4 MASTER PLAN

4-1 Port Development Policy

Through the analysis of port functions, the capacity of Galle Bay and so on, the following conclusions are reached:

(1) Promoting the development of the port for container transshipment cargo, making use of its advantageous location on international shipping routes.

(2) Enhancing the potential of a bulk cargo distribution base, exploiting locational advantage

(3) Contributing to regional development

1) Supporting the development of the EPZ by providing necessary port facilities such as a container terminal

2) Providing necessary facilities for industries directly related to the port

3) Providing necessary facilities for the transportation of commodities in the hinterland of the port

(4) Supporting other activities conducted within the Bay area

1) Maintaining the condition of the present fishery port facilities, to insure their full utilization

2) Securing some spaces for yacht anchoring now being conducted within the basin

(5) While there are some problems to be solved, the entire Bay area is designated as space for future development

(6) Securing safe navigation in the harbour taking into consideration natural conditions such as high waves, rocks scattered on the sea bed and so on.

(7) Connecting the port to land transportation facilities while avoiding traffic congestion

(8) Consideration of environmental preservation

4-2 Vessel Size and Berth Dimensions

(1) Container Cargo

Considering the trend of container vessel size in the world and the vessel size visiting the Port of Colombo, the criteria shown below shall be adopted as an objective container vessel:

50,000 GRT, 3,500 TEU type

Accordingly the berth dimension shall be as follows:

Length = 330 ~ 350m: Depth = -14m

In formulating the master plan, a length of 350 m is adopted.

(2) General cargo

Judging from present ship size visiting the Colombo Port, it would be sufficient to have facilities of 11 m depth.

(3) Bulk cargo

It is anticipated that wheat, fertilizer, clinker and cement will be handled as the main bulk cargoes at the port of Galle in the future.

Considering the trend of bulk carrier in the world and vessel size visiting ports of Colombo and Trincomalee, the following are adopted as maximum and objective vessel for bulk cargo, respectively:

65,000 DWT, 30,000 DWT

Accordingly the dimensions are as follows, respectively:

Berth length = 270m, Depth = -14m

Berth length = 240m, Depth = -12m

(4) Others

According to a plan of the Ceylon Petrochemical Corporation, the below will be adopted as the objective vessel for liquid bulk.

5,000 DWT, LOA = 104m, Dr = 6.5m

Accordingly, the dimensions of the berth are as follows:

Berth length = 120m, Depth = -7.5m

4-3 Required Number of Berth

4-3-1 Container Berth

The container berth to be constructed in the port of Galle is not a remodeled one using the existing wharf but a new one, and many conditions are assumed to be similar to those of the Jaye Terminal in the Port of Colombo. Therefore, in this examination, statistical data of Jaye Terminal are used as parameters for calculation of the required scale of container terminal at Galle.

Based on the result of calculation of berth occupancy rate, the number of container berths required will be 3.

4-3-2 General/Bulk Cargo Berths

Some dry bulk cargoes will be handled at the Port of Galle in 2005. However, the volume of these cargoes is not large enough to plan a separate berth for these commodities. Instead, general/bulk cargo berths are planned for accommodating vessels that convey break bulk, fertilizer, clinker, cement and wheat.

Based on the result of calculations of berth occupancy rate, required number of berths will be 2.

4-3-3 Other berth

One oil products berth is planned for accommodating a 5,000 DWT tanker and bunkering inside the existing breakwater.

4-3-4 Summary

Through the calculations described above, the following facilities are planned:

Berth	Objective vessel	Length	Depth	Number	Main cargo
Container					
Berth	50,000 GRT	1,050	-14	3	Container
General/Bulk					
Cargo Berth	65,000 DWT	270	-14	1	Wheat
	30,000 DWT	240	-12	1	Fertilizer, Others
Oil Berth	5,000 DWT	120	-7.5	1	Oil

4-4 Required Scale of Facilities/Equipment

4-4-1 Container Berth

(1) Handling system

A lift-on, lift-off system on the quay wall and a transfer crane system at the terminal will be used in the port of Galle since these systems have been used at the port of Colombo and a comparatively small area of the container yard is prepared through reclamation.

(2) Container yard

The required number of ground slots is calculated as around 2200.

(3) Container freight station

The required floor area of CFS is estimated at around 4000.

The dimension of the C.F.S is 45m in width and 80m of frontage.

(4) Cargo handling equipment

1) Container crane	6 units
2) Transfer crane	14 units
3) Tractor-trailers at the yard	36 units
4) Tractor at the CFS	3 units
5) Trailors at the CFS	35 units

(5) Others

* Administration office: 800 m^2
* Maintenance shop: 1,000 m^2
* Others (Water supply facility, Cleaning facility, etc.)

It is necessary to secure around 50,000 m2 even if the space is secured for a third of the local container cargo volume other than container yard.

4-4-2 General/Bulk Cargo Berth

(1) Handling system

As described, unloading of fertilizer and clinker will be carried out by ship gear while the unloader and pump will be used for handling wheat and cement. Unloading general cargo conveyed by conventional vessels will be carried out by ship gear, and cargo handling between apron and shed will be done by fork-lifts.

(2) Scale of shed 6000m^2

(3) Cargo handling equipment

* Cement

Hopper	1 unit
Belt conveyer	1 unit
Silo	20,000 ton

* Wheat

Unloader(400t/h)	2 units
Belt conveyer(400t/h)	2 units
silo	100,000 ton

For handling break bulk and fertilizer, 20 units of fork lift (3 tons) will be necessary. There are already 3 fork lifts and 17 more units will be prepared.

4-5 Other Facilities

4-5-1 Breakwater Alignment

The alignment of the breakwater will be determined in one way; namely, a combination of two breakwaters. One will be constructed from the Fort towards the southeast to combat the W to SW sea waves caused mainly by southwest monsoons. Rocks crop out from the front of the Fort, and it is useful to develop this area as the edge of the breakwater. The other breakwater will be constructed from Rumassala towards the west to combat swells mainly from the south. Since the port mouth will be established towards the south to the south-east for easy maneuvering of ships, the main breakwater is the former one. To secure a sufficient water area, it will be necessary to construct breakwaters of approximately 1,500 m in length.

4-5-2 Channel

300 m is adopted as the width of the channel from the maximum length of the objective vessel and 370 m is adopted as the width of the mouth of the port considering the structure of the breakwater..

iii) Stopping distance

To maneuver ships for stopping safely in ports, 5L will be taken into consideration in formulating the master plan.

There are two ways of entering the port; one is from the southeast, the other is from the south. The mouth of the port will be established at the eastern part of the bay taking wave and sea bed conditions into account.

There is a Eastern Channel which is not used now in Galle Bay. This channel runs along places where it is deep and there are less rocks. In the case that the mouth is established toward the southeast, it is very useful to expand this existing channel as the future channel.

4-5-3 Land Transportation Facilities

(1) Road

A road is planned to connect the reclaimed area to the existing road running along the coast.

Traffic volume per hour will be 679, and it is thus necessary to plan a 4-lanes road.

(2) Railway

Since a railway and a CFS are planned for the site of koggala EPZ, the railway should be constructed in the port area.

4-5-4 Navigational Aids

The following navigational aids shall be planned according to the channel and breakwater plan.

* Two tug boats: 2500 HP
* Light beacons on the breakwater 4
* Light buoys along the channel 12
* Light guide post 1

4-5-5 Others

Apart from what has been written above, it is necessary to prepare a water-supply facility, an electric power supply facility and an administrative facility.

4-6 Alternatives of Master Plan Layout

4-6-1 Selection of the Site to be Developed for the Port

Judging from present conditions, especially water area use, there are three sites that be nominated for the development of the port in Galle Bay.

They are listed as follows,

Site 1. West side of the Bay, very close to the centre of Galle city.

Site 2. Centre of the Bay off-shore from the existing port.

Site 3. East side of the Bay next to the hill of Rumassala.

4-6-2 Formulation of Alternatives

There are five alternatives in the master plan layout with a combination of sites or configuration of wharves. They are:

Alternative-1: To develop site 1 as the first container terminal, and continue to develop site 2 for the next stage.

Site 1 is the best equipped to protect the quay wall from southwestern sea waves. However, there are some restrictions. One is caused by the existence of the Fort. Secondly, dredging the many rocks on the sea bed is an expensive procedure.

Alternative-2: To develop site 2 for the long term

If site 1 is to be preserved for environmental reasons, then, the next best site for protection against SW waves is the western side of site 2. This site not only offers protection from SW waves, but it is also easy to connect with existing facilities.

Alternative-3: To develop site 3 as a pier-type berth

In this plan , the calmness and area size of the turning basin are considered most preferable. However, it is necessary to dredge an extensive rocky area.

Alternative-4: To develop simultaneously site 3 as a parallel berth and perpendicular berth to the coast while continuing to extend both berths as the next step.

If wharves are constructed in the western part of the bay, it will cost a lot to dredge the sea bed of many rocks. In this alternative plan, since allocation of the channel and basin are planned mainly considering sea bed conditions, the dredging cost

would be the least.

Alternative-5: To develop site 2 in the cheapest way and develop site 3 as the next step

The costs involved in constructing port facilities such as a breakwater and a basin are high. This alternative plan attempts to increase cost savings in the short term plan. However, the depth of basin is limited to -12m.

They are shown in the next Figures.

