This factor is used for converting the prices of consumer goods from market prices to international prices. In particular, this is required to convent labor costs from market prices to international prices.

233. The Conversion Factor for Consumption is usually calculated in the same manner as the Standard Conversion Factor, replacing total imports and total exports and exports of consumer goods.

234. However, due to the lack of required data, the Conversion Factor for Consumption cannot be directly calculated in this report. Thus, it is assumed as the same value as the Standard Conversion Factor.

(4) Conversion Factor for Labor

1) Skilled Labor

235. For skilled labor, assuming that the market mechanism is functioning properly, the actual market wages are used. But as the data are in domestic prices, they are converted to international prices by multiplying by the Conversion Factor for Consumption.

2) Unskilled Labor

236. For unskilled labor, the economic costs are calculated based on a simplified measure of the opportunity cost. As the wages paid to unskilled laborers by a project are usually above the opportunity cost, these market worked wages should not be used for the calculation of the economic value of the unskilled labor.

237. In this report, the marginal productivity of an unskilled laborer is assumed equal to the per capita GAP of the agriculture, livestock and fisheries sector (hereafter referred to as the

agricultural sector).

238. The Conversion factor for unskilled labor is calculated using the formula given below:

$$\text{Conversion Factor for Unskilled Labour} = \frac{\text{Opportunity Cost of Unskilled Labour}}{\text{Nominal Wage Rate of Unskilled Labour}} \times \text{CFC}$$

239. In this report, the average conversion factor for unskilled labor from 1990 to 1993 is adopted. The conversion factor for unskilled labor is calculated as 0.613. (See TABLE 7.3.2).

TABLE 7.3.2 Conversion Factor for Unskilled Labor

Year	GDP of Agriculture Livestock & Fisheries (mill.Rs)	Population of Agriculture Sector ('000)	Per Capita GDP of Agriculture sect. ('000 Rs)	CFUL
1990	76,488	2,361	32	0.642424
1991	90,257	2,130	42	0.705518
1992	100,080	2,089	48	0.624472
1993	111,659	2,159	52	0.479176
Average				0.612897 (0.613)

Source: Central Bank of Sri Lanka, Department Census Statistics

7.4 Costs of the Projects

(1) Construction Cost

240. The construction investment (see Chapter 6, Part 4) has to be divided into the categories of skilled labor, unskilled labor, foreign labor and equipment, materials cost and others.

241. The cost of laborers excluding foreigners is converted into economic prices using the conversion factors for skilled labor and unskilled labor. TABLE 7.4.1 shows the economic prices for the construction investment.

TABLE 7.4.1 Construction Cost at Economic Prices

Work	Investment Costs in Market Prices (1,000US$)	Foreign Portion	Local Portion				Overall Conversion Factor	Investment Costs In Economic Prices (1,000US$)
			Tradable Goods	Non-traded Goods	Skilled Labor	Unskilled Labor		
		1.000	1.000	0.887	0.887	0.613		
1st Year								
South Port Development	45,573	73.1%	3.3%	21.6%	1.8%	0.2%	97.0%	44,203
Renovation of Existing Port Facility	2,019	87.4%	0.0%	8.8%	3.8%	0.0%	98.4%	1,987
Total	47,592	73.7%	3.2%	21.0%	1.9%	0.2%	97.1%	46,190
2nd Year								
South Port Development	53,263	74.6%	3.4%	20.3%	1.4%	0.3%	97.1%	51,740
Renovation of Existing Port Facility	12,723	87.1%	8.8%	2.6%	1.3%	0.2%	99.4%	12,644
Total	65,987	77.1%	4.4%	16.9%	1.4%	0.3%	97.6%	64,384
3rd Year								
South Port Development	95,616	83.8%	3.4%	11.7%	0.9%	0.2%	98.3%	93,990
Renovation of Existing Port Facility	20,892	85.5%	6.2%	6.7%	1.2%	0.3%	98.5%	20,582
Total	116,508	84.1%	3.9%	10.8%	1.0%	0.2%	98.3%	114,572
4th Year								
South Port Development	113,414	83.1%	3.4%	12.2%	1.1%	0.3%	98.2%	111,350
Renovation of Existing Port Facility	18,032	87.0%	6.1%	5.5%	1.1%	0.3%	99.0%	17,849
Total	131,446	83.6%	3.8%	11.3%	1.1%	0.3%	98.3%	129,199
5th Year								
South Port Development	42,629	72.7%	3.5%	22.3%	1.3%	0.2%	97.0%	41,337
Renovation of Existing Port Facility	0	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0
Total	42,629	72.7%	3.5%	22.3%	1.3%	0.2%	97.0%	41,337
6th Year								
South Port Development	66,628	75.0%	5.2%	18.4%	1.1%	0.2%	97.4%	64,921
Renovation of Existing Port Facility	1,010	87.4%	0.0%	8.8%	3.8%	0.0%	98.3%	993
Total	67,638	75.2%	5.1%	18.3%	1.2%	0.2%	97.5%	65,915
7th Year								
South Port Development	143,971	81.7%	3.9%	13.1%	1.1%	0.3%	98.1%	141,186
Renovation of Existing Port Facility	12,884	88.5%	3.0%	7.1%	1.2%	0.3%	98.8%	12,730
Total	156,854	82.3%	3.8%	12.6%	1.1%	0.3%	98.1%	153,915
8th Year								
South Port Development	121,366	82.3%	3.6%	12.6%	1.1%	0.3%	98.1%	119,080
Renovation of Existing Port Facility	12,884	88.5%	3.0%	7.1%	1.2%	0.3%	98.8%	12,730
Total	134,249	82.9%	3.6%	12.1%	1.1%	0.3%	98.2%	131,809
9th Year								
South Port Development	91,598	85.6%	3.3%	9.6%	1.2%	0.3%	98.5%	90,201
Renovation of Existing Port Facility	15,505	89.1%	5.9%	3.8%	1.0%	0.2%	99.3%	15,390
Total	107,104	86.1%	3.7%	8.8%	1.2%	0.3%	98.6%	105,590
Entire Period								
South Port Development	774,058	80.7%	3.7%	14.2%	1.2%	0.2%	97.9%	758,007
Renovation of Existing Port Facility	95,949	87.4%	5.4%	5.6%	1.2%	0.3%	98.9%	94,907
Total	870,008	81.4%	3.9%	13.3%	1.2%	0.2%	98.0%	852,911

(2) Operation, Maintenance and Repair Costs

242. The main items of the operation costs of this project are personnel, fuel and power expenses. These costs are estimated based on the present operation at the Port of Colombo.