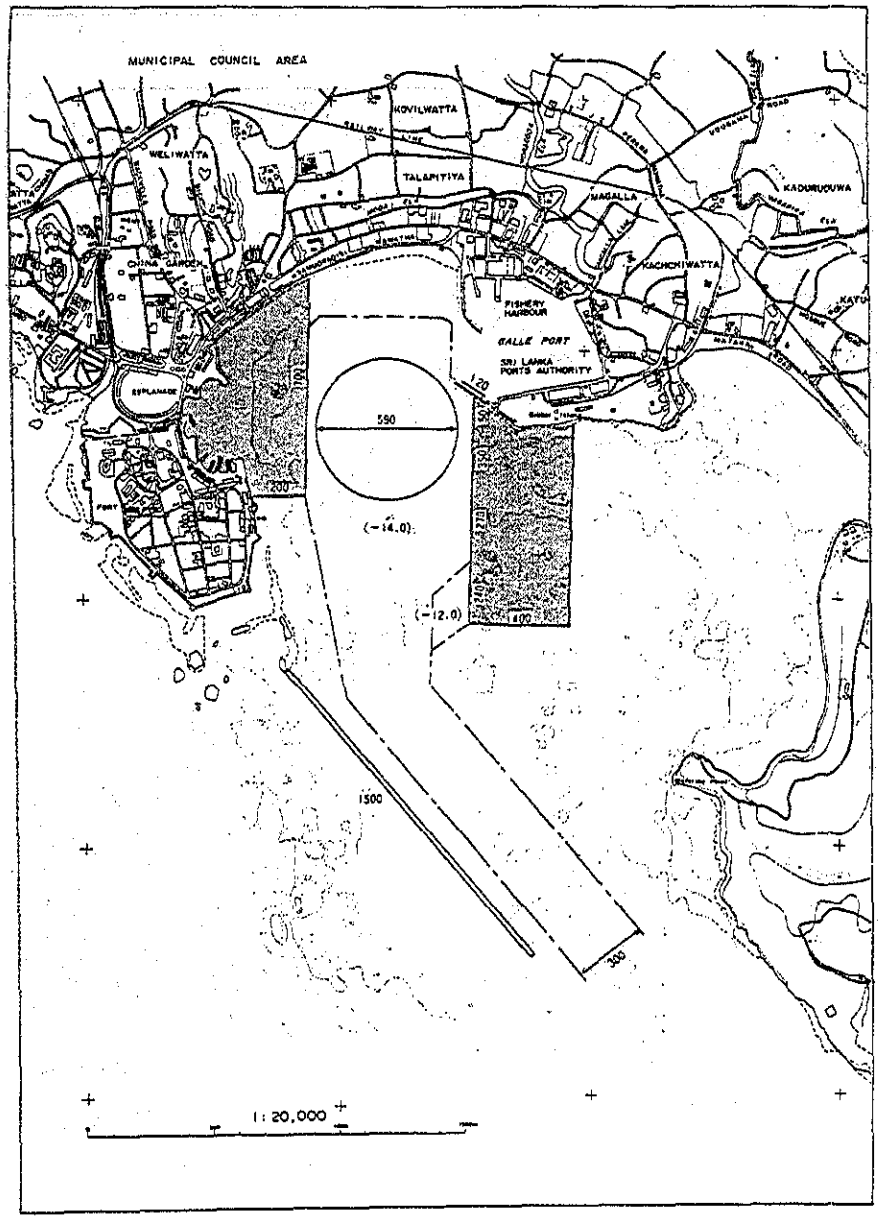


Fig. 4-6-1 Alternative 1

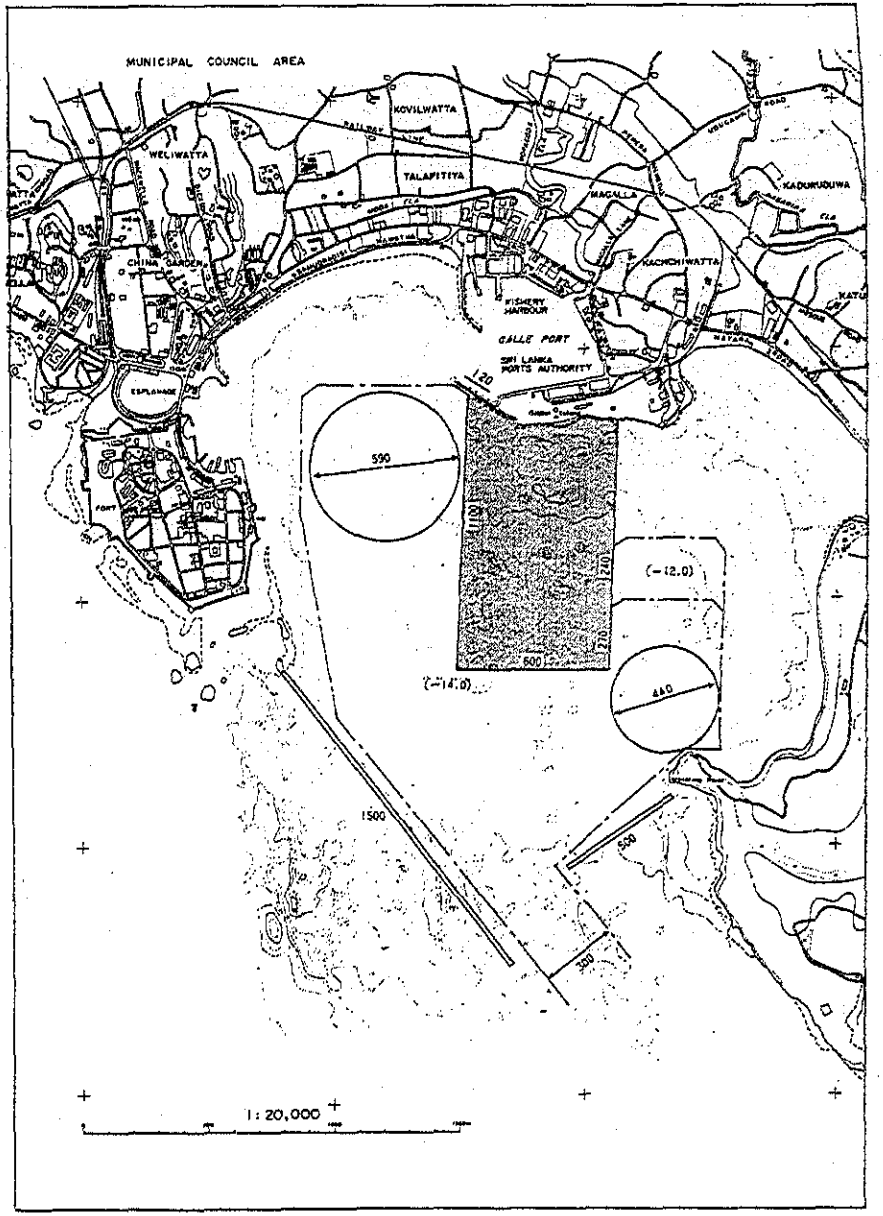


Fig. 4-6-2 Alternative 2

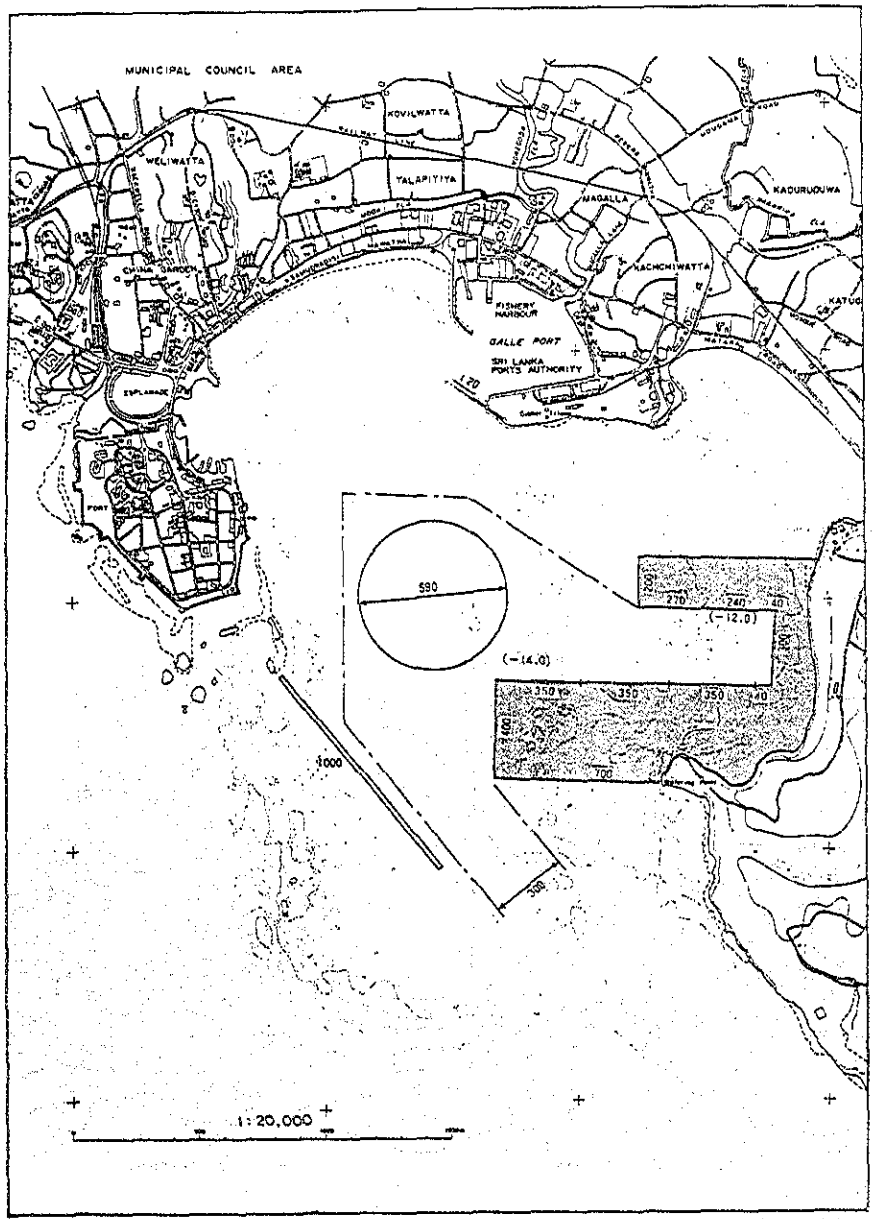


Fig. 4-6-3 Alternative 3

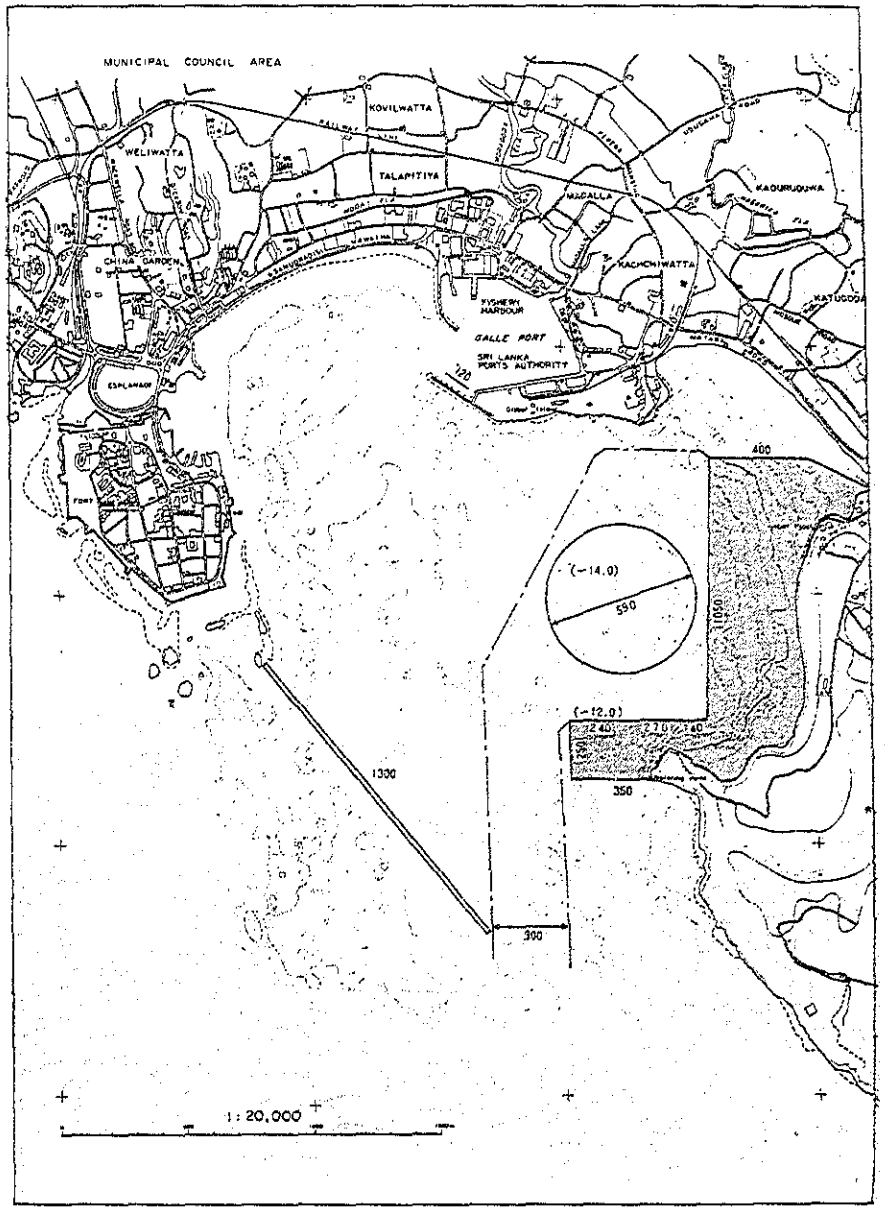


Fig. 4-6-4 Alternative 4

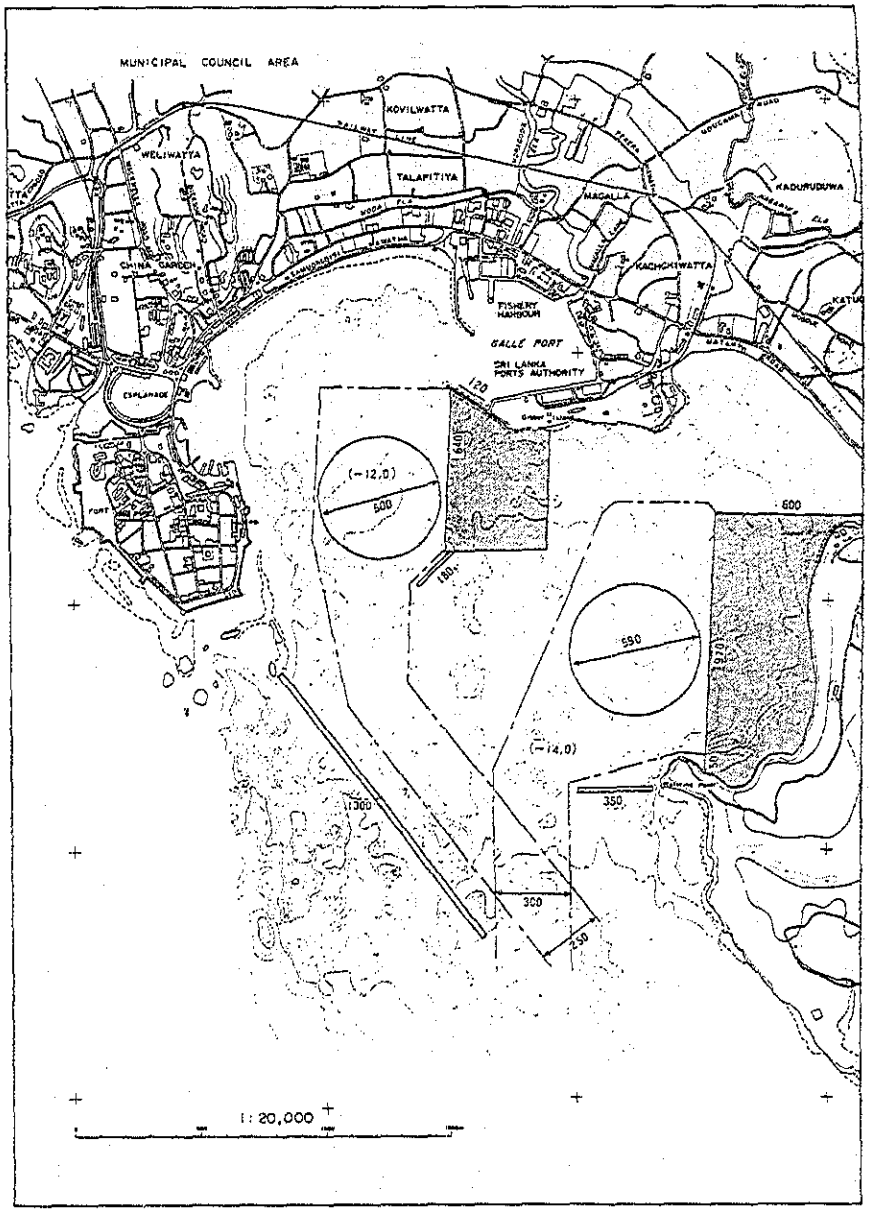


Fig. 4-6-5 Alternative 5

4-6-3 Study of Calmness

A computer-aided simulation analysis has been undertaken to determine the effects on the calnmess of the inner harbour of the five master plan layout alternatives considered for Galle Port, including the proposed breakwater, reclamation works, container berth, and other necessary harbour works.

(1) Incident Wave at Harbour Entrance

The Swells and wind waves in an area 68 m of water off Galle Port vary in height under the influence of depth, refraction, bottom friction and other effects before they reach the harbour entrance which is 15 m of water.

While undergoing aforesaid deformations, swells and wind waves approach to the harbour entrance simultaneously. Table 4-6-1 present the direction-wise frequencies of wind wave height occurrence according to the swell wave heights at the harbour entrance. In this table, the swell wave direction is taken as S 9.7° W.

(2) Wave height Distribution in Inner Harbour

In respect of the five alternative layout plans discussed earlier, height distributions in the inner harbour of incident waves coming from harbour entrance were obtained by a computer-aided numerical simulation analysis.

(3) Degree of Calmness in the Port

Quayside cargo handling efficiency is affected by the motions of moored ships. The magnitude of ship motions varies widely depending on various factors including, among others, (1) the height, direction and period of waves, (2) direction and speed of winds, (3) type and size of ships moored, (4) method of taking mooring lines, and (5) stiffness of fenders.

The wave height in front of the proposed quay structure is the key factor affecting cargo handling efficiency. Generally, wave heights up to 0.5 to 0.7 m are known to produce no adverse impact on the efficiency in loading and unloading an oceangoing vessel moored alongside a quay.

Table 4-6-2 presents the degree of calmness in the basin. This table

shows the frequencies of occurrence of the overall wave height which is below 0.5 m in front of the proposed quay.

Table 4-6-1 Frequency of Wind Wave Height Occurrence According to Swell Scale

Swell $H_{1/3}$ = 0.00~0.49

$H_{1/3}$ (m) \ Direction	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	OTHER	TOTAL
0.00-0.49	0.00	0.00	0.35	0.03	0.00	0.00	0.00	0.00	0.00	0.05	0.45
0.50-0.99	0.00	0.00	0.49	0.27	0.06	0.00	0.00	0.00	0.00	0.00	0.83
1.00-1.49	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.00	0.00	0.00	0.08
1.50-1.99	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.00	0.00	0.00	0.08
2.00-2.49	0.00	0.00	0.00	0.00	0.02	0.09	0.01	0.00	0.00	0.00	0.12
2.50-2.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00-3.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.50-3.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.84	0.30	0.09	0.15	0.10	0.00	0.00	0.05	1.56

Swell $H_{1/3}$ = 0.50~0.99

$H_{1/3}$ (m) \ Direction	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	OTHER	TOTAL
0.00-0.49	0.00	0.00	12.52	0.75	0.77	1.68	1.53	2.02	0.00	5.53	24.80
0.50-0.99	0.00	0.00	5.94	1.27	0.61	1.74	1.85	0.70	0.00	0.00	12.10
1.00-1.49	0.00	0.00	0.17	0.06	0.08	1.11	0.94	0.13	0.00	0.00	2.49
1.50-1.99	0.00	0.00	0.00	0.00	0.08	1.20	0.97	0.05	0.00	0.00	2.29
2.00-2.49	0.00	0.00	0.00	0.00	0.00	0.46	0.26	0.03	0.00	0.00	0.75
2.50-2.99	0.00	0.00	0.00	0.00	0.00	0.15	0.09	0.01	0.00	0.00	0.25
3.00-3.49	0.00	0.00	0.00	0.00	0.00	0.01	0.10	0.00	0.00	0.00	0.11
3.50-3.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	18.62	2.08	1.54	6.35	5.74	2.95	0.00	5.53	42.80

Swell $H_{1/3}$ = 1.00~1.49

$H_{1/3}$ (m) \ Direction	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	OTHER	TOTAL
0.00-0.49	0.00	0.00	0.73	0.13	0.51	0.89	1.45	0.35	0.00	1.24	5.30
0.50-0.99	0.00	0.00	0.31	0.55	0.37	4.71	5.86	0.65	0.00	0.00	12.45
1.00-1.49	0.00	0.00	0.15	0.03	0.26	4.31	5.31	0.20	0.00	0.00	10.26
1.50-1.99	0.00	0.00	0.00	0.00	0.15	1.85	2.41	0.03	0.00	0.00	4.45
2.00-2.49	0.00	0.00	0.00	0.00	0.02	0.58	0.42	0.00	0.00	0.00	1.03
2.50-2.99	0.00	0.00	0.00	0.00	0.01	0.20	0.15	0.00	0.00	0.00	0.35
3.00-3.49	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.04
3.50-3.99	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
TOTAL	0.00	0.00	1.19	0.72	1.31	12.58	15.62	1.25	0.00	1.24	33.89

Table 4-6-1 Frequency of Wind Wave Height Occurrence According to Swell Scale (Continued)

Swell $H_{1/3}$ = 1.50~1.99

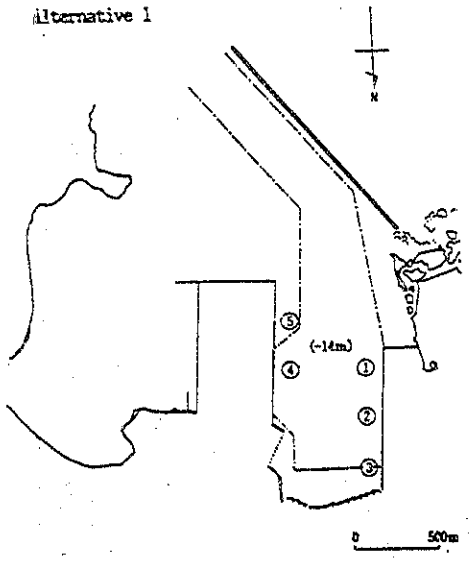
Direction / $H_{1/3}$ (m)	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	OTHER	TOTAL
0.00-0.49	0.00	0.00	0.09	0.01	0.01	0.21	0.26	0.12	0.00	0.31	1.01
0.50-0.99	0.00	0.00	0.00	0.00	0.11	2.21	2.20	0.26	0.00	0.00	4.79
1.00-1.49	0.00	0.00	0.00	0.01	0.27	3.61	3.78	0.18	0.00	0.00	7.84
1.50-1.99	0.00	0.00	0.00	0.00	0.03	1.52	1.84	0.02	0.00	0.00	3.42
2.00-2.49	0.00	0.00	0.00	0.00	0.01	0.37	0.63	0.00	0.00	0.00	1.01
2.50-2.99	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02
3.00-3.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.50-3.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.09	0.01	0.43	7.93	8.74	0.58	0.00	0.31	18.10

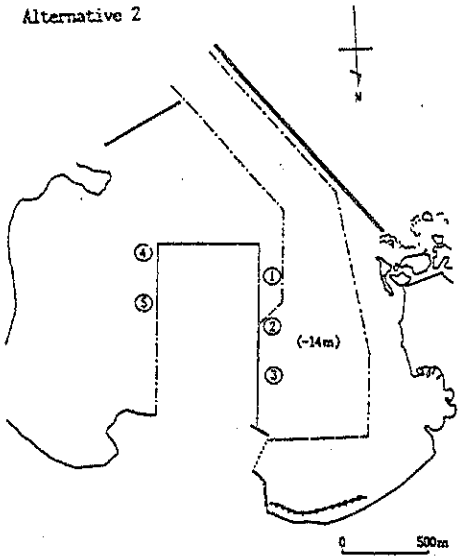
Swell $H_{1/3}$ = 2.00~2.49

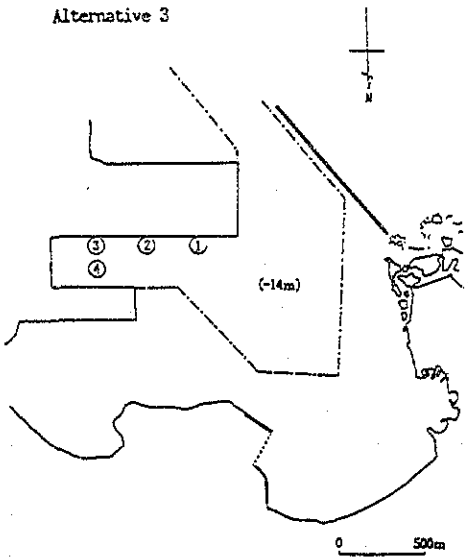
Direction / $H_{1/3}$ (m)	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	OTHER	TOTAL
0.00-0.49	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.08	0.19
0.50-0.99	0.00	0.00	0.00	0.00	0.03	0.42	0.44	0.00	0.00	0.00	0.89
1.00-1.49	0.00	0.00	0.00	0.00	0.03	0.71	0.81	0.00	0.00	0.00	1.55
1.50-1.99	0.00	0.00	0.00	0.00	0.01	0.26	0.20	0.00	0.00	0.00	0.47
2.00-2.49	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.00	0.00	0.00	0.09
2.50-2.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00-3.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.50-3.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.07	1.47	1.55	0.00	0.00	0.08	3.18

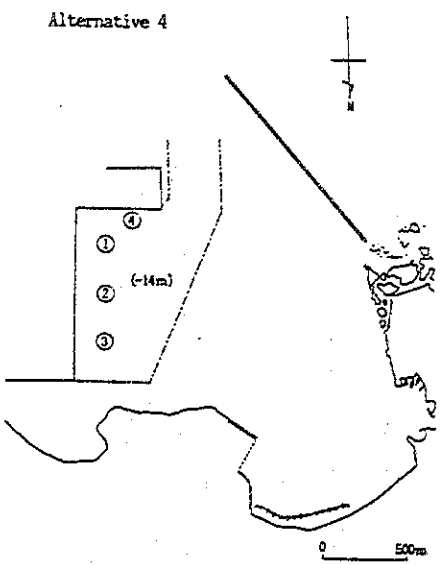
Swell $H_{1/3}$ = 2.50~2.99

Direction / $H_{1/3}$ (m)	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	OTHER	TOTAL
0.00-0.49	0.00	0.00	0.00	0.00	0.00	0.06	0.02	0.00	0.00	0.00	0.08
0.50-0.99	0.00	0.00	0.00	0.00	0.00	0.04	0.12	0.04	0.00	0.00	0.20
1.00-1.49	0.00	0.00	0.00	0.00	0.01	0.08	0.10	0.00	0.00	0.00	0.18
1.50-1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00-2.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.50-2.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00-3.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.50-3.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.01	0.17	0.25	0.04	0.00	0.00	0.47









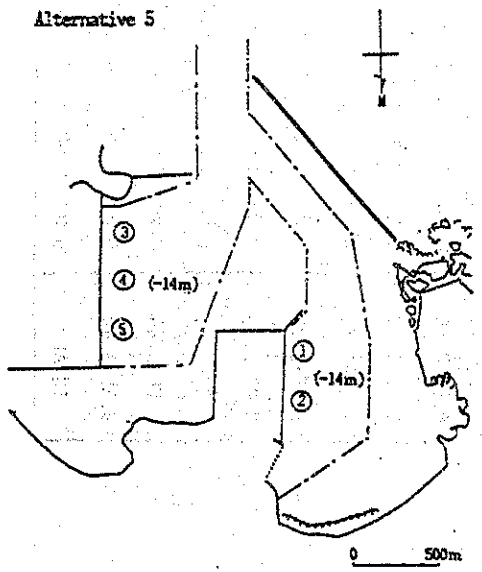


Table 4-6-2 Degree of Calmness

(Critical Wave Height 0.5 m)

Point \ Plan	1	2	3	4	5
1	90.9 (%)	100.0 (%)	100.0 (%)	99.5 (%)	100.0 (%)
2	82.8	100.0	100.0	99.5	100.0
3	70.5	100.0	100.0	96.3	97.1
4	100.0	95.8	100.0	99.3	95.8
5	99.3	94.7	------	------	89.0

4-6-4 Rough Cost Estimate

Comparative cost estimation is carried out to the major port facilities of the five Alternative Proposals contained in the Master Plan.