243. The maintenance & repair cost per year for the cargo handling equipment of this project is assumed to be 4 % of the original investment, and the facilities of this project it is assumed to be 1 % of the original investment. And based on SLPA, the maintenance of dredging cost is adapted the depreciation (project life : 10 years).

(3) Renewal Investment Costs

244. The facilities and equipment will be renewed according to their economic lives. As described hereunder, and cargo handling equipment (Chapter 6, Part 4) will be renewed through the project life.

Equipment etc.	Economic Life (Years)
Container Crane	12
Transfer Crane	12
Trailer Chassis	8
Tug Boat	10
Navigation Aids	10
Communication System	10
Electric Supply	15
Generator	10
Sub Station Equipment	8
Yard Lighting	10

7.5 Benefits

(1) Benefit Items

245. As benefits brought about by the Short-term Development Plan, the following items are identified.

1) Foreign currency earnings from transhipment cargo handling
2) Saving of the transportation costs of import and export cargo
3) Earnings of shipping agencies
4) Ground rent of port premises
5) Savings in waiting time of calling vessels
6) Reduction of cargo damage and accidents at the port
7) Increase in employment opportunities and incomes

246. Of the above items 1) , 2), 3) and 4) are adopted for the calculation of the evaluation of the benefits of this project.

(2) Calculation of the Benefit

1) Foreign currency earnings from transhipment cargo handling

247. The foreign exchange earnings from Colombo port activities are Rs.3,490 million in 1994. Those earnings was contributed to Sri Lankan economy directly.

248. The capacity of "Without" case will be about 1.9 million TEUs after completion of JCT #4, QEQ #2-#3 and North Pier rehabilitation. However, container capacity of the Short-term Development Plan will increase to 5.0 million TEUs in "With" case.

249. This means that foreign currency earnings in handling the balance of the cargo volumes between both cases would be generated in the Short-term Development Plan. (see TABLE 7.5.1)

TABLE 7.5.1 Foreign Currency Earnings

Year	Box Type	Box Volume (1,000 Box)	Unit Price (US$/Box)	Sub-total (1,000US$)	Total Benefit (1,000US$)
	20'	250	* 42	10,500	
2001	40'	125	* 69	8,625	25,125
[2003]	TEU	500	12	6,000	
	20'	500	* 42	21,000	
2005	40'	250	* 69	17,250	50,250
[2005]	TEU	1000	12	12,000	
2006	20'	800	* 42	33,600	
[2008]	40'	400	* 69	27,600	80,400
(2014)	TEU	1600	12	19,200	
2011	20'	800	* 42	33,600	
[2014]	40'	400	* 69	27,600	98,400
(2024)	TEU	3100	12	37,200	

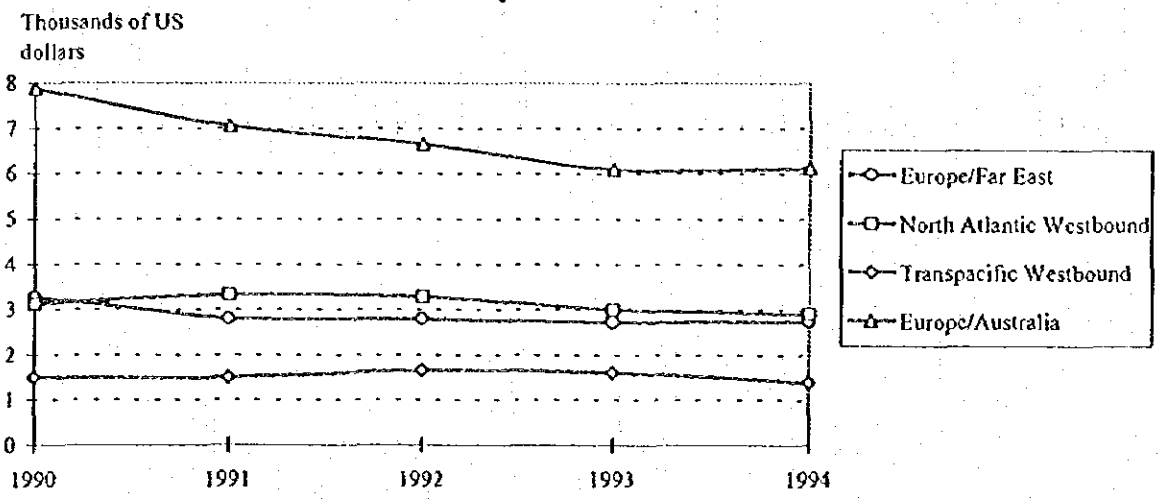
*Note: *: including the incentive charge for handling container*

Bold: High Case,[ ]: Medium Case,( ) : Low Case

2) Savings of the shipping costs

250. Based on "UNCTAD, Review of Maritime Transport 1994", container rates (US$/TEU)in the world freight are leveled since 1991 expect Europe/Australia routes.(see FIGURE 7.5.1)

FIGURE 7.5.1 Major Conference Rates 1990-1994



Source: UNCTAD, Review of Maritime Transport 1994

251. However, based on "Annual Report 1994, Central Freight Bureau", export freight from the port of Colombo to U.K. was US$1,353.60/TEU in 1989, but it decreased to US$900/TEU in 1994 (see FIGURE 7.5.2). Moreover, in comparison with freight rate in Indian ports, Colombo port's freight is considerably low.(see FIGURE 7.5.2)

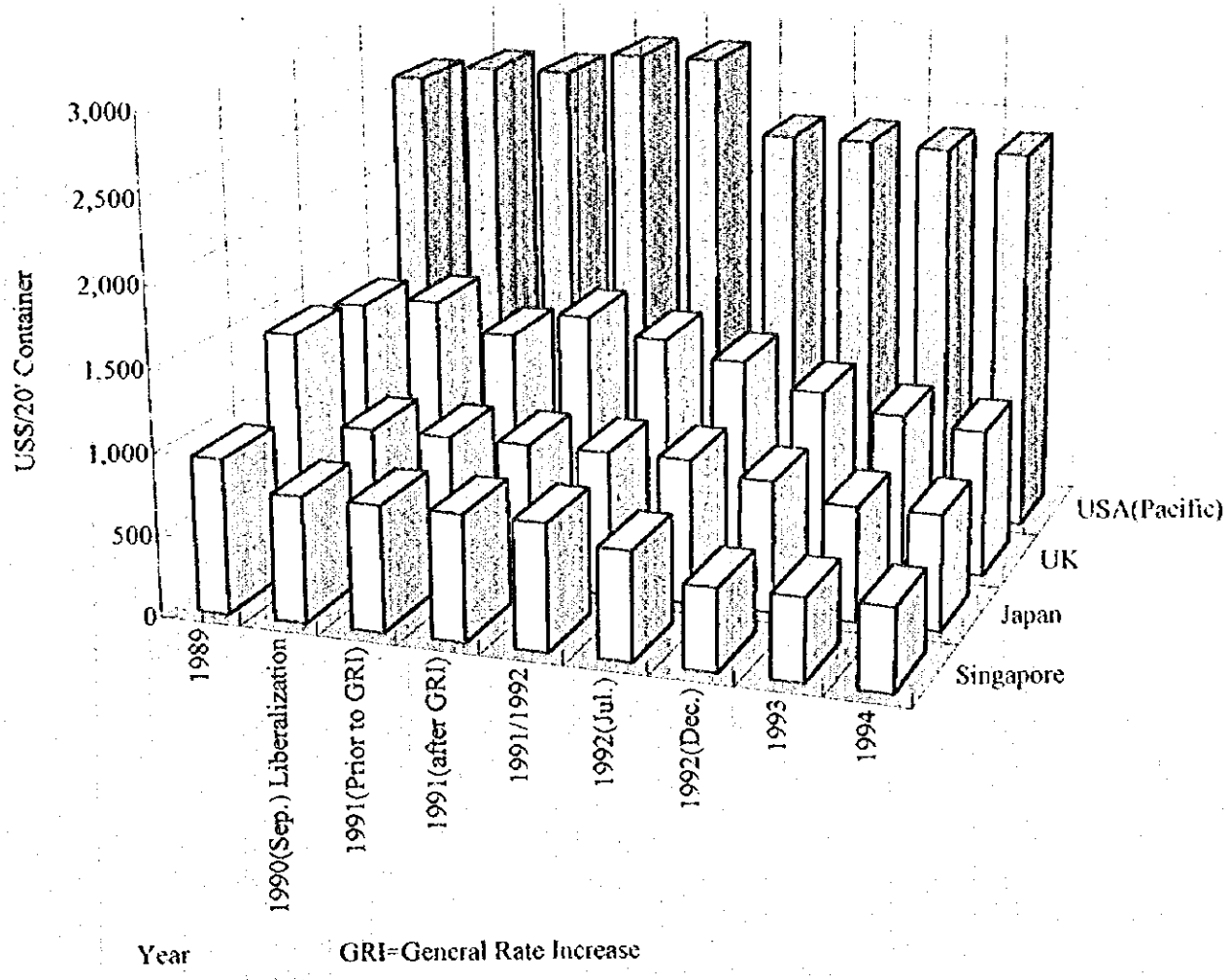
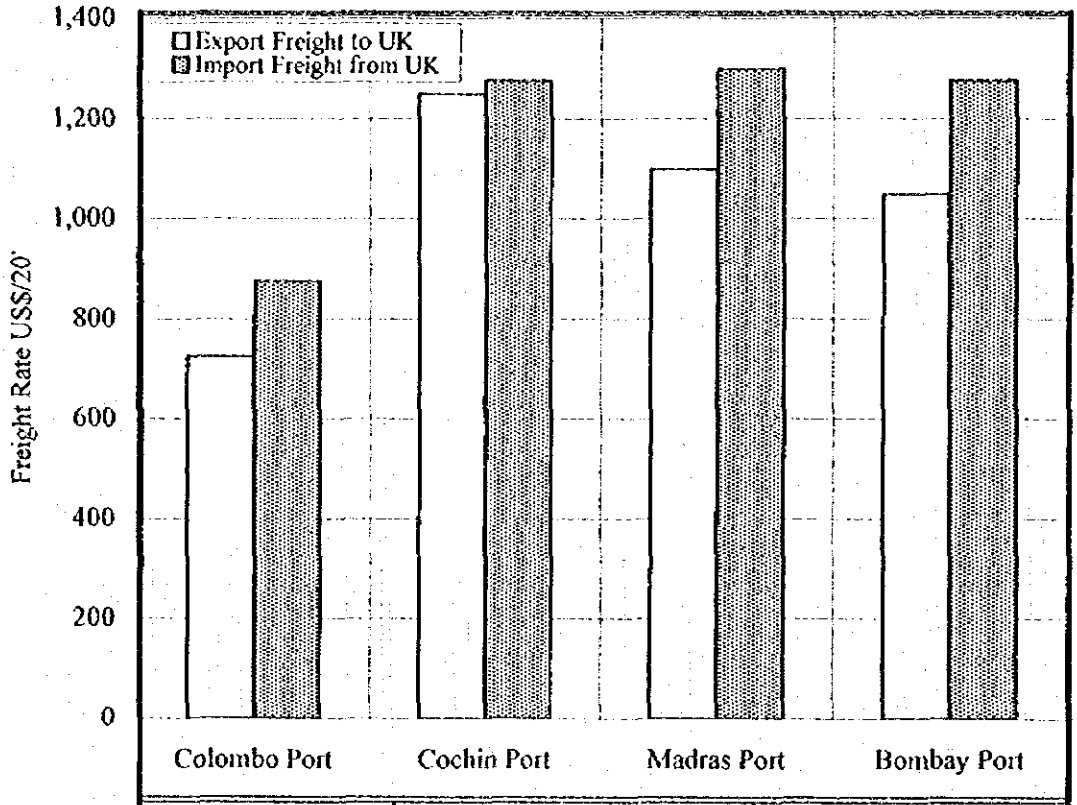


FIGURE 7.5.2 Trends of Export Freight Rate (Tea)

FIGURE 7.5.3 Typical Freight Rate at the Port of Colombo and Major Indian Ports



	Import Freight from UK	Export Freight to UK
Colombo Port	US$ 850-900 / 20'	US$ 650-800 / 20'
Cochin Port	US$1,200-1,350 / 20'	US$1,200-1,300 / 20'
Madras Port	US$1,250-1,350 / 20'	US$1,050-1,150 / 20'
Bombay Port	US$1,200-1,350 / 20'	US$1,000-1,100 / 20'

Source : Main Shipping Agents

252. In comparison with the freight rates of the world, the Port of Colombo and Indian ports, freight of foreign trade container cargo in Sri Lanka benefit from the increase of transhipment container handling.

253. Consequently, in the "Without" case as decreasing transhipment cargo, freight rate of foreign trade is estimated to increase with port congestion and no competition of shipping agents. In the "With" case, domestic cargo freight will keep the advantage of transhipment function of regional hub port. In this study, "Without" case and "With" case adopt average freight rate/TEU in 1991 and in 1994, respectively. (see FIGURE 7.5.4) And the benefits of domestic freight estimated balance of "With" case and "Without" case in TABLE 7.5.2.