The Table No. 4-6-5 and 4-6-6 show the results of the calculation.

Of the five Alternative Proposals, the No. 4 and No. 5 Proposals have a design concept to utilize the back site of the cape in the East as quaywall that is succeeded in huge reduction of the length of the breakwater.

Locations of navigation channel and anchorage position in the No. 4 and No. 5 Proposals are so selected as to minimize the dredging volume of anchorage and rock layer, under which design concept relatively economical port facilities are obtained compared with the other three.

Table 4-6-5 Rough Cost Estimates of Master Plan (Alternative 1-5)

(UNIT ; Million US$)

Facility	Plan-1	Plan-2	Plan-3	Plan-4	Plan-5
Dredging					
Rock Material	96.18	111.99	100.73	42.67	36.73
Other Material	18.52	21.10	16.59	12.31	16.57
Breakwater					
Southwest Breakwater	96.90	96.00	64.77	83.98	95.61
East Breakwater	-	42.80	-	-	29.96
Quays					
-14.0M Wharf	109.58	109.33	88.12	98.41	78.76
-12.0M Wharf	17.20	11.35	21.09	16.81	38.14
Oil Berth	4.43	4.43	4.43	4.43	4.43
Revetment	51.77	66.45	83.20	46.42	39.86
Reclamation	63.35	74.43	87.30	59.78	65.08
Pavement	46.96	43.00	54.35	43.07	48.10
Grand Total	504.89	580.88	520.58	407.88	453.24

Table 4-6-6 Major Works in Five Alternative

Facility	Unit	Plan-1	Plan-2	Plan-3	Plan-4	Plan-5
Dredging						
Rock Material	m3	1,375,000	1,601,000	1,440,000	610,000	525,000
Other Material	m3	3,265,000	3,719,000	2,924,000	2,170,000	2,920,000
Breakwater						
Southwest Breakwater	m	1,500	1,500	1,000	1,300	1,480
East Breakwater	m	-	500	-	-	350
Quays						
Container	m	*1,100	*1,100	*1,140	*1,090	*1,150
Grain	m	270	270	270	270	270
General/Bulk Cargo	m	240	240	240	240	240
Oil	Sum	1	1	1	1	1
Revetment	m	2,000	1,815	2,300	1,770	1,520
Reclamation	m3	5,850,000	6,940,000	8,160,000	5,470,000	5,955,000
Pavement	m2	616,000	564,000	713,000	565,000	631,000

* : Including the transitional part

4-6-5 Evaluation of Alternatives

An evaluation of the 5 alternatives by item are shown in the table below.

Table 4-6-7 Evaluation of Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Construction cost	C	C	C	A	B
Breakwater	B	C	A	A	C
Dredging	C	C	C	A	A
Development potential	A	A	C	B	C
Maneuvering of ships	A	B	A	A	A
Calmness of basin	B	A	A	A	A
Functional connection	B	A	A	A	B
Relation to land transportation	B	A	A	A	A
Total evaluation	C	C	C	A	B

Note: A:preferable, B:normal, C:Not preferable

(1) Construction cost

As described in the previous section, construction costs are highest for Alternative-2 and lowest for Alternative-4.

(2) Development potential

This factor will be judged from the total length of the berth and area to be secured in the long-term plan. Based on a very rough estimation of the length of the reserved quay walls considering unutilized water area, Alternative-1 and Alternative-2 have the biggest potential for future development. However, with the exception of Alternative-3, the difference in length among the quay walls is fractional.

(3) Maneuvering ability of ships

Especially, in the case of Alternative-2, vessels must turn near the entrance of the harbor in order to approach the eastern side berth.

(4) Calmness of the basin

With the exception of Alternative-1, the difference in calmness at the berth side among the alternatives is small.

(5) Functional connection

In the case of Alternative-1 and Alternative-5, reclaimed areas are apart from each other.

(6) Connection to land transportation

In the case of Alternative-1, in which the front of the city center is reclaimed, the connecting point between the access road and the main road is established near the city center, causing traffic problems.

(7) Environmental aspect

The Fort is a living monument and it is believed on the Sri Lankan side that it should be preserved.

(8) Relationship with short-term development plan

According to a very rough estimation of the initial cost for the short term development plan, Alternative-5 is the cheapest, followed by Alternative-4.

(9) Comprehensive evaluation

Based on these evalnations, it is judged that alternative 4 is the best. However, alternative 5 is cost effective for the short term development plan.

4-6-6 The layout Plan

The layout of the master plan is shown in the next Figure.

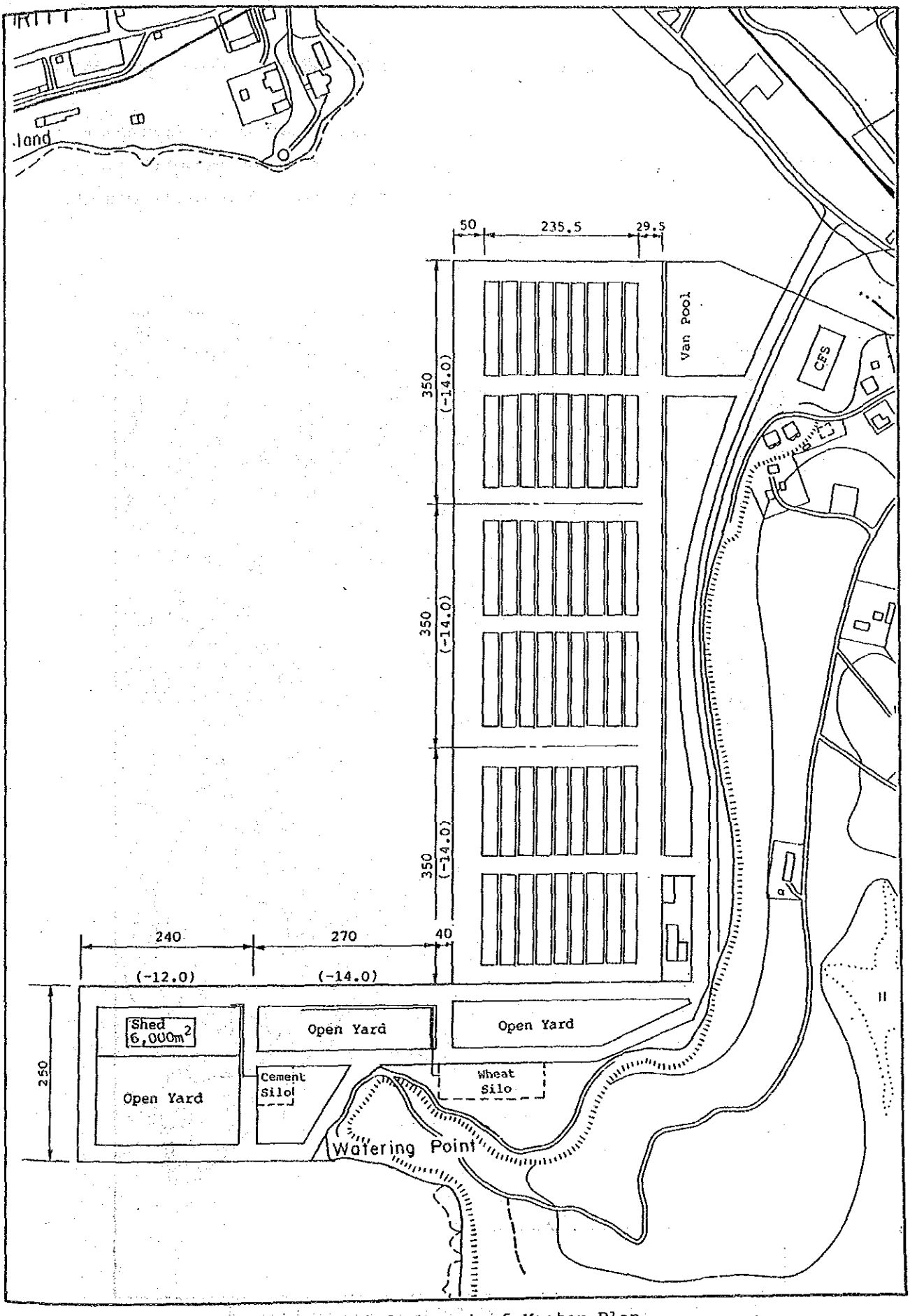


Fig. 4-6-6 Layout of Master Plan

4-6-7 Conceptual Development Plan for the Long Term

In this section, we want to present a conceptual understanding of the bay's future from the viewpoint of port development. Our aim here is not to formulate a long-term plan but to clarify the development potential beyond the year 2005.

This concept is shown in Fig. 4-6-7.

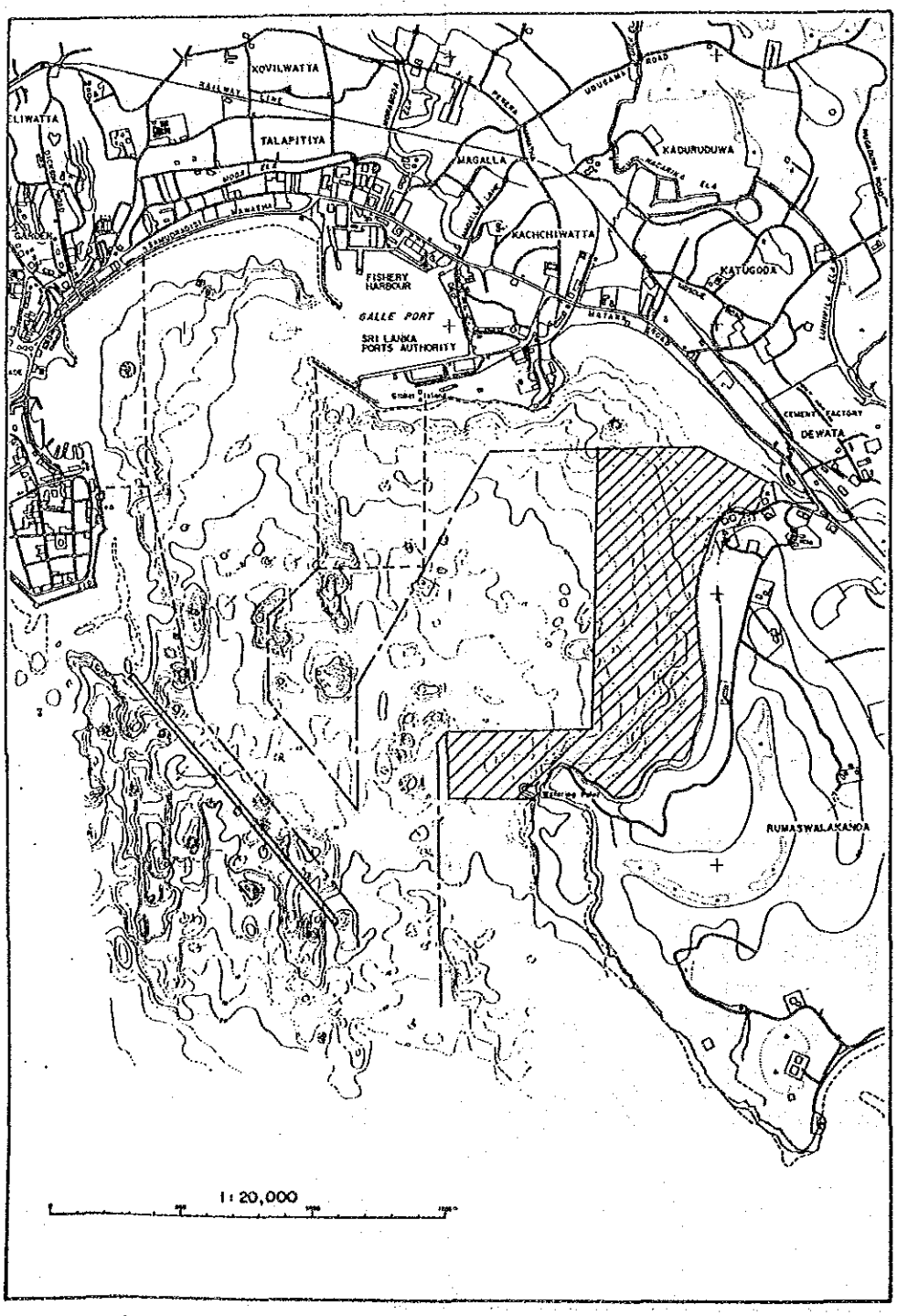


Fig. 4-6-7 Conceptual Full Scale Development Plan

4-7 Design, Rough Cost Estimation and Implementation Program

As mentioned in Section 4-6-4, the No. 4 and No.5 Proposals of the five Alternative Proposals were selected for further study, and the No. 4 Proposal was finally selected as the best-suited plan.

4-7-1 Design

The port facilities to be constructed under the Master Plan Scheme comprise

1) Breakwater
2) Quay Structures
   a) Container Berth (planned depth -12.0 and -14.0 m)
   b) Grain Berth (planned depth -14.0 m)
   c) General/Bulk Cargo Wharf (planned depth -12.0 m)
   d) Oil Berth (planned depth -7.5 m)
3) Revetment
   a) Sea Wall
   b) Revetment

Typical cross sections for those Port Facilities are basically the same as those shown in the Part III Short Term Plan referring to the Fig. 3-2-1 ~ 3-2-6.

4-7-2 Rough Cost Estimation

Of the Alternative Plans presented in the preceding article of 4-6, the Alternative Proposals of No. 4 is selected as the optimum Master Plan and the cost estimation is performed thereto.

The Table No. 4-7-1 account for the results of the calculation.

Table 4-7-1 Rough Cost Estimates of Master Plan Project (2005)
(Alternative No. 4)

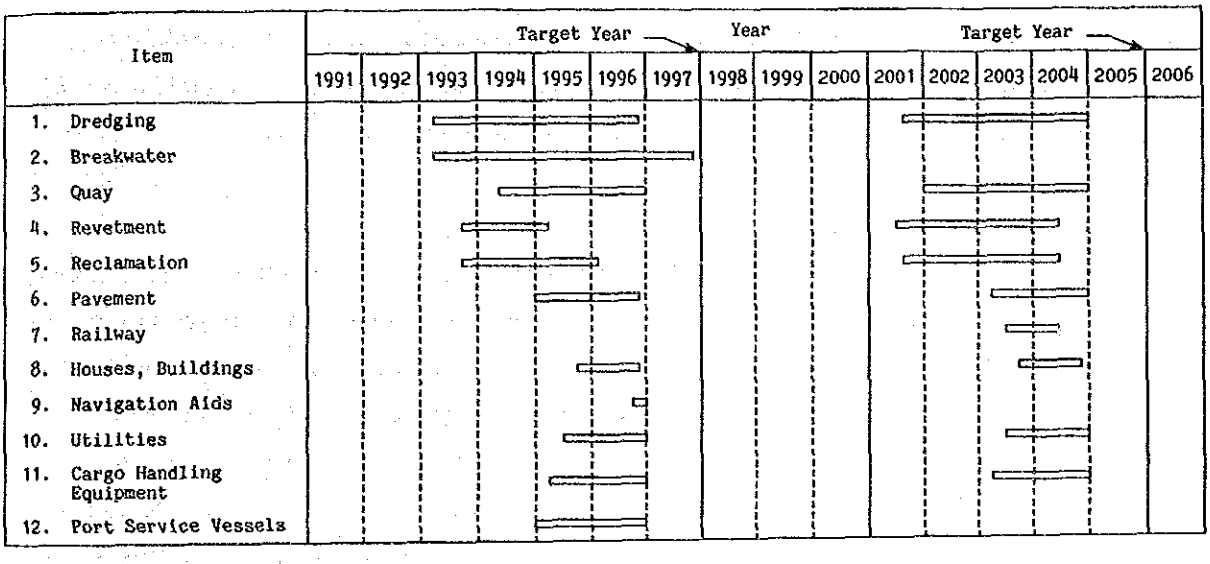
Facility	Quantity		Cost (Million US$)
1. Dredging			
Rock Material	610,000	m^3	42.67
Other Material	2,170,000	m^3	12.31
2. Breakwater			
Southwest Breakwater	1,300	m	83.98
3. Quays			
Container (-14.0m)	1,090	m	80.63
Grain (Wheat)	270	m	17.78
General/Bulk Cargo	240	m	16.81
Bunker Oil	1	Sum	4.43
4. Revetment	1,770	m	46.42
5. Reclamation (Filling)	5,470,000	m^3	59.78
6. Pavement	565,000	m^2	43.07
7. Rail Way	1,000	m	1.08
8. Houses Buildings	1	Sum	11.76
9. Navigation Aids	1	Sum	0.70
10. Utilities (Water and Electric)	1	Sum	25.00
11. Cargo Handling Equipment			
Container	1	Sum	69.35
Grain	1	Sum	25.71
Fertilizer	1	Sum	7.56
Cement	1	Sum	1.50
Bunker Oil (Loading arm)	1	Sum	1.30
12. Port Service Vessels	2	Nos	6.48
13. Contingency (6%)			33.50
Grand Total (1~12)			592.00

4-7-3 Implementation Program

The target years set up in the Implementation Program are 1997 and 2005 for the Short Term and the Master Plan respectively.