FIGURE 7.5.4 Average Freight Rate of Exports

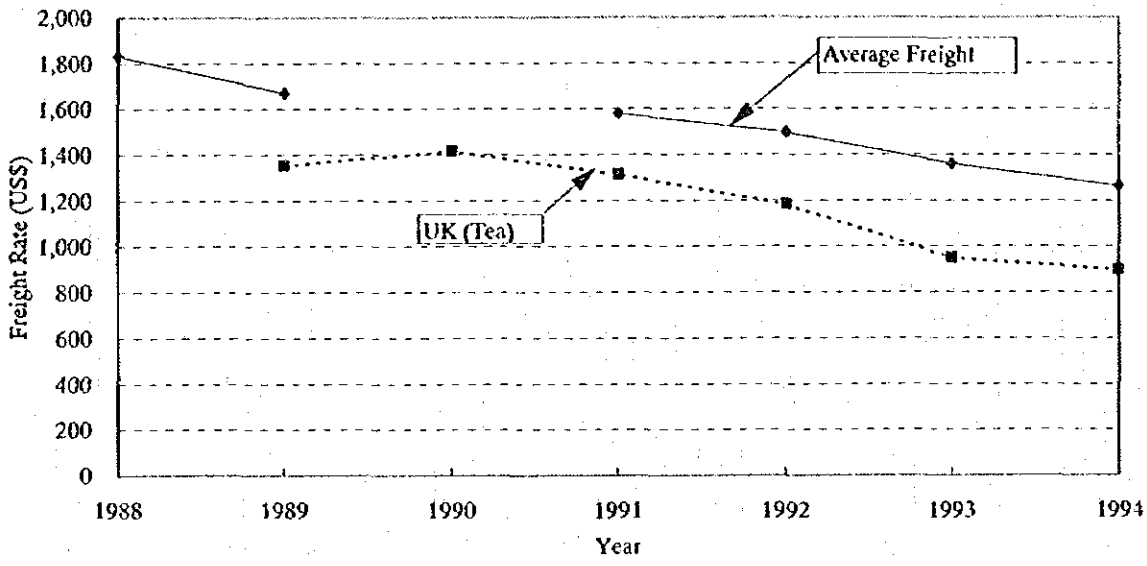


TABLE 7.5.2 Benefit in Domestic Freight

Year	Classification	Cargo Volume (1,000TEU)	Freight Benefit (US$/TEU)	*** Benefit for Sri Lanka (US$ 1,000)
2001	Export	170	* 317	
[2003]	Import	286	** 190	81,285
2005	Export	204	* 317	
[2005]	Import	323	** 190	93,704
2006	Export	240	* 317	
[2008],(2014)	Import	393	** 190	112,710
2011	Export	351	* 317	
[2014],(2024)	Import	590	** 190	167,734

*Note : * : Estimated from Balance of Average Freight/TEU of 1991 and 1994*

***: Estimated by interview of Shipping Agents*

**** : Estimated 50% of Export Benefit for Sri Lanka Economy*

Bold: High Case,[ ]: Medium Case,( ) : Low Case

3) Shipping agency earnings

254. Shipping agent's commission are 2.5% of import container freight, 5% of export container freight and 1% of transhipment container freight in Sri Lanka (see TABLE 7.5.3). Owing to increasing transhipment container volume in the Short-term Development Plan, shipping agency in Sri Lanka will increase the foreign currency earning. Shipping agent's commission of the foreign currency earning is one of the Sri Lanka's benefits from increasing port commercial activities. The benefits of shipping agent's commission are shown in TABLE 7.5.4.

TABLE 7.5.3 Shipping Agents' Commission Tariff in Sri Lanka

	Laden Containers	Empty Containers
Import	2.5% of Freight	US$5.00 per Container
Export	5.0% of Freight	US$5.00 per Container
Transhipment	1.0% of Freight Minimum US$ 15.00 Minimum US$ 40.00 (Reefer)	US$5.00 per Container

Source: Ceylon Association of Ships' Agent

TABLE 7.5.4 Benefit in Shipping Agents' Commission

Year	Balance (1,000TEU)	Box Type	Box Volume (1,000 PCS)	Commission (US$ 1,000)	Commission for Sri Lanka (US$ 1,000)
2001	500	Load	274	4,112	
[2003]		Empty	48	242	2,612
2005	1,000	Load	548	8,224	
[2005]		Empty	97	484	5,225
2006	1,600	Load	877	13,158	
[2008],(2014)		Empty	155	774	8,359
2011	3,100	Load	1700	25,494	
[2014],(2024)		Empty	300	1,500	16,196

Note: Based on the interview of shipping agents, distribution of commission is 60% in Sri Lanka

Bold: High Case,[ ]: Medium Case,( ) : Low Case

4) Royalty Revenue

Chapter 8, Part 4 indicated the royalty revenue for the 3 berths from 2006 to 2035. The royalty revenue as foreign currency is assumed one of the benefits in this study.

(3) Summary of Benefits

255. Summary of benefits above item 1) 2) and 3) in Short-term development Plan are shown in TABLE 7.5.5.

TABLE 7.5.5 Summary of Benefits in Short-term Development Plan

Classification of Benefits	**2001**,[2003]	**2005**,[2005]	**2006**,[2008],(2014)	**2011**,[2014],(2024)
1) Transhipment Handling Charge	25,125	50,250	80,400	98,400
2) Domestic Freight	81,285	93,704	112,710	167,734
3) Shipping Agent's Commission	2,612	5,225	8,359	16,196
4) Royalty Revenue	0	0	0	7,618
Total	109,022	149,179	201,469	289,947

Note: Bold: High Case,[ ]: Medium Case,( ) : Low Case

7.6 Evaluation of the Projects

(1) Calculation of the EIRR

256. The economic internal rate of return(EIRR) based on a cost-benefit analysis is used to appraise the economic feasibility of the project.

257. The EIRR is the discount rate which makes the costs and benefits of a project during the project life equal. It is calculated using the following formula.

$$\sum_{i=1}^{n} \frac{B_i - C_i}{(1+r)^{i-1}} = 0$$

where, n: Period of economic calculation (project life)
Bi: Benefits in i-th year
Ci: Costs in i-th year
r : Discount rate

The EIRR of Short-term Development Plan is calculated as 18.5~20.5%(High Growth Case), 17.0~18.7%(Medium Growth Case) and 10.5~11.5%(Low Growth Case). (see TABLE 7.6.1 and Table A7.6.1-A7.6.6)

TABLE 7.6.1 Results of EIRR

	EIRR	*Sensitivity
High Growth Case	20.5%	18.5%
Medium Growth Case	18.7%	17.0%
Low Growth Case	11.5%	10.5%

*Sensitivity analysis in which costs increase by 10% and benefits decrease benefits decrease by 10% is made

(2) Evaluation

258. The leading view is that the project is feasible if the EIRR exceeds the opportunity cost of capital. In general, the opportunity cost of capital is considered to range from 8% to 10% according to the degree of development in each country. It is generally considered that a project with an EIRR of more than 10% is economically feasible for infrastructure or social service projects. As for this project, even though the economic calculation only takes into account the items which are easily quantified, the EIRR exceeds 10%. Therefore, this Short-term Development plan development project is viable from the viewpoint of the national economy.

8. Financial Analysis

8.1 Purpose and Methodology

8.1.1 Purpose

259. The purpose of the financial analysis is to appraise the financial feasibility of the proposed port development scheme. The analysis focuses on the financial viability of the project itself and the soundness of the port management body (the SLPA) during the project life.

8.1.2 Methodology

(1) Viability of the Project

260. The viability of the project is analyzed using the Discount Cash Flow Method and appraised by the FIRR (financial internal rate of return). The FIRR is a discount rate that makes the costs and the revenues during the project life equal, and it is calculated using the following formula:

$$\sum_{i=1}^{n} \frac{B_i - C_i}{(1+r)^{i-1}} = 0$$

n : project life
Bi : revenues in the i-th year
Ci : costs in the i-th year
r : discount rate

261. Revenues and costs which are taken into account for the calculation of the FIRR are summarized as follows:

Revenues:	(i) Port operating revenue
Costs:	(i) Investments for the project (Initial investments for the project and its reinvestment)
	(ii) Operating expense such as maintenance, repair, personnel and other costs

262. When the calculated FIRR exceeds the interest rate of the funds for the investments of the project, the project is regarded as financially feasible.

(2) Financial Soundness of the port management body

263. The influence on the financial soundness of the port management body (SLPA) is appraised based on projected financial statements regarding the project (Income Statements, Cash Flow Statements and Balance Sheets). The appraisal is generally made from the viewpoints of profitability, loan repayment capacity and operational efficiency, using the following ratios:

1) Profitability

Rate of Return on Net Fixed Assets: (Net Operating Income / Total Fixed Assets) x 100 %

This indicator shows the profitability of the investments, which are presented as net total fixed assets. It is preferable to keep the rate higher than the average interest rate of the funds for the investments.

2) Loan Repayment Capacity

Debt Service Coverage Ratio:

(Repayment of and Interest on Long-Term loans)/(Net Operating Income + Depreciation Cost)

This indicator shows whether the operating income can cover the repayment of principal and interest on Long-Term Loans. It must be more than 1 and it is preferable that it is over 1.00.

3) Operating Efficiency

Operating Ratio: (Operating Expenditure / Operating Revenue) x 100 %

Working Ratio:

Operating Revenue (Operating Expenditure - Depreciation Cost)

The operating ratio shows the operational efficiency of the organization as an enterprise, and the working ratio shows the efficiency of the routine operations of the port. When the calculated operating ratios are less than 70 - 75 %, and the working ratios are less than 50 - 60 %, the operations are considered as being efficient.

8.2 Prerequisites

8.2.1 Construction and Management Systems

264. Construction and management system by each scenario is defined as follows.

<Scenario 1 > Breakwater, Seawall, Dredging: to be developed by the SLPA
QEQ NO6 - 8: to be developed and operated by the SLPA
QEQ NO9 - 11: to be developed on a BOT basis

<Scenario 2 > Breakwater, Seawall, Dredging: to be developed by the SLPA
QEQ NO6 - 11: to be developed and operated by the SLPA.
(the same as current system)

<Scenario 3 > Breakwater, Seawall, Dredging: to be developed by the SLPA
QEQ NO6 - 8: to be developed by SLPA, operated by private sectors

(Land lease system)
QEQ NO9 - 11: to be developed on a BOT basis

265. The details of development in each scenario are shown in TABLE 8.1.1. In Scenario 1, QEQ NO6 - 8 are all managed by SLPA and QEQ NO9 - 11 are managed by private sectors. In Scenario 2, QEQ NO6 - 11 are all managed by SLPA. In Scenario 3, QEQ NO6 - 11 are all managed by private sectors (however, land of QEQ NO6 - 8 is owned and managed by SLPA.)

8.1.2 Prerequisites for FIRR calculation and drawing up of projected financial statements

(1) Project Scope.

Project scope by scenario is shown in TABLE 8.1.2.

(2) Fund raising

In all three Scenarios, SLPA raise funds according to the following conditions.

1) Foreign funds

Foreign funds mean long term loans raised from foreign countries. SLPA raises them with the following conditions.

Range covered by loans:	85% of initial investment costs of the project
Loan period :	30 years, including a grace period of 10 years
Interest rate :	2.3 % per annum.
Repayment:	Fixed amount repayment of principal

2) Domestic funds

Domestic funds mean long term loans raised from domestic banking institutions. SLPA raises them with the following conditions.

Range covered by loans:	15% of initial investment costs of the project
Loan period :	10 years, including a grace period of 3 years
Interest rate :	10.0 % per annum.[1]
Repayment:	Fixed amount repayment of principal

3) Other funds

Other funds mean short term loans raised from domestic banking institutions. SLPA raises them with the following conditions only in the case of cash shortage outbreak.

Loan period :	1 year (with no grace period)

[1] *Actually, interest rate of loans provided by domestic banking institutes is at least 16%. However, this rate allows for decreasing of value by movement of exchange rate or inflation, etc. Therefore, considering movement of exchange rate 1990 -1994, 6% is discounted from actual interest rate.*

Interest rate :	In Scenario 1 (Medium Growth Case) and Scenario 2 -16.0% per annum In Scenario 1 (Low Growth Cas)-4.6% per annum In Scenario 3 -Insterest free
Repayment:	Fixed amount repayment of principal

(3) Revenues

266. In Scenario 1, SLPA gains the following revenues.

1) Marine service charge
   - port due, pilotage charge, tug charge, etc. (tariff: no revision)

2) Cargo handling charge
   - In Low Growth Case, cargo handling tariff is revised by 20% in 2006 and 2011. In Medium Growth Case, no revision.