The time schedule for the major items of works are explained in the Table 4-7-2.

Table 4-7-2 Implementing Steps for The Master Plan
(Alternative No. 4)



4-8 Consideration of Environmental Aspect

4-8-1 Rough Evaluation of Environmental Conditions In Galle Bay

Not only surveyed data concerning water quality, such as COD, BOD, coliform, etc., but also other data related to environmental conditions such as air pollution, vibration and animals and plants do not exist in Galle Bay.

(1) Sewage

Drainage from houses flows directly into the public water without any treatment but is obliged to proceed through a simple treatment process in the case of feces.

(2) Garbage Disposal Yard

There are two areas for Garbage disposal in the Galle area, which are located in the North-Eastern part, and their capacities for disposal will remain sufficient for more than ten years. And this does not have any influence on the water pollution of the sea.

(3) Cultural Protection

Demolition or rebuilding of structures within the Fort are forbidden in principal by the regulations of the Archaeological Department, and also any development activity within 400 yards from the boundary of the Fort has to get approval from the same department.

(4) Maintenance of Hill Environment

The Hill of Rumassala, which is located on the eastern side of Galle Bay, has some restrictions against development. They have some relationship to religious beliefs. Some of the plants found on this hill has special medicinal values as well.

(5) Species to be Protected

It is reported that there are no specific species to be protected in the Bay.

4-8-2 Picking-up of Environmental Components to be Affected by the Port Development

Environmental characteristics of the port plan are as follows:

i) Port facilities themselves don't affect environmental conditions.

ii) However, the construction of the breakwater will result in the closed water area in which it is not easy to exchange water with the outer sea.

iii) It is possibile to assume that environmental conditions in Galle Bay area are generally in good.

iv) On the contrary, some attention should be paid to preservation of the landscape.

Considering these characteristics, components of the environment to be affected by the port development are selected as follows:

* The air condition

Generally speaking, the volume of gas produced by ships and automobiles in the port area is comparatively less than that resulting from automobile in the area surrounding the port.

* Water quality
* Vibrations
* Oceanography, topography
* Animals, plants
* Landscape
* Others

The relationship with activities such as fisheries shall be taken into consideration.

4-8-3 Environmental Impact and Countermeasures against it

Development projects in coastal areas can cause many changes in surrounding environment. Accordingly, it is necessary to examine and exchange views about assessment of environmental influence beforehand.

(1) Oceanography, topography

Construction of a breakwater will cause a big change in waves and currents in Gall Bay and its vicinity. It should be noted that the narrower bay mouth will become an obstacle for exchanging water with the outer sea.

When the breakwater proposed in the Master Plan is built, the waters adjacent to the river mouth will become very calm and the material discharged from the river is likely to be deposited in the relatively narrow sea area in the vicinity of the mouth. Under Alternative 4, reclamation is planned for the area extending to a point close to the river mouth and it may be necessary to undertake monitoring of possible depth changes in the neighborhood of the river mouth as a result of the construction of facilities such as breakwater and quay walls.

(2) Water quality

As describe in (1), the bay mouth will become narrower with the construction of the breakwater and it will become difficult for contaminants to be diluted and dissolved by exchanging with the outer sea. The volume of contaminants flowing into the Bay will increase with activation of many activities and reach a level such that the capacity of the Bay cannot accept them. Besides applying stricter criteria regarding discharge limits, construction of sewage disposal plants and discharging some parts of sewage into outer sea directly should also be considered.

(3) Animals, plants

Although it is difficult to clearly determine the impact on species living in the sea and coastal area because of lack of data concerning living creatures, it is reported that there are no species that need to be protected in these area.

(4) Others

1) Fishery activity

There are some beaches now being used for berthing fishing boats as well as some water areas being used for fishery activities in

the Bay. Some of them will vanish, or their use will be restricted to some extent as a result of reclamation and port activities.

2) Influence of construction activities

a) Muddiness

Some of the soil dredged for construction of the channel and basin will be abandoned near by in the outer sea area. Dredged soils originally composed of sea ground and minute articles that cause muddiness will already have been washed out. Therefore, it is anticipated that there will be little muddiness caused by abandoning dredged soils in the outer sea area.

b) Vibrations

The method used to dredge these areas is to blast rocks and boulders first and gather materials blasted by the grab next. As this method has already been applied in dredging the existing channel, it is assumed that it will not result in many problems regarding environmental conditions.

3) Traffic congestion

Port activities will result in more traffic burdens on the present road system. And yet, there are some parts of the road system around Galle Bay where smooth traffic conditions do not exists. Thus is necessary to improve road conditions such as alignment and width.

4) Landscape design

The main items to be considered for the creation of a good landscape can be listed as follows:

* Creation of landscape by making full use of characteristics of the port
* Harmonizing of many functions in the port space

5) Disposition for the Waste Oil

a) Types of the Waste Oil

The types of waste oil appearing during ordinary operations of

ships are mainly bilge, ballast water and tank cleaning water.

b) International Conventions Relating to Marine Pollution

The Oilpol convention's main object is to restrict discharging crude oil and heavy oil into sea. Sri Lanka has ratified this Oilpol convention.

Sri Lanka has not ratified this Marpol convention.

c) Disposal Facilities for Waste Oil

About 3,000 m^2 will be required for the site, including these facilities, based on actual data.

4-9 Socioeconomic Impact

The implementation of the Master Plan will bring socioeconomic impacts on the Southern Province. For example,

-It will provide direct access to overseas markets from the South ern Province: Galle, Matara and Hambantota, thereby contributing to the reorganization and rational allocation of functions at Sri Lanka's ports.

-It will allow the port of Colombo to relieve the present congestion and to accommodate future traffic demand.

-It will reduce unnecessary traffic on the national road A2 (from Colombo to Hambantota via Galle) and the railway of coast line, which otherwise might be paralyzed due to the increasing demand and progress of motorizations as a whole.

-It will enable the exploitation of the benefit of maritime containerization, thereby improving the service quality and cost condition for the shippers/consignees in Galle's hinterland.

-It will boost regional economy as the Port of Galle become a hub port on international shipping routes.

-It will contribute to the development of an Export Processing Zone (EPZ) in Kogalla in the Galle District. As the port area is developed, the number of the factories located in Kogalla, as well as production generally, will increase.

-It will provide a growth core in the Southern Province, and contributing to revitalization of the economy through industrialization. In particular, the cement factory behind the port and the flour mill to be located near the port will be developed in the near future.

-It will have a good effect on agriculture in the Southern Province due to savings in land transportation costs, compared with to and from Colombo.

-Finally, construction and management of the port combined with the development of local industries, will increase employment opportunities, thereby raising income levels in the Southern Province.

Clearly, the development of the Port of Galle will lead to ongoing regional expansion in the Southern Province.

PART III SHORT TERM PLAN AND FEASIBILITY STUDY

1 PLANNING PREMISES

In the preparation of the Short-term Development Plan, we incorporated the urgent plan.

1-1 Cargo volume

Table 1-1-1 shows the total cargo throughput at the Port of Galle.

Table 1-1-1 Total Cargo Throughput at the Port of Galle

			1997
Discharged	Bulk	('000 Tons)	378
	Break Bulk	('000 Tons)	202
	Container	('000 TEUs)	13
Loaded	Break Bulk	('000 Tons)	17
	Container	('000 TEUs)	23
Sub Total	Bulk	('000 Tons)	378
	Break Bulk	('000 Tons)	219
	Container	('000 TEUs)	36
Ttansshipment	Container	('000 TEUs)	190
Total	Conventional	('000 Tons)	597
	Container	('000 TEUs)	226

1-2 Vessel Size and Berth Dimensions

(1) Container Cargo

Size of objective vessel is set as the same as that of 2005.

And 12,000DWT, 500TEU type is adopted as objective feeder vessel size. Accordingly, the required berth dimensions are as follows :

Container berth length = 330 - 350m Depth = - 14m

Feeder berth length = 170m Depth = - 9m

In the case of Short-term Development Plan, 330m is adopted as the length of container berth.

(2) Bulk Cargo

30,000 DWT is adopted as the maximum vessel size and the required berth dimension is as follows :

Berth Length = 240m Depth = - 12m

(3) Others

According to the plan of the Ceylon Petroleum Corporation, the vessel size is set to be 5,000 DWT.

Berth Length = 120m Depth = - 7.5m

2 MAIN FACILITY PLAN

2-1 Berths

2-1-1 Container Berth

The volume of container cargo to be handled at the Port of Galle is expected to be 226,000 TEUs in 1997.

Although more than one berth is required based on the calculated berth occupancy rate, two full-scale berths will provide more than enough capacity.

Therefore, it can be judged that one berth for a mother vessel and one berth for a feeder vessel will be required.

2-1-2 General/Bulk Cargo Berth

We have planned a General/Bulk Cargo Berth that can be used for handling break bulk, wheat, fertilizer and clinker.

Based on the calculated berth occupancy rate, it is judged that one berth is enough.

2-1-3 Oil Berth

One oil products berth is planned for accommodating a 5,000 DWT tanker and bunkering inside the existing breakwater.

2-1-4 Summary

Through the calculations described above, the following facilities are planned:

Berth	Objective Vessel	Length	Depth	Number
Container Berth	50,000 DWT	330	- 14	1
	12,000 DWT	170	- 9	1
General/Bulk Cargo Berth	30,000 DWT	240	- 12	1
Oil Berth	5,000 DWT	120	- 7.5	1

2-2 Storage Facilities/Handling Equipment

2-2-1 Container Berth

(1) Handling System

For the container berth, a lift-on, lift-off system on the quay wall and a transfer crane system will be applied. For a feeder berth, however, loading and unloading containers will be carried out by ship gears. In this case, cargo handling between the apron and the yard will be done by a top lifter and tractor-trailers.

(2) Container Yard

The required number of ground slots under the same conditions taken in 2005 is calculated to be around 2000.

(3) Container Freight Station $2,025m^3$

(4) Cargo Handling Equipment

Container crane	2
Transfer crane	5
Tractor - Trailer	14
Tractor	1
Trailer	10
Top Lifter (40 ton)	2
Folk Lift (2 ton)	2

(5) Others

Administration Office	800 m^2
Maintenance Shop	1000 m^2
Cleaning Facilities	400 m^2

2-2-2 General/Bulk Cargo Berth

(1) Handling System

The volume of fertilizer, clinker and wheat to be handled at this berth is not enough to install some special handling equipment at quay

side. Then, unloading of these bulk cargoes and handling of break bulk cargo will be carried out by ship gears. Fertilizer after bagging and break bulk will be stored at the shed, and wheat will be stored at the silo, while most of the clinker will be directly delivered to the outside the port. Handling cargoes between the apron and the storage facilities will be done by forklifts and trucks.

(2) Scale of Storage Facilities

Shed	4,000m^2
Silo	30,000Ton

(3) Cargo Handling Equipment

Fork Lifts (3 ton)	11 Units
Packer	3 Units
Hopper	3 Units
Trucks	6 Units

2-3 Other Facilities

2-3-1 Breakwater, Channel

As the maximum objective vessel is assumed as in 2005, the same scale of the channel will be planned.

2-3-2 Land Transportation Facilities

(1) Road

Taking the same procedure in 2005, it is planned to have a two-lanes road.

(2) Railway

As it is considered that the railway system will be introduced after 1997, necessary space is reserved in this plan.

2-3-3 Navigational Aids

Light Beacon	4
Light Buoy	12
Light Guide post	1

2-4 Alternative

2-4-1 Formulation of Alternatives

There are only two alternatives on the location for a feeder berths.

Alternative 1. Alternative for Cost Saving

A feeder berth will be constructed using the northern revetment of the container berth as shown in Fig. 2-4-1. There is little wave influence in front of the feeder berth, and it is now around eight metres in depth. And the required length of the Southwest Breakwater and the East Breakwater are 1200m and 250m respectively. Therefore, it would cost less comparing with Alternative 2. However, at the stage of the next expansion, the feeder berth will become useless. In this case, the length of the container berth will be 350m considering some space for handling feeder cargo at the side.

Alternative 2. Alternative for future plan connection.

The second container berth in the master plan will be constructed continuously, north of the first berth as shown in Fig. 2-4-2. In this alternative, one section of the second berth will be constructed as a feeder berth. To secure the required tranquility in front of the feeder berth, it is necessary to invest more in construction of the East breakwater. The lengths to be prolonged is 100m. Further, since the depth of the bed rock becomes shallower in the northern part, the cost of dredging will increase. However, development in the following phase should prove less difficult.

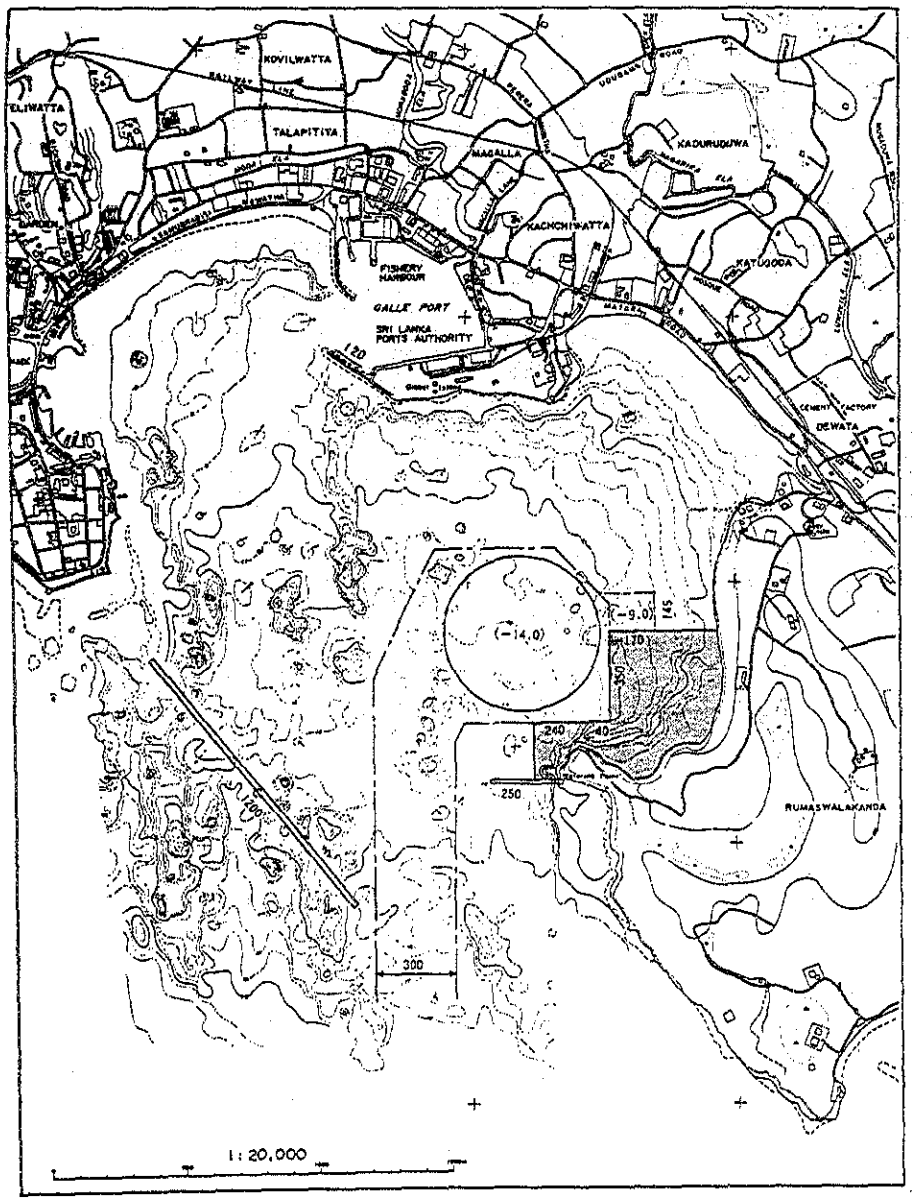


Fig. 2-4-1 Short Term Development Plan (Alternative 1)

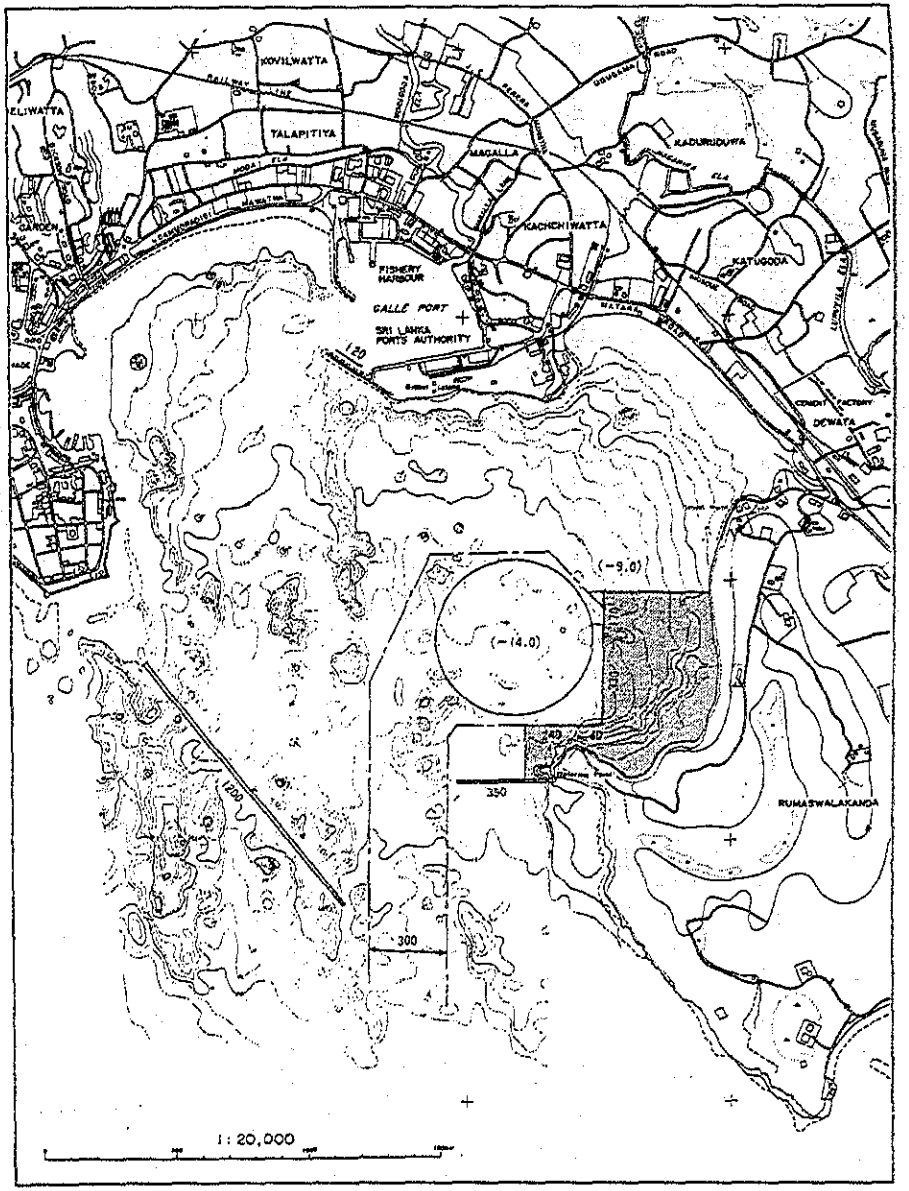


Fig. 2-4-2 Short Term Development Plan (Alternative 2)

2-4-2 Study of calmness

A computer-aided simulation analysis has been undertaken to determine the effect on the calmness of the inner harbor with respect to the two alternative plan layouts.