3) Tally charge (tariff: no revision)

4) Royalty
   - Private developers of QEQ NO9 - 11 will enjoy benefits from seawall and dredging which will be constructed and implemented by SLPA in future. Therefore, SLPA receives a royalty of QEQ NO9 - 11 from them. Royalty per year is calculated as the amount of following items. SLPA receives a royalty from 2011 when QEQ NO9 - 11 open. The amount of royalty is 2,539,000US$ / year / berth.

   a) Total repayment and interest for the loans for funds of seawall construction and dredging X (3 berths / 6 berths) / 30 years
   b) Depreciation costs for seawall

The details of revenues in Scenario 1 are shown in Appendix, TABLE A8.1.1.

In Scenario 2, SLPA gains the following revenues.

1) Marine service charge (tariff: no revision)
2) Cargo handling charge (ditto)
3) Tally charge (ditto)

In Scenario 3, SLPA gains the following revenues.

1) Marine service charge (tariff: no revision)
2) Tally charge (ditto)
3) Royalty (for QEQ NO9 - 11)
4) Land lease charge

   SLPA leases land of QEQ NO8 - 10, and tenants pay a land lease charge (for 1 berth from 2001, 2 berths from 2006, 3 berths from 2007). Land lease charge is calculated as the amount of following items. If the level of land lease charge is too high, users will not lease the berths. Therefore, to ensure that the charge is acceptable to users, the amount of land lease charge is multiplied by 13.0% of discount rate. The amount of land lease charge is 7,872,000US$ / year / berth after discount.

a) Total repayment and interest for the loans for funds of seawall construction and dredging X (3 berths / 6 berths) / 30 years
b) Total repayment and interest for the loans for funds of other civil works for QEQ NO8 - 10 except paving works / 30 years
c) Depreciation costs for above assets

(4) Costs

1) Investment

267. SLPA pays construction and purchase costs for the project (the range of project is shown above TABLE 8.1.2, and the details of costs are shown in Appendix A8.1.2.) as initial investment. The depreciable facilities and equipment are renewed based on their service lives. The service lives of the facilities and equipment are decided based on the standard of SLPA and Japan. SLPA raises the funds for reinvestment from its own internal funds.

2) Personnel costs

268. SLPA pays personnel costs estimated according to required number of employees for management and operation by SLPA. Required number of employees is estimated based on current personnel arrangement at QCT. Unit payroll cost is estimated according to current condition (based on the payroll level increas in Feb 1996). In Scenario 1, unit payroll cost increases by 20% in Low Growth Case, by 30% in Medium Growth Case, in 2006 and 2011. In Scenario 2 and 3, it increases by 30% in 2006 and 2011.

3) Maintenance, repair and operation costs

269. Maintenance, repair and operation costs are calculated as 1% of construction costs for structures and 4% of purchase costs for equipment.

4) Administration costs

270. The annual administration costs are calculated as 20% of the total annual personnel costs.

5) Depreciation costs

271. The annual depreciation costs of the port facilities and equipments are calculated by the straight line method, based on their service lives. Residual values after all depreciations are estimated as 0.1% of initial investment. In this analysis, residual values at the end of the project life are not counted in because selling of fixed assets on that occasion is actually difficult.

6) Taxes

272. SLPA pays following taxes according to current tax structure..

a) Business Turnover Tax (BTT)

This is a tax charged on all operating income and the rate is 5%.

b) Income Tax

This is charged on profit at a rate of 45%.

c) Deemed Dividend Tax

This is charged on profit after-income tax and the rate is 25%.

(5) Cargo handling volume and number of vessels

273. The cargo handling volume and number of vessels is estimated based on the demand forecast in Part 3, Chapter 1 as shown in Appendix, TABLE A8.1.1.

(6) Project Life

274. Taking into account the conditions of the long-term loans and the service lives of the port facilities, the project life for the financial analysis is determined as 30 years after construction.

(7) Base Year

275. For the estimation of expenditures and revenues analyzed quantitatively here, constant prices at 1996 are predominantly used. Neither price inflation nor increases in nominal wages are considered during the project life.

8.3 Sensitivity Analysis

276. Sensitivity analysis is conducted to examine the impact of unexpected future changes. The following three cases are envisioned:

Case 1: The income decreases by 3.4%
Case 2: The project cost increases by 6.2%
Case 3: The income decreases by 3.4% and the project cost increases by 6.2%

277. The rate of income decreasing is determined considering difference between Micro and Macro forecast in demand forecast described in Part 3, chapter 1.3. The rate of cost increasing is determined considering movement of foreign exchange rate for the last five years.

8.4 Evaluation and Conclusion

8.4.1 Results of the FIRR calculation and Appraisal

278. The results of calculation are shown in TABLE 8.4.1, and the FIRR calculation and its details are shown in Appendix, TABLE A8.4.1.

TABLE 8.4.1 *Results of FIRR Calculation*

	Scenario 1		Scenario 2	Scenario 3
	Low Growth Case	Medium Growth Case	Medium Growth Case	Medium Growth Case
Original Case	4.8%	5.3%	7.1%	4.2%
Sensitivity Analysis				
Case 1	4.4%	4.8%	6.6%	3.8%
Case 2	4.1%	4.4%	6.3%	3.9%
Case 3	3.7%	3.8%	5.7%	3.5%

279. Weighted average interest rate of the funds, is 3.5% in this study. In all cases of Scenario 1, 2 and 3, and including above three cases of sensitivity analysis, FIRR exceeds this rate. Therefore, this project is deemed to be financially feasible.

8.4.2 Financial Soundness of the Port Management Body

280. The projected financial statement for the project and financial indicators are shown in Appendix, TABLE A8.4.3.

(1) Profitability

281. Rate of Return on Net Fixed Assets will exceed the average interest rate of the funds after the year 2001 in case of Scenario 1 and 2, 2007 in case of Scenario 3. In the low growth case, it will exceed the average interest rate after the year 2010.

(2) Loan Repayment Capacity

282. Debt Service Coverage Ratio will exceed 1.00 after the year 2001 in case of Scenario 1 and 2, 2006 in case of Scenario 3. In the low growth case, it will exceed the average interest rate after the year 2010.

(3) Operational Efficiency

283. Operating Ratio keeps below 70% after the year 2001 in case of Scenario 1, 2 and 3, 2011 in the low growth case. Working Ratio keeps below 50% after the year 2001 in case of Scenario 1, 2 and 3, 2008 in the low growth case.

(4) Appraisal

284. As shown from above indicators, it can be judged that financial soundness of the port management body (SLPA) is on appropriate level.

8.4.3 Conclusion

285. Results of financial analysis of Scenario 1, 2 and 3 have shown that FIRR of each scenario, while not so high but is in an acceptable range. Financial soundness of the port management body, checked by Rate of Return in Net Fixed Assets, Debt Service Coverage Ratio, Operating Ratio and Working Ratio, maintains an appropriate level. However, in Scenario 1, revision of cargo handling tariff and control of payroll increase are essential conditions, so the SLPA must improve port activity efficiency.