From these examination, it is judged that there are not so much differences between two alternatives in terms of calmness in front of quay walls.

2-4-3 Evaluation

As mentioned in 2-4-1, each alternative has several merits and demerits. The main merit of Alternative 1 is cheaper cost for the time being and that of Alternative 2 is easy connection to future development.

As the amount of initial cost of the short term plan is great, cost saving is the most important point to be considered for the time being. Therefore, Alternative 1 is recommended to be taken as the short term development plan.

2-4-4 Layout

Layout plan of new terminal is shown in Fig 2-4-3.

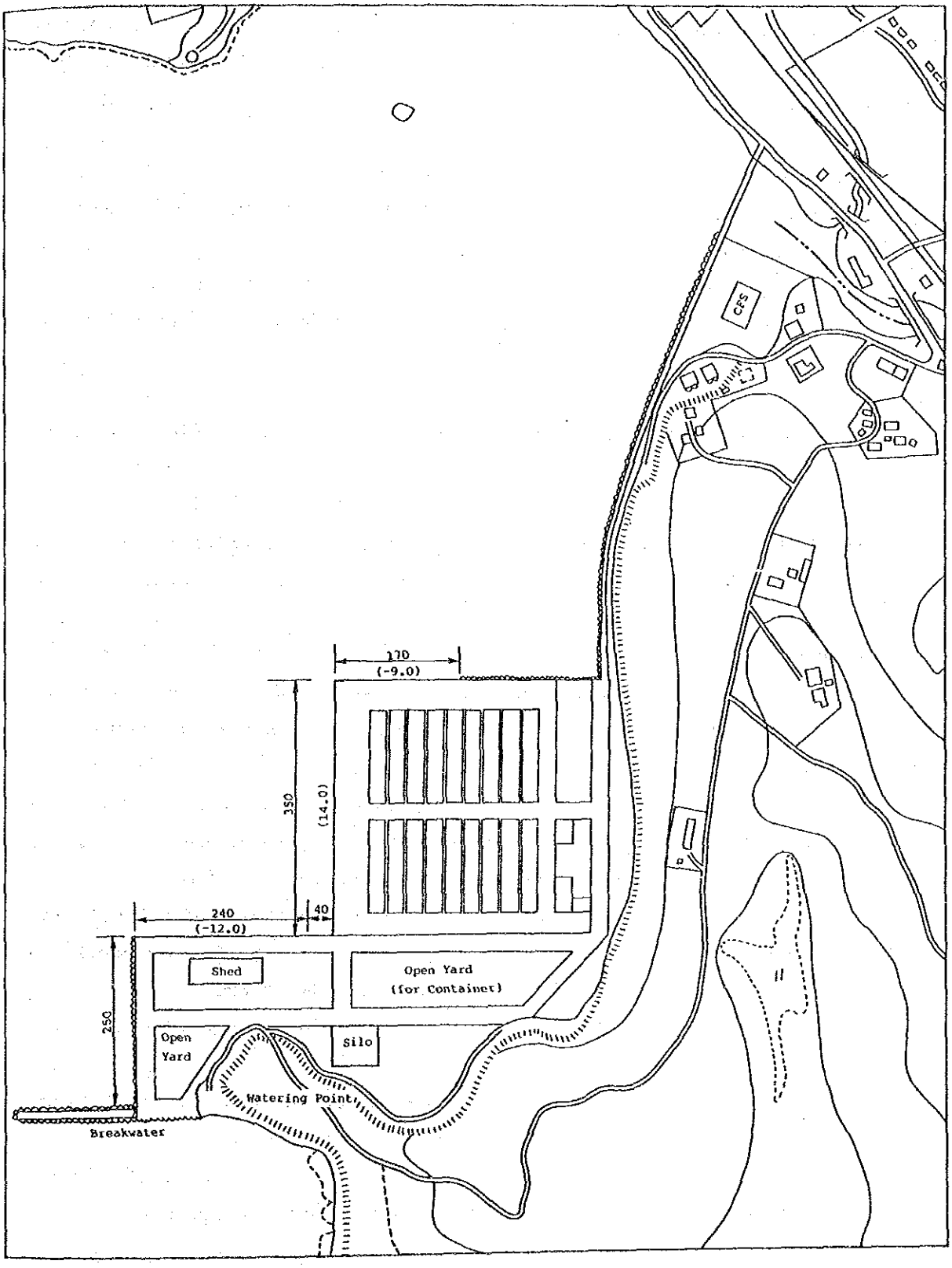


Fig. 2-4-3 Layout of New Terminal

3 PRELIMINARY DESIGN

3-1 Design Criteria

(1) Tide Levels

Mean High Water Level	+ 0.60 m
Mean Sea Level	+ 0.34 m
Mean Low Water Level	+ 0.10 m
Datum Level	± 0.00 m

(2) Waves

The design wave characteristics with a 50-year return period have been defined as follows

Direction	Height (Ho')	Height (H1/3)	Period
W - S	5.5 m	5.1 m	9.5Sec

(3) Geology

The geology of the Port and Bay of Galle and adjacent areas consists primarily of a gneiss formation as the dedrock which is partly overlain by laterite layers.

At the location where the Southwest Breakwater is to be constructed sediments are formed to a limited extent and the substratum is consists primarily of relatively well graded sand and gravel.

At the proposed construction sites of the General Cargo Wharf and East Breakwater, however, the substratum is composed primarily of silty sand and cohesive clay layers (N - Value = 0 - 1) of about 10m thick.

(4) Earthquake

Earthquake are not considered in the design of the Project facilities.

(5) Wind

A wind speed of 40m/sec has been adopted for design purposes.

(6) Design ship Characteristics

1) Container Ship	50,000 DWT	12,000 DWT
2) General/Bulk Cargo Ship	30,000 DWT	
3) Tunker	5,000 DWT	

(7) Crown Height of Quays and Breakwater

For quays with a depth alongside of -7.5 m or more: +8.25 ft (+2.5m)

For breakwater: + 5.0 m

3-2 Preliminary Design

Preliminary designs have been undertaken with respect to the following port facilities proposed under the plan.

Proposed Port Facilities

Facilities	Length (m)	Depth (m)
1) Breakwater		
- Southwest	1,200	Existing Water Depth
- East	250	Alongside
2) Container Berth *	350	-14.0
3) Feeder Berth	170	-9.0
4) General/Bulk Cargo Berth	240	-12.0
		(-14.0)
5) Oil Berth	120	-7.5
6) Transitional part	40	-14.0
7) Revetment on south side	250	Existing Water Depth
8) Revetment on north side	230	Existing Water Depth

Notes:

1. Figure in brackets indicate the design depth alongside the quay
2. The berth marked with Asterisk (*) is to be equipped with a crane

Typical cross section of main port facilities are as shown in Fig. 3-2-1 - 3-2-6.

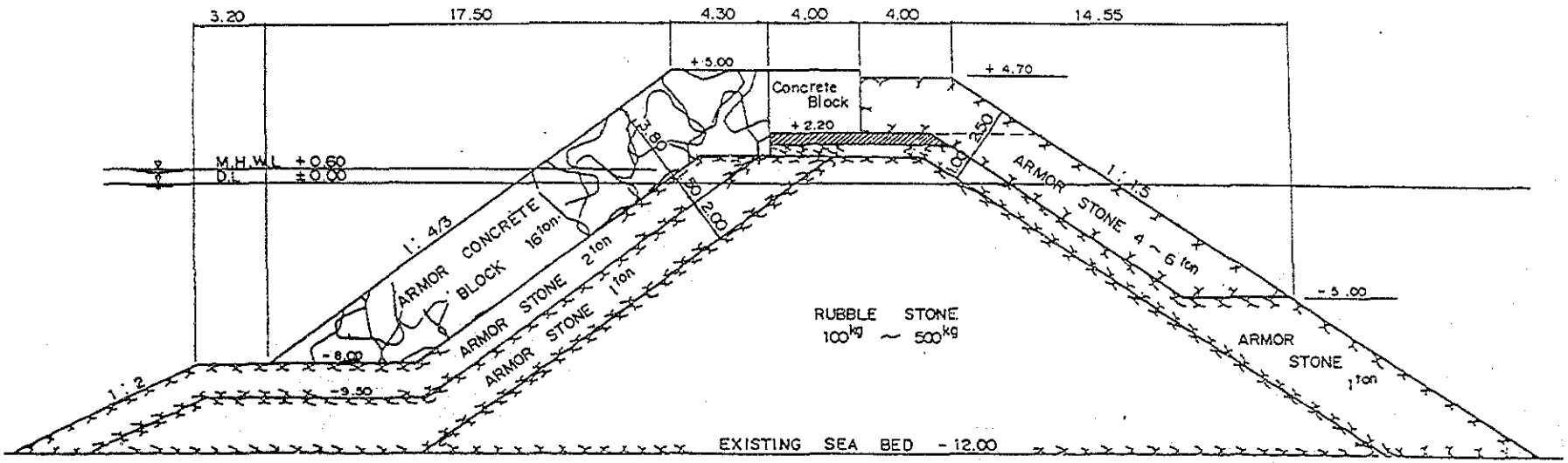


Fig. 3-2-1 Typical Cross Section of Southwest Breakwater

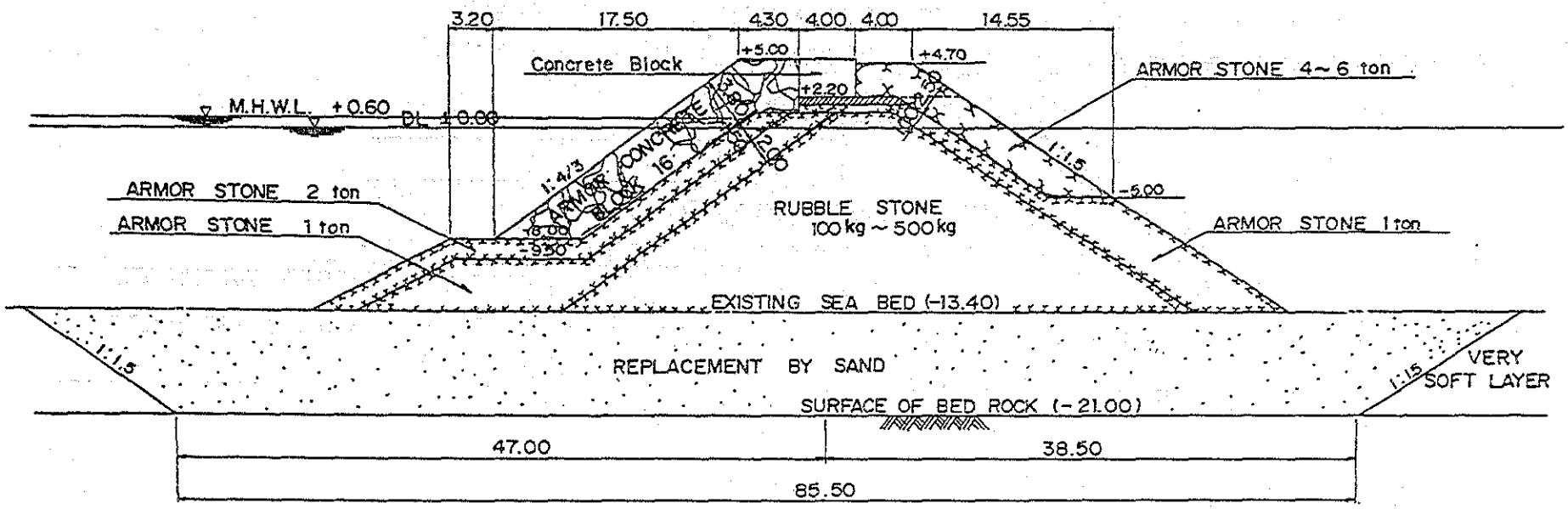


Fig. 3-2-2 Typical Cross Section of East Breakwater

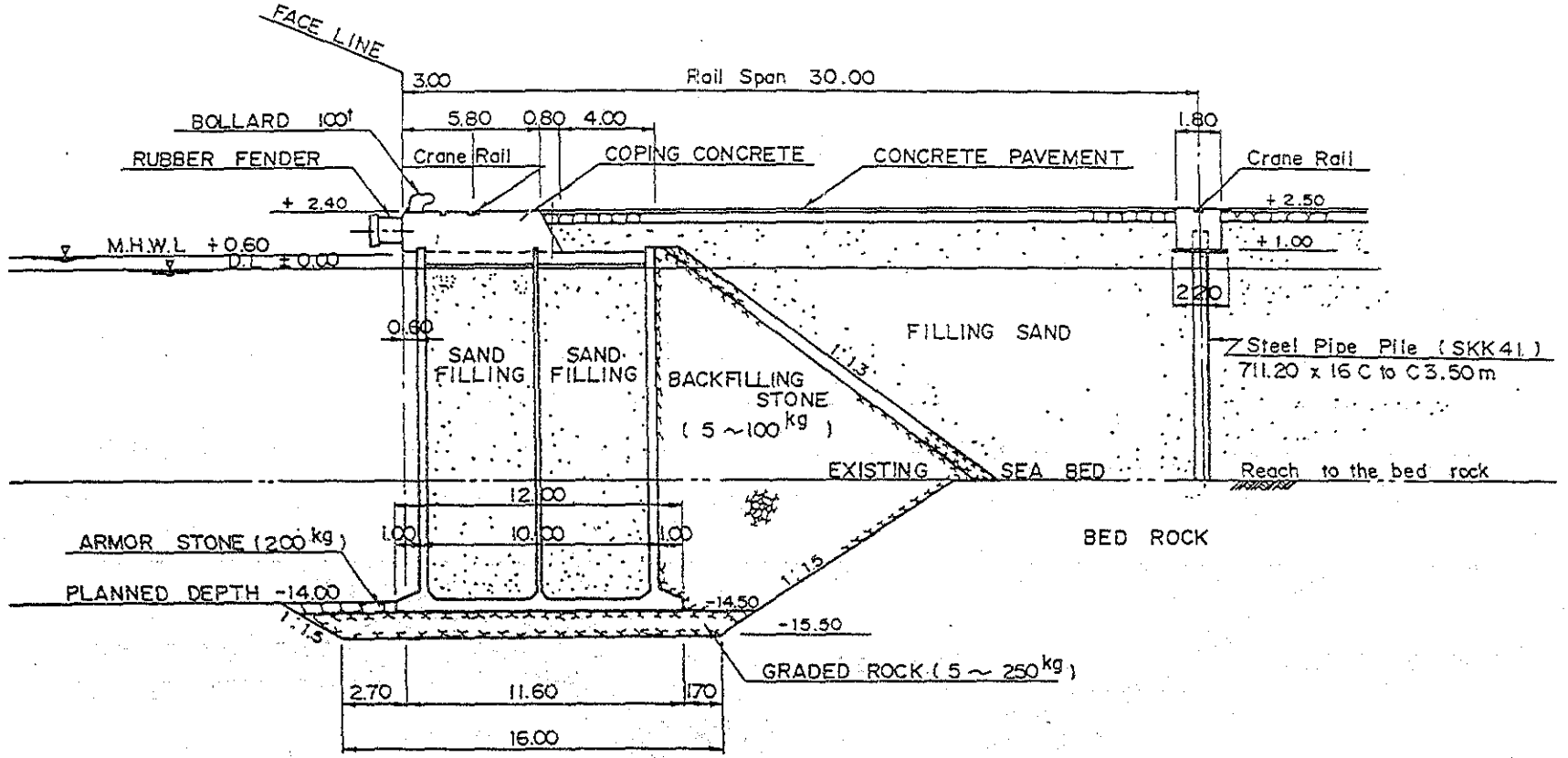


Fig. 3-2-3 Typical Cross Section of Container Berth
(Excavation of Bed Rock)