286. FIRR shows the highest level in Scenario 2, SLPA direct management case. However, by utilizing Scenario 1 or 2, SLPA can reduce the amount of loan, can alleviate risk of huge investment; and can involve shipping lines in the port operation. SLPA should consider public benefits and methods/conditions to invite private sectors to the development.

8.4.4 The financial analysis from a point of view of a private company which implements BOT

287. To analyze viability of the projects in Scenario 1 and 3 more concretely, it is important to consider whether the project yield enough profit to a private company which implements BOT. For reference, viability of the project and financial soundness from a point of view of a private company which implements BOT are analyzed as follows. The methodology of analysis is the same as the one aforementioned in chapter 8.1 in Final Report.

288. The main prerequisites and the result of FIRR calculation of analysis are shown in TABLE 5.8 (2).Other prerequisites which are not included in TABLE 5.8 (2) are the same as the ones in Scenario 1 mentioned in TABLE 5.8 (1).

289. Weighted average interest rate of the funds is 8.5% in this case. Because FIRR exceeds this rate, this project is deemed to be financially feasible. The indicators which show "Profitability", "Loan Repayment Capacity" and "Operational Efficiency" of the private company which implements BOT are all on appropriate levels. Therefore, it can be judged that the private company which implements BOT has financial soundness in this project.

290. Though FIRR and the financial indicators show feasible levels, they are not yet profitable enough for private companies to maintain their commercial activities. Sri Lankan private sectors should help private companies which implement BOT to raise funds at a low interest rate through a guarantee for debt or direct funds supply.

TABLE 8.1.1 Port Development Body

	Scenario 1	Scenario 2	Scenario 3
Seawall/Breakwater	SLPA	SLPA	SLPA
South Port Development (QEQ NO6 - 8)			
Infrastructure	SLPA	SLPA	SLPA
Superstructure(including paving)	SLPA	SLPA	Private Sector
South Port Development (QEQ NO9 - 11)	Private Sector	SLPA	Private Sector
Renovation of Bandaranaike Quay	SLPA	SLPA	SLPA
Navigation Assistance	SLPA	SLPA	SLPA
Widening main Channel	SLPA	SLPA	SLPA
Road Development	SLPA	SLPA	SLPA
North Channel Dredging	SLPA	SLPA	SLPA

TABLE 8.1.2 Works Included in the Financial Analysis

	Scenario 1	Scenario 2	Scenario 3
Seawall/Breakwater	Included	Included	Included
South Port Development (QEQ NO6 - 8)			
Infrastructure	Included	Included	Included
Superstructure(including paving)	Included	Included	-
South Port Development (QEQ NO9 - 11)	-	Included	-
Renovation of Bandaranaike Quay	Included	Included	-
Navigation Assistance	Included	Included	-
Widening Main Channel	Included	Included	-
Road Development	Included	Included	-
North Channel Dredging	Included	Included	-

note: In Scenario 3, SLPA implements Renovation of Bandaranaike Quay. Navigation Assistance, Widening Main Chanel, Road Development and North Channel Dredging by funds from its own accumulated retained earnings. Therefore, these works are not included in the financial analysis.

TABLE 8.4.2 The Main Prerequisites and the Result of FIRR Calculation

(1) Prerequisites - Revenues & Costs

1 Revenues Gained by the Private Company		a. Cargo handling charges (All tariffs are the same as the present levels.)
2 Costs Paid by the Private Company	Initial Investment	Construction costs for QEQ No.9.10.11 (except for breakwater)
	Personnel Costs	Calculated based on personnel arrangement plans (Considering salary levels of foreign private companies, unit costs of executive grade are calculated as ten times as high as the ones of SLPA.)
	Other Costs	a. Maintenance & repair costs b. Administration costs c. Depreciation costs d. Re-investment costs e. Taxes f. Royalty

(2) Prerequisites - Fund raising

	Foreign funds	Other funds
Kinds of Loans	Long-term loans from foreign banking institutions	Short-term loans from foreign banking institutions
Range Covered by Loans	100% of construction costs	Raised only in the case of cash shortage outbreak
Loan Period	20 years (including a grace period of 3 years)	1 year (with no grace period)
Interest Rate	8.5 % per annum	10.0 % per annum
Repayment	Fixed amount repayment of principal	Fixed amount repayment of principal

(3) Result of FIRR calculation

Original Case	11.1%

PART 5

PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

1. General

1.1 National Environmental Act

1. National Environmental Act (NEA) was legislated in 1980 and following the legislation the Central Environmental Agency (CEA) was established in 1981. NEA was once amended in 1988 and recently the Environmental Impact Assessment (EIA) Regulations were gazetted in 1993. National Environmental Action Plan, 1995-1998 was released in June 1994 in collaboration with the World Bank, which includes environmental protection projects with a total cost in the order of US$ 100 million.

2. The current legal framework for environmental management is based on the NEA in 1980, whereby Environmental Protection Licenses are issued to polluting industries and constitute the principal current regulatory mechanism for pollution control. EIA Regulations in 1993 are applied to most large projects, so that improvement in designs and appropriate mitigation measures are expected to be taken. The EIA Regulations also identify project approving agencies.

Project Approval Procedure

3. According to NEA, development projects must be approved by project approving agencies. Procedures for approval of project are prescribed in Section 23 of the National Environmental Act as follows.

- The Minister may by Order published in the Gazette specify the state agencies which shall be the project approving agencies.
- The Minister shall determine the projects and undertakings (referred to as "prescribed projects") in respect of which approval would be necessary.
- All prescribed projects will be required to obtain approval for the implementation.
- The approval shall have to be obtained from appropriate project approving agencies concerned or connected with such prescribed projects.
- For certain prescribed projects to be determined by the Minister, the project approving agency will grant its approval only with concurrence of the Authority.
- Project approving agencies shall require an initial environmental examination report within a specified time.
- A project approving agency shall notify the place and times at which such report shall be available for inspection by the public.
- Any member of the public may within 30 days make his comments. Project approving agency may afford an opportunity to any such person when it considers appropriate.

- Where approval is granted for the implementation, such approval shall be published in the Gazette and in a newspaper.

- The project approving agencies shall determine the procedure it shall adopt in approving any prescribed projects.

- Where a project approving agency refuses to grant approval for any prescribed project, the person shall have a right to appeal against such decision to the secretary of the Ministry.