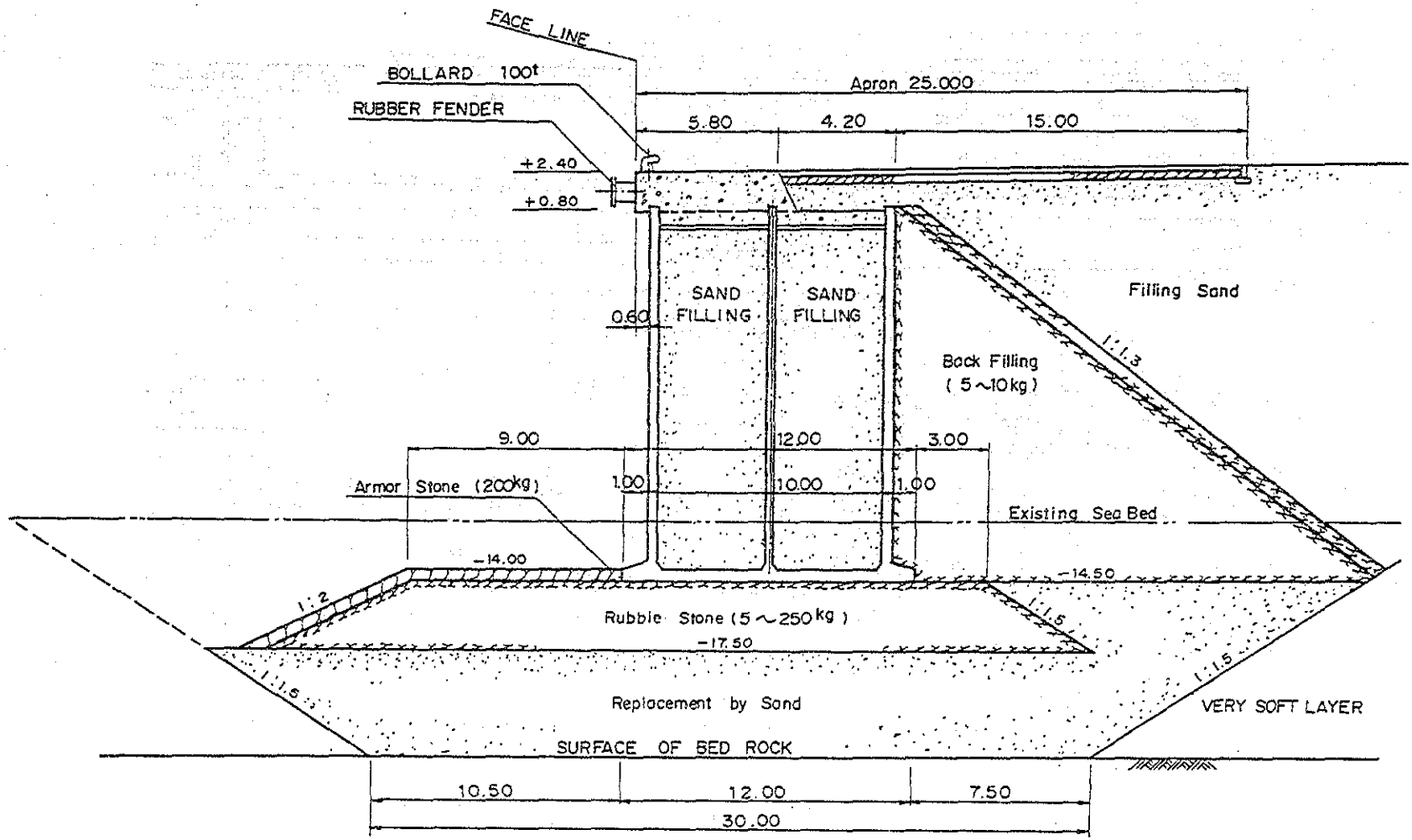


Fig. 3-2-4 Typical Cross Section of General/Bulk Cargo Berth

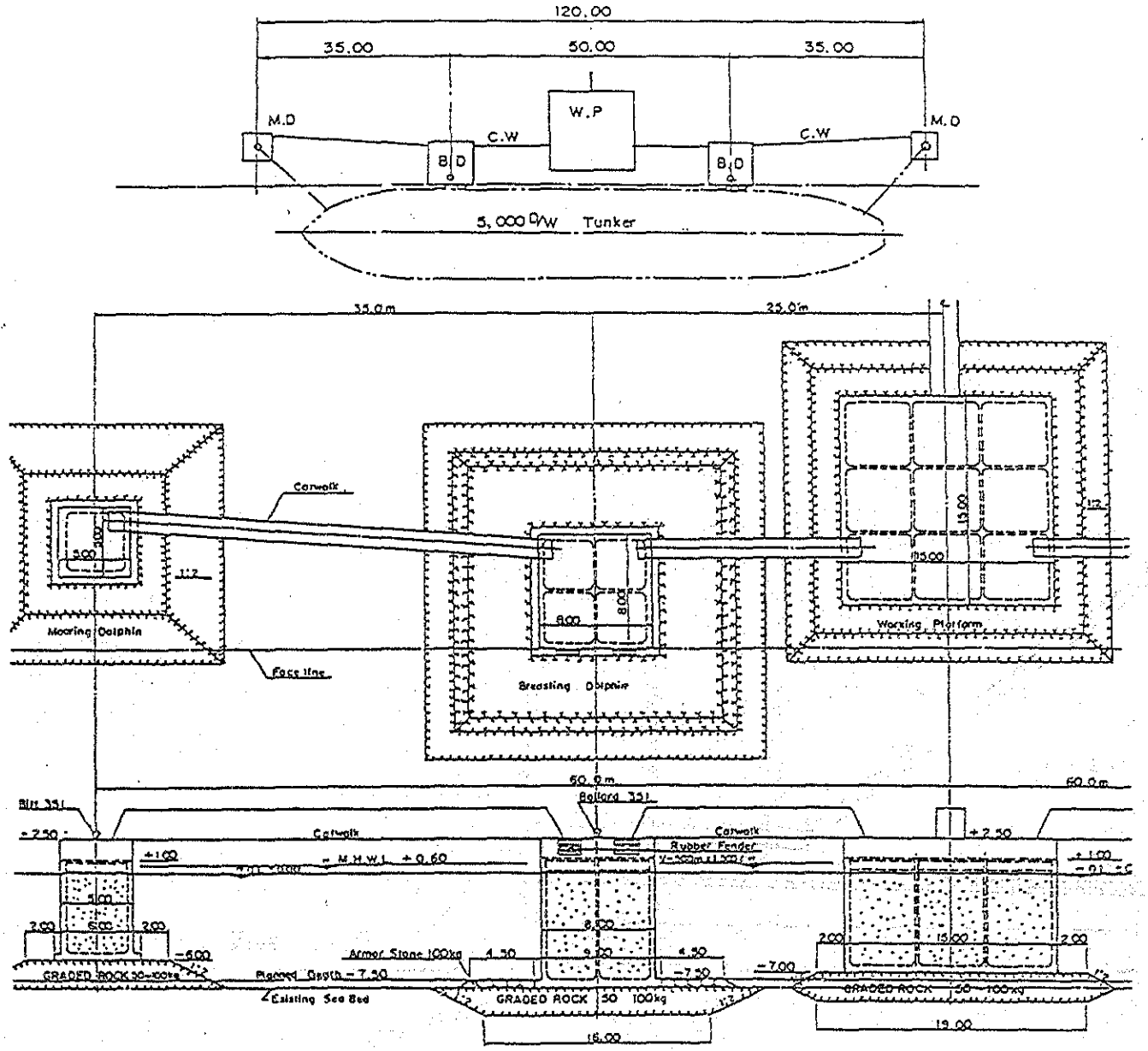
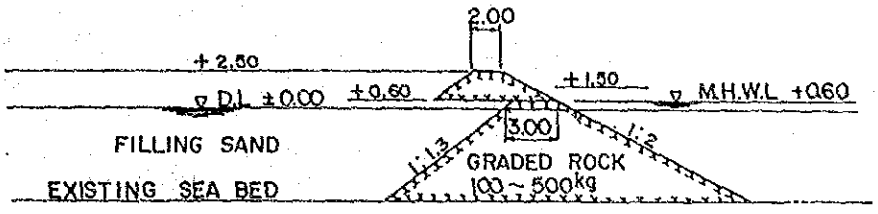


Fig. 3-2-5 Plan and Cross Section of Oil Berth

North Side



South Side

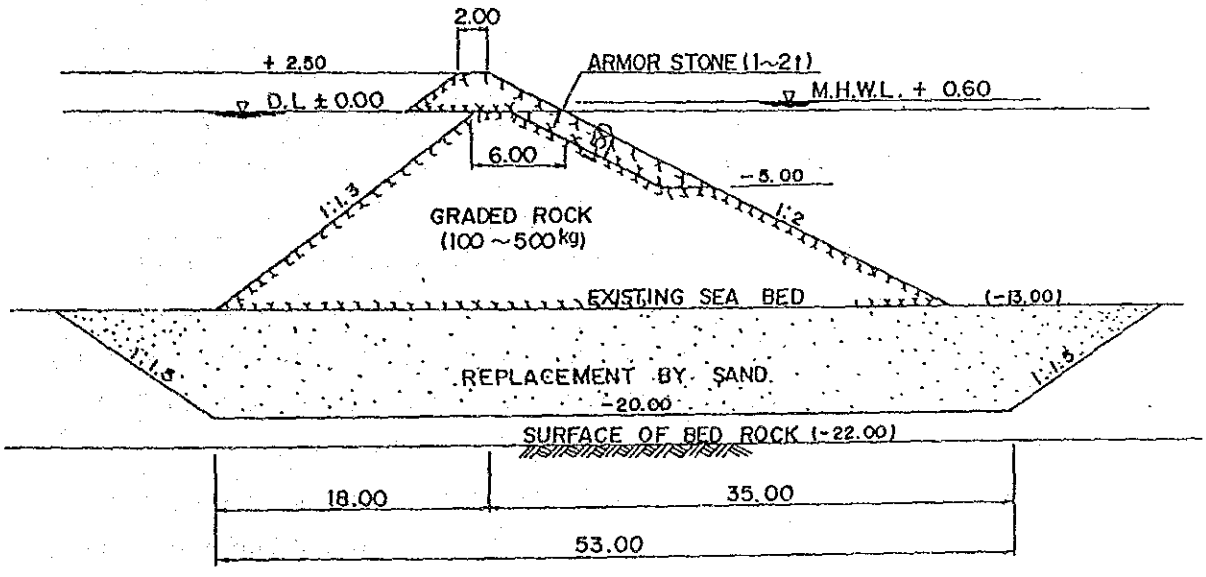


Fig. 3-2-6 Typical Cross Section of Revetment

4 IMPLEMENTATION PROGRAM AND COST ESTIMATION

4-1 Implementation Program

4-1-1 Construction Schedule

Fig. 4-1-1 provides a detailed explanation of the time schedule of construction.

4-1-2 Construction of Breakwater

The following description has relevance to the breakwater construction.

Looking toward the Indian Ocean, Galle Bay is exposed to southerly swells more than 0.5 meter high all the year round. Moreover, wind waves of 1.5 m or more in height reach the bay from S to SW directions during the five southwest monsoon months of May to September.

Wind speeds of 10 m/sec or more and significant wave heights of 0.3 to 0.5 m or more are generally considered critical physical conditions which render harbour works and other marine construction activities impractical. By this standard, the proposed breakwater works in Galle Port will be affected to a greater or lesser degree throughout the year.

The numbers of days available for construction operations as determined on the basis of wave heights in and around the port are as indicated in Table 4-1-1. In this table, the wave heights of less than 1.5 m are considered to permit construction activities to be carried out, though with reduced efficiency, without interruptions.

The available days in the tabulation are for offshore or coastal construction operations. For shore works the number of available days is assumed to be increased by nearly 80 days, which may vary depending on the type of work.

Description	Quantity	
1. Temporary Works	1	Sum
2. Dredging	1,585,000	m3
3. Breakwater	1,450	m
4. Container Berth (-14.0M)	350	〃
5. Feeder Berth (-9.0M)	170	〃
6. General/Bulk Cargo Berth (-12.0M)	280	〃
7. Oil Berth (-7.5M)	120	〃
8. Revetment	480	〃
9. Reclamation	2,530,000	m3
10. Pavement	283,000	m2
11. Navigation Aids	1	Sum
12. Administration Building	800	m2
13. Transit Shed	4,000	〃
14. Maintenance Shop	1,000	〃
15. C.F.S.	2,025	〃
16. Cleaning Facilities	400	〃
17. Utilities	1	Sum
18. Procurement of Equipment	1	〃
19. Procurement of Port Service Vessels	1	〃
21. Engineering Services	1	Sum

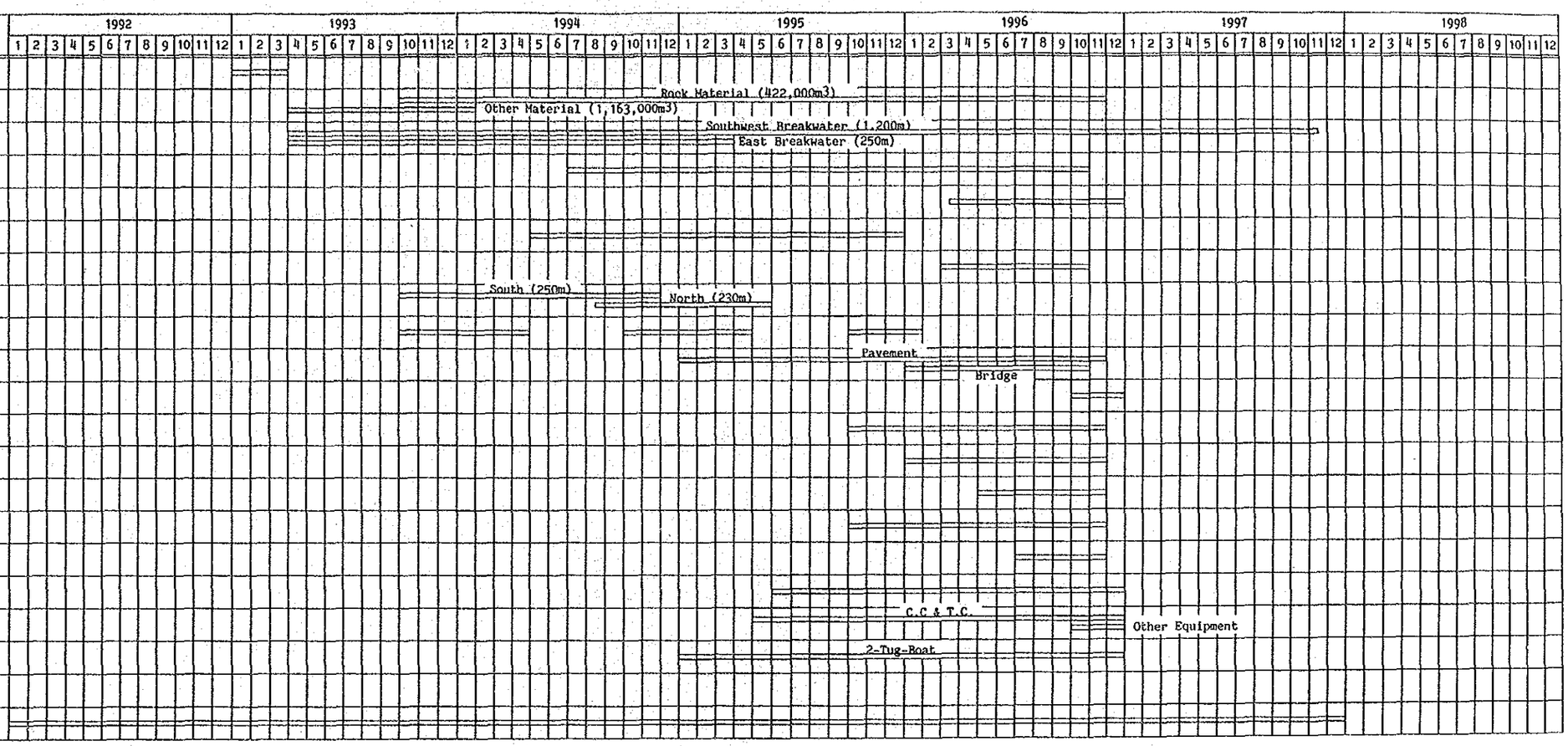


Fig. 4-1-1 Construction Schedule of Short Term Plan

Table 4-1-1 Available Working Days

Season		Wave Height				Available Working Days
		～0.49 m	0.5 m ～ 0.99 m	1.0 m ～ 1.49 m	1.5 m ～	
Month	Total Days	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Total Ⓐ ～ Ⓒ
March - April	61	-	15 days (24.6%)	34 days (55.7%)	12 days (19.7%)	49 days (80.3%)
May - September	153	-	-	4 days (2.6%)	149 days (97.4%)	4 days (2.6%)
October - November	61	-	9 days (14.8%)	27 days (44.3%)	25 days (40.9%)	36 days (59.0%)
December - February	90	-	43 days (47.8%)	45 days (50.0%)	2 days (2.2%)	88 days (97.8%)
Total	365	-	67 days (18.4%)	110 days (30.1%)	188 days (51.5%)	177 days (48.5%)

The major construction materials for the breakwater construction include stones and concrete blocks, all of which will have to be transported from the stock yard onshore for incorporation into the construction works.

Instead of joint operation of plural working crafts, operation of a singles barge is planned to minimize idle time due to high waves. One unit each of floating crane and rock barge will be used for placing concrete blocks and stones.

The Southwest Breakwater construction will experience five monsoon seasons throughout the construction period, while the works on the East Breakwater will undergo two monsoons during the construction. Protection and reinforcement works on the tips of the structures are to be executed before the monsoon seasons come in order to avoid damage.

4-2 Cost Estimation

4-2-1 Conditions of Cost Estimate

(1) The construction cost is broken-down into foreign and local currency portions at the exchange rate of US$ 1.00 = Rs 41.00 = ¥ 138.85 quoted during the Third Filed Survey.

(2) The import duties assessable on materials, equipment and plant to be imported into Sri Lanka are not included in the cost estimates.

(3) The transaction tax (BTT) to be levied on materials and fuels obtainable from local sources is not included in the cost estimates.

(4) The contract tax considered in the cost estimates is as follows:

Construction and procurement cost	3%
Engineering Services	5%

(5) Physical Contingency of 6% is included in the construction cost except for the costs of container handling equipment and engineering services. No price escalation is considered in the cost estimate.

4-2-2 Project Cost

The construction cost for the Short Term Plan is given in Table 4-2-1.

The total construction cost for the Short Term Plan amounts to US$ 334,612,000 broken down into US$ 245,291,000 for the foreign currency component and US$ 89,321,000 for the local currency component.

Table 4-2-2 gives the annual investment plan extending from 1992 to 1997.

Table 4-2-1 Construction Cost of Short Term Plan

Unit : Thousand US$

	Description	Quantity	Unit	Construction Cost			Remarks
				Foreign	Local	Total	
Construction of Civil and Building	Dredging of Rocks	210,000	m^3	10,992	3,699	14,691	Basin
		212,000	〃	11,096	3,734	14,830	Channel
	〃 Other Material	887,000	〃	4,616	416	5,032	Basin
		276,000	〃	1,436	130	1,566	Channel
	Southwest Breakwater	1,200	m	57,710	19,808	77,518	
	East Breakwater	165	〃	11,797	3,379	15,176	
	East Seawall	85	〃	4,683	1,542	6,225	
	Container Berth (-14.0M)	350	〃	17,463	8,428	25,891	
	Feeder Berth (- 9.0M)	170	〃	4,172	2,108	6,280	
	General/Bulk Cargo Berth (-12.0M)	280	〃	12,694	6,917	19,611	Including Transitionnal Part
	Oil Berth (-7.5M)	120	〃	3,135	1,290	4,425	
	Revetment	480	〃	8,800	3,788	12,588	North and South Side
	Reclamation (Yard and Road)	2,530,000	m^3	19,371	2,747	22,118	
	Pavement (Yard and Road)	283,000	m^2	11,794	7,378	19,172	
	Bridge	60	m	1,684	718	2,402	
	Navigation Aids	1	Sum	494	198	692	
	Administration Building	800	m^2	182	738	920	
	Transit Shed	4,000	〃	310	1,734	2,044	
	Maintenance Shop	1,000	〃	112	635	747	
	C.F.S.	2,025	〃	205	819	1,024	
	Cleaning Facilities	400	〃	37	212	249	
	Utilities (Water Supply)	1	Sum	2,350	265	2,615	
	〃 (Electric Supply Computer System)	1	〃	5,485	619	6,104	
	Sub-Total (1)			190,618	71,302	261,920	
Procurement	Container Cargo Handling Equipment	1	Sum	22,514	-	22,514	
	Cargo Handling Equipment for General/Bulk Cargo Berth	1	〃	886	86	972	
	For Oil Berth	1	〃	117	13	130	
	Port Service Vessels (Tugboat)	1	〃	6,482	-	6,482	
	Sub-Total (2)			29,999	99	30,098	
	Total (1) + (2)			220,617	71,401	292,018	
	Engineering Service	1	Sum	13,237	3,570	16,807	Foreign 6% Local 5%
	Physical Contingency	Sub-Total (1) × 6%		11,437	4,278	15,715	
	Tax				10,072	10,072	Construciton & Procurement 3% E/S 5%
	Grand Total			245,291	89,321	334,612	

Table 4-2-2 Annual Investiment Plan (Short Term)

(Unit : 1000 US$)

Description	1992			1993			1994			1995			1996			1997			Total		
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total
I. Civil and Building																					
1. Dredging for Basin				5,022	666	5,688	3,933	1,210	5,143	3,471	1,168	4,639	3,182	1,071	4,253				15,608	4,115	19,723
2. Dredging for Channel				2,169	412	2,581	3,647	1,192	4,839	3,504	1,179	4,683	3,212	1,081	4,293				12,532	3,864	16,396
3. Southwest Breakwater				9,358	3,212	12,570	12,478	4,283	16,761	12,478	4,283	16,761	12,478	4,283	16,761	10,918	3,747	14,665	57,710	19,808	77,518
4. East Breakwater				737	211	948	8,848	2,534	11,382	2,212	634	2,846							11,797	3,379	15,176
5. East Seawall				4,683	1,542	6,225													4,683	1,542	6,225
6. Container Berth (-14.0M)							3,742	1,806	5,548	7,484	3,612	11,096	6,237	3,010	9,247				17,463	8,428	25,891
7. Feeder Berth(-9.0M)													4,172	2,108	6,280				4,172	2,108	6,280
8. General/Bulk Cargo Berth (-12.0M)							5,078	2,767	7,845	7,616	4,150	11,766							12,694	6,917	19,611
9. Oil Berth (-7.5M)													3,135	1,290	4,425				3,135	1,290	4,425
10. Revetment				1,727	673	2,400	6,682	2,775	9,457	391	340	731							8,800	3,788	12,588
11. Reclamation (Yard and Road)				3,229	458	3,687	7,533	1,068	8,601	7,533	1,068	8,601	1,076	153	1,229				19,371	2,747	22,188
12. Pavement (Yard and Road)										6,153	3,849	10,002	5,641	3,529	9,170				11,794	7,378	19,172
13. Bridge													1,684	718	2,402				1,684	718	2,402
14. Navigation Aids													494	198	692				494	198	692
15. Administration Building										39	158	197	143	580	723				182	738	920
16. Transit Shed													310	1,734	2,044				310	1,734	2,044
17. Maintenance Shop													112	635	747				112	635	747
18. C.F.S.										44	176	220	161	643	804				205	819	1,024
19. Cleaning Facilities													37	212	249				37	212	249
20. Utilities (Water Supply)										866	98	964	1,484	167	1,651				2,350	265	2,615
21. Utilities (Electric & Computer)										2,021	228	2,249	3,464	391	3,855				5,485	619	6,104
Sub-Total (1)				26,925	7,174	34,099	51,941	17,635	69,576	53,812	20,943	74,755	47,022	21,803	68,825	10,918	3,747	14,665	190,618	71,302	261,920
II. Procurement of Equipment and Vessels																					
22. Container Cargo Equipment																					
Container Crane & Transfer Crane										7,634		7,634	11,451		11,451				19,085	-	19,085
Other Equipment													3,429		3,429				3,429	-	3,429
23. General/Bulk Cargo Berth													886	86	972				886	86	972
24. For Oil Berth													117	13	130				117	13	130
25. Port Service Vessel										3,241		3,241	3,241		3,241				6,482	-	6,482
Sub-Total (2)										10,875		10,875	18,124	99	19,223				29,999	99	30,098
Sub-Total (1) + (2)				26,925	7,174	34,099	51,941	17,635	69,576	64,687	20,943	85,630	66,146	21,902	88,048	10,918	3,747	14,665	220,619	71,401	292,018
26. Engineering Service	3,310	893	4,203	2,206	595	2,801	2,206	595	2,801	2,206	595	2,801	2,206	595	2,801	1,103	297	1,400	13,237	3,570	16,807
27. Physical Contingency				1,616	430	2,046	3,116	1,058	4,174	3,229	1,257	4,486	2,821	1,308	4,129	655	225	880	11,437	4,278	15,715
28. Tax		210	210		1,224	1,224		2,353	2,353		2,844	2,844		2,905	2,905		536	536		10,072	10,072
Grand Total	3,310	1,103	4,413	30,747	9,423	40,170	57,263	21,641	78,904	70,122	25,639	95,761	71,173	25,710	97,883	12,676	4,805	17,481	245,291	89,321	334,612

5 MANAGEMENT AND OPERATION PROGRAM

5-1 Funds for Constructing the Port

In general, fundamental facilities or infrastructures such as port facilities, transport facilities and so on are often constructed with subsidies from the government, as these facilities are generally used by the public at large. And as the development of an infrastructure generally requires substantial investment and often takes a long time to recover these investments, the government and public organizations have responsibilities regarding the development of an infrastructure.

5-2 Classifications of the Port Management and Operation Model

The following three models offer different solutions to the problems of port construction, management and operation:

- Public Autonomy Model

  In this model, the SLPA constructs, manages and operates the port facilities and activities, much as in the present system.

- Lease Model

  The SLPA constructs the port facilities. The SLPA leases the port facilities to the private company or the joint venture of the government organization and private companies. The lessee manages and operates the port facilities and activities.

  There are three basic types of leases: flat rate, mini-max rate and shared revenue.

- B.O.T. Model

  The private company or the joint venture is responsible for all facets of the project, the construction, management and operation necessary for port activities.

As the mode of model moves from the public autonomy model to the B.O.T. model, a higher ratio of private investment is encountered. Generally speaking, as private investment increases, the economic resources

are used more efficiently, thereby improving the viability of project and the productivity of operations. In the case of the B.O.T. model, the construction costs are also added in the scope of the above judgment.

However, it is difficult to analyze quantitatively the benefits of the improved viability and productivity because the changes in the productivity of cargo handling operations and the changes of the demand forecast of cargo volume are intertwined with the private companies' economic agenda: they are designed to recover their investments, and so the precise measurements cannot be calculated.

We will describe the merits and demerits of each model for this project.

(1) Public Autonomy Model

If the productivity of operations or the cargo forecast are not changed by privatization, this model provides the maximum profit for the SLPA, as the surplus after taxes does not need to be divided among foreign companies.

Furthermore, the SLPA already has its own laborers with the technology to operate and manage the new terminal. So, if the SLPA can obtain foreign loans at a low rate of interest through the government, this model might be suited for managing and operating the new terminal.

(2) Lease Model

The advantages of the lease model are as follows:

1) Securing handling cargo volume and clients for a extended period of time.
2) Gaining the new technology of port operations and the know-how to utilize human resources from foreign companies.
3) Improving the profitability of the project and the productivity of the operation and management through the effects of privatization.

It is critical for the success of the lease model to show how the benefits gained by improving the profitability and the cargo handling efficiency are divided between the lessee and the lessor.

At present, the SLPA already has sufficient technology to operate a container terminal, and is making efforts to operate port activities efficiently. Therefore, the lease model is of little

value besides its capacity for securing clients and handling cargo volume for a extended period of time.

(3) B.O.T. Model

The merit of the B.O.T. model is that it promotes the advantages 1)-3) mentioned in the lease model. Furthermore, when it is difficult to attract investment at a national level, this model is the best choice because the SLPA does not have to raise the funds for construction. Namely, the investment risk does not have to be borne by the SLPA and the government. The construction costs also might decrease through the effects of privatization.

In the case of the Galle Project, because FIRR is very low, it is likely that private companies would experience difficulties in raising funds. Therefore, incentives from the government are necessary, more so than in the case of the public autonomy model.

However, because the B.O.T. model also has an advantage in that the government does not have to raise funds for the construction of a new terminal and can instead direct its funds to other projects, the B.O.T. model is worth inviting proposals from private companies.

5-3 Choice of Port Management and Operation Model

The financial situation of the SLPA is good at present. The SLPA operates and manages all of port activities including those for the container terminal at the Port of Colombo by its own laborers. It also has a training institute which keeps the workers up-to-date with the latest technology.

Therefore, the SLPA is considered to have sufficient human resources and operating technology to manage the port activities of the Port of Galle.

The SLPA can be regarded as the organization best equipped to handle management and operation of the new terminal. We will examine and formulate a port management and operation plan in the next sections.

5-4 Management and Operation Plan

5-4-1 Increment of Tariff

Because the natural conditions in the case of the Galle Project are very severe, the construction costs are extremely high. Therefore, the SLPA needs to receive government subsidies for the construction of the breakwater and for the execution of the channel dredging, and it needs to increase the charges of transshipment container cargoes handled in the Port of Galle by 20% to secure the viability of the project.

5-4-2 Organization

The SLPA should manage and operate new terminals in order to establish an integrated organization with the existing sections of the Port of Galle.

5-4-3 Required Number of the Staff

The number of staff at the Port of Galle is 755 as of 30th Sept. 1990. It is important to make the utmost use of the existing labour force.

But, when the new terminals of the Port of Galle are opened, the number of new staff is about 600.

5-4-4 Operation System

(1) Working Hours and Shifts

As the handling cargoes increase, two twelve hour shifts should be implemented.

(2) Stevedoring Method at the Feeder Berth

The stevedoring at the feeder berth should be performed by the ship gear crane.

5-4-5 Computer System

In order to make use of the computer system in the Port of Colombo

and to manage the container inventory under integrated system, the terminal units should be installed in the Port of Galle and be connected with the main computer in the Port of Colombo. However, because telephone lines are very poor, the terminal units should be connected with the main computer by a radio line. Facilities necessary for radio communication should be built.

5-5 Recommendation of Port Management System

(1) Berth assignment

Because the profitability of the project has improved, the SLPA should consider whether or not to give the priority of berth assignments to partial shipping lines or only to a major shipping line.

(2) Simplicity of Document Procedures

The SLPA should simplify the procedures for ship entry/departure and cargo operations by promoting computerization at the SLPA for the Galle Project.

(3) Port Marketing Activities

The SLPA should carry out intensive port marketing activities to ensure the success of the new port. Without a positive approach, clients may not be attracted to the port.

However, it should be noted that a reputation for prompt, reliable, economical and efficient service as well as publicity is essential for attracting clients. To this end, a quick passage through customs, efficient immigration and quarantine procedures are also vital in attracting potential clients.

(4) Coordination

To operate port activities smoothly, the SLPA should coordinate the various organizations related to port activities such as customs, quarantine and immigration.

(5) Recruitment and Training

The Galle Project requires about 600 new workers, and the

staff of the Colombo Port will need to assist in training the new workers.

(6) Telecommunication and Computer System

The poor telecommunication system between Colombo city and Galle city has a detrimental effect on all aspects of business. Although the telecommunication system is expected to improve in the near future, the SLPA should examine the possibility to permit the companies related port operations to use the radio lines of the SLPA.

6 ECONOMIC ANALYSIS

The purpose of the economic analysis is to appraise the economic feasibility of the Short-term Development Plan for the Port of Galle in the target year (1997) from the viewpoint of the national economy.

Therefore, the purpose of this chapter is to investigate the economic benefits as well as the economic costs that will arise from this project and to evaluate whether the net benefits of the project exceed those that could be obtained from other investment opportunities ("The Opportunity Cost of Capital") in Sri Lanka.

6-1 Methodology of Economic Analysis

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

The flow chart of the economic analysis procedure is shown on Figure 6-1-1.

In estimating costs and benefits of the project, they should be fixed quantitatively as much as possible. Then, "Economic Pricing" is applied. "Economic Pricing" here means the appraisal of costs and benefits in terms of international prices ("Border Prices").

There are several ways of conversion from market price to "Economic Price". In this Study, the benefits and costs are divided into five items: traded goods, non-traded goods, skilled labour, unskilled labour and transfer items. Then, they are revised to "Border Prices" in an effort to determine a more rational valuation (L-M Method or OECD Method). In general, these "Border Prices" are intended to represent the international market value or the world prices. The market prices are changed to "Border Prices" by various conversion factors such as "Standard Conversion Factor", "Conversion Factor for Consumption" and so forth.

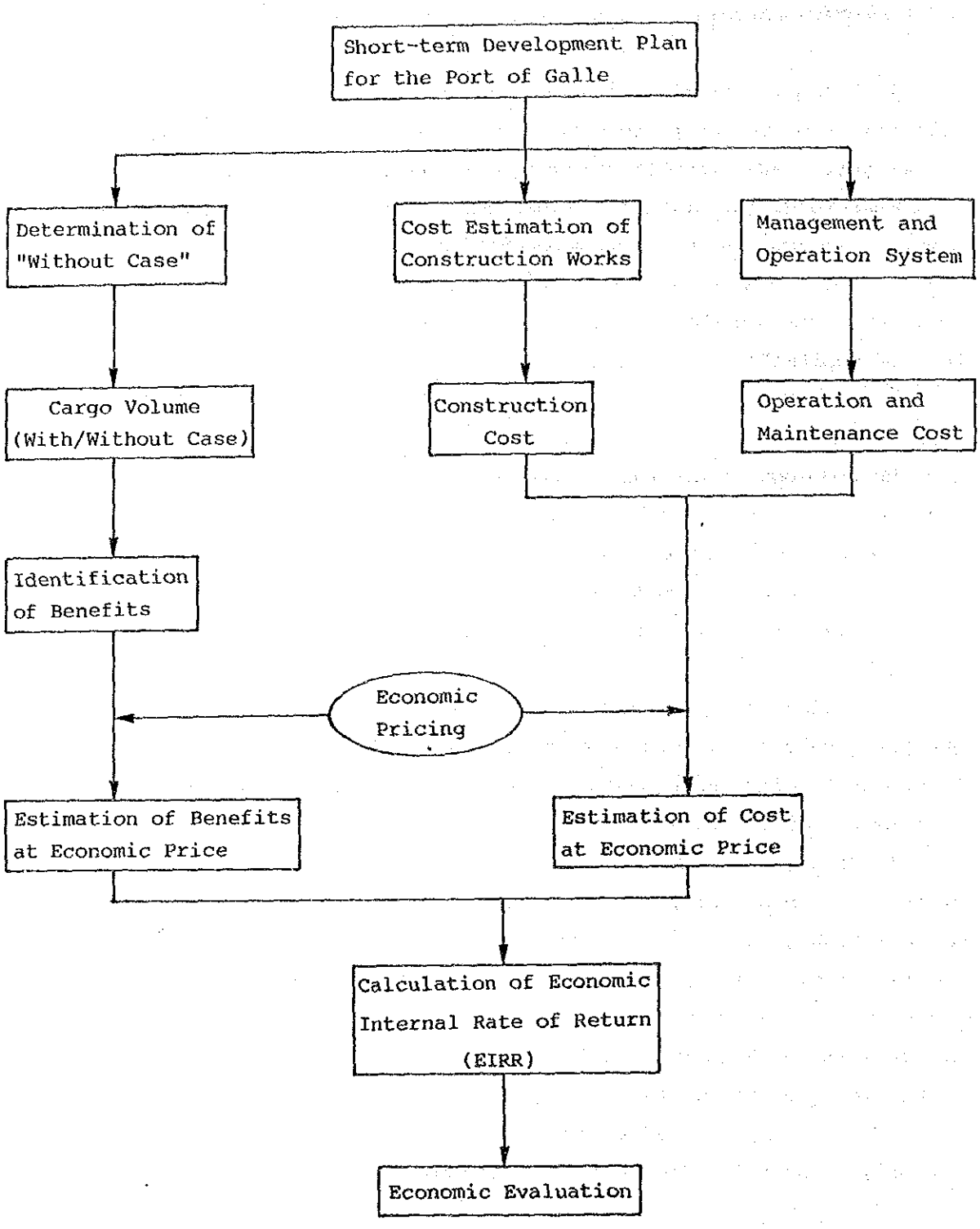


Figure 6-1-1 Flow Chart of Economic Analysis Procedure

6-2 Placing of the "Without" Case

A cost-benefit analysis is conducted on the difference between the "With" case where investment is made and the "Without" case where no investment is made. In arguing the merit of the "Without" case, one must consider the true purpose of the project. Expressed in broad terms the true purpose is the "Regional development of the Southern Province". Secondary aims include "Providing supplementary cargo handling facilities to the Port of Colombo" and "Generation of foreign currency". Then, in this Study, the following conditions are adopted as the "Without" case after various possibilities are discussed:

-No investment is made for the Port of Galle;
-The construction plan for Jaye Container Terminal No.3 & No.4 and rehabilitation of the QEQ Container Terminal of the Port of Colombo is implemented on schedule;
-National development plans, such as Koggala EPZ, etc., are implemented.