- Where any alternations are being made to any prescribed project, or where any prescribed project already approved is being abandoned, responsible entity shall inform the appropriate project approving agency of such alternations.

- All project approving agencies must forward to the Authority a report on each prescribed project.

4. Ministry in charge of environmental affairs was the Ministry of Environment and Parliamentary Affairs until mid-1994, which was established in 1990, however, the ministry responsible for this matter is now the Ministry of Transport, Environment & Women's Affairs.

1.2 Marine Pollution Prevention Act

5. Marine Pollution Prevention Act was legislated in 1981, one year after NEA. In accordance with the provision of the Act, Marine Pollution Prevention Authority (MPPA) was established in 1988, whose main task is to ratify and implement the international conventions with regard to marine pollution and to develop programmes for the prevention, reduction and control of pollution in Sri Lanka waters and the foreshore.

6. The Government of Sri Lanka has not ratified the convention entitled Prevention of Pollution of the Sea from Ships 1973 and the Protocol of 1978 (MARPOL). The main reasons are said to be the absence of port reception facilities, lack of skilled manpower and equipment and so forth. MPPA is seeking a way to provide reception facilities to ratify the convention.

7. Any discharge or escape of oil or other pollutant into Sri Lankan waters from any ship, an offshore installation, a pipeline and any place on land is subject to the provision of the Act. Dumping oil or other pollutants into Sri Lankan waters is also banned by the provision of the Act.

8. National Oil Spill Contingency Plan, finalized in 1995, focussed attention on preventing the release of oil to the marine environment. The plan was drafted 1) to establish a viable operational structure, 2) to identify high risk areas, 3) to identify priority coastal areas for protection and clean up, 4) to provide response equipment, 5) to provide training for personnel, and 6) to coordinate action with other countries in the South Asian Regional Plan. MPPA is going to set up representatives in every port area including fishery harbours to monitor conditions and report regularly to the MPPA office.

9. Regarding other international conventions on oil pollution, Sri Lanka is a party to the 1969 Convention on Civil Liability for Oil Pollution Damage (CLC) and the 1971 Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage.

2. Project Justification

2.1 Proposed Project

10. The port of Colombo handled over 1 million TEUs of containers in 1995 and future demand for container throughput is estimated at about 2.3-3.6 million TEUs in 2005 and 3.8-6.7 million TEUs in 2015. Since the port is located very close to the international major shipping route from Asia to Europe, transhipment of Indian cargo has increased at a rapid pace owing to the economic boom in the Indian Subcontinent.

11. Economic benefits borne by the port have greatly contributed to the Sri Lankan economy in terms of foreign currency earnings, job opportunities, trade promotion and industrial development. However, the capacity of the present port is not enough to cope with the demand anticipated in the near future and the berths cannot accommodate post Panamax vessels deployed recently in trunk line services. In this connection the development of a new port is planned as shown in this report.

12. Optional development sites are found outside of the QEQ (South Port Development) and in the offshore area of Crow Island (North Port Development). Priority was given to the South Port Development from a point of view of construction cost and period. North Port can be economically developed after the offshore area of Crow Island is sheltered from rough waves by the South Port. Development of the North Port will be flexible in accordance with the demand for cargo throughput.

13. Master Plan for 2015 has two stages of the development. In low/medium growth case, South Port Development will be able to cover the demand anticipated in 2015 and in high growth case North Port Development will be necessary in addition to the South Port Development. North Port has two optional plans, Crow Island Offshore Development and PVQ North Development, which will be reviewed following a considerable series of wave and current observation. Outline of Master Plan for 2015 is listed in Table 5.2.1.

14. The proposed projects for the short-term development are 1) QEQ Outer Terminal as a part of South Port Development; 2) Renovation of Jaya Container Terminal; 3) Redevelopment of Bandaranaike Quay; 4) Widening the West Entrance; 5) North Channel dredging; 6) Inter-terminal road expansion; and 7) Procurement of ancillary facilities. Development plan of the QEQ Outer Terminal involves following infrastructure and facilities.

15. As a result of the proposed development, future ship traffic will increase by 1.7-2.6 times in 2005. Daily in/out traffic will reach 31-46 moves so that separation between incoming and outgoing vessels becomes necessary. Short-term Development Plan includes a project to dredge North Channel to minus 12 meters. Installation of Vessel Traffic System (VTS) is recommended to control the approaching and outgoing vessels.

16. Construction works start from new South-West seawall and the extension of QEQ No.6 berth. Shortly after the commencement of the construction, back yard of QEQ can be expanded and be utilized as a container yard. After the completion of QEQ No. 6 extension and the rehabilitation of QEQ No.2-3 with outer expansion of container yard, cargo handling capacity of QEQ will reach to 0.9 million TEUs, which will take five years after the commencement of the construction. By the year 2005, three full-size container berths will be completed in the QEQ Outer Terminal and the capacity of QEQ Outer Terminal will be increased to 2 million TEUs.

17. Development of the new S-W seawall and breakwater makes the approach channel calm, which allows easy manoeuvring to the present port. After the completion of new S-W seawall, the present S-W Extension Arm can be removed and the West Entrance can be widened accordingly.

TABLE 5.2.1 Outline of Master Plan for 2015

Facilities	High Growth Case		Low/Medium Growth Case
	PVQ North Development	Crow Island Offshore Dev.	
Terminal Area	236 ha	340 ha	120 ha
Additional Berths	Main CT: 10 Feeder: 7	Main CT: 11 Feeder: 5	Main CT: 6 Feeder: 3
Handling Capacity	7.7 mil. TEUs	7.7 mil. TEUs	4.9 mil. TEUs
Breakwater & Seawall	6,350 m	7,010 m	3,610 m
Dredging	12.5 mil. m^3	13.3 mil. m^3	5.3 mil. m^3

TABLE 5.2.2 Summary of Short-term Development Plan

Facilities	Quantity
Breakwater	210 m
Seawall	2,920 m
Quaywall	2,370 m
Revetment	390 m
Total=	5,890 m
Dredging	5,300,000 m3
Reclamation	5,100,000 m3
Berths	Main: 3 (6)[1]
	Feeder: 3 (3)[1]
Terminal Area	73 ha (120.4 ha)[1]
Capacity	2.0 (3.5)[1] million TEUs
Completion	10 years
Milestone	Urgent Plan: 5 years
Equipment	Container Cranes: 17 (Total) incl. 11 post Panamax
	Transfer Cranes: 45
	Trailer Chassis: 180
	Tug Boats: 6 (Additional)
Others	CFS, Gates, Maintenance Shop, Administration Buildings, Power Station
Est. Cost	US$ 840 million

Note: ()[1] indicates the final stage of the development.