6-3 Benefits

Considering the "With" and "Without" situations mentioned earlier, the following items are identified as the benefits of the Short-term Development Plan for the Port of Galle:

1) Savings in land transportation costs;
2) Generation of foreign currency earnings from handling container cargoes;
3) Promotion of regional development in the Southern Province as well as national development in Sri Lanka;
4) Increase in employment opportunities/incomes;
5) Increase in value added for port service and the related industries;

Of the above, items 1) and 2) are considered as benefits suitable for the cost-benefit analysis of this project. Other benefits are also considered qualitatively in this Study.

The unit cost of land transportation is estimated at Rs.244 per ton and the total costs are shown in Table 6-3-1.

Table 6-3-1 Savings in Land Transportation Costs

Year	Cargo Volume (tons)	Benefit ('000 Rs)	Benefit ('000 US$)
1997	485,000	118,340	2,753
1998	574,000	140,056	3,258
↓	↓	↓	↓
2026	574,000	140,056	3,258

Table 6-3-2 shows the benefits of foreign currency earnings from 1997.

Table 6-3-2 Earnings of Foreign Currency in Handling Cargoes

(In thousands)

Year	Transshipment		Exported Flour		Imported Wheat		Total
	Volume (TEUs)	Benefit (US $)	Volume (TEUs)	Benefit (US $)	Volume (Tons)	Benefit (US $)	Benefit (US $)
1997	219	15,330	7	1,085	100	730	17,145
1998	261	18,270	7	1,085	100	730	20,085
↓	↓	↓	↓	↓	↓	↓	↓
2026	261	18,270	7	1,085	100	730	20,085

6-4 Costs

The cost items of the project are: construction costs, personnel costs, maintenance costs, operation/management costs and replacement investment costs. "Residual Value" is also considered as a cost in the

final year of the project.

Construction costs are estimated in Chapter 4 of this part at market prices. In the economic analysis, the costs of the breakwaters, dredging of the navigation channel and so forth, which are provided not only for the Short-term Development Plan but also are included as permanent structures in the long-term development plan, is allocated between the both plan. the costs for the Short-term Development Plan are assumed to be one-fifth of the total cost of the above facilities. Table 6-4-1 shows the construction costs at both market prices and economic prices.

Table 6-4-1 Construction costs at Economic Prices

(Unit: '000 US$)

Description	Market Prices	Economic Prices
Dredging	1,320	1,308
Rock Dredging	5,904	5,764
Breakwaters	19,783	19,263
Container Wharf	32,171	30,837
General Cargo Wharf	19,610	18,752
Oil Berth	4,424	4,256
Revetment	12,587	11,664
Reclamation	22,118	21,668
Pavement	19,171	18,430
Access Bridge	2,402	2,325
Buildings	4,984	4,453
Water/Power Supply	8,719	8,562
Navigation Aids	692	653
Handling Equipment	23,616	23,378
Port Service Vessels	6,482	6,418
Engineering Services	10,587	10,467
Physical Contingency	9,233	8,877
Total	203,805	197,095

Total personnel costs at economic prices are calculated as US$ 825,000 per annum.

Maintenance costs are assumed to be 1% of the total construction cost

excluding the cost of dredging/rock dredging and reclamation at economic prices. Annual maintenance costs at economic prices are US$ 1,650,000.

The operation costs are estimated to be 20% of total personnel costs. Annual operation costs at economic prices are US $165,000.

Economic prices of the replacement investment costs and the residual values (they are minus costs) are calculated by multiplying the respective overall conversion factors.

6-5 Evaluation

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

The EIRR is a discount ratio that makes the costs and benefits of a project during the project life equal. It is calculated by using the following formula:

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

where, n: Period of cost-benefit analysis
B_i: Benefit in i-th year
C_i: Cost in i-th year
r: Discount Rate (EIRR)

The EIRR of the Short-term Development Plan of the Port of Galle is calculated as 8.15%.

There are various views concerning the appropriate EIRR level used to determine whether a project is feasible. The leading view is that the project is feasible if the EIRR exceeds the "Opportunity Cost of Capital" (OCC).

The OCC in Sri Lanka is not known. The value of the OCC adopted by International Bank for Reconstruction and Development (IBRD) is 12%, for the United States Agency for International Development (USAID), 8%, and for the Asian Development Bank (ADB), 10%. Meanwhile, the rate varies from 8% to 12%, according to the degree of development in each country. It is generally considered that an EIRR of more than 10% is economically feasible

for infrastructure or social service projects.

From this premise, alone, the calculated EIRR of 8.15% falls slightly short of the benchmark. However, this analysis takes into consideration only two items of benefits as mentioned in 6-3, and calculated EIRR should not necessarily take priority over the incalculable social benefits, including a possible end to poverty in the Southern Province. At the very minimum, the development of the Port of Galle will expand the economy of the province by creating permanent employment for both skilled and unskilled labour. Income per capita will rise in the province as the port and new industry are developed. As a result, the wealth differential between the province and Colombo will narrow, averting potential social and economic friction. Sri Lanka is a small country but with vast potential, and we strongly believe that the development of the Port of Galle will help distribute more evenly the country's potential.

Consequently, we judge that this project should be implemented as a project leading the regional development in the province, in close cooperation with the development of port-related industries and the progress of other development projects in the province.

7 FINANCIAL ANALYSIS

7-1 Purpose of the Financial Analysis

The purpose of the financial analysis is to examine the viability of the project and the financial soundness of the port management body during the project life. (The project means the short-term development plan for the Port of Galle in this chapter.)

7-2 General Presuppositions of the Financial Analysis

7-2-1 Scope of the Financial Analysis

The viability of the project can be analyzed, using the revenues and costs related to the project (namely, the short-term plan for the Galle Port).

On the other hand, the finances of the entire SLPA as the port management body must be analyzed to estimate of financial soundness. Plans for the Colombo Port are generally based on the Report for the Development Study on the Port of Colombo in 1989 issued by JICA (hereinafter referred to as the Colombo Report).

Matters related to the Galle project are dealt with in the following sections, 7-2-2 to 7-2-7. Matters used to analyze the SLPA financial stability are discussed in section 7-2-8.

7-2-2 Project Life

Taking account of 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 35 years from the beginning of the project including six years of detailed design and construction of the port facilities and 30 years of operation.

7-2-3 Base Year

For the estimate, all costs, expenditures and revenues analyzed quantitatively here are indicated in prices as of 1991, when the price

survey was conducted. Neither price inflation nor increases in nominal wages are considered during the project life.

7-2-4 Cargo Handling Volume

Based on the cargo volume forecast and estimated cargo handling capacity of facilities, the annual cargo handling volume is determined.

7-2-5 Port Charges and Revenues

Port charges will remain almost at existing tariffs, which are shown in Appendix III-7-2 and III-7-3. However all charges for the transshipment container operations have to be increased by 20% when the container terminal opens.

We also determined the level rates of new charges by taking account of the feasibility of the project.

Revenues from port activities are calculated based on the above new tariff, the cargo handling volume and the projected calling vessels.

7-2-6 Fund Raising

(1) Government Funds

Funds necessary for construction of certain port facilities -- particularly breakwaters and channel dredging for public-use port facilities-- are assumed to be covered entirely by government investment in the project.

The government funds are assumed to be free of repayment and interest.

These funds are essential to the feasibility of the project. (If all construction costs are borne by the SLPA, FIRR is 2.06%.)

The rest of the necessary funds are assumed to be raised by soft loans from foreign governments and domestic funds in Sri Lanka.

(2) Soft Loans

We assumed that 85% of all construction costs after subsidies will be raised by soft loans in this financial analysis.

A soft loan for this project is assumed to be as follows:

Loan period: 30 years, including a grace period of 10 years

Interest rate: 3.5% per annum
Repayment: fixed amount repayment of principal

(3) Domestic Funds

The other portion of the construction costs financing for this project is assumed to be raised in Sri Lanka as follows:

Loan period: 10 years, including a grace period of three years
Interest rate: 7.0% per annum
Repayment: fixed amount repayment of principal

Any cash shortage should be covered by short-term loans with an annual interest rate of 15% in local currency.

7-2-7 Expenditure

(1) Investments

The initial construction costs of the project are estimated in Chapter 4 of Part III.

The initial investment calculation must include all taxes payable, the Business Turnover Tax, Import Tax and so on. That initial investments will require US$343 million, including US$126 million in the government subsidies.

The depreciable facilities and equipments will be renewed based on their service lives.

It is assumed that the funds for re-investment will be raised from the reserves of the project accounts.

(2) Maintenance and Repair Costs

Maintenance and repair costs are calculated as 1% of depreciable assets.

(3) Personnel and Administration Costs

The annual personnel costs are estimated based on the required number of workers proposed in Chapter 5 and the existing scale of pay.

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

(4) Depreciation Expenses

The annual depreciation expenses 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 zero. At the end of the project life, fixed assets are assumed to be sold at their residual values.

(5) Taxes

Payable taxes are turnover tax, income tax and deemed dividend tax.

7-2-8 Presuppositions for Colombo Port

The presuppositions mentioned in this paragraph are used to analyze the financial statements only of the Colombo Port, the Trincomalle Port and the existing Galle Port.

The short-term plan mentioned in the Colombo Report is assumed to be delayed by one year.

The presuppositions of the short-term plan for the Colombo Port are similar to those in the Colombo Report of 1989. However, some presuppositions have to be adjusted to the Galle Project.

7-3 Evaluation

7-3-1 Viability of the Project

The FIRR of this project is 4.99%.

At 4.99% the rate exceeds the weighted average interest rate of funds of 4.03% during the project life; for our purposes, the weighted average is also the floor limit.

7-3-2 Financial Soundness of the Port Management Body

(1) Profitability

The rate of return on net fixed assets is less than the average interest rate of funds (6.64%) under the construction of port facilities, but after 1999 the rate of return on net fixed assets

exceeds the average interest rate during the project life (See Figure 7-3-1).

(2) Loan Repayment Capacity

Throughout the project life, the debt service coverage ratios exceed 1.0. There will be no problem with the repayments of the long-term loans using the annual operating revenues (See Figure 7-3-2).

(3) Operational Efficiency

Both the operating ratios and the working ratios maintain positive levels (See Figure 7-3-3, 7-3-4).

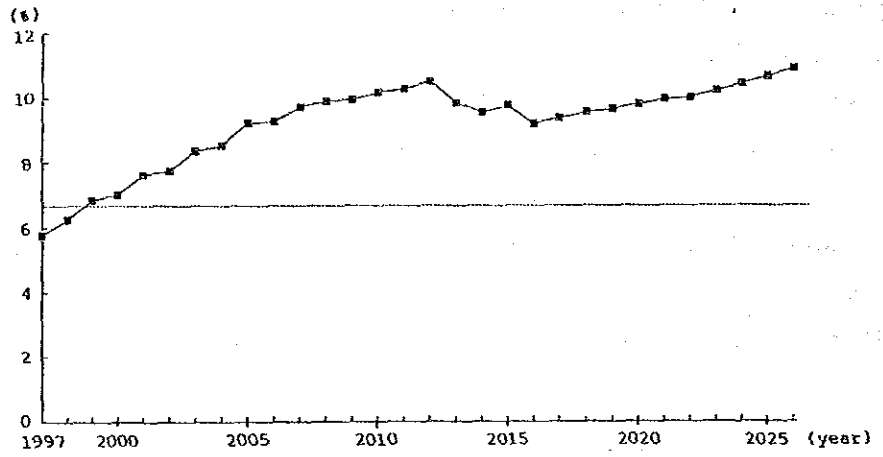


Fig. 7-3-1 Rate of Return on Net Fixed Assets

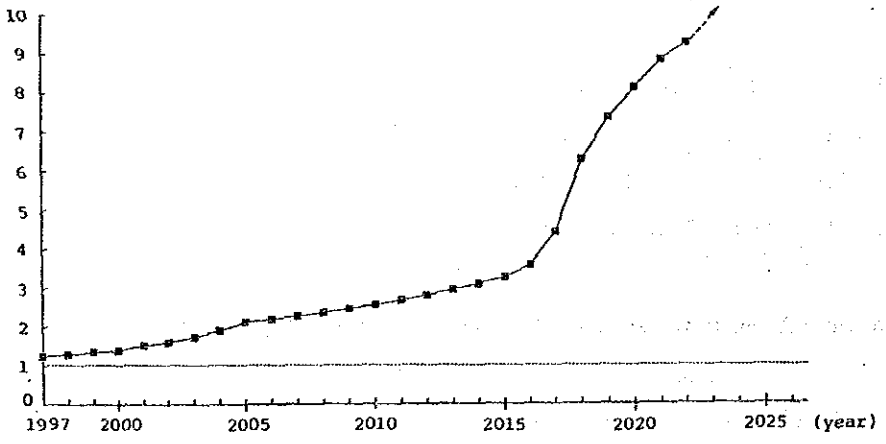


Fig. 7-3-2 Debt Service Coverage Ratio

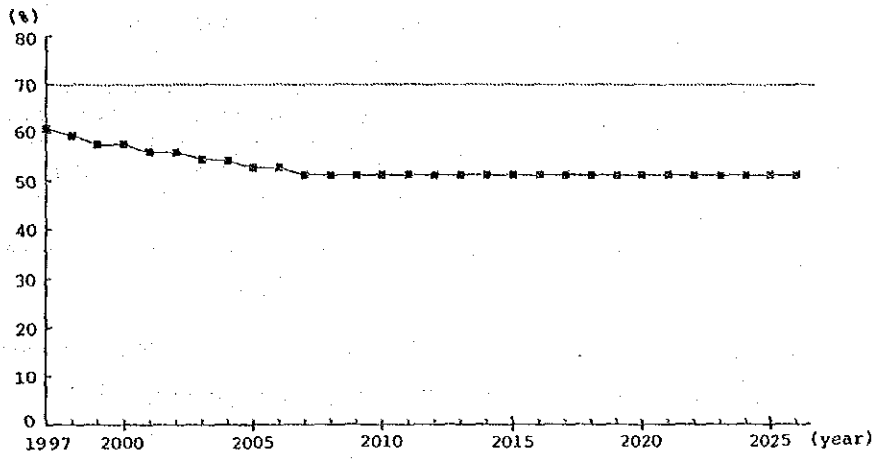


Fig. 7-3-3 Operating Ratio

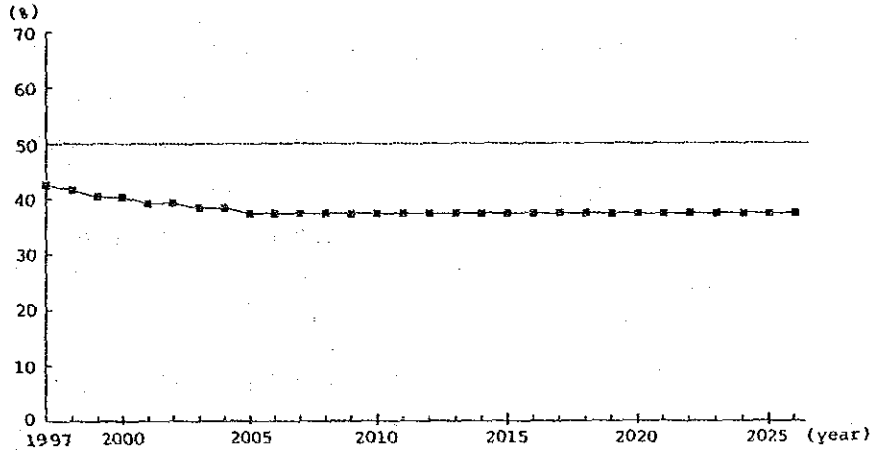


Fig. 7-3-4 Working Ratio

7-4 Sensitivity Analysis

A sensitivity analysis is made for the following three cases:

Case I: The revenues decrease by 10%.
Case II: The construction costs increase by 10%.
Case III: The operating expenses increase by 10%.

The FIRR of each case is as shown in Table 7-4-1.

Table 7-4-1 FIRR in Sensitivity Analysis

	Base Case	Case I	Case II	Case III
FIRR	4.99%	4.09%	4.22%	4.81%
Floor Limit	4.03%			

In each case, the ratio exceeds the weighted average interest rate of funds, which is also the floor limit during the project life.

7-5 Conclusions

Judging from the above analysis, this project can be regarded as financially feasible if the funds necessary for construction of breakwaters and channel dredging is financed through interest-free government funds that require no repayment and if the charges for transshipment container operations in the Port of Galle are increased 20% from the existing tariff.

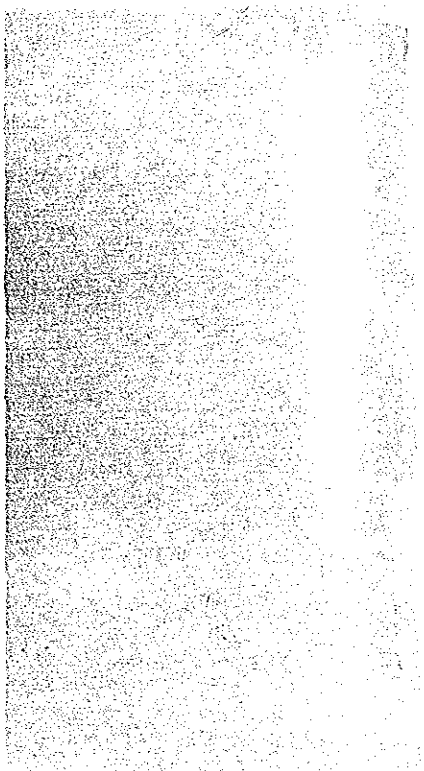
Because the initial construction costs are huge, it will be impossible for the SLPA to invest in the project for itself.

At last, it is recommended that the following measures be taken to improve the financing during the project life.

(1) The re-lending rate on the long-term loans from the government to the SLPA should be kept as low as possible including the development plans of Colombo Port.

(2) The SLPA should maintain its efforts to secure sufficient cargo volume and to improve cargo handling efficiency.

(3) Because the short-term loans with high interest rates are to continue until 2009, the SLPA should attempt to refinance with lower-cost funds, taking account of actual cash flow.



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